INDICE GENERALE / *GENERAL INDEX*

Relazione inaugurale / *Opening Keynote*

Tema / *Topic* 1:

BIODIVERSITÀ E SCIENZA DELLA CONSERVAZIONE: CONTRIBUTO ALLA GESTIONE

BIODIVERSITY AND CONSERVATION SCIENCE: CONTRIBUTING TO MANAGEMENT

Relazioni Introduttive / *Introductory Lectures*

Intervento Programmato / *Invited Presentation*

Comunicazioni / *Oral Presentations*

Poster / *Posters*

Tema / *Topic* 2:

ORGANISMI MARINI ED ECOSISTEMI QUALI SISTEMI MODELLO

MARINE ORGANISMS AND ECOSYSTEMS AS MODEL SYSTEMS

Relazioni Introduttive / *Introductory Lectures*

Intervento Programmato / *Invited Presentation*

Comunicazioni / *Oral presentations*

Poster / *Posters*

Tema / *Topic* 3:

GESTIONE INTEGRATA DELLA ZONA COSTIERA
INTEGRATED COASTAL ZONE MANAGEMENT

Comunicazioni / *Oral Presentations*

Poster / *Posters*

Tema / *Topic* 4:

GLI ELASMOBRANCHI
THE ELASMOBRANCHS

Interventi Programmati / *Invited Presentations*

Comunicazioni / *Oral Presentations*

Poster / ***Posters***

Poster del Comitato Acquacoltura / ***Posters of the Aquaculture Committee***

Poster del Comitato Benthos / *Posters of the Benthos Committee*

Poster del Comitato Gestione e Valorizzazione della Fascia Costiera

Posters of the Management of the Coastal Zone Committee

Poster del Comitato Necton e Pesca

Posters of the Necton and Fishery Committee

Poster del Comitato Plancton / *Posters of the Plankton Committee*

Poster della Sessione Vari / *Posters on Various Topics*

1° WORKSHOP DEL GRUPPO DI LAVORO CETACEI

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WHY EXPERIMENTAL ECOLOGY MATTERS TO CONSERVATION BIOLOGY

PROBLEMATICHE DI ECOLOGIA SPERIMENTALE PER LA CONSERVAZIONE BIOLOGICA

Abstract - *While experimental community ecology is often portrayed as an interesting esoteric field of no practical value, it can play a critical role informing and guiding conservation management decisions and priorities. I argue that experimental community ecology can drive successful marine conservation using two examples from my research: 1) How mechanistically understanding plant zonation in salt marshes provides tools to predict and remediate human impacts on salt marshes and 2) How challenging entrenched dogma about the processes dictating the productivity of salt marshes reveals that we may be blind to some of the most serious conservation threats to salt marshes and other near shore marine communities.*

Key-words: *eutrophication, overfishing, coastal conservation.*

Introduction - Experimental community ecology and conservation biology have had different beginnings, goals and conceptual development. Experimental community ecology developed from an interest to conceptually and mechanistically understand the generation of reoccurring patterns and the dynamics of natural communities (Paine, 1980). Conversely, conservation biology developed independently with the goal of conserving and managing natural and human disturbed populations, communities and ecosystems from further human degradation (Primack, 2008). While these fields developed independently, they can be interdependent, but often are seen as antagonistic rather than complimentary fields.

Here I summarize recent work in Western Atlantic salt marshes that highlights the interdependency of experimental marine ecology and effective marine conservation biology.

Understanding mechanisms of plant zonation - Recent research on mechanisms generating the striking plant zonation of New England salt marshes has shown that the zonation of pristine, nitrogen-limited marshes is dictated by competition for nitrogen (Levine *et al*., 1998). This leads to the competitive dominance of plants with high investment in belowground nutrient harvesting roots and rhizomes. Eutrophication, driven by shoreline development and increased nutrient rich runoff, however, leads to the competitive dominance of plants with high investment in aboveground light harvesting leaves, a dramatic reversal of the competitive hierarchy and zonation of these communities and the loss of most of the native community (Fig. 1; Bertness *et al*., 2001). These findings lead to the simple conservation recommendation of preserving natural woody vegetation buffers around marshes to preserve native marsh communities.

Is human disturbance shifting salt marsh ecosystems from bottom-up nutrient control to top-down consumer control - Salt marsh ecosystems have long been recognized as systems under strong bottom-up control by physical factors. Recent research on Western Atlantic salt marshes, however, has shown that human disturbances, primarily overfishing, are shifting these systems to top-down, consumer-controlled systems, often with catastrophic consequences. Geese herbivory in the

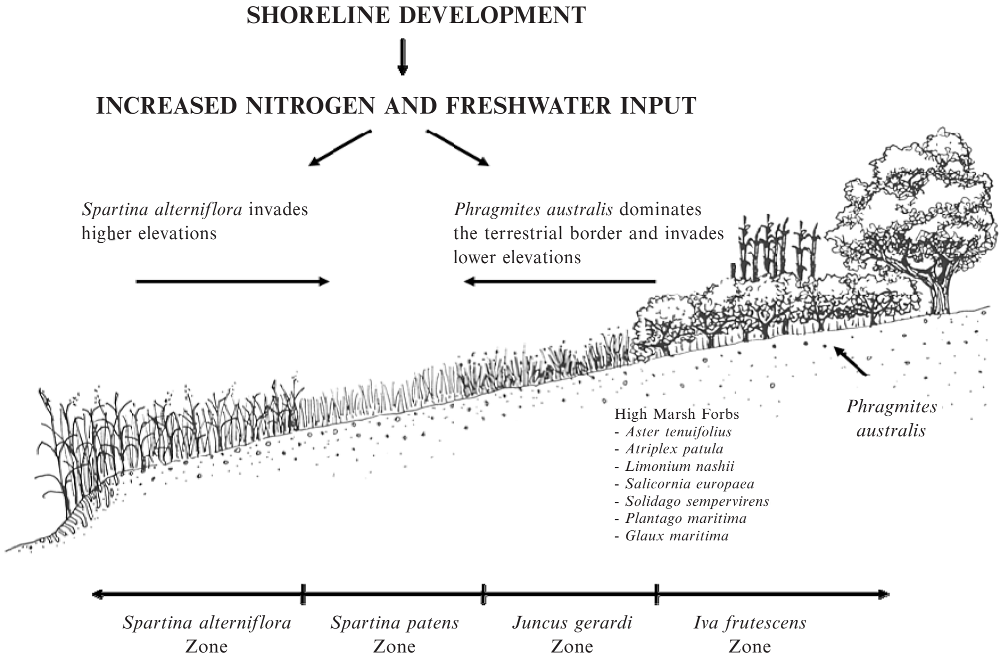

Fig. 1 - Shoreline development consequences on New England salt marsh plant communities (from Bertness *et al*., 2001).

Conseguenze del cambiamento della costa sulle comunità vegetali delle paludi salmastre (from Bertness et al.*, 2001).*

Canadian subarctic (Jefferies 1997), snail grazing on the Gulf of Mexico (Silliman *et al*., 2005), and crab herbivory on Argentinean (Alberti *et al*., 2008) and New England (Holdredge *et al.,* 2009) salt marshes are all leading to significant die-off of salt marshes and loss of the ecosystem services they provide. These results challenge the long-standing paradigm that salt marsh ecosystems are controlled exclusively by bottom up forces and reveal that human disturbances are shifting salt marshes to top down control. Salt marsh conservation and management assumes strong, exclusive bottom-up control, these finding are critical to successful salt marsh conservation and management.

These examples illustrate the necessary interdependence of experimental marine community ecology and successful marine conservation.

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ASSESSING THE STATUS OF SEAS AND OCEANS: DETERMINING THE ROLES OF SCIENCE AND POLICY

VALUTARE LO STATO DI MARI ED OCEANI: DETERMINANDO I RUOLI DELLA SCIENZA E DELLA POLITICA

Abstract - *There are numerous targets related to achieving a particular status for biodiversity, marine ecosystem components, and the marine environment as a whole. The vision adopted at the European and UK level is for "clean, safe, healthy, productive and biologically diverse oceans and seas". The UK government has recently produced its 5 yearly State of Seas report "Charting Progress 2 2010" assessing progress towards that vision. This report is the largest collation and analysis of marine data ever attempted in the UK and provides invaluable information on trends in various ecosystem components. However, providing an assessment of state has produced the challenge of finding agreement on what is meant by clean, safe, healthy, productive and biologically diverse seas. This issue involves a complex interplay of scientific, political/societal considerations and any agreement will be crucial in informing future targets such as achieving "Good Environmental Status" by 2020, which is the central aim of the European Marine Strategy Framework Directive.*

Key-words: *marine assessment, Marine Strategy Framework Directive, baselines, Charting Progress, assessment, conservation.*

Setting goals for the marine environment - A number of targets and strategic objectives exist relating to marine conservation at the international, European and UK level. Examples include a series of agreements aimed at halting or reducing the rate of biodiversity loss by 2010 (CBD, 2005; EC, 2001, 2004, 2006) and the Ecological Quality Objectives set out by Ospar (1998) as part of the ecosystem approach. Legally enforceable targets include achieving "Favourable Conservation Status" under the Habitats Directive (EC, 1992); "Good Ecological Status" and "Good Chemical Status" under the Water Framework Directive (EC, 2000) and "*Good Environmental Status*" (GES) by 2020 under the Marine Strategy Framework Directive (MSFD) (EC, 2008). All of these targets contribute to an overall vision, which in the United Kingdom (UK) is articulated in the aim of having "*clean, healthy, safe, productive and biologically diverse oceans and seas*" (Defra, 2002) and in Europe through the European Marine Strategy Framework Directive, which has "*the ultimate aim of maintaining biodiversity and providing diverse and dynamic oceans and seas which are clean, healthy and productive*".

The conceptual and philosophical underpinning of these biodiversity and ecological quality targets is that scientists and policy makers accept that actions that contribute to an overall loss of biodiversity are "bad" (Noss, 2007) and that the exploitation of our seas should be undertaken in a sustainable way that does not compromise their ability to provide resources and maintain their function in the future. As regards the overall vision, the challenge for the marine environment is to define exactly what the status should be i.e. what does it mean to have "*clean, healthy, safe, productive and biologically diverse oceans and seas*"? Deciding this will then form the basis for developing definitions and indicators for the descriptors of Good Environmental Status (GES).

In order to provide an assessment of progress towards the vision, the UK government produced a report, Charting Progress: State of UK Seas (Defra, 2005) measuring how different aspects of the marine environment compared with the vision. Charting Progress 2 (CP2) 2010 provides an update on the first assessment and also forms the basis for the initial UK assessment of current environmental status required under the MSFD by 2012. The report has highlighted the challenge of defining the desired “status” of UK seas and in agreeing baselines for the marine environment that are crucial in informing discussions on GES.

Measuring progress towards the vision in UK seas - The CP2 report is made up of four separate feeder reports each reporting on different aspects of the vision: an ‘Ocean Processes report’ containing information on the physical and oceanographic conditions in UK seas; a ‘Productive Seas report’ with an analysis of economic productivity; a ‘Clean and Safe Seas report’ with an assessment of contaminants and other pollutants; and a ‘Healthy and Biologically Diverse Seas report’ with an assessment of the state of the marine environment in terms of its habitats and species. A large number of marine scientists were involved in CP2: the Healthy and Biologically Diverse Seas Evidence Group report alone has contributions from over 150 scientists (including 99 primary authors) representing 40 institutions and encompassing information from the academic and research communities as well as experts in government agencies and Non-Governmental Organisations. CP2 therefore provides the largest and most comprehensive assessment ever taken of the health of marine ecosystems in UK waters.

It is the Healthy and Biologically Diverse Seas report that provides the focus here. This report examines the status of habitats (Intertidal Rock; Intertidal Sediments; Subtidal Rock; Shallow Subtidal Sediments; Shelf Subtidal Sediments, and Deep-Sea Habitats); microbes; plankton; fish (marine and estuarine); seals (grey and harbour); turtles; cetaceans and marine birds (seabirds and waterbirds). Information from surveys, monitoring programmes and long-term time series is used where available to assess the various components whilst information on pressures is provided by the ‘Clean and Safe Seas’ and ‘Productive Seas’ reports. Data are analysed to provide information on changes in habitats and species since the last report in 2005 as well as changes from “natural conditions”. Where it is possible and appropriate, results are reported at a regional level using eight regions around the UK (Frost, 2010).

Assessing trends in UK habitats and species - For some components such as microbes and turtles there is too little information available to make any assessment of trend either in the component under investigation or the pressures acting upon it. For some components such as cetaceans and estuarine fish the conclusions are based on fairly limited data so are necessarily tentative. Overall, the picture is mixed with concerns over trends in shallow subtidal and shelf subtidal sedimentary habitats; improvements in many fish communities; continuing changes in plankton communities linked with increasing sea temperatures; declines in numbers of harbor seals and seabirds but increases in the number of waterbirds (for detailed results see UKMMAS 2010). It is important to note that the assessment of habitats depended largely on analysing trends in the distribution and intensity of pressures. Surveyed and modelled habitat maps were then used to assess the impact of the pressures on the habitats with expert judgement being used where data were incomplete or unavailable.

Assessing the state of UK habitats and species – what do we mean by the vision? - Whether the focus is on data from survey and monitoring programmes or on pressures information, an assessment based on trends can be made for many of the marine components. However, the picture becomes more complicated when trying to make an assessment of state i.e. how near or far is the component under investigation from the status articulated by the 'vision' of "*clean, healthy, safe, productive and biologically diverse oceans and seas"*. As there is no agreement on what the status should be overall or for individual species and habitats, different criteria are used to establish baselines against which current status is compared along with an analysis of whether the component under investigation is moving towards or away from this baseline. For example, when assessing species it is often assumed that high population abundances are a good thing and that declines in abundance are not. This is especially true for larger charismatic species of conservation interest such as seals, seabirds and waterbirds and cetaceans.) At the community level it is generally held that high biodiversity is desirable (e.g. fish) with a move towards lower biodiversity constituting a negative trend. For other groups such as plankton, the focus is on the pressures so that changes in abundance or diversity are not considered to be particularly problematic as long as the change is largely "natural change" i.e. not driven by anthropogenic pressures. For habitats, it is assumed that a trend towards more intense and widespread pressures is bad when these pressures overlap with the habitats under investigation.

As well as a variety in the criteria used to assess whether trends are seen as positive or negative, there is also the issue that the baselines used to assess state are usually very much dependent on when monitoring and long-term time series information becomes available. For the species analysis in CP2, trends are measured from the 1940s (plankton), 1960s (grey seals), 1980s (harbour seals), 1986 (seabirds), 1975/76 (waterbirds), 1980s (fish) and 1994 (cetaceans). For habitats there are no monitoring datasets similar to those collected for the species groups, which means the assessment of status cannot be compared against a particular decade: baseline conditions are defined therefore as "a concept of former unimpacted conditions". The benefits of the species analysis is that at least real long term trends can be shown, based on actual evidence, despite the fact that the lack of an agreed reference point (baseline) means changes can't be compared in a consistent way across the groups (how close or far is the status from a specified target value).

The important point to make is that the issue of choosing a "baseline" or reference point to represent the vision goes beyond what scientists can deduce purely by analyzing data and trends and also becomes linked to what is acceptable to policy-makers, stakeholders and the wider public. An example is to consider the assumption already stated that large (and preferably stable or increasing) species populations are a good thing. Grey seal (*Halichoerus grypus)* population numbers are at historically high levels in the UK and recent evidence suggests a "leveling off", probably due to density dependent factors. However, the high numbers of grey seals in the UK, as elsewhere in the world, is actually seen as a problem by groups such as fishermen who see them as competitors for resources, although this argument is often based on a misunderstanding of the wider role of marine predators (Pinnegar *et al*., 2010). At least the high numbers of grey seals can be attributed to positive developments such as being protected from human persecution (Duck, 2010) which is not the case for all populations. For example, despite declines in seabird numbers in many UK regions, there has been a large increase in the number of Fulmars *(Fulmarus glacialis)*. However, this is thought to be almost entirely due to the fact that Fulmars feed on discards from fishing boats so that numbers are elevated beyond levels that naturally occurring food sources can sustain (Mitchell, 2010). There are many other cases in the marine environment where populations of species thrive due to anthropogenic inputs and our response is often linked to what value we (society) assign to a species.

The main issue determining the outcome of an assessment of state is what point is selected as a baseline/reference condition against which to make the judgment. A baseline can be selected along a continuum from completely natural and unimpacted conditions to conditions occurring as a result of high levels of impact or exploitation. Mee *et al* (2008) point out the value-laden nature of making this type of decision as different levels of impact are acceptable to different parties with differing values and expectations. For example, "former natural unimpacted conditions" is used as a reference point for assessing habitats in CP2 and this type of reference point is implicit, if not explicit in many nature conservation approaches. The main difficulty with this approach is that there is very little information on what "unimpacted, natural, historical conditions" actually look like (Crowder, 2005). There is also the issue of whether it is possible or desirable to have a completely un-impacted state as a baseline, as in addition to a lack of information, there is also the more practical issue of whether it would be possible to go back to those conditions or anything remotely similar. The commercial fish assessment takes a completely different approach by accepting high levels of exploitation (impact) as long as this is 'sustainable'. This means that any baseline is far from 'unimpacted' and also that this baseline is always changing. The issue for commercial fish stocks is, therefore, that of 'shifting baselines' as identified by Pauly (1995). For the non-commercial fish communities in CP2 (i.e. all fish sampled in international beam trawl surveys) there was much discussion between scientists, policy advisors and other stakeholders over where along this continuum the baseline should be with the result that two analyses are presented, one using historical relatively unimpacted conditions and one using a more recent period (1980s). This has the advantage of showing how the use of different baselines leads to different value judgments on the present condition of aspects of the marine environment (marine fish communities in this case) but this approach is not possible for many other groups and species where historical data is not available.

Conclusions - To summarise, there is a major challenge in defining what is meant by the vision of healthy and biologically diverse seas and CP2 has made an important contribution to that discussion that will inform the decisions being made on determining GES. Mee (2008) had already anticipated the difficulties that would arise in defining GES due to the value judgements that would have to be made reflecting policy and societal expectations. It is important that we understand this interplay between science and policy so we do not end up with politically driven targets (i.e. that are low so we can easily achieve them or based on short-term thinking leading to an unsustainable use of the environment) or unrealistic conservation related targets that don't take account of the ongoing and necessary interaction of humans with the marine environment. The roles of scientists, policy makers and the wider public are therefore crucial in coming to an agreement on the state of our marine environment. Scientists have a key role to play in collecting and analysing long-term data sets, which are crucial for understanding the state of the marine environment and how things change over time in response to natural and anthropogenic drivers. They can also provide information on the amount of pressure that species or habitats can be subjected to before functional integrity is compromised. A wider discussion of the values underlying the aims and targets is also necessary and what is "acceptable" as regards the state of seas will ultimately be a societal / political decision.

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LARGE SCALE PATTERNS OF MARINE BIODIVERSITY: AN EVIDENCE-BASED APPROACH FOR PRIORITISING AREAS FOR PROTECTION

MODELLI SU GRANDE SCALA SPAZIALE DELLA BIODIVERSITÀ MARINA: UN APPROCCIO BASATO SULLE EVIDENZE PER DETERMINARE LA PRIORITÀ DELLE AREE DA SOTTOPORRE A PROTEZIONE

Abstract *- Areas of high biodiversity may be more resilient to change and protecting these sites can help maintain the structure and functioning of the ecosystem. Additionally, identifying areas with high diversity may also improve the efficiency of an MPA network by capturing greater numbers of species and habitats of conservation importance within individual sites. We present a critical review of approaches to identify large scale patterns in marine biodiversity and discuss how these can be used to inform the selection of MPAs with reference to new national designations in UK waters.*

Key-words: *marine protected areas, biodiversity, conservation, large scale patterns.*

Introduction - MPAs are a valuable tool to protect rare and threatened species and communities and the integrity and functioning of habitats. The UK is committed to the establishment of a network of marine protected areas (MPAs) to conserve marine ecosystems and biodiversity under international conventions (OSPAR convention, World Summit on Sustainable Development, Convention on Biological Diversity) and in achieving the objectives of European Directives (Marine Strategy Framework Directive, Habitats Directive, Birds Directive). MPAs are also a mechanism for implementing the Ecosystem Approach to management, central to which is the integrity of marine systems to ensure the sustained delivery of ecosystem goods and services that benefit human society.

It is fundamental that the best available information is available to those responsible for selecting sites and the ability to identify areas of ecological importance is a key element, alongside the MPA design principles. Areas of high biodiversity may be more resilient to change (Loreau *et al.,* 2001) and species invasions (Stachowicz *et al.,* 1999), and protecting these sites can help maintain the structure and functioning of the ecosystem. Additionally, identifying areas with high diversity may also improve the efficiency of an MPA network by capturing greater numbers of species and habitats of conservation importance within individual sites. Here we present a critical review of approaches to identify large scale patterns in marine biodiversity and discuss how these can be used to inform the selection of MPAs.

Measures of biodiversity - Arguably the most widely accepted definition of biodiversity is "the variability among living organisms from all sources, including, *inter alia* terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems" (defined by the Convention on Biological Diversity). From a practical point-of-view, protection is often reduced to species and habitats, since these provide measurable units for analyses and are most frequently recorded.

Large scale patterns in biodiversity have been quantified using different multispecies surrogates including: 1) priority species (on the assumption that protecting rare/declining/threatened species provides an effective umbrella for overall species richness in an area, but this does not always hold (Bonn *et al.,* 2002)); 2) structural or 'ecosystem engineer' species (Jones *et al.,* 1997); 3) specific groups e.g. molluscs, polychaetes, mammals and sharks that are taxonomically stable and evenly recorded (but are not necessarily indicators of total biodiversity (Smith, 2008)); 4) death assemblages – remains of shell bearing molluscs (Warwick and Light, 2002). All these surrogates have limitations, few have been correlated to overall biodiversity and some approaches are not appropriate for marine assessments such as endemic species (not applicable due to the higher connectivity and lower endemism in marine systems compared with terrestrial).

There are an array of different measures to quantify species diversity (e.g. diversity indices, number of species, number of priority species and taxonomic distinctness) and many of these can also be applied to identify large-scale patterns at the scale of habitats. Each yields a different representation of diversity, and there is often a lack of congruence between measures (Orme *et al.*, 2005). This has led to the combination of a range of measures being used to capture patterns in biodiversity (e.g. Myers *et al.*, 2000, Hiscock & Breckels, 2007).

Each individual measure has its own limitations in terms of data requirements, sensitivity to variability inherent in the data (such as uneven sampling effort), ways of assigning confidence and the application of output in terms of the suitability to represent overall biodiversity over large scales. Species and habitat richness are the most commonly used measures of diversity and do not require abundance data, which can add a significant bias when handling data from multiple sources. Similarly taxonomic distinctness can be calculated without abundance data and provides additional information on the phylogenetic diversity of a site which is arguably more meaningful in terms of assessing ecosystem function.

An approach for large scale pattern detection - The greatest constraint on the approach taken relates to the available data: large scale analyses are dependent on existing data that were originally collected for a multitude of different purposes using various sampling methods. Any approach that attempts to combine these data must take into consideration the quality of the data by filtering out low quality data (that is either old, inaccurate in terms of taxonomy, spatial reference etc.) but also standardize for sampling method and coverage (some areas may be intensively sampled while others rarely visited). We have used regression to standardise for sampling effort, carrying out analyses on data collected by broadly similar collection methods and recombining scores by grid cell (Langmead *et al.*, 2008; Jackson *et al.*, 2009). Other techniques include resampling.

The data also determine the spatial scale of analysis, since the resolution of any grid applied to the area of study needs to be of optimal size; small sized grids result in many empty cells while large sized grids in the loss of fine scale resolution (Fig. 1). In our work around the coast of Wales we used several grids matched to the data coverage: 1) a small grid for the intertidal area (where sampling had better coverage); 2) a large grid for the subtidal area (where data coverage was lower) and 3) an intermediate sized grid to ensure comparison of the intertidal and subtidal areas (Jackson *et al.,* 2009).

Any layer representing patterns of diversity should be viewed together with the confidence we have in those estimations. This confidence can be derived from: 1) quality criteria applied to collated datasets; 2) estimators for extrapolating species richness from limited numbers of samples (in order to check for artefacts in diversity analyses) and 3) concordance between different measures to identify whether high areas for one measure are matched with others. Together this approach gives important context when identifying persistent large scale patterns.

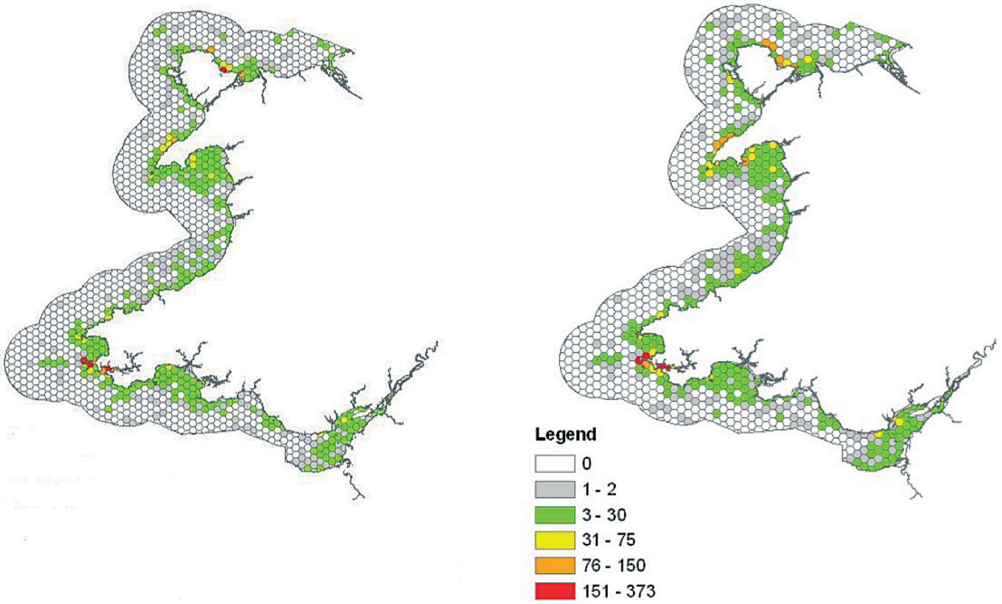

Fig. 1 - Number of species samples available within a) 5 km^2 and b) 20 km^2 grid in subtidal Welsh waters.

Numero di campioni di specie disponibili in un reticolo di a) 5 km^2 e b) 20 km^2 nelle acque subtidali (infralitorali e circalitorali) del Galles.

How this information can be used in selecting areas for protection? - Areas of high biodiversity are one important factor to include in the site selection process for MPAs. However, there are limitations to the use of large scale biodiversity patterns, regardless of how rigorously analyses were conducted. There will always be some degree of bias in the datasets used to base analyses on, and while this can be mitigated to a greater extent, it is impossible to completely remove it. Furthermore, it may be that the gaps in coverage mean that the application is quite limited, generally to inshore areas. Identifying gaps in sampling coverage at this scale can be a useful exercise in itself though to direct future survey effort, and assembling data on a large scale can serve to emphasise the current state of knowledge to decision-makers.

At a more fundamental level, the links between biodiversity, ecosystem resilience and functioning are not fully understood, and the debate continues. While protecting areas of high biodiversity is likely to help ensure the continued ecosystem functioning, this should not be at the expense of low diversity areas, which may be equally important from a functional perspective. In addition, some rare or threatened species with narrow habitat preferences may only be found in these areas, and would be outside of protection if this approach was taken in isolation for site selection.

While the identification of large scale patterns of biodiversity clearly does not provide immediate solutions to all marine nature conservation issues, there is a strong argument for it to have a place in the site selection process since these approaches provide valuable information to assist in the prioritisation of marine sites for designation because of the overall disproportionately greater contribution of high biodiversity areas to ecosystem resilience and functioning.

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'MIND THE GAP' – SCIENCE THAT INFORMS IMPLEMENTATION OF POLICY ON MARINE PROTECTED AREAS

'ATTENZIONE AL 'GAP': LA SCIENZA INTERVIENE NELL'ATTUAZIONE DELLA POLITICA DELLE AREE MARINE PROTETTE

Abstract - *There is no shortage of policy statements that indicate the need for marine protected areas (MPAs), how they will be identified and by when. However, scientists are often unable to provide the evidence to implement policy statements – there is a gap between the information that policy advisors assume scientists will have and what scientists are actually able to deliver. Those information gaps do not prevent the establishment of MPAs but they do make the process difficult and, in the case of establishing a representative site series, incomplete. The key gaps in Britain at least, are in survey data describing what habitats (as biotopes) and species occur where, in identifying fully which are the rare, scarce and threatened habitats and species, in designing the site series including establishing whether separate MPAs benefit each other, and in interpreting change that occurs when MPAs are established.*

Key-words: *Marine Protected Areas, biodiversity, conservation, research.*

Introduction - At the 2008 annual SIBM meeting, I outlined the role of marine protected areas for biodiversity conservation and for science using examples from Britain (Hiscock, 2008). This paper draws attention to some of the gaps between what policy-makers might expect scientists to know and what we do know, and gives a view on what we need to do to fill those gaps. There are also gaps in the way science is translated into policy – but those gaps may be deliberate as policy takes into account socio-economic considerations.

'The science of marine reserves' (PISCO, 2007) is a touchstone for advocates of biodiversity conservation and fisheries enhancement, although almost all of the examples come from areas outside of Europe and the majority of success stories are for fish. We need to generate a NE Atlantic and Mediterranean perspective to collecting evidence for the effectiveness of marine reserves for biodiversity conservation and that means new work.

I am not addressing gaps in knowledge that exist in understanding the role of marine biodiversity in the delivery of functional processes in the marine environment or in resilience and resistance in marine ecosystems. Those topics need to be addressed if we are to understand whether there are tangible benefits, other than for biodiversity, in protecting marine ecosystems from degradation.

What to protect

Habitats - Countries that are members of the European Union are required to implement the Habitats Directive (Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora). That Directive aims to contribute to the conservation of biodiversity by requiring Member States to take measures designed to maintain or restore certain natural habitats and wild species at a favourable conservation status. At the time the Habitats Directive was being drafted, the classification that provided a 'catalogue' of habitats to select from was the CORINE classification (CORINE biotopes – Technical Handbook, volume 1, p. 73-109, 19 May 1988, partially updated February 1989) – which was incompletely developed for marine habitats. The 'certain natural habitats' for the marine environment are very broad types. Although 'a blunt instrument', the Habitats Directive has resulted in the establishment of a large number of MPAs in Europe.

The classification of marine habitats has improved greatly since the CORINE classification and various initiatives have resulted in the development of the marine habitats part of the European Union Nature Information System (EUNIS) classification (Davies *et al.,* 2004). The main source for the north-east Atlantic is the biotopes classification developed initially for Britain and Ireland as a part of the BioMar programme and for the Mediterranean is the revised draft classification of benthic marine habitat types (Barcelona Convention WG 149/5 Annex III, 1998). Identifying which of those habitats should be protected especially requires survey information to know where they occur and information on their rarity and likely sensitivity to human activities. New survey though will inevitably identify species assemblages that do not correspond to an existing biotope in the classification.

Species - There are very few marine species identified in the Habitats Directive for protection and OSPAR (the Oslo and Paris Commissions for the Protection of the Marine Environment of the North-East Atlantic) lists only seven limited-mobility species that were considered threatened (see www.ospar.org). The IUCN Red List criteria require detailed quantitative data on decline and it is large mobile species that generally make it onto the lists. In the UK, many species that would be considered as 'worthy' of conservation action (because they are most likely long-lived, slow growing, reproduce infrequently, have limited dispersal powers and are sensitive to human activities) failed to pass the tests that would make them Biodiversity Action Plan species (see www.ukbap.org.uk) because the criteria used required quantitative information on decline (to be compatible with criteria for terrestrial species) and so 'data deficient' became a widely ticked box in assessments. Nevertheless, the criteria for Nationally Important Marine Features (see Hiscock, 2008 for a summary and Connor *et al*., 2002 for the full report) successfully identified a significant numbers of species (see www.marlin.ac.uk/nimf). However, the list of species has not been fully used because of incompleteness and because some of the species listed were considered very obscure and even of dubious taxonomic status. Another tangible tool that policy advisors and sea users can use is a list of rare and scarce species and, for Britain, pragmatic measures have been developed (Sanderson *et al.,* 1996). For the Mediterranean, implementation of the Protocol Concerning Specially Protected Areas and Biological Diversity (SPA Protocol) includes identifying species in need of protection (Annex II) or whose exploitation is regulated (Annex III) (see www.rac-spa.org and, for a description of almost all of the species, Relini & Tunesi, 2009). The ability to identify which are sensitive species to human activities relies greatly on having information on life history traits for those species and research has been undertaken for many species using the methods described by Hiscock & Tyler-Walters (2006) (see www.marlin.ac.uk/bacs.php).

Locations: 'ecological importance' and 'scientific value' - Our knowledge of areas that are important for key stages in the life history of a species (such as breeding, feeding, resting) is rather piecemeal although spawning areas for commercial species are often known. High productivity areas, often recognized by where the fishing boats can be found, may also be important for conservation of biodiversity. Ecological importance includes areas of high natural biodiversity but identifying such areas when survey data is uneven and incomplete is difficult (but see the paper by Langmead & Jackson in this volume). Such work is a very important part of identifying the best locations to include as many species and biotopes as possible within a MPA; a concept outlined in Hiscock & Breckels (2007). 'Scientific value' is best expressed as areas that have been used for long-term studies or that have historical information or that are used by research scientists.

Design of a series of marine protected areas - The OSPAR Commission (2006) has outlined guidance on design principles for the identification of an 'ecologically coherent network of MPAs'. Those principles have been adopted and developed to prepare Ecological Network Guidance (www.jncc.gov.uk/pdf/100705_ENG_v10.pdf) for the identification of Marine Conservation Zones as a part of a network of MPAs in England under recent legislation in the UK (the Marine and Coastal Access Act, which came into force in November 2009). Those principles in the UK include:

- Representativity
- Replication
- Viability
- Adequacy
- Connectivity
- Protection

'Representativity' and 'Replication' are well-established as criteria although there are questions about the level of the biotopes classification to use. For level 3 of the EUNIS classification, there should be sufficient survey information to universally identify where different habitats occur but identifying representative locations for finer level biotopes will almost certainly have to be undertaken for areas where there is survey data and not for the whole sea area being considered.

'Viability' is another difficult concept to apply and suffers from gaps in the information available on the biology of species (including of characteristic or dominant species in biotopes) required to enable an assessment of sustainability at a location including the area that needs to be protected to maintain ecological functioning.

'Adequacy' (simply expressed as how many MPAs of what size are needed to protect a desirable proportion of the total number of species and biotopes in an area) relies on there being enough survey data for the sea area being considered and that is rarely the case. Nevertheless, Rondinini & Chiozza (2010) identify and test various methods concluding that "No ideal method exists and two factors should guide the choice of a method: the type of biodiversity goal and data availability".

The idea of designing-in connectivity is that separate MPAs will interact with and support each other to create a 'network'. However, connectivity is a particularly difficult principle to apply and its inclusion in marine policy may draw more from the experience of terrestrial ecologists where wildlife corridors are important than from the knowledge that marine systems are very 'open' and connectivity through the water column is a general feature. Furthermore, work that has already been undertaken (see, for instance, Gaines *et al*., 2007) is sufficient to understand that, whilst some larvae and propagules can travel long distances and populate distant areas including other MPAs, some travel no distance at all and therefore the species needs to be protected where they are because recolonisation from distant sources is unlikely. Futhermore, a great many of the species that do travel significant distances are most likely common widely distributed species that are just as likely to recruit into a MPA from the wider marine environment than from another MPA. There is a gap between the aspiration to design-in connectivity to create a network of MPAs and the practicality of doing it for such a wide range of dispersal characteristics. OSPAR (2006) considers that "This [an ecologically coherent network] is particularly important for highly mobile species, such as certain birds, mammals and fish, to safeguard the critical stages and areas of their life cycle (such as breeding, nursery and feeding areas)" and concludes that "Detailed connectivity issues should be considered only for those species where a specific path between identified places is known (e.g. critical areas of a life cycle)".

Management: interpreting change - Management needs to know whether the measures adopted to protect a MPA are working. Well-designed monitoring will identify changes that are occurring within MPAs but searching for a baseline or reference condition that might be considered close to natural will inevitably be difficult, and that baseline will fluctuate within limits. Nevertheless, many species and assemblages of species can be found in exactly the same locations as where they were described even more than 150 years ago and, from my personal experience, more than 40 years ago so, any idea of discarding comparative data that is, say, more than 30 years old should be resisted. Where changes are recorded, they will need to be interpreted (for instance, has an increase in a species been directly attributable to good management or to some natural change in ocean currents etc.?) and whether or not they 'matter' (if a species has declined, is it one that is of conservation concern and/or is it one that is anyway highly variable in occurrence etc.?). Such considerations require information about what to expect in the way of natural fluctuations including changes that might take place on a decadal scale. Such changes are poorly known and may need long-term datasets.

And then there is consideration of the methods to use to detect change. Ideally, we use statistically valid methodologies including BACI (Before After Control Impact: Underwood & Chapman, 2005). However, it is not always feasible (especially in heterogeneous habitats or where a species is inherently patchy in its distribution) to obtain statistically valid results within meaningful values without taking an 'impossible' number of samples.

What to do?

Habitats - The EUNIS classification is a powerful tool for marine conservation but further work is needed including to take account of Baltic and Black Sea habitats if continuity across the EU is to be achieved so that we can provide policy advisors with a tool for any future iterations of the Habitats Directive and for use in other measures such as the Water Framework Directive and the Marine Strategy Directive. With a well-developed and accepted classification of habitats, those that are sensitive to different activities can be identified using their component species in the way outlined in the MarLIN programme (Hiscock & Tyler-Walters, 2006). Those that are 'important' (for instance, because they are rare, in decline or threatened with decline) can be identified using the sort of criteria summarised in Hiscock (2008) and given in full in Connor *et al.* (2002). However, habitats need to be identified to level 4-6 to have meaningful sensitivity or importance characteristics identified. Mapping the location of biotopes at level 4-6 of the EUNIS classification reliably is most likely going to be on a spot location basis and the more 'spots' we can survey and document, the better will be the ability to identify which biotopes are rare, sensitive or important, which examples are the richest and where there are 'hotspots' of biotope richness. The broadscale maps being developed (see, for instance www.jncc.gov.uk/EUSeaMap) do not give the precision needed to identify where rare or threatened (including sensitive) biotopes occur. Attempts to use physical data to predict which biotopes will occur where have only been partially successful (for instance, the HabMap project: www.habmap.org). Much more survey work is needed by experienced marine biologists to provide the precision needed for management.

Identifying which habitats should be protected is, after representativity, greatly based on their rarity of occurrence and on their sensitivity to human activities. 'Rarity' of biotopes has not been defined but is likely to be assessed at the level of physiographic features and habitat types at level 4-6 of EUNIS that are restricted in occurrence and extent. The ability to identify which are sensitive habitats to human activities relies on knowing the sensitivity of component species of the biotopes (see Hiscock & Tyler-Walters, 2006 and the next section).

The inevitability that survey will identify species assemblages that do not correspond to categories in the biotopes classification means that a 'clearing house' mechanism will be needed to submit and have validated 'new' biotopes.

Species - If we are to bridge the gap between policy statements about protecting threatened marine species and knowing what those species are, more work is needed to develop criteria that reflect our levels of knowledge of marine species. Marine is different to terrestrial and marine biologists should develop our own criteria to identify species that are rare and threatened so that our lists are meaningful for marine conservation. Understanding which species need to be protected also requires knowledge of life history traits and what those traits tell us about vulnerability to human activities. Surrogate methodologies are important and molecular genetics offers a route to understanding those species populations that are isolated from others of the same species and are therefore vulnerable to loss. The pragmatic criteria that have been developed to identify which are rare and scarce species by Sanderson *et al.* (2006) need to be further updated. We have extensively researched concepts of 'sensitivity' (Hiscock & Tyler-Walters, 2006) but many more species, especially key structural or functional species and vulnerable species, need to be researched. Furthermore, and as with habitats, we need to know where those species occur and that means *in situ* survey by experienced marine biologists.

Further work is therefore needed to develop and apply criteria that will identify what to protect including:

1. Develop concepts of 'rarity' to identify criteria for marine species and habitats both internationally and nationally (c.f. Sanderson, 1996),
2. Use the Nationally Important Marine Features criteria in Connor *et al.* (2002) as a model to develop 'importance' criteria for marine species.
3. Re-define 'degree of threat' to use assessment of sensitivity/vulnerability for marine species and habitats (c.f. Hiscock & Tyler-Walters, 2006).
4. Research the life history strategies and degree of isolation of populations (via genetic studies) of marine species suspected as vulnerable to damage but for which relevant research into life history traits is not available.
5. Develop and apply methods to overcome survey data uneven-ness to identify areas of high natural biodiversity; but, also, use the knowledge of experienced marine naturalists to identify where those hotspots are.

Design - Representativity and Replication can be designed into a site series whether or not there is comprehensive survey coverage. At Level 3 of the EUNIS classification, the location of different biotopes can be mapped using broadscale data on bottom type and knowledge of physical conditions such as wave exposure and light penetration so that examples of each type can be included in MPAs. However, representing level 3 biotopes will not ensure that there is adequate representation of those biotopes that are rare or sensitive to particular human activities. Those rare and sensitive biotopes would deserve a higher proportionate coverage within MPAs than widespread and robust biotopes and so will need to be identified and located. Inevitably, areas for protection that have special features will be sought and, to fill the gap in knowledge of what is where, more survey will be needed.

Whilst there seems little or no evidence of direct connections of limited-mobility benthic species between MPAs (any more than across the whole marine environment), there are gaps in our understanding of larval behavior that need to be addressed especially with regard to designing MPAs and interpreting monitoring data. For some species, information on life history traits is available which will reveal larval longevity and therefore likely dispersal capability (see, for instance, Jones & Carpenter, 2009 for 'important' species in Britain). More-and-more information will become available on isolation of populations of species as molecular techniques are used. Whether or not there is any direct connection between separate MPA's in relation to recruitment of limited-mobility species needs to be established by science before the proposition of networks for other than highly mobile species is proven.

Our knowledge of the distribution of species and habitats as well as what characteristics are essential to their viability is very poor. That knowledge will of course improve. However, we should not be too ambitious and policy makers should not produce impossible-to-achieve objectives and criteria! Nevertheless, we must use the information available to identify MPAs now and do not need to wait for outstanding science questions to be answered. Meanwhile, decisions about representativity, viability, adequacy etc. may rely more on the knowledge and experience of marine scientists in a heuristic approach to identifying a site series than something that can be used in a formulaic approach.

Management - Commitment of funds to open-ended and costly monitoring is rare but establishing reference data and checking that reference data in a systematic way at intervals will tell us much about change and even about 'shifting baselines', especially with the influence of climate change. Sample design is important but it is also important to make a reality check on the methods advocated (there is a gap between idealism and reality). There is no sense in adopting a superficially statistically robust approach when, on checking, the number of samples that needs be taken to provide meaningful results turns out to be 'impossible'. Better, in many cases, to use fixed quadrats at replicate locations and then you will see not only if there is change but whether it is the same individuals there each time or a turn-over and you can also measure the growth rates of species in photographs. The gap between the need for detailed (and therefore expensive) studies that are impossible to fund on a regular basis and the need for on-going observations may be filled by encouraging and maintaining natural history observations that can tell us much about events that happen unpredictably and at long intervals, including 'disappearances' or declines of species that 're-appear' or become abundant again after several decades. 'Institutional memory' is also important and experienced and knowledgeable but retired staff should be valued, and their views on interpreting change sought!

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MULTIDISCIPLINARY APPROACH AS A TOOL TO EVALUATE PATTERNS OF BIODIVERSITY IN MARINE HABITATS

UN APPROCCIO MULTIDISCIPLINARE COME STRUMENTO PER LA VALUTAZIONE DELLA BIODIVERSITÀ IN AMBIENTE MARINO

***Abstract** – The present paper shows results of a multidisciplinary study carried out around Pianosa Island, in the Tuscan Archipelago National Park, in order to evaluate the importance of a similar approach to detect patterns of biodiversity.*

***Key-words:** biodiversity, cartography, Pianosa Island.*

Introduction – The conservation of natural biodiversity represents a main tool for environment management following the UN conference on Environment and Development in Rio in 1992. In order to manage biodiversity, it is necessary to make inventories of diversity, to monitor change in diversity and to make plans focused on the conservation of diversity (Gray, 2000). In this contest, a lot of studies have been carried out to detect and/or monitor biodiversity in marine systems. The most part of studies on this topic focused on a particular assemblage or taxonomic group (see Gray, 1997). Although each information is important for the knowledge of the structure of ecosystems, results of these studies do not allow a complete assessment of patterns of biodiversity of a determinate system. In fact, the knowledge of diversity related to more taxonomic groups and including more habitats is necessary to obtain information about the biodiversity of an ecological system and to determine patterns of functional diversity. The knowledge of this latter aspect has an important role in ecosystem management and it needs the detection of the most part of species present in each ecosystem (Hooper *et al.*, 2002). The aim of the present paper is to show results of a multidisciplinary study carried out around a little island within a National Park, in order to evaluate the importance of a similar approach to detect patterns of biodiversity.

Material and methods – The study has been performed around the Island of Pianosa, in the Tuscan Archipelago National Park, north western Mediterranean Sea. The island has a coastline of about 14 km. Two different surveys have been carried out, a first investigation in 2004 and a second investigation starting in 2008. In the first survey, 7 sites were studied around the island. In the second survey, 33 sites were studied and *Posidonia oceanica* meadows were investigated at 3 different depth ranges (upper limit from -5 to -15 m; central zone from -18 to -26 m and lower limit from -27 to -48 m) (Fig 1). The study aimed at achieving the following objectives:

- a detailed morphology and bionomic cartography of the bottom
- the structure of *Posidonia oceanica* (L.) Delile meadows
- the structure and biodiversity patterns of benthic assemblages from the surface to a depth of 50 meters.

Fig. 1 - Map of Pianosa Island showing the study sites of 2008-2009 survey.
Mappa dell'isola di Pianosa che mostra i siti di studio dell'indagine 2008-2009.

A morphological cartography of the bottom was obtained through single beam profiles with the system GARMIN GI0272 in June-August 2009; data have been elaborated by the ISMAR-CNR of Bologna. The distribution of the main organisms and assemblages was obtained through direct surveys by scuba divers along transects.

The structure of *P. oceanica* meadows was studied along 14 transects around the island, determining cover, density (number of shoots m^{-2}), phenological variables and production.

Benthic assemblages were sampled along 33 transects. The following assemblages were studied: macroalgal assemblages on hard bottom, macro-zoobenthic assemblages on soft and hard bottom, vagile fauna in *P. oceanica* meadows, epiphyte assemblages on *P. oceanica*, fish assemblages. Samples on rocky bottom consisted of total scraping of substrate with hammer and chisel. Soft bottom assemblages were collected using a 30 cm long and 10 cm wide corer. *P. oceanica* epiphytes were studied collecting 12 shoots in each sampling area. Vagile fauna of meadows was sampled through the hand-towed net method. Species composition and abundance of fish assemblages were obtained through visual census techniques (Gambi and Dappiano, 2003).

Results - Data obtained from transects were used to integrate the cartography of the island with information of a detailed distribution of the main assemblages (Fig. 2).

During the survey of 2004 a total of 642 taxa were identified. After the survey of 2008-2009, a total of 1106 taxa were found in the studied habitats. In particular, 174 Rhodophyta, 48 Heterokontophyta, 32 Chlorophyta, 2 Spermatophyta, 26 Porifera, 30 Cnidaria, 2 Platyhelminthes, 1 Echiura, 1 Nemertina, 22 Nematoda, 10 Sipuncula, 212 Annelida, 189 Mollusca, 203 Arthropoda, 27 Echinodermata, 16 Tunicata, 32 Bryozoa, 1 Cephalochordata, 78 Vertebrata (1 Helasmobranchii, 77 Actinopterygii) were found (Tab. 1).

Tab. 1 - Number of taxa identified around Pianosa Island.
Numero di taxa identificati intorno all'isola di Pianosa.

TAXA	2004	2009
Rhodophyta	162	174
Heterokontophyta	43	48
Chlorophyta	30	32
Spermatophyta	2	2
Porifera	11	26
Cnidaria	19	30
Platyhelminthes	-	2
Nemertina	1	1
Nematoda	-	22
Sipuncula	5	10
Echiura	1	1
Annelida (Polychaeta)	92	212
Mollusca	100	189
Arthropoda (Crustacea)	82	203
Bryozoa	9	32
Echinodermata	16	27
Tunicata	5	16
Cephalochordata	1	1
Vertebrata (Helasmobranchii)	-	1
Vertebrata (Actinopterygii)	63	77
Total	642	1106

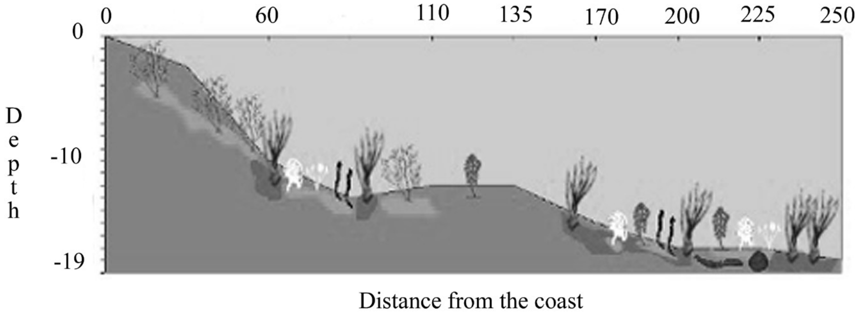

Fig. 2 - Example of bionomic transect.
Esempio di transetto.

Conclusions – Results of the survey showed the importance of a multidisciplinary approach to detect patterns of biodiversity in marine coastal habitats. In fact, the detection of the species composition of assemblages including all main taxa can allow to determine not only the structure but also the functional patterns of ecosystems. Moreover, the knowledge of distribution of the main assemblages, even if not directly related to the diversity of a system, represents a fundamental information to be superimposed to patterns of diversity, in order to plan conservation programs. Finally, the comparison between results of 2004 and 2008-2009 surveys shows the importance of the sampling effort in biodiversity studies.

Results obtained by the survey around Pianosa Island can be used to optimize sampling design in projects with similar objectives. Moreover, data of Pianosa Island may be integrated by other data of the same geographical area, in order to obtain a complete knowledge of patterns of diversity of Tuscan marine coastal systems.

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GENETIC VARIATION OF THE BRACHIOPOD *GRYPHUS VITREUS* (BORN, 1778) ACROSS THE GIBRALTAR SILL

VARIABILITÀ GENETICA DEL BRACHIOPODE GRYPHUS VITREUS *(BORN, 1778) ATTRAVERSO LA SOGLIA DI GIBILTERRA*

Abstract - *Genetic analysis based on two molecular markers, the nuclear Internal Transcribed Spacer 1 (ITS1) and the mitochondrial cytochrome oxidase subunit 1 (COI), was used to investigate the phylogenetic relationship between two populations of the eurybathic species* Gryphus vitreus *(Born, 1778) (Brachiopoda) across the Gibraltar sill. No genetic differentiation was found, thus indicating that Gibraltar sill is not a barrier to gene flow for the species, and that a likely panmixia occurs between the two populations, despite the lecitotrophic development (low potential dispersal).*

Key-words: Gryphus vitreus*, Gibraltar sill, gene flow, lecitotrophic development.*

Introduction - Planktonic larval duration (PLD) is a key factor in shaping patterns of dispersal and degree of connectivity among populations of marine species (Shanks *et al*., 2003). Species having a longer planktonic larval stage (planktotrophic development) show a major dispersion ability than species having a short planktonic larval stage (lecitotrophic development). Nevertheless, the dispersion ability of species depends also on other factors such as past geological events and geographic features (currents and physical barriers) of the area where they are distributed. Studying the relationship among populations of species which are distributed across geographic marine barriers is particularly interesting because, being generally less obvious than continental barriers, they can influence the gene flow through them in a way that not always coincides with a reduction of the dispersal of a species. One of the most well-known oceanic fronts in the Northern Hemisphere is the strait of Gibraltar, formed by the encounter of the incoming Atlantic surface waters with the modified higher density Mediterranean waters. Most studies on population genetics of marine species with an Atlantic-Mediterranean distribution have focused on the genetic differentiation of populations found at both sides of the strait of Gibraltar. Many of them have revealed some degree of genetic differentiation among populations from both marine areas (Stamatis *et al*., 2004) but other ones have shown clearly no or very low genetic diversity (Triantafyllidis *et al.,* 2005). These discordant results about the biogeographical separation between Atlantic and Mediterranean biota indicate that the hypothesis of the strait of Gibraltar as a phylogeographic break is controversial (Patarnello *et al.,* 2007). In this study two different genetic markers, the Internal Transcribed Spacer 1 (ITS1) and the cytochrome oxidase subunit 1 (COI), were used to investigate the phylogenetic relationship between two populations of the eurybathic and Atlantic-Mediterranean distribution brachiopod species *Gryphus vitreus* (Born, 1778) across the Gibraltar sill, in order to establish the role of the Gibraltar strait in preventing or not gene flow between them.

Materials and methods – A total of 31 specimens of *G. vitreus* were collected by dredge across the Gibraltar strait, 22 from the Balearic Sea and 9 from the Gulf of Cadiz. Total genomic DNA was extracted from the lophophore using the CTAB method. A fragment of 642 bp of the COI locus and a portion of the ITS1 region variable in length from 430 to 587 positions, were amplified by PCR using the primers

LCO1490/ HCO2198 and ITS1L/58C respectively. The PCR protocol was as follows: 95 °C 5'; 95 °C 1', 45 °C (COI) or 55 °C (ITS1) 1', 72 °C 2', 35 cycles; 72 °C 5'. All PCR reactions were performed in a total volume of 25 μl included 2.5 μl of 2 mM of each dNTP (GE Healthcare), 2.5 μl of 10× load buffer-MgCl2 (Qiagen), 2.5 μl of 2 μM of each primer (Invitrogen), 0.25 μl of 5 U/μl Taq DNA polymerase (Qiagen), 19 μl of demineralized water and 1 μl of the DNA template. Each amplicon was purified using the GFX PCR DNA and GEL band purification kit (GE Healthcare) and sequenced on both strands. Haplotype diversity (*h*), nucleotide diversity (π), hierarchical analysis of molecular variance (AMOVA), ΦST and *F*ST fixation indices were computed using Arlequin 3.11. A combined data set composed by COI and ITS1 concatenated haplotypes were used to investigate the phylogenetic relationship between the two populations. The analysis was performed using the Bayesian inference (BI), computed with MrBayes 3.1.2 and the Markov Chain Monte Carlo simulations tree sampling procedure. The analysis was run for seven millions generations, assuming the GTR +I +Γ evolution model and with parameter values and trees calculated et every 100th step. The estimated log-likelihood scores were plotted against generation time, to assess when the log-likelihood values reached the stationary. The log-likelihood scores had been clearly plateaued after 10,000 generations, that is after 10,000 generations the changes in trees topology and parameter values did not continue to improve the trees likelihood scores. Therefore the first 100 trees (from the first 10,000 generations) were excluded and the remaining trees were used to make a 50% majority rule consensus and to estimate the Bayesian Posterior Probability (BPP), to give support for tree nodes. Only BPP values equal or above 95% were considered significant.

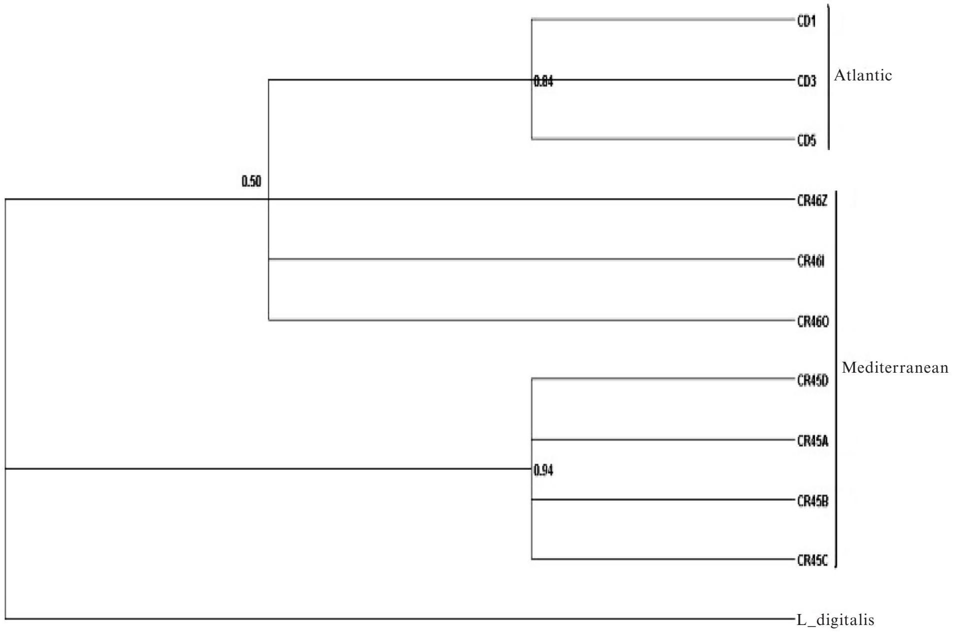

Fig. 1 - Bayesian Inference cladogram of relationship among Mediterranean and Atlantic specimens of *Gryphus vitreus* based on COI and ITS1 concatenated sequences, rooted with *Lottia digitalis* (Mollusks, Gastropods).

Cladogramma dell'Inferenza Baiesiana delle relazioni tra esemplari mediterranei ed atlantici di Gryphus vitreus *basato sulle sequenze COI e ITS1 concatenate, radicalizzato con* Lottia digitalis *(Molluschi, Gasteropodi).*

Results - COI sequences comparison revealed 63 variable sites, and 49 of them were parsimony informative. This polymorphism defined 9 distinct haplotypes among the 31 individuals, giving the sample an overall haplotypic diversity of 0.391 and a nucleotide diversity of 0.002. ITS1 sequences showed 58 variable sites 31 of which were parsimony informative. This polymorphism defined 17 distinct haplotypes among the 31 individuals, giving the sample an overall haplotypic diversity of 0.965 and a nucleotide diversity of 0.048. AMOVA of the COI partial sequence data showed that the majority of the genetic variation was explained by the within populations component, with only a small fraction of no-significant variance explained by the between populations component (ΦST=0.008; p=0.145). Similarly, AMOVA of the ITS1 partial sequence data showed that most variability was found within populations, with a lack of significant variability between populations (*F*ST=0.009; p=0.327). Phylogenetic estimate made for the combined data set (COI+ITS1), reveals clearly two major clades, one consisting of Mediterranean specimens and one including both Mediterranean and Atlantic specimens (Fig. 1). Therefore, while the Atlantic group appears monophyletic, the Mediterranean group is polyphyletic. However, all the BPP values are lower than the limit of 95%.

Conclusions – Both the analysis of molecular variance performed on ITS1 and COI genes (low fixation index values) and the phylogenetic analysis based on the two combined genes (polyphyly of the Mediterranean specimens and low BPP values) rejected the null hypothesis of genetic differentiation between the Mediterranean and Atlantic populations of *G. vitreus*. These data suggest the existence of panmixia between the two populations, thus indicating that the Gibraltar sill does not represent a barrier to gene flow for *G. vitreus*. This result is unusual, considering the low potential dispersal of the species. If panmixia is maintained between geographically separated marine populations such as the ones under study, this is usually due to an high dispersal of planktonic larvae in ocean currents. Nevertheless, the dispersal of *G. vitreus* is achieved during a short pelagic larval stage (lecitotrophic development). Therefore it is likely that the strong currents into the Gibraltar strait, joined with the internal waves that it can often generate, led to genetic exchange across the Atlantic-Mediterranean transition, even if larvae have a short life. Probably this gene flow climbs up to the end of the Messinian salinity crisis when, with the reopening of a communication between Atlantic and Mediterranean, *G. vitreus* colonized the Mediterranean basin from the Atlantic Ocean. Population genetic structure of brachiopods has never been investigated so that the present work represents the first genetic population study on brachiopods, based on specific genetic markers. Therefore, comparisons with other similar works are not possible.

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MONITORING THE "ISOLA DI BERGEGGI" MARINE PROTECTED AREA: A COMPARISON BETWEEN POINT INTERCEPT TRANSECTS AND VISUAL QUADRATS

IL MONITORAGGIO DELL'AREA MARINA PROTETTA "ISOLA DI BERGEGGI": POINT INTERCEPT TRANSECTS E QUADRATI VISUALI A CONFRONTO

***Abstract** – Differences between two visual sampling methods, Point Intercept Transects (PITs) and Visual Quadrats, were investigated on hard bottom subtidal benthic assemblages in the "Isola di Bergeggi" MPA (Ligurian Sea). Results showed that PITs detect differences among sites better than quadrats.*

***Key-words**: quadrat, PIT, Marine Protected Area, hard bottom, Mediterranean Sea.*

Introduction – Monitoring activities were carried out in 2009 in the "Isola di Bergeggi" MPA (Ligurian Sea, NW Mediterranean), instituted in 2007 (D.M. 7/5/2007), aiming to evaluate the condition of hard bottom assemblages. During the kick off of these activities we sampled benthic assemblages using two visual methods that enable to survey areas of different size, in order to compare their performance when investigating differences among sites and zones subjected to a distinct protection regime and to assess the most efficient method for monitoring a MPA.

Materials and methods – Surveys were carried out in May 2009 in a total of six sites: two in zone A (Sites 5, 6), two in zone B (Sites 3, 7) and two in zone C (Sites 1, 2) at 5 m depth (Fig. 1). Two visual methods were applied for sampling benthic assemblages: the Point Intercept Transect (PIT) and the Visual Quadrat (Bianchi *et al.*, 2004). Three 10 m long replicates of PITs and six replicates of quadrats (50 cm ×50 cm) were examined, totalling 18 PITs and 36 quadrats. Data from quadrats were collected either as percent cover and relative frequency.

PIT and quadrat cover and frequency data for each species (or higher ranked taxon) were used to calculate Bray Curtis Similarity and compared using multivariate analyses (Multidimentional Scaling, SIMPER) to investigate similarity among sites. On the basis of the number of species (or taxa) obtained in each replicate the Dispersion Coefficient was computed, in order to analyse effects of the size of sampling area on the dispersion between replicates.

Results – The comparison between PITs and quadrats shows small differences in the number of species detected (PITs: 48 species; quadrats: 52 species). The MDS plot (Fig. 2) shows that samples collected by the two techniques stand into clearly different groups and a much higher variability is observed among replicates from quadrats, compared to replicates from PITs, also confirmed by the Dispersion Coefficient. The SIMPER analysis, finally, shows that the only relevant difference between the two sampling methods is represented by the percentage of bare substrate, that appears relevant only in PIT samples.

When comparing cover data with frequency data from quadrat samples, the MDS plot (Fig. 3) shows that replicates of the two descriptors are similarly dispersed in space and are often coincident.

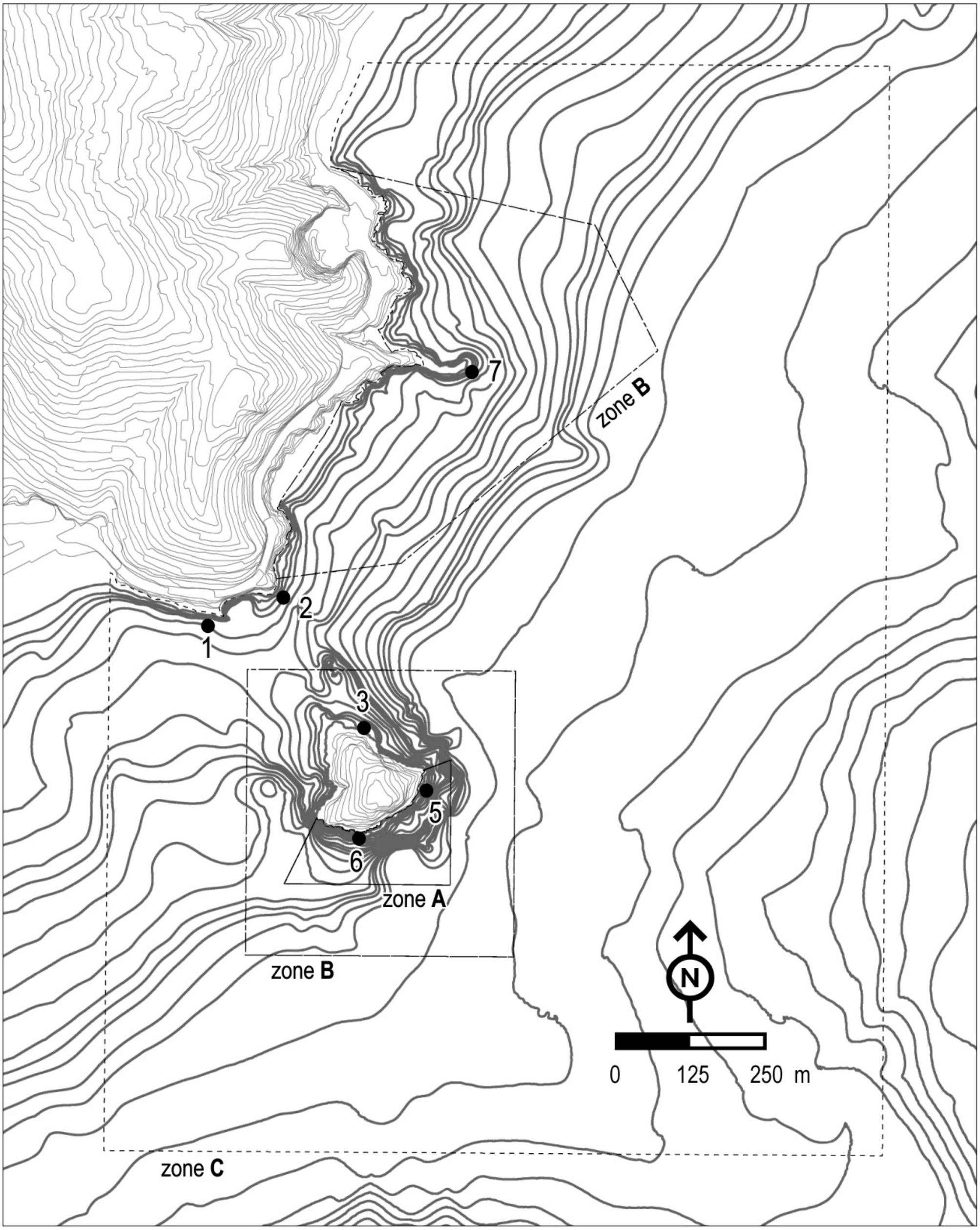

Fig. 1 - Zonation of the 'Isola di Bergeggi' MPA and position of sampling sites.
Zonazione dell'AMP "Isola di Bergeggi" e posizione dei siti di campionamento.

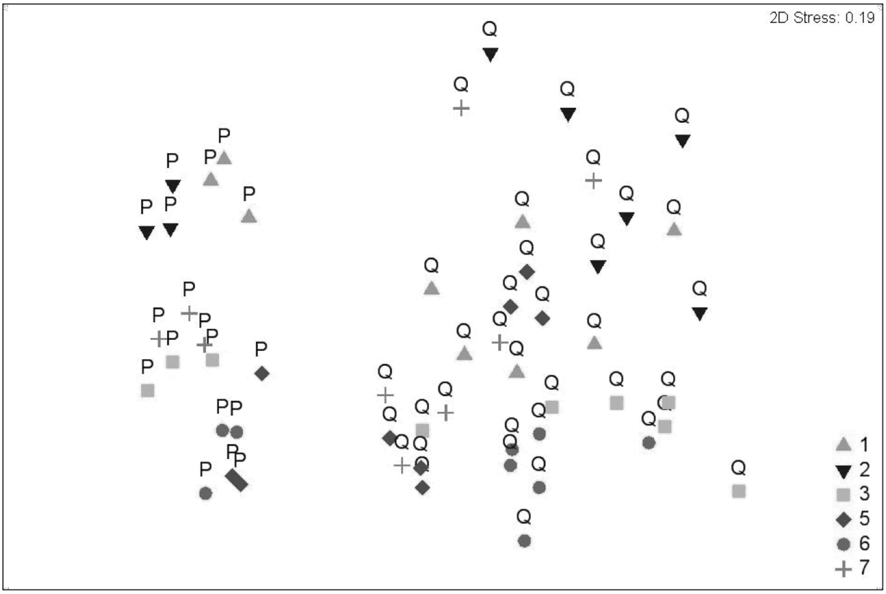

Fig. 2 - Similarity among cover data collected with visual quadrats (Q) and PITs (P). Symbols represent sampling sites.

Similarità tra dati di ricoprimento e dati di frequenza rilevati con i quadrati visuali (Q) e con i PIT (P). I simboli rappresentano i siti di rilevamento.

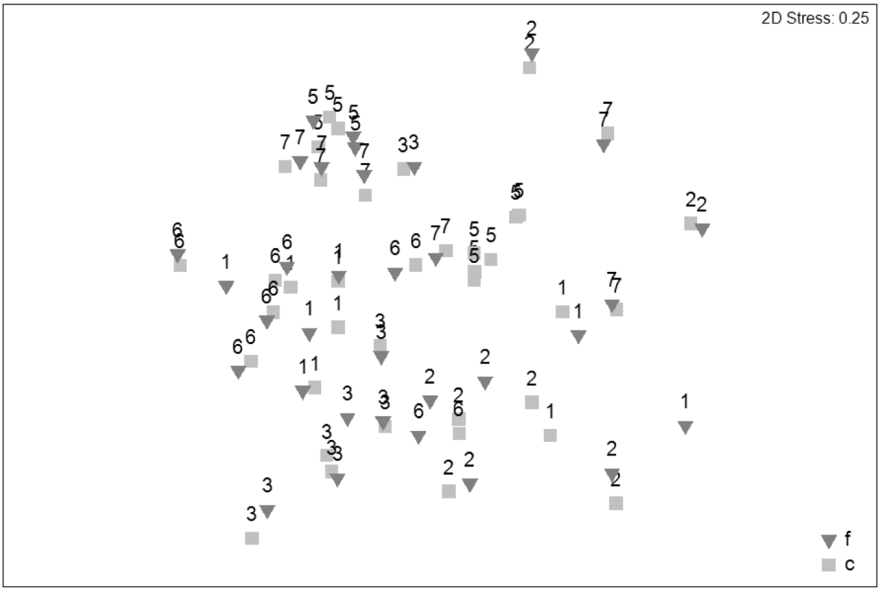

Fig. 3 - Similarity among cover data (c) and frequency data (f) from quadrats. Numbers represent sampling sites.

Similarità tra dati di ricoprimento (c) e di frequenza (f) dai quadrati. I numeri rappresentano i siti di rilevamento.

Conclusions – Results of the comparison between PITs and visual quadrats highlight a high variability among quadrats that hides the differences existing among sampling sites in zones subjected to a different protection regime. To overcame this limit a higher number of replicates is necessary, with a consequent increase in the amount of time spent underwater. On the contrary, PITs have a larger cost/time effectiveness, exhibit a lower variability among replicates and, because of their larger sampling size, should be better candidates to detect differences at larger spatial scales (Parravicini *et al.*, 2009). The MDS plot also ordinates PIT replicates in a way that reflects the zonation of the MPA. However, the institution of the Isola di Bergeggi MPA is too recent, while a high number of studies (Claudet *et al.*, 2008 and references therein) suggest that several years are necessary to make protection effects detectable. Our sampling sites were located along a inshore-offshore gradient, and the zonation of the 'Isola di Bergeggi' MPA exactly superimposes over such a gradient. This might cause a problem in the future monitoring programs to discriminate protection effects from environmental constrains: a more appropriate design will be necessary to disentangle inshore-offshore and protection effects. Actually, visual quadrats and PITs are two complementary sampling techniques, because the former is able to detect the variability on the small scale, while the latter on the large scale.

When comparing cover data with frequency data no significant differences between the two descriptors are found, both being able to collect the same information on benthic assemblages. However, we advocate the adoption of frequency to characterize benthic communities because it requests a comparatively shorter time for collecting data.

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Biol. Mar. Mediterr. (2010), 17 (1): 35-38

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L'AREA MINIMA DI CAMPIONAMENTO: CONFRONTO TRA LE METODOLOGIE VISIVE E DISTRUTTIVE NEL CORALLIGENO DELL'ISOLA DI PIANOSA (PARCO NAZIONALE DELL'ARCIPELAGO TOSCANO)

THE MINIMAL AREA OF SAMPLING: COMPARISON BETWEEN VISUAL AND DESTRUCTIVE METHODS IN THE CORALLIGENOUS ASSEMBLAGES OF THE ISLAND OF PIANOSA (TUSCANY ARCHIPELAGO, NATIONAL PARK)

***Abstract** – Coralligenous assemblages are considered one of the most important benthic systems of the Mediterranean Sea, with an elevated biodiversity. This biocoenosis is the result of an edification process due to the precipitation, by several organisms, particularly algae, of the calcium carbonate present in sea water. The minimal area estimated in the Mediterranean Sea ecosystems range from 300 to 400 cm^2. This value was calculated utilizing destructive sampling methods. Until now no information is available for minimal area of coralligenous assemblages both with destructive and visual sampling methods. In this study the evaluation of qualitative and quantitative minimal area for coralligenous assemblages and comparation between visual and destructive sampling methods, are reported.*

***Key-words:** minimal area, Mediterranean, coralligenous, Island of Pianosa.*

Introduzione – Nel 2006 Ballesteros ha definito il coralligeno come un substrato duro di origine biologica prodotto principalmente dall'accrescimento di alghe calcaree in condizioni di scarsa luminosità. Il coralligeno presenta due caratteristiche essenziali: in primo luogo è sciafilo pur essendo a dominanza vegetale, in secondo luogo è legato alla presenza di substrati duri, primari ma anche secondari, cioè dovuti ad un precedente concrezionamento. Il coralligeno è un popolamento ancora poco studiato, per il quale non sono presenti in letteratura adeguate informazioni sull'area minima di campionamento, definita come l'area in grado di contenere un numero rappresentativo di specie di un popolamento.Cain (1938) ha messo a punto, per lo studio dell'area minima per il benthos infralitorale, il metodo della curva area-specie con il quale è possibile identificare per ogni popolamento un'area minima. Per il Mediterraneo e per un campionamento di tipo distruttivo, l'area minima indicata per il benthos animale è compresa tra 300 e 400 cm^2 (Bellan-Santini, 1969), mentre per il benthos vegetale è compresa tra 150 e 250 cm^2 (Boudouresque, 1974). In questi lavori non si prendono in considerazione, anche per mancanza di sistemi fotografici idonei, campionamenti di tipo visivo. Gli obiettivi di questo lavoro sono quelli di identificare l'area minima qualitativa per il popolamento coralligeno e di confrontare i dati di copertura delle specie cospicue rilevate con la tecnica di campionamento visivo con i dati di ricoprimenti delle medesime specie provenienti da un campionamento distruttivo effettuato su un' area di 400 cm^2.

Materiali e metodi – Lo studio è stato effettuato nel Luglio 2008 nell'ambito della ricerca condotta dall'Università di Pisa e dal NURC (*Nato Undersea Reserch Center*) con immersioni con autorespiratore ad aria (A.R.A) e con tecniche di campionamento visive (photo-quadrats) e distruttive (grattaggio) in tre aree dell'Isola di Pianosa nel Parco Nazionale dell'Arcipelago Toscano. In ciascuna area, si è provveduto a effettuare 5 fotografie con una fotocamera digitale ad elevata risoluzione, prendendo come riferimento un quadrato in PVC di 50×50 cm (suddiviso in 10 sottoquadrati di 100 cm^2) e a prelevare 5 campioni di substrato mediante campionamento distruttivo di un'area di 400 cm^2 (Ros e Gili, 1984). Su entrambi i campioni si è proceduto alla determinazione dei valori di ricoprimento/copertura (Boudouresque, 1971) delle specie identificate. Lo studio dell'area minima, per il campionamento di tipo visivo, è stato effettuato considerando il numero di specie medie presenti in aree sempre maggiori, per ciascuna fotografia, partendo da una superficie di 25 cm^2. Il numero medio di specie identificato per ciascuna superficie è stato poi inserito in un grafico area-specie (Cain, 1938; Boudouresque, 1974; Cinelli *et al.*, 1977; Boudouresque *et al.*, 1979). Dopo aver identificato l'area minima per il campionamento visivo, si è provveduto a confrontare i valori di ricoprimento delle specie cospicue (Gili e Ros, 1985) riscontrate con tale tecnica, con quelli determinati, sempre per le specie cospicue, con la tecnica distruttiva. Il test statistico utilizzato è stato un t-test per la verifica d'ipotesi sulla differenza tra medie di due campioni. Le ipotesi verificate sono: $H_0 : \mu_1=\mu_2$ e $H_A : \mu_1\neq\mu_2$. L'indagine è stata condotta concentrando l'attenzione solo sulle specie: *Flabellia petiolata* (Turra) Nizamuddin, *Halimeda tuna* (Ellis e Solander) Lamouroux, *Peyssonnelia* spp., *Myriapora truncata* Pallas, *Jania rubens* (L.) Lamouroux, *Corallina elongata* Ellis e Solander, *Sertella septentrionalis* Hammer, alghe filamentose e spugne incrostanti.

Risultati – Per lo studio dell'area minima di campionamento si è provveduto alla identificazione, in tutti i campioni fotografici, del numero di specie per superfici di diversa grandezza. Il tutto inserito in un grafico area-specie (Fig. 1).

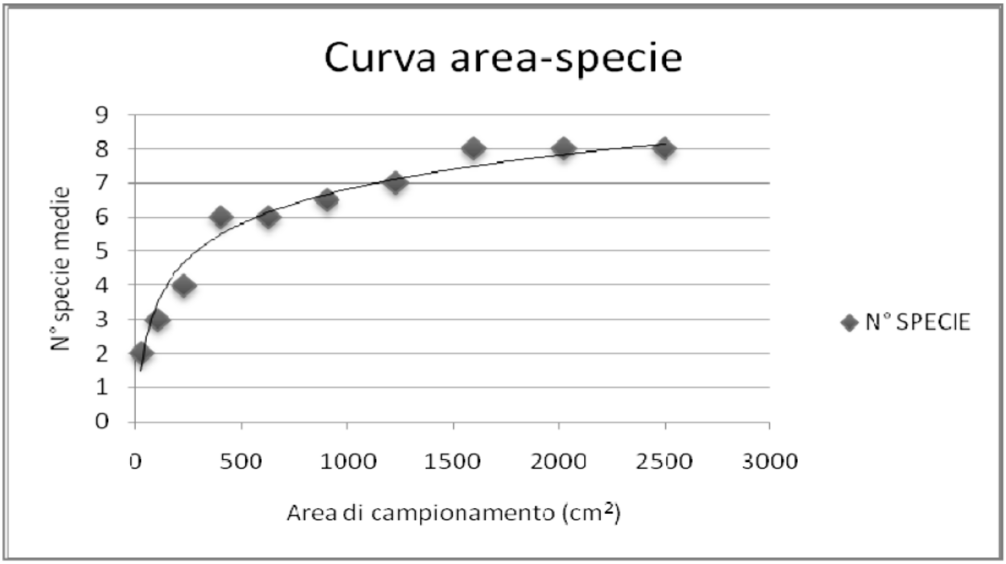

Fig. 1 - Curva area-specie.
Species-area curve for minimal area of sampling.

Una volta identificata l'area minima per un campionamento di tipo visivo, si è provveduto a confrontare i due metodi di campionamento (visivo e distruttivo) effettuando un test sulla differenza tra medie di due campioni. Si sono presi in esame i dati di ricoprimento/copertura di specie cospicue esaminate, ricavati dall'analisi dei campioni di substrato prelevati mediante grattaggio (area di 400 cm^2) e dall'analisi dei campioni fotografici (area di 400 cm^2 e successivamente di 1600 cm^2). Il test statistico prevede la presenza di alcune condizioni sperimentali quali: popolazioni normali, σ_1 e σ_2 ignote ma uguali, n_1 e n_2 piccole. In tali condizioni sperimentali il test t-student prevede le seguenti ipotesi: $H_0 : \mu_1=\mu_2$ e $H_A : \mu_1\neq\mu_2$. Il primo caso esaminato ha permesso di mettere a confronto dati di ricoprimento/copertura ricavati da campioni entrambi di area di 400 cm^2. In questa situazione l'ipotesi nulla H_0 risultava essere rigettata ($T \geq t_{n1+n2-2}$) per *Peyssonnelia* spp., *Halimeda tuna* e spugne incrostanti. Essendo queste specie rilevanti per il coralligeno in esame, si è ripetuto il test considerando un'area di 400 cm^2 ed una di 1600 cm^2. I risultati di questo secondo test hanno portato all'accettazione dell'ipotesi nulla, $T \leq t_{n1+n2-2}$, (tra i due campionamenti non c'è una differenza significativa), per *Myriapora truncata*, *Flabellia petiolata*, *Peyssonnelia* spp., *Halimeda tuna*, *Jania rubens*, *Corallina elongata*, *Sertella septentrionalis* e alghe filamentose. Per le spugne incrostanti il test continua a non prevede l'accettazione dell'ipotesi nulla (Fig. 2).

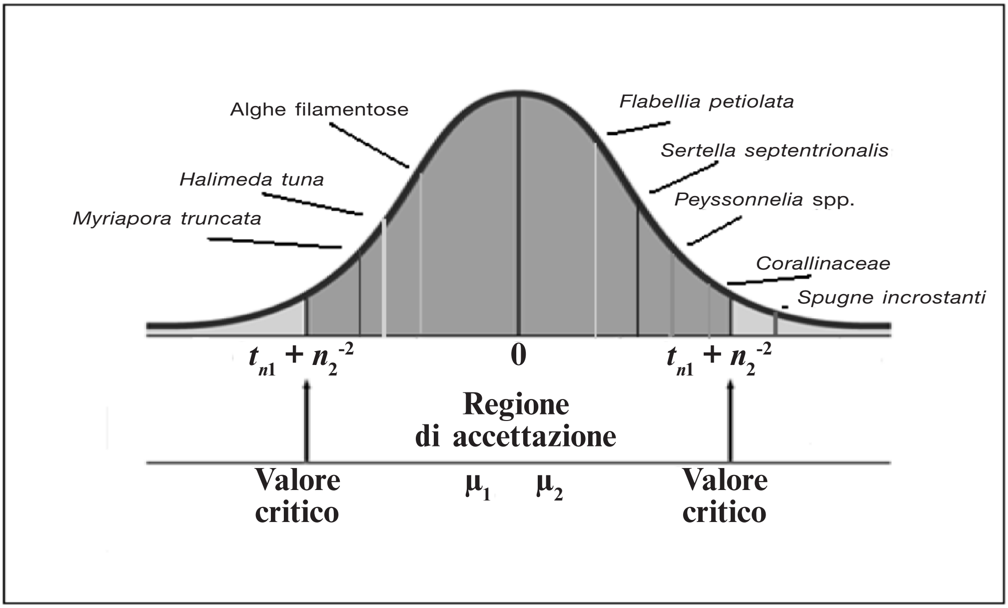

Fig. 2 - Curva t-test con valori di T per ogni specie esaminata.
T-test curve with T values for every species considered.

Conclusioni – Lo studio dell'area minima per il coralligeno di Pianosa, molto uniforme ed omogeneo, condotto mediante un campionamento di tipo visivo, ha permesso di determinare il valore sperimentale di tale area tra i 1600 e i 2000 cm^2 in quanto in quest'area è possibile riscontrare il numero maggiore di specie. Questa conclusione viene poi avvallata dal t-test condotto mettendo a confronto, per le specie cospicue, i valori di ricoprimento ricavati mediante la tecnica di campionamento distruttiva e quelli di copertura ricavati dai campioni fotografici. È possibile concludere quindi che il campionamento di tipo distruttivo potrebbe essere sostituito, per l'analisi delle specie cospicue, da un campionamento visivo se si considera un'area di 1600 cm^2. Questo ovviamente vale per le specie cospicue e superficiali di un popolamento coralligeno, infatti per l'identificazione tassonomica e per i ricoprimenti delle altre specie, continua ad essere necessario il campionamento distruttivo. Nel caso preso in considerazione, come risulta anche evidente dal t-test, le specie dominanti, sia animali che vegetali, sono rappresentate da individui di una situazione di pre-climax, caratterizzato in particolare da specie vegetali a tallo foliaceo (*Halimeda tuna*, *Flabellia petiolata*, *Peyssonnelia* spp.) o filamentoso e da specie animali di tipo coloniale incrostante come *Sertella septentrionalis* e *Myriapora truncata*, particolarmente abbondanti anche in popolamenti più superficiali. Sarebbe quindi opportuno effettuare uno studio dell'area minima per ogni tipo di popolamento coralligeno visto e considerato che tale popolamento risulta essere estremamente variabile nella sua struttura e maturità. Questo è da mettere soprattutto in relazione con le caratteristiche dei fattori abiotici, in particolare la luce, che nel caso dell'Isola di Pianosa raggiunge valori molto elevati anche a profondità rilevanti.

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Biol. Mar. Mediterr. (2010), 17 (1): 39-42

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FISH ASSEMBLAGES ACROSS THE MEDITERRANEAN SEA AND THE EFFECTS OF PROTECTION FROM FISHING

I POPOLAMENTI ITTICI NEL MEDITERRANEO E GLI EFFETTI DELLA PROTEZIONE DALL'IMPATTO DELLA PESCA

Abstract *– Several studies have assessed the effectiveness of individual marine protected areas (MPAs) in protecting fish assemblages, but regional assessments of multiple parks are scarce. Here fish surveys using visual census were done in marine parks and fished areas at 31 locations across the Mediterranean Sea. Fish species richness, diversity and biomass (especially of top predators) were higher in MPAs compared to fished areas, and community structure differed significantly between MPAs and fished areas. Results suggest that MPAs are generally effective means to protect and recover fish populations and assemblages.*

Key-words: *fish biomass, predators, marine parks, fishing impact, visual census, Mediterranean Sea.*

Introduction – Marine protected areas (MPAs) are portions of the coastline and/or sea where human activities, especially fishing, are restricted or banned (Agardy *et al*., 2003). As fish assemblages usually include many species targeted by fishing, they are primarily expected to respond to protection within MPAs, especially those MPAs that have no-take zones (Micheli *et al*., 2004). The evaluation of benefits on fish assemblages, e.g. in terms of increase in density, size and biomass of target fishes (Micheli *et al*., 2004; Guidetti & Sala, 2007), can be useful to assess the ecological effectiveness of MPAs. Moreover, most target fishes are high-level predators in the food webs and their functional extinction may cause community-wide changes (Sala *et al*., 1998; Worm *et al*., 2006). Protection from fishing, therefore, may directly restore populations of target fishes and indirectly drive whole communities towards an unfished state (Sala *et al*., 1998; Micheli *et al*., 2004). Effective MPAs and, more generally, areas characterized by null/low levels of exploitation were found worldwide to host particularly high total fish biomass with a clear dominance of top predators (Friedlander & DeMartini, 2002). In the Mediterranean Sea, approximately 100 MPAs have been established (Abdulla *et al*., 2008), making this region among those with the highest concentration of MPAs in the world. A number of Mediterranean studies assessed direct and indirect 'reserve effects' of protection (Guidetti & Sala, 2007 and references therein). Most of the 'reserve effect' assessment studies in the Mediterranean basin were carried out focusing on fish assemblages associated with rocky reefs, due to the fact that: 1) rocky reefs are the most common habitat protected within MPAs in Mediterranean; 2) previous visual census studies showed that rocky reefs host greater abundance of fish species targeted by fishing and that fish assemblages more clearly respond to protection from fishing than others (e.g., benthic assemblages). This study aims at investigating the generality of responses to protection of fish assemblages associated with shallow rocky reefs across the Mediterranean Sea, by comparing MPAs and areas open to fishing and other human uses.

Materials and methods – Fish surveys were done in late spring 2007 and 2008 at 12 MPAs and 19 fished areas across the northern Mediterranean coast (Spain, Italy, Greece, Turkey; Fig. 1).

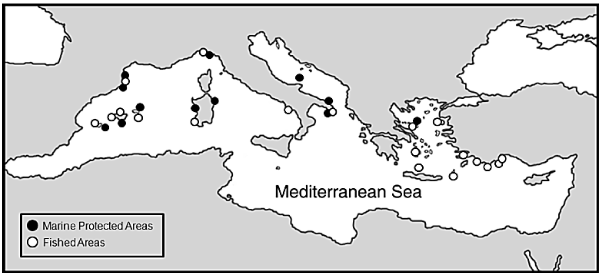

Fig. 1 - Location of Marine Protected Areas and fished areas investigated in this study.
Localizzazione delle Aree Marine Protette ed aree aperte alla pesca oggetto del presente studio.

Fish data were collected by using underwater visual census (UVC) at several stations within each areas (protected or fished), with three replicated UVCs at each station, for a total of 516 UCVs. Each replicate consisted of a 25 m-long and 5 m-wide transect. Along each transect, the diver swam one way (at ~10 m depth) for about 8-10 min, identifying and recording the number and size of each fish encountered (Harmelin-Vivien *et al.*, 1985). Fish wet-weight was estimated from size data by means of length-weight relationships from the available literature and existing databases (Froese & Pauly, 2009). Multivariate and univariate analyses were conducted to examine whether fish assemblage structure (i.e. taxa composition and abundances) and single variables (e.g. species richness) responded to protection. Effects of protection were analyzed on whole fish assemblages (using species×sample matrices) using three-way permutational multivariate analysis of variance (PERMANOVA) both on abundance and biomass data. The sampling design consisted of 3 factors: Protection (Pr; fixed factor with 2 levels), Area (Ar; random and orthogonal) and Station (St; random and nested in Area). Multivariate analyses were based on Bray-Curtis dissimilarity matrices and ln(x+1) transformed data. Univariate analyses on species richness, diversity, and total abundance and biomass of fish were run using t-tests to compare mean values under protected and unprotected conditions. Finally, fish taxa in terms of biomass data from both protected and fished conditions were pooled into trophic groups because fishing disproportionately targets species at higher trophic levels (Pauly *et al.*, 1998), and recovery from fishing potentially includes increased abundances or biomass of high-level predators and shifts in trophic structure (Micheli *et al.*, 2004). Each taxon was assigned to one of 4 trophic macrogroups using the information about diet in the database "FishBase" (Froese & Pauly, 2009), and in Mediterranean studies (Guidetti & Sala, 2007): 1) large apex predators (large carnivores, AP), 2) small carnivores (including piscivores and invertivores, SC), 3) herbivores (He), and 4) planktivores-detritivores (PD).

Results – Multivariate analyses (PERMANOVA tests) showed that considering total fish abundance ($P<0.01$) and even more biomass ($P<0.001$), fish assemblage structures were significantly different between MPAs and fished areas, and that a significant variability was detected at both spatial scales of areas and stations. Species richness (*t*-tests, $P<0.01$), diversity (*t*-tests, $P<0.05$) and total biomass of fish (*t*-tests, $P<0.01$) were significantly higher in protected than in fished conditions, while no statistical differences were found as far as fish abundance (*t*-tests, $P>0.05$) was concerned. In spite of a significant variability among areas (especially among MPAs), total fish biomass clearly tended to be higher in MPAs (Fig. 2).

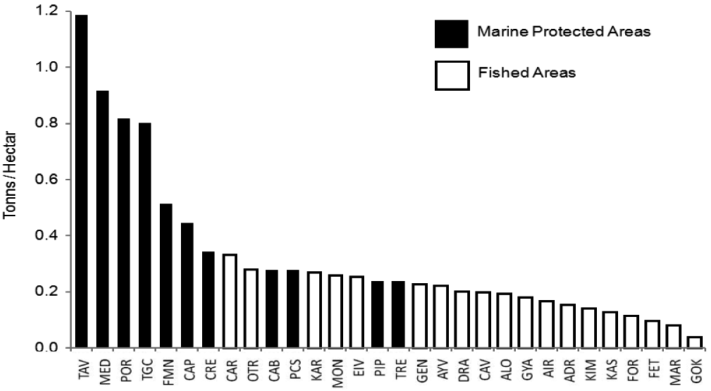

Fig. 2 - Total fish biomass in Marine Protected Areas and fished areas investigated in this study.

Biomassa ittica totale nelle Aree Marine Protette ed aree aperte alla pesca oggetto del presente studio.

Fish biomass split into the 4 trophic groups (see Methods) was different between MPAs and fished areas. At MPAs, in fact, predator fishes, especially apex predators (18.4 vs 5.5%), were far better represented than in fished areas (Fig. 3).

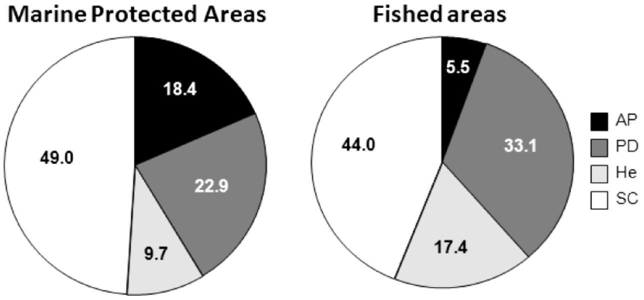

Fig. 3 - Fish biomass of different trophic groups (see Methods) in Marine Protected Areas and fished areas investigated in this study.

Biomassa ittica dei quattro differenti gruppi trofici (vedi Metodi) nelle Aree Marine Protette ed aree aperte alla pesca oggetto del presente studio.

Conclusions – The present study investigated the effects of protection by surveying fish assemblages across the Mediterranean scale. In spite of the large site-to-site variability, fish assemblage structures were found to be significantly different between MPAs and fished areas. Moreover, species richness and diversity were greater in MPAs than in fished areas. The greatest differences, however, concerned fish biomass. Not only on the whole mean fish biomass was higher in MPAs than in fished areas, but in some MPAs the values were dramatically high. In addition, in MPAs a significantly greater contribution to the total fish biomass was attributable to apex predators. These results are in agreement with the available literature from the Mediterranean Sea and elsewhere (Friedlander & DeMartini, 2002; Sandin *et al*., 2008) and stress how effective can be MPAs for recovery of fish at population and ecosystem levels.

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USO DELLA PIATTAFORMA AEREA PER IL MONITORAGGIO DI VERTEBRATI MARINI AI FINI DELLA GESTIONE DELLA BIODIVERSITÀ: IL CASO DEL SANTUARIO PELAGOS

AERIAL SURVEY IN THE PELAGOS SANCTUARY FOR THE MANAGEMENT AND CONSERVATION OF THE PROTECTED SPECIES

Abstract *– Systematic monitoring of density and abundance of large vertebrates is among the priority actions listed in the Pelagos Sanctuary Management Plan, ACCOBAMS and by the Specially Protected Areas and Biodiversity Protocol under the Barcelona Convention. This paper presents the suitability of the aerial surveys methodology in studying protected species by means of data collected in two surveys conducted in the Pelagos Sanctuary in winter and summer 2009.*

Key-words*: aerial surveys, cetaceans, population distribution.*

Introduzione - La conservazione della biodiversità non può prescindere dallo studio della dimensione delle popolazioni; tale esigenza è anche una obbligazione di legge secondo la Direttiva Habitat e la Convenzione sulla Biodiversità. Tuttavia, nonostante l'elevato sforzo di ricerca, sono ancora molte le lacune conoscitive anche per le specie protette. Tra i cetacei, stime di abbondanza sono note per alcune aree del Mediterraneo (*Tursiops truncatus* - Lauriano *et al*., 2004; Bearzi *et al*., 2009 - *Stenella coeruleoalba* - Fortuna *et al*., 2007; Lauriano *et al.,* in stampa; Panigada *et al*., 2009; Forcada *et al*., 1995; *Balaenoptera physalus;* Forcada *et al*., 1995). Isolati censimenti sono stati effettuati per la *Caretta caretta* (Gomez de Segura *et al*., 2006), mentre poche informazioni si hanno sugli Elasmobranchi (Notarbartolo di Sciara *et al.,* 2006). Inoltre, vi sono specie di scarso interesse commerciale o conservazionistico, per le quali lo sforzo di ricerca è ridotto e le conoscenze sul numero di esemplari nelle popolazioni (Pope *et al*., 2010) ricavate solo indirettamente - es. *Mola mola* (Orsi Relini *et al*., 2010). Alcuni motivi delle carenze conoscitive sono ascrivibili a difficoltà logistiche ed economiche insite nello studio di specie pelagiche, la cui presenza in superficie è difficilmente osservabile e aleatoria. Tra le tecniche di indagine della dimensioni delle popolazioni, il *line-transect sampling* è considerato tra i più validi (Buckland *et al.,* 2001) e uno strumento pratico per lo studio di specie su vaste aree (Pope *et al.,* 2010).

Materiali e metodi - ***Area di studio.*** Comprende il Santuario Pelagos per i mammiferi marini (Fig. 1), la prima area marina protetta internazionale al mondo (Hoyt, 2005). All'origine dell'istituzione vi è la presenza di predatori pelagici, la promozione della ricerca e della legislazione in tema di protezione della biodiversità (Notarbartolo di Sciara *et al*., 2008).

***Metodo di studio* -** Per una copertura omogenea dell'area di studio, 82 transetti distanziati tra loro 10 km per totali 8,852.56 km, sono stati tracciati con il *software* dedicato Distance 5.0 (Thomas *et al.,* 2006). Il velivolo, un Partenavia P 68 equipaggiato con finestre a bolla per l'osservazione sulla verticale, volava a una quota (h) di 750 piedi e alla velocità di 100 miglia nautiche orarie. A bordo, tre ricercatori con esperienza nel riconoscimento delle specie e nei metodi di censimento; uno per l'inserimento dei dati in computer e due per l'osservazione. Le informazioni registrate comprendevano la specie, la dimensione dei gruppi, l'angolo di declinazione (α), e l'osservatore oltre alla posizione geografica. Lo stato del mare, (Scala Beaufort), le condizioni soggettive di avvistamento e il grado di riflesso sul mare, erano registrate all'inizio dei transetti e nel caso di cambiamenti. L'angolo α e h, permettono di calcolare la distanza perpendicolare (x) dell'avvistamento dal transetto secondo $x=h*\tan(90°- \alpha)$, misura essenziale nel calcolo dell'abbondanza e densità.

Risultati - Un monitoraggio invernale e uno estivo sono stati realizzati nei periodi 11-31 gennaio - 18-22 febbraio e 21 luglio e 2 agosto 2009, su un'area di 88,267 km^2. Sono stati percorsi 16,638 km di cui 8,144 in inverno e 8,494 in estate, per complessivi 467 (124 invernali, 330 estivi) avvistamenti di cetacei e 443 (104 e 339) delle altre specie in Tab. 1. La distribuzione delle specie di interesse conservazionistico nell'area di studio è in Fig. 1.

Tab. 1 - Specie osservate e *range* dei gruppi nelle due edizioni del censimento aereo.
Specie observed during winter and summer surveys.

Stagione (effort km)	Inverno (8,144) (Panigada *et al.*, 2009)	Estate (8,494)
Cetacei	n [range]	n [range]
✓ *Balaenoptera physalus*	1	24[1-3]
✓ *Physeter macrocephalus*	1	5[1-2]
✓ *Stenella coeruleoalba*	114[1-57]	280[1-170]
✓ *Tursiops truncatus*	7[1-6]	8[1-8]
✓ *Grampus griseus*	0	4[2-19]
✓ *Globicephala melas*	0	5[6-14]
✓ *Ziphius cavirostris*	1	4[2-3]
Rettili		
✓ *Caretta caretta*	9	174[1-2]
Elasmobranchi		
✓ *Mobula mobular*	0	76[1-3]
Osteitti		
✓ *Mola mola*	95[1-3]	89[1-3]

Conclusioni - Il *line-transect sampling* da piattaforma aerea ha permesso di ottenere, per la prima volta dall'istituzione del Santuario Pelagos (2001), robuste informazioni sulla presenza e distribuzione dei cetacei e su altre specie protette (*M. mobular*, *C. caretta*) utili per le future azioni di conservazione. Nel *line-transect sampling* si assume che gli animali sulla linea del transetto siano sempre avvistati [g(0) = 1] (Buckland *et al.*, 2001); tuttavia il loro comportamento può renderli indisponibili (*availability bias*) o l'avvistatore può non osservarli, per fattori meteo climatici o relativi alle proprie capacità (*perception bias*). Quest'ultimo si può considerare trascurabile per alcune specie di cetacei, mentre una correzione della presenza in superficie, con dati di telemetria, è necessaria per l'*avaibility bias,* sopratutto per le specie non legate alla superficie da esigenze respiratorie, per una corretta stima di abbondanza. Per la balenottera comune è stata riscontrata una riduzione numerica estiva rispetto a precedenti *survey* navali (Forcada *et al*., 1995), mentre è stato registrato un solo avvistamento invernale.

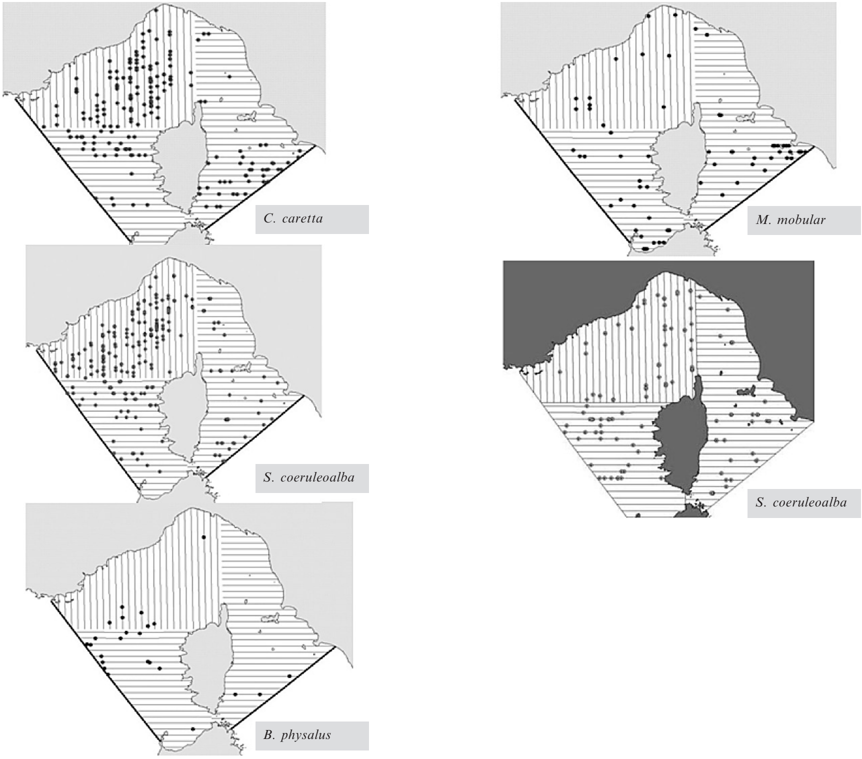

Fig. 1 - L'area di studio e la distribuzione degli avvistamenti per *C. caretta* (estate), *M. mobular* (estate), *S. coeruleoalba* (estate – inverno) e *B. physalus* (estate).

The study area and the sighting distributions of C. caretta *(summer),* M. mobular *(summer),* S. coeruleoalba *(summer – winter) and* B. physalus *(summer).*

Drastiche differenze tra inverno ed estate sono state rilevate anche per la *S. coeruleoalba*, la *C. caretta* e la *M. mobular.*

I vantaggi nell'uso della piattaforma aerea, rispetto alla navale sono:

- ✓ cospicuo sforzo di ricerca in tempi ridotti;
- ✓ esatto conteggio degli esemplari;
- ✓ possibilità di sfruttare al meglio le condizioni meteomarine idonee alla ricerca per l'elevata velocità di "trasferimento";
- ✓ minimo disturbo arrecato agli animali e vantaggio per le stime numeriche che da questo fattore possono essere condizionate;
- ✓ in considerazione dei punti elencati, si ottengono stime robuste (I.C. e C.V., bassi);
- ✓ impiego di sole tre unità di ricerca;
- ✓ opportunità di osservare fauna non oggetto principale della ricerca e maggiore *output* scientifico.

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CITIZIENS SCIENCE EDUCATION: A CHALLENGING TOOL FOR MONITORING MPAs BIODIVERSITY AND ENVIRONMENTAL QUALITY

L'EDUCAZIONE DEL CITTADINO ALLA SCIENZA: UNO STRUMENTO INNOVATIVO PER MONITORARE BIODIVERSITÁ E QUALITÁ AMBIENTALE DELLE AREE MARINE PROTETTE

Abstract *– The employment of volunteer amateur naturalists in scientific data collection is becoming a necessity worldwide due to the unwise lack of investment of the Human Society in exploring Nature in traditional ways (e.g. Species identification and description in their "pristine" environment). In this paper we report preliminary results of two Academic-based pioneering projects of people's science education aiming at scientific data collection in Marine Protected Areas: For-Mare, AMP Isole Pelagie (AG); Seawatching Volunteer Monitoring Programme, AMP 'Cinque Terre', (SP). These experiences had positive implications in conservation, supporting biodiversity knowledge and extending scientific interest to the public.*

Key-words: *Marine Parks, Biodiversity, Conservation*

Introduction – Marine protected areas (MPAs) represent the first real engagement of public administration to preserve marine biodiversity. There are 23 established MPAs in Italy, 2 submerged parks and 1 mammal sanctuary willing to protect about 200,431.53 10^3 he of sea and about 700 km of littoral. MPAs are recognised by the scientific community as important study sites: remaining of pre-industrial ecosystems, good reference condition areas for understanding and monitoring marine ecosystems quality. Legal boundaries are far from being effective both against conventional anthropogenic pollutants (Montefalcone *et al.*, 2009) or the more insidious menace of biological pollution (Olenin *et al.*, 2007). However, alternative systems to prevent marine biodiversity loss are lacking. A key issue for increasing conservation efficacy of a protected area is the development and wise management of sustainable tourism. The experience of Participatory Monitory Programme organizations operating in several European countries reports a successful combination of data-gathering activities and social experience. They empathise the enthusiasm as the most important driver for the expansion and sustainability of volunteer participation and participant's motivation represents the starting point for obtaining trust, respect, recognition, value and enjoyment for the environment (Bell *et al.*, 2008). Along the UK coasts, 'Seasearch' project (http://seasearch.wisshost.net) is an example of how volunteer sport divers can contribute in protecting the marine environment. In a country where there are very few MPAs, Seasearch and its volunteer and academic divers allowed to map out the various types of sea bed found in the near-shore zone, to recognize what lives in each area, to establish the richest sites for marine life and the sites which need protection around the whole of the Britain and Ireland. In Italy similar programs have been recently developed, including: the CEM project (Coastal Environment Monitoring Protocol), involving recreational scuba divers in monitoring activity all along the whole Italian littoral (www.progettomac.it); Seawatching Volunteer Monitoring Programme (SVMP) promoted by Parco Nazionale delle Cinque Terre (http://www.parconazionale5terre.it/) and the newly promoted project 'For-Mare: training and research in marine protected areas' (www.for-mare.eu) for university students, school teachers and citizens. Started in 2007, SVMP is the result of interest showed by the participants who took part to snorkelling week-ends for tourists and residents proposed by the Seawatching group. The regular participation of the same people for several years and their enthusiasm in learning about marine life gave birth to data-gathering activity involving volunteers who spend week-ends doing snorkelling and collecting data on habitat and species that characterize the MPA of 'Cinque Terre'. For-Mare started in summer 2009 as a pilot project which involved students from the University of Pavia who took part to a summer stage in marine ecology and geobotany and developed scientifically relevant studies on population ecology of marine species (Raineri and Savini, 2010) and terrestrial flora (Di Silvestro, unpublished data) in the MPA of Isole Pelagie, AG. The aim of this paper is to report the experiences and preliminary results obtained from these last two mentioned projects (SVMP; For-Mare) by arguing their future development in the light of valuable scientific data collection.

Materials and methods – (1) SVMP was conducted in 'Cinque Terre' MPA from July to September 2007, 2008 and 2009. Volunteers were organized to work in couple and each couple received an underwater board, pencil, waterproof-sheets for recognizing Mediterranean marine organisms (fishes, benthic organisms, algae and plants) and for evaluating cover (for benthic organism) and size (for fishes) classes. For each investigated site, couples reported the name of the site, locality, maximum depth, duration of the survey, visibility and seawater temperature. Habitats such as supralittoral, rocky shore, *Posidonia oceanica* meadow and cave were investigated and from 1 to 3 habitats were monitored during each survey. Data on both benthic and pelagic species for each habitat were collected. For benthic organisms, species' names were reported and data of abundance (number of individuals) or cover range (%) were given using a quadrat (50×50 cm). Regarding pelagic species, visual-census techniques were applied: couple of volunteers looked at different directions and monitored an area of 5 m^2 for 5 minutes. 3 replicates were made by each couple. Name of the species, number of individuals and size classes (cm) were reported. For planktonic organisms (*Ctenophora* and *Scyphoza*) number of individuals and distances among them were recorded.

(2) For-Mare pilot stage was conducted in June 2009. Nineteen participants followed a one-week summer course in Linosa Island- Isole Pelagie. Training was provided by a marine biologist, a geobotanist and a scuba diving instructor. The stages provided fundamental knowledge in marine biology and geobotany (taught courses), followed by field work activity (snorkeling and trekking). The first halve of the week students followed demonstrations concerning commonly non-destructive methods used for marine (bionomic transect, quadrats) and terrestrial (floristic surveys, morphometric analysis) census in population ecology studies. The second halve of the week students were requested to perform an original study by organising them in four working groups. Each groups developed experimental design, data collection, interpretation and presentation of results under teachers' supervision. At the end of the stage the four studies were presented in a final open public assembly on the island with participation of tourists and stakeholders. Data quality control was guaranteed by a scientific steering committee of researchers and university professors that at the end of the season had the commitment of refereeing study outputs and help scientific dissemination in conferences and meetings.

Results - (1) Data from SVMP surveys conducted between July and September 2009 are reported. Monitoring in cave (Manarola) revealed the presence of *Parazoanthus axinellae* (cover: 10-30%.m^{-2}) from 1.5 to 3 m of depth on the southern walls, *Corallina comune* covered the intertidal area (cover: 10-30 %.m^{-2}) extended from the entrance to 3 m within the cave, mainly on the southern wall. Two juveniles of *Octopus vulgaris* (size: ~30 cm tentacles included) were found during the surveys. At the entrance of the cave several individuals belonging to *Ctenophora* taxon (number: 20 indiv./5m^2, distance: <1 m) were floating and within *P. oceanica* patches (depth: 7 m) two *Pinna nobilis* (size: 50-80 cm) were found. Surveys on the supralittoral habitat revealed the dominance of three taxa *Balanus* sp., *Littorina* sp. and *Verrucaria* sp. The highest densities for both *Balanus* sp. (>100 ind.m^{-2}) and *Littorina* sp. (>150 ind.m^{-2}) were found on natural rock while lowest densities (30-50 ind.m^{-2} for both *Balanus* sp and for *Littorina* sp.) were found on anthropogenic substrate (concrete walls). The presence of *Verrucaria* (cover: 60-80% m^{-2}) were also recorded on natural substrate starting from 1 m above the sea-level. Surveys conducted along the coast from the beach of Riomaggiore to Punta Montenero revealed the presence of *Pelagia noctiluca* (3 indiv./5m^2, distance: 2m), one *Balistes carolinensis* (size: >30 cm), 3 individuals of *Ephinepelus marginatus* (size: 30-50 cm), 2 *Dicentrarchus labrax* (size: >30 cm), 2 *Sparus aurata* (size: 10-20 cm), 2 *Muraena helena* (size: 1 m), shoals of *Lithognathus mormyrus* (number: 20, size: 10-20 cm), *Diplodus* sp. (number: >50/5 m^2, size: 30-50 cm) and *Oblada melanura* (number: >50/ 5 m^2, size: 10-20 cm).

(2) For-Mare pilot stage in Linosa Island provided original data on:

a) distribution density and acclimation status of the tropical Atlantic crab *Percnon gibbesi*, which has been found distributed all along the 11 km littoral of the island from 0-4 m depth in a characteristic habitat made of large boulders covered with coralline algae (*Mesophyllum* sp, *Amphiroa* sp.). In these localities mean population density ranged from 30-50 ind. 10 m^{-2}. Maximum density values were recorded in one locality, Casotto (Casotto–DDD= 35.855440N; 12.866664E; mean density=51±28 ind. 10 m);

b) distribution and ecology of the actinian *Cereus pedunculatus.* The species is found in a very restricted bathymetrical range on the island (10-160 cm) with maximum densities reported in one locality, Casotto (Casotto–DDD= 35.855440N;12.866664E; mean density=6±2 ind. m^{-2}). Biometrical comparisons (maximum diameter of the oral disc) between two subpopulations (Casotto, Pozzolana di Ponente) revealed that significant (ANOVA; $p<0.05$) larger specimens live in Casotto (4,9±2,7 cm). This locality seems to provide the best microhabitat for the species, very sheltered from currents with a mixed bottom of made of boulders, volcanic gravel and sand, in which *C. pedunculatus* completely buries and hide;

c) 4 morphological characterization of *Pancratium linosae*, an endemic species of Linosa Island firstly reported by Lojacono (1909), were made. Very similar to *P. maritimum*, a common species growing in sandy Mediterranean coastal habitats, *P. linosae* with its characteristics could be included in the variability of *P. maritimum*. The study is currently on-going and differences between the two species will be tested performing also genetic analysis;

d) floristic surveys confirmed the presence of species reported from literature of the island but also some autochthonous and alien species, new for the island, were found.

Conclusions – Both projects provided original data on community composition and an population structure of marine and terrestrial (plants) organisms in the two study areas. Marine research activities, being conducted in snorkeling, focused on a particularly delicate zone of MPA: from 0-5 m depth - the supra, medium and superior infralittoral fringe - corresponding to the most impacted zone by bathers, and ecologically, to recruitment sites for many marine organisms. Snorkelers data supply provides a real added value to conventional scientific research that usually focus on the inferior infralittoral fringe (common methodologies involve scuba diving, scientific vessels and remote equipment, e.g. ROV) by completing data collection and conservation status assessment. Volunteer and students research activities can be structured both in order to monitor community composition (e.g. SVMP) or population structure of key species (e.g. invasive alien species, For-Mare). In conclusion, as already demonstrated by other experience (Dehrr *et al*., 2007; Bell *et al.,* 2008), people science's education programs for scientific purposes should be considered as useful research tools for conservation biology purposes in Italian MPAs. A well structured and integrated management of data output from volunteers programs could represent a clever system to fill gaps of knowledge caused by limited research funding, with the associated side-effect of developing people motivation for environmental protection and sustainable tourisms in MPAs. Taking into account the above considerations, the establishment of a national network of interest that guarantees scientific level and quality control of data output from such volunteer programs (see www.for-mare.eu aims and objectives) could be an important issue to discuss amongst SIBM.

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TOWARDS THE MANAGEMENT OF TRANSITIONAL WATERS: ASSESSING THE POTENTIAL OF BENTHIC TOOLS

LA RISPOSTA DI INDICATORI BENTONICI PER LA VALUTAZIONE DELLA QUALITÀ NEGLI ECOSISTEMI COSTIERI DI TRANSIZIONE

***Abstract** – In order to assist decision-makers towards the management of coastal transitional waters, we tested the potential of three benthic indices (AMBI, M-AMBI and BITS) in hundreds stations from Italian CTEs, from the Northern Adriatic to Sardinia. Our study highlights i) a high correlation between AMBI and BITS results, despite the different level of taxonomic identification needed, ii) a high correlation between M-AMBI and species' diversity and richness, iii) that M-AMBI overweights the number of species since in its calculation they are counted twice, iv) that M-AMBI acts as a "diversity-corrected AMBI", and, thus, v) it suffers of the reduction of species number along the transitional gradient. This study suggests that in such environments M-AMBI classification seems unable to capture some peculiarities of benthic assemblages in transitional waters. The unmodified use of these indices might impair accurate assessment of ecological quality status and decision-making on the managers' point of view.*

Key-words: *biodiversity, environmental management, coastal transitional ecosystems.*

Introduction - Italian coastal transitional ecosystems (CTEs) exhibit different and peculiar characteristics depending on their geographical, hydrodynamic and ecological features, and are characterised by progressive changes in several environmental variables, often mutually dependent or correlated. These variations generate composite gradients that involve salinity, marine water renewal (e.g. residence time), nutrients, turbidity and sediment structure. (Tagliapietra *et al.*, 2009). CTEs also display distinctive features in terms of their extraordinary history of environmental management, the importance of their productivity and associated economical value, which is reflected on the peculiarity of their fauna (Cognetti and Maltagliati, 2008). Along Italian coasts there are almost 170 CTEs, but 140 of them have a surface area <10 km^2. With the exclusion of Orbetello Lagoon (Central Tyrrhenian Sea), all the largest CTEs are located along the Western Adriatic coasts, and, apart the Apulian Lesina and Varano Lakes, they are all concentrated in the Northern Adriatic area. This study represents a contribution towards the assessment of the potential of benthic indices for environmental quality assessment of Italian CTEs.

Materials and methods – We used soft-sediment benthic macrofaunal inventories gained through several research programs that we carried out on several CTEs located along the Italian coasts: Venice Lagoon, Sacca di Scardovari, Sacca di Goro, Valle di Gorino, Valli di Comacchio (Northern Adriatic), Lesina Lagoon (Southern Adriatic), S.Giusta and Cabras Lagoons (Sardinia Island). The macrofauna was collected with a Van Veen grab (area: 0.027 m^2; volume: 4 l) in triplicate. Taxonomic identification was carried out to the species level whenever possible. Abundance of species at each sample was averaged for each station at each sampling time, leading to a total number of over 400 stations. Three different biotic indices were calculated for each site, namely AMBI (Borja *et al*., 2000) and M-AMBI (Muxika *et al*., 2007), and BITS (Mistri and Munari, 2008). AMBI and M-AMBI were calculated using the freeware program available on www.azti.es. For M-AMBI, reference conditions were: status High, muddy habitats: AMBI=1.67, Diversity=3, Richness=37; sandy habitats: AMBI=1.54, Diversity=3.93, Richness=39; status Bad, all habitats: AMBI=6, Diversity=0, Richness=0. BITS was calculated using the freeware program available on www.bits.unife.it. Regression between indices was performed not using the EcoQ status but the numerical score of each index in each station. Significance was assessed through regression ANOVA. Finally, the relationships between different indices and benthic community attributes were also investigated by means of regression analysis and ANOVA.

Results - Because of the physiographical characteristics of Italian CTEs (closed lagoons have no sandy bottoms, while in semi-closed lagoons sand is found only in proximity of seamouths), the majority of our stations were on mud. Annelida largerly dominated in both habitats: *Polydora ciliata*, *Capitella capitata*, *Heteromastus*

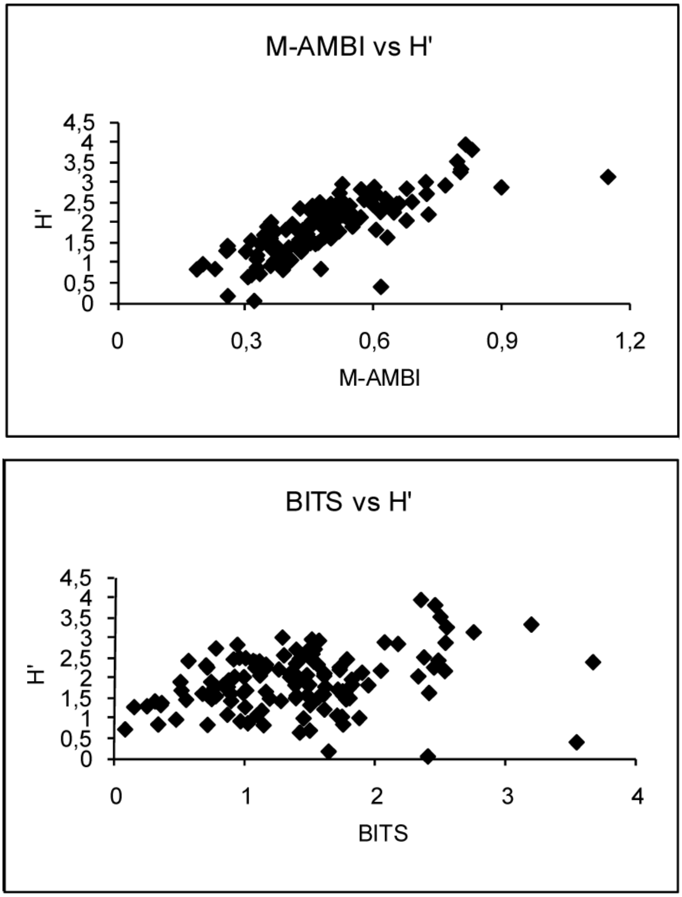

Fig. 1 - Example of relationships between M-AMBI and BITS with diversity in the Po Delta stations.

Esempio della relazione tra M-AMBI e BITS con la diversità nelle stazioni del Delta del Po.

filiformis, *Streblospio shrubsolii*, *Prionospio caspersi*, *Spio decoratus*, *Neanthes succinea* and *Tubificoides vestibulatus* were the most common taxa. Among Crustacea, *Corophium insidiosum* was often recorded with elevated dominance at stations characterized by freshwater inputs, and Gammaridea (*Microdeutopus gryllotalpa*, *Gammarus insensibilis*) were often found associated to macroalgae (mostly *Gracilaria* sp. and *Ulva* sp.). The snail *Hydrobia ventrosa* was often abundant on decaying macroalgal remnants. On mud, richness and diversity were lower, and generally fewer taxa resulted as dominant. Regression between indices allowed us to assess whether the different indices displayed similar tendency in the classification of sites, i.e. it permitted to assess if two indices ranked the sites from worst to best in the same way regardless of the precise classes of EcoQ. Linear regression of BITS and AMBI/M-AMBI accounted for 44% and 36% of the variability of the entire dataset, respectively, with quite a low degree of dispersion over the entire range of both indices. The ANOVA of both regressions was highly significant. It meant that the BITS, AMBI and M-AMBI indices basically ranked stations in the same way from worst to best ecological condition. Only M-AMBI evidenced a very strong relationship with diversity (Fig. 1) and richness, with a low degree of dispersion of points on the graphs. This observation may seem quite trivial, since diversity and richness are the two metrics, together with AMBI, used in the multivariate formulation of M-AMBI. On the other hand, BITS and, to a lesser extent, AMBI showed quite a clear "tendency" to increase (the former) and decrease (the latter) with increasing diversity and richness.

Conclusions – This study provides a good example from a comprehensive large dataset of the levels and ranges of benthic pattern which can be encountered in Italian coastal transitional ecosystems. The pattern of ecological quality status of Italian CTEs obtained by applying three benthic indices was not always concordant, depending to the index selected. In spite of their diversity, these indices are based on the same paradigm: disturbances are generating secondary successions during which tolerant species are at first dominant and then progressively replaced by sensitive species (Pearson and Rosenberg, 1978). In CTEs, an index to be useful should display some "plasticity" in considering anthropogenic or natural disturbance. Ruellet and Dauvin (2007) argued that the inclusion of Shannon diversity and species richness in M-AMBI computation gives too much weight to diversity. Results from this study confirm previous observations (Ruellet and Dauvin, 2007) in Adriatic CTEs, and add the hypothesis that M-AMBI robustness is reduced under low salinity conditions. Conversely, AMBI and BITS, giving no weight to diversity but considering only the ecological meaning of species (or families) produced different classifications respect M-AMBI. In transition environments, chemical-physical parameters can represent limiting factors for species. In particular, salinity plays the most important role, since the distribution of organisms can be established in relation to isohalines (Cognetti and Maltagliati, 2000). The steno and euhaline species living in these environments follow a gradient of resistance to the increasing environmental stress, and at a critical salinity level (5-10 psu) there is a sharp numeric drop in species richness (Cognetti and Maltagliati, 2000)). The distribution pattern of the benthic fauna is similar to that found in polluted waters, since diversity and richness tend to decrease towards the source of disturbance, according to the Pearson and Rosenberg (1978) paradigm. But, as remarked by Cognetti and Maltagliati (2000) the difference as compared to CTEs lies in the fact that the maximum critical point in polluted waters corresponds to disappearance of the fauna, while in CTEs to a community made up of few taxa better adapted to low (or very variable) salinity. M-AMBI classification is too much dependent on diversity and richness, and seems unable to capture some peculiarities of benthic assemblages in transitional waters. On the other hand, AMBI and BITS gave often similar classifications, despite the different level of taxonomic identification needed (at the species level for AMBI and at the family level for BITS). Our study highlights i) a high correlation between AMBI and BITS results, ii) a high correlation between M-AMBI and species' diversity and richness, iii) that M-AMBI overweights the number of species since in its calculation they are counted twice, iv) that M-AMBI acts as a "diversity-corrected AMBI", and, thus, v) it suffers of the reduction of species number along the transitional gradient. Finally, most benthic indices require the use of the species level as the level of identification. According to the taxonomic sufficiency principle it is possible to use the genus or the family level of identification, thus reducing the cost of obtaining results in routine monitoring programs. Despite the AMBI check-list contains the benthic taxa at the species level, the taxonomic sufficiency principle is already present in the list since it also provides the ecological status of most of the genus, families and also higher taxonomic levels (e.g. *Hydroides dianthus*, *Hydroides* sp., Serpulidae; *Tubificoides swirencoides*, *Tubificoides* sp., Tubificidae, Oligochaeta; *Heterotanais oerstedi*, *Heterotanais* sp., Tanaidacea; etc.). A genus or family level of identification for the WFD implementation in the benthic compartment of Italian CTEs might be sufficient for evaluating the status of such water bodies.

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ASPECTS OF BIODIVERSITY IN THE INFRALITTORAL OF ENFOLA ISTMUS (ELBA ISLAND)

ASPETTI DI BIODIVERSITÀ NELL'INFRALITORALE DELL'ISTMO DELL'ENFOLA (ISOLA D'ELBA)

Abstract *– The northern and southern areas of the Enfola istmus (Elba Island) are analyzed to evaluate the biodiversity and conservation status of sea environment. A high level of biodiversity is present, in particular in southern coast, above all in regard to Gastropods and Polychaetes community. The study puts in evidence in both the areas the presence of a wide, well preserved* Posidonia oceanica *meadow and numerous specimens of* Pinna nobilis*, mainly juvenile in the southern area of the istmus.*

Key-words: *Gastropods, Polychaetes,* Posidonia oceanica*,* Pinna nobilis*, Elba Island.*

Introduction – The only established SIC (Site of Community Importance) in the Elba Island is the one named "Capanne Mountain and the Enfola Promontory"; it protects only the land environment. Enfola Promontory is joined to island by an istmus (Fig. 1) placed in N-S direction. At present, data relevant to the marine habitat of the Promontory do not exist.

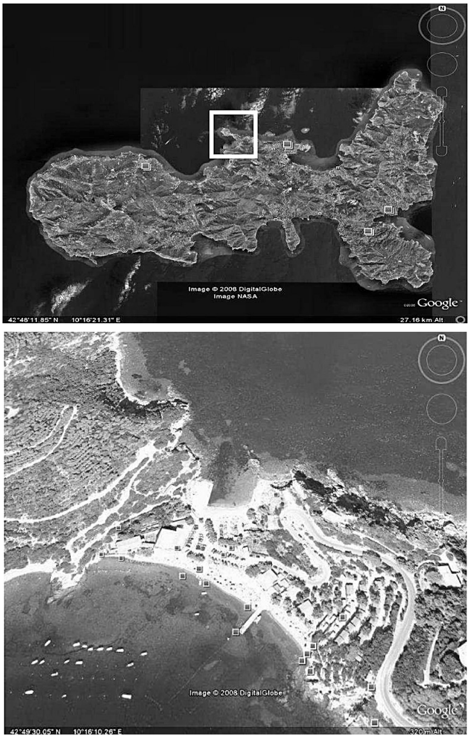


Fig. 1 - Site of the study: Elba Island and detail of Enfola istmus (source: Google Earth).
Area di studio: Isola d'Elba e dettaglio dell'istmo dell'Enfola (fonte: Google Earth).

The aim of this research is to evaluate the health status of the marine environment in northern and southern areas of the istmus through a preliminary description of the: 1) benthonic community of mesolittoral and upper infralittoral hard bottom; 2) *Posidonia oceanica* meadow growing on soft bottom in the two areas.

Materials and methods – At first, data on biology, ecology, geomorphology and vegetation were collected. Then four sampling stations were located in each area (N and S): two on natural hard bottom (granitic and calcareus rocks) and two on artificial hard bottom (mole and quay). The sample and its replicate were collected at the maximum depth of 1 m, in spring (May) and autumn (September, 2008), by scraping of an area of 400 cm^2 (Bianchi *et al.*, 2003). For each of the 16 samples (more 16 replicates), the main macroalgal *taxa* were identified; Molluscs (Poliplacophora, Gasteropoda and Bivalvia), Polychaetes and Decapods were identified at specific level (Bianchi *et al.*, 2003). The quantitative and qualitative results as well as the environmental factors, like seasonal hydrodynamism, wind exposition and substratum, were analyzed through *Cluster Analysis, n-MDS Analysis*, and *Symper Analysis* using Primer v6 β. The biodiversity level was assessed by means of Shannon-Weaver Index. As regard *Posidonia oceanica* beds, shoots density in upper, middle, and lower zones, maximum depth and type of the lower limit were analyzed (Buia *et al.*, 2003). In addition, a *Pinna nobilis* population, present in upper zone of the southern meadow, was studied in detail; for each specimen, settlement depth was noted down, maximum width and length of the bigger valve were measured.

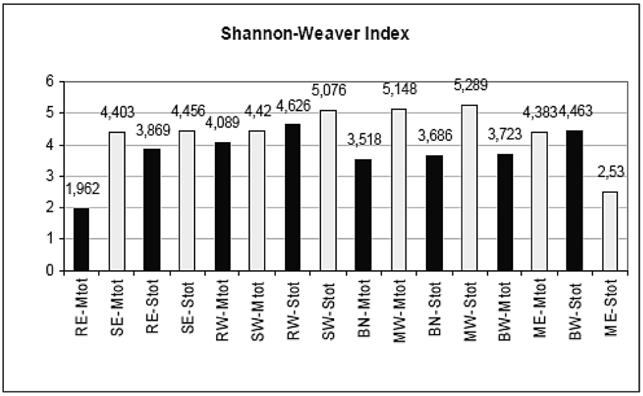
Results – The northern coast is in front of the open sea and exposed to winter winds action (high hydrodynamism area); the southern coast is located inside the Viticcio Gulf and sheltered from these winds (low hydrodynamism area). Photophilic algae community is typical of mesolittoral and upper infralittoral hard substrata: *Cystoseira* spp., *Padina pavonica*, *Stypocaulum scoparium*, *Rissoella verrucolosa*, *Acetabularia* spp. are the main observed *taxa*. In N area 2591 specimens, belonging to 98 species (37 Molluscs, 49 Polychaetes, and 12 Decapods), were identified compared to the 2201 ones, belonging to 157 species (63 Molluscs, 73 Polychaetes and 21 Decapods), in S area. Thirty-eight species characterized N area, 93 species the S one; 64 species are common to both areas. In the southern part of the istmus, species typical of high hydrodynamic conditions, such as the Polychaetes *Syllis armillaris* and *Perinereis cultrifera* (Bellan, 1969), were found.

In the two sites, Polychaetes are the richest *taxon* as regard the number both of species and specimens; a conspicuous quali-quantitative increase of this *taxon* is evident in September, more pronounced in respect to the other *taxa*.

The total biodiversity level is high in all the stations: Shannon-Weaver Index shows noticeable values, especially as regard the samples relevant to the S area (Fig. 2).

Results show that surface hydrodynamism is the main environmental factor of dissimilarity between the two areas, despite the scarce distance (less than 80 meters) which separates them. Benthonic community of northern area, exposed to winter winds action, is more heterogeneous; on the contrary, the community of the southern one seems to be more influenced by the type of substratum rather than by the hydrodynamism (Fig. 3).

The abundance (number of specimens) of the species typical of the photophilic algae biocoenosis (Gastropods *Bittium latreillii*, *Bittium reticulatum*, *Cerithium vulgatum,* and Polychaetes *Polyophthalmus pictus*, *Platynereis dumerilii* and *Syllis prolifera*), present in both areas, is another of factors which differentiate the northern and southern benthonic community, such as *Symper Analysis* demonstrates. Dissimilarity is evident in Spring, when hydrodynamic conditions are more marked and different between areas.



Legend
RE = rocky bottom, E side, N area
SE = rocky bottom, E side, S area
RW = rocky bottom, W side, N area
SW = rocky bottom, W side, S area
BN = quay, N side, N area
ME = mole, E side, S area
BW = quay, W side, N area
MW = mole, W side, S area
-M = samples of May
-S = samples of September

Fig. 2 - Shannon-Weaver Index. N area samples (sample and replicate) in black, S area samples (in grey).

Indice di Shannon-Weaver per i campionamenti (campione e replica) nell'area N (in nero) e nell'area S (in grigio).

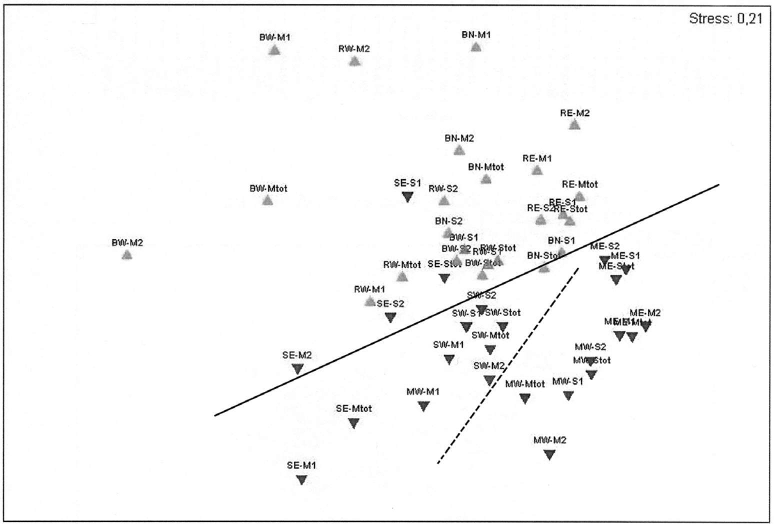


Fig. 3 - n-MDS Analysis. Samples relevant to N area, in grey; samples relevant to S area, in black. Continuous line separates the two areas, dashed line separates the two types of substratum (S area).

n-MDS Analysis. In grigio, i campioni relativi all'area N; in nero, i campioni relativi all'area S. La linea continua evidenzia la separazione tra le due aree, mentre il tratteggio separa i due tipi di substrato (area S).

With respect to *Posidonia oceanica*, the study shows a progressive and deep lower limit (-35.7 m in N area, and -36 m in S area). Meadows are well-preserved, as shoots density data demonstrate in upper, middle and lower zones (Pergent, 1995 in Buia *et al.*, 2003). Disturbance indices were observed in the upper zone of the both meadows, emphasized by sandy areas in which the plant is absent. It is possible to hypothesize that the disturbance is the consequence of high hydrodynamism in N area and the human impact in the S one.

Pinna nobilis, present in both the meadows, constitutes a population in the S area, where 29 juvenile clams are counted. The length of biggest valve vary between 7.9 and 26.7 cm, the width between 7.2 and 23.5 cm. The specimens are settled between -3.2 and -6.1 m.

Conclusions – For the first time a preliminary analysis of the marine benthonic community of the Enfola istmus has been performed. In future, data on algal biodiversity, streams trend, and human impact need to be studied in detail as well as the communities of the lower infralittoral zone. Nevertheless, the presence of a rich biodiversity and species ascribed to Habitat Directive (*Posidonia oceanica* and *Pinna nobilis*) must be an incentive to preserve the marine areas. The Laboratory Zoology and Marine Biology of the Turin University has just asked to Environmental Ministry to include in the existing SIC area also the marine environment of the Enfola itsmus.

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Biol. Mar. Mediterr. (2010), 17 (1): 59-62

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DECADAL EVOLUTION OF A CORALLIGENOUS ECOSYSTEM UNDER THE INFLUENCE OF HUMAN IMPACTS AND CLIMATE CHANGE

EVOLUZIONE DECENNALE DI UN ECOSISTEMA CORALLIGENO SOTTO L'INFLUSSO DEGLI IMPATTI ANTROPICI E DEL CAMBIAMENTO CLIMATICO

Abstract *– Long-term change in the coralligenous community of Punta Mesco (Ligurian Sea) was evaluated merging qualitative information contained in descriptive papers since 1937 with quantitative data obtained from discontinuous photographic surveys since 1961. Increased sedimentation rate and surface-water temperature were responsible for the major changes observed in benthic assemblages.*

Key-words*: coralligenous, long-term change, UW photography, Mediterranean Sea.*

Introduction - Marine coastal ecosystems are among the most vulnerable to global change. The best way to evaluate their decadal-scale variation is to monitor locations where long-term series are available (Bianchi and Morri, 2004). Yet, data sets encompassing time scales longer than a few years are scarce, especially for Mediterranean rocky benthic communities. Nevertheless it is possible to reconstruct

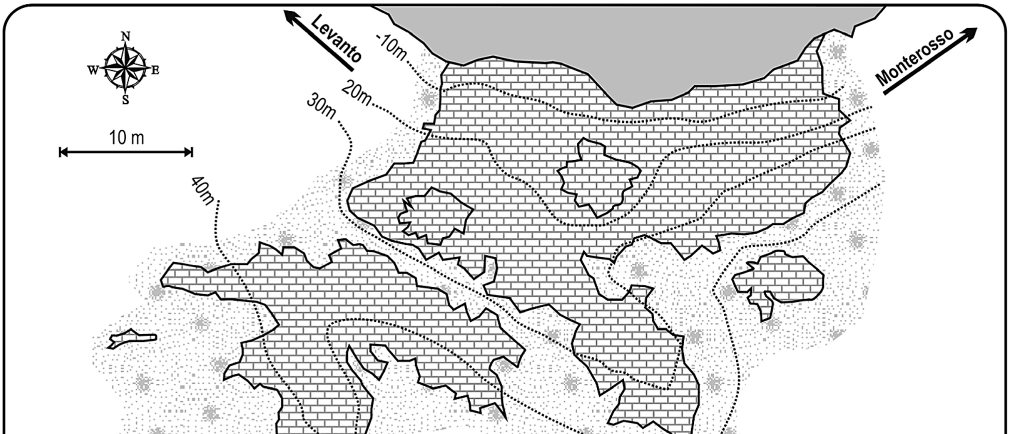

Fig. 1 - Gross morphology of the shoal off Punta Mesco (from Salvati 1997, modified).
Morfologia approssimativa della secca di Punta Mesco (da Salvati 1997, modificata).

the ecological history of an individual community revisiting a site where previous information is available, in the bibliography or in the archives of research institutes. This study explores such a possibility in the case of a coralligenous community, for which knowledge about vulnerability to human impacts and climate change is urgent (Ballesteros, 2006).

Materials and methods - We attempted to assess a 50 years time-scale change of a coralligenous community located on a shoal off Punta Mesco, Ligurian Sea (Fig. 1), comparing biotic cover data collected in 1961, 1990, 1996 and 2008 through underwater photography at about 20 to 45 m depth. These quantitative data have been supplemented with qualitative information, gathered from the analysis of several descriptive studies carried out since 1937 (Tab. 1). Merging qualitative information

Tab. 1 - Available information on Punta Mesco benthic assemblages.
Informazioni disponibili sulle comunità bentiche di Punta Mesco.

Year	References	Kind of data	Notes
1937	Tortonese and Faraggiana, 1937	Qualitative description of the bottoms off Levanto	Presence of *Eunicella verrucosa, Paramuricea chamaleon* and *Petrosia dura*
1960	Rossi, 1961	Species list, qualitative data about gorgonian assemblages	At 20-25 m abundance of *Eunicella stricta*; at 30 m dominance of *Paramuricea chamaleon*, followed by *Leptogorgia sarmentosa, Eunicella verrucosa, Gerardia savaglia*
1960	Rossi, 1965 a	Influence of environmental factors on gorgonian assemblages	Mud favours *Eunicella verrucosa, Alcyonium coralloides, Cellaria fistulosa*. Some bryozoans and corals are tolerant to mud while sciaphilic species thrive in shallower waters because of water turbidity
1960	Rossi, 1965 b	Quantitative biotic cover data from underwater photographs	Use of cover index and bottom classification based on slope and depth; abundance of gorgonians, especially *Paramuricea chameleon*, frequency of *Gerardia savaglia*
1975	Associazione Subacquea Parmasub, 1976	Photographic documentation, qualitative data, species list	Absence of pollution, clear water, scarce differences comparing to Rossi (1965 a, b)
1978	Andreoli *et al.,* 1979	Qualitative data on benthic communities off Levanto	Good state of conservation of benthic assemblages, presence of *Paramuricea clavata* at depths shallower than usual
1985	Relini *et al.*, 1986	Video of bottoms using a ROV, qualitative benthic assemblages description, comparison with Rossi, 1965 a, b	Scarcity of *Eunicella singularis*, lack of *Gerardia savaglia*, and *Paramuricea clavata* reduction especially at depth; intense turbidity from 25 m depth and high sedimentation rate at the bottom
1988	Peirano and Tunesi, 1989	Underwater photographs, quantitative data on anthozoans, comparison with Rossi, 1965 a, b	Increased *Paramuricea clavata* and *Leptopsammia pruvoti* cover, and occurrence of the latter at shallow depths; reduction in the number of scleractinian corals
1989	Tunesi *et al.,* 1989	Visual survey, gorgonian assemblages distribution	Map of gorgonian assemblages, occurrence of *Eunicella singularis*
1990	Peirano and Sassarini, 1992	Underwater photographs, quantitative cover data	Biotic cover percentage, abundance of *Paramuricea clavata, Parazoanthus axinellae* and *Leptogorgia sarmentosa*
1996	Peirano *et al.,* 2000; Bianchi *et al.,* 2001; Morri and Bianchi, 2001	Underwater photographs, quantitative cover data	Slight differences with respect to Peirano and Sassarini (1992). Compared with Rossi (1965), lack of *Lithophyllum frondosum, Peyssonnelia* sp. and increase in *Parazoanthus axinellae* and *Leptopsammia pruvoti* cover: algae diminished, while anthozoans increased and were found at shallower depths. Observed change was related to water turbidity and temperature.
2008	Present work	Underwater pictures, quantitative cover data	See text

and quantitative data allowed a conspicuous, although discontinuous, amount of information on the recent history of this coralligenous ecosystem to be analysed.

Results and conclusions - Two major factors influenced the recent evolution of the benthic community: the increased sedimentation rate, and the rising surface-water temperature. Major alterations in species composition and abundance occurred withinthe 1990s mostly due to the increased siltation of the rocky substrates, favoured by coastal works and the appearance of turfs of filamentous algae (including the alien species *Womersleyella setacea*). This altered dramatically the species composition of the understorey assemblage (disappearance of massive sponges, change in bushy bryozoan species, etc.) and reduced gorgonian cover. *Eunicella singularis* has never been found again at shallow depth after the late 1980s, whereas cover and distribution of *Paramuricea clavata* has decreased; no significant change was observed for *Leptogorgia sarmentosa*. However, interpretation of results must be cautious, since quantitative data may differ because of change in photographic techniques (Rolleimarine to Nikonos), quantitative data gathering, inhomogeneous taxonomic resolution, and lack of replication in old surveys. The most evident recent changes, occurred between 1996 and 2008, were the dramatic reduction of *Paramuricea clavata* cover and the invasion by the tropical alien *Caulerpa racemosa*, especially in depth shallower than 35 m (see also Peirano *et al*., 2009). Both changes might be related to the increase of sea-water temperature: downward lifting of the summer thermocline massively killed gorgonians, while the new environmental conditions favoured the spreading and establishment of tropical aliens to the detriment of native species.

This paper is dedicated to the memory of Gianni Roghi (1927-1967), pioneer in scuba diving and UW photography.

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ANALISI COMPARATIVA DI POPOLAMENTI DI GROTTE SOTTOMARINE DIVERSAMENTE FREQUENTATE DALL'ATTIVITÀ SUBACQUEA

COMPARATIVE ANALYSIS OF DIFFERENT MARINE CAVE ASSEMBLAGES CHARACTERIZED BY DIFFERENT INTENSITIES OF DIVING TOURISM

Abstract *– The benthic assemblages of three marine caves from the MPA of Capo Caccia (Sardinia, Italy) have been compared to evaluate the impact of diving tourism. The caves are characterized by three level of divers frequentation, not visited, visited and highly visited. Data evidenced that organisms with erect calcareous skeletons can be the most endangered by divers and the evaluation of skeletons in the bottom sediment a good indicator of the level of impact the cave is undergoing.*

Key-words: *benthos, man-induced effects, caves, marine parks.*

Introduzione - Le grotte sottomarine, incluse tra gli habitat di interesse comunitario della Direttiva Habitat (Direttiva 92/43/CEE), rappresentano ambienti molto fragili e particolari (Pitruzzello e Russo, 2008). Affascinanti per le strutture geomorfologiche naturalmente generate e per gli intimi meccanismi della loro formazione, le grotte marine sono particolarmente interessanti anche per i processi che hanno portato all'evoluzione di endemismi e adattamenti spesso unici (Cicogna *et al*., 2003). Con lo sviluppo delle tecniche dell'immersione subacquea autonoma e successivamente con la diffusione del turismo subacqueo, le immersioni in grotta sono diventate particolarmente appetibili non solo per la bellezza dei paesaggi sottomarini ma anche per il senso di avventura che offrono ai subacquei più esperti.

Le associazioni bentoniche insediate sulle pareti e sulle volte delle grotte sono principalmente composte da poriferi, madreporari, briozoi e policheti tubicoli (Di Geronimo *et al*., 2000). Questi organismi, caratterizzati da scheletri rigidi, in gran parte carbonatici, sono particolarmente fragili e subiscono gli effetti meccanici derivanti dal turismo subacqueo.

La fragilità delle comunità di grotta e il loro elevato valore naturalistico e scientifico richiedono strumenti di valutazione dell'impatto allo scopo di mettere a punto gli elementi di una corretta gestione e fruizione. In questo lavoro, allo scopo di quantificare gli effetti dei subacquei sulla struttura dei popolamenti di grotta, sono state messe a confronto cavità frequentate con altre non frequentate utilizzando un tipo di campionamento conservativo attuato mediante l'utilizzo di video-transetti e la raccolta di sedimenti. Questi ultimi sono spesso ricchi di frazione organogena, in gran parte costituita dai resti scheletrici provenienti delle comunità sessili delle pareti (Di Geronimo *et al*., 2000). Il loro studio fornisce utili indicazioni sull'evoluzione delle associazioni faunistiche all'interno della grotta e sul livello di impatto al quale sono sottoposte.

Materiali e metodi - Le attività sono state svolte nell'ambito del progetto "Studio degli Ambienti di Grotte Marine Sommerse (Codice Habitat 8330) nelle AMP di Pelagie, Plemmirio e Capo Caccia". Nel presente studio sono state prese in considerazione alcune grotte marine localizzate all'interno dell'Area Marina Protetta di Capo Caccia caratterizzate da un diverso livello di impatto.

La grotta Galatea, normalmente non frequentata da subacquei (impatto nullo), è caratterizzata da un'ampia apertura tra 3 e 9 m di profondità, raggiunge la profondità massima di 12 m ed una lunghezza totale di circa 70 m. La grotta Bisbe è sporadicamente frequentata da subacquei (impatto intermedio), presenta anch'essa un'ampia apertura tra 4 e 9 m di profondità e si sviluppa per circa 37 m raggiungendo la massima profondità di 10 m. Infine la grotta del Falco, normalmente frequentata da subacquei (impatto elevato) è una cavità caratterizzata da due ingressi separati da un largo costone, uno a 5 e l'altro a 12 m di profondità. La grotta si sviluppa per 60 m raggiungendo la profondità massima di 12 m.

L'impatto dei subacquei sul benthos delle grotte è stato valutato tramite due diversi metodi in giugno e settembre 2009.

Video transetti sono stati effettuati mediante utilizzo di videocamera digitale (Canon MVX2i) nella zona centrale di una parete e nel centro della volta di ogni grotta ad una distanza di circa 0,5 m. Durante la riproduzione del video ogni 10 secondi è stato operato un fermo immagine dal quale è stato ricavato il ricoprimento percentuale delle diverse specie e/o gruppi sopraspecifici presenti. In particolare sono stati presi in considerazione: poriferi, madreporari, briozoi (eretti) e serpulidi.

Successivamente alle riprese video è stato effettuato il campionamento dei sedimenti con tre repliche per ciascuno dei tre settori. In laboratorio i campioni di sedimento sono stati seccati (in stufa a 60 °C per 48h) e separati mediante setacci di differente maglia (2 mm, 1mm). Si sono così ottenute e pesate tre frazioni (>2 mm; >1 mm <2 mm; <1mm). Solo la frazione >2 mm è stata analizzata allo stereoscopio al fine di identificare i frammenti di organismi a scheletro calcareo che sono stati selezionati e pesati separatamente.

Risultati - Per quanto riguarda la Grotta Galatea (impatto nullo), dall'analisi dei video-transetti emerge che in parete, presso l'ingresso sono maggiormente rappresentati i poriferi e i briozoi eretti; nella porzione intermedia i poriferi sono ancora abbondanti assieme alle madrepore; nel settore terminale la comunità è composta da serpulidi e madrepore. La volta è caratterizzata da poriferi, madrepore e serpulidi che mantengono percentuali abbstanza costanti in tutti i settori. Nei sedimenti è maggiore la frazione granulometrica fine (75%). La parte grossolana è composta da foglie di *Posidonia oceanica* (100%) al fondo della grotta mentre negli altri settori sono presenti frammenti di molluschi (17%), briozoi eretti (6%) e, solamente nel settore esterno, madreporari (6%).

La parete studiata della grotta Bisbe (impatto medio) è caratterizzata soprattutto da poriferi lungo tutto lo sviluppo, le madrepore sono importanti soprattutto nel settore intermedio, i briozoi eretti diminuiscono dall'esterno verso l'interno mentre i serpulidi aumentano verso l'interno. Sulla volta è possibile osservare una presenza maggiore di serpulidi rispetto ai poriferi, mentre il terzo gruppo rilevante rimane quello delle madrepore. Poco significativa è invece la presenza dei briozoi. Nei sedimenti domina (62%) la frazione granulometrica media (>1 mm <2 mm). Un'elevata percentuale della frazione grossolana è rappresentata da frammenti di molluschi (32%) e da serpulidi (10%) mentre risultano completamente assenti i briozoi eretti.

Nella grotta di Falco (impatto elevato) la parete presenta un elevato ricoprimento di poriferi lungo tutto lo sviluppo, madrepore soprattutto nel settore terminale, briozoi eretti e serpulidi che diminuiscono dall'esterno verso l'interno. La volta è caratterizzata da una presenza rilevante di madreporari principalmente nel settore intermedio, di serpulidi principalmente nella parte terminale e di poriferi in prossimità dell'ingresso. I briozoi sono rari. Il corallo rosso è presente solo nel settore intermedio e terminale della volta della grotta. Nei sedimenti domina (60%) la frazione >2 mm. Per quel che riguarda gli organismi a scheletro calcareo la frazione grossolana è rappresentata principalmente da madreporari (27%) e da frammenti di molluschi (20%) e, in misura minore da frammenti di colonie di briozoi eretti (5%) e corallo rosso (2%).

Conclusioni - Il confronto tra le tre grotte ha evidenziato come l'analisi dei sedimenti consenta di definire alcuni possibili indicatori per la valutazione dello stato di fruizione delle cavità. Nella grotta di Falco, maggiormente impattata dal turismo subacqueo, i frammenti di organismi a scheletro calcificato rappresentano il 26,7% in peso del sedimento totale mentre nelle altre due grotte la percentuale è molto più bassa (2 e 1,5% rispettivamente per le grotte Bisbe e Galatea). In questa grotta il maggiore apporto è dato dalle madrepore che contribuiscono al sedimento totale per oltre il 16%. Questo dato può essere solo parzialmente spiegato dalla maggior presenza di questi organismi sulla volta della grotta del Falco come messo in evidenza dai videotransetti (Fig. 1A, B).

Anche i frammenti di serpulidi rappresentano un buon indicatore dell'impatto dei subacquei. Infatti, benché la loro abbondanza sia maggiore sulla volta dalla grotta di Falco, intermedia nella grotta Bisbe e minima nella grotta Galatea, la loro presenza nei sedimenti ha un andamento esattamente contrario (Fig. 1C, D). I briozoi eretti hanno una percentuale di ricoprimento bassa sulla volta delle grotte ma aumentano di importanza sulle pareti. Ciononostante il confronto tra Falco e Galatea indica che anche questo gruppo può rappresentare un utile indicatore (Fig. 1E, F). È probabile che, a causa dell'estrema fragilità del loro scheletro, i frammenti di briozoi nei sedimenti vengono rapidamente resi irriconoscibili. Per questo i briozoi

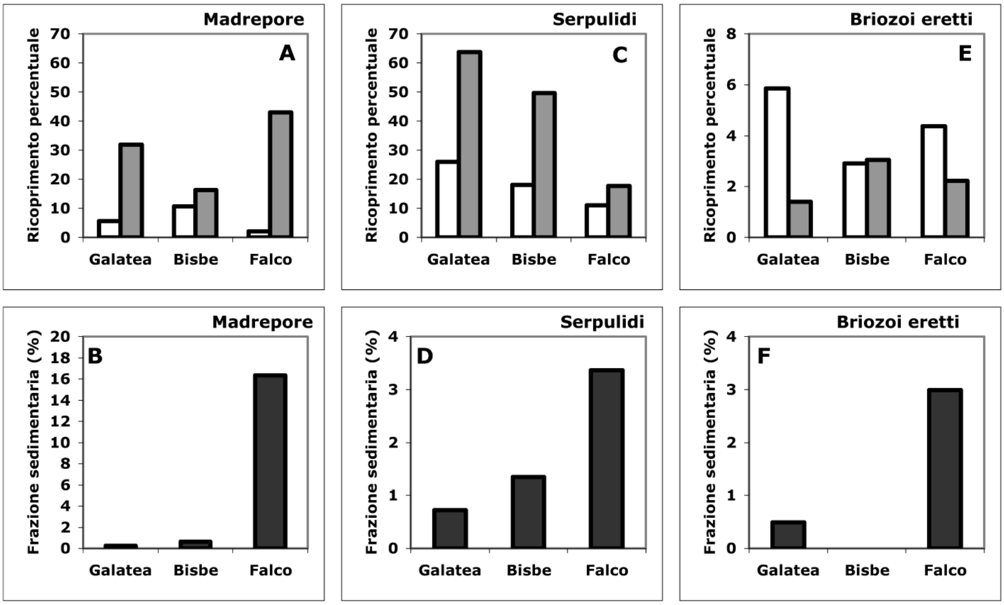

Fig. 1 - A, C, E, percentuale media di ricoprimento dei principali gruppi di organismi sulle pareti (barre bianche) e sulla volta (barre grigie) delle tre grotte. B, D, F, percentuale media del sedimento totale rappresentata da frammenti degli scheletri degli stessi gruppi.

A, C, E, average percent covering of the main groups of organisms on the walls (white bars) and on the roofs (grey bars) of the studied caves. B, D, F, average percent of the total sediment represented by the skeletal fragments of the same groups.

potrebbero essere un indicatore di impatto recente mentre serpulidi e, soprattutto, madrepore, potrebbero meglio spiegare una pluriennale storia di impatto sofferta dalle grotte.

È noto che gli organismi a scheletro carbonatico sono spesso attaccati da poriferi bioperforatori che contribuiscono a staccarli dalle pareti (Cerrano *et al.,* 2001). Anche l'idrodinamismo può giocare un ruolo in questo fenomeno. Benché lo studio dei sedimenti in relazione alle comunità presenti sulla volta e sulle pareti delle grotta rappresenti un utile strumento nel valutare lo stato di sofferenza dovuto all'ingresso di subacquei è necessaria, in questa valutazione, una buona conoscenza dei processi biologici e idrologici che influiscono sulla composizione delle comunità delle singole cavità.

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Biol. Mar. Mediterr. (2010), 17 (1): 67-70

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MACROPHYTES AS BIOLOGICAL ELEMENT FOR THE ASSESSMENT AND MANAGEMENT OF TRANSITIONAL WATER SYSTEMS IN THE MEDITERRANEAN ECOREGION

L'ELEMENTO BIOLOGICO MACROFITE PER LA VALUTAZIONE E LA GESTIONE DEGLI AMBIENTI DI TRANSIZIONE NELL'ECOREGIONE MEDITERRANEA

Abstract *– Macrophytes (macroalgae and angiosperms) are one of the biological quality elements (BQE) proposed by the European Water Framework Directive (WFD, 2000/60/EC) to assess the ecological status of coastal waters and transitional systems. Here the application of the available indices (MaQI, Italy and EEI, Greece) set up to attempt to the WFD requirements for the Mediterranean Ecoregion are presented and applied to 5 Venice Lagoon areas of different ecological status. Indices are based on a different rationale but whereas MaQI can be used also in the presence of a single taxon with a negligible biomass coverage, EEI requires a coverage >30%.*

Key-words: *phytobenthos, aquatic plants, environmental monitoring, MaQI, EEI, Venice Lagoon.*

Introduction – The first studies that related macrophytes to some environment pollution events go back to the 1970s. Phytosociological studies and the Rhodophyceae/Phaeophyceae ratio (R/P) were the most interesting application of macrophyte vegetation in the coastal waters of Trieste, Marsiglia and in some Sardinia and Sicilia areas but only in the 2000s, under the WFD promotion, the first well structured phytobenthic indices were proposed (Giaccone & Catra, 2004).

In 2001, some Greek researchers proposed the application of the Ecological Evaluation Index (EEI) based on the per cent coverage and macrophyte distinction in two functional groups: the late successional (ESG I) and the opportunistic (ESG II) species (Orfanidis *et al.,* 2001, 2003). The index is applied both to coastal and transitional waters and now it is also accepted by Cipro, Slovenia and Croatia. In Italy, since the 2002 (Sfriso *et al.,* 2002), a strong relationship between the Rhodophyta/ Chlorophyta ratio (R/C) and the environment ecological status was recorded and this index was employed for the assessment of both coastal waters and transitional systems. Concurrently, for transitional systems, a more precise methodology: the Macrophyte Quality Index (MaQI), both in an expert (E-MaQI) and rapid (R-MaQI) version was set up (Sfriso *et al.*, 2007, 2009). In 2009 MaQI was accepted by Italy for the national transitional water assessment.

At present an intercalibration exercise between the Mediterranean Geographycal Intercalibration Groups (Med-GIG) of each Mediterranean Member State is occurring by applying the national method of Greece (EEI) and the national method of Italy (MaQI).

In this paper an example of their application in stations of different ecological status sampled in Venice Lagoon in 2008 is presented.

Materials and methods – Fig. 1 shows the central part of the Venice Lagoon and the 5 sampling sites. Each station has a ray of 15-20 m and it includes both soft and hard substrata. Macroalgae have been recorded in June and October 2008 by SCUBA divers. Concurrently, total macrophyte coverage was determined. The coverage of the dominant taxa was obtained by sorting and weighting the dominant taxa of 3-6 samples recorded by a rake according to ISPRA sampling methodologies (ISPRA, 2008) and their successive integration which is under publication. The reference EQR values are 1.03 and 1.00 for euhaline and polyhaline stations, respectively (Sfriso *et al.*, 2009).

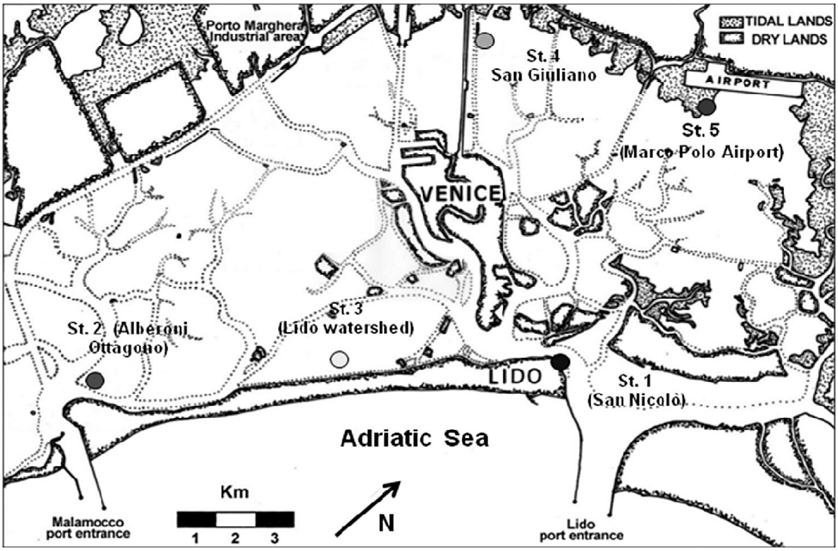

Fig. 1 - Central part of the Venice Lagoon and sampling stations. Assessment by MaQI application.
Parte centrale della laguna di Venezia e stazioni di campionamento. Valutazione dello stato ecologico mediante l'applicazione dell'indice MaQI.

Results – Total macrophytes ranged from 107 taxa (105 macroalgae and 2 angiosperms) at St. 1 (San Nicolò) to 17 taxa at St. 5 (Marco Polo Airport) (Tab. 1). The numbers are the sum of the taxa recorded in June and October and, obviously they are higher than each single sampling. Seagrasses were recorded only at St. 1 (San Nicolò) and at St. 2 (Alberoni Ottagono). The R/C ratio, ranged from 1.8 at St. 1 to 0.4 at St. 5. By normalising the values with the highest values recorded in the reference areas (2.21 and 2.00 for euhaline and polyhaline stations, respectively, Sfriso *et al.,* 2009) the station assessment is "High" for St. 1, "Good" for Sts. 2 (Alberoni Ottagono) and 3 (Lido watershed), "Poor" for St. 4 (San Giuliano) whereas at station 5 (Marco Polo Airport) the index is not applicable because of the number of species is lower than 20.

The results obtained by applying E-MaQI are similar to the R/C assessment, except at St. 3 (Lido watershed) where the classification results to be "Moderate". However, the normalised scores obtained by the two indices are very close one to the other and to the boundary classes. Also E-MaQI is not applicable at St. 5 (Airport) because of the low number of taxa.

On the contrary R-MaQI can be applicable also if macrophytes are quite missing and St. 5 (Marco Polo Airport), as expected, is assessed as "Bad". For all the other stations the environmental assessment is the same of that obtained by E-MaQI.

EEI is applicable only at Sts. 1, 2, 3 where macrophyte biomass was higher than 30%. However, the classification is the same only at St. 2 (Alberoni Ottagono) whereas the assessment of the other two stations differs even of two classes: St. 1 (S. Nicolò) is assessed as "Moderate" and St. 3 (Lido watershed) is assessed as "Bad". In fact, that index is mainly based on macrophyte coverage whereas MaQI takes into consideration mainly the presence of high score taxa and their relationship with some environmental parameters and pollutants.

Tab. 1 - Check-List of macrophytes (macroalgae and angiosperms) recorded in some stations of the Venice Lagoon in June and October 2008 and indices of ecological status application.
Lista delle macrofite (macroalghe e angiosperme) raccolte in alcune stazioni della laguna di Venezia in giugno ed in ottobre 2008 ed applicazione di indici di stato ecologico.

Macrophytes	St. 1 (S. Nicolò)			St. 2 (Alberoni Ottagono)			St. 3 (Lido watersched)			St. 4 (San Giuliano)			St. 5 (Marco Polo Airport)		
	June	October	June + October	June	October	June + October	June	October	June + October	June	October	June + October	June	October	June + October
Total taxa	**89**	**91**	**105**	**66**	**65**	**88**	**56**	**49**	**75**	**30**	**25**	**40**	**14**	**9**	**17**
%Chlorophyta	29	30	31	33	35	35	45	43	41	47	52	53	71	89	71
%Rhodophyta	60	59	58	59	60	58	52	57	56	50	48	45	29	11	29
%Phaeophyceae	8	8	9	5	2	5	4	0	3	3	0	3	0	0	0
R/C	2.0	2.0	1.8	1.8	1.7	1.6	1.2	1.3	1.4	1.1	0.9	0.9	0.4	0.1	0.4
(R/C) / EQR	0.92	0.90	0.84	0.80	0.77	0.74	0.52	0.60	0.61	0.48	0.42	0.39	0.18	0.06	0.19
R/C Assessment	High			Good			Good			Poor			-		
E-MaQI score	0.90	0.96	0.96	0.84	0.77	0.82	0.55	0.56	0.58	0.39	0.31	0.37	0.21	0.00	0.12
E-MaQI score / EQR	0.87	0.93	0.93	0.81	0.75	0.80	0.54	0.54	0.56	0.39	0.31	0.37	0.21	0.00	0.12
E- MaQI Assessment	High			Good			Moderate			Poor			-		
	% Taxa Coverage														
Cymodocea nodosa	50	50	50	-	-	-	-	-	-	-	-	-	-	-	-
Nanozostera noltii	2.0	1.0	1.5	20	25	22.5	-	-	-	-	-	-	-	-	-
Zostera marina	+	+	+	60	70	65	-	-	-	-	-	-	-	-	-
Total seagrass coverage	52	51	51.5	80	95	87.5	-	-	-	-	-	-	-	-	-
Chaetomorpha linum	-	-	-	3	5	4	-	-	-	-	-	-	-	-	-
Ulvaceae	15	12	13.5	10	18	14	53	45	49	8	5	7	1	+	0.5
***Cladophora* spp.**	6	3	4.5	4	9	7	2	1	2	2	+	3	+	-	+
Gracilariaceae	18	10	14	7	12	10	13	24	19	6	3	5	+	+	+
Polysiphonia-Neosiphonia	3	2	2.5	8	8	8	1	1	1	+	+	+	+	-	+
Agardhiella subulata	6	3	4.5	2	1	2	3	1	2	1	-	+	-	-	-
Others	6	4	5	6	4	5	5	3	4	+	+	+	+	+	+
Total macroalgal coverage	54	34	44	40	57	49	77	75	76	17	8	14	1	0	0.5
Number of high score taxa	21	24	29	12	11	16	4	3	5	0	0	0	0	0	0
% macroalgal high score taxa	24	26	28	18	17	18	7	6	7	0	0	0	0	0	0
R-MaQI score	0.9	0.9	1.0	0.8	0.8	0.8	0.6	0.6	0.6	0.3	0.3	0.3	0.2	0.1	0.15
R- MaQI Assessment	High			Good			Moderate			Poor			Bad		
EEI Assessment	Moderate			Good			Bad			-			-		

Conclusions – Macrophytes are very sensitive to the ecological conditions of transitional waters and some indices can supply a very useful tool both in their monitoring and management. In fact, the presence/absence of high score taxa such as angiosperms and many macroalgae is strongly related to the environment trophic state and pollution level. Therefore, the preservation or restoring of angiosperm meadows should be the first objective for the transitional system management.

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Biol. Mar. Mediterr. (2010), 17 (1): 72-73

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BIODIVERSITY INDEX EVOLUTION IN SHALLOW WATER AREAS OF SARDINIAN SEAS (10-100 M)

EVOLUZIONE DEGLI INDICI DI BIODIVERSITÀ NELLA FASCIA COSTIERA DEI MARI SARDI (10-100 M)

Abstract *– Biological diversity is considered an important factor for ecosystem stability. The aim of this study is to examine the temporal evolution of classical biodiversity indexes for shallow waters (10-100 m) demersal assemblages in specific locations of the Sardinian seas, which have been subject to different fishing pressure over the past 14 years (1994-2007). Our results indicate that fishing pressure appeared to affect the diversity of shallow waters species, showing different biodiversity index reactions on different levels of fishing effort. The validity and reliability of this index as a measure of environmental stress and its potential use for the monitoring of demersal ecosystem is then discussed.*

Key-words: *demersal assemblages, Sardinia, biodiversity.*

Introduction - The high concentration of human population near coasts and the oceans' productive coastal margins, strongly affects marine ecosystems and its resources (Halpern *et al.,* 2008). Industrial fishing in particular can have both direct and indirect consequences on marine systems (Fogarty *et al.,* 1998; Greenstreet and Hall, 1996), including effects on species diversity. Several studies have underlined the role of biodiversity in ecosystem functioning (Worm *et al*., 2006; Hector and Bagchi, 2007). In the light of the above, come out the importance of biological diversity, and the development of further tools for monitoring its status should be considered imperative. The aim of this study is to examine the answer of biodiversity indexes in consequence of fleet evolution, on shallow waters demersal assemblages.

Materials and methods – Data were collected over 1994-2007 period, within the framework of the international MEDITS research programme. The year 2002 was excluded due to a sensible delay in starting the survey. Only the 10-100 m depth range were considered. Species abundances data were used to calculate Shannon's index (H'), species richness (lnS) and Pielou's evenness (J'). Fishing effort were evaluated by means of Regione Autonoma della Sardegna fleet archives. These data regarded the number of trawlers (<30 GT) involved in shallow water fishing, considering 7 separated zones.

Results – Investigated areas, due to fleet renewal which involved the replacement of the old low-tonnage wooden boats with large deep sea iron boats, have been subjected to a decreasing fishing pressure over the past 14 years, resulting in a general decrease of about 24% in fishing boats but different for each zone (Tab. 1).

We found sensible changes in biodiversity, with an increase for areas SE, N, and S and a decrease for area W. These results are in agreement with the diverse behavior of fishing effort, which usually display opposite trends than biodiversity indexes do.

Conclusions – The use of biodiversity indexes as an instrument for assessing marine resources is a subject of continued debate (Ungaro *et al.,* 1998).

Our analysis on biodiversity, based on data from 14 annual trawl surveys, showed different temporal trends in the 8 areas considered. The varying intensity of

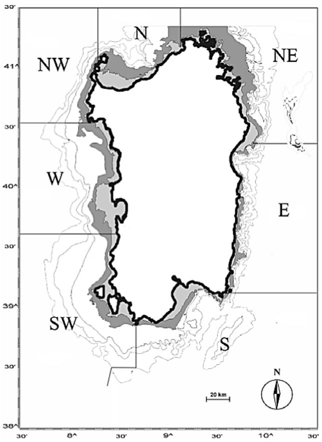

Fig. 1 - Location of the investigated areas.
Localizzazione delle aree investigate.

				H'				
Years	SE	NE	N	NW	W	SW	S	TOT
1994	1.517	2.308	1.455	1.234	2.712	2.799	1.992	2.196
1995	2.104	2.385	2.087	2.478	2.948	0.849	1.259	1.685
1996	1.517	2.308	1.455	2.218	3.044	2.299	2.102	2.196
1997	2.085	2.893	2.343	2.796	2.549	2.492	2.232	3.077
1998	1.130	2.653	1.293	2.973	1.863	2.025	2.715	2.405
1999	2.822	2.851	2.306	1.619	3.102	2.728	1.906	3.125
2000	2.932	2.805	1.843	2.678	3.118	0.891	2.289	2.548
2001	2.601	2.958	2.552	2.352	2.714	2.760	2.747	3.270
2003	2.484	2.753	2.297	2.377	2.744	2.098	2.437	3.079
2004	2.888	2.093	2.342	1.797	1.165	2.600	1.827	2.861
2005	2.149	2.753	2.639	2.481	2.899	2.417	1.557	3.233
2006	1.734	3.027	2.872	2.541	2.797	2.897	3.252	3.423
2007	2.864	2.987	2.914	2.267	0.650	0.482	2.772	1.978
b	0.065	0.032	0.097	0.018	-0.083	-0.012	0.054	0.060
R^2	0.218	0.210	0.620	0.026	0.213	0.004	0.182	0.212
H' Trend	↑	↔	↑	↔	↓	↔	↑	↑
Fleet trend	↓	↔	↓	↔	↑	↔	↓	↓

Tab. 1 - Shannon's index trends.
Trends dell'indice di Shannon.

exploitation described, enabled us to identify the effects that such disturbance has had on biodiversity, both positively correlated with fishery yield (Ungaro *et al.*, 1998; Worm *et al.*, 2006).

According to our results evaluation of biodiversity trend evolution, allow us to detect environmental modifications that otherwise would pass unnoticed. Although further investigations are necessary, biodiversity indexes could be an important support to classical stock assessment methodologies.

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PROPOSTA PER IL PARCO NAZIONALE NELLO STRETTO DI SICILIA: LA A.M.P. DI PANTELLERIA

PROPOSAL FOR THE NATIONAL PARK AREA OF SICILY CHANNEL: THE PANTELLERIA MARINE PROTECTED AREA

Abstract *– In the present paper the authors put forward a proposal for the future zonation of Pantelleria MPA's, which provides both the protection of marine areas along the coast of the island as a portion of offshore sea area called "Bank of Pantelleria".*

Key-words: *Pantelleria, MPAs, Sicily Channel, biodiversity, Mediterranean Sea.*

Introduzione – Da oltre un ventennio da più parti vengono avanzati modelli di zonazione per i fondali dell'Isola di Pantelleria in vista della istituzione della AMP che interessi il mare di questa isola nello Stretto di Sicilia. Il Ministero dell'Ambiente e della Tutela del territorio e del Mare, dopo aver approvato lo scorso anno l'istituzione del Parco Nazionale Isola di Pantelleria in quest'area, minacciata in questi ultimi tempi da interessi economici di varia natura (ricerche petrolifere, impianti eolici off-shore, e una pesca sempre più intensiva), ha recentemente stanziato la somma di circa mezzo milione di euro al fine di effettuare gli studi preliminari per la fattibilità della Amp e la istituzione della Amp, così da dar seguito a quanto previsto dalla legge quadro sulle aree protette nazionali n° 394/91. È in quest'ottica che, facendo seguito alle considerazioni scaturite da recenti studi di oceanografia biologica (Bianchi e Acri, 2003a,b; Bianchi *et al.*, 2004) oltre che alle indicazioni che vengono dagli operatori della locale marineria, gli Autori avanzano una proposta di zonazione un po' fuori dalle righe. Tale rimappatura della AMP vede articolata l'area oggetto di protezione tra ambiente marino costiero e pelagico.

Area di studio – L'area presa in esame interessa non solo il profilo costiero di Pantelleria, ma anche una vasta area sommersa a nord dell'isola conosciuta come Banco di Pantelleria.

Lungo le coste di Pantelleria si propone di fare oggetto di protezione l'intero perimetro costiero dell'Isola sottoponendo a maggiori attenzioni il tratto di costa conosciuto come l'Arenella, posto a sinistra dell'area portuale, compreso tra Punta della Croce e Punta Fram. Quest'area, caratterizzata da bassi fondali rocciosi, riccamente colonizzati, ben si presterebbe, infatti, a divenire meta di visite guidate mediante l'istituzione di percorsi di snorkeling e di itinerari percorribili con i battelli a fondo trasparente. Il Banco di Pantelleria è costituito da un massiccio edificio vulcanico successivamente collassato caratterizzato da grandi fessurazioni e canyons ad orientamento N-S. La porzione orientale del Banco presenta acque meno profonde ed i suoi fondali sono caratterizzati da una notevole copertura vegetale a *P. oceanica*. In questa zona il Banco si eleva fino a 13 m dalla superficie e lungo il suo perimetro, particolarmente lungo il versante sud, è facile riconoscere le paleo-spiagge lungo cui si aprono, numerose, grotte sommerse che denunciano le antiche linee di costa allorquando l'intero edificio vulcanico emergeva dalle acque. L'area intorno le scogliere già descritte è costituita da fondali sedimentari che si estendono tra le batimetriche dei 50 e dei 70 m di profondità. Da questi fondali fangosi si elevano tre piccoli edifici rocciosi di straordinaria bellezza che rappresentano una vera e propria oasi di vita sottomarina. La zona centrale del Banco è più profonda (mediamente sui 40 m), e qui la posidonia diventa una vera e propria foresta raggiungendo valori di densità foliare elevati. La zona Ovest, caratterizzata da creste, pinnacoli ed enormi massi franati, è mediamente più profonda della zona Est (-30-40 m), e si spinge con un pinnacolo fino a 16,5 m dalla superficie. Il Banco è interessato da una corrente occidentale di origine atlantica, che trovando sulla propria strada questo grande edificio roccioso, è, in sua prossimità, soggetta ad una forte accelerazione per una sorta di effetto Venturi naturale. Cosa questa che contribuisce ad un notevole arricchimento in nutrienti delle acque circostanti l'area.

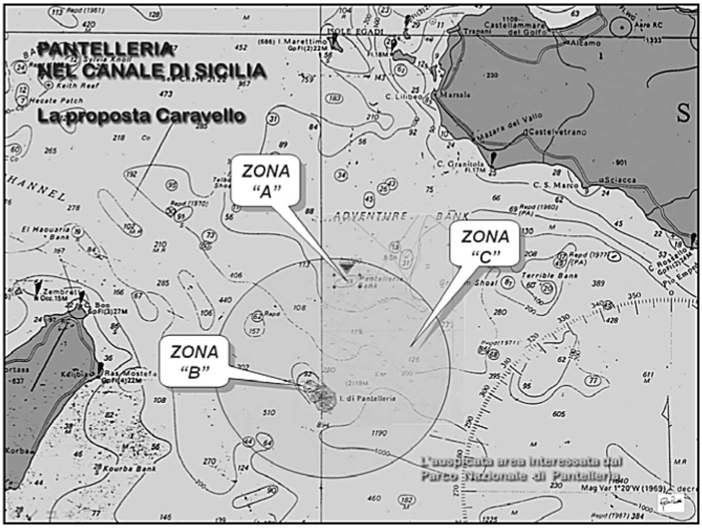

Fig. 1 - Localizzazione delle aree da sottoporre a regime di protezione.
Location of the future protected areas.

Conclusioni – Ben consci che una tale proposta vuole essere tanto reale quanto provocatoria, gli Autori auspicano che le competenti autorità, MATTM *in primis*, vogliano prenderla seriamente in considerazione. La protezione di una porzione di mare aperto, infatti, presenta non poche difficoltà giuridiche che possono, comunque, essere superate se solo il mondo politico, oltre che accademico, prendono consapevolezza che tali proposte, provenienti dal "basso", derivano dalle esperienze che da secoli le genti di mare si tramandano sotto forma un bagaglio di conoscenze non scritte che oggi stanno irrimediabilmente perdendosi.

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THROUGH THE PORTAL – IMPROVING THE FLOW OF INFORMATION ON NON-NATIVE SPECIES IN GREAT BRITAIN

'THROUGH THE PORTAL' - MIGLIORANDO IL FLUSSO D'INFORMAZIONE SULLE SPECIE NON INDIGENE IN GB

Abstract *- The Great Britain Non-Native Species Information Portal (GBNNSIP) is being established to collect and collate data on non-native species in Great Britain and make this and related information available online. A register of all known non-native species will be generated, and supplemented by detailed fact sheets for a sub-set of these species. Rapid reporting of new records of species will be supported, linked to a system of alerts and risk analyses to trigger rapid responses as appropriate. The Marine Biological Association of the UK is the GBNNSIP partner responsible for all marine non-native species within this scheme.*

Key-words: *introduced species, distribution records, environment management, data collections.*

Introduction - A three-year (2009-2011) project funded by the UK Department for Food, Environment and Rural Affairs (Defra) will establish the Great Britain Non-Native Species Information Portal (GBNNSIP). The scheme will ensure the rapid and efficient flow of information concerning non-native species, from a wide variety of sources, onto the Web where it will be available to researchers, environmental managers, stakeholders and the public. The scheme is intended to allow the early recognition of potential threats to environmental and economic interests in Great Britain (GB) and to promote rapid response to new arrivals. It will also underpin the regular updating of a new index of environmental health based on the status of invasive non-native species in GB. In general, the data will be stored by the National Biodiversity Network (NBN) but accessed via the Web site of the GB Non-Native Species Secretariat (NNSS). Marine species data will be permanently and securely archived in the Data Archive for Seabed Species and Habitats (DASSH). The GBNNSIP covers both terrestrial and aquatic habitats, with the Marine Biological Association (MBA) having responsibility for all marine taxa. The various components of the general scheme are outlined below, followed by a listing of the MBA's responsibilities.

Components of GBNNSIP

Register of non-native species. This will provide basic information on all recognised non-native species, including: habitat, ecological role, region of origin, pathway of introduction, status in England, Scotland and Wales respectively, ecological and human impact, site and date of first occurrence, and key references. The register will update and build on the GB species list produced for the European DAISIE project.

Species factsheets. The sheets will provide relatively detailed information on species' ecology, pathways of introduction, management, and any relevant legislation, with links to appropriate risk assessments, identification information and images, plus information on any researchers or managers involved with a particular taxon. Factsheets will be available online, through the NNSS website.

Distributional data online. Interactive distribution maps (as seen on the NBN Gateway, http://data.nbn.org.uk/) will be displayed on the NNSS website, using web services provided by the NBN. The scheme will ensure distributional data flows as smoothly as possible to the NBN Gateway, so that distributional information is as up to date and as comprehensive as possible.

Improved flow of data from existing recording schemes and data sets. Data will be sought from local records centres, voluntary recording schemes, specialist groups, statutory bodies undertaking survey work, etc., and continued improved flow of new distributional data into the central repository will be encouraged.

New recording schemes. The development of new voluntary recording schemes will be promoted to ensure that records of sightings are submitted rapidly to the appropriate authorities, and also to raise awareness of non-native species, and how and why to report them.

Alerts and review of future threats. Mechanisms will be developed to ensure rapid reporting of high-risk species to trigger alerts and rapid response actions. The most probable arrivals in the near future will be determined, with information on likely new introductions detailed on the NNSS website.

Analysis of trends. Data will be analysed to assess evidence of consistent change over time in the prevalence of non-native species within GB biota, and to enable early detection of significant change. Detected change will feed into Invasive Non-Native Species component of the UK's biodiversity indicators of environmental status.

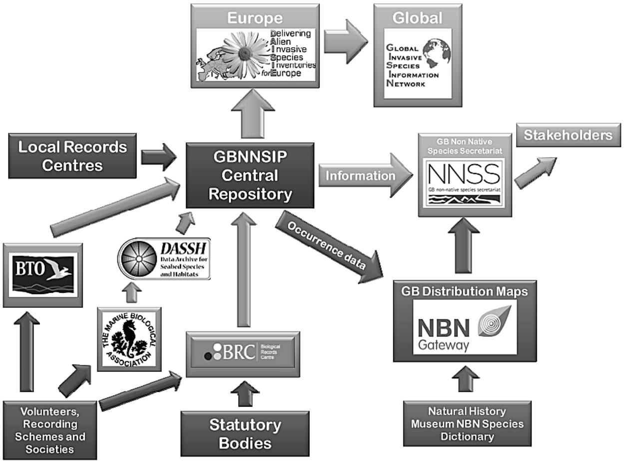

Fig. 1 - Flow of information through the Great Britain Non-Native Species Information Portal.

Flusso di dati trasmessi attraverso il portale d'informazione sulle specie non indigene che si trovano in Gran Bretagna.

Responsibilities of the MBA within GBNNSIP

- Collate data on all GB non-native marine species for the species register
- Contribute factsheets on 50 non-native marine species
- Supply non-native species distributional data to the central repository for display via the NBN Gateway on the NNSS website
- Search for and incorporate existing published and unpublished marine life data sets
- Develop voluntary recording schemes through public outreach
- Contribute to a system of alerts for rapid interception of new introductions
- Conduct an annual search for and review of emerging threats
- Report on significant changes in the distribution or abundance of non-native species

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ABSENCE OF GENETIC STRUCTURE IN THE GORGONIAN *PARAMURICEA CLAVATA* (CNIDARIA, OCTOCORALLIA), FROM THE NW MEDITERRANEAN, AS INFERRED BY THE COI GENE

ASSENZA DI STRUTTURA GENETICA NELLA GORGONIA PARAMURICEA CLAVATA *(CNIDARIA, OCTOCORALLIA), DAL MEDITERRANEO NORD OCCIDENTALE, COME EVIDENZIATO DAL GENE COI*

Abstract *– Sequences of the subunit I of the mitochondrial cytochrome oxidase c gene (COI) were gathered from samples of the red gorgonian* Paramuricea clavata *(Risso, 1826) (Cnidaria, Octocorallia) from four locations of the NW Mediterranean. All sequences obtained were identical showing absence of polymorphism at this gene. A slow rate of mutation of the gene or an efficient repairing system of this species' mtDNA may account for this result.*

Key-words: Paramuricea clavata*, genetic structure, COI, NW Mediterranean.*

Introduction – *Paramuricea clavata* (Risso, 1826), a gorgonian endemic of the Mediterranean Sea (Carpine & Grasshoff, 1975), plays a central role in the structure and functioning of the coralligenous community, one of the most peculiar and diverse Mediterranean biogenic reef. Recently, in the NW Mediterranean, *P. clavata* was heavily damaged by repeated mortality events that occurred in conjunction with anomalous seawater warming (Cupido *et al*., 2008). Since information about gene flow in Mediterranean gorgonians is scarce, the aim of this study was to assess the population genetic structure of *P. clavata* in an area affected by mass mortality as a consequence of climate changes. Results on species' genetic structure and population connectivity may provide a valuable contribution to the development of opportune conservation plans.

To date, a single study investigated the genetic structure of this species (Calderón *et al*., 2006) by employing the mtDNA gene cytochrome c oxidase I (COI). Results highlighted lack of genetic variability in the sequence of one individual from Marseille and two from the Medes islands (Fig. 1). Given the limited number of individuals and the restricted geographical area examined by Calderón *et al*. (2006), we decided to extend the analysis to a higher number of specimens and a broader spatial scale.

Materials and methods – Specimens were gathered from three locations in the Tyrrhenian Sea: Elba Island (42°45' N, 10°25' E), Quercianella (43°27' N, 10°21 E) and two sites at the Isle of Tinetto (44°02' N, 9°85' E), and from one location in the Catalan Sea, Palamós (41°49' N, 3°05' E) (Fig. 1). At least 30 samples were collected at each location.

Each sample consisted of a 6-8 cm long fragment collected from the tip of a colony and preserved in 96% ethanol. Sampling was carried out only on those gorgonians that were at least 50 cm high. DNA was extracted from 20 polyps of each fragment using a Salting Out protocol modified from Aljanabi & Martinez (1997). The new protocol employed a highly concentrated lysing solution (EDTA 100 mM; Tris HCl

10 mM pH 7.5; SDS 0.6%; NaCl 400 mM) in which tissue was incubated overnight. DNA was PCR-amplified using the COI primers reported in Calderón *et al.* (2006).

(COI Cni F: 5'-GGYACTYTATATTTACTATTTGG-3'; COI Cni R: 5'-CCSGCAGGATCAAAGAAWGTTG-3'). Amplified products were then purified and sequenced by a commercial company. Two individuals were sequenced from each location and the obtained nucleotide sequences aligned using the software BioEdit vers. 7.0.9.0 (Hall, 1999).

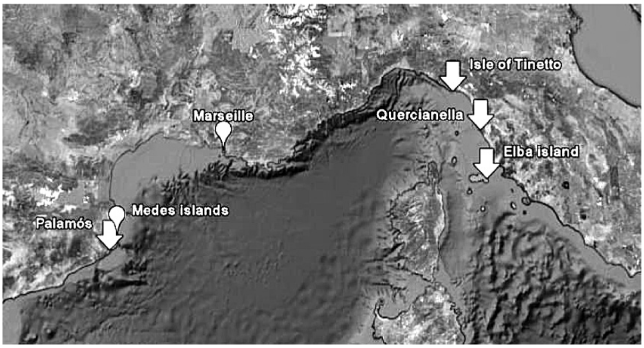

Fig. 1 - Sampling locations of Calderón *et al.* (2006) (paddle) and of the present work (arrow).
Località di campionamento di Calderón et al. *(2006) (pagaia) e del presente lavoro (freccia).*

Results – PCR amplifications delivered fragments of 545 bp size. Nucleotide sequences were inserted in GenBank and they confirmed amplification of the COI region. All obtained sequences were identical to each other and to the one of *P. clavata* deposited in GenBank by Calderón *et al.* (2006) (GenBank access n°: AY827539.1).

Conclusions – The genetic homogeneity at the COI locus of *P. clavata*, in individuals sampled at locations that were several hundred kilometers distant, confirms Calderón *et al.*'s (2006) results even after enlargement of the study area and use of a higher number of individual colonies. The lack of polymorphism at the COI region in *P. clavata* could be attributed to a slow rate of mutation of the gene or efficient repairing system of this species' mtDNA. To fully accomplish the objective of this work the characterization of genetic markers with a sufficient degree of polymorphism is needed.

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MARINE BIODIVERSITY AND UNEXPECTED EXPERIMENTAL MODELS: THE ROLE OF MARINE STATIONS

LA BIODIVERSITÀ MARINA E MODELLI SPERIMENTALI INATTESI: IL RUOLO DELLE STAZIONI MARINE

Abstract - *Experimental organisms are used to elucidate basic processes regarding the manifold features of the structure and function of living beings. Each model satisfies the particular needs of specific fields of investigation. Suitability to experimental manipulation and easy reproduction under laboratory conditions are common features of experimental model systems. These features allow selection of genetically related strains and continuous availability of experimental organisms. These characteristics, however, are not common to most species being, on the contrary, rather exceptional. Animals like the zebrafish, Drosophila, Coenorabditis, Hydra and, of course, mice and rabbits, are exceptional, hence the paradox that we infer about rules from information obtained from exceptions!*

Marine stations, first of all the Zoological Station of Naples, were founded for two main reasons: study biodiversity, and provide organisms for experimental biology. These organisms do not need being kept under laboratory conditions, they can be obtained from natural populations in the vicinity of the station, as exemplified by two striking cases: the sea anemone Anemonia sulcata leading to the discovery of anaphylaxis, and the jellyfish Aequorea victoria, leading to the isolation of the Green Fluorescent Protein. Studies on both organisms led to Nobel Prizes, namely Richet in 1913 and Shimomura, Chalfie and Tsien in 2008, respectively. In both cases large amounts of specimens were obtained from natural populations sampled in the surroundings of the Station Biologique de Roscoff in Brittany for Anemonia and of the Friday Harbor Laboratories, a Marine Station in Washington State, for Aequorea. In the end of the XIX century, August Weissman developed his general theory on the early segregation of the germ-line while working on colonies of the hydrozoan Eudendrium racemosum, continuously supplied by the fishery service at the Stazione Zoologica A. Dohrn. A similar case is the "immortal jellyfish", Turritopsis dohrnii, a species with the unique ability of reversing its life cycle and, hence, a beautiful model for developmental biology. The species, however, is difficult to rear in the laboratory and is to be sampled from natural populations, during the months of medusa production.

Salvatore Lo Bianco, an eminent naturalist at the Stazione Zoologica of Naples, in 1909 published a monograph covering the animal diversity of the Gulf of Naples, reporting, species by species, the locations where they occurred, the periods of both presence and sexual maturity. That monograph was the catalogue of experimental animals for the biologists visiting the Station, but is also a precious account on the biodiversity of the Gulf of Naples, covering also the phenology of the species. This information can become a benchmark for studies on the impact of global change.

The use of a limited number of model animals is depriving experimental biology of organisms that might be conducive to important discoveries: the exploration of biodiversity and of the natural history of the species can lead to the unravelling of many biological questions, but this cannot be planned in advance. The limited diversity of model animals is to be implemented with new models, with mutual benefit of both biodiversity studies and experimental approaches. Many unexpected novelties are waiting to be discovered, if we only were able to look for them.

Key-words*: biodiversity, model organisms, experimental biology.*

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COCCOLITHOPHORE BIOMINERALIZATION: FROM MOLECULES TO GLOBAL PROCESSES

BIOMINERALIZZAZIONE DEI COCCOLITOFORIDI: DALLE MOLECOLE AI PROCESSI GLOBALI

Abstract *– Coccolithophores are responsible for a major component of biogenic calcite formation in the oceans. Despite their biogeochemical importance, the molecular and cellular mechanisms of calcification are poorly understood. However, a deep understanding of the transport and biomineralization processes underlying coccolithophore biology is essential for understanding their ecological success and for predicting how they may be affected by or respond or adapt to future ocean acidification scenarios.*

Key-words: *coccolithophores, calcification, genomics, cell biology.*

Introduction - Coccolithophores occur in all of the world's oceans and are represented by many different unicellular species. They are characterized by the production of intricate calcium carbonate (calcite) scales (coccoliths) during at least one phase of their life cycle. Some species form massive seasonal blooms in temperate oceanic waters and the reflectance of the calcite in these blooms renders them visible from space. Estimates suggest that coccolithophores account for approximately half of global biogenic calcium carbonate production. This group of organisms thus plays an important role in the biogeochemical cycling of carbon in the oceans. A significant proportion of the carbon fixed into calcite sinks to the ocean floor where it may form sediments that give rise to chalk and limestone deposits. This represents a significant long-term sequestration of inorganic carbon.

Coccolithophores are known to produce two types of calcite scales: Holococcoliths that have a simple crystal structure, and heterococcliths that are formed by interlocking calcite crystals made up of calcite crystal elements of complex shape. Significantly, heterococcolith production has been demonstrated to occur in an intracellular compartment - the coccolith vesicle (CV). This vesicle is derived from the Golgi body and encloses the forming coccolith in a membrane-bound isolated compartment, allowing the chemical composition to be regulated to promote the ordered deposition of the calcite crystals (Brownlee and Taylor, 2005). A wide rang of experimental studies have shown that external bicarbonate is the inorganic substrate for calcification. The intracellular precipitation of carbonate results in the production of protons. It follows that calcification requires transport of the substrates for calcification (bicarbonate and calcium) into the cell and removal of the ionic products (protons) from the cell. Our earlier work has shown that the magnitude of the fluxes involved in calcification is extremely large, since fixation of inorganic carbon by calcification can often occur at similar rates to the photosynthetic fixation of carbon.

Some key questions relating to transport processes underlying calcification relate to the identification of membrane transporters. Do coccolithophore cells have calcification-specific transport systems or does calcification recruit the cell's normal transport machinery in bringing about the required fluxes? What are likely to be the effects of decreased ocean pH on the calcification process?

Changes in ocean pH will potentially affect both the speciation of carbon in the ocean, the dissolution of calcite and the ability of cells to remove protons. Only by acquiring more detailed knowledge of transport processes and their regulation will we be able to address these fundamental questions.

Results - We have adopted a combination of cell physiological, genomic and molecular approaches to try to understand the mechanisms underlying calcification. Our electrophysiological studies have shown some unique features of the coccolith membrane physiology and the presence of unexpected ion channels (Taylor and Brownlee, 2003). For example, coccolithophores have similar ion channels to those involved in generating action potentials in animals and indeed we have shown the occurrence of spontaneous action potentials in single coccolithophore cells (Taylor and Brownlee, 2003). More recently we have shown the presence of an ion conductance pathway in the plasma membrane that allows protons to efflux from the cell down their electrochemical potential gradient. Recent combination of genomic, imaging and patch clamp electrophysiology has shown for the first time in a non-animal cell the presence of the molecular counterpart of the proton channel that is able to perform this function. We have proposed that this is involved in short-term pH regulation and its activity is essential for calcification.

We have also begun to characterize other transporters that genomics studies indicate are involved in calcification since their expression levels are strongly dependent on calcification. These include a putative calcium/proton exchanger and an anion exchanger that may be involved in inorganic carbon transport.

Genomics studies are also beginning to allow an understanding of the genetic variability in populations of coccolithophores that will be important in understanding how these organisms may respond or adapt to changing seawater chemistry. One particular gene (GPA) that encodes a protein that is intimately associated with the coccolith crystals has been shown to vary in sequences that correlate with coccolith morphology. We are beginning to map the occurrence of different coccolith morphotypes at the molecular level to gain an understanding of the genetic variability in existing coccolith populations. Collaborations with the Sir Alistair Hardy Foundation for Ocean Science Continuous Plankton Recorder (CPR) are for the first time enabling the molecular composition of past coccolithophore populations to be reconstructed.

Conclusions – Understanding the mechanisms of calcification at the molecular and cellular level, the variability between populations of the same species and, indeed, between different species will allow us to construct population-scale models of the fundamentally important geochemical processes of calcification. These will allow us to understand how coccolithophore populations may adapt to predicted changes in ocean chemistry that will inevitably occur over the coming decades to centuries.

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Biol. Mar. Mediterr. (2010), 17 (1): 86-88

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USING VOLCANIC MARINE CO_2 VENTS TO STUDY THE EFFECTS OF OCEAN ACIDIFICATION ON BENTHIC BIOTA: HIGHLIGHTS FROM CASTELLO ARAGONESE D'ISCHIA (TYRRHENIAN SEA)

UTILIZZO DI EMISSIONI VULCANICHE MARINE DI CO_2 PER LO STUDIO DEGLI EFFETTI DELL'ACIDIFICAZIONE SUL BENTHOS: ESPERIENZE AL CASTELLO ARAGONESE D'ISCHIA (MAR TIRRENO)

Abstract *– Current research into ocean acidification is mainly being carried out using short-term experiments whereby CO_2 levels are manipulated in aquaria and enclosures. We have adopted a new approach in our studies of the effects of ocean acidification on Mediterranean marine biodiversity by using volcanic carbon dioxide vent systems as 'natural laboratories' as they cause long-term changes in seawater carbonate chemistry. A range of organisms, including macroalgae, seagrasses, invertebrates, and selected scleractinians and bryozoans have now been investigated in a shallow area located off the island of Ischia (Castello Aragonese, Tyrrhenian Sea, Italy). Our in situ observations give support to concerns, based on model predictions and short-term laboratory experiments, that ocean acidification will likely combine with other stressors (e.g., temperature rise) to cause a decrease in Mediterranean marine biodiversity and lead to shifts in ecosystem structure.*

Key-words**:** *CO_2 vents, ocean acidification, pH, benthic organisms, biodiversity.*

Our seas currently absorb over 25 million tons of CO_2 every day. This has caused surface waters to become 30% more acidic since wide-spread burning of fossil fuels began (Doney *et al*., 2009). As well as lowering pH, increased pCO_2 levels are altering surface water chemistry with falling carbonate levels a major concern since these are the building-blocks of tests and skeletons for many marine organisms from tiny coccolithophores to giant coral reefs (Kleypas *et al.,* 2006). Current research into ocean acidification is mainly being carried out using short-term experiments whereby CO_2 levels are manipulated in aquaria and enclosure mesocoms (CIESM, 2008). We have adopted a new approach in our studies of the effects of ocean acidification on Mediterranean marine biodiversity by using volcanic carbon dioxide vent systems as 'natural laboratories' as they cause long-term changes in seawater carbonate chemistry (Hall-Spencer *et al*., 2008).

In this study system, volcanic vents occurred in shallow waters on the north and south sides of Castello Aragonese, island of Ischia (Tyrrhenian Sea, Italy), adjacent to a steeply sloping rocky shore emitting 1.4×10^6 $l d^{-1}$ of gas comprising 90-95% CO_2. At the south vent site, gas was emitted at mainly >5 vents m^{-2} whereas at the north vent site, gas was emitted at mainly <5 vents m^{-2} acidifying seawater along a pH gradient from 8.17 down to 6.57 for 300 m running parallel to the rocky shore on both sides of the Castello Aragonese (Hall-Spencer *et al*., 2008). Monitoring stations have been established along the pH gradient, where experimental transplants have been performed. Here we synthesise projects to date. Specific methods for each study can be found in the published papers (see references).

Macroalgae, seagrasses, invertebrates, scleractinians and bryozoans have been investigated in collaboration between the Stazione Zoologica Anton Dohrn, the Plymouth University (UK), the IAEA-Monaco (MC) and the ENEA-CRAM (La Spezia, Italy).

The most obvious effects on benthic plants and animals was that all calcifiers (coralline algae epiphytes on *Posidonia oceanica* leaves, molluscs, polychaete spirorbids, foraminifera) show an important reduction in abundance or are absent from the low pH areas (pH down to 6.6) reducing benthic biodiversity in the acidified zone (Hall-Spencer *et al*., 2008; Hall-Spencer & Rodolfo-Metalpa, 2008; Porzio *et al*., 2008; Martin *et al*., 2008; Cigliano *et al*., 2010). A few species, including some macroalgae, crustacean peracarids and polychaetes were resilient to the low pH values predicted for the end of this century (Caldeira & Wickett, 2003), as well as lower values. While *P. oceanica* meadows survived in the vents areas, and shoot density remained high at low pH, the daily leaf growth rate was lower compared to plants growing at normal local pH and no difference in the photosynthetic performances was detected in comparison to normal pH exposed plants (Buia *et al*., 2009).

Some experiments were conducted on selected scleractinians and on the calcitic bryozoan *Myriapora truncata* (Pallas) transplanted to normal, low, and extremely low pH conditions (Rodolfo-Metalpa *et al.,* 2010). In extremely low pH (mean pH 7.43) dead skeletons of both scleractinians and the bryozoan dissolved rapidly and, although the live bryozoans gained weight in these conditions, the net calcification rates of live specimens were significantly lower than at normal pH. Moreover, in the live specimens the organic tissue covering the skeleton was still present when exposed to the acidic conditions reflecting a possible role of organic tissues in protecting the skeleton (Rodolfo-Metalpa *et al.,* 2010). Therefore, while the bryozoan seemed to be quite resilient to low pH, they died at the end of an unusually warm summer during the experiment in 2008, by the combination of both stressors.

Overall, our *in situ* observations give support to concerns, based on model predictions and short-term laboratory experiments, that ocean acidification, especially when combined with other stressors (e.g., temperature rise), will cause a decrease in Mediterranean marine biodiversity and lead to shifts in ecosystem structure. Further studies are in progress on plant and animal species to test eco-physiological responses to increased $p\mathrm{CO}_2$. Although the CO_2 venting sites, such as the Castello d'Ischia example, are not precise analogues of global-scale ocean acidification, due to their localised nature and relatively high temporal variability in pH, nonetheless they can provide information about the ecological effects of long-term exposures to high CO_2 levels that encompass the life cycles of interacting macrobenthic organisms as they include the feedbacks and indirect effects that occur within natural marine systems (Hall-Spencer *et al*., 2008).

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THE THERMOPHILOUS SPECIES *ECHINOLITTORINA PUNCTATA* AS A NEW DESCRIPTOR OF TROPICALIZATION IN THE MEDITERRANEAN SEA – FIRST DATA

LA SPECIE TERMOFILA ECHINOLITTORINA PUNCTATA*: NUOVO INDICATORE DI TROPICALIZZAZIONE DEL MEDITERRANEO – PRIMI DATI*

***Abstract** – Data suggest that the prosobranch gastropod* Echinolittorina punctata *(Gmelin, 1791) (Mollusca, Gastropoda) has extended its range northwards along the Italian coastline due to climate variability in marine conditions. Its ease of identification and mesolittoral habitat suggest this species may be a new practical indicator of Mediterranean Sea changing conditions, easy to monitor.*

Key-words: *climatic changes, indicator species, intertidal environment, Italy.*

Introduction – The scientific investigations of the past decade demonstrated that the climate observational record contains warming trends. Small and semi-enclosed seas like the Mediterranean can react faster to the causes of these temperature trends and in turn the changes in temperature can force changes in the biota due to both Non Indigenous Species (NIS), most of them of warm-water affinity, and significant distribution shifts of autochthonous warm-water affinity Indigenous Species (IS).

The effects of Non Indigenous Species lead to the "tropicalization" of the Mediterranean Sea, while the northward range expansion of autochthonous species leads to its "meridionalization". However, Bianchi (2007) suggests that both phenomena respond in a similar way to the same drivers and could be treated as a single phenomenon.

Echinolittorina punctata (Gmelin, 1791) is an autochthonous Mediterranean prosobranch gastropod living on mesolittoral hard substrates. It used to be distributed mainly along the southern and eastern Mediterranean shores. Known for Sicilia since the mid-20th century only (Antit *et al.*, 2007), its range has extended northwards along the Tyrrhenian coastline and is now reported as north as Civitavecchia (Albano, 2010). New stations were reported from Puglia too (Albano *et al.*, 2008).

The northward extension of the species along the Tyrrhenian coastline could be simply favoured by the characteristic northward currents transporting planktonic larvae. However it is difficult to consider this as the main cause of northward displacement since the species were largely present only in the southern coasts until a decade ago. Therefore, a climate trigger could be taken into consideration to explain the northward shift. This hypothesis was reinforced by the seasonality of the reproductive cycle which takes place during the summer months (Palant *et al.*, 1968) thus affecting the species recruitment.

Our objective is to present the first data which support the hypothesis of the warm climate trend driven range extension of *E. punctata*, describing its potential as a practical indicator of Mediterranean Sea climate variability and tropicalization.

Materials and methods – Records of *E. punctata* have been collected for a few years and organized in a database. Both data from literature and public and private collections were considered. The database contains 145 lots from the Italian coastline, representing 5982 specimens (but abundant populations were often greatly underestimated). Unfortunately, data derive from the occasional sampling effort of researchers and collectors and not from a planned monitoring. Therefore, it is possible that the discovery of new stations of *E. punctata* happened later than its real colonization. However, since the Italian coastline was searched for shells by private collectors with great intensity in the last decades, especially in the northernmost stations of Campania and Lazio, we suppose this bias does not affect our understanding of the phenomenon. A synthesis of the records along the Italian Tyrrhenian coastline is given in Tab. 1.

Tab. 1 - First records of *Echinolittorina punctata* along a latitudinal transect from southern Sicilia to the Tyrrhenian Sea coastline.

Prime segnalazioni di Echinolittorina punctata *lungo un transetto latitudinale dalla Sicilia meridionale alla costa del Mar Tirreno.*

Locality	Latitude N	First records
Agrigento	37.3	Mid 20th century
Catania	37.4	Mid 20th century
Messina	38.3	Late 20th century
Vibo Valentia	38.7	1997
Napoli	40.8	2004
Fiumicino	41.8	2007

Sea Surface Temperature data comes from a re-analysis dataset which combines in optimal way model and observations data in order to obtain the most accurate estimates on a regular spatial and temporal grid. The model has an horizontal resolution of about 6.5 km and 72 unevenly spaced vertical levels. The dataset contains the most important physical features of the ocean circulation (i.e. temperature, salinity, current velocities and directions, etc).

A first qualitative correlation between distributional and temperature data was looked for through the analysis of the temporal series of the March mean sea surface temperature. March was chosen since it is the very beginning of the reproductive cycle and therefore supposed to be the key month in the process. The mean SST in March in Agrigento was selected as a reference temperature for all stations, since in Agrigento the species has always been recorded in the analysed time frame (1985-2007). This temperature was considered the minimum temperature needed for the reproduction of the species and then superimposed on the SST graph of other stations to see to which extent temperatures were above this level and how the presence of *E. punctata* could be correlated.

Results – The mean March SST in Agrigento in 1985-2007 is 14.6 °C and this temperature was chosen as a reference temperature, characterizing the minimum temperature conditions needed by *E. punctata* to start its reproductive cycle.

The SST series of Agrigento, Catania and Messina are similar in shape with the highest value in 1990, the peak of a period of temperatures above the reference level from 1988 to 1991. Further peaks above the reference level are 1994, 1998 and then again 2001. In Agrigento, Catania and Messina the species has been recorded for the whole considered time frame (despite data suggest that the colonization of Messina took place later than the other southern Sicilia localities).

In Vibo Valentia, the temperature trend is similar in shape to the stations in Sicilia with slightly lower temperatures. The first record of *E. punctata* is in 1997 (D'Anna, 1997). The hypothesis is that the temperature peak in 1990 allowed the settling of reproductive populations along the Tyrrhenian coastline north of Sicilia and that populations slowly spread northwards until the first records in Vibo Valentia (almost 100 km from Messina). The time lag between the first evidence of adequate temperatures and the recording of populations depends on how far new stations are from the already established ones and the time needed by larvae to travel, settle and develop reproductive populations.

In Napoli, temperature peaks above the reference level happened in 1990, 1994, 1998 and 2001 as for more southern stations but the first record of the species is in 2001 in Salerno (80 km coastline south of Napoli, Soppelsa *et al.*, 2004) and 2004 in Napoli. Therefore, the temperature peak in 2001 allowed the colonization of this stretch of coastline. The explanation for the lack of records in the 1990s, despite adequate temperatures were present, could be explained with the time lag phenomenon described for Vibo Valentia: the settling of reproductive populations requires time since the colonization is a progressive phenomenon along the coastline.

In Fiumicino the mean temperature in March is often close to the reference level, but it is never above it until 2007. The first records of *E. punctata* date to 2007 (Albano, 2010). The analysis of a longer time series may confirm the phenomenon already described for Vibo Valentia and Napoli.

In Argentario and Livorno the mean temperature in March is never above the reference level and the species is, consistently, not recorded so far.

A similar interesting phenomenon has taken place in Puglia, despite driven by different currents. In Gallipoli, the first peak above the reference level takes place in 2001, but already in 1998 and 1999 the temperature is close to the reference level. The first records of *E. punctata* can be traced back to 2000 (Albano *et al.*, 2008). If a continuous flow of pelagic larvae from Greece could be hypothesized, then in the late 1990s the temperature is close to the adequate one for colonization and the first records are consistently found in 2000. Otranto, despite closer to the supposed origin of Puglia populations, is colder than Gallipoli. There is a single temperature peak in 2001, but other years are well below the reference level.

Conclusions – It is clear that the range expansion of *E. punctata* is driven by currents transporting pelagic larvae but that the establishment of reproductive populations need temperatures high enough to allow its reproductive cycle.

This phenomenon has to be read not only as a new case of warm-water affinity species which extends its range northwards. Its potential is of becoming a new indicator of Mediterranean Sea tropicalization characterized by cheap and easy monitoring.

Its size and morphological characters allow easy identification. The species can't be misidentified with others. It lives in the mesolittoral, most populations can be accessed without even entering the water, therefore no special techniques nor any diving equipment is needed for observations and collections. However, its reproductive cycle is strictly associated to the sea water temperature and it is the key factor in its distribution expansion. Last, but not least, the wide latitudinal range of the Italian coastline is perfect for the study of these phenomena.

Our plans, funding pending, are to establish a richer database of presence data of *E. punctata* from the Italian coastline, obtain a wider SST time series, look for a formal correlation between distribution and temperature data, fully understand the biological reproductive mechanism of the species (comparing, for example, the time of the gonad maturation at different latitudes) and the origin of populations (with molecular markers), define a monitoring protocol and evaluate the possibility of a previsional model.

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THE MEGABENTHIC ASSEMBLAGES OF THE VERCELLI SEAMOUNT (NORTH TYRRHENIAN SEA)

LE COMUNITÀ MEGABENTONICHE DEL VERCELLI SEAMOUNT (MAR TIRRENO SETTENTRIONALE)

Abstract - *The megabenthic assemblages of the Vercelli Seamount (North Tyrrhenian Sea) were studied through ROV imaging from 60 to 500 m depth and a peculiar benthos zonation was observed. The shallower rocky peak (60-100 m depth) hosted a very reach coralligenous community characterized, on the top by the kelp* Laminaria rodriguezii, *by gorgonian assemblages on the southern flank and by sponges-soft corals assemblages on the northern one. On the detritic bottom at the base of the peak, a very dense population of the crinoid* Leptometra phalangium *was observed. On the edge of the detritic plain, around 180-200 m depth, a ring of the yellow scleractinian coral* Dendrophyllia cornigera, *mainly dead, was recorded. The rocky slopes from 200 to 500 m depth, covered by a thick iron-manganese crust, were very poorly colonized, mainly by encrusting sponges and serpulids. This research is the first detailed investigation, through ROV imaging, of megabenthic communities living on a Mediterranean seamount, representing therefore a study model for this peculiar ecosystem.*

Key-words: *benthos, seamounts, Tyrrhenian Sea, ROV imaging.*

Introduction - Seamounts are considered to be hotspots of marine biodiversity being characterised by rich benthic suspension-feeding communities of hard substrates mainly composed of sponges, hydrozoans, scleractinians, antipatharians and gorgonians providing habitat for numerous smaller, mobile invertebrates and hosting an abundant and diversified ichthyofauna (e.g. Samadi *et al.*, 2007). The Mediterranean seamounts have been relatively well investigated from the geological point of view (e.g. Zhuleva, 1988), but few data are available concerning the composition of their megabenthic assemblages. An example is the description of a rich algal community and the mollusc fauna on the top of the Amendolara Bank in the Ionian Sea by dredging program (from 20 m depth) (Cecere & Perrone, 1988). Also the benthic fauna of the top of the Eratosthenes Seamount (750 m depth) was studied by trawl and grab, to the south of Cyprus, in the Eastern Mediterranean Sea (Galil & Zibrowius, 1998). Recently ROV surveys were used to describe the coralligenous assemblages from 80 to 170 m depth on four seamounts along the Spanish coast (Aguiliar *et al.*, 2009). Moreover, the biodiversity of several banks and shoals has been investigated along the continental shelf of the North Tyrrhenian Sea, Sicily Strait, and the Aegean Sea. Studies focusing on deep coral assemblages were made on some rocky shoals along the Calabrian mesophotic zone (Bo *et al.*, 2009) and on the white coral reefs found in the Ionian Sea and mainly composed by the scleractinians *Lophelia pertusa* and *Madrepora oculata*. The Tyrrhenian bathyal plain is spotted by at least 14 large and intermediate seamounts. Their peaks are generally several hundred metres beneath the surface of the sea, Vercelli Seamount however, together with Strabo Seamount, are shallow mountains and photosynthetic communities may develop on their tops. The megabenthic assemblages zonation along the Vercelli

Seamount may represent a study model to describe, through ROV imaging, seamount ecosystems in the Mediterranean Sea.

Materials and methods - Vercelli Seamount, rising from the flat muddy bottom of the Tyrrhenian Sea around 2000 m depth, is located at about 50 miles off Olbia, along the Sardinian coast (41°06.114'N - 10°53.979'E). The survey was conducted with an observer class Remotely Operated Vehicle, ROV *Pluto* (Gaymarine, Switzerland). The ROV was equipped with an underwater acoustic tracking position system (HDR made by Gaymarine ultrashort baseline operating with a 30kHz responder), providing records of its track along the seabed. Additionally it had a depth sensor, a compass, and two parallel laser beams providing a 10 cm scale for measuring the areas of the frames (approximately 1-2 m^2). The ROV, moving at about 1 m height from the seabed (about 2 m of visual field), was equipped with a digital camera and a high definition video camera. To confirm the taxonomic determination of the specimens observed in the frames, we examined samples collected by dredging on the seamount (60-120 m depth) during an oceanographic campaign on board of the R/V *Urania* in May 2009.

Results - The geomorphological characteristics of the Vercelli Seamount were previously studied by underwater photoprofiling (Zhuleva, 1988). The topography of the structure is characterised by steep rocky or detritic walls rising from the sea bottom and turning into flat coarse detritic planes gently sloping from 200-250 to 100 m depth where a rocky peak rises reaching its maximal elevation around 60 m depth (Fig. 1). The ROV observations indicated that the different portions of the rocky pinnacle (summit, from 60 to 70 m depth, SW flank and NE flank, from 70 to 100 m depth) hosted different coralligenous biocoenoses (Fig. 1). The top of the seamount showed a dense population of the kelp *Laminaria rodriguezii* covering almost 80% of the substratum. The substratum free from the algae was colonised by encrusting sponges. Many specimens of the crinoid *Antedon mediterranea* (on average 50 individuals m^{-2}) occurred on the algal thalli. The two flanks of the peak were characterised by significantly different assemblages (Fig. 1). The southern side of the ridge was dominated by gorgonians which sometimes reached very high densities. On the rocky boundary close to the detritic bottom (90-100 m) the only large coral present was the gorgonian *Eunicella cavolinii*, and the more rare *Paramuricea clavata*. Specimens of *Callogorgia verticillata*, *Corallium rubrum* and the scleractinian *Dendrophyllia cornigera* were occasionally observed in the deepest part (90-100 m) of the pinnacle. Several specimens of *Axinella verrucosa* and *Axinella damicornis* were observed. Between 70 and 90 m the density of *P. clavata* progressively increased while that of *E. cavolinii* decreased. One colony of the arborescent antipatharian *Antipathella subpinnata* was observed at about 90 m depth. The northern side of the peak was characterised by the dominance of suspension feeding organisms. From the bottom to 80 m depth we recorded a very large number of colonies of the blue soft coral *Paralcyonium spinulosum*, while *Alcyonium palmatum* was only occasionally observed. *P. clavata* and *E. cavolinii* were also present on the northern side but with lower densities. Specimens of *Axinella* spp. were observed at all depths while the dominant sponge species from 70 to 80 m depth was *Tethya citrina* here showing unusual densities. Other observed suspension feeding organisms, such as the colonial ascidian *Diazona violacea* and the polychaete *Sabella pavonina*, were extremely abundant on the northern flank while they were significatively less recorded on the southern one.The detritic bottom around the peak, between 140-150 m depth, was densely populated by the crinoid *Leptometra phalangium* with densities of up to 43 specimens m^{-2} (Fig. 1). A part from this dense facies, crinoids were absent for the entire length of the slope (about 1 mile), where only some rare *Cidaris* sp. were recorded. On the edge of the detritic bottom (around 180-200 m depth) a wide belt of dead *Dendrophyllia cornigera* (yellow scleractinian coral) was recorded, with sparse living colonies (Fig. 1). The dead calyxes of this species were frequently covered by the blue sponge *Oceanapia* sp. From 200 to 500 m depth the rocks, emerging from the coarse sand, were covered by a thick black crust of iron-manganese oxide (Zhuleva, 1988). On this substratum the biocoenosis is particularly poor, composed by tubes of serpulids and rare encrusting specimens of the sponge *Hamacantha (Vomerula) falcula*.

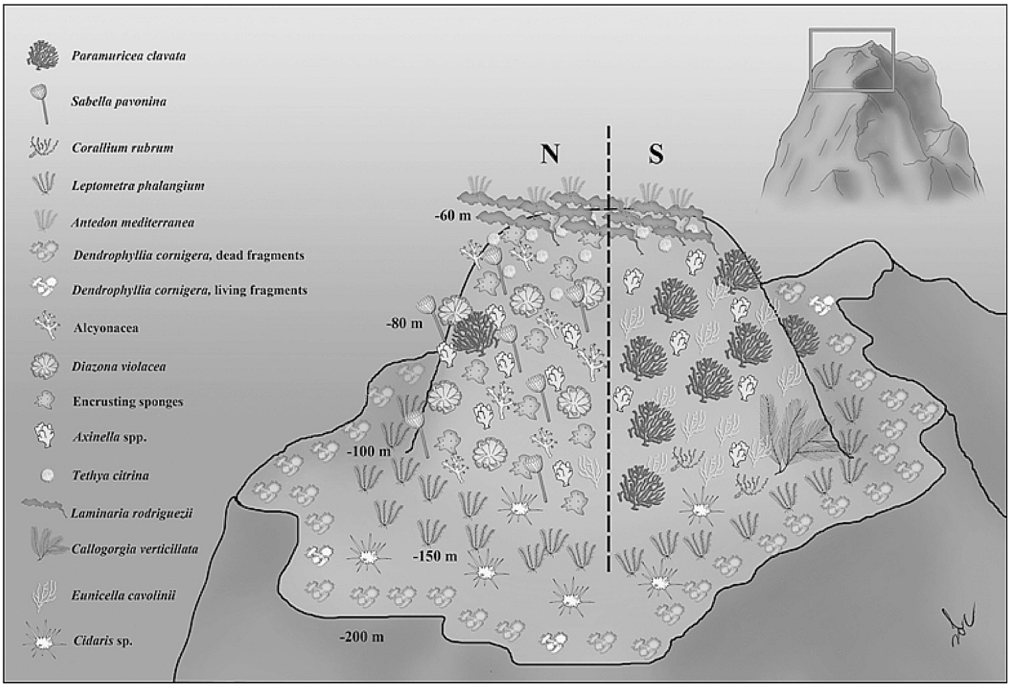

Fig. 1 - Zonation of the megabenthic assemblages of the Vercelli Seamount (60-200 m).
Zonazione delle comunità megabentoniche del Seamount Vercelli (60-200 m).

Conclusions - The coralligenous assemblage recorded on the summit of the Vercelli Seamount is similar to those recorded on other seamounts along the Spanish coast (Aguilar *et al.*, 2009) and to that of the Gorringe Bank (Atlantic Ocean) characterised by a dense assemblage of *Paramuricea clavata* and, on its upper portion, by a dense meadow of *Laminaria ochroleuca* (OCEANA, 2005). The composition of the benthic assemblages on the two sides of the seamount is in agreement with the hydrodynamic conditions of the area (Artale *et al.*, 1994). In the northern area the upwelling conditions likely produce re-suspension of organic particles, but also can increase the phytoplankton biomass development in the euphotic layer, with a subsequent sinking of organic detritus to the bottom, favouring suspension feeding organisms. The very dense population of suspension feeding crinoids is clearly related to the sinking of organic matter produced on the upper pinnacle, in fact, when the distance from this structure increases, the biomass drastically decreases. This is the first ROV description of a Mediterranean seamount representing therefore an useful model of the benthic zonation of these peculiar geological structures.

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PREDATION ON YOUNG *PARACENTROTUS LIVIDUS* SETTLERS: IMPLICATIONS FOR MEDITERRANEAN ROCKY INFRALITTORAL STABILITY

PREDAZIONE SU GIOVANILI DI PARACENTROTUS LIVIDUS*: IMPLICAZIONI PER LA STABILITÀ DEI SISTEMI INFRALITORALI ROCCIOSI MEDITERRANEI*

***Abstract** – Predation of young sea urchins settlers are often invoked as a key process in the control of sea urchins populations and therefore in the structure and stability of rocky infralittoral communities. In this study a number of decapod species were detected as predators of young settlers of the sea urchin* Paracentrotus lividus *and their predation rates estimated by laboratory experiments. Abundance of these predators also resulted significantly lower in barren than in macro algae forests, suggesting that lack of predation of juvenile sea urchins facilitates the stability of Mediterranean barren systems.*

***Key-words:** ecosystem stability, predator-prey interactions, sea urchin, crustaceans, hard bottoms.*

Introduction - In the last decades temperate infralittoral ecosystems have undergone a loss of habitat-forming algae. Erect macroalgae canopy can be massively reduced by perturbation (e.g., loss of top-down control of grazers, destructive harvesting) leading to a shift towards an alternative phase dominated by sea urchins and encrusting organisms named *barren* (Sala *et al.,* 1998). Whether encrusting- and erect macroalgae dominated communities represent alternate stable states of rocky systems has not been proven (Knowlton, 2004). Sea urchins biomass and abundance maintain high in barren areas where few-months old individuals can be more numerous than in macro algae forests (Rowley, 1989). Echinoids are invertebrates with a planktonic larval phase and their population structure strictly depends on larval supply, settlement process and post-settlement mortality. Some authors suggest that mortality of young settlers could represent the bottleneck for sea urchin populations in erect macroalgae forests (Jennings & Hunt, 2010 and reference therein). Given that erect macroalgae are habitat-formers, they add physical complexity to the substratum by increasing species richness and functional diversity of mobile epifaunal organisms (Taylor, 1998). Density of small invertebrates is positively correlated with structural complexity of the habitat, being low in barrens and high in erect algae assemblages (Taylor, 1998). The fact that young settled sea urchins are vulnerable to predation by various small invertebrates (Scheibling & Robinson, 2008), may make erect algae systems less suitable for the survival of recruits. Mediterranean rocky littorals are characterized by either barren or macro algae forests (Sala *et al.*, 1998). The sea urchin *Paracentrotus lividus* resides in both systems but displays always higher biomass and abundance in the former. Since the settlement of *P. lividus* is probably independent from the benthic assemblage (Hereu, 2004), the difference of the sea urchin population structure may depend on the post-settlement mortality between the two systems. Mortality of *P. lividus* recruits has been estimated to reach 75% during the first six months in a macro algae system (Sala & Zabala, 1996). In this light, considering the potential role of predation on *P. lividus* recruits in regulating their abundance, this study planned: (1) to individuate the predators of *P. lividus* recruits and evaluate their predation rates, (2) to compare the abundance of predators of early settled *P. lividus* in barren and erect macroalgae systems.

Materials and methods – The study area included the Medes Island Marine Reserve and the nearby Montgri unprotected area (NW Mediterranean Sea) in summer 2009. The study was carried out on rocky bottoms at 5-8 m depth, characterized by two distinct types of algal assemblage state including: (1) Barren State (BS), dominated by encrusting corallines *(Lithophyllum incrustans, Mesophyllum alternans, Spongites notarisii*) and (2) Erect macroalgae state (EAS) dominated by a canopy of perennial (e.g. *Cystoseira compressa*, *Codium vermillara*) and seasonal (e.g.: *Dictyota dichotoma*, *Asparagopsis armata*) macroalgae and understorey species (e.g.: *Corallina elongata, Rhodymenia ardissonei, Halopteris filicina*).

In order to individuate the potential predators of *P. lividus* juveniles and their predation rates, we exposed young sea urchin settlers to a variety of decapod crustaceans in the laboratory, based on our previous experiments and on the literature (Scheibling & Robinson, 2008). Decapods and sea urchin juveniles were collected by scraping off rocky substrates. In the laboratory, small decapods (<20 mm) and newly settlers of *P. lividus* (<2 mm) were sorted and taxonomically identified. Sea urchins were maintained on coralline crusts and decapods in chilled Millipore-filtered (0.45 µm) seawater (FSW) until use in experiments (Scheibling & Robinson, 2008). In each experimental trial, 10 *P. lividus* juveniles and an individual of a potential predator were placed in a 250 ml beaker with 150 ml of FSW maintained at 19 °C. After 48 h, the surviving sea urchins were counted to calculate the predation rate, and the length of predators measured. In each replicate trial (n=4-16, Tab. 1), different individuals of prey and predators were used.

In order to evaluate the abundance of the predators in BS and EAS, macrofaunal samples were collected by scraping off the rocky substrate defined by quadrats of 20×20 cm. In the laboratory, samples were sieved through a 0.5 mm mesh and identified under a binocular microscope. The predators were counted. Two sites for

Tab. 1 - Species used in the predation experiments.
Specie usate negli esperimenti di predazione.

Species	**Predation rate** Mean ± SD (*n*/10 in 48h)	**Size** mm	*n*
Hermit crabs			
Pagurus anachoretus	0.74 ± 0.23	1.5-5.5	16
Calcinus tubularis	0.77 ± 0.24	1.5-5.5	16
Cestopagurus timidus	0.00 ± 0.00	1.2-2.2	5
Clibanarius erythropus	0.00 ± 0.00	1.3-3.3	16
Crabs			
Pilumnus hirtellus	0.83 ± 0.17	3.9-12	16
Pilumnus villosissimus	0.93 ± 0.10	4.8-19.5	4
Xantho pilipes	0.13 ± 0.10	11-16.8	4
Xantho poressa	0.20 ± 0.14	10-13.4	4
Liocarcinus arcuatus	0.93 ± 0.10	3-4.5	4
Sirpus zariquieyi	0.00 ± 0.00	3-3.7	4
Acanthonyx lunulatus	0.00 ± 0.00	3-5.2	4
Macropodia rostrata	0.00 ± 0.00	5-6.5	4
Pistol shrimp			
Alpheus dentipes	0.34 ± 0.36	3-8.4	16

each community state type (BS and EAS) and three replicates for each experimental block were considered. Analysis of variance was performed using the GMAV5 software package (coded by A.J. Underwood and M.G. Chapman, University of Sydney, Australia) to test for differences in the density of pistol shrimps and crabs that consumed juveniles in the laboratory experiments (Tab. 1), in relation to community state (State; fixed factor, two levels) and between sites within each level of state (Site; nested factor, two levels). Variables were not transformed as they held homogeneity of variances in Cochran's C test. Subsequent pairwise comparisons were performed by Student-Newman-Keuls (SNK) tests. No ANOVA was computed on hermit crabs density as it did not hold homogeneity of variance, even after that transformations were applied.

Results – Only some species of decapod crustaceans utilized in the trials predated *P. lividus* juveniles. Among hermit crabs, *Pagurus anachoretus* and *Calcinus tubularis* had a high predation rate (Tab.1). On the contrary, *Cestopagurus timidus* and *Clibanarius erythropus* did not prey on the urchins (Tab. 1). Among 8 species of crabs presented to young settlers of *P. lividus*, the two *Pilumnus* species and *Liocarcinus arcuatus* resulted efficient predators, consuming almost all the sea urchins offered. The two *Xantho* species had a low predation rate (Tab. 1). The pistol shrimp *Alpheus dentipes* showed an intermediate predation rate (Tab. 1).

Predators of *P. lividus* were abundant in EAS and almost absent in the BS, where only one individual of *A. dentipes* was found (Tab. 2).

Tab. 2 - ANOVA on the abundance of *P. lividus* predators.
ANOVA sulle abbondanze dei predatori di P. lividus.

		Crabs		**Pistol shrimp**	
Source of variation	df	MS	F	MS	F
State (BS *vs* EAS)	1	24.08	289.00**	36.75	441.00**
Site (State)	2	0.08	0.05 n.s.	0.08	0.06 n.s.
Residuals	8	1.83		1.50	
Total	11				

Conclusions – In the Mediterranean Sea, high densities of *P. lividus* may maintain coralline barrens state determining drastic changes on ecosystem functioning. Theoretical and empirical studies suggest that resilience of alternative community states can be enhanced by self-perpetuating process (Knowlton, 2004). Many authors suggest that post-settlement events, like predation, may strongly influence the abundance of sea urchins (Jennings & Hunt, 2010 and references therein). This study for the first time investigates predation on young settlers of *P. lividus* by small invertebrates. Our predation experiments provide laboratory evidence that different crustacean decapods voraciously consume few days-weeks old *P. lividus*. Unexpectedly, we found profound differences in predation rates among different hermit crabs and among different crabs. The difference in the predation patterns among species might depend on species-specific morphological and/or behavioural traits and may have profound repercussions on the mortality of early-post settlement sea urchins in natural conditions. As expected, predators were significantly more abundant in the erect macroalgae assemblage and almost absent in barren areas. Our findings strongly support the hypothesis that the absence of erect algae in a barren system may cause the reduction of predators of *P. lividus* young-settlers, thus enhancing sea urchin recruit survival and representing a self-perpetuating process for the stability of Mediterranean barren systems. This study suggests different and complementary roles of small invertebrate species in controlling the abundance of sea urchin recruits and underlines the importance of the functional diversity of small invertebrates in this process. We encourage future research aimed to understanding the factors involved in the interaction strength between sea urchin recruits and their small invertebrate predators.

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PHYTOPLANKTON COMMUNITIES AS INDICATORS OF ECOLOGICAL CHANGE IN THE ANTHROPOGENICALLY IMPACTED MAR PICCOLO OF TARANTO (IONIAN SEA)

LE COMUNITÀ FITOPLANCTONICHE QUALI INDICATORI DELLE VARIAZIONI DI UN ECOSISTEMA SOGGETTO AD IMPATTO ANTROPICO: IL MAR PICCOLO DI TARANTO (MAR IONIO)

Abstract *– The preliminary results on phytoplankton community dynamics obtained by constructing a system based simulation model are here presented. This constitutes a component in a larger ecological model, which has been developed under the FP6 Integrated Project SPICOSA (Science and Policy Integration for Coastal Assessment). This model is aimed to quantify the main forcing due to human activities and environmental factors acting on the Mar Piccolo coastal system (Taranto, Italy) that is changing its response to these forcing. The succession of phytoplankton groups provides a useful indicator of system response to human perturbations, a calibration parameter for the species-specific growth, an indicator of trophic changes, and a control on the growth of mussels reared in Mar Piccolo.*

Key-words: *coastal zone, indicators, model, phytoplankton, Ionian Sea.*

Introduction - Coastal lagoons and semi-enclosed seas have peculiar functional and structural characteristics due to their location between land and sea. They generally show large temporal and spatial variations in hydro-chemical characteristics and considerable biological diversity (Castel *et al*., 1996). By considering the dynamic nature of these ecosystems, there is an urgent need to develop sensitive and broadly applicable indicators for detecting water quality and ecosystem health. Phytoplankton, which conduct a bulk of primary production and can rapidly respond to a wide range of environmental perturbations, represent a sensitive and important indicator for detecting ecological change in coastal systems (Paerl *et al*., 2009), like Mar Piccolo in Taranto. In this ecosystem, in the last fifty years, urban expansion and intensive agricultures have caused an increase in nutrients and organic matter levels, which are higher than the self-depurating capacities of the basin. Since 2000, to improve the water quality, a depuration plan has been implemented in Mar Piccolo. In the framework of the Integrated Project, SPICOSA (Science and Policy Integration for COastal Systems Assessment), system-based models are being developed to provide higher-level information and decision-support tools for solving problematic issues in coastal zones. In this paper, we refer about the phytoplankton sub-model that is included into a more complex ecological model developed under the SPICOSA Mar Piccolo experiment.

Materials and methods – The simulation model was developed considering a System Approach Framework and the principles of the Systems Theory (von Bertalanffy, 1968). Globally, the System Theory states that complex, non-linear systems function differently *in vivo* than a separate scrutiny of their component parts might indicate. This requires the best-possible understanding of the processes and dynamics of a system.

Geo-morphologically, the Mar Piccolo has two interacting basins with a double-layer stratification in which we simulated the main bio-geo-physical processes related to freshwater balance, salt budget, circulation exchange, vertical diffusion, light attenuation, oxygen budget, nitrogen, phosphate and silicate budget, total carbon regeneration and primary production. In this paper, we show and discuss the details of phytoplankton growth modelling inserted as a block into the more complex ecosystem model (Caroppo *et al*., 2010). The ecological modelling of Mar Piccolo is based on the simulation software EXTEND™-Sim ”(http://www.extendsim.com/).

In order to reconstruct the whole dynamics of Mar Piccolo phytoplankton communities we built a three-group phytoplankton box-model that fundamentally follows the modified formulation of the Villefranche Bay model (Ross and Nival, 1976). The purpose is to reproduce three major plankton groups dynamics (e.g. diatoms, dinoflagellates, and phytoflagellates) in order to simulate the normal seasonal succession observed into Mar Piccolo ecosystem. For this specific case, some approximations have been introduced adding linearly growth and light (mean daily values) coefficients and reproducing the succession as a reflection of the differences between groups’ maximum nutrients assimilation rates. The fundamental equation for phytoplankton growth (PP) is based on the main forcing variables (nutrients and light) taking into account death (Km), respiration (Kr), and a constant grazing parameter (Kg), as in the following form:

$$PP_{(t)}=(PP_{(t-1)}*(Mu+Light(t)*KI)-(Km+Kr)*PP_{(t-1)}{}^{2}-Kg*PP_{(t-1)}))*dt+PP_{(t-1)}$$

Extend calculates the growth per time step (day) and integrates it over time. Nutrients uptake is based both on new and regenerated nitrogen concentrations into the top layer of the Mar Piccolo basin, such as:

$$Mu=Mu_{Nnew}+Mu_{Nreg}$$

in which Mu parameters follow the Michaelis-Menten kinetics both for regenerated and new nitrogen. The light-growth dependency is simulated introducing an attenuation parameter (KI) that depends on the Total Suspended Matter concentration into the upper layer of the basin. The mortality rate (Km) and respiration loss (Kr) are considered both population dependent and group-specific. Also the grazing coefficient (Kg) is here considered dependent on the population dynamic with a time delay that allows simulating a simplified predator-prey population response. All calculations into the model are expressed in grams of carbon per area. The results here reported are based on preliminary simulations of the Mar Piccolo model components, calibrated by using existing observational data directly collected by the IAMC-CNR of Taranto, or obtained from literature, and local Authorities.

Results - The ecological model of Mar Piccolo is deterministic in the sense that it is driven by its external inputs of meteorology, light, external salinity variations. The land runoff, nutrient, and organic loading (BOD) are calculated using available observations of these and of the river and aquifer flows (years 2002-2003). The phytoplankton growth is driven by the light and nutrient conditions, modified by the circulation and diffusion. The general ecological model calibration on primary forcing showed a good level of accuracy compared primarily with the surface layer dataset (years 2002-2003) acquired by stations located in Seno II that gave an idea of the annual trend for nutrient loads (Fig. 1).

The calibration of the phytoplankton community changes are based on observed data (years 2002-2003). The phytoplankton succession is complicated by a feedback with nutrient regeneration and grazing by predators (e.g. zooplankton and mussels).

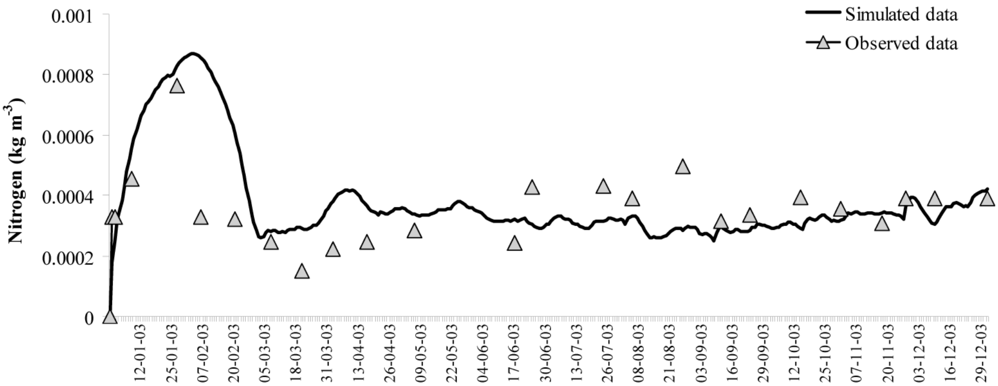

Fig. 1 - The simulated total nitrogen concentration at the surface layer (solid line), compared to the experimental data (triangles).

I risultati del modello relativi alla simulazione della concentrazione di azoto totale nello strato superficiale (linea continua) comparati con i dati determinati sperimentalmente (triangoli).

The succession of the three groups indicates that diatoms prevail in winter (with high runoff and consequently high new nitrogen load), dinoflagellates and phytoflagellates increase during summer (with higher ammonia values) (Fig. 2).

The field data testify that throughout the years, a drastic reduction of the total phytoplankton and particularly of diatom abundance has been observed (Caroppo C., unpub. data). So, it seems that the qualitative composition of the communities is changing with a shift from diatoms to nano-phytoplagellates as dominant group in terms of cell densities. Probably, this last is an evidence of the change of system's nutrient load due to the sewer discharge reduction occurred between 2000 and 2007 (Caroppo *et al.*, 2010).

Conclusions – Historical studies of Mar Piccolo ecosystem are mostly limited only to models of circulation (Umgiesser *et al.*, 2007) and to statistical studies on hydrology and chemico-physical features (Alabiso *et al.*, 1997).

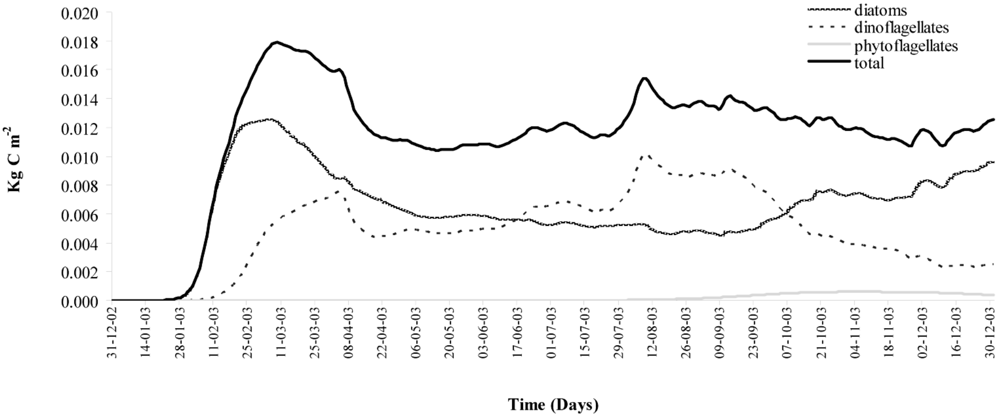

Fig. 2 - The modelled results of the three phytoplankton groups and total biomass (kg C m^{-2}).

I risultati del modello riferiti alla biomassa totale ed ai tre gruppi fitoplanctonici (kg C m^{-2}).

Globally, the ecological model of Mar Piccolo developed under the SPICOSA experiment allowed us to reproduce the environmental conditions of such ecosystem: the fresh-water runoff, the water circulation, and the nitrogen budget that constitute the most important forcing factors for primary production. By considering the performed test simulations, the phytoplankton growth is driven by the light and nutrient conditions, and modified by the circulation and diffusion. The idea of simulating the regenerated-nitrogen growth allowed us to evaluate the feedback with nutrient regeneration that seems to be one of the most relevant aspects for phytoplankton groups succession and indicator of environmental stress.

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POPULATION GENETIC STRUCTURE OF THE TOXIC DINOPHYCEAE *ALEXANDRIUM MINUTUM* IN THE MEDITERRANEAN SEA: A CASE STUDY

STRUTTURA GENETICA DI POPOLAZIONE DI ALEXANDRIUM MINUTUM *(DINOFLAGELLATA) IN MAR MEDITERRANEO: UN CASO DI STUDIO*

Abstract – Alexandrium minutum *(Dinophyceae) is a worldwide distributed species and is responsible for paralytic shellfish poisoning (PSP) outbreaks throughout the world. In the Western Mediterranean Sea, this species causes also high biomass events in many enclosed coastal sites with relevant negative implications on environment and economic activities. Using new molecular markers characterized by a higher mutational rate than ribosomal genes, as the microsatellite markers, it has been possible to investigate the population genetic structure on large scale in the Mediterranean basin to understand the phylogeographical dynamic dispersion of this species.*

Key-words: *Dinoflagellates, microsatellite, population genetic structure.*

Introduction – The occurrence of Harmful Algal Blooms (HABs) in recent decades has particularly affected the coastal regions worlwide. In particular, the dinoflagellate *Alexandrium minutum* is widely distributed in the Mediterranean Sea and is mainly responsible of high toxic biomass events producing the paralytic shellfish poisoning (PSP). This dinoflagellate is considered as one main representative species of HAB events in the Mediterranean Sea (Vila *et al.,* 2005).

Phylogenetic studies on the ribosomal DNA sequences of *A. minutum* from different geographical areas showed that Mediterranean and worldwide strains belonged to the same group forming a homogeneous clade, the Global clade (Lilly *et al.,* 2005). This genetic information didn't permit to resolve the potentially genetic diversity of *A. minutum* population in relation to the regional scale harmful blooms (Penna *et al.,* 2008).

The microsatellite markers have been applied to several *A. minutum* isolates in order to understand evolutionary relationships within this species and to assess the genetic variability among *A. minutum* populations from different coastal areas of the Mediterranean Sea.

Understanding population connectivity, the spread mechanisms, and the genetic structure of the toxic species *A. minutum*, is crucial for its capacity of dispersion and impact with potential harmful outbreaks in the Mediterranenan coastal environments.

Materials and methods – A total of 116 *A. minutum* strains were isolated from field samples, collected in 6 different coastal areas, as northern western Adriatic Sea, Ionian Sea, Tyrrhenian Sea, Catalan Sea, Balearic Sea and eastern Atlantic (Spain).

Total genomic DNA was extracted and purified using DNeasy Plant Mini Kit (Qiagen, Valencia, CA, USA) according to manufacturer's instructions. The ribosomal 5.8S gene and ITS regions of each *A. minutum* isolate were amplified using ITSA and ITSB primers according to the protocol of Penna *et al.* (2008) and the PCR products were sequenced. Seven microsatellite loci (Nagai *et al.,* 2006) were used to genotype all *A. minutum* isolates. Samples were amplified in an Applied Biosystems

DNA Thermo Cycler 2720 (Applied Biosystems Inc., USA). Each PCR product was visualized on agarose gel 2.5% (w/v), analyzed by ABI PRISM 3100-Avant Genetic Analyzer (Applied Biosystem, USA) and finally sized by GeneMapper software ver. 4.0 (Applied Biosystems Inc., USA). The global and pairwise genetic diversity and fixation indices (FST), and Analysis of Molecular Variance (AMOVA) among the different populations were calculated by the Arlequin software ver. 3.1 (Excoffier *et al.,* 2005) and Fstat software ver. 2.9.3 (Goudet, 2001). The Principal Coordinate Analysis (PCoA) based on the genetic distance matrix was carried out by the Excel application GenAlEx ver. 6.1. Bayesian analyses were performed using Structure software ver. 2.2 (Pritchard *et al.,* 2000).

Results - The alignment of the 5.8S-ITS rDNA sequences showed a nucleotide sequence identity of 100% among all *A. minutum* isolates. The seven primers used for the PCR amplification of 7 microsatellite loci of *A. minutum* isolates provided PCR amplified products of the expected range size. The different genetic diversity indices within population of *A. minutum* (Tab. 1) indicated that all loci were polymorphic in all the sampling stations and showed a number of alleles ranging from 2 to 12. The allelic richness varied from 3.64±1.29 to 7.17±0.80 and the gene diversity from 0.62±0.17 to 0.89±0.04.

Tab. 1 - Genetic variability of *A. minutum* based on seven microsatellite loci.
Variabilità genetica di A. minutum *stimata per sette loci microsatelliti.*

	CLUSTERS						
	N. ADRIATIC	**C. ADRIATIC**	**IONIAN**	**TYRRHENIAN**	**CATALAN**	**BALEARIC**	**ATLANTIC**
N	8.71±0.76	20.00±2.94	17.29±1.70	22.86±1.68	20.29±1.89	10.57±1.13	8.57±0.53
Na	5.14±1.35	9.43±1.18	4.14±1.46	5.57±1.99	4.43±2.30	4.00±1.41	4.57±0.53
GD	0.87±0.07	0.89±0.04	0.62±0.17	0.71±0.14	0.62±0.28	0.71±0.13	0.74±0.12
Ar	5.07±1.37	7.17±0.80	3.64±1.29	4.57±1.57	3.68±1.64	3.84±1.39	4.49±0.54

N, number of individuals; Na, number of alleles observed per locus; GD, gene diversity; Ar, allelic richness.

N, numero di individui; Na, numero di alleli osservati per locus; GD, diversità genetica; Ar, ricchezza allelica.

The global FST index, reached a value of 0.19 ($p<0.001$). The indices of molecular diversity referred to the pairwise comparison among *A. minutum* populations were statistically highly significant ($p<0.001$) with exception of the northern Adriatic population compared with central Adriatic population, and central Adriatic population compared with the Atlantic one, where observed p-values were not significant ($p>0.05$). The Principal Coordinate Analysis (PCoA) showed the presence of 4 major groups, as northern Adriatic, Ionian, Tyrrhenian and Catalan.

Bayesian analysis was also carried out. It has been possible to clearly distinguish 4 groups with a genetically homogeneous component for each group, that is the Ionian, Adriatic Tyrrhenian and Catalan. Further, it was not possible to identify a unique genetic component for Balearic and Atlantic areas, as the individuals were characterized by mixed genotypic components (Fig. 1). Based on the Bayesian analysis the presence of both allochtonous and mixed genotypes, not belonging to the initial population, were observed within each group.

Conclusions – The results obtained by the screening of the microsatellite markers were different from those obtained by previous analyses of ribosomal markers (Penna *et al.,* 2008; Lilly *et al.,* 2005) conferming that ribosomal DNA was not informative to estimate genetic diversity within *A. minutum* populations from different coastal areas.

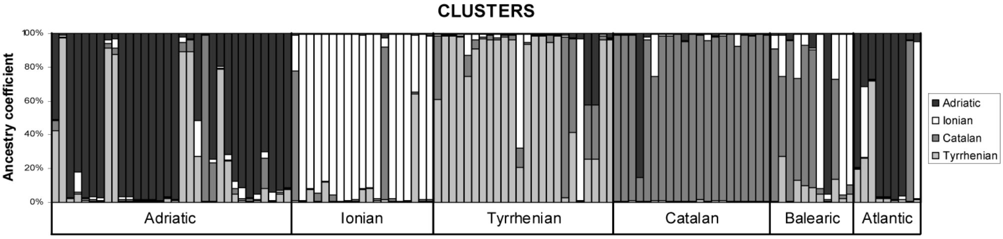

Fig. 1 - Population structure based on 7 microsatellite loci in *A. minutum*. Assigment of 116 individuals to 4 genetically distinct groups. Each individual is represented by a vertical bar coloured according to the assigned group.

Struttura genetica di popolazione basata sull'analisi di 7 loci microsatelliti in A. minutum. *Assegnazione di 116 individui a 4 gruppi geneticamente diversi. Ciascun individuo è rappresentato da una barra verticale colorata in base al gruppo di assegnazione.*

In the Mediterranean Sea, it has been possible to identify four distinct genetic clusters corresponding to 4 *A. minutum* populations through the analysis of 7 microsatellite loci. The results showed a strong phylogeographical structure probably due to the presence of physical and hydrographical barriers. Population isolation resulting from the limited connectivity leaded to a low gene flow among *A. minutum* populations. This isolation didn't lead to a loss of variability (the gene diversity values were all above 62%). The presence of allochtonous and mixed genotypes within each population could be explained (i) by assuming that the allochtonous genotypes can belong to original populations that have re-colonized the Mediterranean after the Messinian Salinity Crisis, or (ii) by both hypothesis of natural and/or human assisted way of dispersal, as ballast water or aquaculture (Casabianca *et al.,* unpublished data).

In this case study of the harmful microalgal species *A. minutum*, the application of the microsatellite markers were useful and more sensitive tool for diagnostic screening of different populations within this species that is responsible of potential harmful outbreaks, thus giving a tool for the improved control and management activities of the HAB events in the Mediterranean Sea.

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Biol. Mar. Mediterr. (2010), 17 (1): 109-111

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A MACHINE LEARNING APPROACH TO THE STUDY OF A RED CORAL *CORALLIUM RUBRUM* (L.) POPULATION

UN'APPLICAZIONE DEL MACHINE LEARNING PER LO STUDIO DI UNA POPOLAZIONE DI CORALLO ROSSO CORALLIUM RUBRUM *(L.)*

***Abstract** – This study deals with the application of a machine learning algorithm (a classification tree) to assess the weight of* Corallium rubrum *(Cnidaria, Octocorallia) ramifications on the basis of the number of apices. Our approach can be easily applied to obtain in situ estimates of weight and basal diameter of colonies. Future developments include the integration with image acquisition and processing hardware.*

***Key-words*:** Corallium rubrum*, biometry, machine learning.*

Introduction – Due to their trophic role, biomass and biogenic activities, long-lived species play a major role in benthic marine ecosystems (Garrabou & Harmelin, 2002).

The Mediterranean red coral (*Corallium rubrum* (L.) is certainly among these species, but it is also a heavily exploited species (Santangelo *et al*., 2007). This study aims at using red coral colonies as models for searching a non-destructive method for the assessment of weight and basal diameters of the ramifications based on the number of apices, using a machine learning approach (Fielding, 1999). This could be helpful for registered divers in order to prevent fishing colonies below the legal size.

Materials and methods – The study area is located 7 nm SSW of Alghero (Italy) (40° 23.668' N - 8° 13.418' E) at a depth of nearly 120 m. The fishing grounds of this area were already investigated (Cudoni & Chessa, 1991). The coral was fished by a registered professional diver. 123 colonies were used for model calibration, 63 for validation only. Linear models were computed for the following relationships: wet weight (W) *vs.* basal diameter (D), basal diameter *vs.* number of apices (A) and wet weight *vs.* number of apices. A Classification Tree (Breiman *et al.,* 1984) was then trained to predict wet weight on the basis of the number of apices. This method allows to overcome some limitations that may hinder statistical models (e.g. normality, linearity, etc.).

Results – The correlation between W and A was quite good (r=0.77**), while the one between D and A was somewhat weaker (r=0.50**). This could be due to the fact that the W *vs.* A correlation depends on colony shape, which in turn depends on D. This means that the relation that links A to the other parameters is not a simple one. The log-log linear correlation between W and D ($W=0.4634 \cdot D^{1.9125}$, MSE=369.2) (Fig. 1), was a rather good one. According to it, the ramifications that can be fished on the basis of local regulations are those with a minimum weight of 37.9 g (10 mm diameter). Colonies of 24.7 g (8 mm diameter) can be fished with some limitations. The correlation between predicted and observed wet weight, based on the validation set, was r=0.76**, thus showing that using A to assess W was a viable solution for red coral colonies. Using the

Classification Tree (see a sample branch in Fig. 2) not only provided slightly better weight estimates (MSE=355.7), but it also allows obtaining those estimates with no calculations, using a simple table. For instance, the expected weight of a colony with 18 apices is 26 g (see second "leaf" from left in Fig. 2) and therefore its expected basal diameter is larger than 8 mm (see Fig. 1). This way even a diver in action can easily decide whether a colony can be harvested or not.

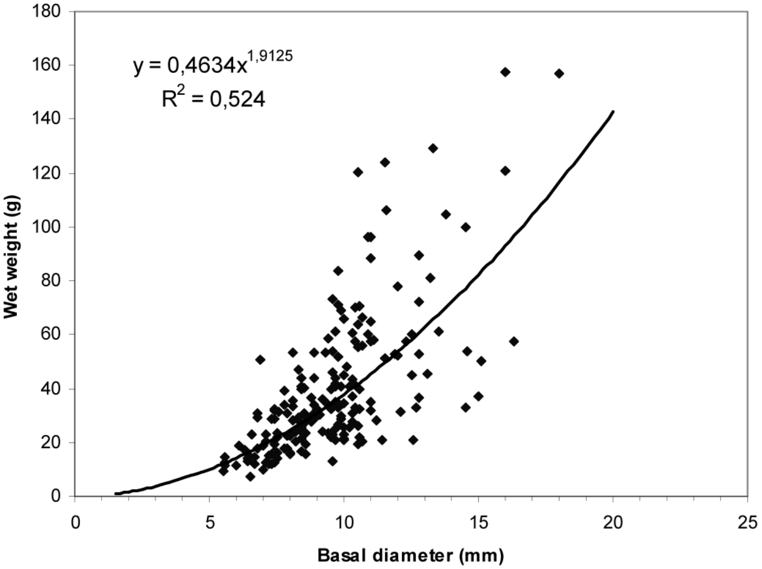

Fig. 1 - Regression of wet weight *vs.* basal diameter.
Regressione del peso umido sul diametro basale.

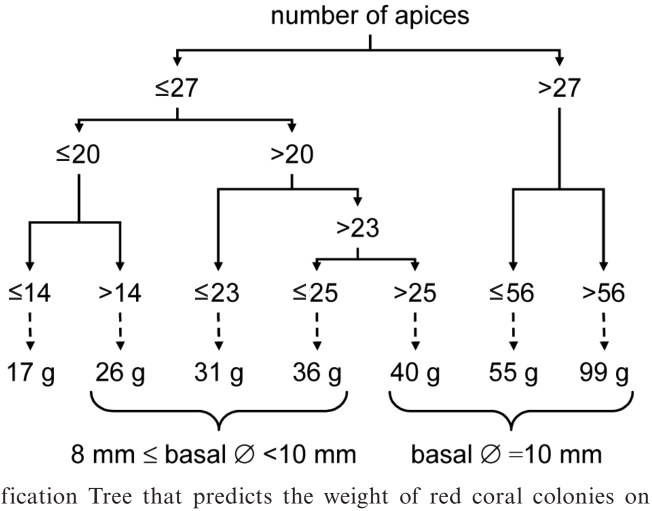

Fig. 2 - A Classification Tree that predicts the weight of red coral colonies on the basis of the number of apices.
Un Classification tree che predice il peso delle colonie di corallo rosso sulla base del numero di apici.

Conclusions – Our approach makes it possible to define a simple table that summarizes the apices *vs.* weight *vs.* basal diameter relationships, thus supporting the diver's decision about which colonies can be harvested according to Sardinian regulations. This Machine Learning approach can be easily improved in case more predictive information is used (eg. exposition; depth; local ecological conditions). In particular, future work will be aimed at refining the Classification Tree for small colonies because the basal diameter estimates are critical for colonies that are close to the lower size limit for legal harvesting. Moreover, we aim at integrating our approach into a complete hardware solution for underwater image acquisition and real time processing.

Acknowledgements - This work is dedicated to the memory of Tonino Paddeu who recently passed away while fishing red coral in Alghero.

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Biol. Mar. Mediterr. (2010), 17 (1): 112-115

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THE BENTHIC ASSEMBLAGE OF CONERO PROMONTORY: A MODEL FOR THE STUDY OF SEASONAL CYCLES IN THE NORTH ADRIATIC SEA

LA COMUNITÀ BENTONICA DEL PROMONTORIO DEL CONERO: UN MODELLO PER LO STUDIO DEI CICLI STAGIONALI NEL NORD ADRIATICO

***Abstract** – It is widely accepted that in the Mediterranean temperate waters several filter feeding organisms undergo a seasonal life cycle characterized by alternate active phases and starvation periods with production of resting stages. The warm season is considered as an adverse period for the majority of the filter-feeders due to the scarcity of plankton production resulting in a marked oligotrophy of the waters. The study of the seasonal cycle of several hard-bottom benthic species of the Conero Promontory (North Adriatic Sea) showed, on the contrary, that most of them are active during summer. This situation, probably representing a model for the entire North Adriatic hard-bottom communities, is due to extremely low winter temperatures, high plankton availability all around the year and exploitation, as food source, of meroplanktonic larvae mainly released during summer.*

Key-words: *benthos, seasonal cycles, plankton, Adriatic Sea.*

Introduction - Marine benthic organisms of Mediterranean littoral areas show seasonal trends of abundance, growth and reproduction. In particular several species, mainly calcareous sponges, hydrozoans and ascidians, are active only during the favorable season while they go through the adverse periods as resting stages (Bavestrello *et al*., 2006). Studies conducted in the western Mediterranean Sea indicate that the majority of the seasonal taxa undergoes to a cycle of growth and expansion in winter while reduces the activity or enters to dormancy in summer. Although water temperature and irradiance variations are usually considered as the main factors triggering seasonal cycles, Coma *et al*. (2000) highlighted also the importance of food availability in determining the life strategy of benthic suspension feeders. Most of these species are active in winter-spring, when they exploit the plankton blooms, while they reduce their activity during the warm, oligotrophic season. The western side of North Adriatic Sea shows different geomorphological and hydrological characteristics respect to the rest of the Mediterranean Sea, such as the shallowness of the basin, the high sedimentation rate and the sharp thermal excursion between summer and winter. Moreover, this coastline receives 20% of the total Mediterranean river inputs, mainly from the Po river (Russo & Artegiani, 1996). The Italian coasts of the northern Adriatic Sea generally are sandy except for limited rocky areas, such as Colle S. Bartolo (Pesaro) and Conero Promontory (Ancona). These zones, together with scattered substrates of anthropic origin, break the continuity of the sandy coast and may represent important stepping stones for species dispersal.

The peculiarity of this area impels to deepen the knowledge concerning the life histories of its benthic communities, still poorly studied. In this work the seasonal cycle of four of the most representative benthic species of the Conero Promontory is described. This study suggests that, in the North Adriatic Sea, the model describing the seasonal patterns generally accepted for the Western Mediterranean waters, is modified according to the peculiar conditions of this area.

Materials and methods – The life cycles of four benthic organisms living along the Conero Promontory coasts (Ancona) were monthly studied from July 2006 to November 2009. The area includes natural rocky barriers, scattered rocks and artificial substrates hosting rich communities mainly composed of mussels, sponges and cnidarians. In particular we focused on the sponge *Tedania anhelans* (Lieberkühn, 1859), the scyphozoan *Aurelia aurita* (L., 1758), the hydrozoan *Eudendrium racemosum* (Cavolini, 1785) and the stoloniferan *Cornularia cornucopiae* (Pallas, 1766). In order to estimate the percentage cover of the sponge, seven squared areas 50×50 cm were considered between 5 and 6 m depth and pictures of the specimens, taken with an underwater digital camera, were analysed with the Image J software in order to measure the sponge areas. 75 random replicates of a 20×20 cm frame were carried out to determine the density variation (in terms of number of colonies m^{-2}) of the hydroid species, while the abundance of stoloniferans and scyphopolyps was determined with 5 replicates of 10×10 cm frames.

Results – The Conero Promontory presents shallow bottoms, not exceeding 14 m depth, is continuously invested by currents and is characterized by high sedimentation rates. The sea temperature in this area reaches the lowest values between January and February (about 7 °C) while the peak is recorded in August (about 27 °C). Regarding the seasonal cycle, three pools of species can be recognized: a first group observed all around the year including several bivalves (mainly *Mytilus galloprovincialis* and *Ostrea* spp.) and massive sponges (*Chondrosia reniformis, Ircinia variabilis, Aplysina aerophoba*); a second group including organisms occurring only during the winter period (for example the hydroids *Ectopleura crocea, Obelia dichotoma* and *Coryne* sp. and the bryozoan *Bugula* sp.); the third and most important group is composed by spring-summer species (the sponges *Oscarella lobularis* and *T. anhelans,* the hydroids *E. racemosum, Halocordyle disticha* and *Coryne eximia* and the stoloniferan *C. cornucopiae*). *A. aurita* polyps are eurythermal, able to adapt to a wide range of environments, and at Conero Promontory they are observed throughout the year; while low temperatures trigger the strobilation in winter, there is a positive relation between polyp number and temperature increase in summer.

Concerning the organisms studied in detail, *T. anhelans* (Fig. 1A) shows a marked seasonal cycle reaching maximum values of percentage covering in summer (20% ±3.5 SE) and almost disappearing in autumn-winter. The species intensively reproduces asexually from April to August giving rise to simple or ramified propagules that detach from the sponge body. *A. aurita* (Fig. 1B) reaches density values higher than 45 polyps cm^{-2} in summer then decreases showing the minima between February and April (12-20 polyps cm^{-2}) (Di Camillo *et al*., 2010). *E. racemosum* (Fig. 1C) shows low densities during autumn (15-160 colonies m^{-2}) then falls down to zero during winter when hydrorhizae act as resting stages. The colony density quickly increases in spring (22-200 colonies m^{-2}) and reaches the maximum value in August (with an average of almost 400 colonies m^{-2}). The reproduction also occurs in the warm season. *C. cornucopiae* finally shows minimum densities in the coldest period, with a minimum of 1840 polyps m^{-2} ±467.55 SE in February, and greater abundance in summer, with an August peak of 29620 polyps m^{-2} ±630.40 SE. Polyps reproduce from April to June with the 80% of fertile polyps in spring. The cnidarian gut content analyses revealed that the three considered species feed on *Mytilus galloprovincialis* pediveligers. In particular *E. racemosum* intensively feed on these and other meroplanktonic larvae showing an estimated predation rate of 2,400,000 prey items m^{-2} day^{-1} (Di Camillo *et al*., in press).

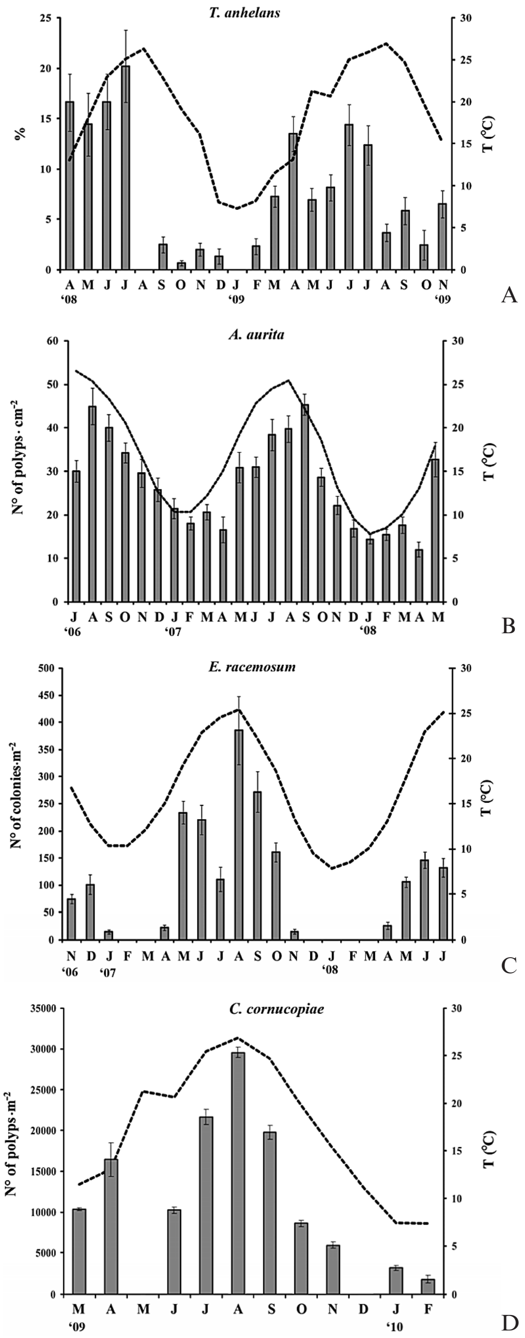

Fig. 1 - Trends of density and % coverage of four benthic species of the Conero Promontory. A) *T. anhelans*; B) *A. aurita*; C) *E. racemosum*; D) *C. cornucopiae*. The dotted line shows the monthly average sea temperatures during the study periods (http://www.mareografico.it).

Andamenti di densità e % di ricoprimento di quattro specie bentoniche del Promontorio del Conero. A) T. anhelans*; B)* A. aurita*; C)* E. racemosum*; D)* C. cornucopiae*. La linea tratteggiata mostra l'andamento delle medie mensili della temperatura del mare durante i periodi di studio (http://www.mareografico.it).*

In this area the densities and the sizes of the studied organisms are perceptibly higher than the same species observed in other Mediterranean sites. *E. racemosum,* for example, shows densities six-fold higher than Medas Islands (Gili, 1982) while the common sponge *C. reniformis* may cover more than a squared metre surface.

Conclusions – The filter-feeders assemblage of the Conero Promontory is composed by a large number of species, mainly sponges and cnidarians, with an evident seasonal cycle. Moreover contrarily to the western Mediterranean Sea (Coma *et al*., 2000; Bavestrello *et al*., 2006), the most conspicuous seasonal species typically occur in summer.

The high incidence of seasonal species in the Conero area is probably due to the sharp water temperature variations occurring during the year (7-27 °C *vs* 13-25 °C temperature ranges registered in the Adriatic and western Mediterranean basins respectively). In this environment only few eurythermal species are able to tolerate the drastic temperature variations. Moreover, while the summer water temperature is quite similar to that of western Mediterranean waters, the winter one is strongly lower and this fact enhances the number of species with an active phase during the warm season. In the western Mediterranean basin the number of summer species is strongly constrained by the decreasing of food available for filter feeders. On the contrary in the North Adriatic Sea the food availability is high all around the year, moreover we have shown that carnivorous filter feeders can be supported by a high production of meroplanktonic organisms, mainly veliger and pediveliger of bivalves that reach their maximal density during summer months. It is therefore probable that food supply is not a limiting factor in this area, consequently the seasonality of benthic species is mainly triggered by the physiological adaptations of each species to a restrict range of temperatures. This fact is supported by the strong correlation observed between the cycle of abundance of the studied species and that of water temperature. On the contrary, in the western Mediterranean Sea, these cycles are shifted suggesting the involvement of other possible cues (Boero & Fresi, 1986).

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Biol. Mar. Mediterr. (2010), 17 (1): 116-118

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HYPO-OSMOTIC STRESS TOLERANCE AMONG THREE INTERTIDAL *FUCUS* SPECIES: EFFECTS ON SURVIVAL, RECRUITMENT AND COMMUNITY COMPOSITION

TOLLERANZA ALLO STRESS IPOOSMOTICO IN TRE SPECIE INTERTIDALI DI FUCUS*: EFFETI SU SOPRAVIVENZA, RECLUTAMENTO E COMPOSIZIONE DELLA COMUNITÀ*

Abstract – *These studies aimed to test the extent to which the distribution of fucoid algae is determined by recruitment and survival of early developmental stages (zygotes and embryos); in particular the influence of abiotic (osmotic) stress at early development stages on subsequent growth and survival. Comparative physiological experiments have been carried out on three dominant fucoid species native to the UK. A further investigation into the acute responses to hypo-osmotic treatment, has shown that embryos are susceptible to osmotic stress caused both by exposure to rainfall at low tide and re-immersion into seawater following periods of desiccation. This work has also shown that zygotes and embryos of the three most common fucoid species (*Fucus spiralis*, *F. vesiculosus *and* F. serratus*) display dramatically different physiological strategies for tolerating osmotic stress.*

Key-words: *Ecological zonation, osmotic pressure, seaweed embryo.*

Introduction - Temperate rocky shore habitats comprise complex interacting physical gradients and show temporal fluctuations in a number of environmental variables (Stephenson & Stephenson, 1949; Lewis, 1964). The varying levels of stress associated with these gradients and fluctuations contribute to the competitive interactions between organisms in this habitat (Baker, 1909, 1910; Davison & Pearson, 1996). On the other hand, physical heterogeneity creates numerous potential ecological niches that may underlie both high biodiversity and biomass (Helmuth & Hofmann, 2001). Hypo-osmotic stress is likely to be encountered with every tidal cycle, either through sporadic events of rainfall or re-immersion into seawater following periods of desiccation. The resistance to physical stress of fucoid algae has previously been demonstrated through adaptive mechanisms within established adult populations (Chapman, 1995; Davison & Pearson, 1996). However, this has not been fully examined in early developmental stages, such as zygotes and embryos that are potentially exposed to the same physical factors as adults and are likely to be more vulnerable to stresses. Higher shore levels experience exposure to emersion, specifically osmotic, stresses more frequently and for longer periods of time than lower shore levels (Stephenson & Stephenson, 1949). We have demonstrated that zygotes and embryos of *Fucus* species from higher shore levels display very different physiological strategies for tolerating osmotic stress than neighbouring species lower down the shore gradient. We have developed new approaches to monitor fucoid propagule supply and recruitment *in situ*. Field studies reveal that physiological tolerance mechanisms identified from laboratory experiments have real ecological relevance in terms of survival, recruitment, and community.

Materials and methods – Experiments characterising physiological parameters were designed to examine individual tolerance, adaptive mechanisms and ecological relevance in the field.

Tolerance: Cell burst assays recorded species survival following exposure to a severe (10‰ S) hypo-osmotic treatment throughout the first 48h of development. Species survival was assessed following a period of induced desiccation and re-immersion into natural seawater.

Adaptive Mechanisms: Cell volume measurements monitored volumetric changes occurring within zygotes during and immediately after mild (15‰ S) hypo-osmotic exposure. Sub-lethal effects of hypo-osmotic exposure were tested by exposing zygotes to several dilute salinity concentrations over varying lengths of exposure time, measuring the ratio between length/width growth over seven days.

Field studies: involved both manipulative and descriptive experiments. Manipulative experiments transplanted laboratory released zygotes to high, mid and low shore levels for 24h. Descriptive sampling monitored the supply of propagules *versus* percentage recruitment. Wild fucoid embryos were identified to species level using a pioneered technique relying on auto-fluorescence using confocal microscopy and ratio image analysis identification.

Results – *Tolerance*: Resistance to hypo-osmotic shock varied throughout development in all three fucoid species. Inter-specific differences in tolerance were also apparent. Embryos of the high shore alga, *Fucus spiralis*, as expected burst significantly less than the mid shore, *F. vesiculosus,* and low shore, *F. serratus*, embryos respectively when given the same hypo-osmotic treatment. Fucoid embryos also encountered hypo-osmotic stress after a period of desiccation followed by re-immersion to seawater. Bursting was highest among embryos from the low shore (*F. serratus*) with survival increasing respectively in *F. vesiculosus* and then *F. spiralis*. *Adaptive Mechanisms*: To examine mechanisms, we looked at volume control during mild stress exposure the high shore alga, *F. spiralis*, exerted considerable control over its internal volume preventing rhizoid apex swelling. However, when re-immersed in natural (34‰ S) seawater, *F. spiralis* expressed ion loss as a function of drastic rhizoid shrinking. The mid shore species, *F. vesiculosus*, demonstrated negligible fluctuations to its internal volume both during exposure and following re-immersion to seawater, no significant swelling or shrinking. The low shore species, *F. serratus,* possessed little internal volumetric control, swelling considerably during exposure and once re-immersed returned to a volume comparable prior to exposure. Burst characterisation indicated that the mid shore species, *F. vesiculosus*, possesses a high internal pressure despite not swelling prior to bursting, suggesting that cell walls may be reinforced in a thickening process. Assessing the sub-lethal effects following various exposure regimes, higher shore species (*F. spiralis* and *F. vesiculosus*) exhibited a negative response in terms of length/width growth compared to low shore species (*F. serratus*).

Field studies: Manipulative field sampling showed survival to be highest among higher shore species, *F. spiralis* and *F. vesiculosus*, and lowest survival recorded among low shore species, *F. serratus* at all shore levels. Wild embryos of all three *Fucus* species could be identified on the basis of their autofluorescence properties. Descriptive field sampling indicated a significant export of low shore species' (*F. serratus*) propagules to higher shore levels; similarly higher shore species' (*F. spiralis* and *F. vesiculosus*) propagules were also being supplied to lower shore levels. Higher shore species exhibit a similar recruitment success at all shore levels. However, *F. serratus* (low shore) propagules exhibited a declining recruitment success with increasing shore height.

Conclusions - Closely related fucoid species demonstrate very different osmotic strategies to optimise survival within natural shore position. The high shore fucoid, *Fucus spiralis*, possesses a higher tolerance to hypo-osmotic stress through the development of an intricate osmo-regulatory mechanism. This mechanism comes at a price to growth and competitive ability likely to be responsible for its inability to significantly colonise lower shore levels. The mid shore fucoid, *F. vesiculosus*, does not seem to possess an osmo-regulatory mechanism; instead it is likely to rely on structural reinforcement through thicker cell walls conferring tolerance. The low shore fucoid, *F. serratus*, a passive osmometer, invests little energy into tolerating hypo-osmotic stress and as a result is less capable of recruiting outside its natural shore position on higher shore levels. There is an indication that greater exposure on higher shore levels contributes to a higher tolerance of fluctuations in the external osmotic environment. Hypo-osmotic stress is a likely significant selective pressure acting negatively on vulnerable early developmental stages in recruiting fucoid algae, contributing to community composition.

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THE MPA "ISOLA DI USTICA": A MODEL OF BENTHIC COMMUNITY NATURAL CHANGES

L'AMP "ISOLA DI USTICA": UN MODELLO DI CAMBIAMENTI NATURALI DELLA COMUNITÀ BENTONICA

***Abstract** – This study, aimed to evaluate the protection effects on* Paracentrotus lividus *and* Arbacia lixula *populations and benthic assemblage, spanned four years (2006-2009) at the MPA "Isola di Ustica". Results showed a decrement of sea urchin abundance and a consequent recovery of erect macroalgae. Multiple factors like lack of sea urchin recruitment and natural predation have possibly promoted the observed pattern.*

***Key-words:** benthos, protected resources.*

Introduction – Rocky infralittoral benthic communities may be controlled by sea urchin abundance. At high densities, sea urchins eliminate erect macroalgae maintaining barrens (areas dominated by encrusting algae). In Mediterranean MPAs, fishing prohibition generally leads to the recovery of populations of sea urchin predators, such as seabreams (i.e. *Diplodus sargus* and *D. vulgaris*), thus promoting the growth of an erect macroalgae canopy *via* sea urchin control. The opposite trend has occurred at the MPA of Ustica Island (SW Italy) where, after the cessation of harvesting activities, urchin barrens formed due to a burst of the two co-occurring sea urchins *Paracentrotus lividus* and *Arbacia lixula* populations. The natural scarcity of the two seabream species has probably favoured this process (Bonaviri *et al*., 2009). Ustica MPA is characterized by a particular protection regulation; during the summer season, recreational fishing of the edible *P. lividus* is permitted exclusively in the take zone (zone C). It was demonstrated that recreational *P. lividus* fishing affects abundance of the species itself and has no effect on the co-occurring, non-edible species *A. lixula* in the fished sites of Ustica MPA (Gianguzza *et al*., 2006). In order to evaluate if this pattern maintains, the effect of protection on sea urchins abundance was monitored along four years. We expected that the potential differences in sea urchins abundance allow a different development of the benthic assemblages in zones A (integral protection) and C at Ustica MPA. According to these considerations we hypothesized: (1) higher abundance of *P. lividus* in the no-take zone (A), (2) similar abundance of *A. lixula* in the zones A and C, (3) a different pattern of benthic assemblage cover in relation to sea urchins abundance. We excepted that this pattern maintains along years.

Materials and methods – During summers of the years 2006-2009, sea urchin density and benthic assemblage cover were estimated on rocky bottoms 2-6 m deep, in two sites for each A and C zones (Fig. 1). At each site and sampling time, sea urchins density was measured in ten independent random quadrates (1 m^2). Thirty-two pictures of 400 cm^2 of the substrate were taken to characterize benthic assemblage cover, summarized in functional group according to Steneck & Dethier (1994) modified to include animal components. To assess differences in sea urchin density, a PERMANOVA analysis including Species (fixed, 2 levels: *P. lividus* and *A. lixula*), Year (fixed, 4 levels: '06,'07,'08,'09) Protection (fixed, 2 levels A, C) and

Site (random, 2 levels) factor was performed, while the PERMANOVA of benthic assemblage cover included Year, Protection and Site factor.

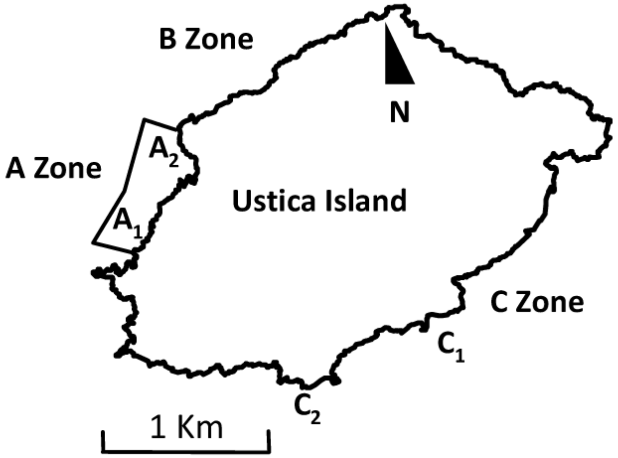

Fig. 1 - Sampling sites at the MPA "Isola di Ustica": A_1, A_2, C_1 and C_2.
Siti di campionamento nell'AMP "Isola di Ustica": A_1, A_2, C_1 and C_2.

Results – Density of both sea urchin populations was lower in 2009 than in 2006. *P. lividus* and *A. lixula* densities ranged between 4±0.5 ind./m^2 and 3.35±0.3 ind./m^2, respectively, in 2006 and 0.5±0.1 ind./m^2 and 0.6±0.0 ind./m^2 in 2009. During this decrement of both sea urchins, a benthic algae shift from Corallinales (barren state) to erect macroalgae was observed. PERMANOVA showed only an important interaction between "Year x Site" terms of both sea urchin density and benthic assemblage. For every site, Pair-Wise tests confirmed the important effect Year on the studied variables.

Conclusions – No protection effect on sea urchin abundance was detected. *P. lividus* and *A. lixula* showed a strong decrement within both take and no-take zones. Multiple natural control factors (like low sea urchin recruitment and natural predation) may have provoked the drop of sea urchins abundance. This change in sea urchin abundances likely promoted the flourishing of erect macroalgae in the upper infralittoral of Ustica MPA. These results offer new tips of reflection for a simple cascade trophic model in Mediterranean rocky infralittoral systems.

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A VOLTAGE GATED H^+-CONDUCTANCE UNDERLYING pH HOMEOSTASIS AND CALCIFICATION IN COCCOLITHOPHORIDS

IL VOLTAGGIO "GATED" PER IL FLUSSO DI MEMBRANA DI IONI H^+ COME BASE DELL'OMEOSTASI DEL pH DELLA CALCIFICAZIONE NEI COCCOLITOFORIDI

Abstract *– Intracellular precipitation of calcite in calcifying coccolithophorid such as* Coccolithus pelagicus *generate large amounts of H^+ load in cytosol. Therefore, these cells have a requirement for an efficient high capacity mechanism for H^+ excursion. In many animal tissues, it has been demonstrated that voltage-gated proton (H^+) channels play an important role in cellular defense against acidic stress. In this report, we have characterized a similar voltage dependent proton conductance in the calcifying coccolithophorid, Coccolithus pelagicus, using patch-clamp technique. We have also demonstrated that in voltage-clamp mode, depolarization of these cells from a holding potential of -50 mV to +70 mV caused an increase in pH_i that was accompanied by a sizeable outward conductance. These findings are consistent with the existence of a conductive H^+ (equivalent) pathway.*

Key-words: *Coccolithophorid,* Coccolithus pelagicus*, patch-clamp technique, voltage-gated proton (H^+) channels, pH.*

Introduction - Coccolithophorids are photosynthetic marine microalgae that form extensive blooms in the surface waters of the world's oceans and are considered to be the most significant producer of calcite on earth. It has been shown that in *Coccolithus pelagicus* calcification occurs in a specialized centrally located intracellular compartment, the coccolith vesicle, which is derived from the Golgi (Taylor *et al.,* 2007). The process of intracellular calcification requires efficient and energetically cost-effective ion transport to the coccolith vesicle as well as intracellular homeostasis of both Ca^{2+} and H^+.

Materials and methods – Whole cell patch clamp recordings were conducted at 20 °C. In some experiments, decalcified cells were either loaded with 300 μM BCECF free acid in the patch clamp pipette. Changes in intracellular pH_i were monitored using a Zeiss 510 confocal microscope.

Results - Using the patch clamp technique, we characterized a conductance that is activated by depolarisation more positive than the equilibrium potential for H^+. Tail current analysis revealed that the conductance reversed positively to $E_K{}^+$ and $E_{Cl}{}^-$, and closest to $E_H{}^+$. These data show that the biophysical characteristics of the outward conductance in *C. pelagicus* are consistent with those described for animal H^+ channels and led us to hypothesize a role in rapid H^+ efflux during pH homeostasis.

Simultaneous patch clamp and pH imaging demonstrated that in cells that were clamped at voltages more negative of $E_H{}^+$ no change in pH_i was observed in response to sub-threshold depolarization, whereas significant reversible cytoplasmic alkalinisation (0.5 pH units) was induced by 10s depolarization that activated the H^+ conductance. These observations bear key similarities to results from animal cells in which H^+ currents are known to mediate pH homeostasis and charge balance.

Conclusions – The calcifying coccolithophorid, *Coccolithus pelagicus* expresses an animal-like H^+-selective conductance which is activated by depolarization. As with previously well-characterized animal H^+ channels, the properties of this H^+ conductance appear ideally suited to mediating rapid, energy-efficient H^+ efflux during metabolic acidosis.

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SPARUS AURATA (L.) EMBRYOS AS MODEL ORGANISM FOR ECOTOXICOLOGICAL STUDIES

EMBRIONI DI SPARUS AURATA *(L.) QUALE ORGANISMO MODELLO PER STUDI ECOTOSSICOLOGICI*

Abstract – Sparus aurata *(L.) embryos have been proposed as model organism for aquatic biosciences. Particularly the Authors propose eleutheroembryos for exceeding limitations presented in European laws for the management of experimental animals; these embryos are year-round available because this specie is commonly reared; moreover this model showed high sensitivity to xenobiotic substances in ecotoxicological tests.*

Key-words: Sparus aurata*, fish embryos, aquatic model, ecotoxicology.*

Introduction – The gilthead seabream, *Sparus aurata* (L.), one of the most important fish for aquaculture in Mediterranean countries, is becoming a model organism for marine teleosts as a result of its high commercial value and intensive research efforts from the European scientific community (Franch *et al.*, 2006), such as the network of excellence Marine Genomics Europe (MGE) (www.marine-genomics-europe.org) (Rafael *et al.*, 2006). The European Council Directive n. 88/609/EEC, transposed in Italy by Legislative Decree no. 116/1992, imposes strict rules on use of acute and chronic toxicity tests performed on teleost fishes.

Recently, attention has focused on the use of fish embryos in ecotoxicological acute assays (Embry *et al.*, 2010) as alternative method for environmental risk assessment.

The large availability of seabream embryos is correlated to conditioning of the reproductive cycle and to the daily spawning, because the asynchronous gonads maturation. This work suggests the use of sea bream embryos as a model for aquatic ecotoxicology and more generally for aquatic biosciences.

Materials and methods – *Sparus aurata* embryos, supplied by Mediterranean farms, were year-round used in the last ten years. The embryos, obtained from natural spawning, were collected at 1–2 cell stage and transported into the laboratory. 48h toxicity tests were performed with growing concentrations of $CdCl_2$ (UNICHIM ring test reference toxicant) using 24h and 72h embryos post fertilization at the following conditions: T 19±1 °C, salinity 37±1‰, pH 8±0.5, O_2 7±1 ppm, density 25 embryos/100 ml. Survival was evaluated at the end of the exposure and after 48h from Cd removal. Statistical analysis was performed by t-Student test ($n \geq 9$) and significance $p<0.02$.

Results – The embryo survival percentage in the controls, until complete resorption of the yolk sac, was rarely less than 90% over the past 10 years independently from sampling season.

Assessing survival 48h post-exposure period, pre-hatched embryos (24 h max aged) showed LOEL at 0.06 ppm and an EC50 to concentrations more than 0.5 ppm

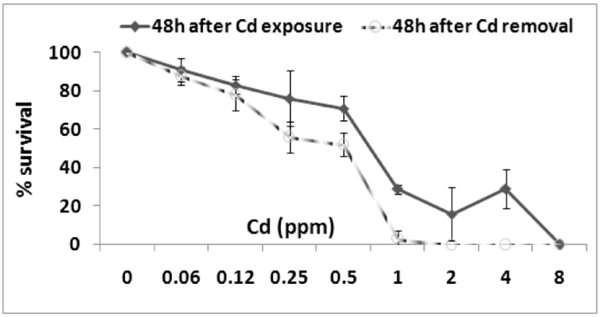

Fig. 1 - Survival at endtest and after 48h of *S. aurata* embryos exposed to Cd.
Sopravvivenza fine test e 48h post fine test degli embrioni di S. aurata *esposti al Cd.*

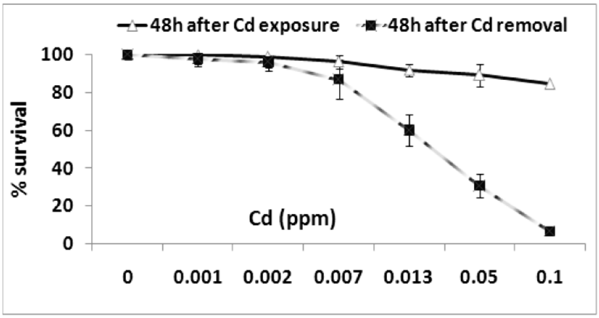

Fig. 2 - Survival at endtest and after 48h of *S. aurata* eleutherioembryos exposed to Cd.
Sopravvivenza fine test e 48h post fine test degli eleuterioembrioni di S. aurata *esposti al Cd.*

(Fig. 1). Post-hatched embryos (aged between 72h and 120h) showed higher sensitivity to the reference toxicant; LOEL value was at 0.007 ppm, with an EC50 less than 0.05 ppm (Fig. 2).

Conclusions – The lower sensitivity of pre-hatched embryos is probably due to the presence of chorion. In relation to the large availability of *Sparus aurata* embryos, this model can be proposed for a general tool in aquatic biosciences; post-hatched embryos will be interesting model in ecotoxicological researches and related applications.

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MORTALITY EVENTS ALONG THE CAMPANIA COAST (TYRRHENIAN SEA) IN SUMMERS 2008 AND 2009 AND RELATION TO THERMAL CONDITIONS

EVENTI DI MORTALITÀ LUNGO LE COSTE DELLA CAMPANIA (MAR TIRRENO) NELLE ESTATI 2008 E 2009 E RELAZIONI CON LE CONDIZIONI TERMICHE

Abstract *- Local mass mortality events of anthozoans and bivalves were observed along the Campania coast (Tyrrhenian Sea) in late summer 2008 and 2009 and both related to high water surface temperatures. The gorgonian* Eunicella cavolinii *was the damaged species inside the cave "Grotta Azzurra" off Palinuro (Salerno) in late summer 2008, while in 2009 a strong mortality was observed along the coast off the island of Ischia, affecting the gorgonians* Eunicella singularis*,* E. cavolinii *and* Paramuricea clavata*, as well as for the first time the thermophilic scleractinian* Astroides calycularis *and the bivalve* Spondylus gaederopus.

Keyw-words*: Anthozoa, Bivalvia, mass mortality, thermal conditions, Tyrrhenian Sea.*

Introduction – Trans-phyletic mass mortality phenomena are frequent in the Western Mediterranean in the least decade due to global climate change and summer heat waves (Garrabou *et al*., 2008). Along the Campania coast (Tyrrhenian Sea) such events have been first documented in the Gulf of Naples in 2002 and 2003, this latter related to a large scale heat-wave (Garrabou *et al*., 2008), and in 2005 related to a local thermal anomaly (Cigliano & Gambi, 2007); both events affected the most common local Gorgonacea, *Paramuricea clavata, Eunicella singularis* and *Eunicella cavolinii*. In this paper we report two further mortality events along the Campania coast occurring in summers 2008 and 2009, which affected key-organisms in areas of high ecological relevance, such as the marine cave with sulphur water springs "Grotta Azzurra" off Palinuro (Salerno) (Benedetti-Cecchi *et al*., 1998), and the coast of the island of Ischia (part of the MPA "Regno di Nettuno").

Materials and methods – The mass mortality event of the gorgonian *Eunicella cavolinii* was visually observed within the Grotta Azzurra off Palinuro in mid October 2008, while quantitative monitoring was carried out during summer 2009. Three horizontal transects 20 m long were carried out at 15 m, 20 m and 25 m depth. In each transect six random 1 m^2 plots were considered for estimate of colony density and extent of tissue damage and necrosis. Mortality of various Anthozoa and Bivalvia was observed off the island of Ischia during the first two weeks of September 2009, and visually estimated along the cliff off Sant'Angelo, one of the most pristine sites of the island.

Results – In the Grotta Azzurra the gorgonian *Eunicella cavolinii*, one of the most abundant and conspicuous organisms inside the cave, was heavily affected by the mortality especially in the first 20 m depth. At 15 m depth a mean of 77% of the counted colonies were completely dead, while a mean of 8.5% had still all tissues alive (Fig. 1); at 25 m the trend was reversed (significant at the Student t-test, $p>0.01$) (Fig. 1). Whole alive colonies, at all studied depths, were represented by more than 80% by juveniles (>15 cm height). At the island of Ischia mass mortality was observed at the beginning of September 2009 in various sites around the island. Along the pristine cliff of Sant'Angelo we observed the gorgonians *P. clavata, E. singularis* and *E. cavolinii* with various extent of tissue necrosis (about 75% of all individuals) up to 25-28 m depth. Up to 15 m depth also the scleractinian *Astroides calycularis* and the bivalve *Spondylus gaederopus* were affected by mortality. *A. calycularis* showed about 20% of the colonies completely or partially dead, with white corallites, in an appearance similar to that of bleached corals. *S. gaederopus* appeared with the lower valves attached to the rocks and the upper valves detached on the bottom. Analysis of the surface water temperature profiles, revealed for both summers thermal anomalies with extremely high values in August and September: max up to 28-29°C on the surface, and up to 25-26 °C at 30 m depth. For Palinuro the mortality event in summer 2008 represents the first documented in this area, while for Ischia that in summer 2009 represents the fourth mass mortality occurring since 2002, thus jeopardizing the local survivorship of some species (e.g., *E. singularis*) which were affected in all the events. In addition, to our knowledge this is the first time that the thermophilic *A. calycularis* is affected by mortality.

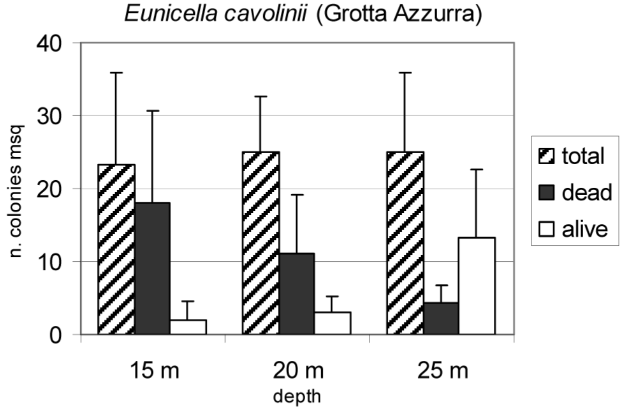

Fig. 1 - Mean density of total, deas and alive *Eunicella cavolinii* colonies at three depths within the Grotta Azzurra off Palinuro, after the mass mortality event in summer 2008. Bars = s.d.

Densità media totale e di colonie morte e vive di Eunicella cavolinii *a tre profondità nella Grotta Azzura di Palinuro, a seguito della moria di massa dell'estate 2008. Barre = d.s.*

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PRELIMINARY SCREENING OF PERFLUOROOCTANE SULPHONATE (PFOS) AND PERFLUOOCTANOIC ACID (PFOA) IN A FISH SPECIES (*SERRANUS CABRILLA*) FROM THE COAST OF SICILY (SOUTHERN TYRRHENIAN SEA)

SCREENING PRELIMINARE DI PERFLUOROTTANO SULFONATO (PFOS) ED ACIDO PERFLUOROTTANICO (PFOA) IN UNA SPECIE ITTICA DELLA COSTA SICILIANA (SERRANUS CABRILLA)

Abstract *– Perfluorooctanoic acid (PFOA) and perfluorooctane sulphonate (PFOS) are environmental contaminants belonging to a chemical group known as perfluorinated compounds (PCFs). Extensive screening analyses of PFCs in biota samples from all over the world have identified perfluorooctane sulfonate (PFOS) as a global pollutant and have shown its behaviour similar to those of persistent compounds with regard to global biospheric distribution, bioaccumulation and biomagnification. In this study, a preliminary screening of PFOS and PFOA has been performed in liver samples of combers (*Serranus cabrilla*) from northern coast of Sicily.*

Key-words: *PFOS, PFOA, Perfluorinated compounds, Marine environment, Sicily.*

Introduction - PFCs, typically epitomized by perfluorooctane sulphonate (PFOS) and perfluooctanoic acid (PFOA), comprise a diverse class of chemicals that are used in a wide range of commercial and consumer products, as surfactants, water repellents, lubricants, adhesives, additives and coatings, and in fire fighting foams. Because of the high-energy carbon-fluorine bond, PFOS and related fluorochemicals are stable in the environment and resist hydrolysis, photolysis and biodegradation. They are nonvolatile, have high molecular weights and can repel both water and oils (Kannan *et al*., 2001a). The toxicity of perfluorinated compounds has not been well characterized, but PFOS and PFOA have been found to exert endocrine disrupting effects in fish. In 2001 it was discovered that fluorochemicals such as PFOS were accumulating in biota throughout the world (Kannan *et al*., 2001b). Perfluorinated compounds bind to blood proteins and accumulate in liver and gall bladder. The global distribution of PFOS and related fluorochemicals in fish, birds, marine and terrestrial mammals has been demonstrated by several studies from both North America, Europe and Asia. The present investigation reports the results from a screening of PFOS and PFOA in a fish species (comber, *Serranus cabrilla*) in order to provide a first clue to the levels of PFCs in the marine ecosystem off the northern coast of Sicily.

Materials and methods – Twenty samples of liver were excised from comber specimens (*Serranus cabrilla*) used for the investigation and caught in September 2009 by fishing off the northeastern coasts of Sicily (from Capo Peloro to the Gulf of Milazzo; Southern Tyrrhenian Sea). A fast sample treatment, followed by an LC–ESI–MS/MS method was followed (Corsolini *et al*., 2008) for identification and quantification of PFOA and PFOS in liver of fish.

Results – In agreement with scientific literature on monitoring of perfluorinated acids in biota, PFOS was the predominant fluorochemical in the combers analyzed.

PFOS was found at concentrations above LOD (0.5 ng/g wet weight) in 6 out of 20 samples. The greatest concentration of PFOS in liver of comber was 8.5 ng/g wet weight. PFOS levels are lower than the mean level (176.3±12.8 ng/g w.w.) found in liver of brown comber (*Serranus hepatus*) from the Augusta Gulf (Southeastern coast of Sicily) and higher than the concentration of PFOS in hepatic tissue (<5 ng/g w.w.) of brow combers from the Gulf of Castellamare (Northwestern coast of Sicily), reported by Perra *et al.* (2006). The concentrations of PFOA was below LOD or not detected for all samples. The results showed PFOA and PFOS levels in comber lower than those reported in a study (Nania *et al.*, 2009) to monitor the current levels of PFOS and PFOA in some types of Mediterranean Sea fish which are most consumed in Italy (mean levels of PFOS in liver: 13 ng/g w.w., in pelagic fishes - 53 ng/g w.w., in benthonic fishes; mean levels of PFOA in liver: 6 ng/g w.w. in pelagic fishes - 9 ng/g w.w. in benthonic fishes).

Conclusions – In summary, PFOS were detected in liver of combers from the northeastern coast of Sicily. Concentrations of PFOS in fish were an order of magnitude lower than the concentrations reported in previous studies of fish from industrialized countries. Our biomonitoring results did not show that the northeastern coast of Sicily had any particularly alarming pollution by PFCs. More data are needed about the spatial distribution of these compounds in the Sicilian coastal areas in order to trace their sources.

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HABITAT REQUIREMENTS FOR THE CHOICE OF NESTING SITE IN *SYMPHODUS OCELLATUS* (FORSSKAL)

REQUISITI DI HABITAT PER LA SCELTA DEL SITO DI NIDIFICAZIONE IN SYMPHODUS OCELLATUS *(FORSSKAL)*

***Abstract** – This study is aimed to assess the habitat requirements for nesting site in the fish* Symphodus ocellatus *(Forsskal) (Labridae). For this reason a set of biotic and abiotic variables has been collected in 84 areas surrounding the nests during summer 2009 in a coastal area of southern Tyrrhenian Sea (Sicily). The influence of variables on the habitat requirements of nesting site was studied by Principal Coordinate Analysis (PCO). The result showed that presence of Dictyotales and high canopy algal forms represented the elective requirements for the choice of nesting site.*

***Key-words:** habitat selection, nesting, marine fish, Tyrrhenian Sea.*

Introduction - The choice of nesting site is a process that can have important effects on fitness of several animal species (Boulinier *et al.*, 2008). Indeed, many abiotic and biotic factors have a strong influence on reproductive success. For marine fishes that build nest during the reproduction, the selection mechanisms of the site are quite unknown. The knowledge of habitat requirements for nesting is the first step in order to understand these mechanisms of selection. Several authors performed an evaluation of the habitat requirements for marine fishes, on various life history stages, by correlating different environmental variables with their abundance (La Mesa *et al.*, 2002; Letourneur *et al.*, 2003). The aim of this work is to evaluate the habitat requirements for the choice of nesting site in the Labridae fish *Symphodus ocellatus* (Forsskal) used as a model.

Materials and methods - We performed runs of samplings during summer 2009 along the north-west Sicilian coast (Southern Tyrrhenian Sea). Data have been collected on 84 nests using underwater observations according to a standard protocol. During sampling the following biotic and abiotic variables have been recorded: slope of the substrate; presence (%) of the most abundant algal taxa such as Dictyotales, *Cystoseira* sp. and *Jania rubens*; presence of sandy substrate; depth of nest (in meters); type of cavity used for nest building (crevice/hole); average algal canopy height surrounding the nest. We expressed all variables in numerical ranks and the influence of these variables on the habitat requirements of nesting site of the *S. ocellatus* have been studied by PCO (Principal Coordinate Analysis).

Results - The results of the distribution patterns of the variables are plotted in Fig. 1. The first two axes explained 41.2% of the total variance (PCO1 23.9%; PCO2 17.3%). Presence of *J. rubens*, Dictyotales, *Cystoseira* sp. and canopy variables affect the most the distribution of samples. The results show that samples are concentrated principally around the Dictyotales and algal canopy variables.

Conclusions - The results of this study indicate that the presence of Dictyotales and high canopy algal forms are elective requirements for the choice of nesting site in *S. ocellatus*. The other variables seem not to have a significant role maybe because

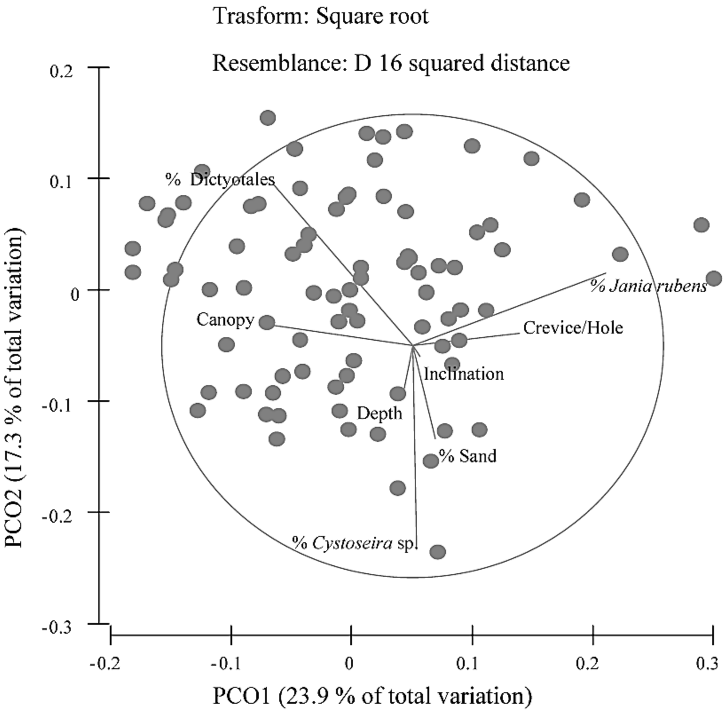

Fig. 1 - Results of Principal Coordinate Analysis, distribution pattern of nests and variables.
Risultati della PCO, modello di distribuzione dei nidi e delle variabili.

the samplings is not sufficient to explain a preference. This first analysis shows that the algal species at high canopy may provide protection to the nest. Further investigations will determine if this protection is related to a lower visibility of the nest by predators or if these erect algae have a role in the mitigation of wave-motion.

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ANDAMENTI DELLE CATTURE E CONDIZIONI METEO-MARINE NELLA TONNARELLA DI CAMOGLI (MAR LIGURE)

CATCH TRENDS AND METEO-MARINE CONDITIONS INSIDE THE CAMOGLI "TONNARELLA"(LIGURIAN SEA)

Abstract – *Herein the historical data catches of the Tonnarella of Camogli inside the Portofino MPA from 1890 to 2008 are discussed in order to understand biological fluctuations in a context of continual environmental changes.*

Key-words: *Tonnarella of Camogli, catches, fishing, Portofino MPA.*

Introduzione - In Liguria la piccola pesca, un'attività spesso praticata sottocosta con piccole imbarcazioni, occupa un posto di rilievo nell'economia di molti borghi costieri e assolve un ruolo sociale e culturale di primaria importanza. Tra queste attività, la Tonnarella di Camogli rappresenta uno dei rari esempi, ancora oggi economicamente attivi, di antichi impianti-trappola utilizzati in Mediterraneo per la cattura di pesci pelagici e di passo (Cattaneo-Vietti e Bava, 2009). Grazie al vortice di correnti che si crea nel Golfo Paradiso per l'incontro di masse d'acqua di provenienza opposta, molte specie pelagiche d'interesse commerciale, quali ricciole (*Seriola dumerili*), boniti (*Auxis rochei*), palamite (*Sarda sarda*) e sugarelli (*Trachurus trachurus* e *T. mediterraneus*), seguendo il *gyre* che si muove in senso orario, passano sottocosta e possono essere catturate in prossimità di Punta Chiappa. La Tonnarella di Camogli entra in funzione, ogni anno, nella Zona C dell'AMP Portofino, precisamente nelle acque sottostanti la Chiesa di S. Nicolò di Capodimonte tra aprile e settembre. Dati relativi alla qualità ed alla quantità del pescato vengono annotati per le 3 "levate" giornaliere dalla Cooperativa Pescatori di Camogli, fondata nel 1974 e che gestisce l'impianto. La disponibilità di questa ed altre serie storiche (Parona, 1898; Balestra *et al*., 1976; Relini, 2001) e di dati relativi alle principali variabili chimico-fisiche raccolti quindicinalmente (l'AMP è sito LTER, *Long Term Ecological Research,* dal 2007) permette di studiare le eventuali relazioni tra tipo ed entità delle catture ed alcuni dati meteo-marini pregressi, studi particolarmente importanti anche in un'ottica di una corretta gestione delle risorse.

Materiali e metodi - Per verificare possibili variazioni quali-quantitative nel pescato sono stati presi in considerazione dati di fine '800 (Parona, 1898), dati relativi ai periodi 1950-74 (Balestra *et al*., 1976) e 1996-2000 (Relini, 2001) e quelli relativi al 2004-2008, forniti all'Ente Gestore dell'AMP dalla Cooperativa Pescatori di Camogli.

I dati relativi alla variabili meteorologiche sono stati acquisiti dalle serie storiche disponibili presso l'Osservatorio Meteorologico di Chiavari, il Dipartimento DICAT dell'Università degli Studi di Genova e l'archivio APAT. I dati relativi alle variabili oceanografiche si riferiscono alle indagini che il Dip.Te.Ris.-Università degli Studi di Genova effettua nell'area dagli anni '80.

Risultati - L'andamento delle catture della Tonnarella di Camogli ha subito importanti variazioni quali-quantitative: i primi dati di fine 19° secolo (Parona,

1898) mostrano valori totali annuali mediamente più bassi (15-39 t/anno) rispetto alle medie dei periodi successivi, ma è probabile che a quel tempo non tutto il pescato venisse "ufficialmente" conteggiato e che la rete fosse meno "produttiva". A partire dagli anni '50 e fino al 1974, il pescato oscillava tra le 20 e le 50 t/anno (Balestra *et al.*, 1976), mentre nel periodo 1996-2000, i valori variavano tra le 40 e le 70 t/anno (Relini, 2001). Negli ultimi cinque anni (2004-2008), le catture si attestano intorno a 40-44 t/anno. In generale, i quantitativi totali non sembrano aver subito, negli ultimi 50 anni, significative variazioni, mantenendosi mediamente intorno alle 40-50 t/anno, mentre si sono registrate forti oscillazioni annuali (Fig. 1), probabilmente legate alla variabilità delle condizioni meteo-marine stagionali.

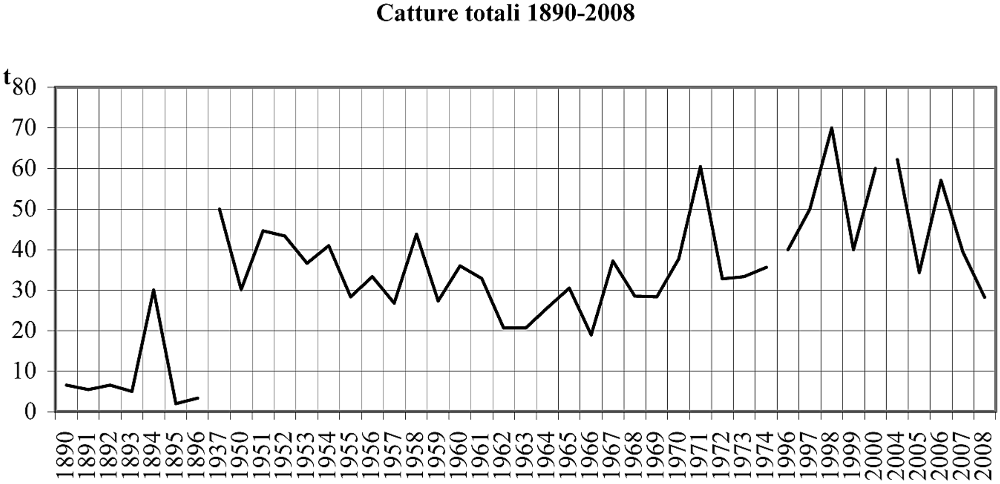

Fig. 1 - Andamento generale delle catture totali nei 4 periodi considerati.
General trend of the total catches in the 4 considered periods.

Un periodo di brutto tempo durante un cambio di luna o nel periodo d'avvicinamento del pesce alla costa può compromettere il pescato per tutto il mese, tenendo anche conto che il pesce di passo nel Mar Ligure ha un calendario annuale abbastanza ben definito: i sugarelli si avvicinano alla costa fino a maggio-giugno, le ricciole adulte scompaiono a fine luglio, la costardella (*Scomberesox saurus*) appare in agosto-settembre, mentre con la luna piena di giugno si assiste ad una repentina caduta dei quantitativi del tombarello (Boero *et al.,* 1980). Ad esempio, le anomalie della salinità e della temperatura verificatesi nel 2007 e nel 2008 (Figg. 2-3) sembrano correlabili ad un calo generale del pescato. I maggiori cambiamenti si sono verificati, tuttavia, a livello specifico: alcune specie si sono alternate ad altre nel corso degli anni, alcune sono del tutto scomparse ed altre comparse di recente. Il tonno, ad esempio, sembra ormai assente da tempo ed il suo peso nelle statistiche della tonnarella negli ultimi 50 anni è sempre percentualmente irrilevante. In generale (Tab. 1) si assiste, dunque, ad una progressiva diminuzione degli sgombroidi (sgombri, tombarelli, tunnidi) ad esclusione della cavalla (*Scomber colias*) e della palamita, ed un aumento percentuale di carangidi (sugarelli, ricciole) e di specie tipiche delle acque meridionali come la lampuga (*Coryphaena hippurus*) e il barracuda atlantico orientale (*Sphyraena viridensis*).

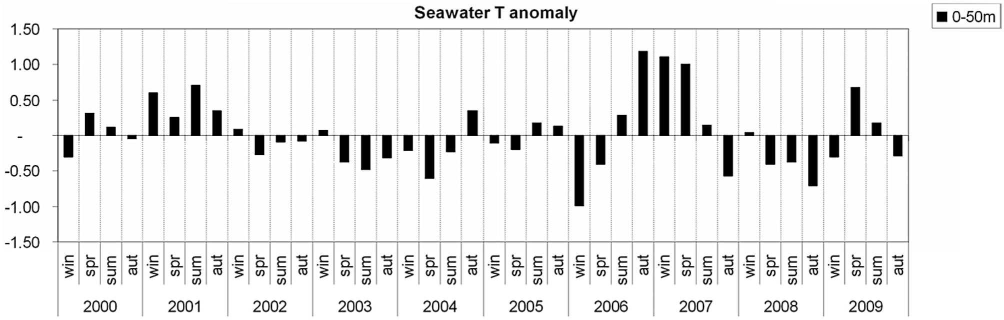

Fig. 2 - Anomalia della temperatura dell'acqua di mare tra 0 e 50 m (serie storica dal 2000 al 2009). *Seawater Temperature anomaly between 0 and 50 m (historical time series from 2000 to 2009).*

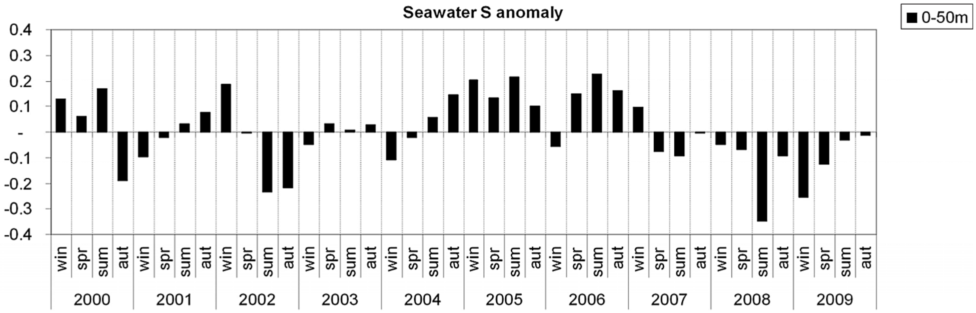

Fig. 3 - Anomalia della salinità dell'acqua di mare tra 0 e 50 m (serie storica dal 2000 al 2009). *Seawater Salinity anomaly between 0 and 50 m (historical time series from 2000 to 2009).*

Tab. 1 - Le principali specie catturate nella Tonnarella di Camogli: medie quinquennali espresse in q. *Main species catched by the Camogli tuna net: average data (q).*

	1890-96	**1950-54**	**1955-59**	**1960-64**	**1965-69**	**1970-74**	**1996-2000**	**2004-08**
Auxis rochei	?	214	112	70	47	41	95	69
Boops boops	?	40	30	11	14	29	40	21
Oblada melanura	?	.2	3	5	14	14	?	5
Sarda sarda	.04	.02	.09	.02	.03	.03	29	24
Sarpa salpa	?	7	14	30	87	141	15	3
Scomber colias	?	2	2	3	.04	3	24	58
Scomber scombrus	.004	.003	.008	.01	.002	.005	2	0.00
Scomberesox sauros	?	13	32	25	33	15	60	.03
Trachurus spp	?	35	21	55	17	70	120	136
Seriola dumerili	?	0	0	0	0	0	90	63

Conclusioni - Forti fluttuazioni nelle catture della Tonnarella di Camogli sono sempre avvenute (Parona, 1898) e di tale importanza da determinare, tra l'altro, le vicissitudini gestionali ed economiche a cui la tonnarella andò incontro alla fine dell'800 (Cattaneo-Vietti e Bava, 2009). L'andamento generale delle catture è piuttosto costante nel tempo, ma l'analisi dei dati sembra ipotizzare un'influenza degli andamenti stagionali legati al più o meno ritardato riscaldamento degli strati superficiali: i massimi valori di cattura si hanno, infatti, nei periodi tardo-primaverili, prima del riscaldamento estivo; successivamente, anche se l'impianto resta attivo fino a settembre, intorno a metà luglio esaurisce quasi del tutto la sua potenzialità. Secondo Morri e Bianchi (2001), l'andamento generale del pescato nel periodo 1950-74 sembrerebbe correlabile alla temperatura dell'aria: negli anni in cui la temperatura invernale raggiunse i valori minimi, diminuì la pesca ed in particolare le catture di specie ad affinità calda, come il tombarello. L'ipotesi è confermata: appare evidente una relazione tra andamenti di pesca ed alcune anomalie termiche e saline, con un incremento negli ultimi anni delle catture di specie ad affinità calda (*Seriola dumerili, Coryphaena hippurus*, *Sphyraena viridensis*). In conclusione, lo studio degli andamenti annuali delle catture, specie per specie, correlati alle condizioni ambientali e meteo-marine del Mar Ligure, rappresenta, oggi, uno strumento di grande potenzialità per comprendere, oltre i cicli biologici delle singole specie, anche la variabilità dei processi ecologici che avvengono nel Mar Ligure ed è pertanto è sempre più evidente l'importanza di perseverare nella raccolta di *long-term data* non esclusivamente per il comparto ittico, ma anche per quello oceanografico e meteo-marino. Solo serie storiche lunghe potranno consentire di ricostruire determinate situazioni completamente sconosciute, fare previsioni a breve e lungo termine ed ipotizzare scenari futuri.

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Biol. Mar. Mediterr. (2010), 17 (1): 138-141

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SEAWEEDS AND AQUACULTURE: AN INDISPENSABLE ALLIANCE FOR THE INTEGRATED MANAGEMENT OF COASTAL ZONE

LE MACROALGHE MARINE E L'ACQUACOLTURA: UN CONNUBIO STRATEGICO NELLA GESTIONE INTEGRATA DELLA FASCIA COSTIERA

Abstract *– Seaweed cultivation in aquaculture plant effluents can reduce the impact of farming activities on coastal waters so making aquaculture an eco-sustainable activity. In this respect, the capability of nitrogen uptake, the fatty acid composition and the antimicrobial activity of six seaweeds from the Apulian coasts were investigated. They proved to be good bioremediators as well as a suitable feed for reared species due to the presence of essential fatty acids and the antimicrobial activity of their lipidic extracts.*

Key-words: *ammonium uptake, antimicrobial activity, bioremediation, fatty acids, seaweeds.*

Introduction – Marine macroalgae can be successfully used to reduce the impact of aquaculture activities on the coastal zone; indeed, due to their capability to uptake phosphorus and nitrogen salts, these last even as ammonium, seaweeds can strongly reduce these salts concentrations in the fish farm effluents, where they are usually very high (Hernández *et al.*, 2002). These wastes, when discharged into coastal waters, cause their eutrophication and the consequent undesirable well known phenomena (e.g. algal blooms, ipoxia, etc.). Moreover, macroalgal biomass resulting from the bioremediation process could be used for the preparation of innovative feeds (Valente *et al.*, 2006), drugs and fertilizers thus resulting in an added value. Therefore, seaweeds could increase and diversify the income of aquaculture farms, making aquaculture an eco-sustainable activity (Neori, 2009). Despite this, abroad seaweeds were usually cultivated to this aim at a pilot plant level and, only rarely, at industrial scale in aquaculture plants (Hernández *et al.*, 2002). In Italy, the interest for this kind of research has always been scarce (Cecere, 2006) and is still scarce even though at the end of the '70s, some researchers realized the potential importance of seaweeds as bioremediators (Giaccone *et al.*, 1979). In this paper, we present the ongoing studies in the frame of a large multidisciplinary project for the exploitation of the macroalgae present along the Apulian coasts. One of the aim of the project is to realize integrated polyculture farms in order to make aquaculture a friendly environmental activity in the view of the integrated management of coastal zone.

Materials and methods – The following 6 species: *Gracilaria dura* (C. Agardh) J. Agardh, *G. gracilis* (Stackhouse) Steentoft, L.M. Irvine *et* Farnham and *Gracilariopsis longissima* (S.G. Gmelin) Steentoft, L.M. Irvine *et* Farnham (Gracilariales, Rhodophyta), *Cystoseira barbata* (Stackhouse) C. Agardh (Cystoseiraceae, Ochrophyta), *Cladophora rupestris* (Linnaeus) Kützing and *Chaetomorpha linum* (O.F. Müller) Kützing (Cladophorales, Chlorophyta) from the Apulian coasts were examined to detect the: 1) ammonium uptake capability both in N-limited and N-replete status in lab tests (for methods see Alabiso *et al.*, 2007, 2008); 2) lipidic and fatty acids composition of both winter and summer thalli to test suitability for feed (for methods see Biandolino *et al.*, 2007); 3) *in vitro* antimicrobial activity of lipidic extracts against several pathogens for fish and humans recording the diameter of bacterial growth inhibition (Tab. 1) (for methods see Stabili *et al.*, 2007, 2008).

Tab. 1 - Lipidic extracts antimicrobial activity. Numbers report the inhibition diameter in cm.
Attività antimicrobica degli estratti. Il diametro di inibizione è riportato in cm.

Microbial strains	***C. barbata***	***G. gracilis***	***Gs. longissima***	***G. dura***	***C. linum***	***C. rupestris***
Candida albicans	0	0	0	0	0	0
Candida famata	0	0	0	0	0	0
Candida glabrata	0	0	0	0	0	0
Pseudomonas aeruginosa	0.9	0	0	0	0	0
***Salmonella* sp.**	0	0	0	0	0	0
***Enterococcus* sp.**	0	0	0	0	0	0.8
Streptococcus agalactiae	0	0	0	0	0	0.8
Vibrio salmonicida	0	0.8	0.8	0	0	0
Vibrio fluvialis	0	0.8	0.8	0.8	0	0
Vibrio vulnificus	0.6	0	1.5	0	1.2	0
***Vibrio cholerae* non –O1**	0	0.8	1.0	0.8	0	0.8
Vibrio alginolyticus	3.5	0	2.5	1.0	0	0

Results – 1) Ammonium uptake: all the examined species showed a high capability in removing N-NH_4^+ even when cultivated in N-replete status. In this last condition *Gracilaria dura* removed about 6 µmol g^{-1}_{fw} h^{-1} (Alabiso *et al.*, 2007); *C. linum*, *G. gracilis* and *C. rupestris* removed from 4 to 4.5 µmol g^{-1}_{fw} h^{-1}; finally, *Gracilariopsis longissima* (Alabiso *et al.*, 2008) and *C. barbata* removed about 3 µmol g^{-1}_{fw} h^{-1}. After one hour, the absorption capability of *G. gracilis* and *C. barbata* remained almost constant; on the contrary, the other four species still showed a slight increasing trend (Fig. 1).

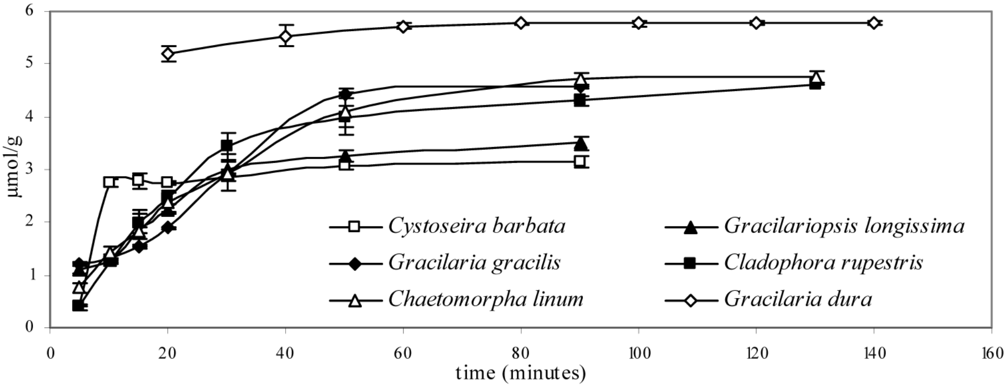

Fig. 1 - Variation vs. time of N-NH_4^+ removed by each species in N-replete status.
Variazione nel tempo del N-NH_4^+ rimosso da ciascuna specie.

2) Lipidic and fatty acids composition: palmitic acid was the most abundant among saturated fatty acids in all the studied species, even though with different percentages; among the polyunsaturated fatty acids, the arachidonic acid (ARA) was the most abundant in *G. gracilis* and *C. linum*; the eicosapentaenoic acid (EPA) and the docosahexaenoic acid (DHA) were the most abundant in *C. linum* and *G. dura*

(Fig. 2). The best values of ω3/ω6 ratio were found in *G. dura* (Biandolino *et al.*, 2007) and *Gracilariopsis longissima* (Biandolino, unpublished data).

3) Antimicrobial activity: *Gracilariopsis longissima* extract proved to be active against the highest number of the tested bacterial strains, probably due to the palmitic acid present in its lipidic extract with the highest percentage (Fig. 2) (see also Stabili *et al.*, 2010); however, all the species showed a good antimicrobial activity mainly against several *Vibrio* species (Tab. 1) (see also Stabili *et al.*, 2007, 2008).

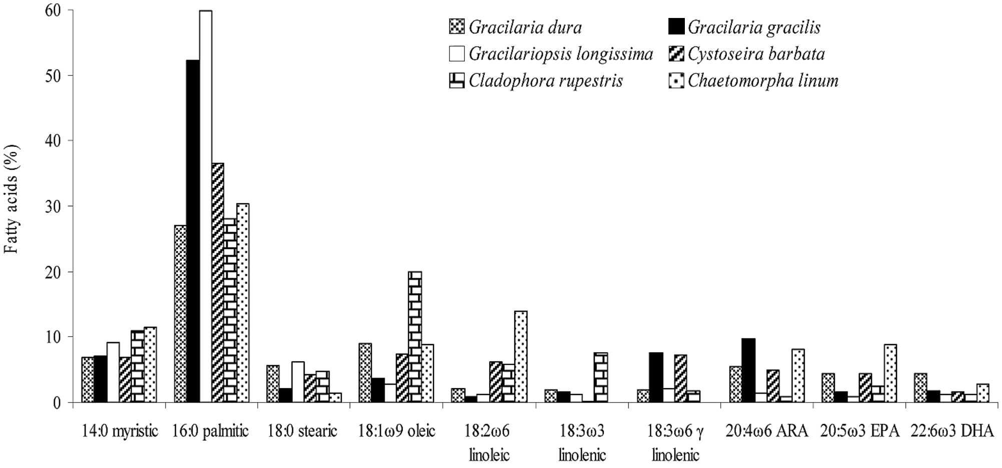

Fig. 2 - Fatty acids composition of the studied species (*C. linum* data are from Biandolino and Prato, 2006).

Composizione in acidi grassi (per C. linum *vedi Biandolino e Prato, 2006).*

Conclusions – 1) All the tested species are suitable for ammonium removal even when they are N-replete which would probably represent the usual conditions in aquaculture farm effluents; 2) The several health-promoting and essential fatty acids and the good levels of ω3 found in the studied seaweeds would produce fish rich in ω3 so contributing to balance the ω3/ω6 ratio in humans. 3) All the tested species extracts showed a high antimicrobial activity at least against one of the most common pathogenic *Vibrio* species tested including those which cause diseases in many farmed species. Fish, often stressed by the farming high density, fall in more easily; this causes high mortality which strongly affects production. The addition of the examined seaweeds to feed could reduce the administration of antibiotics so contributing to the reaching of a "biological aquaculture".

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CONTRIBUTION TO UNDERSTANDING THE EROSION PROCESSES IN ALGHERO COAST

CONSIDERAZIONI SUI FENOMENI EROSIVI COSTIERI DEL LITORALE DI ALGHERO

Abstract *– The sandy shore comprised between Alghero and Fertilia (Alghero Gulf, NW-Sardinia) has been monitored through satellite and aerial images from 1977 to 2009 and uploaded in ARCGIS system. Results indicate that the area is suffering a severe erosion mainly due to the building of marina docks and breakwaters.*

Key-words: *coastal erosion, sediment distribution, coast, Mediterranean Sea, Alghero.*

Introduction – Over 20% of the European coasts have been subjected to erosion, an increasing phenomenon possibly linked to climate change. Therefore, Public Institutions have been involved in coastal conservation management, mostly stimulated by the economic importance of shores for tourism (EUROSION project., 2005).

Coastal changes such as sediment transport and some rock-cliff collapse are occurring around Alghero Gulf, and in most cases in some of the highly visited seashores. All these changes are, therefore, producing negative economic, social and environmental effects.

Materials and methods – Satellite images, air photos and maps of several years, from 1977 to 2009, have been uploaded in ArcGis 9.3 - ESRI ArcMAP®. Coastal lines analyses have been performed using Digital Shoreline Analysis System (DSAS), v.3.2 - USGS Woods Hole, Massachusetts (Thieler *et al*., 2005). Inter-annual image data have allowed to estimate the erosion rate through time.

DSAS can automatically generate orthogonal transects to the coastal line and define the coastal variation occurred between two times. The base line has been created using the "cast" function with 100 m interval (Jones *et al*., 2008). The erosion rate has been calculated in 48 places, along a 4.5 km of sandy shore in 1977, 1989 and 2009.

Twenty samples of sand have been treated to perform grain size analysis. The data were statically elaborated with SW Gradistat.

Results - Alghero coastal area (Lido di S. Giovanni and Maria Pia, Fig. 1) is made of mesokurtic gently negative skewed sand deposits, composed of 70% siliciclastic and 30% bioclastic grains. Mean grain size of the swash zone is between 296 μm (medium sand) in the northern Fertilia area, 256 μm (medium sand) in central Maria Pia (just north of the Marine Hospital) and 145 μm (very fine sand) in the southern part (S. Giovanni). Next to Alghero marina (Fig. 1), along 450 m of coastal line, 6,868 m^3 of *Posidonia oceanica* beached debris have been estimated, they are spread over a surface area of 10,932 m^2 with an average thickness of 0.62 m. In the opposite side, next to Fertilia marina, an additional 2,600 m^2 storage area of *Posidonia oceanica* has been found.

For the area between 1st and 14th transects (Alghero marina), shoreline variation during 1977-2009 (EPR data, Fig. 2) shows an overall increase of 1.2 m a^{-1} SD±0.88.

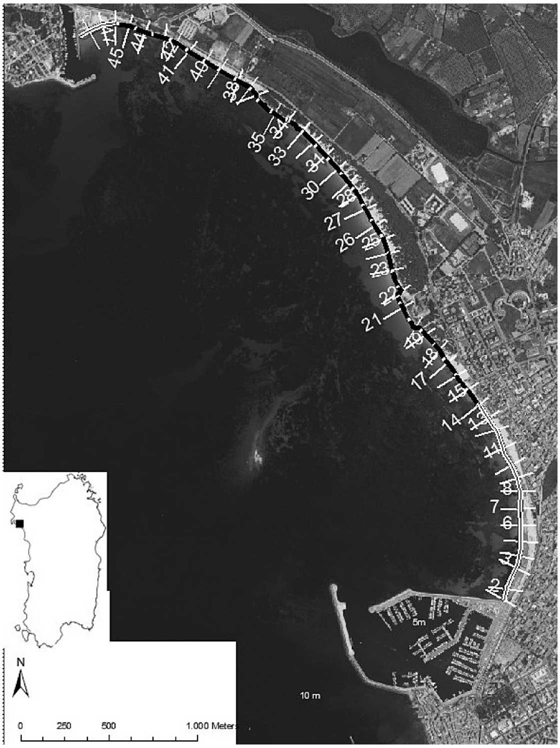

Fig. 1 - Localizzazione dei 48 transetti e linea di riva; (nera tratteggiata, in erosione; bianca continua, in avanzamento).

Alghero Gulf. Location of the 48 considered transects and shoreline (black line=erosion, white line=accretion).

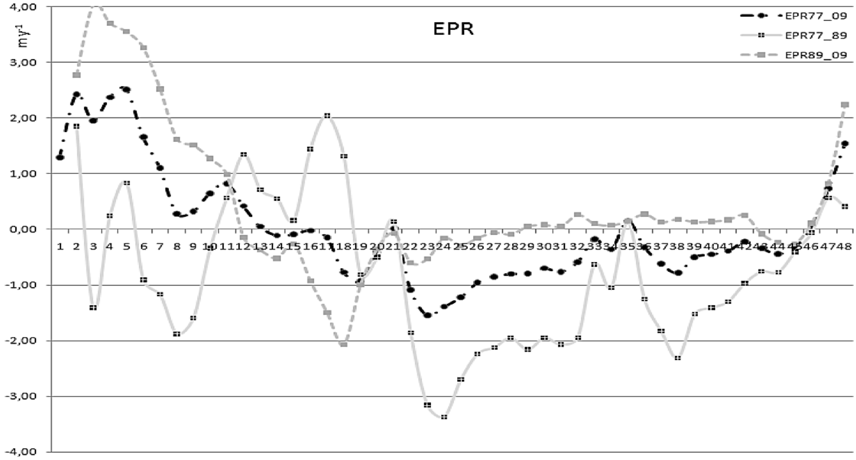

Fig. 2 - Tasso di erosione del litorale espresso come End Point Rate (EPR). I valori indicano le variazioni delle linee di riva nei transetti rispettivamente nei periodi 1977-89, 1989-2009 e 1977-2009; in ordinata i transetti come in Fig. 1.

Erosional rate as derived by End Point Rate (EPR). Values are indicative to shoreline variations along the measured transect during 1977-89, 1989-2009 e 1977-2009 time interval; x-axis=transects of Fig. 1.

Conversely, between 15 and 46 transects EPR is negative except for transect 35 where an average rate of -0.56 m a^{-1} SD±0.46 has been calculated. The highest values are found between 23th and 27th transects where values are all larger than 1 m a^{-1}. Next to Fertilia marina an increase of 0.8 m a^{-1}, SD±0.76 is found. During the considered time the Fertilia sandy shore covers an area of 11 ha: 5.5 are accreted and 5.4 are retreated. However, the retreating sandy shoreline is the most visited by tourists. During 1977-89 EPR highlights the effects of the breakwater barrier, built in the 1983. Positive values are found between 1th-18th transects, where a strong erosion just N of the Marine Hospital occurs (22th transect). During 1989-2009 EPR probably highlights the influence of the external marina Alghero dock. This shades winds coming from SW and allows accumulation of 4.5 ha of sand close to the eastern part of the marina. During this time period an evident erosion has occurred close to the Marine Hospital with an average EPR of -0.62 m a^{-1} (13th-20th transects), which is the highest rate we have estimated. This part during 1977-89 shoreline was, instead, increasing. Most likely, the causes of this strong erosion have to be found in both docks and breakwaters. Also the *Posidonia oceanica* meadow shows evidence of regression as the lower limit has become deeper with several matte discontinuities.

Conclusions - A detailed estimation of erosion which has been occurring through the last decades in Alghero area seems the only tool allowing evaluation of the present erosion rate and the urgency of management interventions. An appropriate estimation of temporal variability of the sandy shores can address activities to buffer the negative effects. The data collected provide some important evaluation to forecast the importance of future changes of the shoreline and to drive urban plans as management actions and land use. In the Alghero area cement actions, excessive human frequentation with no protection of the dune system, marinas constructions and breakwaters are all factors responsible of the weakness of the sandy shores, especially in the most visited areas. This work contributes to a much wider study which is needed and still to develop to address any management actions aiming to protect and re-establish the shores quality.

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METHODOLOGICAL APPROACH TO INTEGRATED COASTAL ZONE MANAGEMENT: A CASE OF STUDY IN THE STRAIT OF SICILY

APPROCCIO METODOLOGICO ALLA GESTIONE INTEGRATA DELLA FASCIA COSTIERA: UN CASO DI STUDIO NELLO STRETTO DI SICILIA

Abstract **-** *In the coastal area of Sciacca (Strait of Sicily), where delicate ecosystems (e.g.* Posidonia oceanica *meadows), fishery (small-scale, industrial and recreational), tourism, nautical and small industrial activities coexist, a study of integrated coastal management, focusing on sustainable development of artisanal fishery, was carried out. This study describes a methodological approach to ICZM through the analysis of territorial and anthropic data, the identification of strength points and limits to development, of the conflicts and of the potential in the study area, and the proposal of management suggestions.*

Key-words: *integrated coastal management, artisanal fishery, cultural heritage, Sciacca.*

Introduction - The multifaceted approach to the management of coastal resources, currently known as Integrated Coastal Zone Management (ICZM), has been described as the process of combining all aspects of the human, physical and biological components of the coastal zone within a single management framework (Pernetta & Elder, 1993). In the Mediterranean, such a concept has been formalized in the ICZM Protocol signed in Madrid on 21 January 2008 within the framework of the Barcelona Convention. The main purpose of ICZM is the realization of a plan of environmental development aiming at increasing social and economical prosperity of coastal communities toward long-term, including interaction and resolution of conflicts between economical sectors, reaching sustainable use of natural coastal resources with maintenance of biodiversity (Clark, 1992). In the coastal area of Sciacca (southern Sicily) delicate ecosystems, sites of community importance (Fondali di Capo San Marco and Foce del Fiume Verdura), fishery, tourism, nautical and small industrial activities coexist. This area, therefore, is of huge interest for studies aiming at integrated coastal management. In the present study, a methodological approach to ICZM mainly focused on artisanal fishery is proposed.

Materials and methods - The study was carried out from December 2005 to November 2007, in the coastal zone of Sciacca (Strait of Sicily), and was articulated in two main aspects: analysis of the territory and fishery characterization. The study was developed in three consecutive phases:

a) cognitive phase to delineate the environmental situation and the main activities interacting within the coastal zone, using both available data and experimental ones; the methods applied are resumed in Tab. 1;

b) identifying phase to individuate the limits to development, the conflicts and the potential of the area;

c) proposing phase to define instruments aiming at removing limits, solving conflicts and increasing productive capacity.

Results – *Cognitive phase.* The analysis of the territory evidenced a high-density population (214 inhabitants/km^2) in the study area. The coast shows a heterogeneous

Tab. 1 - Methods used and parameters analysed within the Sciacca ICZM study.
Metodi impiegati e parametri analizzati per lo studio di ICZM di Sciacca.

COGNITIVE PHASE		METHOD
ICZM LEGISLATION		Literature
TERRITORY	Demography	Literature and surveys on the field
	Environmental components of coastal zone Anthropic activity	
	Tourism	
CLIMATIC DATA	Atmospheric temperature Total precipitation Prevailing winds	Agro-meteorological information system of Sicily (SIAS)
	Sea surface temperature	National tide-gauge station (ISPRA)
GEOMORPHOLOGY	Morphology	Side Scan Sonar Cartography editing
	Bathymetry	Singlebeam echo-sounder Cartography editing
BIONOMY	Bionomical study of the main bottom typologies	Scraping and box-corer by SCUBA diving
	Health state of *Posidonia oceanica*	Phenological analysis (Giraud, 1977)
ARTISANAL FISHERY	Fishery fleet composition (Grosse Tonnage, engine power , vessel age). Harbour infrastructures supporting artisanal fishery	Consultation of official data of Vessels Register and surveys on the field
	Artisanal fishery characterization (gears in use, socio-demography of artisanal fishery operators, gears seasonality, fishing areas, target species, etc.)	Fortnightly landings Interviews to fishermen
	Experimental fishery surveys	Gillnet and longline
TRADITIONS	Fishery traditions, trades and gears in disuse Ethno-anthropologic traditions	Literature Interviews
GEOGRAPHICAL INFORMATION SYSTEM (GIS)	Thematic maps (territory, constraints, population density, human pressure, land use, hydrography, vulnerabilities, etc.)	Literature GEODATABASE and data implementation ArcGIS 9.2 (ARCINFO) ESRI
	Management of environmental and fishery data	GEODATABASE and data implementation ArcGIS 9.2 (ARCINFO) ESRI

physiognomy, with alternation of rocky and sandy littorals, occurrence of buildings, coastal defence structures (artificial reefs, breakwaters) and one of the biggest harbours of southern Sicily. Two important tourist complexes are in the eastern side of the city, while seasonal bathing structures develop in the western one. Virgin coastal traits with wide beaches and dune complexes can be found mainly in the eastern area. Tourist occurrences were particularly concentrated in summer with a peak in August. Nautical tourism is also well developed. The meteorological analysis evidenced good climatic conditions for most of the year, with autumn months more rainy than winter ones and collapse of pluviometric levels during summer. Prevailing and strongest winds are those from I and IV quadrants. The superficial sea temperature has a regular seasonal cyclical trend, typical of Sicilian coastal waters, with increasing temperatures from June to September. The geomorphological and bionomical surveys revealed high heterogeneity of coastal bottoms, for the co-occurrence of hard bottoms, soft (mainly silt-clay) bottoms and wide zones colonised by *Posidonia oceanica* (L.) Delile which generally resulted in good state of health; benthic communities appeared qualitatively and quantitatively poor, due to high sedimentation (Perzia *et al*., 2010). The main human activities are small-scale fishery and tourism. The artisanal fleet (26 total active vessels) resulted in high contraction, compared with that (66 vessels) recorded in 1992. Trammel net was the most used gear during the whole study period; entangling net for capture of European hake (*Merluccius merluccius*) and drifting longline for capture swordfish (*Xiphias gladius*) are used seasonally; seine net for "bianchetto" (larvae of clupeiforms) is also a seasonal gear, according to regional authorizations; all the other gears (bottom longline, monofilament, purse seine) are very rarely utilized (Falautano *et al*., 2008). The principal target species of Sciacca artisanal fishery resulted *Palinurus elephas, Diplodus* spp, *Sepia officinalis*, *M. merluccius* (adult stage) and *X. gladius*. The data analysis by GIS revealed that the fishing areas mainly exploited by artisanal fishermen are displaced near the coast. The socio-demographic analysis showed an encouraging percentage of fishermen's sons working with their own fathers and willing to go in for the paternal profession (Falautano *et al.,* 2008). The analysis of cultural heritage showed the disappearance of some fishing metiers and the permanence of some cultural traditions linked to local fishery such as gastronomic traditions, folk songs, poetry, legends and architectonical elements typical of fishing villages (Falautano *et al*., 2008).

Identifying phase. The environmental limits are ascribable to the occurrence of urban wastes, conspicuous coastal building and rubbish dispersed on the beaches and deposited on coastal bottoms which cause ecological alteration and may conflict with fishery activities. The factors limiting and impoverishing small-scale fishery in the study area are referable to the sector structure and to the use of resources and space. The artisanal vessels resulted old and poorly modernized, to the detriment of safety on board and product quality. Their limited engine power obliges most fishermen to operate only near the coast. Another structural limit is the inadequacy and paucity of harbour infrastructures supporting artisanal fishery: there are no reserved mooring areas for fishing vessels which are sparsely displaced in harbour areas at unhealthy sanitary conditions, nor fishing gear storages. The use of resources is limited by the well developed and uncontrolled recreational fishery, which operates in unfair competition with the artisanal fishery; also industrial fishery competes with artisanal fishery, illegally exploiting coastal resources, as evidenced by the traces of trawling observed by side scan sonar (Perzia *et al.,* 2010). Terrritorial limits are represented by flourished nautical tourism which competes with artisanal fishery for spaces exploitation at sea and in the harbour.

Proposal phase. The principal intervention activities to be actuated for overcoming the identified limits are: to promote behaviours and actions aiming at safeguarding the environment; to provide incentives for the modernization of artisanal vessels in order to improve safety and life quality onboard and product quality, also favouring fishing offshore; to improve harbour infrastructures supporting artisanal fishery; to regulate and to increase controls on recreational and industrial fisheries; to promote further scientific researches in this poorly studied area; to develop collaboration between small-scale fishery and tourism sectors, in order to introduce tourists to fishing activity in the field and to allow the reintroduction of disused fishing methods (e.g. bottom traps); to promote underexploited ichthyic products and local gastronomic traditions through the creation of structures and events focusing to divulge fishery culture.

Conclusions - The analyses carried out allowed to define a general picture of the coastal area of Sciacca and of its human activities, *in primis* artisanal fishery. This study allowed to devise some management proposals for a sustainable use of resources in this coastal area analysing the strength points and the limits identified. The overcoming of such limits is a long and integrated process which needs the involvement of local administration, stakeholders, research institutes and surveillance bodies. Despite the described crisis, the artisanal fishery shows some strengths for a desirable reclamation, such as a high percentage of fishermen younger than 40 years old and many elements belonging to fishery culture that could be recovered, improved and employed as tourist and cultural attraction. The good climatic conditions for most of the year could favour the development of fishing tourism activities from spring to fall, contributing to deseasonalize tourist flux, currently concentrated in July-August. Suggestions aiming at the recovery of the small-scale fishery and at the valorisation of its traditions, may contribute to increase the social and economical prosperity of coastal communities and to maintain the culture biodiversity. In this context, fishing communities are really reservoirs of knowledge, experience and understanding of local fisheries that cannot be replicated in any other form (Symes & Phillipson, 2009).

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NATAL ORIGIN OF EUROPEAN ANCHOVY: A CASE STUDY IN THE LIGURIAN SEA (NW MEDITERRANEAN)

ORIGINE NATALE DELL'ACCIUGA EUROPEA: UN CASO DI STUDIO IN MAR LIGURE (ITALIA, MEDITERRANEO NORD OCCIDENTALE)

Abstract *– Persistence of fishing stocks depends also on the supply of eggs and larvae. Here the natal origin of European anchovy in the eastern Ligurian Sea was investigated by using LA-ICPMS analyses on otolith cores. The indication of single or multiple natal origins was found to change year by year (i.e. for each annual cohort). These first results could involve a different risk of fluctuation or collapse (higher in the case of a single natal origin) of European anchovy stocks year by year.*

Key-words: *larval origin, otolith core, LA-ICPMS,* Engraulis encrasicolus*, Ligurian Sea.*

Introduction – Small pelagic fish are essential in marine ecosystems for connecting lower and upper trophic levels (Palomera *et al.*, 2007). Some species, in addition, like European anchovy *Engraulis encrasicolus* L., represent valuable resources for fisheries in the Mediterranean Sea (Lleonard & Maynou, 2003). Fluctuations of pelagic fish stocks, therefore, may have relevant ecological impacts and socio-economic implications (Chavez *et al.*, 2003; Palomera *et al.*, 2007).

Dynamics and persistence of fish populations strongly depend on production/supply of eggs and larvae (Fontes *et al.*, 2009 and references therein) and the related mortality rates (La Mesa *et al.*, 2009). In recent years, new approaches have been developed and proposed to investigate larval dispersal and to identify natal origin, which represent useful information for conservation and stock management purposes. Microchemical analyses of otoliths, from this perspective, are becoming more and more popular worldwide to investigate natal origin of fish (Panfili *et al.*, 2002; Fontes *et al.*, 2009). The technique is based on the fact that varying physico-chemical characteristics of seawater reflect in the otolith, forming a permanent record of past environmental conditions experienced by the fish (Panfili *et al.*, 2002).

The aim of this study is to assess the potential of the use of microchemical analyses of otolith cores of anchovy to investigate natal origin of individuals forming local stocks.

Materials and methods – A number of 100 adult anchovies were collected at Sestri Levante (Genoa; eastern Ligurian Sea; Fig. 1) in August 2009.

Sagittal otoliths were extracted under a stereomicroscope, cleaned and stored to dry. One otolith from each pair was aged, mounted on glass slide, and ground (with 3M Imperial lapping film) to expose the core. Otoliths were then rinsed, sonicated for 10 min in de-ionized water, and analyzed using a LA-ICPMS (laser ablation inductively coupled plasma mass spectrometer) for 8 elements (Li, Mg, Mn, Zn, Sr, Ba, Pb and Hg; the values of Mn and Hg were consistently below the detection limits and therefore excluded from the data analyses). The LA-ICPMS system was calibrated using 610 and 612 glasses. Calcium was used as internal standard to take into account variation in ablation and aerosol efficiency. Three replicates from each core were sampled by three sequential pits vertically collected (Ruttenberg *et al.*, 2008) using a spot size of ~28 µm. Three additional pits were collected in the juvenile region (~40-50 μm far from the core; Cermeño *et al.*, 2006) to assess potential differences in the microchemical composition of the otolith related to the ontogenetic development (Elsdon & Gillanders, 2005). Prior to analysis, samples were pre-ablated to remove any surface contamination (laser at 50% power). The putative differences between 'core' and 'juvenile' otolith sectors, and among otoliths (using otolith × element matrices) were analysed using two-way permutational multivariate analysis of variance (PERMANOVA; Anderson, 2001). The sampling design consisted of 2 factors: "core" vs "juvenile" otolith sectors (C vs J; fixed factor with 2 levels) and 'otolith' (Ot; random and orthogonal). Multivariate analyses were based on dissimilarity matrices based on Euclidean distances and log(x+1) transformed data. nMDS of centroids for each otolith (separating cores and juvenile sectors) was used to visualize the pattern observed (Clarke & Warwick, 2001). The SIMPROF (similarity profile) test, associated to cluster analysis (PRIMER 6 package; Clarke & Gorley, 2006), was used to test the null hypothesis that our set of otolith cores, not *a priori* divided into groups, do not differ from each other in microchemical composition. The SIMPROF test was run after having split anchovy samples into age groups. Otoliths corresponding to specimens 3 (n=10) and 4 years old (n=3) were too scarce numerically and were excluded from the statistical analyses.

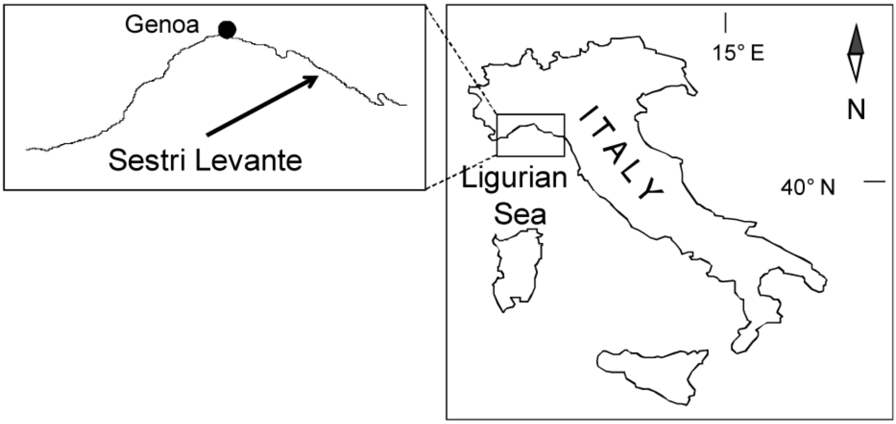

Fig. 1 - Map of the sampling location.
Localizzazione geografica del sito di campionamento.

Results - Otoliths of European anchovy from Sestri Levante showed different microchemical patterns when cores were compared with juvenile otolith sectors (Fig. 2). PERMANOVA test revealed that cores and juvenile sectors were significantly different (d.f.: 1; pseudo-F: 1766.98; P<0.001) in spite of a significant variability among otoliths (d.f.: 99; pseudo-F: 8.76; P<0.001). The nMDS plot shows a partial, but quite clear separation between otolith core and juvenile sectors (Fig. 2).

Otoliths from fish born in 2008 and 2007 (corresponding to anchovies 1 and 2 years old, respectively, having been sampled in 2009) showed different microchemical patterns. Otolith cores of anchovies born in 2008 (i.e. 1 year old anchovies; Fig. 3A) showed a quite homogeneous chemical composition (except from a single specimen) suggesting a single natal origin. Anchovies born in 2007 (i.e. 2 years old anchovies; Fig. 3B), instead, showed 5 statistically different groups (suggesting multiple natal origins).

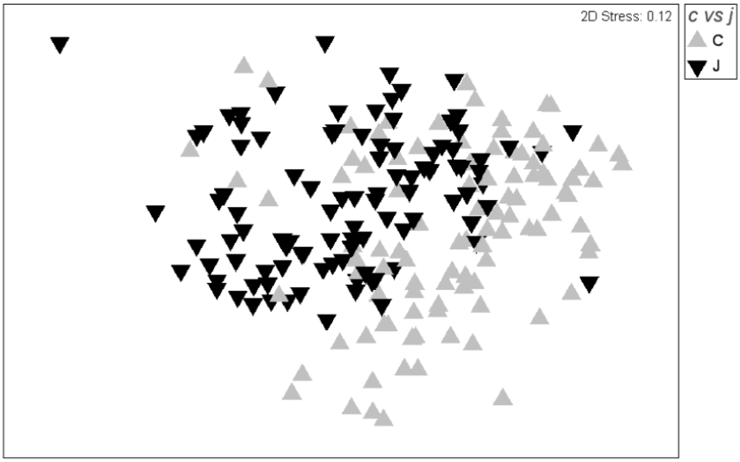

Fig. 2 - nMDS plot of chemical composition of European anchovy otoliths from Sestri Levante (Ligurian Sea). Centroids of each otoliths were plotted (C: core; J: juvenile sector).

Grafico nMDS relative alla composizione microchimica degli otoliti di acciuga campionati a Sestri Levante (Mar Ligure). Sono riportati i centroidi di ogni otolite (C: 'core'; J: settore giovanile dell'otolite).

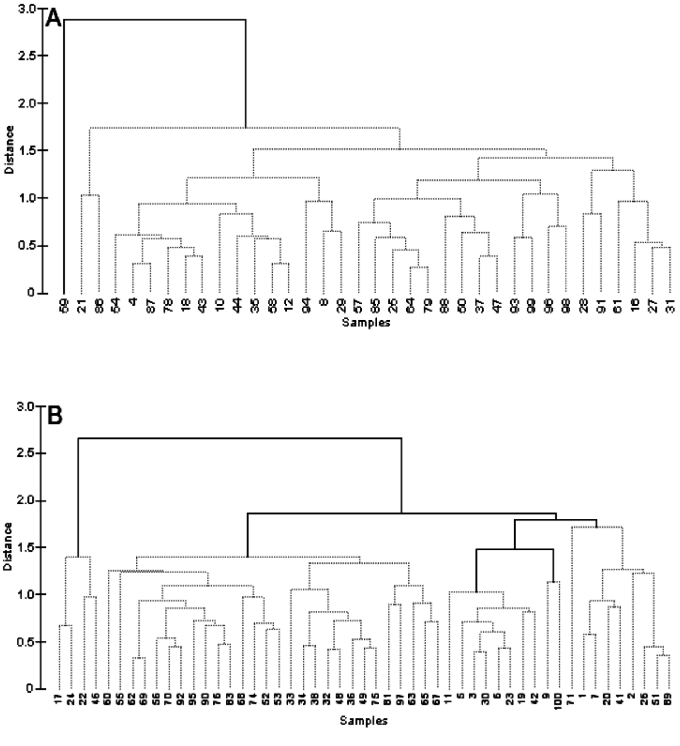

Fig. 3 - Classification of otolith cores of anchovy (A: born in 2008; B: born in 2007). Dashed lines indicate non-significantly different samples (SIMPROF, P>0.05).

Classificazione dei campioni di otoliti (cores) di acciuga (A: nate nel 2008; B: nate nel 2007). Le linee tratteggiate indicano campioni non significativamente differenti (SIMPROF, P>0.05).

Conclusions – These first results suggest that:

1) direct comparisons among different otolith regions may come out with significant differences. Such a general pattern can be attributed to both intrinsic differences in absorption of microelements among the different stages of the life cycle (Green *et al*., 2009) or effective habitat/spatial changes experienced by fish during the ontogenetic development (Fontes *et al*., 2009 and references therein);

2) LA-ICPMS analyses seem to be promising in elucidating patterns and processes that may help better understand the pluriannual dynamics of fish species relevant for fisheries;

3) depending on the year considered (and probably the related oceanographic-climatic conditions), the natal origin of European anchovy stocks can be single or multiple. This outcome could involve a risk of fluctuations or collapses of natural populations and related fishing stocks that may change year by year. The risk of stock collapse, in fact, can be higher if/when local stocks depend on single sources of juveniles as their eventual failure in proving juveniles may seriously impact local stocks, especially of short-living species like European anchovy.

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GRADIENTS OF ABUNDANCE OF *DIPLODUS SARGUS* AND *D. VULGARIS* ACROSS THE RESERVE BOUNDARIES OF THE PORTOFINO MPA (LIGURIAN SEA)

GRADIENTI DI ABBONDANZA DI DIPLODUS SARGUS *E* D. VULGARIS *ATTRAVERSO I CONFINI DELL'AMP DI PORTOFINO (MAR LIGURE)*

Abstract *– Gradients of abundance of the sea breams* Diplodus sargus *and* D. vulgaris *(Sparidae) across the reserve boundaries of the MPA of Portofino were assessed in order to determine reserve effect and to provide evidence of spillover. Fish was visually censused in shallow rocky habitat (4-7 m depth), within the MPA zones and in adjacent fished areas. Density and biomass of both species were usually higher within the reserve than outside, likely due to the enforcement of protection regime. The drastic drop of fish abundance just 100 m outside the MPA and its partial recovery at greater distance from the protected zone would suggest a moderate spillover across the eastern reserve edge.*

Key-words*: spillover, sea breams, Portofino MPA.*

Introduction - One of the potential benefit of marine protected areas (MPAs) is to maintain or enhance adjacent fisheries through the net emigration of adult and juvenile fish to nearby fished areas (spillover effect) (Russ and Alcala, 1996; McClanahan and Mangi, 2000). Assessment of spillover has been usually carried out by monitoring catch rates and fish densities within and outside reserves (McClanahan and Mangi, 2000). Negative gradients of fish density and biomass across reserve borders have been considered evidence of fish spillover (McClanahan and Mangi, 2000; Kaunda-Arara and Rose, 2004). Studies on fish movement by tagging methods indicated spillover to be usually limited to hundreds of meters to a few kilometers from the reserve boundary (McClanahan and Mangi, 2000). Moreover, the effect of export of adult fish biomass may require a lot of time (many years) to develop (Russ and Alcala, 1996). The presence of gradients is likely to concern species and size classes which are more vulnerable to local fishing activities. In Mediterranean rocky shore, the sea breams of the genus *Diplodus* are heavily targeted by fishers, due to their high commercial value. Nowadays very few investigations have attempted to collect experimental evidence of fish spillover through reserve boundaries of Mediterranean MPAs (Harmelin-Vivien *et al.*, 2008). In the present study, the abundance and biomass of the sparids *Diplodus sargus* and *D. vulgaris* were quantified at many sites within and outside the Portofino MPA, in order to assess the presence of gradient across the reserve boundaries and to provide evidence of fish spillover.

Materials and methods - The marine reserve of Portofino was formally established in 1999, though a real enforcement occurred some years later. This MPA is characterized by one small (10 ha) "no entry-no take" area (A zone), two "entry regulated-take regulated" zones (B) and two buffer zones (C). Only local professional fishermen operating with traditional fishing gears are allowed to fish in the B and C zones. Sea breams were censused by SCUBA in November 2004 and September 2005. Fish density was evaluated along strip transects (25×5 m) in shallow (4-7 m) rocky habitat. During each period, eight replicated transects were surveyed at each of 18 sites: 6 within the MPA (2 at each reserve zone) and 12 in nearby fished areas (6 beyond the western reserve boundary and 6 beyond the eastern boundary up to a distance of about 3.6 km from the reserve edge) (Fig. 1).

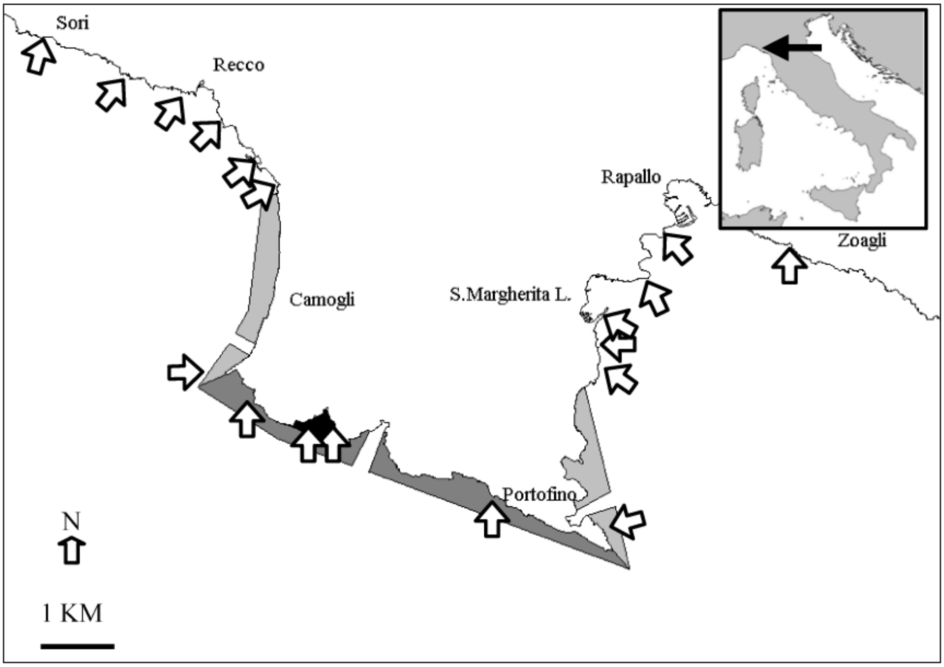

Fig. 1 - Map of the Portofino promontory (Ligurian Sea) showing the different zones (zone A=black; zone B=dark grey; zone C=light grey) of the marine reserve. The arrows show sampling sites location within and outside the MPA.

Mappa del promontorio di Portofino (Mar Ligure) con le differenti zone (Zona A=nero; Zona B=grigio scuro; Zona C=grigio chiaro) della riserva marina. Le frecce indicano la posizione dei siti di campionamento dentro e fuori l'AMP.

All sea breams along the transect were recorded and their total length estimated to the nearest 2 cm. Fish weights were estimated using published length-weight relationships (Froese and Pauly, 2003). To determine the relationships between mean fish abundance (density and biomass) and distance from the innermost reserve zone, we used a logistic function (Kaunda-Arara and Rose, 2004). The logistic decay model was fitted separately for the eastern and western reserve boundaries and only to data initially showing a significant linear decline across the reserve boundaries.

Results - To evaluate the size distribution of the three species in the study area, each sample was divided into three size classes (small: <14 cm, medium: 14-24 cm and large: >24 cm TL). Large individuals were recorded only within the MPA, whereas fish samples outside the reserve were dominated by small individuals. To assess gradient in fish density and biomass across the reserve boundaries only medium and large individuals (i.e. those most heavily targeted by fishery) were considered. A significant linear decrease in sea bream density and biomass across the reserve borders was always observed, except for biomass of *D. vulgaris* in September 2005, likely due to the occurrence of many large individuals in the eastern side of C zone. Density and biomass of both species were usually higher within the MPA zones than outside and in September 2005 with respect to November 2004 (Fig. 2).

Particularly steep gradient of sea breams density and biomass across the reserve boundaries were recorded in September 2005. Regardless to species, both density and biomass dropped sensibly just 100 m outside the reserve and remained close to zero in the westward sampling sites. Along the eastern coasts, sea bream density and biomass slightly recovered about 1 Km apart from the reserve boundary (Fig. 2). Density and biomass data of *D. sargus* fitted significantly a decay model across both reserve borders, but only during September 2005. In *D. vulgaris*, the fits for density were always significant (except eastward in November 2004), whereas a significant gradient of biomass was detected only in September 2005 across the eastern boundary. The inflection point (the distance at which mid-reserve density or biomass is halved) of the logistic decay model was usually located inside the AMP boundaries, within the B or C zone; in two cases only (both in *D. vulgaris*), it was outside the MPA borders.

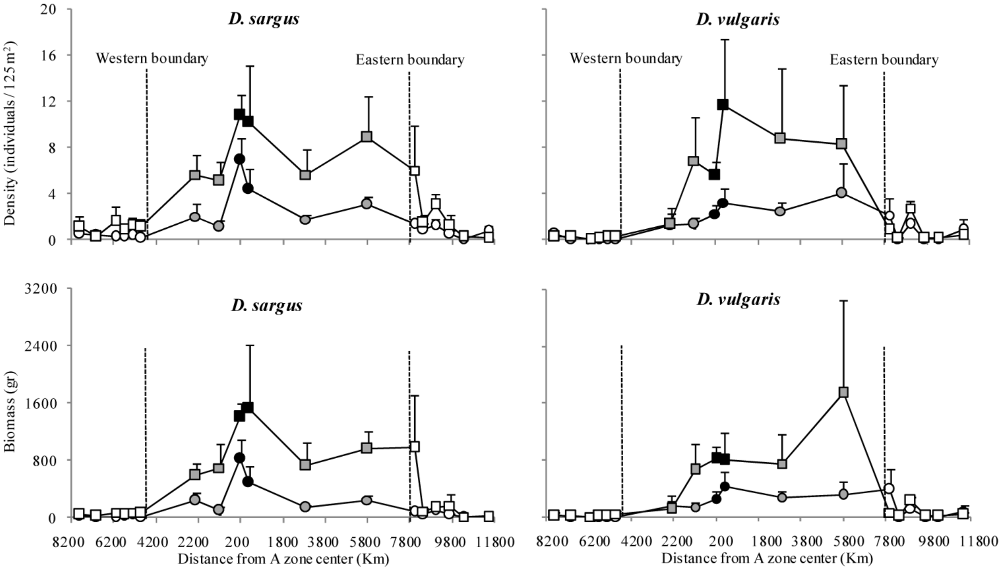

Fig. 2 - Density and biomass (mean+SE) of sea breams across the MPA boundaries (broken vertical lines). Circles and squares (A zone=black; B-C zones=grey; unprotected areas=white) refer to sampling carried out in November 2004 and September 2005, respectively.

Densità e biomassa (media+ES) dei saraghi dentro e fuori i confini (linee tratteggiate verticali) dell'area marina protetta. Cerchi e quadrati (zona A=nero; zone B-C=grigio; aree non protette=bianco) si riferiscono ai campionamenti effettuati in Novembre 2004 e Settembre 2005.

Conclusions - The higher density and biomass of sea breams as well as the larger size of the individuals within the Portofino MPA than in the adjacent unprotected areas demonstrated a positive effect of the protection on the sea breams populations. The very small size of the "no take" area and the low fishing pressure usually occurring in the B and C zones made all the protected area fairly homogeneous in terms of fish density or biomass. In the last decade, a number of species heavily targeted by fishing, such as the sparids *D. sargus* and *D. vulgaris*, benefitted from the enforcement of regulation on fishing activities in the B and C zones (Guidetti *et al.*, 2008). The patterns of decrease in density and biomass of sea breams observed beyond the western and eastern reserve edges were asymmetric and changed in time. The western side of the Portofino promontory is likely characterized by a bottom morphology and type of cover less suitable for sea breams than the eastern one. Furthermore, most of local artisanal fishermen, which typically exploit these fish species, operate preferentially along the western coasts. Despite the collected data evidenced negative gradients of sea bream abundance across the MPA boundaries, the presence of spillover seemed questionable, due to the very low abundance of sea breams outside the reserve. Nevertheless, the level of fishing outside the MPA boundaries could be high enough to prevent the development of a pattern of gradual decline in abundance. That is, spillover from the MPA might occur but fishers could deplete quickly any potential increase in abundance just outside the reserve. This hypothesis is corroborated by frequent observations of many people fishing close to reserve boundaries (a very common situation termed as "fishing the line"). Moreover, the slight recovery of fish abundance recorded along the eastern coasts in proximity to the harbour of S. Margherita would suggest a moderate spillover. An important issue derived for the present work to consider in future investigations concerns sampling effort. To gain more robust evidence of spillover, it would be advisable to relocate sampling effort so as to enhance the number of sampling sites close to the MPA boundaries, where a drastic change in fish abundance do occur.

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POSIDONIA OCEANICA THROUGH TIME: MODERN AND PALEOECOLOGICAL PERSPECTIVES FROM THE BERGEGGI - VADO LIGURE AREA (SV)

POSIDONIA OCEANICA *NEL TEMPO: PROSPETTIVE MODERNE E PALEOECOLOGICHE NELL'AREA BERGEGGI-VADO LIGURE (SV)*

Abstract - *Diachronic cartography and one sediment core in the Bergeggi-Vado Ligure area (NW Mediterranean Sea) were used to assess, respectively, short-term and long term evolution of the* Posidonia oceanica *meadow. A preliminary evaluation of its economic value has been performed.*

Key-words: Posidonia oceanica*, evolution, diachronic cartography, Ligurian Sea.*

Introduction - The endemic *Posidonia oceanica* (L.) Delile is the most abundant seagrass in the Mediterranean Sea, where it forms extensive meadows from the surface down to 40 m depth and plays major ecological roles for coastal ecosystems and generates important services for coastal population (Montefalcone, 2009 and reference therein). Geomorphology of the coast is influenced by *P. oceanica* meadows that damp the swell and form an obstacle to the movement of sediments on the bottom (Tigny *et al*., 2007; Vacchi *et al*., 2010). Meadows also contribute to water oxygenation, keeping the ecosystem healthy. The preservation of these functions implies economic benefits for coastal areas (e.g. fisheries, tourism) not necessarily perceived by society and ascribed by economy. Regression of *P. oceanica* meadows, due to both natural and human effects, has been surely accelerating in recent decades. In the Ligurian Sea, for instance, nearly 30% of the original meadow surface area has been lost in the 1960s, during the period of rapid urban and industrial development occurred along the Ligurian coast (Bianchi and Morri, 2000). The health and occurrence of *P. oceanica* meadows along the coastline, and their change over time, can be seen as one of the "reading keys" of the evolution of soft coasts: the diachronic cartography represents an important tool for measuring temporal changes in term of percentage gain or loss of meadow extension. Superimposed to short term changes, *P. oceanica* is believed to have had its climatic optimum around 6000±2750 years BP (Mateo *et al*., 1997). In this contribution we attempt to evaluate long (millennial) and short (decadal) term evolution of *P. oceanica* in the Bergeggi-Vado Ligure area (Ligurian Sea). This evolution has been tentatively translated in monetary terms aiming at making clear related economic outcomes.

Materials and methods - The extension and typology of the *P. oceanica* meadows in the study area has been drawn in Bianchi and Peirano (1990), MSS-ENEA (1991), Diviacco and Coppo (2006) using Side Scan Sonar (SSS). Cartographic outputs have been vectorised at the same resolution scale (1:25000) and processed with GIS to obtain concordance maps. One core (V1) was made in the study area and different sections containing dead matte of *P. oceanica* have been dated through ^{14}C at Beta Analytic Laboratories. Radiocarbon dates were calibrated and corrected for the marine reservoir effect. All dates reported are expressed in years Before Present (BP). The monetary value has been assessed using emergy analysis (Odum, 1996). This methodology allows to quantify resources keeping a system or an eco-function. To evaluate the economic value of *P. oceanica* different functions have been considered: oxygen release, primary production, nursery role.

Results - Cartography obtained from indirect and direct surveys between Bergeggi and Vado Ligure (Diviacco and Coppo, 2006) allowed to obtain the extension and typology of coverage of: *P. oceanica*, mosaic of *P. oceanica* and dead matte, dead matte. In 1990 have been recognized exclusively areas characterized by the presence of *P. oceanica,* in 1991 the surveys allowed to map mosaic of *P. oceanica* and dead matte and a small percentage of dead matte (Fig. 1; Tab. 1). Spatial analyses allowed to assess that the three cartographies show extremely low percentages of concordance (Tab. 2).

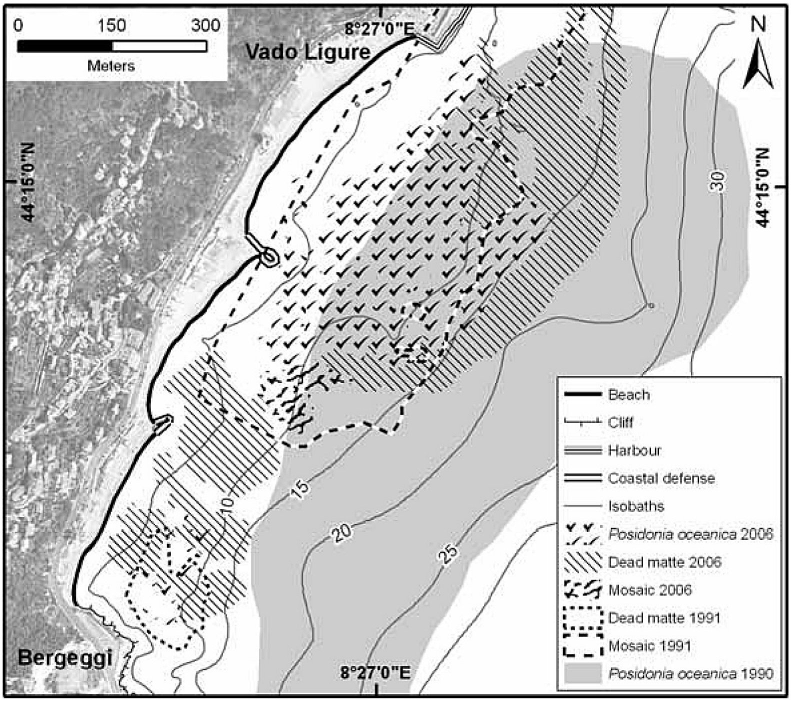

Fig. 1 - Study area, with the results of the vectorisation of the cartographies of 1990, 1991 and 2006.

Area di studio, con i risultati della vettorializzazione delle cartografie del 1990, 1991 e 2006.

Tab. 1 - Extension (ha) respectively of: *Posidonia oceanica* meadows, mosaic of *P. oceanica* and dead matte, dead matte in the three years of reference.

Estensione (ettari) rispettivamente di: praterie di P. oceanica*, mosaico e matte morta.*

Year	1990	1991	2006
Posidonia oceanica	51,3	0,0	10,4
Mosaic of *P. oceanica* and dead matte	0,0	24,0	0,9
Dead matte	0,0	1,5	15,0

The V1 core (Fig. 2) is characterized by at least three continuous levels of dead matte of *P. oceanica*: ^{14}C datations have been coupled with relative sea level and bottom

Tab. 2 - Concordance (%) of coverage in the three years. A: *Posidonia oceanica*; B: mosaic of *P. oceanica* and dead matte; C: dead matte.

Concordanza (%) del ricoprimento nei tre anni. A: P. oceanica*; B: mosaico; C: matte morta.*

		1991					**2006**					**2006**		
		A	**B**	**C**			**A**	**B**	**C**			**A**	**B**	**C**
1990	**A**	0			**1990**		37.2			**1991**		0		
	B		0					0					3.8	
	C			0					0					3.7

position obtained for the same area by Carobene *et al.* (2008) throughout the Holocene, allowing to reconstruct the millennial evolution of a section of *P. oceanica* meadow.

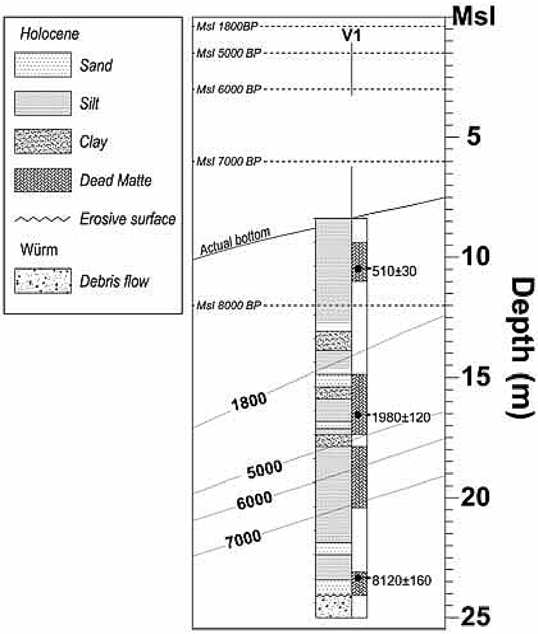

Fig. 2 - V1 core with ^{14}C dates. Depth of the bottom at a given time during Holocene (lines below the actual bottom, years BP) and the relative msl position have been derived from Carobene *et al.* (2008).

Carota V1 e datazioni C^{14}. La profondità del fondale Olocenico (linee al di sotto del fondale attuale, anni BP) e la relativa posizione del lmm sono state derivate da Carobene et al. *(2008).*

The monetary value of *P. oceanica* has been summarized in Tab. 3 and compared with a previous evaluation by Blasi (2009).

Tab. 3 - Per square meter monetary values of some *Posidonia oceanica* eco-fuctions.

Valori monetari per metro quadrato di alcune funzioni ecologiche di P. oceanica.

Function	Unit of measure	This study	Blasi, 2009
Primary production (of which carbon)	€·m^{-2}·y^{1}	0.177 (0.024)	1.66 (0.01)
Nursery role	€·m^{-2}·y^{1}	0.026	-
O_2 release	€·m^{-2}·y^{1}	0.007	14.21

Conclusions - Three main conclusions can be drawn on the short-term and long-term evolution of *P. oceanica* in the study area and on its economical value trough time.

i) High discordances among cartographies realized in three different periods. As large differences in meadow extension and typology in a single year are unlikely, these are to be considered as due to errors in the positioning and/or interpretation of sonograms. Such large errors prevent any possibility to evaluate evolution of the meadows over short term time scales (i.e., between 1990-91 and 2006). A well definite protocol for the use of acoustic techniques when mapping seagrass is recommended, including the adoption of systematic ground truthing criteria and designs.

ii) Superimposed to short term (i.e. decadal) time scale, *P. oceanica* meadows show a long-term (i.e. millennial) time scale evolution. The results obtained from core V1 call for integration with more spatially dispersed data, but suggest that long-term evolution of the meadow comprises periods of natural expansion and regression. Additional data are also needed to clarify the link between climatic events during Holocene and *P. oceanica* evolution.

iii) discordances in meadows extension evaluation lead to variations of the economic value of Vado-Bergeggi meadow: 102460 $€\cdot y^{-1}$ (1990), 0 $€\cdot y^{-1}$ (1991), 20818 $€\cdot y^{-1}$ (2006). It is compulsory to specify that these values probably represent an underestimation of *P. oceanica* value since they not include other services as, e.g., biodiversity source and coastal protection from erosion.

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A NEW METHOD FOR THE ASSESSMENT OF THE ECOLOGICAL STATUS OF CORALLIGENOUS ASSEMBLAGES

UN NUOVO METODO PER LA DETERMINAZIONE DELLA QUALITÀ ECOLOGICA DEI POPOLAMENTI CORALLIGENI

Abstract *– The paper proposed a new method for the assessment of ecological status of Mediterranean coralligenous assemblages. The proposal is based on data obtained from photographic samplings carried out by ARPAT in 5 locations along the coast and islands of Tuscany. Results showed that the proposed method allowed to clearly separate the studied locations, in agreement with other methods already used in monitoring survey.*

Key-words: *coralligenous assemblages, environmental quality, Tuscany.*

Introduction – Coralligenous habitat represents one of the most important Mediterranean coastal systems in relation to its distribution, biodiversity and production (Ballesteros, 2006). The maintenance of this habitat is due to a balance of constructive and destructive forces and each impact can influence this balance. Thus, coralligenous assemblages are considered sensitive to disturbance and they can represent effective bio-indicators in monitoring programs (Balata *et al*., 2005; Piazzi *et al*., 2010). We proposed a new method for the assessment of Ecological Status of Coralligenous Assemblages (ESCA index) .

Materials and methods – The proposal is based on data obtained from samplings carried out by ARPAT in 5 locations along the coast (Meloria Shoals, Livorno, Vada Shoals, Monte Argentario) and islands (Montecristo) of Tuscany. In each location, two sites were chosen and in each site two areas were sampled; in each area 15 photographic samples of 1878 cm^2 were collected on vertical bottom at the depth of 30 m. Images were analyzed by Image J to evaluate the cover of the main taxa or groups. An ecological values ranging between 1 and 10 was attributed to each taxon/group identified with photographic sampling (Tab. 1).

Tab. 1 - Sensitivity levels of the taxa/groups identify with photographic sampling.
Sensitivity levels dei taxa/gruppi identificati mediante campionamento fotografico.

Taxa/group	**Sens. lev.**
Gorgonacea	10
Halimeda tuna, *Cystoseira* spp.	9
Flattened corticated Rhodophyta, erect Bryozoa, Madreporaria	8
Large-size terete Rhodophyta with cortication	7
Flabellia petiolata	6
Zanardina typus, Hydrozoa, Tunicata, encrusting Bryozoa	5
Peyssonnelia spp, *Palmophyllum crassum*, *Valonia* spp., Porifera, Polychaeta	4
Encrusting Corallinales	3
Dictyotales, articulated Corallinales	2
Turf, *Caulerpa* spp.	1

Three descriptors have been considered: ecological values of organisms (values attributed at each sample correspond to values of the organism with the highest sensitivity level present in the sample), number of organisms/groups, heterogeneity of assemblages (calculated through PERMDISP analysis; Anderson, 2006). Values of Environmental Quality (EQV) calculated from these three descriptors were divided from reference values (values obtained from Montecristo Island) to obtain the Environmental Quality Ratio (EQR'). The EQR of the water bodies was evaluated as the mean of the three EQR'. According to the European Water Framework Directive, five ecological status classes were defined (0-0.4 bad, 0.4-0.55 poor, 0.55-0.7 moderate, 0.7-0.85 good, 0.85-1.0 high).

Results – The application of the proposed method to the 4 locations sampled along the coast of Tuscany, showed that Monte Argentario resulted in high condition, while the other locations resulted in good condition (Tab. 2).

Tab. 2 - Results of application of the new method to 4 locations of Tuscany coasts.
Risultati dell'applicazione del nuovo metodo (E.S.C.A.) nelle quattro località toscane.

Location	EQR' sensitivity level	EQR' Number of taxa/group	EQR' heterogeneity	EQR	Ecological status
Argentario Month	0.97 (high)	0.99 (high)	0.79 (good)	0.92	High
Vada Shoal	0.92 (high)	0.89 (good)	0.66 (moderate)	0.83	Good
Meloria Shoal	0.90 (high)	0.82 (good)	0.61 (moderate)	0.78	Good
Calafuria (LI)	0.90 (high)	0.77 (good)	0.54 (moderate)	0.74	Good

Conclusions – The proposed method allowed to clearly separate the studied locations, in agreement with results obtained with other methods already used in monitoring programs (eg. CARLIT). The three selected descriptors sowed similar patterns in the attributing ecological values at the five locations. The widest range of EQR values was related to the level of heterogeneity, that seems to represent a valid descriptor of ecological quality of coralligenous assemblages. The proposed method shows the advantages that it is not a destructive method, it does not require highly specialized taxonomists and it considers different ecological aspects of the assemblages. However, this method needs to be tested on a large set of data, in order to evaluate its effectiveness and to highlighted possible differences related to geographic areas.

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RECENT DATA FROM THE MONITORING OF *POSIDONIA OCEANICA* IN TWO MARINE PROTECTED AREAS OF THE APULIAN COASTS (CENTRAL-EASTERN MEDITERRANEAN SEA)

DATI RECENTI SUL MONITORAGGIO DI POSIDONIA OCEANICA *IN DUE AREE MARINE PROTETTE DELLE COSTE PUGLIESI (MEDITERRANEO CENTRO-ORIENTALE)*

Abstract *– This paper reports recent bio-ecological data on the* Posidonia oceanica *meadows located in two Marine Protected Areas of the Apulia region, Tremiti Islands and Porto Cesareo, placed in the Southern Adriatic Sea and North-Eastern Ionian Sea, respectively. The main features of the meadows (morpho-ecology, phenology, lepidochronology) were estimated. Moreover, in situ (-15 depth) continuous recording of light intensity (Lux) and water temperature (°C) was carried out during the period Oct. 2008-Sept. 2009.*

Key-words: Posidonia oceanica*, monitoring, MPAs, central-eastern Mediterranean Sea.*

Introduction – European and National acts (Directive EC/2000/60, Italian Law Decree 152/2006, Italian Ministry Decree 56/2009) strongly recommend the monitoring of phanerogams, including *Posidonia oceanica* (L.) Delile, as Biological Quality Element for the assessment of the environmental status of marine coastal waters. In the framework of the monitoring program in the Apulian region, two *P. oceanica* sites respectively located in the MPAs "Tremiti Islands (Adriatic Sea)" and "Porto Cesareo (Ionian Sea)" have been investigated (Oct. 2008 – Nov. 2009) in order to collect both biotic and abiotic data.

Materials and methods – The two investigated *P. oceanica* meadows are located into distinct basins (Southern Adriatic Sea, North-Eastern Ionian Sea) (Fig. 1). The sampling plan, as well as the laboratory analysis protocol (phenology and lepidochronology), were standardized at national level (Cicero & Di Girolamo, 2001; ISPRA, 2009). In each meadow, n. 1 sampling stations were investigated by scuba divers at the fixed depth of 15 m (n. 9 counts in 40×40 cm square; n. 18 shoots sampled; morpho-ecological observations). At this depth a waterproof temperature/light data-logger was placed close to the sea floor for the continuous data recording (20' time step).

Results – The analytical results from the monitoring of both bio-ecological parameters and physical ones (annual trend of temperature and light intensity at -15 m depth) are reported in the Tab. 1 and in the Fig. 2. Higher values of "Density","Leaf Area Index" and "Leaf Standing Crop" have been estimated for the Porto Cesareo meadow, while higher values of "Epiphytes Biomass" resulted for the Tremiti meadow. The sea floor temperature highlighted the same annual trend in both the sites; the annual average values calculated over the Oct. 2008-Sept. 2009 period were 17.14 °C and 18.39 °C in the Tremiti and Porto Cesareo meadows respectively. At the same time interval the average value of light intensity was 82.86 lux in the Tremiti and 292.15 lux in the Porto Cesareo meadows.

Conclusions – Preliminary results highlighted some differences between the two meadows, probably linked to the local environmental features. According to the well known role of the light for the distribution and growth of the species, the variation of some morpho-ecological and phenological traits in the two investigated *P. oceanica* sites can be mostly related to the different light intensity value as recorded at the respective -15 m depth stations. The water temperature, the average value higher in the Porto Cesareo meadow, can be another driver. The results agree with the information from the scientific literature, describing the Southern Adriatic Sea and the North-Eastern Ionian Sea quite different basins (oceanographic characteristics, trophic level) (Cardellicchio *et al*., 1993; Vilicic *et al*., 1995; Marano *et al*., 1998). Notwithstanding, the apparently stressed condition highlighted in the Tremiti Islands meadow needs further investigation on the impact of human activities occurring in marine areas under protection regime.

Tab. 1 - Bio-ecological data for the two *P. oceanica* investigated meadows.
Dati bio-ecologici relativi alle due praterie di P. oceanica *indagate.*

***Posidonia oceanica* monitoring station (-15m depth)**				
Parameters	**Tremiti Islands** *(S. Domino - P.ta Spido)*		**Porto Cesareo** *(S. Isidoro Tower)*	
Coordinates (° ' " WGS84)	N42 07 01.2 E015 29 51.9		N40 12 21.5 E017 54 30.0	
Sampling date	16 oct 2008	23 sept 2009	18 oct 2008	14 nov 2009
Density (shoots m^{-2})	135	163	225	234
Cover (%)	60	70	80	70
Lower limit depth (m)	21		29	
Intermediate leaf mean length (cm)	19.7	21.8	16.4	19.9
Intermediate leaf mean width (cm)	1.0	1.0	0.9	0.9
Adult leaf mean length (cm)	49.1	45.7	43.2	39.1
Adult leaf mean width (cm)	0.9	1.0	0.9	0.9
Shealts mean length (cm)	3.4	3.1	4.7	4.6
Total coeff. "A" (%)	38.0	39.5	26.2	15.5
Leaf surface (cm^2 $shoot^{-1}$)	123.6	145.8	130.7	149.8
Leaf biomass (g d.w. $shoot^{-1}$)	0.591	0.672	0.818	0.600
Leaf Area Index (LAI) (m^2 m^{-2})	1.7	2.4	2.9	3.5
Leaf Standing Crop (LSC) (g d.w. m^{-2})	80.1	109.3	184.1	140.3
Epiphytes biomass (g d.w. shoot-1)	0.152	0.333	0.044	0.012
LFR (no. of leaves $shoot^{-1}$ $year^{-1}$)	6.0	6.1	5.6	6.5
RhP (Rhizome Production g d.w. $year^{-1}$)	0,083	0,064	0,080	0,073
RhER (Rhizome Elongation Rate cm $year^{-1}$)	1.07	0.75	0,92	0.78
Rhizome mean full length (cm)	9.6	6.4	10.3	8.9
No. lepidochronological years on average examinated	9	7	12	8
Sediment analysis				
T.O.C. (Total Organic Carbon mg.kg^{-1})	-	<100	-	<100
Sand (0.063 mm < x < 2 mm) (%)	-	93.1	-	98.2
Gravel (> 2 mm) (%)	-	0.2	-	0.0
Mud (< 0.063 mm) (%)	-	6.7	-	1.8

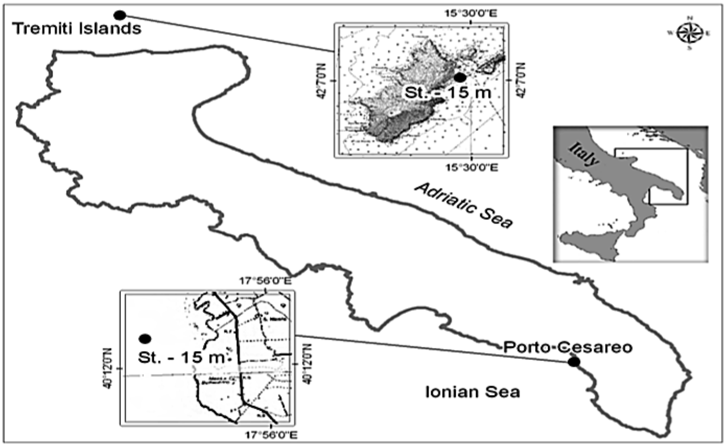

Fig. 1 - Location of the investigated *P. oceanica* meadows.
Localizzazione delle praterie di P. oceanica *investigate.*

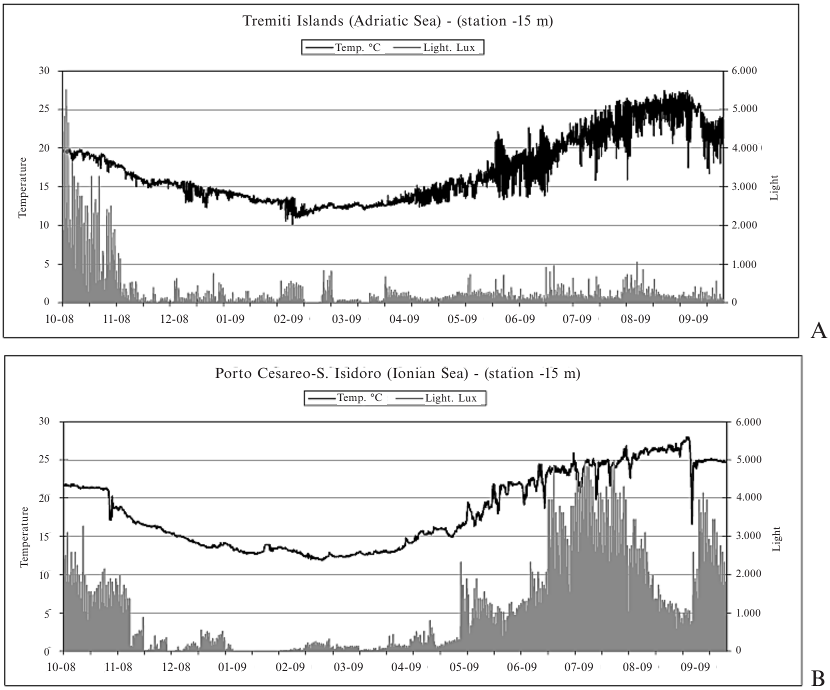

Fig. 2 - Temperature and light intensity trends measured in the *P. oceanica* meadows at Tremiti Islands (A) and Porto Cesareo (B).

Andamento della temperatura e dell'intensità luminosa nelle praterie di P. oceanica *delle Isole Tremiti (A) e di Porto Cesareo (B).*

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Biol. Mar. Mediterr. (2010), 17 (1): 167-168

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THE SUSTAINABLE DEVELOPMENT OF MEDITERRANEAN AQUACULTURE IN MARINE PROTECTED AREAS

LO SVILUPPO SOSTENIBILE DELL'ACQUICOLTURA NELLA AREE MARINE PROTETTE

Abstract *– The aim of the present paper is to evaluate the sustainability of fish farming activities in relation to marine protected area. Results of an environmental impact assessment of two farms in islands of a marine park suggested that small activities may be environmentally acceptable and socially equitable.*

Key-words: *aquaculture, marine protected areas, sustainability.*

Introduction - According to the definition of sustainable development, a sustainable aquaculture should be environmentally acceptable, economically viable and socially equitable (Simard *et al.*, 2008). The aim of the present paper is to evaluate if these requisites are respected when a fish farming takes place in a marine protected area. To fulfil this aim, macrobenthic communities and *Posidonia oceanica* (L.) Delile epiphytes were chosen as descriptors to evaluate the possible effects of two different fish farms under the cages and in the surrounding areas. This paper, part of a multidisciplinary project, reports only some data as representative examples of the results of the project.

Materials and methods – The study was carried out in 2009 during the summer period to investigate two fish farms located in Gorgona and Capraia islands included in the National Park of the Tuscan Archipelago. The Gorgona farm is constituted by 3 pre-fattening suspended cages (130 m^3) and 5 REFA TLC 800 (Tension Leg Cage) (4000 m^3) and sited on a 16-18 m deep colonised by *Posidonia oceanica*. The Capraia farm is constituted by 5 units located on a sandy bottom at 30-32 meter depth. At both study farms, 5 sites were selected: one under the cages (T), two 300 m distant from the cages (I=intermediate sites), and further two at 1000 m from them (C=control sites). In each site two areas were chosen.

In Gorgona, in each area, five haphazardly chosen shoots of *P. oceanica* were uprooted and the percentage cover of dominant taxa or morphological groups were estimated in the first 30 cm from the tip of the two external leaves; moreover, epiphytes were scratched with a razor blade and their biomass was evaluated as dry weight after 48 h at 60 °C. In Capraia five sediment samples for benthic community analyses, were collected, washed through 0.5 mm mesh sieve, sorted and the organisms were counted and classified to the lowest possible taxonomic level.

Results – In Gorgona, biomass values of *P. oceanica* epiphytes were very high under the fish farm, but in intermediate areas were similar to those of controls. In particular, Dictyotales significantly increased in cover in the impacted meadow (Fig. 1). In Capraia a total of 3726 organisms belonging to 143 species were found. The highest values of abundances were detected under the cages and they sharply decrease already at 300 meters from them. An opposite pattern was observed for equitability (Fig. 1).

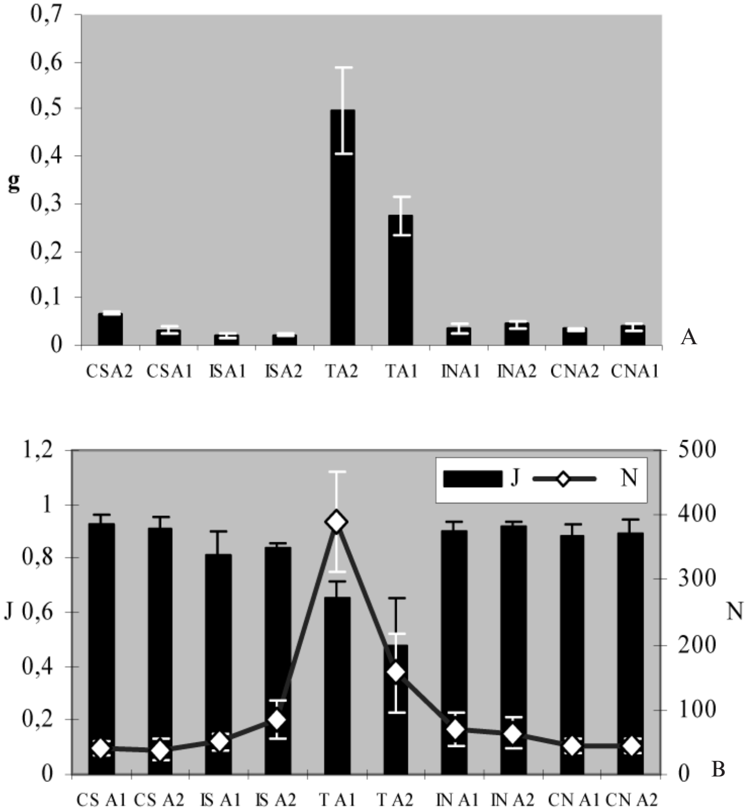

Fig. 1 - Epiphyte biomass of Gorgona meadows (A) and abundance and equitability of macrozoobenthic assemblages (B). T=disturbed site; I=intermediate site; C=control site; A1, A2, areas.

Biomassa degli epifiti nelle praterie di Gorgona (A) e abbondanza ed equitabilità dei popolamenti macrobentonici di Capraia (B). T=sito di impatto;I=sito intermedio; C=sito di controllo; A1, A2, aree.

Conclusions – Results showed that the impact of these two farms can be clearly identified under the cages both on *P. oceanica* and unvegetated sediments. However, in both cases, the effects were very localized being already limited or absent even at 300 meters from the cages. These data suggested that small activities can guarantee the environmental acceptability of farms also in marine protected areas. Thus, small displaced farms with low environmental impact located in healthy areas may be considered sustainable for the environment and they can offer the vantage of a local distribution of their products with an important role in sustaining local livelihoods and alleviating economic losses due to restrictions imposed by protection measures.

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THE ROLE OF MARINE BIOLOGIST IN THE MARITIME SPATIAL PLANNING

IL RUOLO DEL BIOLOGO MARINO NELL'AMBITO DELLA PIANIFICAZIONE DELLO SPAZIO MARITTIMO

Abstract *–The recent European regulations draws the fundaments for the application of a new instrument: the Maritime Spatial Planning (MSP) aimed at integrating the different territorial plans presently in force and at optimizing the usage of the maritime space to improve both economic development and marine environment. In the future the need for a more substantial "sea regulation plan" will become more and more crucial. The marine biologist role will have a fundamental importance to this respect.*

Key-words: *ICZM, planning, management.*

Introduction – The main EU instruments for the promotion and Integrated Coastal Zone Management (ICZM) are represented by the "Recommendation" of the Parliament and of the European Council on the implementation of the ICZM in Europe (2002/413/CE, GU L 148 dated 6.6.2002) along with the "Protocol" on Mediterranean ICZM issued by the Barcelona Convention and acknowledged in GU L 34/19 dated 04.2.2009.

A new pulse towards the ICZM was given by the recent European laws, with the issue of "Marine Strategy Framework Directive" (2008/56/CE, GU L 164 dated 25.6.2008), aimed at the adoption of necessary measures for the maintaining of a good environmental state of the marine habitats within 2020, and with the implementation of the "integrated maritime policy, IMP" (COM, 2007: 575 – *The Blue Book*), defining the strategical framework of the whole sector "sea/coast". The ICZM is considered by the European Council (2009/89/CE, GU L34/17 del 4.2.2009) an essential component of IMP, that should be integrated with the "Maritime Spatial Planning" (MSP) as in the "action plan" of IMP (COM, 2008: 791). MSP, therefore, represents a fundamental instrument along with ICZM, helping the authorities 'in force' to coordinate their actions towards a better maritime economy and marine environmental quality. Thus, marine biologists must play a fundamental role in IMP.

Materials and methods – The Cilento coastal area was chosen as study area. It extends for about 130 Km, within Salerno province, from Agropoli (North) to Sapri (South). Present and future of this area is strictly linked to the sea. It shows a high population density and trading and production activities, with maritime and tourist connotations, along with a network of marine and terrestrial protected areas. In this area, an analysis of the coastal territorial planning instruments was performed, taking into account both National and local laws, underlining adequacies and inadequacies.

Results – The results are very heterogeneous and scattered due to the lack of National general address lines determining the creation of different regulation plan with different and also contrasting planning instructions (Tab. 1). With the Law L.R. n.13/08, regulating the Regional Territorial Plan (RTP), Campania Region applied a planning instrument defining criteria, lines and the strategic contents of the regional planning through which the local authorities shall sinergically operate to update and produce new integrated planning instruments, according to European regulation. Including the MSP guidelines in RTP 'proposal' would be essential to this scope.

The aim of MSP is to establish the realistic destination of maritime space according to the local tradition in order to avoid conflict amongst different activities (MPAs and aquaculture plants, recreational fishing and boating, local traditional fishing and marine tourism, etc…) (Russo, 2010). Marine biologists, therefore, may have a central role in establishing the natural destination of a marine territory and in the implementation of ecological classification techniques, within the Geographic Information System (GIS), integrating all environmental and socio-economic data (Russo *et. al.*, in press).

Tab. 1 - Tools for the Cilento coastal planning and management.
Strumenti di pianificazione e gestione della fascia costiera cilentana.

Piano stralcio di Assetto Idrogeologico - **PSAI**	ADOTTATO con Del. n. 55 del 12/06/2002 (BURC n. 40 del 26/08/2002)
Piano Stralcio Erosione Costiera - **PSER**	ADOTTATO con Del. n. 52 del 21/12/2006 (BURC n. 29 del 28/05/2007)
Piano di Tutela delle Acque - **PTA**	ADOTTATO con D.G.R. n. 1220 del 20/08/2007) (BURC n. 46 del 20/08/2007)
Piano Territoriale Regionale - **PTR**	Legge Regionale n. 13 del 13/10/2008 (BURC n. 45 Bis del 10/11/2008)
Piano Territoriale Paesistico Cilento Costiero - **PTP**	23 gennaio 1996 (G.U. 80 del 4.4.96) 4 ottobre 1997 (G.U. 35 del 12.2.98) Annullato dal TAR Campania con sentenza 950/96, e successivamente riapprovato
Piano del Parco - PNCVD	Approvato con DGR n. 617 del 13/04/2007 (BURC n. 9 del 27/01/2010)
Piano Territoriale di Coordinamento della Provincia di Salerno - **PTCP**	APPROVATO con DGP n. 16 del 26/01/2007 In fase di aggiornamento (L.R. n. 13/08)
Piano delle Comunità Montane dell'Alento e Monte Stella e del Lambro e Mingardo	(legge regionale 6/1998)
Piani Regolatori Generali - **PRG**	15 comuni costieri su 9
Regolamento della Zona a Tutela Biologica di Santa Maria di Castellabate	D.M. 25/8/1972
7 Piani di Gestione per i SIC e ZPS a carattere prevalentemente marino e costiero	In fase di realizzazione
Regolamento dell'AMP di Santa Maria di Castellabate (In fase di istituzione)	Regolamento non ancora approvato
Regolamento dell'AMP di Costa Infreschi e della Masseta (In fase di istituzione)	Regolamento non ancora approvato

Conclusions – The recent European Marine Strategy Framework Directive represents an ideal reference point to solve the inadequacies amongst the different territorial plans presently in force. In the future the need for a more substantial "sea regulation plan" will be more and more important and the cultural role of marine biologists role will become crucial.

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Biol. Mar. Mediterr. (2010), 17 (1): 171-172

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THE ASSESSMENT OF THE ECOLOGICAL QUALITY OF COASTAL WATER THROUGH THE CONCURRENT USE OF DIFFERENT BIOLOGICAL INDICATORS

LA VALUTAZIONE DELLA QUALITÀ ECOLOGICA DELLE ACQUE COSTIERE ATTRAVERSO L'UTILIZZO CONTEMPORANEO DI DIFFERENTI INDICATORI BIOLOGICI

Abstract *– The paper aimed to compare values of ecological quality of coastal water obtained for 3 locations sited along the Tuscany coasts through the concurrent use of different biological indicators. Results showed that Monte Argentario resulted in high condition, while the other locations resulted in good condition. An interesting result of the study was a general correspondence among values of different indicators.*

Key-words: *biological indicator, monitoring, environmental quality, Tuscany.*

Introduction – The assessment of the ecological quality of coastal water, such as required by the European Framework Directive 60/2000, implies the use of different biological indicators. The ecological status has to be evaluated as ratio (Ecological Quality Ratio, EQR) between values of biological elements observed in a determinate water body and reference values. Five classis of ecological status have to correspond to intervals of this ratio (high, good, moderate, poor, bad). Several studies has been carried out to test methods used for particular habitats (Mangalajo *et al*., 2007; Lopez y Rojo *et al*., 2010).

In this paper, we compared values of EQR obtained for 3 locations sited along the Tuscany coasts through the concurrent use of different biological indicators.

Materials and methods – The data used for comparison were obtained from samplings carried out by ARPAT in 3 locations along the coast of Tuscany: Livorno, Piombino and Monte Argentario. Both CARLIT approach for rocky shore macroalgal assemblages (Ballesteros *et al*., 2007) and BiPo approach for *Posidonia oceanica* (L.) Delile meadows (Lopez y Rojo *et al*., 2010) were used. Moreover, a new proposed approach for coralligenous assemblages was added (Cecchi *et al*., 2010). Reference values to calculate EQR were those suggested by Ballesteros *et al*. (2007) and Lopez y Royo *et al*. (2010) for CARLIT and BiPo respectively; values detected at Montecristo Island were used as reference values for coralligenous assemblages. The EQR for each location was calculated as the mean of EQR obtained from all the habitats present in the location and reported to an arbitrary scale with class ranges of 0.2 (0-0.2 bad, 0.2-0.4 poor, 0.4-0.6 moderate, 0.6-0.8 good, 0.8-1 high).

Results – Values of EQR of *Posidonia oceanica* meadows are reported in Tab. 1. In Tab. 2 are shown the EQR values calculated as a mean among EQR of the three habitats. The use of different biological indicators showed that Monte Argentario resulted in high condition, while the other locations resulted in good condition (Tab. 2).

Tab. 1 - Values of EQR for *Posidonia oceanica* meadows. Density=shoots m^{-2}; SLsurface=Shoot Leaf surface (cm^2 $shoot^{-1}$); LLdepth=Lowel Limit depth (m); Type=type of limit.

Valori di EQR relativi alle praterie di Posidonia oceanica. *Densità=fasci m^{-2}; SLsurface=Superficie foliare per fascio (cm^2 $fascio^{-1}$); LLdepth=profondità del limite inferiore (m); Type=Tipo di limite.*

Location	EQR'$_{density}$	EQR'$_{SL\ surface}$	EQR'$_{LLdepth}$	EQR'$_{type}$	EQR
Piombino	0.77 (good)	0.81 (high)	0.36 (moderate)	0.44 (moderate)	0.60 (good)
Livorno	0.62 (good)	0.64 (good)	0.44 (moderate)	0.89 (high)	0.65(good)

Tab. 2 - Values of ecological status of 3 locations of Tuscany coasts obtained with the use of different biological indicators.

Valori relativi allo stato ecologico delle tre località della costa toscana ottenuti con tramite l'applicazione di diversi indicatori biologici.

Location	EQR *P. oceanica* meadows	EQR Macroalgal assemblages	EQR coralligenous assemblages	EQR	Ecological status
Monte Argentario	-	0.96 (high)	0.92 (high)	0.925	High
Piombino	0.60 (good)	0.71 (good)	-	0.670	Good
Livorno	0.65 (good)	0.69 (good)	0.74 (good)	0.716	Good

Conclusions – The present paper allowed to compare values of ecological quality of coastal water obtained through the use of different biological indicators and to evaluate the effectiveness of the concurrent study of more habitats to determine the ecological status of a determinate water body. This approach is important in relation to the high variability of natural systems and the possibility that differences among assemblages could be due to causes others than anthropogenic disturbance. A synthesis of results obtained through a higher number of indicators may allow to make adequate comparisons. An interesting result of the study was a general correspondence among values of different indicators.

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CHARACTERISATION OF *POSIDONIA OCEANICA* MEADOWS USING BOTH HYPERSPECTRAL AND LIDAR DATA: A NEW APPROACH

CARATTERIZZAZIONE DELLE PRATERIE DI POSIDONIA OCEANICA *ATTRAVERSO L'USO DI DATI IPERSPETTRALI E LIDAR: UN NUOVO APPROCCIO METODOLOGICO*

Abstract *– ISPRA has started an environmental characterization study in two Latium coastal areas using both hyperspectral and LiDAR data. This study regards emerged and submerged portion of the coastal zone. In this paper we describe a new approach aimed at mapping the* Posidonia oceanica *meadows.*

Key-words: Posidonia oceanica*, spectra mixing analysis, LiDAR, data fusion, Tyrrhenian Sea.*

Introduction – Integrated costal zone management is calling to develop and apply data fusion techniques to combine active and passive remote sensing data for mapping shallow-water and coastal environments. The present research is developed in the framework of the Regione Lazio funding program and regards both emerged and submerged portion of the coastal zone. The aim of this paper is to combine hyperspectral MIVIS (Multispectral Infrared and Visible Imaging Spectrometer) resolution data with LiDAR (Ligth Detection and Ranging) detection data in order to characterize the *Posidonia oceanica* meadows present in two studied areas of the Latium coast.

Materials and methods – The northern study area extends from the regional boundary of Tuscany and S. Agostino (VT) and the southern one between Capo Portiere (LT) and San Felice Circeo (LT). Airborne remotely sensed survey, carried out in May 2009, has provided two stretches for a total of 100 Km^2 hyperspectral (MIVIS) and LiDAR (Hakw-eye) data. The MIVIS dataset ground resolution at nadir for an average flight height of 1500 m is of 3 m. The LiDAR dataset acquired in slant range for an average flight height of 500 m is of 2 m. Analysis of the shallow water and coastal environment is done in the context of the spectral mixing space defined by the low order principal components of the spectra (Small, 2004). Basically the works focuses primarily on nonlinear mixing arising from intimate mixtures, then to test the validity of the spectral mixing model we use the low dimensional parameter space defined by the Principal Components in order to select the representative *P. oceanica* endmebers. Our analysis combines the use of the first 20 MIVIS bands (atmospherically normalized), so that radiance were converted into reflectance. A mask of land area was applied to minimized the variability in digital numbers, increasing the contrast in the study area. The contemporary acquisition of LiDAR data highlights bathymetry morphological characterization and intensity data (Red and Near-InfraRed) to detect the presence of *P. oceanica* meadows, rocks and sandy substrata.

Results – MIVIS hyperspectral sensor reached 10 m depht in both of areas and signal accurrancy decrease with depth and turbidity increase. Normalization of sensor irradiance does not influence mixing space shape and endmembers selection. Reflectance information within visible and infrared regions, from 0,433 µm and 0,833 µm, allows the identification of *P. oceanica* meadows upper limits (Fig. 1) and their coverage. The accuracy of the classification results was assessed using a second dataset of ground-truth data. Validation polygons were compared with the final classification, and statistics were summarized in the form of a confusion matrix. Based on the above the backscatter signal of seabottom roughness was finally used in order to fit the optical data results.

Conclusions - The combined use of both MIVIS and LiDAR remote data produced a novel paradigm in order to map *P. oceanica* meadows. Results highlight the need of a more controlled field based spectral profiles acquisition in order to obtain a more detailed characterization of different typologies of *P. oceanica* meadows based on the different effects on reflectance media.

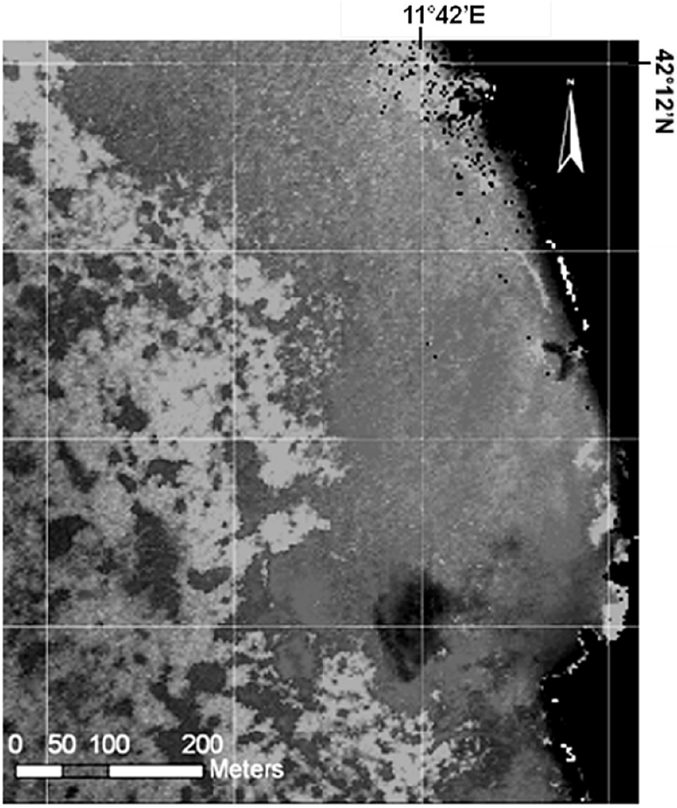

Fig. 1 - An example of *Posidonia oceanica* meadow upper limit visualization through a linear unmixing classification (black=masked land; light grey=*P. oceanica* meadow).

Un esempio di visualizzazione del limite superiore della prateria di Posidonia oceanica *mediante classificazione di linear unmixing (nero=parte emersa; grigio chiaro=prateria di* P. oceanica*).*

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Biol. Mar. Mediterr. (2010), 17 (1): 175-176

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BIODIVERSITY AND MOLLUSC TRANSFER: NEED OF OBSERVANCE OF THE LAWS TO AVOID ALIEN SEAWEEDS INTRODUCTION

MACROALGHE ALLOCTONE E IMPORTAZIONE DI MOLLUSCHI

Abstract *– The seaweeds* Undaria pinnatifida*,* Codium fragile*,* Grateloupia turuturu *and* Ascophyllum nodosum *were accidentally introduced into the Taranto seas probably by means of pacific oysters both as a packing material and as microscopic life stages settled on mollusc valves. Therefore, the need is highlighted of making mussel farmers and fishmongers aware of risks coming from alien species introduction and of severe control measures.*

Key-words: *alien species,* Crassostrea gigas*, introduced species, Ionian Sea, Mediterranean Sea.*

Introduction – Taranto seas are particularly subject to the introduction of alien species (Gravili *et al.*, 2010). Despite the numerous laws issued by the European Commission to regulate the transfer of molluscs (e.g. 2003/804 and 2007/158) and, in particular, of exotic species for aquaculture purposes (2008/535), in Taranto the number of introduced species is more and more increasing due to the lack of both sense of responsibility and controls. In the present paper we deal with four introduced seaweeds and their more probable vector.

Materials and methods – The Mar Piccolo of Taranto is an enclosed where many mussel farms are present. Monthly surveys, also by SCUBA diving, were carried out since 1998 in this basin, along the dock of the old town which houses many fish-shops and mollusc import-export firms, to early detect possible alien seaweeds. Specimens of the suspicious species were brought to the lab for taxonomic identification. Inquiries were performed among mussel farmers and fishmongers to know their possible vector.

Results – First finding of each species follows: in 1998 *Undaria pinnatifida* (Harvey) Suringar (Ochrophyta, Laminariales) (Fig. 1a), in 2001 *Codium fragile* (Suringar) Hariot (Chlorophyta, Bryopsidales) (Fig. 1b) and in 2007 *Grateloupia turuturu* Yamada (Rhodophyta, Halimeniales) (Fig. 1c) specimens were found settled on the dock (Cecere and Petrocelli, 2009). In 2009, floating thallus fragments of *Ascophyllum nodosum* (Linnaeus) Le Jolis (Ochrophyta, Fucales) (Fig. 1d) were observed, by chance, outside the Mar Piccolo basin, near a mussel culture farm (Cecere, personal communication).

Conclusions – *U. pinnatifida*, *C. fragile* and *G. turuturu* are native from Japan and are present along the Atlantic French coasts where they were probably introduced by *Crassostrea gigas* Thunberg specimens to be reared. *A. nodosum* is native from northern Atlantic. Great quantities of oysters are usually imported to Taranto from northern France. Since it was already demonstrated that oyster transfer is one of the main vector for unintentional macroalgal introductions (Hewitt *et al.*, 2007), we hypothesized that *C. fragile* was probably introduced as microscopic life stages settled on oyster valves; *A. nodosum* as a packing material to keep oysters fresh and the other two species in both ways. Oyster valves and packing thalli or even thallus fragments were surely thrown into the sea. These events highlight that mussel farmers and fishmonger are still unaware of the problems of alien/invasive species introduction. Based on our experience, we suggest: 1) to perform necessarily widespread information campaigns in easy parlance to increase awareness and sense of responsibility of each worker and to teach him correct practices to avoid aliens introduction; 2) to make more frequent controls and to apply sanctions for not correct practices if necessary; 3) to monitor risk zones (e.g. import/export firms, unloading zones) frequently for early findings; and last but not least 4) to continue to train taxonomists since they are the only ones who are able to recognize alien species.

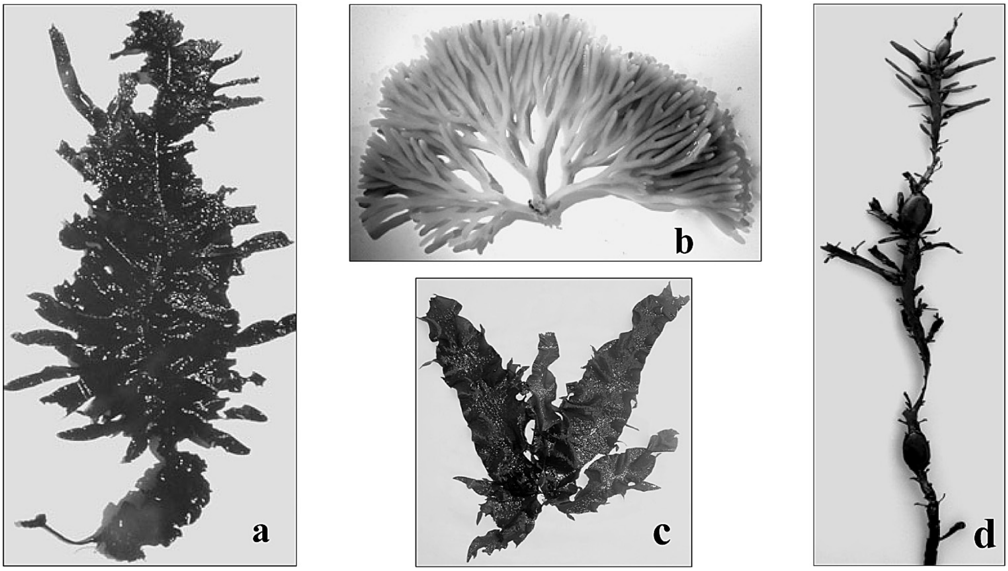

Fig. 1 - *Undaria pinnatifida* (a) (1 cm=13.8 cm), *Codium fragile* (b) (1 cm=4.6 cm), *Grateloupia turuturu* (c) (1 cm=10.6 cm), *Ascophyllum nodosum* (d) (1 cm=6.8 cm).

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BENTHIC ASSEMBLAGES ON ARTIFICIAL PYRAMIDS ALONG THE CENTRAL AND NORTHERN ADRIATIC ITALIAN COASTS

POPOLAMENTI BENTONICI SU PIRAMIDI ARTIFICIALI LUNGO LE COSTE ITALIANE CENTRO E NORD ADRIATICHE

***Abstract** – Benthic assemblages living on Tecnoreef® pyramids off Scardovari (Po river delta, Veneto region) and Pedaso (Marche region) were investigated three years after their deployment. Even though analysed artificial reefs had same material, depth and age, their benthic assemblages were significantly different. Scardovari assemblages were characterised by* Sabellaria spinulosa *and* Epizoanthus *sp. which could take advantage of the high water turbidity, sedimentation rate and nutrient load due to the closeness of the Po river mouth. Besides,* Mytilus galloprovincialis *could provide habitat for* Corophium acherusicum *on Pedaso reefs.*

***Key-words:** artificial habitats, fouling, zoobenthos, Adriatic Sea.*

Introduction - Sessile and motile species colonise artificial reefs according to complex ecological processes affected by seasonal larval supply, water circulation, turbidity and nutrients, depth, orientation and material of the substrata (Ardizzone *et al.*, 1989; Turner and Todd, 1993; Rodriguez *et al.*, 1993; Relini *et al.*, 1994; Nicoletti *et al.*, 2007).

Starting from the ’60 more than 70 artificial reef complexes, built of different materials, were deployed along the Italian coasts. In the present study benthic assemblages colonizing concrete pyramids were investigated in two central and northern Adriatic sites: Scardovari and Pedaso, 120 nm apart.

Materials and methods - At each study site, artificial reefs include few dozen of Tecnoreef® pyramids (2 and 3 floors, 1.8 and 2.4 m height), made by ‘sea-friendly’ certified reinforced concrete, manufactured using only natural components without synthetic additives, deployed at 13-15 m in depth. Pedaso (AP, Marche region, 43°05’N 13°54’E) reefs were deployed in the summer 2005, while those of Scardovari (RO, Veneto Region, 44°54’N 12°33’E) were deployed in autumn 2006. Macrobenthic assemblages were investigated in august, 3 years after the deployment, by scraping off 4 replicate samples of 40x40 cm using hammer and chisel. Species were identified to the lowest possible taxonomic level and their abundance was estimated as number of individuals per square decimetre. Differences between sites were assessed by uni- and multivariate permutational analysis of variance (PERMANOVA, Anderson and ter Braak, 2003).

Results - On overall, 61 taxa were identified, 25 common between the two sites. *Corophium acherusicum* was the most abundant species, followed by *Sabellaria spinulosa*, and *Polydora ciliata*, all of them present at both sites. Assemblages appeared significantly different between sites (PERMANOVA $P<0.05$). Taxa that better explain the observed Bray-Curtis dissimilarity between Scardovari and Pedaso assemblages are reported in Tab. 1. In particular, *Corophium acherusicum*, often associated with the mussels, was significantly more abundant at Pedaso, while *Sabellaria spinulosa* characterised the Scardovari assemblages. Mean species richness didn’t differ between sites while Shannon diversity and Pielou evenness resulted significantly higher at Scardovari.

Tab. 1 - Taxa that better explain the observed Bray-Curtis dissimilarity between Scardovari and Pedaso assemblages (mean abundance, ind. dm^{-2}±s.e., individual and cumulative contribution).

Taxa che maggiormente spiegano la dissimilarità di Bray-Curtis tra i popolamenti di Scardovari e Pedaso (abbondanza media, ind. dm^{-2}±e.s., contributo individuale e cumulativo).

Taxa	Scardovari	Pedaso	Contrib%	Cum.%
Corophium acherusicum	26.17 ± 8.17	167.42 ± 59.97	15.82	15.82
Ericthonius punctatus	0.00 ± 0.00	15.28 ± 6.20	8.11	23.93
Sabellaria spinulosa	22.45 ± 10.00	1.53 ± 0.73	7.79	31.72
Elasmopus rapax	0.00 ± 0.00	10.47 ± 4.97	6.58	38.29
Epizoanthus sp.	5.30 ± 1.71	0.00 ± 0.00	5.24	43.53
Actinaria ind.	3.80 ± 1.30	15.81 ± 5.02	4.69	48.22
Polydora ciliata	3.42 ± 0.83	16.61 ± 7.17	4.67	52.89
Anomia ephippium	2.56 ± 1.12	9.50 ± 5.04	3.60	56.49
Mytilus galloprovincialis	0.09 ± 0.06	3.02 ± 1.52	2.89	59.37
Serpula vermicularis	2.06 ± 0.28	0.13 ± 0.04	2.84	62.21
Stenothoe valida	0.00 ± 0.00	2.09 ± 1.43	2.45	64.66
Pomatoceros triqueter	4.64 ± 0.71	7.84 ± 3.98	2.25	66.91
Modiolarca subpicta	1.22 ± 0.64	0.91 ± 0.35	1.69	68.60

Conclusions - Even though the two artificial reefs had same typology, material, and depth and were sampled at the same age (three years after the deployment), the benthic assemblages found at Scardovari and Pedaso were well differentiated. Species characterizing Scardovari assemblages included *Sabellaria spinulosa* and *Epizoanthus* sp. which could benefit of the higher water turbidity, sedimentation rate and nutrient load due to the closeness of the Po river mouth. Moreover *Sabellaria spinulosa* produces secondary substrate that could increase substratum heterogeneity and therefore species diversity.

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CARATTERIZZAZIONE DEL PESCATO E DELLE BIOCENOSI BENTONICHE IN UNA ZONA COSTIERA TIRRENICA SICILIANA (CAPO PELORO-ISOLE EOLIE-CAPO RAISIGERBI)

CHARACTERISATION OF CATCH AND OF THE BENTHIC BIOCENOSIS IN A SICILIAN COASTAL TYRRHENIAN ZONE (PELORO CAPE-EOLIAN ISLANDS-RAISIGERBI CAPE)

Abstract *– This study makes a further contribution to the knowledge of the composition of yields of bottom trawl at depths between 20-150 m, distributed along the Tyrrhenian coast of Sicily including Aeolian Islands. For each investigated area the biocenosis associated with fish populations have been identified.*

Key-words: *bottom trawl, catch, benthic biocenosis, southern Tyrrhenian Sea.*

Introduzione - La densità e la struttura dei popolamenti ittici e macrobentonici sono aspetti molto importanti per lo studio dell'ecologia delle comunità marine; a tale scopo sono molteplici gli strumenti di campionamento, quali benne, draghe, box corer, carotatori, prelievi subacquei e la pesca. La stima delle specie ittiche in relazione alla superficie campionata, può essere eseguita attraverso l'utilizzo di reti a strascico (*trawl-surveys*), che rappresentano lo strumento maggiormente utilizzato per valutare l'entità e lo stato delle risorse (La Mesa e Vacchi, 2003). Lo scopo dell'indagine è stato quello di definire il grado di biodiversità ittica dell'area e valutare gli insediamenti bentonici associati.

Materiali e metodi – I campionamenti sono stati distribuiti nell'area compresa tra Capo Peloro e Capo Raisigerbi, comprendendo l'arcipelago delle Eolie. L'area è stata suddivisa in 5 zone (A, B, C, D, E) (Fig. 1). Tra settembre 2008 e maggio 2009, sono state eseguite 2 campagne di pesca in mare utilizzando un M/P di 20,7 m LFT, 43,95 TSL con potenza motore di 221 Kw ed una rete a strascico di tipo italiana con maglia del sacco di 20 mm di lato. Sono state effettuate un totale di 65 cale, della durata di 1h ciascuna, su livelli batimetrici compresi tra 20-150 m. Il pescato è stato suddiviso in frazione commerciale, scarto, sporco e rifiuti. L'aliquota dello sporco è stata opportunamente separata per le analisi mirate alla stima quantitativa e qualitativa delle specie componenti i popolamenti bentonici.

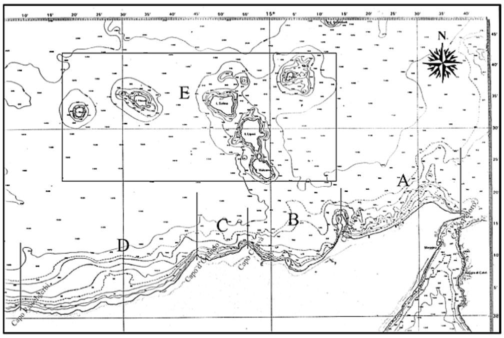

Fig. 1 - Area d'indagine.
Area of investigation.

Risultati – Dalla Tab. 1 si evince come i valori (%) del commerciale per zona siano costituiti da poche specie significative (*Pagellus erythrinus* Linneo, 1758*, Mullus barbatus* L.,1758 ed *Octopus vulgaris* Cuvier, 1797); solo la zona B ha fatto registrare un maggior numero delle specie commercialmente valide. In tale zona le biocenosi più rappresentative sono costituite dai Celenterati: *Alcyonum palmatum* Pallas, 1766*, Pennatula rubra* (Ellis,1764)*, Pteroides spinosum* (Ellis, 1764). I fondali delle Isole Eolie (zona E), hanno rilevato scarsa biodiversità di specie commerciali con una predominanza biocenotica caratterizzata dalla specie *Stylocidaris affinis* (Philippi, 1845*)* tipica delle fondali detritici costieri.

Tab. 1 - Percentuale delle aliquote medie di pescato (Kg) per zona e biocenosi associata.
Percentages of catch for each zone and associated biocoenosis.

Aree di pesca	Aliquote pescato (%)				Frequenze percentuali specie commerciali										Biocenosi associate						
	Rifiuto	Sporco	Scarto	Commerciale	*C. lastoviza*	*L. vulgaris*	*M. merluccius*	*M. barbatus*	*M. surmuletus*	*O. vulgaris*	*P. acarne*	*P. erythrinus*	*P. pagrus*	*S. officinalis*	**DE** (*A. palmatum*)	**DE** (*L. racemus*)	**DC** (*N. cochlear*)	**DE** (*O. texturata*)	**DC** (*S. affinis*)	**DE** (Asteroidei)	**DC** (Pennatulacei)
ZONA A (n.9 cale) C. Peloro - C. Milazzo	25	32	17	26		7		65		18		10					X		X		
ZONA B (N.19 cale) C. Milazzo - C. Calavà	26	16	25	33		9	7	60			15	9			X						X
ZONA C (N.8cale) C. Calavà - C. D'Orlando	26	14	28	32				27		50			23					X		X	
ZONA D (N.13 cale) C. D'Orlando - C. Raisigerbi	24	25	21	30					23	21		47		9				X		X	
ZONA E (N.16 cale) Isole Eolie	2	85	3	10	22					67				11		X	X		X		

Conclusioni – La rete a strascico si è rivelata un metodo di campionamento piuttosto valido per definire e caratterizzare lo *status* dei fondali della zona indagata. I bassi rendimenti di pesca ottenuti evidenziano un notevole grado di sfruttamento cui tali fondali sono soggetti, soprattutto per le specie tradizionalmente importanti per l'area. Solo la zona B, ricadente in un'area a parziale protezione, presenta ancora una discreta stabilità produttiva, come osservato in precedenti lavori (Greco *et al*., 2003; Potoschi *et al*., 2006; Rinelli *et al*., 1998). Deludente è apparsa la situazione delle risorse rinvenute nei fondali delle Eolie, solitamente caratterizzati da notevole ricchezza faunistica.

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DPSIR MODEL AS TOOL FOR AN INTEGRATED COASTAL MANAGEMENT IN THE AEOLIAN ISLANDS

MODELLO DPSIR COME STRUMENTO PER UNA GESTIONE INTEGRATA DELLA FASCIA COSTIERA NELLE ISOLE EOLIE

Abstract *– The application of the DPSIR model (Driving Forces-Pressures-State-Impact-Response) to Aeolian fishery chain and coastal areas permitted to well understanding troubles and strong points of this fishery and provided suggestions to a better coastal zone management. Responses provided by the model application could be useful tools to target the realization of objectives scheduled by the Council Regulation (EC) No 1198/2006 on the European Fisheries Fund.*

Key-words: *Aeolian Islands, Mediterranean Sea, fishery, coastal zone management, DPSIR model.*

Introduction - The Aeolian Islands are an archipelago located in the southern Tyrrhenian Sea, declared a UNESCO Human Heritage site in 2001 thanks to their ecological, biological and landscape relevance and also proposed as a Marine Protected Area (Italian Law 979/82, Art. 31). Fishery is the most important economic activity, after tourism. In the past, a large part of revenues for fishing boats were coming from offshore driftnet fishery. Nevertheless, the ban of "spadara" driftnet targeting swordfish (EC Regulation 1239/98, executive in the 2002) led to a greater polyvalence and seasonality of fishing activities, exacerbating competition among fishermen in coastal areas and contrast between fishermen and government Institutions (Battaglia *et al.*, 2010). Moreover, the increment of volcanic activity after a critical event in 2002, determined an increase of hydrothermal emissions, representing a potential source of natural pollution for the whole marine ecosystem. The application of the DPSIR model (Driving Forces-Pressures-State-Impact-Response) to the Aeolian costal areas targets the final objective to provide management suggestions, particularly in response of troubles of fishery chain and of the potential contamination of fish resources.

Materials and methods – Within the DPSIR model several indicators related to the area were examined. Human population density, the number of fishermen, the tourist flux, socioeconomic data of fishery activities were considered as "driving forces". "Pressure" indicators were the characteristic of fleet, CPUEs for main gears and species, aquaculture and other productive activities in the area. The water quality (concentration of chlorophyll a) represented a "status" indicator, while the potential harmful trace elements (PHE) (mercury Hg, cadmium Cd, lead Pb, arsenic As) were assigned to the "impact" indicator category and were analyzed in the muscle of two benthic fish species: *Helicolenus dactylopterus* and *Serranus cabrilla*.

Results – Overall 13,000 inhabitants were censed in the Aeolian Islands in 2007 (human density=112.84 inhabitants/km^2), 240 of which were fishermen. A percentage of 92% of them was associated in 11 fishing cooperatives. Fleet census recorded 157 polyvalent boats. In spite of the presence of 5 wholesalers, there are no fish markets. The tourist flux (88.78 visitors/inhabitants per year) provided good incomes for Aeolian people specially in summer season, but the fishing tourism was still poorly considered (only 3 fishing boats carried out this integrative activity). All fishing activities had high costs and low yearly net incomes (mean: 4,670 € for trammel net, 7,653 € for squid hand-jig line, 6,979 € albacore drifting longline), related to the low ex-vessel prices of the main large pelagic fishes. The most abundant commercial species were *Thunnus alalunga* (CPUE=2,898.2 kg/1000 hook*day) and *Todarodes sagittatus* (1,509.9 kg/day). The level of trace elements in fish species recorded high values for mercury (mean: 2.669 mg/g d.w. for *H. dactylopterus*; 1.167 mg/g d.w. for *S. cabrilla*).

Conclusions – The application of DPSIR model allowed to specify some management actions that could improve the actual status of Aeolian fishery sector and coastal areas: the institution of a MPA or no take zones in nursery areas, the reduction of fishing effort in coastal areas, the shift of fishing effort towards offshore areas targeting pelagic resources with an underexploited stock (es: *T. alalunga, Coryphaena hippurus, Ommastrephes bartramii*), the valorization of the Aeolian historical and cultural fishing heritage, a better valorization of fishing products by the quality certification and by fish preserving (i.e.: smoking, canning, salting), a periodic monitoring of trace element in fishing products, the building of a fish market, the shortening of the fishery chain by deleting superfluous intermediate steps, the improvement of tourism-fishery interaction by a direct involvement of fishermen in fishing-tourism activities or whale-watching. These management suggestions could be useful tools to target the realization of objectives scheduled by the Council Regulation (EC) No 1198/2006 on the European Fisheries Fund.

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ANNUAL TREND OF THE DINOFLAGELLATE *OSTREOPSIS OVATA* IN TWO SITES ALONG THE SOUTHERN ADRIATIC COAST

ANDAMENTO ANNUALE DEL DINOFLAGELLATO OSTREOPSIS OVATA *IN DUE SITI LUNGO LA COSTA ADRIATICA MERIDIONALE*

Abstract – *The annual trend of the benthic and potentially toxic dinoflagellate* Ostreopsis ovata *was studied in two sites along the Apulian Adriatic coast. The monthly monitoring highlighted a well defined annual trend of the* O. ovata *population and the potential relationships among the dinoflagellate occurrence and the seasonal variation of some physical-chemical parameters in the sea waters.*

Key-words: *benthic microalgae,* Ostreopsis ovata*, HABs, marine coastal area, Adriatic Sea.*

Introduction – The benthic dinoflagellate *Ostreopsis ovata* Fukujo is mainly distributed in tropical and sub-tropical geographical areas where it is considered as potentially toxic (Yasumoto *et al.,* 1987). Blooms of the species, as well as palytoxin-like compounds in the *O. ovata* cells, have been recorded in the last years in different Italian locations (Congestri *et al*., 2006) (Ciminiello *et al*., 2008). *O. ovata* has been reported since the year 2000 along the Apulian coasts (Ungaro *et al.,* 2008), where it was supposed the main cause of syndromes affecting people on the sea-shore during summer (Gallitelli *et al*., 2005).

Materials and methods – Two coastal sites characterised by rocky bottoms and located at north and south of the town of Bari (Fig. 1) were monitored each month from October 2007 to September 2008 to follow the annual trend of the *O. ovata* population.

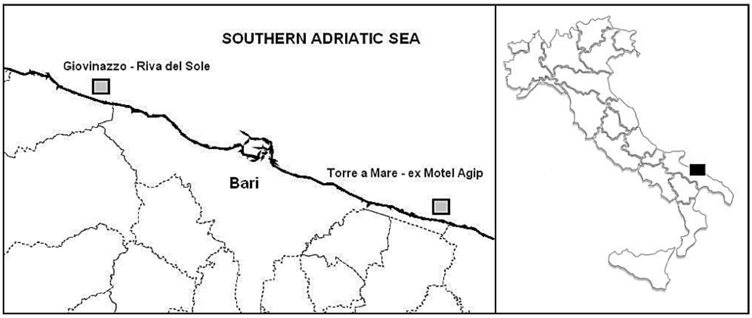

Fig. 1 - Location of the sampling stations (grey squares) for the annual monitoring of *Ostreopsis ovata*.
Localizzazione delle stazioni (quadrati grigi) per il monitoraggio annuale di Ostreopsis ovata.

In the two sites some chemical-physical parameters as water surface temperature, conductivity, pH, macronutrients and *a*-chlorophyll were also measured. Water samples were collected close to the coast (0.5-1 m bathymetry), sampling by means of a bottle in the sub-surface layer (-0.4/-0.8 m depths). Moreover, a bottom water sample was collected close to the seabed using a 50 ml syringe (three replicates) for the quantification of *O. ovata*. The results from the analysis were elaborated in order to investigate about the potential relationships among *O. ovata* and abiotic parameters.

Results – Both the investigated sites highlighted a seasonal trend according to the *O. ovata* occurrence. The species was found during October 2007 and from June to September 2008 in the sampling station named "Giovinazzo-Riva del Sole", the abundance ranging from 6.400 to 1.945.600 cell/l in the in the bottom water samples. In the station named "Torre a Mare-ex Motel Agip", *O. ovata* was recorded during October-November 2007 and from July to September 2008, the abundance ranging from 320 to 2.496.000 cell/l. The peaks of abundance were recorded in the August-September period in both the sites, when values ranged between 2.000.000 and 2.500.000 cell/l. Very low abundance values were recorded in the months of October and November, while no findings were reported in the period December 2007-May 2008. The species abundance and the chemical-physical parameters measured data were analyzed using univariate statistical approach (correlation matrix, Spearman coefficient). Results from the statistical analysis highlighted a significant (a=0.05) positive correlation among *O. ovata* abundance and water temperature (0.66) (Fig. 2), conductivity (0.52), pH (0.45), *a*-chlorophyll (0.45), N-NO_3/N-NO_2 ratio (0.41), N-NO_3/ N-NH_4 ratio (0.41), while negative correlation with N-NO_2 (-0.51). No significant correlation was found among *O. ovata* abundance and N-NH_4, N-NO_3, N-tot., P-PO_4, P-tot., SiO_2.

Conclusions – The preliminary results highlighted a well defined annual trend of the *O. ovata* population in both the sites, with peaks of abundance in the summer-autumn months and the depletion in the winter-spring period. Potential relationships among the dinoflagellate occurrence and the water quality parameters came from the correlation study. The seasonal variation of some chemical-physical parameters (i.e. increase of water temperature) can be assumed as the main driver for the presence and abundance of *O. ovata*, although it needs to be better investigated by an appropriate and more extensive monitoring programme.

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CHONDRICHTHYES CAUGHT DURING THE MEDITS SURVEYS IN ITALIAN WATERS

I CONDROITTI PESCATI DURANTE LE CAMPAGNE MEDITS NELLE ACQUE ITALIANE

Key-words: *fish, trawl survey, biomass, Mediterranean Sea.*

Abstract *– Data on chondrichthyes fished during 16 surveys as part of the MEDITS project carried out from 1994 to 2009 on trawlable bottoms up to 800m depth in all seas around Italy are presented and discussed. From a total of 7 GSAs (10255 hauls) 38 elasmobranch species, including 21 rays and skates, 16 sharks and 1 chimaera, have been identified. Only 10 species occurred in all GSAs, 31 in the Strait of Sicily and 19 in the South Adriatic Sea. The number of species caught per year ranged from 23 to 31.*

Introduction - Although the contribution of elasmobranchs to the market is low (in Italy during 2008, 1375t were landed, according to IREPA data) the by-catch discarded at sea is high and so the management of these fish needs particular attention above all in order to maintain biodiversity and the functions and services of the ecosystem. The interaction between species and the removal of top predators are crucial for the structure and function of the ecosystems. At present some species are threatened, often as a result of human activities. The main reasons for this is that these fish have a k-strategy life span: they grow slowly, mature at a relatively late age, have few young, low natural mortality rates and a very slow population increase (Hamlett 1999, 2005), they are generally top predators and some are rare. They are an important indicator of resource exploitation and the evolution of the community in an area, particularly where there are important multispecies fisheries. The non-sustainable exploitation of elasmobranchs implies an urgent need for a more systematic approach to the assessment and conservation of elasmobranchs.

Action Plans for the conservation of Cartilaginous Fish in the Mediterranean have been proposed at national and international level (in particular, UNEP MAP RAC/SPA 2003; FAO 1998). But there is an urgent need for our knowledge to be updated and no specific research on elasmobranchs has been financed or carried out for more than a year. Most of the data come from trawl surveys for demersal stock assessment (Relini, 2000 and Relini *et al.*, 2000) or, in the case of pelagic fish, from longline fisheries. Some data were collected during the ELASMOIT project (Relini *et al.*, 2010) supported by the Ministry for the Environment, Land and Sea Protection. There are 72 species present in Italian seas (plus 7 doubtful species) of which one is a chimaera, 41 are sharks and 30 are rays and skates (Vacchi and Serena, 2010). Some species are large, high-speed swimmers, which makes them very difficult to catch by bottom trawling.

At present there is no target fishery for elasmobranchs in Italy. All the landed catch is a by-catch of other fisheries. As mentioned above, the landed commercial catch in 2008 was 1375t, 63% of which was fished by otter trawlers and 54% were sharks.

Materials and methods - Data were collected during the Medits surveys carried out each year from 1994 to 2009 in the 7 GSAs (Geographical SubAreas established by GFCM-FAO in 2001) of Italian seas (Fig. 1) between May and July on all trawlable bottoms between 10m (Posidonia meadows excluded) and 800m depth. The sampling design was random stratified, five strata were established (see Tab. 1) and the number of hauls was proportional to the surface of strata and the position of hauls was the same in all years. The duration of the hauls was one hour at depths more than 200 m and half an hour at depths less than 200 m. The gear had a vertical opening of 2-2.5 m and small cod end (20 mm stretched mesh).

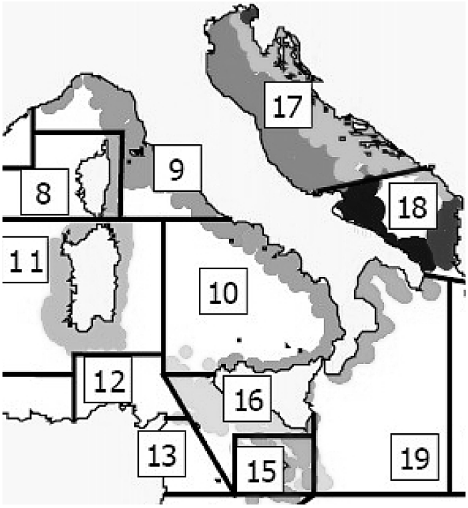

Fig. 1 - The seven Italian GSAs (9, 10, 11, 16, 17, 18, 19).
Le sette GSA italiane (9, 10, 11, 16, 17, 18, 19).

Tab. 1 - The total number of hauls per stratum and GSA.
Numero totale di cale per strato e GSA.

Depth strata (m)	GSA9	GSA10	GSA11	GSA16	GSA17	GSA18	GSA19	Total
0-50	283	118	294	106	671	206	144	1822
51-100	304	145	345	208	494	234	128	1858
101-200	554	248	413	165	359	385	160	2284
201-500	606	324	343	281	110	163	233	2060
501-800	437	403	353	345	11	195	487	2231
0-200 (Shelf)	1141	511	1052	479	1524	825	432	5964
200-800 (Slope)	1043	727	696	626	121	358	720	4291
0-800 (Total)	2184	1238	1748	1105	1645	1183	1152	10255

For information on gear, protocol of methods and processing of data, see Relini *et al.*, 2008 and the website (www.sibm.it/SITO%20MEDITS/principalemedits.htm).

The number of hauls per GSA is given in Tab. 1 and a total of 10255 were performed during 16 surveys. Estimates of abundance indices (density n/km^2, biomass kg/km^2) were based on stratified random sampling and swept area method and were computed for two macrostrata: shelf (10-200 m depth) and slope (200-800 m depth).

For species caught in at least 12 out of 16 campaigns carried out (≥75%) a non-parametric Spearman's rho value was estimated so as to test time trends.

The main references for identification and updated nomenclature are Fisher *et al.* (1987), Serena (2005), Serena *et al.* (2010) and Vacchi & Serena (2010).

The references give record of all the papers published by GSAs on elasmobranchs fished during Medits surveys.

Results - During the course of 16 years, 38 species (Tab. 2) including 21 rays and skates, 16 sharks and 1 rabit fish were collected and identified. Only 9 species (including 5 sharks) occurred in all GSAs, and another 10 were present in 6 GSAs.

Tab. 2 - List of species fished during Medits surveys (1994-2009) in each GSA.
Lista delle specie catturate durante le campagne Medits (1994-2009) in ciascuna GSA.

	GSAs								
Species	9	10	11	16	17	18	19	**Total**	**% GSA**
Chimaera monstrosa Linnaeus, 1758	*	*	*	*	*	*	*	**7**	**100.0**
Galeus melastomus Rafinesque, 1810	*	*	*	*	*	*	*	**7**	**100.0**
Scyliorhinus canicula (Linnaeus, 1758)	*	*	*	*	*	*	*	**7**	**100.0**
Scyliorhinus stellaris (Linnaeus, 1758)	*	*	*	*	*	*	*	**7**	**100.0**
Galeorhinus galeus (Linnaeus, 1758)		*						**1**	**14.3**
Mustelus asterias Cloquet, 1821				*	*			**2**	**28.6**
Mustelus mustelus (Linnaeus, 1758)	*	*	*	*	*		*	**6**	**85.7**
Mustelus punctulatus Risso, 1826				*	*			**2**	**28.6**
Heptranchias perlo (Bonnaterre, 1788)	*		*	*			*	**4**	**57.1**
Hexanchus griseus (Bonnaterre, 1788)	*	*	*	*				**4**	**57.1**
Centrophorus granulosus (Bloch and Schneider, 1801)	*	*	*	*		*		**5**	**71.4**
Centrophorus uyato (Rafinesque, 1810)		*		*			*	**3**	**42.9**
Dalatias licha (Bonnaterre, 1788)	*	*	*	*	*	*	*	**7**	**100.0**
Etmopterus spinax (Linnaeus, 1758)	*	*	*	*	*	*	*	**7**	**100.0**
Oxynotus centrina (Linnaeus, 1758)	*	*	*	*	*		*	**6**	**85.7**
Squalus acanthias Linnaeus, 1758	*	*	*	*	*	*		**6**	**85.7**
Squalus blainvillei (Risso 1826)	*	*	*	*		*	*	**6**	**85.7**
Dasyatis centroura (Mitchill, 1815)							*	**1**	**14.3**
Dasyatis pastinaca (Linnaeus, 1758)	*	*	*	*	*		*	**6**	**85.7**
Pteroplatytrygon violacea (Bonaparte, 1832)		*						**1**	**14.3**
Gymnura altavela (Linnaeus, 1758)							*	**1**	**14.3**
Myliobatis aquila (Linnaeus, 1758)	*	*	*	*	*	*		**6**	**85.7**
Pteromylaeus bovinus (Geoffroy St-Hilarie, 1817)					*		*	**2**	**28.6**
Dipturus batis (Linnaeus, 1758)	*							**1**	**14.3**
Dipturus oxyrinchus (Linnaeus, 1758)	*	*	*	*			*	**5**	**71.4**
Leucoraja circularis (Couch, 1838)	*		*	*	*	*	*	**6**	**85.7**
Leucoraja fullonica (Linnaeus, 1758)	*			*		*	*	**4**	**57.1**
Leucoraja melitensis (Clark, 1926)				*				**1**	**14.3**
Raja asterias Delaroche, 1809	*	*	*	*	*	*	*	**7**	**100.0**
Raja brachyura Lafont, 1873			*	*				**2**	**28.6**
Raja clavata Linnaeus, 1758	*	*	*	*	*	*		**6**	**85.7**
Raja miraletus Linnaeus, 1758	*	*	*	*	*	*	*	**7**	**100.0**
Raja montagui Fowler, 1910	*	*		*	*	*	*	**6**	**85.7**
Raja polystigma Regan, 1923	*	*	*		*	*		**5**	**71.4**
Rostroraja alba Lacépède, 1803				*				**1**	**14.3**
Torpedo marmorata Risso, 1810	*	*	*	*	*	*	*	**7**	**100.0**
Torpedo nobiliana Bonaparte, 1835	*	*	*	*	*	*	*	**7**	**100.0**
Torpedo torpedo (Linnaeus, 1758)	*	*	*	*	*		*	**6**	**85.7**
Total species caugth (38)	**27**	**26**	**25**	**31**	**23**	**19**	**24**		

The highest number of species was found in the Strait of Sicily (GSA16: 31 species), the lowest (19 species) in the South Adriatic Sea (GSA18). Eight species including 1 shark were found only in one GSA and three of them during one year only: they are *Galeorhinus galeus* (GSA10, 1995 and 2001), *Dasyatis centroura* (GSA19, 2002) *Pteroplatytrygon violacea* (GSA10, 2000 and 2002), *Gymnura altavela* (GSA19, 2006) *Pteromylaeus bovinus* (GSA17, ten years), *Dipturus batis* (GSA9, 1996) *Leucoraja melitensis* (GSA16, all years excluding 1994 and 2003) and *Rostroraja alba* (GSA16, 1995, 2000, 2003, 2005, 2007, 2008 and 2009).

The number of species caught per year (Tab. 3) was 23 in 1994, 30 in 1995 and fell to 23 in 1997, then increased with some fluctuation to 31 in 2008 and 2009.

Tab. 3 - List of species caught per year in all GSAs.
Lista delle specie catturate ogni anno in tutte le GSA.

	Years																	
Species	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	**Total**	**% su GSA**
Chimaera monstrosa Linnaeus, 1758	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	**16**	**100.0**
Galeus melastomus Rafinesque, 1810	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	**16**	**100.0**
Scyliorhinus canicula (Linnaeus, 1758)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	**16**	**100.0**
Scyliorhinus stellaris (Linnaeus, 1758)		*		*	*		*	*	*			*		*		*	**9**	**56.3**
Galeorhinus galeus (Linnaeus, 1758)		*						*									**2**	**12.5**
Mustelus asterias Cloquet, 1821									*			*	*		*	*	**5**	**31.3**
Mustelus mustelus (Linnaeus, 1758)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	**16**	**100.0**
Mustelus punctulatus Risso, 1826								*		*	*				*	*	**5**	**31.3**
Heptranchias perlo (Bonnaterre, 1788)		*				*			*	*	*	*	*	*	*	*	**10**	**62.5**
Hexanchus griseus (Bonnaterre, 1788)	*	*	*		*	*	*	*	*		*		*	*	*	*	**13**	**81.3**
Centrophorus granulosus (Bloch and Schneider, 1801)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	**16**	**100.0**
Centrophorus uyato (Rafinesque, 1810)		*					*						*				**3**	**18.8**
Dalatias licha (Bonnaterre, 1788)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	**16**	**100.0**
Etmopterus spinax (Linnaeus, 1758)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	**16**	**100.0**
Oxynotus centrina (Linnaeus, 1758)	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	**15**	**93.8**
Squalus acanthias Linnaeus, 1758	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	**16**	**100.0**
Squalus blainvillei (Risso 1826)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	**16**	**100.0**
Dasyatis centroura (Mitchill, 1815)									*								**1**	**6.3**
Dasyatis pastinaca (Linnaeus, 1758)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	**16**	**100.0**
Pteroplatytrygon violacea (Bonaparte, 1832)							*		*								**2**	**12.5**
Gymnura altavela (Linnaeus, 1758)													*				**1**	**6.3**
Myliobatis aquila (Linnaeus, 1758)	*	*	*		*	*	*	*	*	*		*		*	*	*	**13**	**81.3**
Pteromylaeus bovinus (Geoffroy St-Hilarie, 1817)		*	*	*		*			*		*	*	*		*	*	**10**	**62.5**
Dipturus batis (Linnaeus, 1758)			*														**1**	**6.3**
Dipturus oxyrinchus (Linnaeus, 1758)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	**16**	**100.0**
Leucoraja circularis (Couch, 1838)			*	*			*	*		*	*	*	*	*	*	*	**11**	**68.8**
Leucoraja fullonica (Linnaeus, 1758)					*	*									*		**3**	**18.8**
Leucoraja melitensis (Clark, 1926)		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	**15**	**93.8**
Raja asterias Delaroche, 1809	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	**16**	**100.0**
Raja brachyura Lafont, 1873	*	*	*		*		*	*	*	*	*	*	*	*	*	*	**14**	**87.5**
Raja clavata Linnaeus, 1758	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	**16**	**100.0**
Raja miraletus Linnaeus, 1758	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	**16**	**100.0**
Raja montagui Fowler, 1910	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	**16**	**100.0**
Raja polystigma Regan, 1923	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	**16**	**100.0**
Rostroraja alba Lacépède, 1803		*					*			*		*		*	*	*	**7**	**43.8**
Torpedo marmorata Risso, 1810	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	**16**	**100.0**
Torpedo nobiliana Bonaparte, 1835	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	**16**	**100.0**
Torpedo torpedo (Linnaeus, 1758)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	**16**	**100.0**
Totale species caught	**23**	**30**	**27**	**23**	**26**	**26**	**29**	**28**	**30**	**27**	**27**	**29**	**29**	**28**	**31**	**31**		
Percentage of total species (38)	**57.5**	**75.0**	**67.5**	**57.5**	**65.0**	**65.0**	**72.5**	**70.0**	**75.0**	**67.5**	**67.5**	**72.5**	**72.5**	**70.0**	**77.5**	**77.5**		

With regard to vertical distribution, the presence of species in different strata is reported (Tab. 4). In the last column on the right there are literature data on the vertical distribution of the species. In grey are the Medits data that conflict with the literature data and hence change the known vertical distribution of some species. There is interesting information about *S. stellaris*, *T. marmorata* and *T. torpedo*: whereas previously their vertical distribution was known up to 100 m depth, during the Medits surveys they were collected at more than 500 m depth. Sixteen species were found in all five strata, five in one stratum alone. The highest number of species occurred at the fourth and fifth strata, while the lowest was found at the second stratum, with a difference of five species. Five species were found only on the slope and six only on the shelf.

Tab. 4 - Species occurrence in different strata and literature data regarding depth range.
Presenza delle specie nei diversi strati e dati della letteratura sulla distribuzione batimetrica.

Species	0-50m	51-100m	101-200m	201-500m	501-800m	Literature depth range (m)
Centrophorus granulosus	*			*	*	150-1400
Centrophorus uyato		*			*	50-1400
Chimaera monstrosa			*	*	*	200-700 (1000)
Dalatias licha				*	*	90-1000
Dasyatis centroura	*					up to 200
Dasyatis pastinaca	*	*	*	▨ *	▨ *	up to 200
Dipturus batis					*	up to 600
Dipturus oxyrinchus	*	*	*	*	*	90-900
Etmopterus spinax	*		*	*	*	100-1000
Galeorhinus galeus				*	▨ *	20-470
Galeus melastomus		*	*	*	*	200-1200
Gymnura altavela				▨ *		up to 60
Heptranchias perlo			*	*	*	50-400 (1000)
Hexanchus griseus				*	*	100-1000
Leucoraja circularis			*	*	▨ *	70-275
Leucoraja fullonica				*	*	30-550
Leucoraja melitensis	*	*	*	*	*	60-600
Myliobatis aquila	*	*	*			semipelagic up to 200
Mustelus asterias	*		*			up to 100
Mustelus mustelus	*	*	*	*	▨ *	up to 450
Mustelus punctulatus	*		*			up to 200
Oxynotus centrina		*	*	*	*	60-660
Pteromylaeus bovinus	*					semipelagic 100
Pteroplatytrygon violacea	*	*				pelagic 100 (240)
Raja asterias	*	*	*	▨ *	▨ *	up to 200
Raja brachyura	*	*	▨ *	▨ *		up to 100
Raja clavata	*	*	*	*	*	20-700
Raja miraletus	*	*	*	▨ *	▨ *	50-150
Raja montagui	*	*	*	*	*	up to 650
Raja polystigma	*	*	*	*	▨ *	100-400
Rostroraja alba		*		*	▨ *	40-500
Squalus acanthias	*	*	*	*	*	10-700
Squalus blainvillei	*	*	*	*	*	15-720
Scyliorhinus canicula	*	*	*	*	*	up to 550
Scyliorhinus stellaris	*	*	▨ *	▨ *	▨ *	20-100
Torpedo marmorata	*	*	▨ *	▨ *	▨ *	10-100
Torpedo nobiliana.	*	*	*	▨ *	▨ *	10-150
Torpedo torpedo	*	*	▨ *	▨ *	▨ *	70 (+)
N° species per stratum	**25**	**23**	**26**	**30**	**30**	
Percentage of total species (38)	**66**	**61**	**68**	**79**	**79**	

Grey areas represent new data that conflict with the literature
Le aree in grigio si riferiscono a dati nuovi discordanti con quelli della letteratura

Data on numbers of individuals and biomass per GSA and year in the shelf (10-200 m) and in the slope (200-800 m) are given in Tabs. 5, 6, 7, 8, in which (when applicable) the Spearman rho values show the trend in each GSA.

The most abundant species on the shelf (Tab. 5) are *S. canicula*, *R. asterias*, *R. brachyura* and *R. miraletus.*

A clear negative trend occurs for *S. acanthias* in GSA 17, while positive trends are evident for *R. brachyura* (GSA11), *M. mustelus* (GSA16), *R. clavata* (GSA9 and GSA16), *R. miraletus* (GSA11) and *S. blainvillei* (GSA16). In 87 out of 110 series the data are insufficient to calculate the coefficient, in 24 there is no trend, 6 are positive and 1 negative as mentioned above.

Tab. 5 - Density index (n/km²) for shelf stratum (10-200 m depth) per GSA. Medits 1994-2009. Significant Spearman rho values are in bold.

Indici di densità (n/km²) per la piattaforma (10-200 m) e per GSA. Medits 1994-2009. In grassetto i valori del rho di Spearman significativi.

C. granulosus	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9																0.076	n.c.
GSA11							0.220										n.c.
C. uyato	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA16	4.314																n.c.
C. monstrosa	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA18											0.454						n.c.
D. centroura	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA19									0.873								n.c.
D. pastinaca	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9											0.303				0.378		n.c.
GSA10				0.689													n.c.
GSA11		37.654	4.546	12.660	21.420		6.344	8.909				33.237		70.876	15.238	34.319	n.c.
GSA16									2.316	0.814	0.785	1.361	0.430	0.400	1.607	0.399	n.c.
GSA17									0.415	0.222				0.320			n.c.
GSA19					1.622		7.440	0.880			6.006	10.985	0.858	0.851	10.485	2.623	n.c.
D. oxyrhincus	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	0.241			0.234	0.243			1.032		0.330		0.324		0.326	0.319	0.941	n.c.
GSA11	6.234	3.319	1.076	1.791	0.638	4.339	2.143	8.810		8.373	2.387	2.325	2.801	1.684	2.031	6.898	0.079
GSA16									0.772								n.c.
E.spinax	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA11		3.626					64.690					37.780					n.c.
GSA18														5.274			n.c.
G. melastomus	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9			1.438					0.258									n.c.
GSA11						0.189		0.404		0.242	6.600	5.870		0.237	9.641		n.c.
GSA16													0.430				n.c.
GSA18							0.485				3.635						n.c.
H. perlo	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9														0.326			n.c.
GSA16														1.201			n.c.
L. circularis	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA16														0.400			n.c.
GSA18												0.460					n.c.
L. melitensis	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA16		2.635								4.070	0.785		1.719	0.400	2.009	3.591	n.c.
M. aquila	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	0.270								1.197					0.410		0.376	n.c.
GSA10		0.698	0.717		2.824	4.245	2.773	4.347		0.778				1.405			n.c.
GSA11	0.277	0.263			1.008		0.529		0.255			0.478			0.996		n.c.
GSA16										4.070					0.402	1.197	n.c.
GSA17				1.451	0.563	6.407	2.154	3.266	16.878	2.188	1.034	1.408	7.584	0.961	7.125	3.330	0.231
GSA18															0.569		n.c.
M. asterias	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA16												0.454	3.009		2.411	0.399	n.c.
GSA17									0.866								n.c.
M. mustelus	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9					0.262	0.263		0.601									n.c.
GSA10													0.402				n.c.
GSA11					0.252												n.c.
GSA16	1.438	1.318	12.175	5.337	2.547	26.854	11.259	3.896	31.657	8.953	29.056	15.884	8.597	8.008	18.887	32.320	**0.582**
GSA17			7.363	8.526		2.218	0.269	3.859	15.364	1.591	0.207	20.513	7.788	0.801	6.563	1.726	-0.143
GSA18	0.512	2.091				0.371		0.356									n.c.
GSA19	1.595	7.590	2.309	6.776	8.111		0.930	0.880	18.566	1.504	0.858	0.738	6.864	27.246	0.855	25.270	-0.004
M. punctulatus	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA16											1.571				2.411	0.798	n.c.
GSA17								1.187		2.785	0.414					0.555	n.c.
O. centrina	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	0.241	0.469	0.266											0.326			n.c.
GSA11						0.189	0.380		132.238								n.c.
GSA16		1.318											0.430				n.c.
P. bovinus	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA17				0.284													n.c.
GSA19		2.577	0.778	0.847		0.835			0.873		0.858	1.690	2.574		0.855	0.874	n.c.
P. violacea	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA10							0.699		0.704								n.c.
R. asterias	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	1.526	1.680	5.576	2.112	2.367	8.922	2.505	1.080	4.473	8.076	3.227	1.799	0.413	2.016	1.491	0.376	-0.344
GSA10	1.744	1.871	1.386	0.666	1.263	0.545	2.627	0.725			0.661	2.128			0.756		n.c.
GSA11	14.980	4.654	6.566	1.756	7.985	6.235	5.858	4.657	5.908		1.923	43.059	31.076	18.643	5.509	10.253	0.289
GSA16	10.066	11.858	1.353	2.668	1.273	8.951	2.502	7.792	3.088	2.442	5.497	5.446	4.299	39.237	2.411	9.576	0.059
GSA17	0.289	0.752		0.284	0.992	0.810	0.486		4.253	0.580	0.857	2.166	0.922	0.320	0.844	0.370	0.200
GSA18	0.321	0.548			0.934	0.371			0.538	0.536	0.463	0.465	1.726			0.682	n.c.
GSA19		1.715	1.555			0.835	0.930		1.746		0.858	0.738	7.517	3.406	3.393		n.c.
R. brachyura	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA11	0.456	1.580	0.432		1.260		0.264	15.076	2.348	15.269	102.858	57.466	35.001	42.956	9.756	44.166	**0.754**
GSA16													0.430	0.801	4.822		n.c.
R. clavata	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	0.963	2.629	2.877	4.520	2.432	4.091	2.050	5.936	8.885	4.616	4.241	4.861	5.499	8.137	16.758	6.943	**0.794**
GSA10	0.558					0.545	0.553						0.466			2.106	n.c.
GSA11	32.738	48.799	30.557	34.605	29.012	33.791	18.708	53.234	14.450	43.082	47.787		54.361	39.858	23.598	38.173	0.161

(Segue/*Follows*)

GSA16	8.628	9.223	6.764	16.010	19.099	7.672	20.016	2.597	19.303	24.418	32.983	31.314	61.901	30.429	47.419	37.507	**0.829**
GSA17		0.236		0.284	0.300	0.880	1.347			0.995	0.207	0.894	1.435	0.481	0.913	0.956	0.483
GSA18	0.321		0.451													2.589	n.c.
R. miraletus	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	5.761	7.423	8.028	10.113	10.644	27.746	14.351	6.046	7.540	11.137	5.151	5.623	10.205	8.051	5.541	5.375	-0.318
GSA10	1.744		2.868	3.443		1.415		0.725		1.555		2.165	0.121		0.602	0.646	n.c.
GSA11	13.546	17.900	11.326	22.576	27.663	15.003	12.790	66.283	3.209	34.817		69.189	38.814	56.100	27.652	40.040	**0.589**
GSA16	66.151	169.965	198.865	381.561	145.152	79.282	290.236	97.399	121.222	90.348	168.055	131.155	165.499	144.537	151.099	246.990	0.047
GSA17			2.383	3.484	2.397	3.590	0.595	1.818	3.575	2.398	0.857	3.268	1.677	2.173	1.256	2.612	-0.244
GSA19				0.742		0.717	6.510	1.539	4.288	3.464	4.290	13.413	4.353		2.564	1.749	n.c.
R. montagui	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	0.722	0.469	0.240	1.441	0.973	2.277	1.794		2.962	0.659	0.909						n.c.
GSA10													0.214				n.c.
GSA16			8.117	20.012	3.820	1.279	3.753	10.389	4.633	3.256	7.068	5.900	2.579	5.205	6.028	5.586	-0.121
GSA17										0.182		0.178					n.c.
R. polystigma	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9												0.972	2.200	4.235	9.264	6.900	n.c.
GSA10								0.668									n.c.
GSA11	15.765	23.788	37.945	31.659	45.179	45.496	33.956	119.790	7.809	44.396	44.720	34.387	60.035	81.235	21.261	19.091	0.141
GSA17						0.246											n.c.
R. alba	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**n.c.**
GSA16							2.502								0.402	0.798	n.c.
S. acanthias	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9				0.234													n.c.
GSA10													0.690				n.c.
GSA11								1.678					0.560				n.c.
GSA17	12.753	50.877	7.403	7.247	387.306	18.549	21.161	20.308	11.331	15.049	14.930	5.457	9.273	7.587	9.106	7.747	-0.368
GSA18	0.321		0.451			0.411											n.c.
S. blainvillei	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9					3.892												n.c.
GSA11	2.724	2.849	1.937	3.382	20.275	99.050	0.577	0.210	10.538	3.115	6.336	0.470	1.680	0.242	2.030	0.276	-0.421
GSA16		6.588	2.706	1.334			1.251		29.340	1.628	21.203	36.306	92.852	58.856	93.633	78.606	**0.811**
GSA18																0.518	n.c.
S. canicula	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	26.261	15.986	16.807	15.211	16.804	14.514	29.473	14.968	4.273	26.708	13.026	8.864	25.609	44.933	39.475	28.940	0.279
GSA10	0.558	1.123							1.273				0.263			0.646	n.c.
GSA11	142.691	148.370	173.564	197.214	212.531	359.392	201.579	557.129	205.049	335.793	148.576	127.126	163.596	329.751	184.288	275.355	0.200
GSA16	33.075	72.466	82.522	129.411	34.378	46.035	35.028	23.376	42.466	18.721	74.604	60.359	105.318	38.837	39.784	72.222	0.021
GSA17	0.266	0.473	10.393	8.187	3.088	13.721	8.370	5.141	4.695	3.656	2.174	3.726	1.615	0.799	2.080	3.325	-0.168
GSA18	5.770	1.274	0.451		0.467	0.960		0.481			0.454			0.499			n.c.
GSA19	0.898	0.856		0.899						0.950	1.637	1.779	1.842		0.931	0.919	n.c.
S. stellaris	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9				0.234					0.329								n.c.
GSA10					0.557				1.273					0.627			n.c.
GSA11								0.404									n.c.
GSA16				2.668	1.273							0.454					n.c.
GSA17							0.269		0.216			0.402					n.c.
GSA18																1.036	n.c.
GSA19							0.930										n.c.
T. marmorata	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	1.509	1.864	1.492	1.804	1.014	2.767	1.025	0.995	0.982	1.319	1.212	0.324		2.031	1.315	2.030	-0.125
GSA10	3.825		1.137	0.555			0.553		1.273				0.322		0.788		n.c.
GSA11	0.636		1.077	0.180			0.192					0.239		0.726	0.249	0.526	n.c.
GSA16	4.314	3.953	6.764	6.671	1.273	3.836	3.753	2.597	2.316	8.139	1.571	3.177	1.290	4.404	5.224	5.586	-0.047
GSA17		0.292				0.274	0.297	0.310	0.409	0.218	0.287		0.205			0.216	n.c.
GSA18		1.504	0.409	0.407	0.403	2.044		2.313	2.564	1.015	1.389	0.465	0.485	0.499	0.944	2.127	0.178
GSA19	3.593	3.422	0.853		2.329	0.717	6.541	1.842	1.591	0.950	1.556	3.362	1.842	0.749	2.538	0.919	-0.291
T. torpedo	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9			4.808	0.785	0.992		0.546		0.399	4.600	0.606	0.770		0.652	1.708		n.c.
GSA10		1.685				2.830	0.677										n.c.
GSA11	0.277	1.317	0.936					0.492	0.259		0.290	0.713	0.537	5.092	1.010	0.251	n.c.
GSA16										1.628		0.908		0.400	1.206		n.c.
GSA17										0.218							n.c.
GSA19					28.719	1.670	1.860	19.355		5.195	3.432	0.845	9.336	17.778	7.692	1.749	n.c.
T. nobiliana	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9						0.454	0.256		0.329								n.c.
GSA11		0.263	0.215	0.846	0.847	2.025	1.710	1.122		0.242		0.474	0.840	0.484			n.c.
GSA16	1.438			1.334					0.772						0.402		n.c.
GSA19							0.946	0.921			0.819	1.779			0.931	1.568	n.c.

The most abundant species On the slope (Tab. 7 and 8) are *G. melastomus* (GSA9), *E. spinax* (GSA9), *S. canicula* (GSA11), *R. clavata* (GSA11) and *D. oxyrhincus* (GSA11). In 103 out of 144 series the data are insufficient to calculate the Spearman coefficient; in 29 situations there are no trends, in two there are negative trends for biomass and three for density. There are ten positive trends for biomass and seven for density.

The trends of some common species on the shelf and on the slope in different GSAs are shown in Figs. 2-8. On the slope the biomass of *R. clavata* and *S. canicula* is quite different from one GSA to another. The highest values were reached in

Tab. 6 - Biomass index (kg/km^2) for shelf stratum (10-200 m depth) per GSA. Medits 1994-2009. Significant Spearman rho values are in bold.

Indici di biomassa(kg/km^2) per la piattaforma (10-200 m) e per GSA. Medits 1994-2009. In grassetto i valori del rho di Spearman significativi.

C. granulosus	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*rho Spearman*
GSA9																0.296	n.c.
GSA11							0.022										n.c.
C. uyato	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA16	1.079																n.c.
C. monstrosa	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA18											0.545						n.c.
D. centroura	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA19									0.087								n.c.
D. pastinaca	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9											1.759				1.211		n.c.
GSA10				1.377													n.c.
GSA11		27.990	11.011	18.516	11.441		7.534	6.135				11.119		29.972	9.248	32.415	n.c.
GSA16									6.061	3.256	0.020	7.057	10.231	0.761	3.617	0.718	n.c.
GSA17									1.844	0.333				0.881			n.c.
GSA19					4.461		14.139	0.792			7.642	8.257	0.264	0.736	2.981	4.762	n.c.
D. oxyrhincus	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	1.373			0.328	0.131			0.186		0.178		0.536		0.052	0.006	3.669	n.c.
GSA11	8.702	5.641	2.001	1.701	0.950	6.575	2.667	11.243		10.687	0.833	2.119	5.769	2.298	3.679	10.305	0.125
GSA16									0.178								n.c.
E.spinax	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA11		0.596					2.737					4.902					n.c.
G. galeus	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA18														0.204			n.c.
G. melastomus	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9			0.324					0.005									n.c.
GSA11						0.057		0.030		0.019	1.056	1.479		0.071	0.190		n.c.
GSA16													0.010				n.c.
GSA18							0.080				0.918						n.c.
H. perlo	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9														0.603			n.c.
GSA16														2.002			n.c.
L. circularis	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA16														0.080			n.c.
GSA18												0.251					n.c.
L. melitensis	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA16		0.395								0.488	0.232		0.288	0.320	0.362	1.564	n.c.
M. aquila	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	0.243								0.311					0.148		0.113	n.c.
GSA10		1.012	1.792		3.918	13.301	2.175	5.180		4.978				10.706			n.c.
GSA11	0.802	0.053			2.016		0.925		0.153			0.167			0.796		n.c.
GSA16										3.500					2.411	2.574	n.c.
GSA17				5.708	0.338	11.631	4.993	10.146	31.925	2.823	2.316	2.508	22.527	1.362	9.900	8.554	0.033
GSA18															5.275		n.c.
M. asterias	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA16												0.340	2.257		1.929	0.559	n.c.
GSA17									0.675								n.c.
M. mustelus	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9					0.068	0.105		0.075									n.c.
GSA10													1.609				n.c.
GSA11					0.030												n.c.
GSA16	0.431	0.329	3.585	4.936	1.592	15.422	24.457	6.234	24.476	16.523	44.605	25.165	25.319	5.565	24.654	21.451	**0.741**
GSA17			2.036	1.947		2.390	0.059	1.062	4.662	0.899	0.414	4.062	7.106	0.292	3.731	2.925	0.258
GSA18	0.114	0.311				1.079		0.082									n.c.
GSA19	0.361	1.113	0.525	0.556	0.815		0.061	0.076	4.032	1.506	0.071	2.583	0.858	4.852	0.112	31.277	0.371
M. punctulatus	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA16											0.942				1.343	1.317	n.c.
GSA17								0.338		3.155	1.344					0.317	n.c.
O. centrina	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	0.349	0.798	0.744											0.176			n.c.
GSA11						0.491	1.815		1.611								n.c.
GSA16		2.108											1.075				n.c.
P. bovinus	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA17				0.256													n.c.
GSA19		6.012	0.933	1.694		4.509			3.318		1.793	2.403	2.227		1.003	1.118	n.c.
P. violacea	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA10							4.018		1.337								n.c.
R. asterias	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	1.052	1.043	3.329	1.329	2.261	3.458	1.670	1.100	1.937	3.988	1.132	0.294	0.050	1.158	1.198	0.143	-0.318
GSA10	0.305	1.188	0.765	0.999	1.289	0.009	1.899	1.449			1.058	1.440			1.059		n.c.
GSA11	9.568	4.765	6.882	4.150	2.595	6.301	3.092	3.627	6.298		1.877	25.579	20.105	11.362	4.455	9.722	0.286
GSA16	3.955	6.258	2.435	1.227	1.401	3.708	1.126	3.636	1.390	1.574	2.042	1.951	1.999	2.142	1.266	3.783	-0.206
GSA17	0.029	0.622		0.438	0.625	0.607	0.351		0.783	0.291	0.113	0.635	0.120	0.126	0.346	0.154	-0.244

(Segue/*Follows*)

GSA18	0.105	0.400			2.077	0.214			0.020	0.054	0.434	0.050	0.693			0.341	n.c.
GSA19		1.288	1.400			1.002	0.886		0.306		0.955	0.072	6.385	0.867	3.431		n.c.
R. brachyura	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA11	2.303	0.606	2.332		1.386		0.397	7.755	1.325	7.952	2.612	22.555	11.461	13.222	5.032	22.713	**0.763**
GSA16													0.774	1.902	4.139		n.c.
R. clavata	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	0.703	1.922	2.131	8.877	2.785	4.048	3.844	3.783	7.990	9.628	4.257	3.027	5.254	5.418	10.336	6.388	**0.650**
GSA10	0.017					0.392	0.020						0.657			2.224	n.c.
GSA11	13.807	25.218	29.900	23.931	17.836	27.972	17.992	54.311	11.408	35.133	37.690		38.938	27.354	19.183	28.549	0.336
GSA16	15.747	3.426	6.899	10.540	17.444	12.404	31.025	2.208	32.742	21.364	29.114	31.312	57.415	24.940	32.598	40.025	**0.759**
GSA17		0.274		0.014	0.120	2.418	1.454			0.740	0.004	0.735	3.156	0.530	1.753	1.284	0.420
GSA18	0.571		0.812													2.087	n.c.
R. miraletus	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	1.304	1.881	1.571	2.579	2.374	3.566	3.329	1.429	1.836	3.015	1.197	1.027	2.369	1.663	1.300	1.215	-0.385
GSA10	0.698		0.072	0.138		0.071		0.029		0.078		0.321	2.413		0.181	0.168	n.c.
GSA11	1.902	2.090	2.100	5.017	4.840	2.236	2.316	9.992	0.907	5.900		10.763	6.249	7.625	4.978	6.174	**0.639**
GSA16	8.700	13.110	28.612	47.295	22.919	14.642	30.838	25.752	21.728	16.346	31.181	20.331	28.973	21.344	30.300	49.314	0.412
GSA17			0.511	0.999	0.402	0.300	0.027	0.250	0.131	0.298	0.133	0.490	0.209	0.508	0.202	0.397	-0.262
GSA19				0.152		0.359	0.126	0.505	0.179	0.104	0.226	1.009	0.345		0.138	0.066	n.c.
R. montagui	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	0.157	0.471	0.024	2.004	0.146	0.768	0.682		0.609	0.152	0.106						n.c.
GSA10													0.657				n.c.
GSA16			1.420	2.135	0.764	0.384	2.565	2.877	1.523	1.343	1.999	2.494	1.096	1.822	1.973	2.390	0.204
GSA17										0.135		0.004					n.c.
R. polystigma	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9												0.175	0.418	0.848	2.364	2.051	n.c.
GSA10								0.160									n.c.
GSA11	4.301	4.609	16.954	5.863	13.880	13.893	8.231	31.396	1.622	9.644	14.037	9.452	12.292	26.215	5.440	5.035	0.115
GSA17						0.017											n.c.
R. alba	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA16							5.442								0.100	4.230	n.c.
S. acanthias	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9				1.240													n.c.
GSA10													1.314				n.c.
GSA11								1.028			0.700						n.c.
GSA17	10.061	22.173	5.883	5.422	303.940	19.785	17.402	5.265	8.502	8.893	7.563	3.166	7.816	3.268	6.093	5.138	**-0.562**
GSA18	1.118		0.572			0.085											n.c.
S. blainvillei	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9					0.973												n.c.
GSA11	2.724	2.072	0.506	8.351	2.465	10.613	0.719	0.514	6.856	2.252	6.600	0.493	0.678	0.073	0.951	0.055	-0.491
GSA16		2.042	1.488	0.667			0.250		19.226	1.628	10.013	15.997	29.188	26.245	45.121	35.421	**0.839**
GSA18																3.676	n.c.
S. canicula	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	3.158	2.651	2.705	3.089	2.745	2.735	3.401	2.906	0.871	4.939	2.360	1.415	3.059	6.552	5.191	4.637	0.344
GSA10	0.140	0.309							0.267				0.657			0.097	n.c.
GSA11	16.461	11.545	19.970	15.017	23.431	28.516	21.660	45.499	25.290	27.262	17.134	14.825	16.833	69.347	19.098	16.623	0.174
GSA16	7.406	13.834	17.249	25.615	7.894	9.591	9.258	6.597	9.743	4.612	15.551	11.391	14.447	8.646	8.866	13.410	-0.050
GSA17	0.013	0.161	1.716	1.052	0.480	2.336	1.365	0.832	0.941	0.727	0.323	0.469	0.689	0.264	0.451	0.544	-0.150
GSA18	0.718	0.226	0.021		0.211	0.418		0.133			0.136			0.006			n.c.
GSA19	0.449	0.214		0.005						0.321	0.675	0.662	0.536		0.306	0.339	n.c.
S. stellaris	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9				0.983					1.645								n.c.
GSA10					0.167				0.038					2.384			n.c.
GSA11								0.030									n.c.
GSA16				1.668	5.093							0.045					n.c.
GSA17							0.037		0.078			0.056					n.c.
GSA18																0.054	n.c.
GSA19							0.015										n.c.
T. marmorata	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	0.327	0.245	0.183	0.520	0.523	0.839	0.208	0.161	0.221	0.142	0.258	0.039		0.342	0.101	0.784	-0.204
GSA10	0.324		0.284	0.166			0.553		0.216				0.804		1.378		n.c.
GSA11	0.202		0.151	0.108			0.010					0.239		0.060	0.174	0.317	n.c.
GSA16	1.726	2.174	1.623	1.468	0.025	2.302	0.976	1.169	1.042	1.791	0.287	0.522	0.301	1.670	1.712	2.657	-0.050
GSA17		0.018				0.007	0.008	0.035	0.040	0.033	0.023		0.074			0.041	n.c.
GSA18	0.233	0.179	0.082	0.042	0.093	0.329		0.531	0.442	0.161	0.220	0.040	0.176	0.078	0.107	0.292	-0.064
GSA19	0.539	0.257	0.036		0.511	0.038	6.062	0.179	0.867	0.154	0.220	0.661	0.467	0.142	0.385	0.101	-0.107
T. torpedo	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9			0.272	0.042	0.139		0.029		0.040	1.505	0.340	0.031		0.059	0.278		n.c.
GSA10		0.112				0.672	0.047										n.c.
GSA11	0.014	0.570	0.638					0.321	0.026		0.023	0.251	0.048	3.053	0.421	0.251	n.c.
GSA16										0.520		0.136		0.112	0.261		n.c.
GSA17										0.007							n.c.
GSA19					3.467	0.206	0.051	0.931		0.903	0.569	0.120	0.703	4.993	1.126	0.275	n.c.
T. nobiliana	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9						0.082	0.038		0.066								n.c.
GSA11		0.024	0.022	1.086	0.478	0.979	0.595	0.333		0.012		0.203	0.028	0.547			n.c.
GSA16	0.072			0.133					0.232						0.024		n.c.
GSA19							0.063	0.037			0.065	0.094			0.045	0.049	n.c.

Tab. 7 - Density index (n/km²) for slope stratum (200-800 m depth) per GSA. Medits 1994-2009. Significant Spearman rho values are in bold.

Indici di densità (n/km²) per la scarpata (200-800 m) e per GSA. Medits 1994-2009. In grassetto i valori del rho di Spearman significativi. In grassetto i valori del rho di Spearman significativi.

C. granulosus	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	1.182		1.542	1.486	0.897	0.548	0.152	0.452		0.368			0.699	0.477			n.c.
GSA10	0.531	0.227		0.232	0.693	1.632		0.453		0.240	0.523		0.264	0.264	0.257		n.c.
GSA11			1.344			0.575	0.139	0.402			1.569	0.274					n.c.
GSA16	4.217	0.421	0.859		3.795	2.076	4.501	1.655	6.717	1.338	1.094	8.060	8.128	3.503	6.232	6.733	0.536
GSA18						0.593			0.834					0.819			n.c.
C. uyato	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA10							0.214										n.c.
GSA16		0.421											1.912				n.c.
GSA19							0.199										n.c.
C. monstrosa	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	4.533	4.230	7.204	5.718	7.753	6.545	4.241	5.275	4.010	4.023	5.098	5.858	2.980	5.833	6.266	5.335	-0.056
GSA10	0.266	2.270	1.602	3.019	1.778	2.798	2.574	2.715	0.788	0.240	1.046	1.288	1.056	0.264	1.406	1.637	-0.350
GSA11			2.091	0.949	0.747	1.294	2.925	1.071	0.479	0.435	1.345	0.549	0.450	1.242	1.595	2.188	0.007
GSA16	17.394	8.414	7.300	6.188	12.648	15.360	21.277	8.687	9.404	15.258	17.785	8.746	12.431	13.555	17.137	14.249	0.268
GSA17	14.322		42.034	10.945				13.157		6.229	3.344				2.041		n.c.
GSA18		12.348	35.446	54.466	32.135	85.412	29.241	75.012	76.823	31.855	17.536	55.186	39.871	49.275	25.784	87.116	-0.154
GSA19	1.794	2.910	2.291	2.630	2.368	2.064	5.169	4.084	3.719	6.050	3.100	4.038	4.644	3.171	6.877	1.484	0.424
D. licha	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	1.990	0.619	0.617	0.892	0.449	0.548	1.219	0.301	0.349	0.736	0.146		0.699	0.863	1.044	0.431	-0.193
GSA10	2.015		0.229	0.929	0.462	0.933	0.429	0.905	0.525	0.479	0.957	0.266	0.528	0.529		2.456	0.125
GSA11		0.172		0.158	0.149	0.719		0.535		0.335						0.729	n.c.
GSA16	0.527	0.421	0.429	0.413			1.227	1.655	1.612	2.409	1.915	1.715	0.956	2.132	1.714	2.192	**0.745**
GSA17		1.503		5.970													n.c.
GSA18		0.771		1.649	1.276			2.861		2.631	1.684	2.590	0.868			0.763	n.c.
GSA19		0.909	0.382	1.618	0.911	0.938	0.596	1.377	0.930	1.895	2.215	2.763	1.689	0.634	1.688	0.848	0.325
D. pastinaca	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA11						12.282											n.c.
GSA16													0.159				n.c.
D. batis	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9			0.154														n.c.
D. oxyrhincus	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	0.849	1.401	1.631	0.394	0.951	2.165	1.978	3.698	2.501	1.834	1.819	1.139	0.488	2.100	0.162	1.571	0.026
GSA10	0.421	0.770	0.770	0.570	0.979	1.587	0.917	0.173	0.441	0.835	0.217	0.452	0.224	1.986	0.846	0.706	0.006
GSA11	12.412	17.777	23.211	1.791	38.315	18.851	15.875	23.670	25.780	24.589	12.008	31.881	10.619	15.153	21.186	17.461	0.000
GSA16	0.527	1.683	1.288	4.125	3.373	1.245	8.592	5.791	5.642	4.283	3.831	3.773	8.925	3.655	5.297	3.601	0.471
GSA19						0.188	0.199	0.208		0.237	0.221	0.213	0.633	0.211	0.211	0.212	n.c.
E.spinax	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	57.468	83.124	40.652	36.775	51.656	70.323	64.424	51.542	33.728	48.652	64.260	56.477	50.793	58.633	76.401	76.264	0.197
GSA10	95.704	66.919	51.539	96.612	67.135	110.992	51.017	39.250	19.475	23.939	34.380	44.675	44.434	41.920	58.131	49.573	**-0.544**
GSA11		51.664	40.567	61.567	75.841	80.256		50.619	11.620	36.810	67.142	80.414	49.346	104.506	138.498	112.214	0.521
GSA16	30.572	84.561	103.915	12.788	30.778	21.586	42.144	34.333	51.855	33.192	42.958	40.985	47.971	100.522	75.869	64.355	0.359
GSA17	14.053	13.878	15.486		1.168		4.570	2.067	2.065	14.534	40.133				1.020		n.c.
GSA18		51.246	54.864	193.927	126.760	127.907	156.545	58.593	88.908	81.248	76.957	274.289	126.931	39.486	73.631	177.480	0.111
GSA19	5.512	45.461	64.148	53.340	57.599	61.936	81.612	65.322	44.390	200.724	69.757	96.494	39.457	42.909	58.521	51.647	0.082
G. galeus	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA10		0.681						0.173									n.c.
G. melastomus	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	229.516	268.521	253.986	356.137	316.481	298.430	290.815	415.245	412.700	293.347	258.993	245.122	224.098	827.945	356.717	350.291	0.282
GSA10	127.180	131.794	147.134	350.731	2694.070	263.116	135.211	200.381	114.991	239.724	247.617	244.191	265.330	354.387	253.216	383.988	0.462
GSA11		685.851	735.007	762.155	698.225	999.987	455.720	1234.797	513.184	626.448	663.898	936.686	906.884	996.671	713.924	507.510	-0.043
GSA16	85.391	81.616	112.503	34.650	69.567	96.723	164.893	100.930	138.640	157.661	162.257	219.500	254.519	423.714	553.669	465.203	**0.897**
GSA17	59.996	13.528	174.541	124.096	17.521	17.706	16.349	32.613	4.180	8.276	9.459	16.307	3.525	31.460	7.143		**-0.600**
GSA18		85.478	176.898	210.653	170.752	306.439	144.544	118.053	217.762	95.320	218.601	362.727	199.318	371.348	39.802	183.797	0.211
GSA19	123.406	97.440	153.658	85.793	61.716	111.030	167.293	110.108	49.541	224.262	113.049	106.044	56.867	78.209	182.354	92.929	-0.109
G. altavela	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA19													1.384				n.c.
H. perlo	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9										0.160		0.168					n.c.
GSA11						0.162											n.c.
GSA16		0.421			0.422				0.537	0.268	0.547	0.514	0.797	0.762	0.935	0.626	n.c.
GSA19						0.317									0.348		n.c.

Tab. 8 - Biomass index (kg/km²) for slope stratum (200-800 m depth) per GSA. Medits 1994-2009. Significant Spearman rho values are in bold.

Indici di biomassa (kg/km²) per la scarpata (200-800 m) e per GSA. Medits 1994-2009. In grassetto i valori del rho di Spearman significativi.

C. granulosus	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	4.237		5.566	5.700	4.156	1.004	0.663	1.809		1.361			2.551	1.907			n.c.
GSA10	2.086	1.589		0.418	3.259	5.572		1.991		0.910	1.673		0.924	1.111	1.518		n.c.
GSA11			6.797			2.186	0.488	1.124			3.417	0.988					n.c.
GSA16	19.187	3.597	2.576		12.438	5.999	15.344	5.315	21.105	4.604	3.749	30.696	25.374	11.568	19.215	23.033	0.511
GSA18						1.723			2.419					0.002			n.c.

(Segue/*Follows*)

C. uyato	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA10							0.794										n.c.
GSA16		0.715											3.873				n.c.
GSA19							0.696										n.c.
C. monstrosa	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	1.465	1.278	1.628	1.858	2.445	2.484	1.140	0.913	1.414	1.023	1.030	1.537	0.795	1.480	1.126	0.739	**-0.544**
GSA10	0.027	0.102	0.080	0.186	0.145	0.520	1.137	1.011	0.420	0.024	0.025	0.079	0.011	0.005	0.092	0.049	-0.418
GSA11			0.192	0.055	0.056	0.246	0.347	0.133	0.036	0.047	0.040	0.022	0.014	0.062	0.065	0.289	**-0.657**
GSA16	5.930	3.976	2.791	2.164	4.933	6.505	9.509	2.742	4.046	6.344	8.009	3.563	3.619	3.963	6.852	5.202	0.168
GSA17	0.980		9.789	2.189				5.778		6.125	3.441				0.918		n.c.
GSA18	12.582	5.183	7.183	25.492	18.345	39.328	16.708	37.791	16.946	14.327	4.756	15.372	12.756	11.904	7.601	22.000	-0.024
GSA19	0.777	0.227	0.237	0.865	0.542	0.768	2.241	0.736	0.948	0.736	0.989	0.285	0.491	0.229	0.823	0.367	-0.050
D. licha	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	2.685	0.937	1.426	1.379	2.063	1.189	0.808	0.053	0.666	0.699	0.035		3.610	0.624	0.875	0.883	-0.468
GSA10	4.390		0.064	1.718	0.647	2.868	1.718	2.251	1.114	2.611	4.248	0.093	1.636	0.132		3.481	-0.046
GSA11		1.033		0.047	0.060	5.480		1.720		0.570						1.957	n.c.
GSA16	1.239	0.968	0.086	1.774			2.741	3.992	4.057	5.043	4.665	4.201	3.259	5.864	3.334	6.064	**0.785**
GSA17		0.451		0.318													n.c.
GSA18	1.553	3.855		0.449	2.108			1.189		5.812	0.284	4.276	1.002			0.153	n.c.
GSA19		4.286	0.064	1.036	0.211	1.562	2.150	0.407	1.413	2.062	3.565	1.882	2.563	1.503	2.322	1.361	-0.375
D. pastinaca	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA11						11.556											n.c.
GSA16													0.008				n.c.
D. batis	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9			0.002														n.c.
D. oxyrhincus	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	2.264	1.772	0.959	1.341	0.258	0.057	1.838	1.866	1.011	2.314	0.290	1.775	0.845	2.280	0.013	2.713	0.100
GSA10	0.179	0.096	0.269	0.059	0.391	1.803	0.413	0.130	0.882	0.522	0.007	0.316	0.075	1.446	0.486	0.282	0.241
GSA11	10.878	8.487	11.838	1.701	25.019	17.532	14.737	16.443	11.736	24.183	12.973	21.432	5.497	11.163	15.503	16.630	0.253
GSA16	1.581	2.629	1.159	7.858	2.445	0.922	4.435	5.150	6.596	5.204	6.649	5.222	11.625	2.773	7.615	6.481	**0.591**
GSA19						0.030	0.012	0.042		0.013	0.007	0.425	0.239	0.014	0.010	0.247	n.c.
E.spinax	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	3.652	4.860	2.788	3.241	4.360	6.432	5.127	4.685	3.049	4.275	5.135	4.872	5.339	3.974	5.517	5.019	0.453
GSA10	6.703	2.696	2.661	5.659	4.193	5.581	2.644	2.095	1.964	1.784	2.615	3.038	2.696	3.320	3.522	3.462	-0.176
GSA11		2.221	2.757	2.757	4.986	5.141		3.567	0.577	2.240	3.539	4.975	3.751	3.675	6.940	5.917	0.560
GSA16	2.477	4.546	5.157	0.726	2.635	2.088	3.895	3.371	4.077	3.027	3.567	3.166	3.830	6.199	6.450	6.690	0.521
GSA17	0.545	0.844	0.299		0.013		0.331	0.010	0.413	1.142	2.207				0.051		n.c.
GSA18	1.894	1.807	1.978	5.051	2.782	4.038	5.554	1.684	4.558	3.904	3.791	10.127	5.354	1.155	2.133	7.331	**0.550**
GSA19	0.061	1.841	2.249	2.060	2.412	2.993	3.954	3.273	2.619	5.588	2.961	3.613	2.122	2.260	2.594	3.353	0.391
G. galeus	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA10		0.023						2.250									n.c.
G. melastomus	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9	35.827	39.769	30.591	39.331	37.735	46.863	45.486	46.325	44.384	27.076	28.861	31.711	33.677	81.273	48.955	34.123	0.050
GSA10	13.571	9.976	12.774	33.048	39.624	29.614	12.772	22.327	9.098	24.838	26.197	30.361	29.338	43.287	28.087	52.719	0.482
GSA11		20.591	37.326	57.566	53.379	42.133	33.543	61.270	40.871	45.322	42.461	40.280	52.328	57.331	40.639	41.317	0.150
GSA16	19.851	9.718	15.557	5.367	11.443	15.812	29.296	16.902	17.459	27.164	28.576	27.730	34.929	55.407	71.033	67.581	**0.847**
GSA17	3.764	1.804	12.039	13.454	2.208	2.405	2.537	5.975	1.651	1.528	3.594	1.994	0.186	2.569	1.276		-0.514
GSA18	21.756	7.636	12.001	31.442	25.153	43.585	23.455	25.251	31.076	23.114	38.164	57.128	33.300	28.479	6.759	43.824	0.418
GSA19	15.164	6.578	7.752	5.121	5.836	13.562	17.687	15.243	8.198	22.066	12.525	15.737	9.710	8.303	20.498	17.084	0.503
G. altavela	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA19													0.070				n.c.
H. perlo	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***rho Spearman***
GSA9										0.256		0.404					n.c.
GSA11						0.162											n.c.
GSA16		1.893			1.349				0.161	0.402	0.424	1.286	0.234	0.533	2.056	0.877	n.c.
GSA19						0.412									1.322		n.c.

Sardinia (GSA11) and the Strait of Sicily (GSA16). A clear positive trend occurs in GSA9 and GSA16. In GSA19 *R. clavata* was not fished, so in Fig. 4 the trend of *T. nobiliana* and *S. canicula* are shown. When the first species decreases the second increases; but this could be fortuitous.

On the slope *G. melastomus* was fished in all GSAs and all years (Fig. 5). The highest values of biomass were obtained in GSA9 (Ligurian and Northern Tyrrhenian Sea) and GSA11 (Sardinia) and in the last years also in GSA16 (Strait of Sicily) where there was an increasing trend of the catch. The lowest values were obtained in the northern and central Adriatic Seas, but this is due mainly to the reduced surface of the slope.

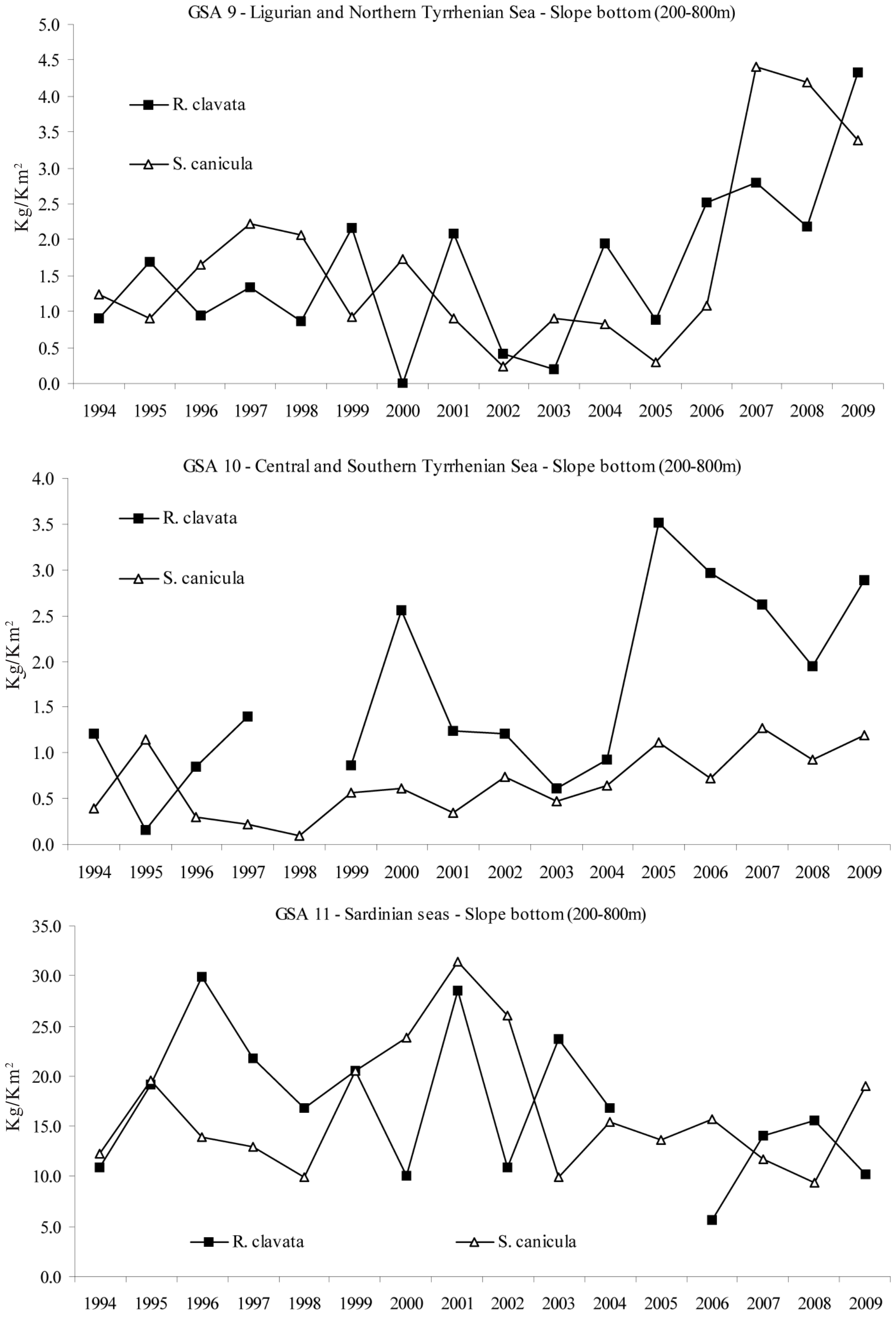

Fig. 2 - Biomass trends (kg/km²) of *R. clavata* and *S. canicula* in different years on the slope of GSA 9, 10 and 11.

Andamenti della biomassa (kg/km²) di R. clavata *e* S. canicula *in diversi anni sulla scarpata delle GSA 9, 10 e 11.*

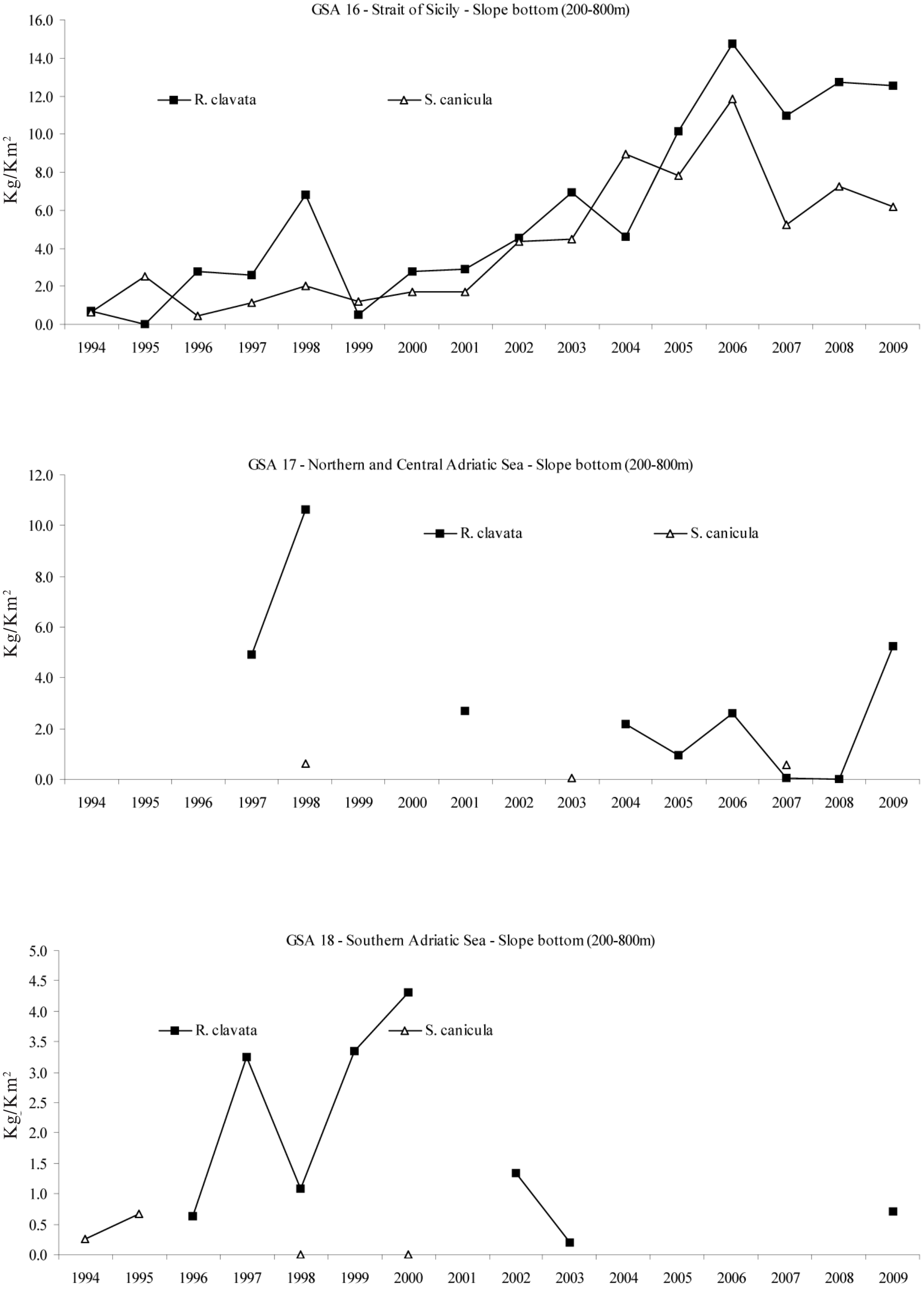

Fig. 3 - Biomass trends (kg/km^2) of *R. clavata* and *S. canicula* in different years on the slope of GSA 16, 17 and 18.

Andamenti della biomassa (kg/km^2) di R. clavata *e* S. canicula *in diversi anni sulla scarpata delle GSA 16, 17 e 18.*

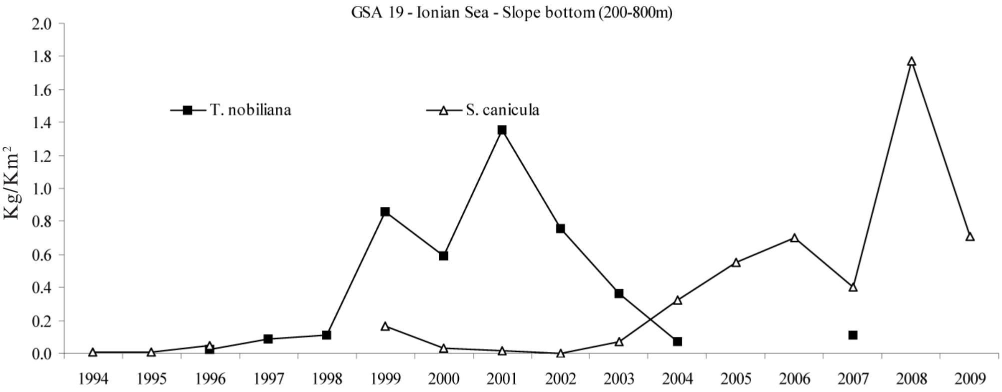

Fig. 4 - Biomass trends (kg/km^2) of *T. nobiliana* and *S. canicula* in different years on the slope of GSA19.

Andamenti della biomassa (kg/km^2) di T. nobiliana *e* S. canicula *in diversi anni sulla scarpata delle GSA19.*

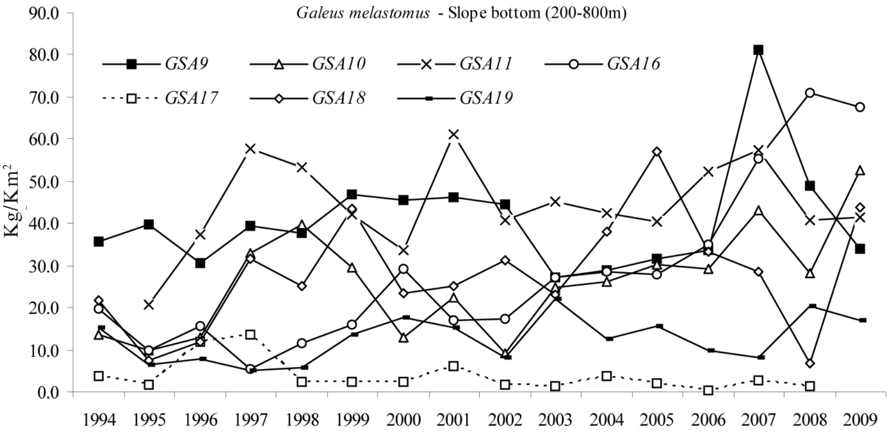

Fig. 5 - Biomass (kg/km^2) of *G. melastomus* caught in different years on the slope of seven GSAs.

Biomassa (kg/km^2) di G. melastomus *presente nei diversi anni sulla scarpata delle sette GSA.*

R. clavata and *S. canicula* were also caught in the shelf bottoms and the biomass trends of these two species and of the *R. asterias* in three GSA are shown in Fig. 6. The highest biomass was fished in Sardinia (GSA11) and in Sicily (GSA16). The biomass trends of some species fished on the shelf of Northern and Central Adriatic seas are given in Fig. 7. There was an exceptional catch of *S. acanthias* (304 kg/km^2) in the 1998 survey, where normally the catch is between 3 and 22 kg/km^2. The catch of *M. mustelus* is irregular. This species was caught in good quantity (31 kg/km^2) in GSA19 during the 2009 survey (Fig. 8). The total biomass of chondrichthyes caught each year during the Medits surveys is given in Fig. 9. The highest values were obtained in Sardinia (GSA11) and Sicily (GSA16), while the lowest were in the Southern Adriatic (GSA18) and Ionian Seas (GSA19). There are no clear trend, positive or negative.

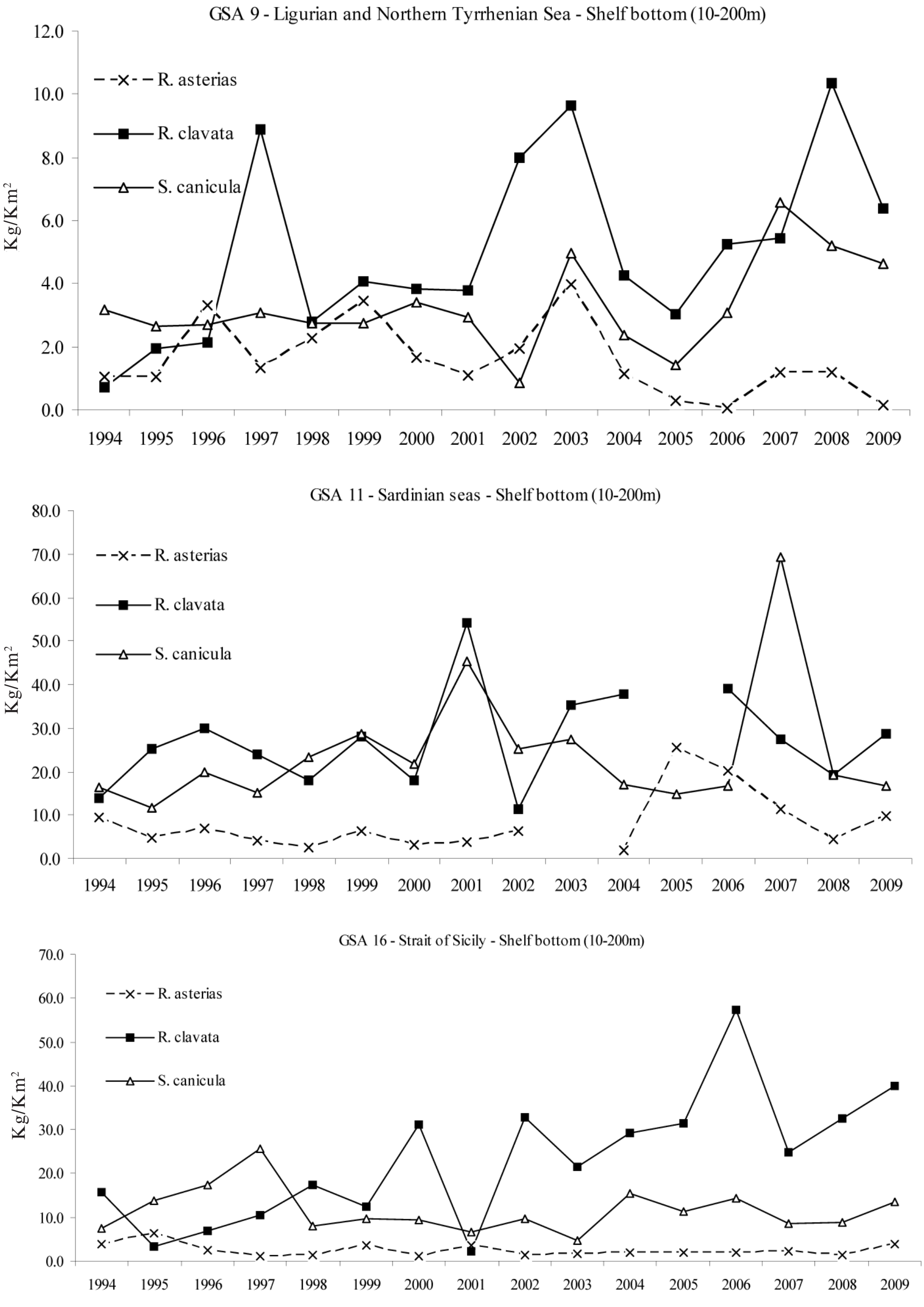

Fig. 6 - Biomass trends (kg/km²) of *R. asterias, R.clavata* and *S. canicula* in different years on the shelf of GSA 9, 11 and 16.

Andamenti della biomassa (kg/km²) di R. asterais, R. clavata *e* S. canicula *in diversi anni sulla piattaforma delle GSA 9, 11 e 16.*

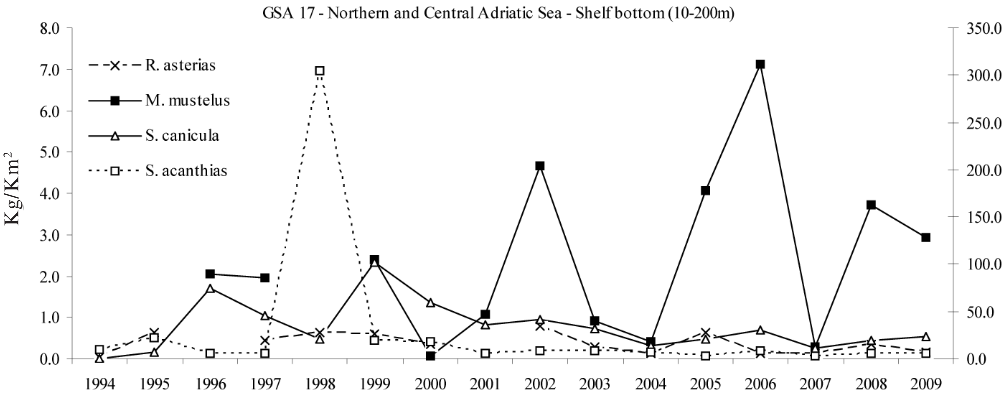

Fig. 7 - Biomass trends (kg/km²) of some species on the shelf of GSA17 in the period 1994-2009. The scale on the right is for *S. acanthias.*

Andamenti della biomassa (kg/km²) di alcune specie della piattaforma delle GSA17 dal 1994 al 2009. La scala sulla destra è per S. acanthias.

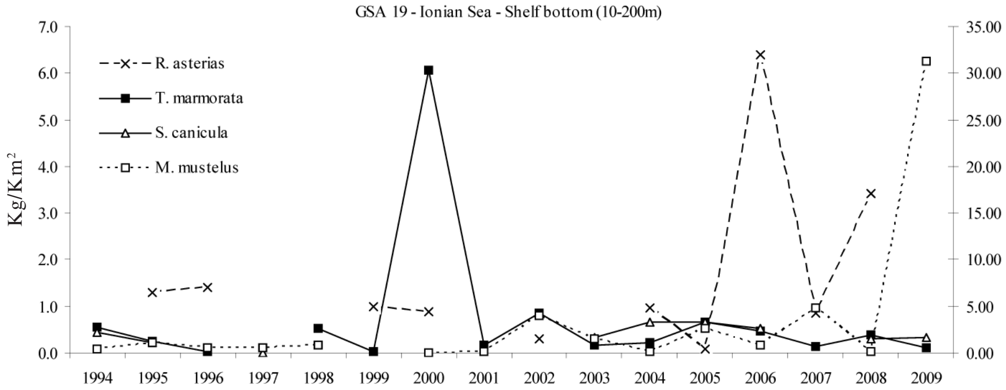

Fig. 8 - Biomass trends (kg/km²) of some species of the shelf of GSA19 in the period 1994-2009. The scale on the right is for *M. mustelus.*

Andamenti della biomassa (kg/km²) di alcune specie della piattaforma delle GSA19 dal 1994 al 2009. La scala sulla destra è per M. mustelus.

Conclusions - During the Medits surveys 16 sharks out of 22 demersal species listed in the checklist of Italian Fauna (Vacchi and Serena, 2010) were fished. All torpedos and 12 skats out of 16, 6 Myliobatiformes out of 9 (some are pelagic) were caught.

In a previous paper (Bertrand *et al.,* 2000) dealing with elasmobranches caught in the whole area covered by the Medits surveys from 1994 to 1998, 44 species were described: 1 chimaera, 19 sharks and 24 rays and skates, of which 35 species are common to the present work. *G. altavela*, *M. punctulatus* and *P. bovines* were not fished in the period 1994-1998, while *S. squatina*, *S. aculeata*, *Galeus atlanticus* (not present in Italian waters), *Hexanchus vitelus* (=*H. nakamurai* only one record in Italy), *Raja naevus*, *R. radula*, *R. undulate*, *Dasyatis tortonesei* (not considered a valid species), *Rhinoptera marginata* are not mentioned in the present paper.

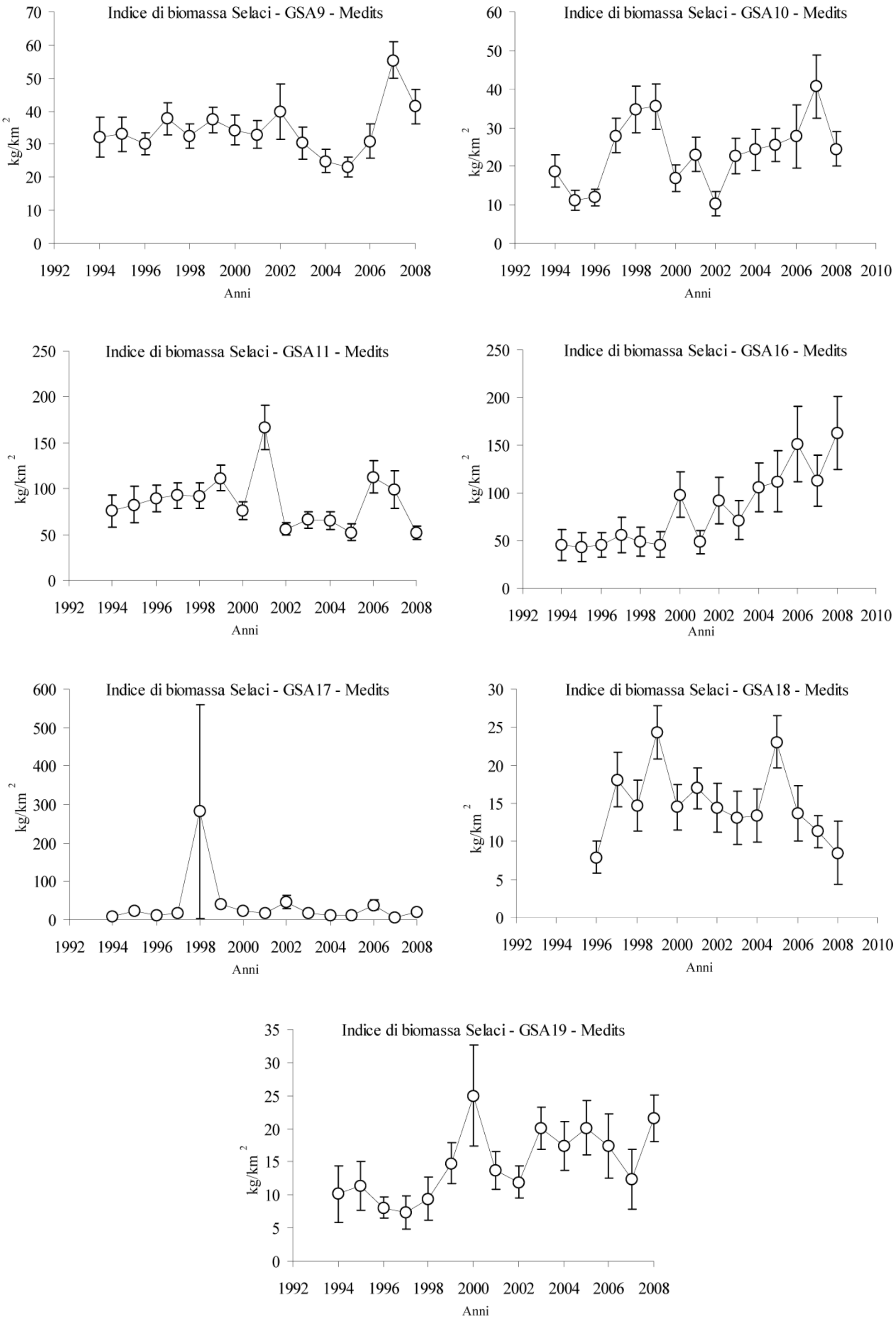

Fig. 9 - Trends of the total biomass of Chondrichthyes in the 7 GSAs.
Andamenti della biomassa totale dei Condroitti nelle 7 GSA.

When we compare these data, we have to bear in mind the different areas and numbers of years considered. For the Italian seas important data come from the GRU.N.D. surveys carried out from 1985 to 1998 (Relini *et al*., 2000). During the Grund surveys all the species recorded in the present paper were found with the exception of *Gymnura altavela*. The species *R. radula*, *R. naevus*, *R. rondeleti* (not valid species), *R. undulata*, *M. mobular* and *S. squatina* fished in Grund surveys were not caught during the 1994-2009 Medits surveys. Although comparison and conclusions are not easy, we can recognize a reduction in the number of species of rays and the disappearance of the *Squatina* species. According to the Medits data, the situation of elasmobranches seems quite stable in the period 1994-2009 both in terms of number of species and biomass. This conflicts with some landing data collected during the Elasmoit project (Relini *et al.,* 2010) which showed low numbers of species and individuals and poor quantity in weight.

In conclusion, we can say that during the Medits surveys there were no changes in the demersal elasmobranch population, whereas there are changes if we compare the Medits data with data collected before 1994. The main difference, as mentioned earlier, is the reduction in the number of rays and the disappearance of the *Squatina* species.

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IL PROGETTO ELASMOIT

ELASMOIT PROJECT

Abstract *– A project supported by the Ministry for the Environment Land and Sea Protection and aimed to improve knowledge on elasmobranchs of Italian seas, for a national protection action plan, is described. Data collected in landing sites and on board of fishing boats targeted to large pelagic fish are referred.*

Key-words: *elasmobranchs, distribution, by-catch, Italian waters, conservation.*

Introduzione - Gli elasmobranchi sono tra le principali specie chiave dell'ecosistema marino e tra i taxa marini a maggior rischio. Molti di loro sono posizionati all'apice delle catene alimentari e sono caratterizzati da una strategia riproduttiva di tipo k. Presentano, infatti, bassa resilienza nei confronti dell'impatto con le attività umane (inquinamento e pesca) che li rende particolarmente vulnerabili, ciò è dovuto alle specifiche caratteristiche biologiche come la taglia di prima maturità raggiunta dopo molti anni, bassa fecondità e basso tasso di riproduzione. Inoltre, la maggior parte delle specie è presente in natura con valori di abbondanza relativamente bassi. Pertanto i pesci cartilaginei risultano particolarmente vulnerabili alla pressione di pesca e molto esposti al pericolo di *over-fishing* (Bonfil, 1994; Camhi *et al.*, 1998). In Italia, solo in passato si avevano rari esempi di pesca mirata ai pesci cartilaginei, oggi la pesca di questi pesci è solo accessoria come in genere accade nel resto del bacino mediterraneo e si verifica prevalentemente con l'uso di reti da posta, palangaro, ma anche con lo strascico professionale. In alcuni mari italiani si assiste a preoccupanti declini di alcune specie, che in certi casi evidenziano locali estinzioni. Tale situazione si evince dall'analisi delle tendenze che sono condotte sui dati provenienti dalle campagne di pesca scientifiche nazionali e internazionali. Tutto ciò è ancora strettamente legato alla loro strategia di vita e poiché sempre e comunque questi pesci, a differenze di quelli ossei, non conoscono selettività degli attrezzi in uso presso le marinerie italiane. Per questo motivo le varie specie di elasmobranchi sono catturate fin dai primi momenti della loro vita. In tutti i mari italiani si assiste quindi costantemente ad una riduzione del numero di specie pescate e spesso anche ad una riduzione quantitativa, del tutto analoga a quella riscontrata in altri settori marittimi (Baum *et al.*, 2003; Baum & Myers, 2004).

In Mediterraneo sono state classificate poco più di 80 specie di pesci cartilaginei, molte di queste conducono vita pelagica. Alcune di loro sono abbondanti e ampiamente distribuite sia nel bacino occidentale, sia in quello orientale; altre sono presenti solo in aree ristrette o addirittura sono rarissime, una settantina di queste specie frequenta regolarmente anche i mari italiani (vedi Vacchi e Serena, 2005, Checklist della Fauna Italiana, www.sibm.it/checklist/principalechecklist.htm).

Le informazioni sullo stato delle popolazioni spesso sono frammentarie nell'intero bacino, cosi come i dati sulle caratteristiche biologiche. Fortunatamente negli ultimi venti anni vi è stata un'attività di ricerca abbastanza intensa rivolta a migliorare le conoscenze sugli stocks ittici (prevalentemente demersali) compreso i pesci cartilaginei. Il progetto comunitario di valutazione delle risorse demersali MEDITS (Bertrand *et al*., 2000a; Relini, 2000), nonché quello nazionale GRUND (Relini, 1998a, 2000) svolgono (o hanno svolto nel caso di GRUND) un ruolo fondamentale nel programma di raccolta dati (Relini *et al*., 2000; Bertrand *et al*., 2000b), ma non per le specie pelagiche, tra le quali si annoverano i grandi squali a maggior rischio. Per queste ultime pertanto i dati sono alquanto scarsi e, soprattutto, non esistono le serie storiche disponibili per le specie demersali che vengono catturate con lo strascico, salvo i dati di alcuni gruppi di ricerca che da molti anni seguono la pesca con i palangari di fondo e di superficie.

Per quanto riguarda le normative di protezione occorre sottolineare che la più importante, la Direttiva Habitat (43/92), non annovera alcuna specie di elasmobranchi. Nel protocollo SPA/BIO della Convenzione di Barcellona sono elencate tre specie nell'allegato II [specie in pericolo; *Carcharodon carcharias* (Linnaeus, 1758), *Cetorhinus maximus* (Gunnerus, 1765), *Mobula mobular* (Bonnaterre, 1788)] e cinque nell'allegato III [specie che richiedono una gestione razionale; *Isurus oxyrinchus* Rafinesque, 1810, *Lamna nasus* (Bonnaterre, 1788), *Prionace glauca* (Linnaeus, 1758), *Rostroraja alba* (Lacepede, 1803), *Squatina squatina* (Linnaeus, 1758)]. Tali specie sono riprese, almeno in parte, dalla Convenzione di Berna. All'ultima riunione dei NFP (Malta, Giugno 2009) è stato proposto l'inserimento di altre 18 specie (3 dall'Allegato III al II) nell'Allegato II ed 11 nell'Allegato III. Per la CITES vengono presi in considerazione lo squalo bianco e lo squalo elefante. Preoccupanti sono le valutazioni dell'IUCN sullo stato di conservazione dei pesci cartilaginei, perché considera che il 42% delle specie mediterranee sia in pericolo, il 13% gravemente minacciato.

L'Italia avendo firmato le sopra menzionate convenzioni si è impegnata a migliorare la protezione di questi animali anche nel più ampio contesto del mantenimento della biodiversità attuando specifici piani di azione per la cui realizzazione sono indispensabili adeguate conoscenze. In questo contesto la DPNM del MiATTM ha voluto affidare alla SIBM un primo studio dal titolo "Elementi per la valutazione dello stato di sfruttamento e di conservazione degli elasmobranchi dei mari italiani", acronimo ELASMOIT.

L'obiettivo principale del progetto è quello di valutare lo stato di sfruttamento e le misure di conservazione dei pesci cartilaginei del mari italiani, con particolare riguardo alla frazione pelagica. Sulla base dei dati esistenti e della letteratura scientifica disponibile, il progetto si prefigge anche di riunire l'informazione reperibile e creare nel tempo stesso i presupposti per la costituzione di una rete di raccolta dati a livello nazionale. Tale rete potrebbe rappresentare in futuro un sicuro punto di riferimento per fornire utili indicazioni sulla gestione degli elasmobranchi, nonché nodo essenziale per futuri piani d'azione nazionali ed internazionali per la protezione dei selaci.

Per il raggiungimento degli obiettivi sopra indicati sono state proposte due attività:

1. una da svolgere in sede e consistente nell'analisi ed elaborazione dei dati disponibili, con lo scopo di fornire linee guida per la stesura di una proposta di piano nazionale. E' inoltre compresa la raccolta di dati morfologici, biometrici e biologici delle diverse specie su base bibliografica;
2. una di campo con rilevamenti nei luoghi di sbarco (anche mercati ittici) ed a bordo di natanti, in particolare barche che usano i palangari e nelle cui catture potrebbero essere presenti selaci.

Prima attività - Comprende i seguenti punti:

1. Creazione di un database per l'archiviazione delle referenze bibliografiche, dei lavori scientifici e della letteratura grigia, dei piani di azione per la protezione

e delle normative riguardanti la pesca e la protezione e conservazione degli elasmobranchi;

2. Produzione cartografica della distribuzione delle principali specie con indicazioni (ove possibile) sulla frequenza/abbondanza. Si è ritenuto importante inserire anche la cartografia relativa ad alcune specie demersali maggiormente sbarcate quali ad es. i Rajidae;
3. Raccolta dei parametri biologici disponibili per le diverse specie;
4. Raccolta dei dati relativi alla pesca (specie target, statistica delle catture commerciali, mestieri impiegati) nel tentativo di stimare il by-catch;
5. Revisione critica dei piani di azione del RAC/SPA, della FAO e di quello già proposto da un gruppo di lavoro coordinato dall'ICRAM, nonché delle valutazioni IUCN sullo stato di conservazione delle specie in Mediterraneo. Normative;
6. Produzione di linee guida al fine di sviluppare una proposta di Piano Nazionale Italiano e supporto scientifico al Ministero dell'Ambiente e della Tutela del Territorio e del Mare (MiATTM) per la eventuale futura stesura del Piano stesso.

Seconda attività - Consiste nell'esame dello sbarcato in alcuni porti campione e nelle osservazioni, ospiti a bordo di motopesca che operano in particolare con palangari per grandi pelagici e che, quindi, possono catturare anche selaci. L'attenzione è stata concentrata sulle specie pelagiche perché minori sono i dati delle loro catture e perché molte sono specie in grave pericolo. Per le specie demersali ci sono alcuni dati, come già detto provenienti dalle campagne MEDITS e GRUND.

Materiali e metodi - Sulla base delle conoscenze sulla pesca dei selaci in Italia e dell'esistenza di gruppi di ricerca con esperienza pluridecennale nella pesca dei grandi pelagici (in particolare tonno e pesce spada), sono stati scelti porti di sbarco in Liguria, Sardegna, Sicilia e Puglia.

In Liguria l'attività è stata svolta dal gruppo del DIP.TE.RIS., coordinato dalla prof.ssa Lidia Orsi Relini, in Sardegna è intervenuto il gruppo del prof. Angelo Cau (Dipartimento di Biologia Animale ed Ecologia, Università di Cagliari, in Sicilia il dott. Antonio Di Natale (Aquastudio, Messina), in Puglia il prof. Gregorio De Metrio (Dipartimento di Sanità e Benessere Animale, Fac. Medicina Veterinaria, Università di Bari). Come da programma l'attività di monitoraggio è stata condotta seguendo due linee diverse.

1) Rilevamenti dello sbarcato in alcuni porti campione, riguardanti il prodotto commerciale della pesca pelagica, della pesca a strascico e della piccola pesca costiera artigianale. In ognuna delle quattro regioni sopra menzionate sono stati scelti almeno due porti di sbarco, nei quali sono stati effettuati rilevamenti durante tutto il periodo interessato dalla ricerca, con massima attenzione a diversificare le osservazioni su attrezzi differenti. Contemporaneamente sono stati sensibilizzati pescatori e commercianti in modo da poter segnalare la cattura di individui di specie particolarmente rare o interessanti dal punto di vista faunistico.

2) Osservazioni compiute direttamente a bordo delle unità della pesca professionale. L'attenzione si è concentrata sulle imbarcazioni che operano con palangari di superficie per la cattura di grandi pesci pelagici (soprattutto tonno, alalunga e pesce spada), il cui *by-catch* spesso è rappresentato da elasmobranchi pelagici.

In Liguria sono stati scelti come porti di sbarco del pescato ed imbarco dei ricercatori Santa Margherita Ligure (prevalentemente strascico) e Sanremo (prevalentemente palangari di superficie e reti). In Sardegna sono stati monitorati gli sbarchi nei porti di Cagliari (strascico), Teulada (strascico) e Pallosu (palangaro pelagico). Imbarchi su palangaro di superficie (Arbatax e Pallosu) e palangaro di fondo (Pallosu). In Sicilia sono state effettuate 80 giornate di osservazioni sullo sbarco nei porti di Acitrezza (palangaro pelagico e di fondo), Marsala (palangaro pelagico e di fondo, strascico), Lampedusa (palangaro pelagico, tramaglio, strascico), Ponza (palangaro pelagico), Isola delle Femmine (palangaro pelagico, tramaglio).

Gli imbarchi per palangaro da pesce spada sono stati effettuati nei porti di Giardini e Lipari, per palangaro da alalunga a Lipari e Riposto. In Puglia le 80 giornate di osservazioni sullo sbarcato sono state nei porti di Gallipoli (ferrettara, palangaro, strascico) e Porto Cesareo (ferrettara, palangaro, 'schiavina' piccola rete pelagica), mentre gli imbarchi hanno avuto come punto di riferimento Porto Cesareo, 20 giornate con ferrettara e 14 con palangaro e 6 con 'schiavina'.

Per ogni imbarco sono state registrate le principali caratteristiche dell'attività di pesca (dati geografici, ora e punto di inizio e fine cala, numero di ami, numero di cale ecc.) e le catture complessive, non solo quelle di squali e razze, in modo da poter valutare meglio il rapporto tra catture delle specie target e *by-catch*, ossia la selettività degli attrezzi nei confronti degli elasmobranchi.

Sia allo sbarco che durante gli imbarchi, i vari individui sono stati determinati dal punto di vista specifico, misurati, pesati e si è determinato il sesso. Ove possibile sono stati raccolti campioni per successivi approfondimenti in laboratorio riguardanti aspetti della biologia delle specie. In alcuni casi particolari si è proceduto all'acquisto degli esemplari completi, quando questi presentavano caratteri di particolarità.

Schede di rilevamento dati - Il gruppo GRIS (Gruppo Ricercatori Italiani sugli Squali, razze e chimere) della Società Italiana di Biologia Marina (SIBM) si è occupato di stilare i protocolli di campionamento e di osservazione da utilizzare sia a bordo che a terra, durante il monitoraggio dello sbarcato. Sono state redatte tre diverse schede per il rilevamento dei dati, inoltre sono stati suggeriti anche punti importanti da tenere presenti nelle operazioni di campo:

- ✓ acquisire opportuno materiale iconografico utile alla corretta identificazione delle specie osservate sia a bordo che a terra;
- ✓ tentare di acquisire gli esemplari di specie rare (per esempio *Squatina* sp., *Rostroraja alba*, ecc.), al fine poi di conservarli in idonee strutture museali, come i musei di Genova, Napoli e Palermo;
- ✓ sollecitare il rilascio di eventuali esemplari catturati vivi di specie protette dalla Convenzione di Barcellona;
- ✓ analizzare la bibliografia disponibile inerente le chiavi di riconoscimento delle specie ittiche "toilettate" (eviscerate e spellate), al fine di un riconoscimento il più preciso possibile delle specie sbarcate.

Risultati - È iniziata una raccolta di dati bibliografici, sia di lavori pubblicati che di letteratura grigia, per un totale di 357 citazioni. Sono state preparate diverse tipologie di cartine di distribuzione delle principali specie. Per quanto riguarda la raccolta dei dati sui parametri biologici disponibili in letteratura (punto 3), sono state presentate informazioni su 83 specie (quindi non solo quelle italiane) e, per 10 di queste che rappresentano quelle di maggior interesse conservazionistico e gestionale in ambito pelagico, è stata preparata una scheda. Tutto questo materiale è stato riunito in un DVD, consegnato al Ministero.

La pesca dei condroitti in termini di sbarcato nazionale (punto 4) - Al momento attuale, le statistiche di cattura sono disponibili solo in base alla struttura del programma comunitario "*Data Collection Regulation*", e come previsto dal Programma Nazionale di Raccolta di Dati Alieutici, quindi sulla base di una segmentazione per attrezzo prevalente.

Ciò comporta che non necessariamente la cattura di una specie sia riferibile all'attrezzo che l'abbia veramente catturata, quanto genericamente all'attrezzo prevalentemente usato da quelle unità, le cui catture, sommate, vengono uniformemente attribuite all'attrezzo principale.

Questo fatto pone una difficoltà non irrilevante sia nella lettura dei dati, sia nelle verifiche di coerenza, dato che specie bento-nectoniche potrebbero facilmente trovarsi tra le catture di attrezzi pelagici o viceversa.

Anche la determinazione delle specie necessiterebbe di verifiche ulteriori, in quanto non sempre esse sono facilmente distinguibili da rilevatori non specialisti. Ciò si aggiunge al fatto che in alcune marinerie i condroitti vengano sbarcati privi di pelle (soprattutto Rajformi e piccoli Squaliformi) o privi di capo e coda (soprattutto alcuni grandi squali pelagici), rendendo molto problematica l'identificazione allo sbarco. Ulteriore confusione nell'identificazione è causata dai nomi comuni, che talvolta identificano con il medesimo appellativo specie diverse, non sempre ben note agli stessi pescatori.

Di fatto, in base ai dati forniti dall'IREPA, relativi all'anno 2008 (Tab. 1), la flotta da pesca italiana ha dichiarato catture ufficiali di condritti per un totale di oltre 1375 tonnellate, in massima parte Squaliformi; tutte le quantità si riferiscono a quantità sbarcate e commercializzate, non a catture effettive, che sono certamente molto più elevate, visto che diverse specie vengono ributtate in mare, in quanto poco commerciabili, talvolta in base alle caratteristiche del mercato delle varie località. Certamente, specie poco frequenti o rare, che pure rientrano tra le catture commercializzate, sono state inserite tra le specie riportate, ma da questa statistica non è possibile trarre indicazioni ulteriori.

Mantenendo le riserve sopra citate sulla identificazione specifica delle catture, la specie maggiormente catturate secondo i dati statistici sono *Raja clavata* Linnaeus, 1758 (23,87%, paria a 328 t), *Mustelus punctulatus* Risso, 1826 (20,12%, pari a 277 t), *Raja* spp. (19,28%, pari a 265 t), *Prionace glauca* (Linnaeus, 1758) (15,14%, pari a 208 t) e *Scyliorhinus canicula* (Linnaeus, 1758) (8,49%, pari a 117 t). Le quantità delle altre specie sono decisamente minori, mentre 10 specie su un totale di 19 hanno evidenziato quantità inferiori, ognuna, all'1% del totale.

Per quanto riguarda gli attrezzi che effettuano queste catture, sempre in base alle statistiche dettagliate fornite nell'ambito del Programma Nazionale di Raccolta dei Dati Alieutici, il sistema di pesca che mostra le catture più elevate di condritti è lo strascico, inteso nel suo complesso. Infatti, i pescherecci armati con reti a strascico con divergenti catturano circa il 62% del totale dei condritti sbarcati, pari a circa 852 t.

La gran parte dei condritti catturati dalle reti a strascico sono Rajiformi *sensu lato* seguiti da diversi squaliformi, e ciò è strettamente correlato al tipo di attrezzo. Quali siano effettivamente le specie sbarcate costituisce un problema di non facile soluzione, dato che le specie vengono solitamente mescolate all'interno delle cassette, rendendo non facile l'identificazione allo sbarco. Inoltre, gli esemplari più grandi vengono talvolta sbarcati spellati o viene commercializzata solo la parte laterale del corpo, rendendo molto difficoltosa od addirittura impossibile l'identificazione specifica. Ad esempio, si ha il sospetto che le catture relative all'aquila di mare [*Myliobatis aquila* (Linnaeus, 1758)] possano riguardare in parte altre specie, talvolta chiamate con nomi simili, ma senza una verifica specifica, una migliore determinazione diviene difficile. Questo sistema di pesca cattura, ovviamente, anche altre specie di condritti demersali, tra cui diversi squaliformi. Tra i quali, il più abbondante è il *Mustelus punctulatus* Risso 1826, con circa 131 t, seguito dal gattuccio [*Scyliorhinus canicula* (Linnaeus, 1758)], con circa 95 t.

Le reti da posta sono una vasta categoria di attrezzi che, sulla base degli sbarchi ufficialmente registrati, catturano circa il 25.5% dei Condritti, pari a circa 350 t.

Tab. 1 - Catture (Kg) di condritti in base alle statistiche ufficiali della flotta italiana durante l'anno 2008 (fonte IREPA).
Catches (Kg) of chondrichthyes during 2008 from official statistical data of Italian fleet (from IREPA).

Specie	**Reti**		**Nasellara**		**Palangaro**		**Volante**		**Divergente**		**Totale**	
	catture kg	cv	catture kg	cv	catture kg	cv	catture kg	cv	catture kg	cv	catture kg	cv
Alopias vulpinus	3.867	0,26104					1.272	0,41095			5.139	0,22121
Carcharhinus plumbeus							351	0,73615			351	0,73615
Dasyatis spp.									42	0,61983	42	0,61983
Galeus melastomus			337	0,85423					8.149	0,50876	8.486	0,48973
Heptranchias perlo			30.335	0.88381							30.335	0,88381
Hexanchus griseus									1.584	0,81031	1.584	0,81031
Lamna nasus					1.138	0,54950			199	0,49416	1.337	0,4937
Mustelus asterias	43	0,96937							346	0,86052	389	0,78649
Mustelus mustelus									21.089	0,36070	21.089	0,36070
Mustelus punctulatus	145.549	0,28166			388	0,55428	171	0,82816	130.537	0,13604	276.645	0,15819
Myliobatis aquila	2.153	0,36183							1.437	0,69149	3.590	0,34952
Prionace glauca	41.960	0,78796			153.329	0,44203			12.848	0,41179	208.137	0,39035
Raja clavata	63.396	0,20276			3.362	3,34939			261.479	0,08328	328.237	0,07711
Raja miraletus	191	0,90354							39.944	0,20134	40.136	0,20041
Raja spp	44.581	0,42303			544	2,09626			220.046	0,07955	265.171	0,09530
Scyliorhinus canicula	16.755	0,27833			2.989	0,64911			97.064	0,11749	116.808	0,10679
Scyliorhinus stellaris	231	0,68674									231	0,68674
Squalus acanthias	252	0,52271			389	0,68396	20	0,78961	64.122	0,19023	64.782	0,18839
Squalus blainvillei									2.705	0,47681	2.705	0,47681
Totale specie	318.978	0,16916	30.672	0,87416	162.139	0,39584	1.813	0,29328	861.591	0,05692	1.375.193	0,06246

I palangari nel loro complesso mostrano sbarchi equivalenti a circa l'11,8% del totale dei condritti, pari a circa 162 t. In questo caso, la specie più commercializzata risulta essere la verdesca (*Prionace glauca*), con oltre 153 t: è evidente che si tratta di catture ottenute con palangari pelagici, così come quelle di *Lamna nasus* (circa 1,1 t); al contrario, le catture di *Raja clavata* (circa 3,4 t) e di *Scyliorhinus canicula* (circa 3 t) sono riferibili a palangari fissi e di fondo. La statistica, in questo caso, rispecchia poco le catture effettive, poiché è noto come la specie più catturata dai palangari pelagici sia il Trigone viola [*Pteroplatytrygon violacea* (Bonaparte, 1832)] che, però, viene raramente tratto a bordo o sbarcato e commercializzato. Analogamente, anche la verdesca può essere liberata o meno in base alle tradizioni locali e al basso prezzo di mercato in varie zone.

Interessanti sono anche le catture ottenute dai pescherecci armati con reti volanti, che sbarcano circa 1,8 t di condritti (pari allo 0,13% del totale), tutti squaliformi. In questo

Tab. 2 - Catture (t) di cartilaginei in Italia per attrezzo di pesca (IREPA).
Catches (t) of elasmobranchs fished in Italy by different gears (IREPA).

Raiformi	Strascico	Pelagico	Volante	Circuizione	Draghe	Piccola pesca	Polivalenti	Polivalenti passivi	Palangari	Flotta tonno	Totale
2003	426	1	0	0	0	180	24	10	0	8	649
2004	1095	0	0	3	0	166	30	5	1	0	1301
2005	1041	0	0	2	0	157	3	14	8	0	1224
2006	772	0	0	0	0	102	0	43	5	0	922
2007	713	0	0	0	0	132	0	36	3	0	884

Squaliformi	Strascico	Pelagico	Volante	Circuizione	Draghe	Piccola pesca	Polivalenti	Polivalenti passivi	Palangari	Flotta tonno	Totale
2003	406	5	0	0	1	333	148	21	0	13	927
2004	308		38	6	0	517	10	21	50	0	951
2005	412		5	6	0	803	0	18	43	0	1287
2006	520		147	0	0	187	0	19	104	0	977
2007	449		1	0	0	351	0	149	57	0	1008

Tab. 3 - Catture (t) degli elasmobranchi per regione e per anno (IREPA).
Catches (t) of elasmobranchs per year and region (IREPA).

	2003		2004		2005		2006		2007	
	squaliformi	raiformi	squaliformi	raiformi	squaliformi	raiformi	squaliformi	raiformi	squaliformi	raiformi
Liguria	14	3	12	11	3	21	16	14	5	2
Toscana	5	41	5	97	4	85	16	67	27	60
Lazio	3	37	1	210	5	167	22	105	9	91
Campania	66	51	0	111	2	65	1	43	0	45
Calabria	2	1	0	2	1	3	0	0	4	0
Puglia	101	63	97	101	150	99	113	103	167	57
Abruzzo*	5	26	3	63	1	50	129	31	1	20
Molise	vd.Abruzzo		vd.Abruzzo		0	7	2	8	1	8
Marche	291	62	144	79	162	96	189	103	125	65
Emilia Romagna	11	3	17	2	7	2	5	2	4	2
Veneto	60	1	178	2	163	3	230	5	84	5
Friuli Venezia Giulia	250	3	407	11	631	13	158	3	154	3
Sardegna	24	98	14	248	63	313	91	171	263	172
Sicilia	83	252	72	364	95	300	128	268	162	354

*Il 2003 ed il 2004 dell'Abruzzo comprendono anche i dati del Molise
**The data of Abruzzo in 2003 and 2004 are added to those of Molise*

caso, le catture maggiori sono di *Alopias vulpinus* (Bonnaterre, 1788) (1,3 t), ma esistono anche catture di *Carcharhinus plumbeus* (Nardo, 1827) (0,4 t) e *Mustelus punctulatus* (0,4 t).

Per quanto riguarda il Piano d'Azione Nazionale (punto 5), è stata fornita una revisione critica di quelli pregressi presentati dalla FAO IPOA-sharks, dell'UNEP-MAP RAC/SPA e di quello preparato alcuni anni fa dall'ICRAM (FAO, 1998; Serena *et al.*, 2002; UNEP, 2003), nonché delle raccomandazioni dell'UE. È stata anche fatta una panoramica sugli strumenti normativi riguardanti la tutela delle specie di Elasmobranchi nei paesi del Mediterraneo e le valutazioni dell'IUCN. Lo *Species Survival Commission's Shark Specialist Group* (SSG) recentemente (2007) ha portato a termine un programma decennale relativo alla valutazione dello stato di conservazione delle varie specie di pesci cartilaginei del Mediterraneo ed ha compilato una Red List. Tutto ciò è stato possibile grazie ad un *Global Shark Red List Assessment* che ha coinvolto un gran numero di specialisti impegnati nei numerosi workshop tematici regionali. Applicando i criteri della *Red List* furono valutate 71 specie delle circa 84 che vivono in Mediterraneo. I risultati sono stati pubblicati in un rapporto (Cavanagh e Gibson, 2007). Aspetti dettagliati sullo stato di

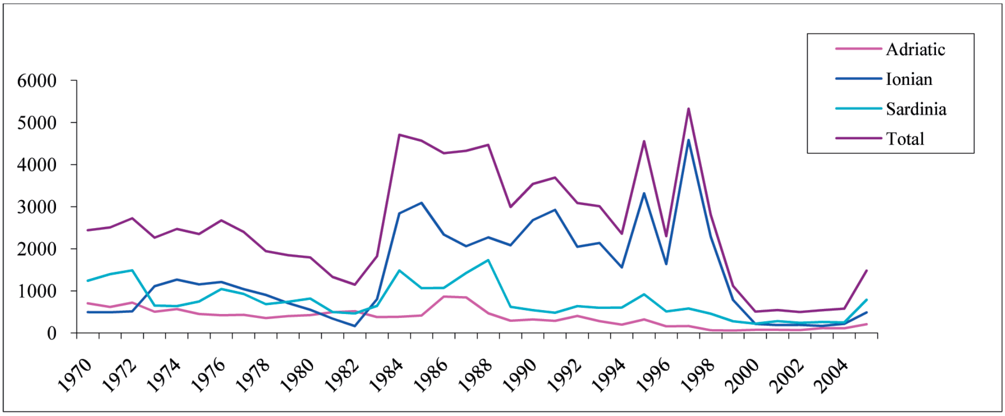

Fig. 1 - Catture (t) dei Raiformi in Italia dal 1970 al 2005 (FAO).
Catches (t) of Raiformes in Italy from 1970 to 2005 (FAO).

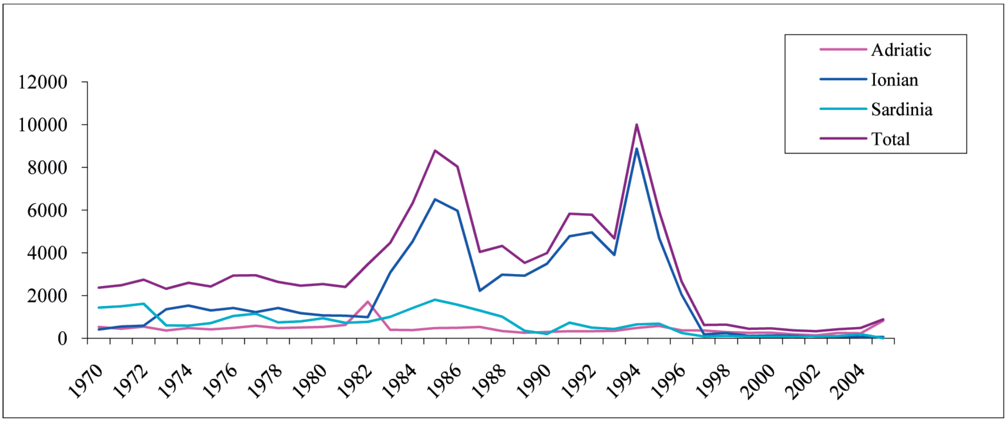

Fig. 2 - Catture (t) degli Squaliformi in Italia dal 1970 al 2005 (FAO).
Catches (t) of Squaliformes in Italy from 1970 to 2005 (FAO).

conservazione di ogni specie mediterranea possono essere consultati direttamente nel sito web dell'IUCN (www.iucnredlist.org), il quale viene costantemente aggiornato e reso disponibile. Lo IUCN-SSG *Global Shark Red List Assessment* ha concluso che il Mar Mediterraneo mostra una percentuale più alta di specie minacciate rispetto ad altre regioni esaminate. Il 42% (30 specie) dei pesci cartilaginei del Mediterraneo è stato valutato come *Threatened* (in pericolo), il 13% *Critically Endangered* (gravemente minacciato), l'11% *Endangered* (minacciato), il 13% *Vulnerable* (vulnerabile), il 18% *Near Threatened* (quasi a rischio), il 14% *Least Concern* (a rischio relativo). Questi dati sono ancora più preoccupanti se si tiene conto che per il 26% delle specie i dati sono insufficienti, si tratta spesso si specie rare come quelle appartenenti ai generi *Pristis*, *Sphyrna*, *Squatina*, *Rhinobatos.*

Sulle base di tutte queste analisi sono state quindi elaborate le linee guida essenziali (punto 6) per un Piano d'Azione Nazionale per la Conservazione e Gestione dei pesci Cartilaginei. Questo documento, oltre a radicarsi nel quadro della Convenzione di Barcellona e nel Contesto più ampio della Convenzione UNCLOS e del suo Accordo per le Specie Transzonali e Altamente Migratorie delle Nazioni Unite (vedi Accordo Straddling Stock, Appendice A), trova inoltre ragion d'essere nel contesto internazionale promosso dalla FAO e dalla U.E.

Questo documento si compone di tre Parti e otto Temi per un totale di 21 Azioni.

Tab. 4 - Sbarcato della pesca a strascico. Percentuale in peso delle diverse specie.
Otter trawl landings. Percent weight of different species.

STRASCICO	LIGURIA	SARDEGNA		SICILIA		PUGLIA
	S. Margherita Lig.	**Cagliari**	**Teulada**	**Marsala**	**Lampedusa**	**Gallipoli**
n. giornate	41	21	6	5	4	27
tot. Sbarcato (kg)	23'678.00	5'942.96	1'666.02	663.00	264.00	8'687.00
Tot. Condroitti (kg)	217.00	325.17	108.30	344.00	20.00	344.00
% condroitti	0.92	5.47	6.50	51.89	7.58	3.96
n. specie	6	10	7	4	3	3
Galeus melastomus	62.25					
Etmopterus spinax		0.82				
Scyliorhinus canicula	21.19	35.92	40.77		3.31	
Centrophorus granulosus		13.29	11.75			
Squalus blainvillei		5.55	1.93			
Prionace glauca						4.65
Mustelus mustelus					84.99	
Mustelus sp.				45.03		
gattucci'				0.32		
razze'				3.49		
Dasyatis pastinaca		0.82				
Rostroraja alba					11.70	
Raja asterias	16.49	6.10	13.56			
Raja clavata	0.08	30.64	18.98	51.16		
Raja miraletus		4.35				
Raja polystigma		1.45	7.95			
Rostroraja brachiura		1.06	5.06			
Squatina sp.						28.49
Torpedo sp.	6.83					

Per ciascuna di queste Azioni è indicato il grado di priorità (A, B e C) in funzione dell'urgenza richiesta e del tempo di realizzazione.

La prima Parte elenca 10 azioni prioritarie da portare a compimento in tre anni. I Temi 1, 2 e 3 riguardano le specie protette o considerate minacciate e quindi ricadenti in un ambito di competenza del Ministero dell'Ambiente, del Territorio e del Mare. I Temi 4 e 5 della Parte A sono relativi allo sfruttamento sostenibile delle risorse ittiche, e quindi ricadono in un ambito di competenza del Ministero delle Politiche Agricole Alimentari e Forestali.

La parte B, di competenza di entrambi i Ministeri, analizza sia lo stato di conservazione, sia lo sfruttamento dei pesci cartilaginei, la cui presenza è regolarmente segnalata in Mediterraneo, nonché le strategie di intervento per contrastare le minacce.

Infine la Parte C comprende le schede biologiche di ogni singola specie, gli strumenti legislativi riguardanti i pesci cartilaginei e un elenco delle fonti bibliografiche usate nel documento.

Per quanto riguarda le attività di campo riportiamo solo alcuni dei dati più salienti per lo sbarcato dello strascico (Tab. 4) e dei palangari pelagici (Tab. 5) e per le osservazioni fatte a bordo di natanti con palamiti di superficie e ferrettara (Tab. 6). Nello sbarcato dello strascico sono state rilevate 17 specie di elasmobranchi più due categorie generali 'gattucci' e 'razze', che possono riferirsi a

Tab. 5 - Sbarcato (n° individui) della pesca con palangaro pelagico e ferrettara.
Landing (n° of individuals) of surface longline fishery and ferrettara (driftnet).

	LIGURIA	**SARDEGNA**	**SICILIA**			**LAZIO**	**PUGLIA**		
		Pallosu	**Acitrezza**	**Marsala**	**Lampedusa**	**Ponza**	**Porto Cesareo**	**Porto Cesareo ferrettara**	**Gallipoli**
n. giornate	50	7	7	13	5	16	18	16	12
n. cale	116								
pesci ossei (%)	21		3.23	15.14	3.45	1.53	10.77	13.54	22.83
condritti (%)	21		3.23	15.14	3.45	1.53	10.77	13.54	22.83
Prionace glauca	86	6		3		1	96	32	61
Isurus oxyrinchus			1	4	1	1			
Pteroplatytrygon violacea		21							
Alopias vulpinus				4		1			
Galeorhinus galeus				22					
Mobula mobular							6	25	10

Tab. 6 - Catture (n° individui) della pesca con palamito pelagico e ferrettara (osservazioni a bordo dei motopesca).
Catch (n° of individuals) of surface longline and ferrettara (observations on board).

	LIGURIA	**SARDEGNA**		**SICILIA**				**PUGLIA**	
		Pallosu	**Arbatax**	**Lipari**	**Giardini**	**Mar Libico**	**Tirreno Merid.**	**Porto Cesareo**	**Porto Cesareo ferrettara**
n. giornate	132	11	5	2	4	9	5	14	20
pesci ossei (%)	51.15	71.4	58	94.44	99.29	83.69	62.75	27.52	90.13
condritti (%)	48.85	28.57	41.67	5.56	5.71	9.15	23.45	72.48	9.87
n. specie	3	1	2	1	2	1	1	2	2
Prionace glauca	8		2					37	13
Pteroplatytrygon violacea	30	8	3	1	1	485	445	200	
Isurus oxyrinchus	1								
Somniosus rostratus					1				
Mobula mobular									31

qualcuna delle 17 specie. La maggior ricchezza specifica risulta in Sardegna, dove le razze raggiungono il 43-45% dei selaci. Incredibilmente basso è il numero di specie a Lampedusa ed a Gallipoli. Nello sbarcato dei palamiti pelagici le specie sono ridotte a 6 e la percentuale dei selaci nel pescato sbarcato oscilla dal 2 al 23%. Il numero di specie si riduce a 4 (5 se si tiene conto delle ferrettara) nelle catture osservate a bordo dei natanti che usano il palamito di superficie. La specie maggiormente catturata è *P. violacea*, che fa alzare di molto la percentuale dei selaci rispetto al pescato totale.

Conclusioni e considerazioni - *ELASMOIT* ha dato inizio ad un percorso di acquisizione delle informazioni che costituiscono fonte prioritaria per l'impostazione di qualsiasi programma di ricerca e speriamo possa proseguire per approfondire in particolare le problematiche legate alla pesca. I dati raccolti sulle catture dei selaci, anche se limitate per ovvie ragioni di tempo e mezzi, consentono un aggiornamento dei dati della letteratura. Le Linee Guida formulate in questo progetto hanno, come riferimento principale, il monitoraggio delle attività di pesca che direttamente o indirettamente agiscono sugli stocks dei pesci cartilaginei.

Il progetto *ELASMOIT* ha quindi fornito risultati tesi a migliorare le conoscenze sui condroitti presenti nei mari italiani, con particolare riguardo agli squali pelagici.

Nel confronto preliminare tra i dati storici e quelli ottenuti dalle attività di campo emergono alcune criticità che confermano l'attuale stato di depauperamento di questa importante frazione del popolamento ittico dei nostri mari, sia in termini di numero di specie, sia di abbondanza. Il depauperamento è ancor più marcato se si prendono a confronto vecchi lavori; è interessante l'esame delle specie elencate da Faber (1883) per l'Adriatico, con qualche annotazione sulla frequenza, da Parona (1898) per il mercato di Genova, da D'Ancona e Razzauti (1935) per l'Arcipelago Toscano. Importanti sono anche i materiali museologici (Mancusi *et al.*, 2000; Psomadakis *et al.*, 2009). Molte specie un tempo comuni tra i prodotti della pesca oggi sono rare o rarissime. Nei casi in cui è possibile valutare la struttura della popolazione, di solito si registrano preoccupanti diminuzioni della taglia media. Durante 16 anni di campagne di pesca Medits non sono state riscontrate variazioni significative (Relini *et al.*, 2010) sia in termini di numero di specie sia di biomassa degli squali demersali, mentre risulta una diminuzione nel numero di specie se il confronto viene fatto con dati delle campagne GRUND precedenti il 1994. Maiorano *et al.* (2000) in 6 campagne di pesca a strascico (1996-98) nel Mar Ionio nord-occidentale hanno rinvenuto 8 specie di selaci e segnalano un rendimento medio di 1,26 kg/h ed una cattura del 6,3% della cattura totale media; valori superiori a quelli riportati in Tab. 4 per lo sbarcato di Gallipoli sia in numero di specie che di rendimento; ovviamente occorre tener presente che alcune specie non vengono sbarcate.

Per quanto riguarda le specie pelagiche i dati da noi raccolti sono piuttosto preoccupanti per il numero ridotto di specie catturate e di biomassa. Le due specie maggiormente catturate dal palamito (Tab. 5 e 6) sono *Pteroplatytrygon violacea*, normalmente non commercializzata, e *Prionace glauca*, lo squalo di gran lunga più diffuso, superando il 96% degli squali catturati in Adriatico e Ionio con la pesca al tonno e al pescespada (Megalofonou *et al.*, 2005). In Mar Ligure era undici volte più abbondante dell'insieme di tutti gli altri squali pelagici d'altura catturati con il palamito (Orsi Relini 2000). Ulteriori dati sono disponibili in Orsi Relini *et al.*, 1999, De Zio *et al.*, 2000, De Metrio *et al.*, 1984, Filanti *et al.*, 1986, Di Natale, 1998. Vale la pena di soffermarsi maggiormente su un'importante ricerca (Megalofonou *et al.*, 2005) svolta per due anni (1998-99) sugli squali catturati in Mediterraneo dagli attrezzi usati per la pesca del tonno e del pesce spada. Sono state monitorate 5826 giornate di pesca e 5124 luoghi di sbarco e sono state fatte 702 osservazioni a bordo di natanti, in totale sono stati esaminati 8733 squali (153,6 t biomassa) e 131912 pesci di altri gruppi (teleostei, razze, trigoni, ecc.). In totale gli squali rappresentano il 6,2% in numero e 13,5% in biomassa delle catture della pesca al tonno ed al pesce spada. Sono state identificate 12 specie, di cui la più comune è la verdesca (*Prionace glauca*) con 8295 individui sul totale di 8733, cioè il 95%, seguita dal mako (*Isurus oxyrinchus*) con 321 individui, *Alopias vulpinus* con 62 individui, *Galeorhinus galeus* (19), *Lamna nasus* (15), *Alopias superciliosus* (7), *Sphyrna zygaena* (4), *Haxanchus griseus* (3), *Carcharinus plumbeus* (2), *Squalus blainvillei* (2), *Cetorhinus maximus* (2) e *Mustelus mustelus* (1). Tra i mari italiani esaminati l'Adriatico è risultato quello con la più alta cattura di squali (2064 di cui il 99,5% verdesca), seguito dallo Ionio con 974 di cui 96% verdesca, 11 squali (3 verdesca) nello Stretto di Sicilia, ma le osservazioni sono state solo 32, contro le 777 dell'Adriatico e le 1548 dello Ionio, di cui 715 fatte sulle reti derivanti. La cattura degli squali varia da zona a zona e dipende dall'attrezzo. Le catture maggiori in biomassa (pari al 17,7%) sono state ottenute con i palamiti da pesce spada, l'11,3% con le reti derivanti e solo lo 0,3% con il palamito da alalunga. Le massime catture cono state osservate nel Mare di Alboran con il 34,3% di squali ed in Adriatico con il 15,11%; le minime nello Stretto di Sicilia con 0,89%. In termini di CPUE ad Alboran sono stati raggiunti 3,8 squali per 1000 ami ed in Adriatico 1 squalo per 1000 ami nei palamiti del pesce spada. Per la rete derivante sono stati ottenuti 0,04 squali per 1000 m di rete. È stata segnalata l'alta percentuale di squali vivi issati a bordo (solo circa il 50% erano morti; nel caso della verdesca il 97% degli individui era vivo) e ciò è molto importante per misure di conservazione e protezione di questi pesci.

In alcune zone, come ad esempio in Adriatico, è stata segnalata una diminuzione delle taglie di verdesca negli anni (Pomi, 1977; De Zio *et al.*, 2000), evidente segno di sovra sfruttamento.

Tale situazione di *over-fishing*, analoga a quella che si sta verificando su scala globale (Dulvy *et al.*, 2008), pone notevoli apprensioni per la tutela di questi pesci. Per contrastare questa tendenza la FAO, nel 1998, ha lanciato il Piano d'Azione Internazionale per i pesci cartilaginei (*IPOA-SHARKS*), chiedendo a tutti gli stati di sviluppare, su base nazionale e di concerto con i paesi confinanti, piani di gestione per la salvaguardia e il recupero delle popolazioni dei condroitti.

Nel 2009 l'UE, attraverso il Consiglio d'Europa, ha approvato, all'unanimità, le linee guida del Piano d'Azione Europeo per la tutela e gestione dei pesci cartilaginei, primo passo verso una specifica Direttiva in materia. In questo contesto l'Italia, con i risultati del progetto *ELASMOIT*, benché preliminari, risponde prontamente all'orientamento dell'UE, dimostrando sensibilità e concretezza, essendosi dotata di specifiche linee guida, anche se dovranno essere ulteriormente approfondite al fine di consentire la formulazione di un reale Piano Nazionale di Azione.

In conclusione, dal progetto è emersa l'impellente necessità di migliorare le conoscenze, in particolare per quanto riguarda la distribuzione spazio-temporale di questi pesci e la loro cattura con i diversi attrezzi da pesca e l'urgenza di concrete misure di protezione degli elasmobranchi e di quelli pelagici in particolare. Ciò sarà possibile solo grazie ad una seria ed intensa collaborazione tra il MiAATM ed il MiPAAF e tra ricercatori esperti di pesca e di condroitti ed i pescatori. Non è un compito facile anche perché è impensabile il totale divieto di utilizzare quegli attrezzi di pesca che maggiormente catturano elasmobranchi. Ma è una sfida che occorre vincere se vogliamo la sopravvivenza di questi pesci nel Mare Nostrum.

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TEMPORAL EVOLUTION OF LANDINGS OF ELASMOBRANCHS IN TUSCANY (MEDITERRANEAN SEA)

EVOLUZIONE TEMPORALE DELLO SBARCATO DI ELASMOBRANCHI NEI MARI TOSCANI

Abstract *– The time series of landings per unit of effort of some elasmobranch species/category by the Porto S. Stefano and the Viareggio bottom trawl fleets were analyzed by means of Min/Max Auto-correlation Factor Analysis. This approach was useful to highlight the increasing trend of such species during the investigated period (1991-2008). The trends were positively affected by the reduction of fishing effort in both Porto S. Stefano and Viareggio trawl fleets. The effects of the environmental variables were significant as well.*

Key-words: *bottom trawling, shark fisheries, landings, time series, Mediterranean Sea.*

Introduction – Sharks and rays appear to be particularly vulnerable to fishing exploitation. The biological characteristics of elasmobranchs, such as low fertility, low growth rate and late maturity, make them vulnerable to drastic increases in mortality rates. Shark depletion, however, often goes unnoticed and the capture may continue for many years, as fisheries are sustained by the more productive target fishes). Given the mainly artisanal and semi-industrial aspects of Mediterranean fisheries, and the relatively low economic value of elasmobranchs, fishery statistics are rarely adequately reported (Ferretti *et al*., 2005). Notwithstanding these problematics, previous studies carried out in different Mediterranean areas highlighted that shark species diversity and biomass have decreased in the last century due to fishing pressure (Abella & Serena, 2002; Ferretti *et al*., 2005).

The present study aims to investigate the temporal variations of landings per unit of effort (LPUE) of elasmobranchs in Tuscany through the analysis of the time series of data obtained from landing and effort monitoring surveys. In addition, the temporal evolution of LPUEs was related to three explanatory variables: overall fishing effort indices, superficial seawater temperature (SST) and North Atlantic Oscillation (NAO) index.

Materials and methods – During the period 1991-2008, landing and effort data were collected monthly at the auctions of Porto S. Stefano and Viareggio. Monthly landings per unit of effort (LPUE) were calculated (as kg/day/vessel) for the Black mouth catshark, *Galeus melastomus*, the Small-spotted catshark, *Scyliorhinus canicula*, the Longnosed skate, *Dipturus oxyrinchus*, and for the commercial category "Rays" from the Porto S. Stefano data. As concerns Viareggio data, the LPUE were computed (as kg/h) for the Black mouth catshark, the Small-spotted catshark, and the Starry ray, *Raja asterias*. To investigate the effect of hydrological conditions on LPUEs, mean monthly values of SST (°C) and NAO index were collected from www.pfeg.noaa.gov archives. Overall trawl fishing effort indices were computed as days at sea per month (Porto S. Stefano), and hours at sea per month by shelf and slope (Viareggio). Data exploration and analysis were performed using the software package Brodgar 2.6.6 (www.brodgar.com). All the time series were standardized and explored by means of the auto- and cross-correlation functions to highlight the presence of cyclic patterns in time series and to highlight potential relationship between two variables. Cyclic patterns were removed from the data through the seasonal decomposition by Loess smoothing. The trends obtained were further analysed through Min/Max Auto-correlation Factor Analysis (MAFA) (Solow, 1994), which extracts trends from multiple time series. In MAFA, the first axis has the highest auto-correlation with time lag 1, thus it represents the main pattern in the data: a trend is associated with high auto-correlation with time lag 1. Correlations between the variables and the trends were computed to evaluate the significance of their relationship.

Results – The time series of the elasmobranchs LPUEs and the explanatory variables are summarized in Figs. 1 and 2. The fishing effort by the Porto S. Stefano fleet highlighted a general decreasing pattern, while the effort by the Viareggio fleet showed two scenarios: a decrease on the shelf and an increase on the slope. The presence of cyclical components with time lag 12 was found using the auto-correlation function; thus, the series were deseasonalized.

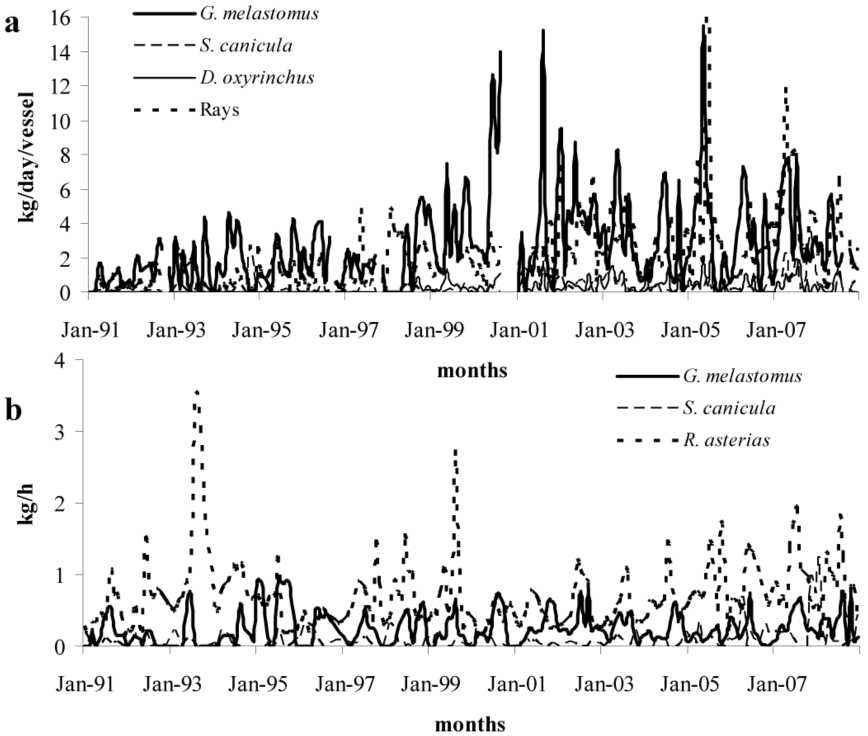


Fig. 1 - Porto S. Stefano (a) and Viareggio (b): time series plot of the mean monthly LPUE (kg/day/vessel and kg/h, respectively).

Porto S. Stefano (a) e Viareggio (b): serie temporali di LPUE (kg/giorno/barca e kg/h, rispettivamente).

From the Porto S. Stefano data set, an increasing common trend was extracted by means MAFA, positively correlated to all the response variables and SST, and

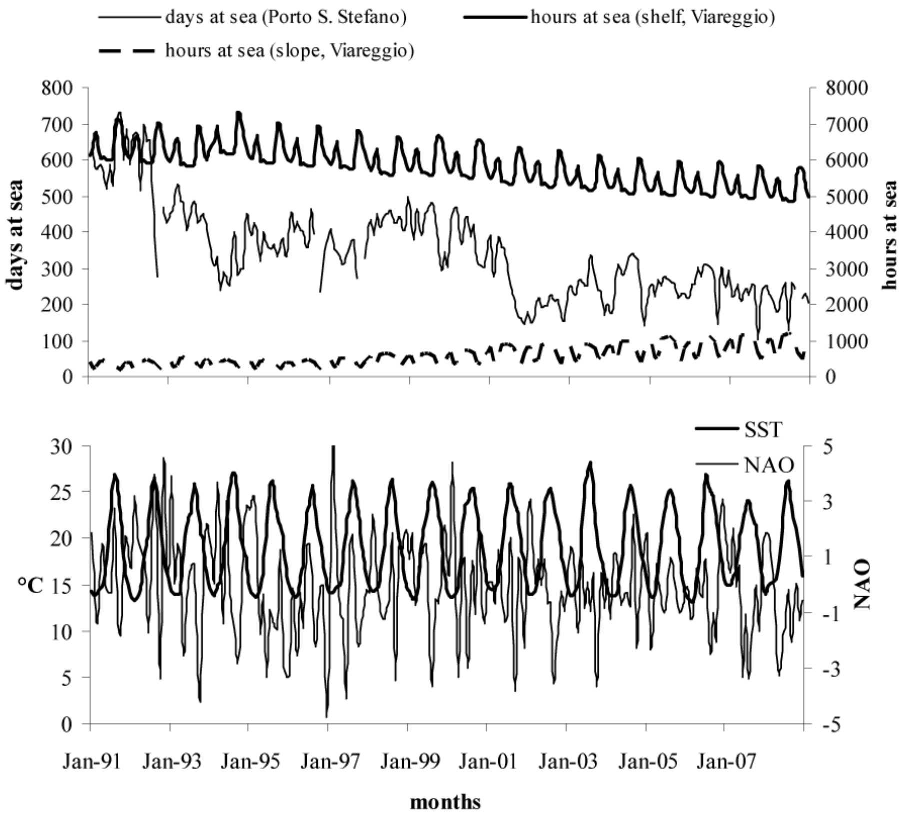
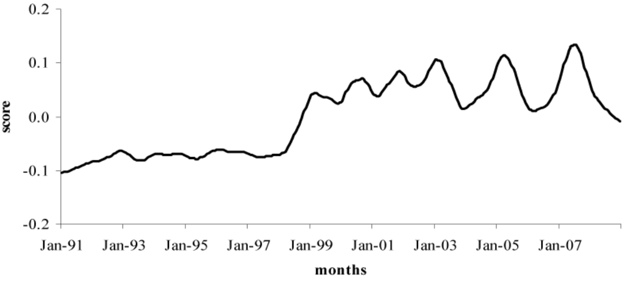


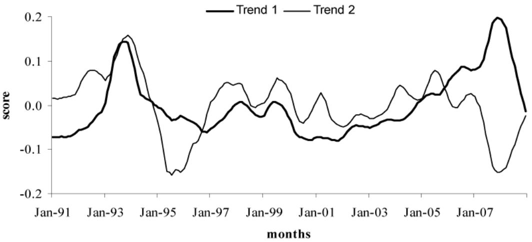
Fig. 2 - Time series plot of the mean monthly values of the explanatory variables.
Serie temporali delle variabili esplicative.

negatively correlated to the fishing effort (Fig. 3). As concerns Viareggio, two trends were computed: the first trend significantly related to *S. canicula*, *R. asterias*, and the fishing effort, the second to *G. melastomus* and the NAO index (Fig. 4).



response variables	Correlations
G. melastomus	**0.91**
S. canicula	**0.62**
D. oxyrinchus	**0.85**
Rays	**0.98**
explanatory variables	
days at sea	**-0.71**
SST	**0.57**
NAO	-0.22

Fig. 3 - Porto S. Stefano: trend estimated with MAFA and correlations between variables and trend (significant correlations are in bold, $p<0.05$).
Trend calcolato con MAFA e correlazioni tra variabili e trend (valori significativi, $p<0.05$, in grassetto).



	Trend 1	**Trend 2**
response variables	**Correlations**	**Correlations**
G. melastomus	0.07	**-0.83**
S. canicula	**0.77**	-0.34
R. asterias	**0.84**	0.26
explanatory variables		
hours at sea (shelf)	**-0.35**	0.26
hours at sea (slope)	**0.41**	-0.23
SST	-0.11	0.05
NAO	-0.12	**0.63**

Fig. 4 - Viareggio: trends estimated with MAFA and correlations between variables and trends (significant correlations are in bold, p<0.05).

Trend calcolati con MAFA e correlazioni tra variabili e trend (valori significativi, p<0.05, in grassetto).

Conclusions – The application of MAFA highlighted the presence of three trends underlying in the multi-species data sets. The available evidence suggests that the reduction of fishing effort should have mainly driven these trends. The trawl fleet capacity in Porto S. Stefano decreased of almost 50% since 1990s (Sbrana *et al.*, 2006). This reduction was mainly due to the Common Fishery Policy. The Viareggio trawl fleet suffered a less sharp decrease in capacity, whereas the fishing effort showed a sharp shift from the continental shelf to the slope. The reduction of fishing effort on the shelf favoured the biomass increase of *S. canicula* and *R. asterias*. The trend of the deep-water species *G. melastomus* was influenced by the NAO index. The influence of NAO on marine resources has been already highlighted (Solow, 2002). The SST was positively correlated to the evolution of LPUEs of Porto S. Stefano fleet. A warming process of the upper and intermediate water layers of the western Mediterranean occurred since 1950s (Briand, 2000; Vargas-Yánez *et al.*, 2009), and it may favoured the population biomass increase. Further investigations are requested to combine different sources of data (surveys, landings, log-books, interviews, etc.), in order to face with an accurate scenario of the spatial and temporal evolution of chondrichthyan communities, and to get suitable protection and conservation measures. The depletion of the elasmobranchs in the Mediterranean could be largely underestimated and requires an immediate large scale reassessment (Ferretti *et al.*, 2005).

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REMARKS ON *GALEUS MELASTOMUS* IN THE NORTHERN LIGURIAN SEA

OSSERVAZIONI SU GALEUS MELASTOMUS *NEL NORD DEL MAR LIGURE*

Abstract – Galeus melastomus *(Chondrichthyes, Scyliorhinidae) is a deep sea elasmobranch that is fished as a by-catch species of the bottom trawl fishery targeted to norway lobster and red shrimps. The mapping of its distribution shows that adults and juveniles occupy bottoms at different depths. Analyses of abundance doesn't show significant trends in MEDITS while a decrease is detected in GRUND surveys.*

Key-words: Galeus melastomus*, Selachians, trawl surveys, GIS, Ligurian Sea.*

Introduction – The study of by-catch species is considered significant in those kinds of fisheries that capture a wide range of species, as bottom trawling fishery does. Elasmobranchs are often part of by catch species and are reckoned as more vulnerable than other species, due to their biological and reproductive characteristics (Walker, 1998). This group is characterised by a slow growth, late attainment of sexual maturity and long life spans (Stevens *et al.,* 2000), moreover they are often top predators in the trophic web, that is why they are taken in account as good indicator, both, of the "top-down" effect of the trophic chain, and of populations variations due to overfishing (Carbonell *et al.,* 2003; Serena *et al.,* 2002; Baum *et al.,* 2003). The main objective of this work is the identification of areas of distribution of a deep sea elasmobranch, *Galeus melastomus,* in the northern Ligurian Sea, dividing the population into adults and juveniles to verify if the last ones have preferential habitats. Having a 15 years time series of data derived from seasonal bottom trawl surveys, we got the chance to observe the trend of abundance, biomass, mean weight and lengths distribution, to determine the population status of adults and juveniles. This species has been studied in the past, in the same area, concerning reproduction and feeding patterns (Orsi Relini and Wurtz, 1975).

Materials and methods - The study area is the Northern Ligurian Sea, from the French borderline to the North Gorgona Isle (belonging to Tuscany Archipelago). The dataset used was made taking data from GRUND (autumn season) and MEDITS (spring season) scientific trawling campaigns based on a random stratified sampling scheme, using a dataset of 15 years, from 1994 to 2008. A total number of 248 and 213 hauls were carried out on bathyal grounds respectively in GRUND and MEDITS surveys. To realize the cartography representing the species distribution, we used mean points of trawling transects, representing them through ArcGIS 9.2. To have a more robust representation of the distributions using abundances of species, we put together abundances of all the 15 years for each fishing point and then realized an interpolation through the IDW technique building different maps for adults and juveniles (when data were available). Our interpolation has been limited to fishing points comprised between 200 m and 80 0m, since this species has never been found in shallower waters. We built trends to observe fluctuations of the population trying to assess the population status. We divided the dataset between epibathyal and mesobathyal layers to identify differences of depth in the distribution of the species, specifically among juveniles and adults. From those data we obtained graphs of the abundance, the biomass and the mean weight. With length measures we built a length frequency distribution to realize a box plot graph to observe the median, the minimum and the maximum trends. Having total lengths we choose a cut off of 25cm to identify juveniles on the basis of literature (Tursi *et al.,* 1993) and of the observations of modes of length frequency distributions. Time series of all those parameters have been tested by SYSTAT programme through the non parametric correlation Spearman test with a significance level of 0.05 and freedom degree equal to n° of observations minus 2.

Results – The cartographic representation of abundances related to fishing points, shows that *G. melastomus* is distributed mostly in the south-east part of our study area. Specifically the population occupies the north area of the S. Lucia bank (Fig. 1), with juveniles concentrating between 200m and 500m (Fig. 2).

Observing trends obtained by the GRUND dataset we can see that they are clearly negative (Fig.3), specifically abundance undergoes a half of values starting with 965 N/km^2 in 1994 to 400 N/km^2 in 2008. At the same time biomass undergoes a significant

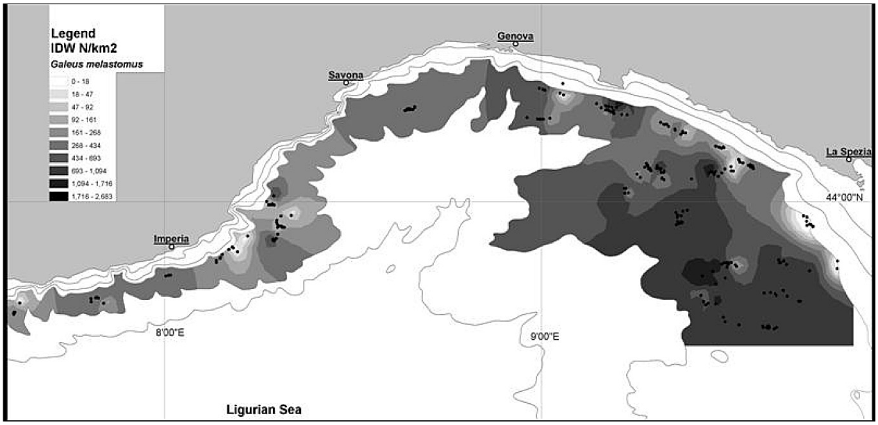

Fig. 1 - *Galeus melastomus.* Abundance distribution of adults and juveniles. GRUND (1994-2008).
Galeus melastomus. *Distribuzione dell'abbondanza degli adulti e dei giovanili. GRUND (1994-2008).*

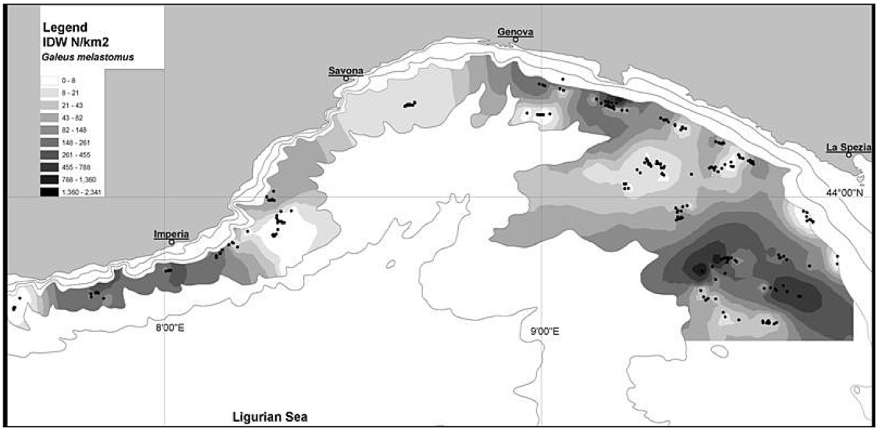

Fig. 2 - *Galeus melastomus.* Abundance distribution of juveniles. GRUND (1994-2008).
Galeus melastomus. *Distribuzione dell'abbondanza dei giovanili. GRUND (1994-2008).*

decline until 2006 with a small increase in 2008 that is given by the biomass of the mesobathyal layer. As a matter of fact both in abundance and biomass is the epibathyal layer that shows the greatest decline with values that from 2003 are negligible.

On the contrary mean weight has a positive trend (Fig.4) with values that increase

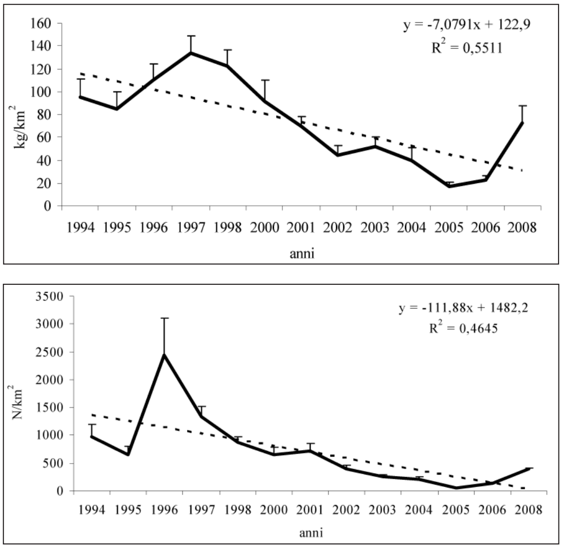

Fig. 3 - *G. melastomus.* Biomass and abundance trends in 200-800 m depth. GRUND (1994 -2008).

G. melastomus. *Andamento della biomassa e dell'abbondanza tra 200-800 m di profondità. GRUND (1994-2008).*

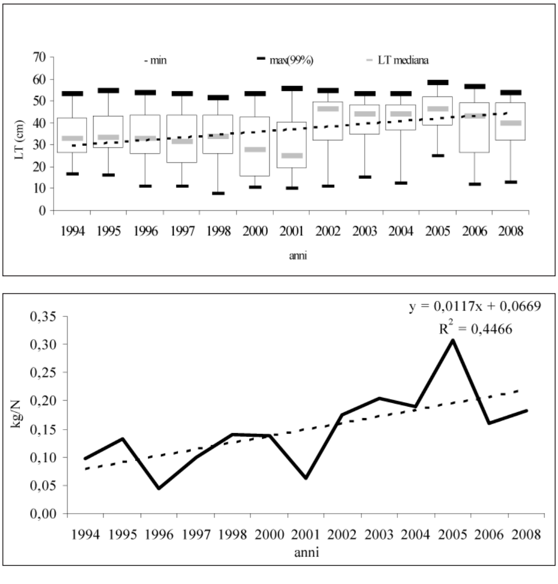

Fig. 4 - *Galeus melastomus.* Trends of median length of females and total mean weight trend in 200-800 m depth. GRUND (1994-2008).

Galeus melastomus. Tendenza della mediana delle femmine e peso medio della popolazione totale tra 200-800 m di profondità. GRUND (1994-2008).

of the double starting from 0.09 kg/N in 1994 to 0.18 kg/N in 2008, specifically the increase is effective in the mesobathyal layer while the epibathyal layer is influenced by the lack of organisms fished. Analyzing the abundance of juveniles we observed that they are the part of the population that most suffer in decline, in fact starting from 2003 they almost disappear both in the epibathyal and mesobathyal layer. Looking at box plot graphs, both for females (Fig.4) and males (not shown) there is a significant increase in the median length of almost 10 cm from 1994 to 2008.

All those parameters have been tested through the Spearman test resulting each one significant in their trends. Moreover correlations between abundance and biomass, and between median (males+females) and total mean weight have resulted positive with a high statistical significance. Although since 2003 the number of GRUND hauls were halved, the decrease in both abundance and biomass indexes started between 1996-1997, meaning that the decrease seems not affected by the sampling scheme. Concerning MEDITS results (not shown), any significant trend has been detected. As a matter of fact we found out that the MEDITS net has a 3-4 times lower catch efficiency of bottom species in respect to the GRUND one. This means that MEDITS dataset are not so suitable to describe some aspects of the dynamic population of *G. melastomus* in our study area.

Conclusions – If we should observe only GRUND results we would say that *G. melastomus* population (both adult and juvenile fraction) of the northern Ligurian Sea could be undergoing a decline in the last decade. It is important to underline that during the last years the juvenile component has significantly deceased, specifically on preferential bathyal grounds. This become even more concerning if we think that generally in *G. melastomus* only 25% of the total population is represented by reproductive adults (Rey *et al.,* 2005). From the maps it is possible to observe that juveniles never distribute over the line of 500m of depth, while adults are more concentrated between 500m and 800m of depth. This has been verified both, in the GRUND and MEDITS campaigns. Moreover the decrease of juveniles is confirmed also by the increase of the median length of both, males and females and the increase of the total mean weight. This means that we are fishing bigger animals loosing the juvenile component and underlines the need to deepen the monitoring of the population status.

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FISHERMEN PERCEPTIONS ON THE ELASMOBRANCH ABUNDANCE EVOLUTION OVER TIME IN THE ITALIAN TRAWL FISHERIES

EVOLUZIONE TEMPORALE DELL'ABBONDANZA DEGLI ELASMOBRANCHI NELLA PESCA A STRASCICO ITALIANA SECONDO LE PERCEZIONI DEI PESCATORI

Abstract *- This paper examines the long-term evolution in elasmobranch catches by Italian trawl fishery from 1940 to the present. Historical data on catches and species composition were collected by fishermen interviews. The results, validated by the available scientific literature, show an evident temporal decline for many species and, in some cases, the complete disappearance from the catches.*

Key-words*: trawling, elasmobranchs, depletion, temporal variation.*

Introduction - Recent studies show that the population abundance of sensitive marine species, such as elasmobranchs, decreased during the XX century in the Mediterranean Sea (Ferretti *et al.*, 2008). Demersal sharks like *Squatina* spp. and *Mustelus* spp. were relatively abundant until the 1950s and locally were the target of small-scale fisheries; these species have at present practically disappeared from the commercial catches and are only occasionally caught through experimental surveys (Aldebert, 1997).

The present study is targeted to provide a picture on the temporal evolution of elasmobranchs abundance in different Italian trawl fisheries starting from the 1940's, according to information collected by interviews to old or retired fishermen.

Fishermen perception can be a source of information complementary to scientific data. According to Freire and Garcia Allut (1999), traditional ecological knowledge of fishermen (TEK), could add new data in marine ecology and fisheries biology. If interviews to fishermen are performed through a standardised approach with well structured questionnaires, not only qualitative, but also quantitative or semi-quantitative data could be gathered (Bergmann *et al.,* 2004). At present, this approach has been applied only in small Mediterranean areas (Sardà and Maynou, 1998).

Materials and methods - In the framework of the UE project "EVOMED ("The 20th Century evolution of Mediterranean exploited demersal resources under increasing fishing disturbance and environmental change" (Sartor, 2010), 50 interviews to old or retired fishermen were realised in different Italian Mediterranean areas: Ligurian Sea, northern and central Tyrrhenian Seas (GFCM-FAO GSA 9) and northern Adriatic (GFCM-FAO GSA 17).

In the selection of the fishermen to interview, preference was given to vessel Captains. Information has been collected according to a standardised questionnaire and interview protocol. The main contents of the questionnaire concerned information on vessels characteristics, fishing gears and fishing grounds, as well as on catches (main target species, discards, etc). The questionnaire was designed to gather information for three main time periods, in order to facilitate the estimation of eventual changes over time: from 1940's to 1960's, from 1960's to 1980's and from 1980's to present.

As concerns elasmobranchs, specific questions were made to ask for trends over time, as well as on catches, economic importance and eventual disappearance or rarefaction of species. The collected information was entered in a standardised data base: data were analysed to obtain quantitative or semi-quantitative results.

Results - Thirty five interviews were realized in these ports of GSA 9: Viareggio and Livorno (Ligurian Sea), Castiglione della Pescaia, Porto Santo Stefano and Porto Ercole (northern Tyrrhenian Sea), Civitavecchia and Fiumicino (central Tyrrhenian Sea).

According to what reported by the fishermen, the importance of elasmobranchs, both in terms of abundance and commercial value, was higher in the past that at present. The main species caught in the past were rays (*Raja* spp.), small spotted catshark (*Scyliorhinus canicula*), smoot hound (*Mustelus* spp.) and spiked dogfish (*Squalus* spp.). Sixty four percent of the interviewed fishermen reported that Elasmobranch catches in the earlier period (from 1940's to 1960's) were more abundant (at least two times) than those of the present (Fig. 1). This percentage decreases in the comparison with the second period (51%) and it is very low for the most recent one (6%). Many fishermen declared that from the 1980's the catches of elasmobranchs were more or less the same than those of the present and 14-30% of fishermen was not able to evaluate the temporal trend of abundances. The percentage contribution of elasmobranchs to the total catch showed a decrease over time as well (Tab. 1).

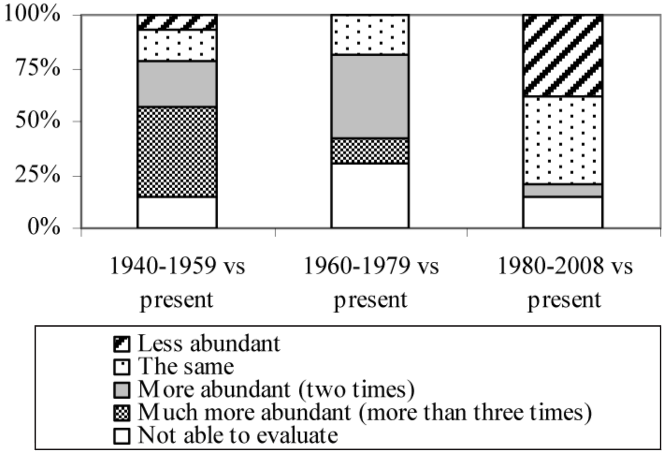

Fig. 1 - GSA 9, fishermen interviews. Comparisons of the elasmobranch catches of different time periods with those of the present.

GSA 9, interviste ai pescatori. Comparazione delle catture di elasmobranchi di diversi periodi con quelle attuali.

Tab. 1 - GSA 9, fishermen interviews. Percentage contribution of elasmobranchs to the total catch over time.

GSA 9, interviste ai pescatori. Variazione nel tempo del contributo percentuale degli elasmobranchi alle catture totali.

	From 1940's to 1960's	From 1960's to 1980's	From 1980's to present
Mean % Elasmobranch contribution to the total catch	14.2 (±13.4)	10.3 (±11.4)	5.3 (± 4.8)

The decrease reported by fishermen was observed especially for some species, like *Mustelus spp., Squalus* spp. *and Squatina* spp. In particular, it was noticed that in the fishing grounds of GSA9 the abundance of species like *Squatina* spp. was already reduced in the earlier period (1940-1960). The last catches of *Squatina* spp. were dated to the end of 1970's, while many fishermen reported that *Mustelus* spp. have been caught abundantly until the middle of 80's.

A total of 15 interviews were performed in Civitanova Marche, central Adriatic Sea (GSA 17). The main species caught over time by the interviewed fishermen were the same of those reported by the fishermen contacted in GSA 9.

Also in Civitanova Marche an evident decrease of catches of elasmobranchs over time was reported. About 95% of interviewed noticed that the catches of sharks and rays observed until the 1980's were more abundant than those at present (Fig. 2). On the other hand, it emerged that the catches of the more recent period did not show evident differences with those of the present. A similar pattern results from the temporal evolution of the percentage contribution of elasmobranchs to the total catch (Tab. 2).

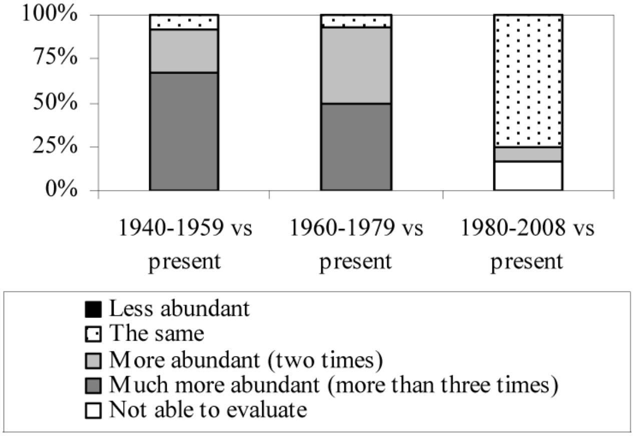

Fig. 2 - GSA 17, Fishermen interviews. Comparisons of the elasmobranch catches of different time periods with those of the present.

GSA 17, interviste ai pescatori. Comparazione delle catture di elasmobranchi di diversi periodi con quelle attuali.

Tab. 2 - GSA 17, fishermen interviews. Percentage contribution of Elasmobranchs to the total catch over time.

GSA 17, interviste ai pescatori. Variazione nel tempo del contributo percentuale degli elasmobranchi alle catture totali.

	From 1940's to 1960's	From 1960's to 1980's	From 1980's to present
Mean % Elasmobranch contribution to the total catch	12.7 (±11.3)	10.9 (±6.3)	5.8 (± 4.7)

As concerns single species, from 1960's a notable decrease of species like *Squalus* spp. and *Raja* spp was reported. In some cases also a decrease of *Mustelus* spp. was noticed. The latest abundant catches of *Squalus* spp. were reported until the middle of 1970's.

Conclusions - The results of the interviews performed in both areas closely agreed in showing a decrease in the catches of elasmobranchs over time. This reduction has been noticed particularly for some species like *Mustelus* spp., *Squalus* spp. and *Squatina* spp. As a matter of fact, these species have been included as critically endangered, endangered or vulnerable species in the IUCN red lists (Cavangh and Gibson, 2007). In many cases it was reported their complete disappearance. It seems that species like *Mustelus* spp. were notably more abundant at the beginning of last Century and in some areas, as in GSA9, where they were also targets of a specific fishery, until 1960's. In certain areas, however, an evident decrease of elasmobranchs was already observed immediately after the Second World War.

Even though these results can be qualified as anecdotal or lacking of scientific value, this anthropological information could contribute to improve the historical picture of the fisheries and associated fish communities. On the other hand, the results obtained from the interviews are validated by several researches and scientific papers (e.g. Aldebert, 1997; Ferretti *et al.*, 2008).

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MEDITERRANEAN CARTILAGINOUS FISHES: 25 YEARS OF ITALIAN RESEARCH

I PESCI CARTILAGINEI DEL MEDITERRANEI: 25 ANNI DI RICERCA ITALIANA

Abstract *– A brief historical overview of the actions related to management and data collection on cartilaginous fishes in Italy is presented. A table summarises the main events of the past 25 years.*

Key-words*: research programmes, monitoring, shark fisheries, Mediterranean, Italian seas.*

Introduction – In the last 25 years several projects aimed at the assessment of the stocks exploitation have been carried on in Italy. Our country is always present in these kind of research even because the fisheries represent an important sector of the Italian economy. The most important project is perhaps represented by the GRUND (GRUppo Nazionale risorse Demersali) started in 1985. A national expert group coordinating the project was build up and Italy became the Mediterranean country with the longest time series of demersal resources. In 1994 also the UE project MEDITS (MEDIterranean Trawl Survey) started and several UE countries joined the collection of data. The GRUND and MEDITS projects allowed the collection of a huge number of data on cartilaginous fishes, for example on their biology, spatial distribution, trophic relations etc. Moreover, other specific projects on cartilaginous fishes were conducted in this period. The collection of data about large cartilaginous fishes stared in Italy since 1985 as the LEM project (Large Elasmobranchs Monitoring). Starting from 2002 the project became the MEDiterranean Large Elamobranchs Monitoring programme (MEDLEM) and has been provided an updated source of information on large cartilaginous fishes for national and international organizations involved in the management and the conservation of these fish in the Mediterranean Sea. Moreover, in 2006 the DG Fisheries and Maritime Affairs of the European Commission financed the project “Status of rays populations in the Mediterranean Sea and advices for sustainable exploitation of the stocks”, aimed to analyse and discuss data on skates captures collected during MEDITS surveys, giving to Italy the coordination of the project. Finally, the project “Elements for the Assessment and Protection of Elasmobranchs in the Italian Seas” (ELASMOIT), an Italian project with a primary goal to collect information on the status of exploitation and conservation of elasmobranches in the Italian Seas. The project started in February 2009 and was completed in April 2010. The ELASMOIT project especially focued on the pelagic species, and the output was also the proposal of guidelines supporting the Ministry for the Environment, Land and Sea (MiATTM) in the compilation of the future Italian Action Plan. In the Tab. 1 the main events of the past 25 years are summarised.

Overview on the MEDLEM project - The MEDLEM has the objective of recording data on by-catch, sighting, stranding or bibliographic references and allows the search for species, country and gear. The MEDLEM protocol was more and more refined in order to obtain a standard and easy field sheet for fishers and common people, representing also a valid reference for the collection of morphometric data.

Tab. 1 - List of the main actions related to management and direct (D) or collateral (C) data collection on cartilaginous fishes in Italy.

Elenco delle principali azioni legate alla gestione diretta (D) o indiretta (C) della raccolta dei dati relativa ai pesci cartilaginei nei mari italiani.

YEAR	**Action**	**PROGRAMMES and other ACTIVITIES**	**General objectives and activities related to cartilaginous fishes**	**Notes and links**
1985	C	GRUND project – Demersal trawl survey in Italian seas	Collection of information on demersal resources in the Italian seas, trough a common standardized sampling methodology.	Important time series (1985-2008) of data of elasmobranch species.
1985	D	MEDLEM project – MEDiterranean Large Elasmobranch Monitorning	Monitoring programme on the captures and sightings of the large cartilaginous fishes occurring in the Mediterranean Sea. Historical and present data on rare and vulnerable species of elasmobranches.	(Serena *et al.* 2006) *www.arpat.toscana.it/medlem*
1994	C	MEDITS - International Bottom Trawl Survey in the Mediterranean	Collection of information on demersal resources in the Mediterranean Sea, trough a common standardized sampling methodology. Important time series (1994) of data of elasmobranch species.	*www.sibm.it/SITO%20MEDITS/principaleprogramme.htm*
1995	D	GRIS – Gruppo Ricercatori Italiani sugli Squali, razze e chimere	Italian group of experts on elasmobranch fishes representing Italy in the European Elasmobranch Association (EEA).	GRIS belongs to the "*Necton e Pesca*" committee of the Italian Society of Marine Biology.
1999	D	IPOA Shark – International Plan of Action for the conservation and management of Sharks	Aims to ensure the conservation and management of sharks and their long-term sustainable use, through the development and the implementation of subregional, regional and national plan of action. It is voluntary but all the States are encouraged to implement it.	*www.fao.org/fishery/ipoa-sharks/en*
2000	D	FAO - Identification Field Guide to Sharks and Rays of the Mediterranean and Black Sea	Aims at providing a fully illustrated field guide for the identification of the sharks and rays most relevant to the fisheries of the Mediterranean	The field guide was promoted by FAO-COPEMED (Serena, 2005).
2000-2002	D	Italian Action Plan for the conservation and management of Sharks	A technical framework was created by Italian shark specialists for the development of the Italian Action Plan for the conservation and management of Sharks.	Promoted by ICRAM
2002	D	Mediterranean Action Plan for the conservation and management of Sharks	The Mediterranean Action Plan for the Conservation of Chondrichthyan Fishes constitutes a proposal for regional strategies, pointing out priorities and actions to be undertaken at national and regional levels.	RAC/SPA Tunis assigned the development of the Action Plan to two experts: one Italian and one French UNEP MAP RAC/SPA (2003)
2003	D	IUCN Shark Specialist Group – Workshop in San Marino	Aimed to the assessment of the Mediterranean elasmobranches species for the IUCN Red List of Threatened Species.	An Italian expert become Co-chair for the Mediterranean. The output of the workshop were published in 2007 (Cavanagh and Gibson, 2007)
2004	D	MEDLEM project at the GFCM/SAC Sub-Committee on Marine Environment and Ecosystems	GFCM/SAC/SCMEE reiterated the importance of a wider use of the MEDLEM protocols and information system already adopted by a number of regional bodies to favour timely exchange of information on Large Elasmobranchs. **D**	(FAO, 2005)

(Segue/*Follows*)

YEAR	Action	PROGRAMMES and other ACTIVITIES	General objectives and activities related to cartilaginous fishes	Notes and links
2005	D	Update of the checklist on cartilaginous fishes in the Italian seas	Essential tool for the knowledge and conservation of the marine biodiversity in the Italian seas.	Promoted by the Ministry for the Environment, Land and Sea (MiATTM) and coordinated by Prof. Giulio Relini. www.sibm.it/CHECKLIST/principalechecklistfauna.htm
2006	C	Status of rays population in the Mediterranean Sea and advice for sustainable exploitation of the stocks Project FISH/2004/03-41	Aimed to update biology, dynamics and exploitation status of Rajidae, analysing data from scientific trawl surveys in the Mediterranean (MEDITS). A first example in Mediterranean of data sharing for the assessment of a group of species. **C**	Promoted by the European Commission (DG Fisheries and Maritime Affairs).
2008	D	Technical workshop on the status, limitation and opportunities for improving the monitoring of shark fisheries and trade	Considered global and country specific information on shark fisheries and trade to identify limitation and strategies for improving their monitoring.	Promoted by FAO (Serena *et al*, 2009b)
2009	D	European Action Plan for the conservation and management of Sharks	To contribute to the objective of the FAO IPOA SHARKS by ensuring the rebuilding of many depleted stocks fished by the Community fleet within and outside Community waters.	Italian experts participated to the consultation of stakeholders for the development of this Action Plan
2009	D,C	ELASMOIT	Primary objectives were a critic revision and implementation of the National Action Plana and a periodic monitoring of landings at the main harbors of the selected regions (Liguria, Sardinia, Sicily and Apulia). **C**	This project is promoted by the Ministry for the Environment, Land and Sea (MiATTM) and coordinated by the Italian Society for the Marine Biology (SIBM) with the participation of the Italian group for the research on sharks, skates and chimaeras (GRIS)
2010	D	Workshop on Sexual Maturity Staging of Elasmobranches	Agree on a common maturity scale for Elasmobranches (sharks and rays) across laboratories comprising a comparison of existing scales and standardization of maturity determination criteria	Promoted by ICES Malta, 11-15 October 2010

In the last years the MEDLEM programme has been presented and discussed several times in the framework of the GFCM. Other international organization, IUCN (International Union for Conservation of Nature and Natural Resources) and EEA (European Elasmobranch Association), also endorsed the project showing a great interest and a positive appreciation of the concept. From the 2007 the MEDLEM Database Application has been freely accessible at the website: http://www.arpat.toscana.it/progetti/medlem (Serena *et al.*, 2006). The background and the update of the programme is consultable in two papers presented at the GFCM-SAC Transversal workshop on selectivity improvement and by-catch reduction held in

Rome in 2008 and in Tunis in 2009 (Serena *et al.,* 2009a). A total of 1224 records have been registered so far. 17 research institutes, from corresponding Mediterranean countries, participate in the MEDLEM programme. The greater proportion of data come from Italy followed by Croatia and Spain. However, it is worth noting that records from Croatia and Spain are mainly referred to bibliography. About 50% are records of the basking shark (*Cetorhinus maximus*), but some records are referred to species rarely observed, such as *Squatina squatina* and *S. oculata*, representing in prospective an important source of information for the distribution, behaviour and biology of these species.

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SEXUAL SEGREGATION IN ELASMOBRANCHS

SEGREGAZIONE SESSUALE NEGLI ELASMOBRANCHI

Abstract *– Sexual segregation is widespread in the animal kingdom, yet the underlying causes remain poorly understood. Within the marine realm, sexual segregation is often considered a general characteristic of shark populations. Nonetheless, no systematic investigations have been conducted into the underlying causes of sexual segregation in any species to date. This paper reviews the evidence for sexual segregation in elasmobranchs and introduces some of the hypotheses that have been forwarded to explain spatial separation of the sexes. We also suggest an elasmobranch model species (the small spotted catshark,* Scyliorhinus canicula*) for future investigative research into the underlying causes of sexual segregation across all animal groups and introduce recent research which aims to determine the factors that underpin the alternate behavioural strategies we have observed in this species.*

Key-words: *behaviour, conservation, distribution elasmobranchs, sex structure.*

Introduction - There is a burgeoning literature documenting sex differences in animal behaviour. These differences range from divergent foraging strategies (e.g. feeding rates) to gross differences in the geographical distribution of the sexes. Sexual segregation can be defined as the separation of members of a species such that males and females live apart, either singly or in single sex groups. This separation may be temporal in nature, for example, occurring only during the breeding season, or it may occur year-round. Sexual segregation is widespread in the animal kingdom, yet the underlying causes remain poorly understood. Understanding sex differences in habitat use is of particular relevance because understanding the mechanisms governing how and why the sexes differentially distribute themselves in nature is important in attempts to predict population processes and dynamics. It also has resonance in the successful management and conservation of animal populations since the spatial dynamics of the sexes influences overlap with area-focused human activities such as fishing. Within the marine realm, no systematic investigations have been conducted into the underlying causes of sexual segregation in any vertebrate to date, although there have been several descriptive studies and potential causes have been proposed (see Wearmouth & Sims, 2008). This paper reviews the evidence for sexual segregation in elasmobranchs and introduces hypotheses which have been forwarded to explain spatial separation of the sexes in sharks, skates and rays. Finally, we suggest an elasmobranch model species for future investigative research. This research will improve our understanding of the underlying causes of sexual segregation, not just in elasmobranchs, but across animal groups.

Sexual segregation in elasmobranchs - The first evidence for sexual segregation in elasmobranchs populations came from fisheries observations which recorded unequal sex ratios in trawl catches of dogfish, skates and rays. However, despite widespread reporting of biased sex ratios in elasmobranch landings it was not until the early 20th century that researchers investigated whether these inequalities reflected a bias in the operational sex ratio or differential behaviour of the sexes. By examining the catches of individual vessels, Ford (1921) and Steven (1933) were able to identify that, where catches were composed of immature individuals, the sexes occurred in approximately equal proportions, indicating no deviation from a 1:1 sex ratio at birth. However, biased sex ratios did occur in catches of mature specimens.

Steven (1933) noted that, whilst female thornback ray (*Raja clavata*) generally predominated in inshore areas throughout the fishing season (January – March), their numbers declined towards the end of March when male numbers began to increase. Similarly, Ford's (1921) investigations revealed that male lesser spotted dogfish (*Scyliorhinus canicula*) dominated Plymouth landings during winter (65% of numbers caught) whereas females marginally predominated in summer (58%). Ford (1921) and Steven (1933) were in broad agreement that sexual segregation of adult fish and the consequential sampling of unisexual aggregations as individuals undertook sex-specific migrations into inshore areas, provided the most satisfactory explanation for sex-biased landings.

Over the next 40 years numerous studies similarly documented unequal sex ratios in fishery and fishery-independent catches of sharks. By the end of the 1960s, there was a burgeoning literature of observations of sexual segregation in sharks and sexual segregation was considered a general characteristic (Springer, 1967). Further studies in the 1970s and 1980s expanded the number of species for which sexual segregation was observed or suspected (for further details, see Wearmouth & Sims, 2008). In a recent review, Sims (2005) found documented evidence for sexual segregation in 38 of the 400 or so shark species, of which 19 are found in the NE Atlantic and Mediterranean (see Tab. 1). More recently, the spatial scale over which sexual segregation has been observed in shark populations has increased to that of ocean basins: longline catches of shortfin mako sharks, *Isurus oxyrinchus*, show spatial separation of the sexes within an area of the South Pacific Ocean of an equivalent size to Australia, with females dominating in one half of the area and males in the other (Mucientes *et al*., 2009). However, despite the widespread nature of sexual segregation in elasmobranch populations, the causes of sexual segregation remain uninvestigated in the majority of species. Nonetheless, a number of explanatory hypotheses have been forwarded to explain the patterns of segregation observed. For example, segregation of active shark species into sex-specific schools is thought to result from sex-specific swimming capabilities. As many shark species exhibit sexual size dimorphism, sex-assorted schools may be maintained by the different swimming speeds that can be sustained by different-sized individuals. This size-related segregation may also explain age-assorted schooling in sharks. On the other hand, it has been suggested that juvenile scalloped hammerhead sharks (*Sphyrna lewini*) move away from inshore nursery areas at a younger age than males due to sex-specific dietary requirements. Increased consumption of pelagic prey and greater predatory success has been inferred from larger stomach content masses in females than in males of the same size (Klimley, 1987). Similarly, sex differences in the diet of blue sharks, *Prionace glauca*, have been interpreted to result from sex-specific preferences in foraging locations (McCord and Campana, 2003).

Sexual segregation in some species of shark is thought to result from sex-differences in reproductive strategies. For example, the migration of gravid females to designated pupping areas where they give birth to live young may be driven by the need of females to reduce predation risk and therefore maximise security of their offspring. Pupping areas are often sheltered, inshore areas where predation rates are low. In contrast, aggregation of female grey reef sharks *Carcharhinus amblyrhynchos* in the shallow lagoons of Johnston Atoll in the Central Pacific Ocean may be driven by sex-specific temperature preferences. Water temperatures in the lagoons are 1-2 °C warmer than in the open ocean and, as sampled sharks contained embryos in the early stages of development, Economakis and Lobel (1998) hypothesised that pregnant female sharks were aggregating in shallow warm waters to raise their body temperature thereby increasing rate of embryonic development. Divergent reproductive strategies may also be attributable for sexual segregation in nurse sharks (*Ginglymostoma cirratum*). However, in this species it has been suggested that females are segregating from males to avoid mating. Female nurse sharks, inhabit female-only areas, exhibit behaviours which appear to avoid copulation and are capable of storing sperm and thus they may wish to control the frequency of mating attempts or alternatively, to control access by particular males (Carrier *et al.*, 1994). Despite the widespread nature of sexual segregation amongst elasmobrachs and several explanatory hypotheses being proposed, the causes of sexual segregation have not been formally investigated in any species. This may be partially attributable to the challenges involved in studying free-ranging elasmobranchs in the inaccessible, concealing, three-dimensional marine environment, coupled with the difficulties involved in maintaining these species in captivity. Behavioural experiments are particularly informative when testing competing hypotheses explaining sexual segregation. However, controlled laboratory manipulations are not feasible in large, wide-ranging marine vertebrates. One further complication which has plagued the study of sexual segregation across all animals groups, including terrestrial vertebrates within which sexual segregation has been best studied, is the existence of sexual dimorphism with respect to body size. Sex differences in body size are likely to confer significant sex differences in attributes such as predation risk, nutritional requirements and activity budgets, all of which are likely to influence spatial and temporal habitat use of the sexes. Therefore, sexually size-dimorphic species may not be the most appropriate models for examining differences due to sex per se. Thus, there is much need for hypothesis-led research which uses an integrative approach of field-based tracking and complementary laboratory studies to evaluate the potential of the sexual segregation hypotheses in a monomorphic species.

A model species - The small spotted catshark, *Scyliorhinus canicula*, is monomorphic with respect to body size which, coupled with its relatively high abundance, a largely coastal distribution and small adult size enabling laboratory experiments, identifies *S. canicula* as a good model species with which to investigate the underlying causes of sex differences in behaviour and sexual segregation. However, whilst there exists an abundance of information on the physiology, feeding ecology and reproductive cycle of this species, comparatively little was known about its natural free-ranging behaviour until relatively recently.

Sims *et al.* (2001) were the first to investigate the behaviour of individual male and female small spotted catsharks in any detail. Through the application of acoustic telemetry they showed male and female *S. canicula* exhibited alternative behavioural strategies. In the study location in south west Ireland (Lough Hyne, a tidal sea lough), males were observed to be crepuscularly and nocturnally active, moving from deep (12-24 m) to shallower (<4 m) water to feed at dusk and during the night. In contrast, females refuged in shallow water (0.5-1.5 m) rock crevices and caves during daytime and were nocturnally active in deeper water only once every two or three days. The home ranges of the sexes also appeared spatially separated (Sims *et al.*, 2001).

In this presentation we will discuss the results of our recent investigations into the underlying causes of sexual segregation in the small spotted catshark. The aim of this research is to determine why female dogfish refuge (segregate from males) by examining the factors that may influence habitat use. This research employs an integrative approach of field-based tracking and complementary laboratory studies. Using a hypothesis driven approach, behavioural manipulations were used to identify the costs and benefits of refuging in the laboratory. The results of these experiments were related to wild observations of female behaviour and male-female interactions. This research will improve our understanding of the processes governing sex-based difference in the behaviour and habitat selection of marine fish and animals in general.

Tab. 1 - The 19 shark species of the NE Atlantic and Mediterranean for which sexual segregation has been documented (Sims, 2005). The degree of sexual dimorphism is given as the relative (percentage) difference in minimum total length at sexual maturity between female and male, where positive values indicate larger females and negative values larger males. Species classed as social are those which are often found in groups or aggregations.

Squali dell'Atlantico NE e nel Mediterraneo per i quali è stata documentata la segregazione sessuale (Sims, 2005). Il grado di dimorfismo sessuale è espresso come differenza percentuale della minima differenza di lunghezza totale raggiunta alla maturità sessuale dai maschi e dalle femmine,. I valori positivi indicano femmine di dimensioni maggiori e i valori negativi maschi più grandi. Le specie classificate come sociali sono quelle che spesso si trovano in gruppi o aggregazioni.

Order	**Family**	**Species**	**Sexual dimorphism (% difference of female)**	**Social (Sc) or solitary (Sl)**
Squaliformes	Squalidae	*Centrosycllium fabricii*	-	-
		Somniosus microcephalus	-	Sl
		Squalus acanthias	18.6	Sc
		Squalus megalops	32.5	Sc
Orectolobiformes	Ginglymostomatidae	*Ginglymostoma cirratum*	2.2	Sc/Sl
Lamniformes	Odontaspidae	*Carcharias taurus*	0	Sc
	Alopiidae	*Alopias vulpinus*	17.9	Sl
	Ceterohinidae	*Ceterohinus maximus*	62.0	Sl
	Lamnidae	*Carcharodon carcharias*	33.3	Sl
		Lamna nasus	-30.6	Sl
Carcharhiniformes	Scyliorhinidae	*Scyliorhinus canicula*	4.0	Sc/Sl
	Triakidae	*Galeorhinus galeus*	8.3	Sl
	Carcharhinidae	*Carcharhinus brevipinna*	6.9	Sc/Sl
		Carcharhinus limbatus	-11.1	Sc/Sl
		Carcharhinus longimanus	2.9	Sl
		Carcharhinus melanopterus	5.5	Sc/Sl
		Carcharhinus plumbeus	9.9	Sl
		Prionace glauca	21.4	Sl
	Sphyrnidae	*Sphyrna mokarran*	6.8	Sl

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PURIFICATION AND CHARACTERIZATION OF AN F-TYPE LECTIN FROM SMALL-SPOTTED CATSHARK (*SCYLIORHINUS CANICULA*) SERUM

*ISOLAMENTO E CARATTERIZZAZIONE DI UNA NUOVA LECTINA DI TIPO F DAL SIERO DEL GATTUCCIO (*SCYLIORHINUS CANICULA*)*

***Abstract** – The "F-type" lectins has been recently characterized by an unique sequence motif and a characteristic structural fold. Here we describe the purification and characterization of a 87 kDa F-type lectin (ScFBL) from a small-spotted catshark (*Scyliorhinus canicula*) serum. This is the first evidence of the F-lectin presence in elasmobranchs.*

***Key-words:** F-type lectin,* Scyliorhinus canicula*, Teleost, serum hemagglutinins.*

Introduction - Sugar binding proteins (lectins) and free or cell surface-bound sugars constitute an evolutionary conserved recognition system involved in innate immunity. Lectins are multivalent proteins that recognize and bind carbohydrate moieties through specific domains (CRDs). Because most lectins may display CRDs in combination with other domains, they not only recognize carbohydrates on the surface of potential pathogens, but also mediate several effector functions including agglutination, immobilization, and opsonization of microbial pathogens. They are involved in complement pathway and phagocyte activation. Soluble lectins exhibit considerable structural diversity, and have been described in various tissues, mucus, serum and eggs of marine and freshwater fish. They participate in various biological processes, including innate and adaptive immune responses. On the contrary, the chondrichthyan lectins, despite of their key phylogenetic position, have been poorly studied. The described structure of the fucose-binding European eel agglutinin revealed a novel lectin fold (the "F-type" lectin fold) shared with other carbohydrate-binding proteins as well as with apparently unrelated proteins from prokaryotes to vertebrates. An unique fucose-binding sequence motif is present in this invertebrate and cold-blooded vertebrate lectin family.

Materials and methods – Fish were anesthetized in sea water containing 0.02% 3-aminobenzoic acid ethyl ester (MS222) and bled by caudal vessel puncture. The blood was allowed to clot at room temperature for 1 h and the serum was separated by centrifugation (10 min, 800×g, 4 °C). To perform hemagglutination assay (HA), rabbit erythrocytes were suspended at 1% in Tris buffer 0.1% gelatin, and used in a microtitre plate. The hemagglutinating titre (HT) was evaluated after 1 h incubation at 37 °C. Purification on a fucose agarose column and characterization of serum fucose-binding lectin were done following Cammarata *et al.* (2007).

Results - As reported for other F-type lectins, the fucose-binding properties of the *S. canicula* lectin enabled us to isolate it through a fucose–agarose column in a single affinity chromatography step. Electrophoretic mobility of the purified fraction revealed apparent molecular weights of 87 and 102 kDa under reducing and non-reducing conditions, respectively (Fig. 1). Agglutinating activity towards rabbit erythrocytes at 37 °C was not significantly modified by calcium or EDTA addition, was decreased by preincubation at 70 °C, and fully inactivated at 90 °C. As shown by western blot analysis, ScFBP disclosed intense cross-reactivity with antibodies raised to the sea bass (*Dicentrarchus labrax*) fucose-binding lectin (data not shown). Since the electrophoretic micro heterogeneity was revealed by reducing conditions the possibility exists that isoforms of this molecule were present (Fig. 1).

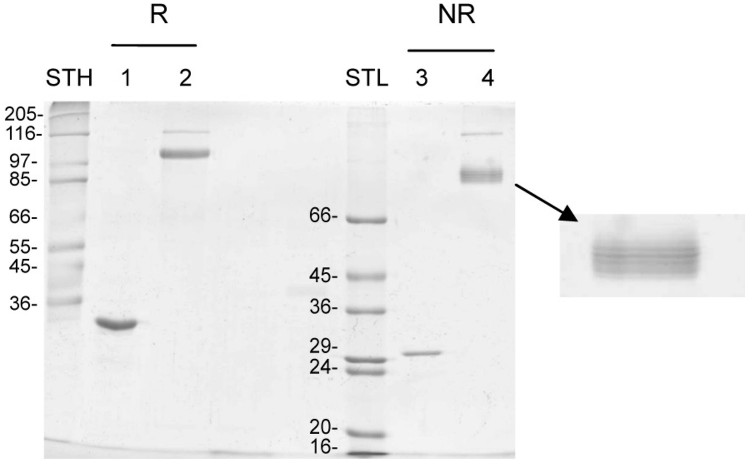

Fig. 1 - SDS-PAGE of *S. canicula* purified lectin. STH: Standard High (kDa) Lanes: 1 & 3, purified *Dicentrarchus labrax* lectin; 2 & 4, purified *S. canicula* lectin; STL: Standard Low; lectin; R: reducing conditions; NR: Non reducing conditions.

SDS-PAGE della lectina purificata di S. canicula. *STH: Standard ad alto peso molecolare (kDa) Linea: 1 & 3, lectina purificata di* Dicentrarchus labrax*; 2 & 4, Lectina purificata di* S. canicula*; STL: Standard a basso peso molecolare; R: Condizioni ridotte; NR: Condizioni non ridotte.*

Conclusions – Lectins play important roles in the immune response of invertebrates and vertebrates either by recognizing exposed glycans of potential pathogens or by their immunoregulatory roles through the binding to carbohydrates on the surfaces of immunocompetent cells. In this study we show, for the first time in elasmobranches, the presence of an F-lectin isolated from serum of the small-spotted catshark (*Scyliorhinus canicula*), a representative of the largest order of extant sharks. Due to the relatively small size, wide distribution in the Mediterranean sea and easy maintenance in aquarium, *S. canicula* could be an interesting model for lectin study.

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OCCURRENCE OF JUVENILES OF *SCYLIORHINUS CANICULA* AND *MUSTELUS MUSTELUS* IN THE NORTH-WESTERN IONIAN SEA

RINVENIMENTO DI GIOVANILI DI SCYLIORHINUS CANICULA *E MUSTELUS MUSTELUS NEL MAR IONIO SETTENTRIONALE*

Abstract - *Occurrence of juveniles of* Scyliorhinus canicula *(Chondrichthyes: Scyliorhinidae) and* Mustelus mustelus *(Chondrichthyes: Triakidae) was investigated as part of trawl surveys carried out from 1994 to 2009 in the North-western Ionian Sea. Two main finding areas were observed for juveniles of* S. canicula *and one of* M. mustelus.

Key-words*: juveniles, elasmobranchs,* Scyliorhinus canicula*,* Mustelus mustelus*, Ionian Sea.*

Introduction - Elasmobranchs show slow growth rate, late age at maturity and low fecundity, resulting highly vulnerable to overfishing as well as to the reduction and modification of habitats in the Mediterranean Sea (Vacchi and Notarbartolo di Sciara, 2000; Serena *et al*., 2005). In this note, the authors provide information on the occurrence of *Scyliorhinus canicula* (Linneus, 1758) and *Mustelus mustelus* (Linneus, 1758) juveniles in the North-western Ionian Sea.

Materials and methods - Data were collected from 1994 to 2009 in the framework of national (GRUND) and international (MEDITS) research projects on the assessment of demersal resources in the Mediterranean Sea (Bertrand *et al*., 2000; Relini *et al*., 2000). The study area was the North-western Ionian Sea (GSA19). The total length (TL in mm) was measured for *S. canicula* and *M. mustelus* providing length/frequency distributions (LFDs). The sex was recorded and the maturity of gonads was observed according Stehmann (1998). All the immature specimens (stage 1), with size less than 300 and 540 mm TL, were considered juveniles in *S. canicula* and *M. mustelus* respectively, according to Capapé *et al*., (2008) and Saïdi *et al*., (2008). For both species, the density indices (N/km^2) of juveniles was estimated for each sampling haul. The spatial distribution of juveniles was carried out by means of Arcview GIS 3.2 (Esri).

Results - During the investigated period both *S. canicula* and *M. mustelus* were rarely caught throughout the study area. The former species was captured between 115-634 m and the latter between 12-357 m depth. The minimum and maximum sizes were respectively 88 and 558 mm TL in *S. canicula* and 250 and 1620 mm TL in *M. mustelus* (Fig. 1). The bulk of the sampled population consisted of juveniles (79% in the former and 74% in the latter species). The main concentration of *S. canicula* juveniles occurred with temporal continuity southward S. Maria di Leuca and Siracusa on the upper continental slope. The maximum density value was recorded during autumn 2003 (513 N/km^2). The greatest number of *M. mustelus* juveniles was observed with persistency southward Catania, within 50 m depth. The maximum density value was recorded during summer 2007 (781 N/km^2).

Conclusions - The sampled population of *S. canicula* and *M. mustelus* in the North-western Ionian Sea mostly consisted of juveniles, probably due to the overexploitation

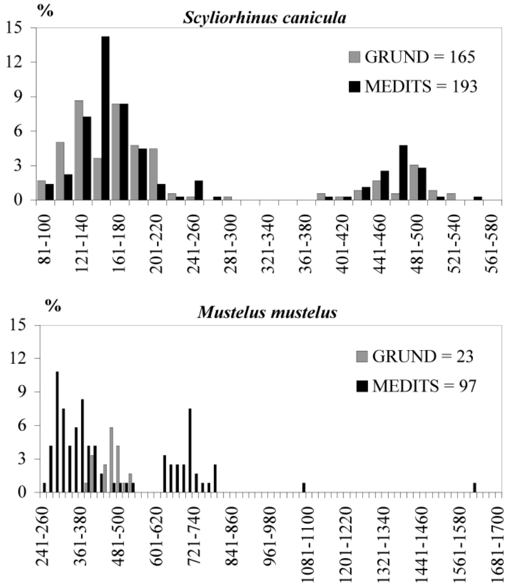

Fig. 1 - Length/frequency distribution of *Scyliorhinus canicula* and *Mustelus mustelus* in the Ionian Sea from 1994 to 2009.

Distribuzione lunghezza/frequenza di Scyliorhinus canicula *e* Mustelus mustelus *nel Mar Ionio dal 1994 al 2009.*

of adult specimens. In particular, for *M. mustelus* the size distribution appears to be typically truncated probably in relation to its distribution in shallower waters where trawling is more concentrated. On the other hand, adults of *S. canicula* seem to take advantage from some refuge areas or habitats. The greater number of specimens collected of both species in the Sicilian and S. Maria di Leuca areas could be due to particular environmental conditions, as high trophism and the narrowness extend of the continental shelf. In addition, the protection areas and measures developed in Sicily could provide lower impact to adults enhancing the production of offspring.

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PUBLIC SIGHTING SCHEME REVEALS THE SEASONAL PRESENCE OF *CETORHINUS MAXIMUS* AROUND NORTH SARDINIA, ITALY

UN PROGETTO DI AVVISTAMENTO PUBBLICO RIVELA LA PRESENZA DI CETORHINUS MAXIMUS *NELLE ACQUE DELLA SARDEGNA SETTENTRIONALE*

Abstract *– This study aims to contribute data on the presence, distribution and seasonal changes in numbers of basking sharks* Cetorhinus maximus *(Chondrichthyes) around North Sardinia (Central Mediterranean sea). Thanks mainly to a public sighting record scheme begun in 2005, 55 records of 99 basking sharks were collected in an area where only 14 individuals had previously been recorded. This ongoing public sighting scheme has significantly improved scientific understanding as well as public awareness of this species.*

Key-words: *Basking shark,* Cetorhinus maximus*, Mediterranean, Sardinia, Marine Protected Area.*

Introduction - The basking shark (*Cetorhinus maximus* Gunnerus, 1765) is a very large, filter-feeding cold-water pelagic species named from its habit of 'basking' on the surface in good weather conditions, usually singly or in small groups. It is a migratory and widely distributed species, but only regularly seen in a few favored coastal locations. Much of the basking shark's life history, movements, population dynamics and general ecology have not yet been described.

Up to 2002 only 14 out of 535 basking sharks recorded in the MEDLEM program on captures and sightings of large cartilaginous fishes, which provides a general picture of the distribution of this species in the Mediterranean, were from Sardinian waters (Mancusi *et al.*, 2005). In 2005 *Operazione Squalo Elefante* (OSE) was launched to gather general data on basking sharks in Sardinian waters, to identify particular areas for future investigations and to raise public awareness of the species, mainly through a public sighting recording scheme. Such schemes have been successfully used to gather simple, non-effort related data on basking sharks in several regions of the world (Speedie, 2003; Clò *et al.,* 2002).

Materials and methods – *Data Collection.* In 2005 a network of observers was established - that included the Coast Guard, personnel of Marine Protected Areas (Asinara, La Maddalena, Tavolara), biologists, recreational and professional fishermen, dive centre operators, yachtsmen and journalists - to report sightings and captures of basking sharks.

In order to avoid overestimating shark numbers, in case of multiple sightings over a period up to 10 days in the same area we considered only one entry – selecting the one with the highest number of sharks seen at the same time. Pictures and video were also collected when available. Furthermore, a review of scientific and reliable grey literature yielded several entries dating from 1910.

Results – Only 55 of the 75 overall sightings and captures reported were considered, yielding a total of 99 basking sharks (73 sighted, 26 captured) mainly from North Sardinia. Size ranged from 240 cm to 800 cm. Aggregations of up to 11 individuals were recorded. Sightings peaked between January and March. Three 'hotspots' emerge: most sightings fall within the Pelagos Sanctuary and/or three marine protected areas: Asinara, la Maddalena, Tavolara (Fig. 1).

On the basis of these sightings, dedicated searches by aircraft and boat were conducted, which resulted in the tagging of one individual with NMFS tags; a photo-ID project was started and tissue samples were also collected from dead animals for further DNA analysis. All sightings were shared with MedLem.

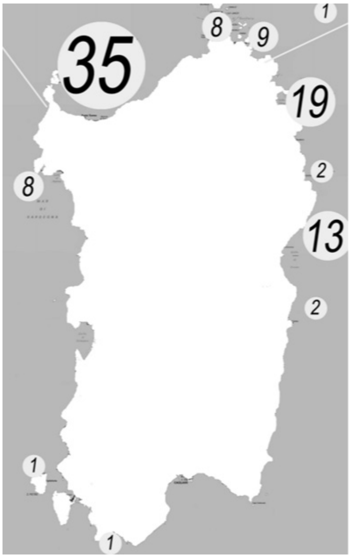

Fig. 1 - Sightings-captures.
Siti di avvistamenti e catture.

Conclusions – These reports suggest that basking sharks are regular seasonal visitors in coastal waters of North Sardinia. The sharp increase in numbers since the public sighting scheme was launched in 2005 – from 20 between 1910-2004 to 79 between 2005-2010 – is most likely due to greater public awareness rather than a growth in population of this shark, which is listed by IUCN as Endangered in the Mediterranean.

These reports are of a casual nature and have a more limited value than sightings reported from properly structured effort-related surveys. However they can provide at a low cost general information on the distribution and relative abundance of this species.

The enthusiastic participation of members of the public in *Operazione Squalo Elefante* has not only significantly increased our current knowledge on the presence of the basking shark in Italian waters, but it generated considerable public awareness. Such sighting schemes should therefore be encouraged in other potential basking shark hotspots.

Acknowledgements – This work would not have been possible without the cooperation of the many people who reported their sightings; our sincere thanks go to all and to the Italian Coast Guard personnel; the La Maddalena Park, Tavolara, and Asinara Marine Protected Areas, and Tethys and ISPRA for the aerial survey.

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Biol. Mar. Mediterr. (2010), 17 (1): 248-249

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FIRST REPORT ON LEPTIN IN A CARTILAGINOUS FISH

PRIMA EVIDENZA DELLA LEPTINA IN UN PESCE CARTILAGINEO

***Abstract** - Leptin is a hormone involved in food intake. It is conserved through evolution, but no studies that have focused on its presence in cartilaginous fish are available to date. Here we report the presence of leptin-like immunoreactivity in the gut of the cartilaginous fish* Scyliorhinus canicula *(Linnaeus,1758) using Western Blot and immunohistochemical analyses. A 16 kDa band, corresponding to leptin, was detected in the homogenate of the stomach, while no immunoreactivity was observed in the intestine. Immunohistochemistry of the gastric mucosa revealed leptin-like staining localized to mucous-secreting cells and endocrine cells. This is the first report on the presence of a leptin-like peptide in a cartilaginous fish.*

***Key-words**: fish, histochemistry, stomach, hormones.*

Introduction - Leptin is a 16 kDa circulating hormone produced by the *ob* gene identified in mammalian adipose tissue (Zhang *et al*., 1994) that plays a key role in the regulation of food intake and energy balance (Schwartz *et al*., 2000). The leptin gene has been sequenced in mammals, birds, amphibians and bony fish (Zhang *et al*., 1994; Doyon *et al*., 2001; Kurokawa *et al*., 2005) but no information on leptin is available in cartilaginous fish. Leptin expression has been reported in adipose tissue, liver and gut of many vertebrates (Johnson *et al*., 2000; Muruzàbal *et al*., 2002; Kurokawa *et al*., 2005; Gambardella *et al*., in press). Among fish, most studies on leptin have been restricted to bony fish, therefore we attempted to verify the presence of leptin in the small-spotted catshark (*Scyliorhinus canicula*) as a representative cartilaginous fish, since it has often been used as a model species in the study of vertebrate evolution.

Materials and methods - Five adult specimens of *S. canicula* were collected in the Ligurian Sea, anesthetized, killed and then dissected to collect the gut. For immunohistochemistry, the stomach and the intestine were fixed in 4% paraformaldehyde in a 0.1 mol/L phosphate-buffered solution (pH 7.4) at 4 °C, embedded, and cut into 5-μm thick sections. Immunohistochemical labeling was performed using rabbit polyclonal antiserum against leptin (LEP) (1:200; Santa Cruz Biotechnology Inc.). Reactions were visualized by immunofluorescence and by immunoperoxidase, using DAB (di-amino-benzidin, Sigma). Negative controls were performed by neutralising LEP primary antiserum with its antigen (1:200; Santa Cruz Biotechnology Inc.). For Western Blot analyses stomach and intestine homogenates were prepared according to the Laemmli method (Laemmli, 1970) on a 10%-23% gradient SDS-polyacrylamide gel.

Results - Leptin-like immunoreactivity (***ir***) was only observed in the gastric mucosa. Leptin-like ***ir*** cells showing two different morphological aspects were located in the gastric pits: scattered open-type neuroendocrine ciliated cells were found in the neck zone and mucous-secreting cells were identified in the basal gastric pits. All controls for antibody specificity generated negative results. Further, no leptin-like ***ir*** was detected in the nervous elements. Western Blot analysis showed a single immunoreactive band of 16±1 kDa (mean±SD) only in the stomach homogenate.

Conclusions - Here we reported for the first time the presence of LEP-like ***ir*** in the gut of *S. canicula*. Western Blot analysis showed ir with a band close to 16 kDa in the small-spotted catshark stomach, in according to previously reports on LEP in bony fish (Gambardella *et al*., in press). Immunohistochemical results confirm Western Blot analysis, showing a specific localization of LEP in the gastric portion. Thus stomach, and in particular gastric mucosa, may be considered the common location for LEP production in non mammalian vertebrates, as reported by multiple authors (Muruzàbal *et al.,* 2002), even if further investigations are required to support this hypothesis.

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ELASMOBRANCH ASSEMBLAGES IN THE IONIAN SEA

ASSOCIAZIONI DI ELASMOBRANCHI NEL MAR IONIO

Abstract *– Multivariate analysis was applied to the abundance of elasmobranch species collected in the Ionian Sea during eleven trawl surveys carried out from 1996 to 2008. Two main assemblages were detected: one regarding the northern sites of the study area, almost exclusively characterized by* Galeus melastomus *and* Etmopterus spinax*, and the other constituted by the Southern-Calabria and Eastern-Sicilian sites, characterized by a greater number of elasmobranch species.*

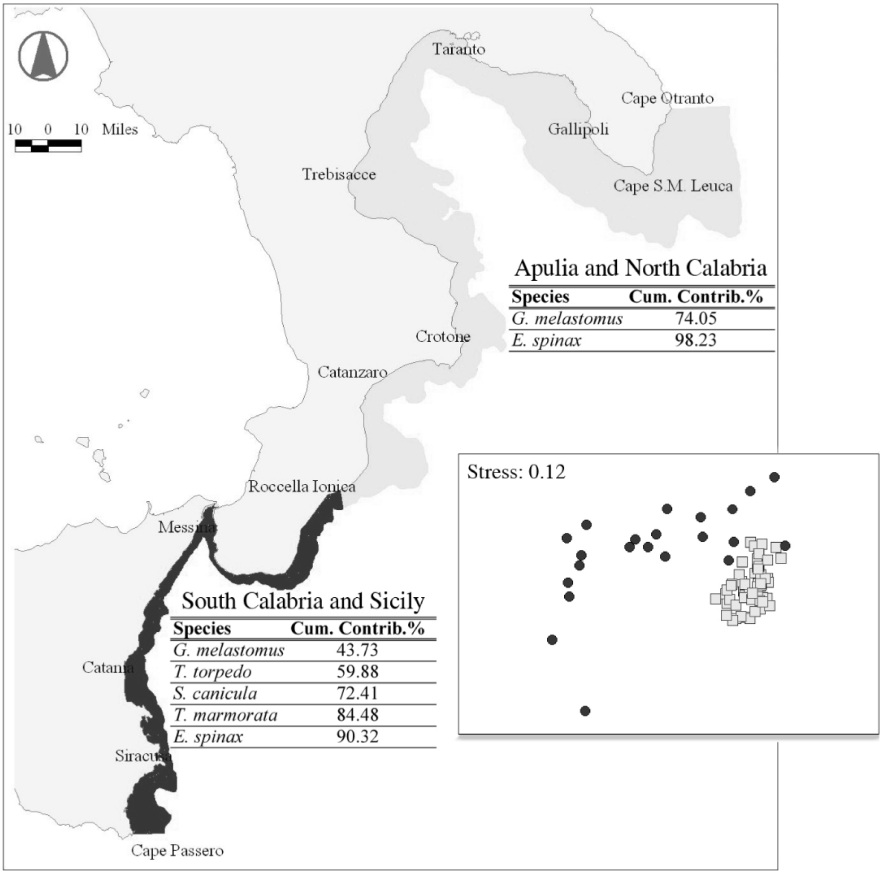
Key-words: *Chondrichthyes, geographical distribution, multivariate analysis, Mediterranean Sea.*

Introduction - In the Ionian Sea elasmobranch species have been investigated with respect to their occurrence, depth distribution and biology (e.g. Sion *et al.*, 2004) while very little is known on their geographic distribution pattern. This work provides the first contribution to the knowledge on the elasmobranch assemblages in the Ionian Sea.

Materials and methods - Data were collected between 1996 and 2008 during eleven experimental bottom trawl surveys carried out in the North-Western Ionian Sea as part of the GRU.N.D. program (Relini, 1998). Catch data of elasmobranches coming from 470 tows were standardized to the swept area and grouped according to geographic zones; replicates for each site were represented by the different surveys in the resulting density matrix (N/km^2). In order to reduce the effect of extreme data, the matrix was fourth root-transformed and Bray-Curtis similarities were estimated between samples. Non-metric Multi Dimensional Scaling ordination was applied in order to identify groups of sites that could correspond to some geographic distribution pattern. The ANOSIM test was applied to evaluate the differences among groups identified. The individual species contributions to discriminate and typify the groups were examined by means of the PRIMER SIMPER routine (Clarke and Warwick, 2001).

Results - The MDS ordination of the samples of elasmobranch abundance data revealed the presence of two distinct groups (Fig. 1): one corresponding to the sites located in the northern region of the study area and another constituted by the Southern-Calabria and Eastern-Sicilian sites. The discrimination of these groups was confirmed by ANOSIM test ($R=0.82$; $p=0.01$). The main contribution to the separation of the identified elasmobranch assemblages was due to *Galeus melastomus* (63.21% contribution to dissimilarity) followed by *Etmopterus spinax* (24.94%). *G. melastomus* proved to be not only the major discriminator of the assemblages, but also the most abundant species in both the assemblages, although with a different contribution to their intra-group similarities (Fig. 1). The Southern Calabria-Sicilian assemblage, in fact, resulted to be characterized by a greater number of elasmobranch species.

Conclusions - A broader spectrum of elasmobranch species was found to characterize the southernmost assemblage in the NW Ionian Sea. This result is in agreement with previous studies along the Italian coasts (Relini *et al.*, 2000)



Apulia and North Calabria

Species	Cum. Contrib.%
G. melastomus	74.05
E. spinax	98.23

South Calabria and Sicily

Species	Cum. Contrib.%
G. melastomus	43.73
T. torpedo	59.88
S. canicula	72.41
T. marmorata	84.48
E. spinax	90.32

Fig. 1 - MDS ordination of the elasmobranch density data and the corresponding zonation of assemblages, with indication of the species percentage cumulative contribution to their similarity.

Ordinamento mediante MDS dei dati di densità degli elasmobranchi e zonazione delle associazioni corrispondenti, con indicazione del contributo percentuale cumulato alla loro similarità.

and could be linked to the local environmental conditions, in terms of sea-water temperature, water mass circulation and the steep and narrow slope that reduces the extension of trawlable bottoms, leading to a lower level of exploitation. These characteristics, coupled with the protection areas developed in the last years, seem to favour a higher presence of sensitive species as those of the elasmobranches.

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Biol. Mar. Mediterr. (2010), 17 (1): 252-253

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HUNTING FOR PREY IN THE OPEN OCEAN: SEARCH PATTERNS OF MARINE PREDATORS

LA CACCIA DELLA PREDA NELL'OCEANO APERTO: I MODELLI DI RICERCA DEI PREDATORI MARINI

Abstract *– An optimal search theory known as the Lévy flight foraging hypothesis predicts predators should adopt search strategies known as Lévy flights where prey is sparse and distributed unpredictably. Empirical studies have generated controversy because less accurate methods have been used to identify Lévy behaviour; consequently whether foragers exhibit Lévy flights in the wild remains unclear. We present results from a study using robust statistical methods to test for Lévy flight behaviour from the largest dataset of animal movements assembled for this purpose from 19 species of open-ocean predator.*

Key-words: *Lévy flight, searching, marine predators.*

Introduction – When searching for sparsely and unpredictably located prey a specialised random walk known as a Lévy flight has been shown in theoretical studies to be the most efficient movement pattern (Viswanathan *et al.,* 2008). A Lévy flight has move step lengths drawn from a power law distribution where the probability of a step of length l is defined by $P(l) \sim l^{-\mu}$, with $1 < \mu \leq 3$ where μ is the power law exponent, resulting in a movement pattern that comprises many short steps connected by fewer long relocations. Free-ranging open-ocean predators, such as pelagic sharks, may be among those most likely to exhibit Lévy behaviour because they occupy unpredictable and depauperate environments with highly patchy prey distributions (Sims *et al.,* 2008), where Lévy motion is hypothesised to increase new-patch encounter probability (Viswanathan *et al.*, 2000). However empirical support for Lévy flights has foundered recently because less accurate statistical methods were used to identify Lévy flight behaviour. Consequently whether Lévy searching occurs in nature remains an open question. In this study rank frequency plots together with robust and reliable maximum likelihood estimation was used to test for the presence of Lévy behaviour in diverse marine predators.

Materials and methods – We analysed vertical move step lengths recorded by archival data-storage tags because they record depth with high resolution and generate the large datasets required for reliable statistical analysis. By contrast horizontal data has large measurement errors and few data points resulting in less accurate estimation of Lévy exponents (Bradshaw *et al.,* 2007; Sims *et al.,* 2007). Data has been made available from several oceanic predators such as planktivorous sharks, tunas, leatherback turtle, Magellanic penguin, several pelagic sharks, billfish and ocean sunfish covering 19 species and a total of >13 million move steps. Animals were tagged in the NE Atlantic and N Pacific in a range of coastal and off-shore habitats. Time series of vertical move displacements were analysed by using rank-frequency plots to test goodness of fit and maximum likelihood estimation (Clauset *et al.,* 2009) to derive exponents. Movement patterns with Lévy characteristics have exponents (μ) between 1 and 3. Modelling studies indicate that optimal Lévy flight search patterns occur with $\mu \sim 2$ (Viswanathan *et al.,* 1999, 2000).

Results - While some final analyses are still being drawn together, it is clear from our early results on basking shark, bigeye tuna, blue sharks, white tip sharks, leatherback turtle and Magellanic penguin that Lévy behaviour is present. We found exponents for individuals of these species with μ close to the optimum of 2. Although the analysis is not yet complete some interesting differences have been identified between species. In particular the billfish and the bigeye thresher shark have Lévy exponents close to 1. These species perform diel vertical migrations (Sedberry and Loefer, 2001; Nakano *et al.,* 2003), resulting in long vertical displacements as they travel to and from deep water which produce low Lévy exponents. It is an interesting confirmation of the statistical methods that these known behavioural differences have been correctly identified.

Conclusions – Using electronic tag data recording the diving movements of large marine predators such as sharks and tunas, we show evidence for the presence and diversity of Lévy behaviour. This provides the most comprehensive and convincing support for the idea that organism search strategies evolved to exploit optimal Lévy searches.

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Biol. Mar. Mediterr. (2010), 17 (1): 254-255

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TEMPORAL AND SPATIAL DISTRIBUTION OF SOME ELASMOBRANCHS IN THE NORTHERN AND CENTRAL ADRIATIC SEA

DISTRIBUZIONE SPAZIO-TEMPORALE DI ALCUNI ELASMOBRANCHI IN ALTO E MEDIO ADRIATICO

***Abstract** – Data collected from trawl survey, carried out in the Northern and Central Adriatic Sea, were analysed in order to know about the spatial distribution of* Myliobatis aquila*,* Mustelus mustelus *and* Squalus acanthias*. Distribution areas with relation to different seasons were discussed.*

***Key-words:** Elasmobranchs, Adriatic Sea, geographical distribution.*

Introduction - *Myliobatis aquila* (L., 1758), *Mustelus mustelus* (L., 1758) and *Squalus acanthias* (L., 1758) are three demersal elasmobranchs species widely distributed in the Mediterranean. In the Adriatic Sea the eagle ray lives on sand and soft substrates up to 100 m in depth, but most often down to 50 m. The smooth-hound lives on sandy and muddy-sandy bottom of the continental shelf up to 200 m depth. The spiny dogfish lives in shallow waters, especially at 10-200 m depth, but exceptionally it can be also found up to 900 m (Jardas, 1984). The aim of this work is to analyse their spatial distribution and to consider possible seasonal changes.

Materials and methods – Data were collected in the Northern and Central Adriatic from 2001 to 2007; in summer in the framework of the MEDITS project (Bertrand *et al.*, 2002) and in autumn-winter in the framework of GRU.N.D. project (Relini, 2000) and FAO/AdriaMed Trawl Surveys Program. The sampling gear was an experimental bottom trawl in summer surveys and an Italian commercial gear in autumn surveys. In both surveys, a depth-stratified random scheme of sampling was applied. Four depth-strata were explored (10-50 m, 50-100 m, 100-200 m and 200-500 m). Catches data were standardised per km^2. In both seasons abundances per stratum in the three sub-area (North Adriatic, Central Adriatic and Croatia), as provided in the Medits project, were calculated. Statistical comparison of catches per stratum were carried out by means of the non-parametric test of Kruskal-Wallis; in the event of the H_0 hypothesis being refused, a pairwise comparison procedure (test of Mann-Whitney) was used to check significant differences between strata. Seasonal distribution area were also mapped by means of geostatistical analysis using the Indicator Kriging method. All spatial analysis and variography studies were carried out using GStat; Arcview GIS 3.2a (Esri) was used for maps production.

Results – *M. aquila* was found up to 90 m depth. In summer, highest abundance indices were estimated in the stratum 10-50 Croatia; catches in this stratum were significantly higher respect to catches in the strata 10-50 North Adriatic and 50-100 Croatia (posthoc Mann-Withney test, p<0.01). In autumn catches also occurred in the strata 50-100 North Adriatic and 50-100 Central Adriatic; in this season, Kruskal-Wallis test did not show significant differences among strata. *M. mustelus* was found up to 170 m. In summer, highest abundance indices were recorded in the stratum 10-50 Croatia, followed by the 10-50 North Adriatic; catches deeper than 50 m occurred only in Croatia. Catches of stratum 10-50 Croatia were significantly higher than catches in other positive strata (posthoc Mann-Withney test, p<0.01). In autumn, it was also caught in the strata 50-100 North and Central Adriatic and 100-200 Central Adriatic; Kruskal-Wallis test did not highlight significant differences among strata. *S. acanthias* was found up to 240 m. In both seasons highest abundance indices were estimated in the stratum 10-50 North Adriatic followed by the 50-100 North Adriatic and 50-100 Croatia.

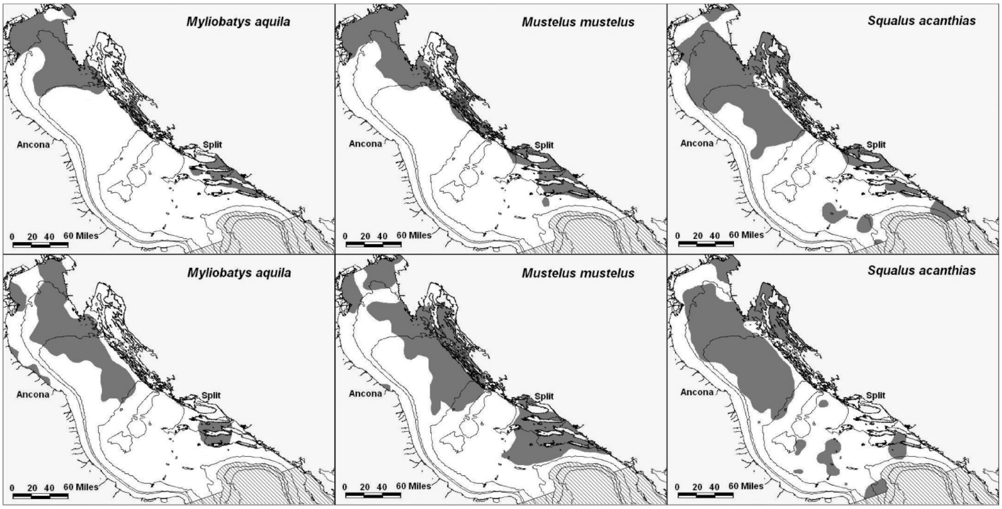

Fig. 1 - Distribution area for the studied species in summer (above) and autumn (below).
Area di distribuzione delle specie indagate in estate (sopra) ed autunno (sotto).

Conclusions – Vertical distribution of the studied species agreed with the bathymetric range reported by Jardas (1984). *S. acanthias* showed no significant differences of distribution area between seasons. *M. aquila* and *M. mustelus* pointed out a different distribution per stratum, also confirmed by the geostatistical analysis; in summer, their distribution areas were limited to the North Adriatic and Croatia while in autumn they also extended to the Central Adriatic. According to Jardas (1984) their distribution depends on both depth and granulometric composition of the bottom sediments but it probably also depends on other ecological and/or environmental factors.

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REPRODUCTIVE BIOLOGY OF THE BLONDE RAY *RAJA BRACHYURA* (CHONDRICHTHYES: RAJIDAE) IN SARDINIAN SEAS

BIOLOGIA RIPRODUTTIVA DI RAJA BRACHYURA *(CHONDRICHTHYES: RAJIDAE) NEI MARI SARDI*

Abstract *– The reproductive biology of* Raja brachyura *(Chondrichthyes: Rajidae) in Sardinian waters was analysed. A total of 839 specimens (431 males and 408 females) were collected at depth of 30-175 m in 2005-2009. Females ranged from 131 to 1055 mm in Total Length and males from 156 to 965 mm. No significant differences in size distribution among sexes were detected. Mature females and males were found during spring and summer and from winter to summer respectively. Spent specimens were found in all seasons except in autumn for females and spring for males.*

Key-words: *Rajidae,* Raja brachyura*, reproduction, Sardinian seas.*

Introduction - The typical low fecundity and late maturity of rajid species make them particularly vulnerable to fishing pressure and over exploitation. However, little is known about their reproductive biology. The blonde ray *Raja brachyura* Lafont, 1873 shows a clear preference for sandy sea bottoms in the upper continental shelf (Serena, 2005). Generally, it is considered an uncommon species in the Mediterranean (Serena, 2005), but the observations from Follesa *et al.* (2003, 2010), Catalano *et al.* (2007) and Ragonese *et al.* (2003) indicate that the Sardinian coasts and the western Sicily represent a zone of the basin where *R. brachyura* is relatively abundant.

In the last years, few reproductive data were collected (Catalano *et al.,* 2007). This paper provides new and more complete information about the reproductive biology of the blonde ray in the Sardinian seas (central western Mediterranean).

Materials and methods - Specimens of *R. brachyura* were caught during experimental trawl surveys MEDITS and GRUND carried out between 30 and 175 m depth in 2005-2009 in Sardinian waters. Each specimen was identified, measured (Total Length, TL and Disc Width, DW, mm), and weighted (TW, g). The fishes were sexed following the maturity scales of elasmobranchs reported in Relini *et al.,* 2008. In males, the length of the claspers (CL, mm) were recorded.

Results – The length distribution of the blonde ray showed a range in size between 131 and 1055 mm TL. The females (N=408) ranged between 131 and 1055 mm (329±147, mean±SD), while the males (N=431) between156 and 965 mm TL (323±124, mean±SD). No significant differences in size distribution among sexes were found (Kolmogorov Smirnov, P>0.05).

The slope of the logarithmic relationship TW-TL among sexes was not significantly different (*t*-test, P>0.01) (Tab. 1). At the same TL, females had higher DW than males (linear relationship among sexes was found statistically different (*t*-test, P<0.05)) (Tab. 1).

The overall SR (males: females) was 1.06:1, not significantly different from the expected sex ratio of 1: 1 (χ^2=0.09; P<0.05). This ratio showed no statistical differences (P<0.05) during spring (SR=1.15: 1), autumn (SR=1.23:1) and summer (SR=0.95:1) while a dominance of males was observed during winter (SR=1.76:1,

Tab. 1 - Morphometric and reproductive data for males and females of *Raja brachyura*.
Dati morfometrici e riproduttivi per maschi e femmine di Raja brachyura.

MALES		**FEMALES**	
DW and TL relationship	DW=0.7406*TL-21.847 ($R^2 = 0.98$)	DW and TL relationship	DW=0.7332*TL-16.372 ($R^2 = 0.99$)
Smallest mature male	845 mm TL	Smallest mature female	925 mm TL (with egg cases)
Largest immature male	710 mm TL	Largest immature female	755 mm TL
TW and TL relationship	$TW=6*10^{-7}*TL^{3.3622}$ ($R^2 = 0.98$)	TW and TL relationship	$TW=5*10^{-7}*TL^{3.3962}$ ($R^2 = 0.97$)

P>0.05). Immature females ranged in size between 131 and 755 mm TL. Maturing females were between 235 and 920 mm TL, while the mature ones ranged in size between 925 and 1055 mm TL. The males between 156 and 710 mm TL were at maturity stage 1. A faster growth of clasper length was detected from the maturing specimens (380-760 mm TL) reaching a maximum length of 245 mm CL in mature individuals (845-965 mm TL). Mature females carrying egg cases and males with hard and ossified claspers were found during spring and summer and from winter to summer respectively. Spent specimens were found in all seasons except in autumn for females and spring for males.

Conclusions – In this study, detailed seasonal reproductive data of *R. brachyura* in the Sardinian seas (Central Western Mediterranean) are given. The reproductive period of the blonde ray agree with the information reported for the Atlantic (Clark, 1922), where the maximum number of females carrying egg cases was observed between May and June. As reported for many other elasmobranchs, including rajids, females reached a greater Total Length and matured at significantly larger size than males. Statistical differences of the linear relationship DW-TL among sexes could be justified by the need of abdominal space to better carry egg cases, as hypothesized also by Catalano *et al.* (2007).

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NEW MAXIMUM LENGTHS FOR THE STRIPED SMOOTH-HOUND *MUSTELUS FASCIATUS* (GARMAN, 1913) (CARCHARHINIFORMES, TRIAKIDAE)

NUOVE TAGLIE MASSIME PER IL MUSTELUS FASCIATUS *(GARMAN, 1913) (CARCHARHINIFORMES, TRIAKIDAE)*

Abstract *– Two valuable specimens (a female of 177 cm total length and a male of 162 cm total length) of the striped smooth-hound* Mustelus fasciatus *were caught by artisanal fisheries off Uruguay coasts in 2007 and 2009. These specimens reached the largest sizes of the species reported in literature.*

Key-words**:** *Triakidae,* Mustelus fasciatus*, maximum length, Uruguay, South Western Atlantic.*

Introduction – The Striped smooth-hound *Mustelus fasciatus* (Garman, 1913) is a shark endemic to a restricted area of the inner continental shelf (South Brazil to Argentina) in the Southwest Atlantic Ocean. High fishing pressure on this species is reported in the southern Brazil. In Uruguay *M. fasciatus* is sporadically caught by local fisherman with gillnets and trawlers. This specie was described by Garman in 1913 on the basis of juvenile individuals. The first adult specimen was collected in the Uruguayan waters (Sadowsky, 1977), and later, a few adult specimens were sited from Uruguay and the southern and northern coasts of State of Rio Grande do Sul, Brazil (Soto, 2001a). This note reports the largest specimens documented in literature.

Materials and methods – The two specimens reported in this note were identified according to Compagno (1984). The first specimen, a female, was caught on October 15th 2007, by trammel net of the fishing boat Lina Valeria III off S. E. Punta del Diablo, Rocha, Uruguay (approximate coord. 34°10'S-53°16'W on sandy-muddy bottom at 18 m depth (Fig.1a-c). This specimen is stored in a Belgian private collection. The second shark, a male, was caught in Pozo de Fango off La Paloma, Rocha, (approximate coord. 34°47'50S-53°48'50W) by a trammel net, on November 15th 2009, at 70 m depth (Fig. 1d). This specimen will be taxidermies and stored in the "Wilderness Studi Ambientali" collection in Palermo. Both specimens were measured as total length (cm) and weighted as total weight (kg). Other biometries were taken only in female.

Results – *M. fasciatus* female was 177 cm total length and 29,7 kg weight. Other significant biometries were: Head (41 cm), Trunk (54 cm), Tail (82 cm), Caudal fin length (36 cm), Second dorsal fin length (23 cm), Interdorsal space (52 cm), Pectoral fin length (25 cm), Precaudal tail (47 cm), Precaudal height (5.5 cm), Dorsal fin base (25 cm), Dorsal fin height (14 cm), Pectoral fin base (11 cm), Internasal distance (5.0 cm), Preoral length (12 cm), Mouth width (12 cm). More than 30 large yolk follicles were present in the ovary (see Fig. 1b). The male was 162 cm total length; and 17,5 kg weight. Both sharks showed a dorsal surface grey-brown, ventral surface light. Brown vertical bars are present although not evident as in juveniles.

Conclusions – The species lives on shelf bottom over a restricted area (1,500 km of coastline) of the Southwest Atlantic. Neonates are typically found off beach between

1 and 5 m depth, juveniles are found in inshore waters between 15 and 50 m, and adults are found down to 50 m up to 250 m (Soto, 2001b). According to the literature gravid females migrate to the coast at less than 20 m depth to give birth in October-December. After they reach depth between 20 and 50 m, where mature males occur for mating. The gestation period lasts 11-12 months. This endemic species occurs at low densities. Trawl surveys carried out in north Argentina and Uruguay showed that biomass indices decreased by 96% from 1994 to 1999. There is serious concern regarding further declines in the absence of conservation and enforced management measures. In 2002 *M. fasciatus* was classified as a species threatened with extinction. The maximum size reported for *M. fasciatus* are 147 cm TL in males and 158 cm TL in females (Soto, 2001a; Soto and Mincarone, 2004). The sizes of the specimen reported in this note are the largest of the literature (female 177 cm, male 162 cm). The findings of very large individuals just three years ago seem in contrast with the much depleted status assessed for the stock. This contrasting result might be interpreted as the effect of an increase in fishing efficiency to explore/exploit wider and wider fishing-grounds.

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OCCURRENCE OF *LEUCORAJA FULLONICA* (LINNAEUS, 1758) IN THE SOUTH ADRIATIC SEA

RITROVAMENTO DI LEUCORAJA FULLONICA *(LINNAEUS, 1758) NELL'ADRIATICO MERIDIONALE*

***Abstract** – Ten specimens of* Leucoraja fullonica *(Rajidae) 3 males and 7 females, were caught during the trawl surveys conducted in the South Adriatic Sea in autumn 2008 (GRUND) and spring 2009 (MEDITS). Length and weight were comprised respectively from 230 to 760 mm and from 41.5 to 2300 g. Specimens were caught in a depth range of 297 and 574 m.*

Key-words: Leucoraja fullonica*, South Adriatic Sea, trawl surveys.*

Introduction – In the Mediterranean Sea, skates commonly represent a low valued by-catch of the demersal fisheries (Ragonese *et al*., 2003). However, species of this group have generally an important ecological role, as they are top predators. Moreover, life-history traits, such as large size at first maturity and low fecundity, make the populations particularly vulnerable to fishing pressure (Serena, in press). Some of the skate species living in restricted areas (Ragonese *et al*., 2003), such as *Leucoraja fullonica* (Linnaeus, 1758) are actually considered rare in the Mediterranean (Serena, in press).

Materials and methods – Specimens of *L. fullonica* (Fig. 1) were collected during trawl surveys (GRUND, autumn 2008; MEDITS, spring 2009) carried out in the South Adriatic Sea (GSA 18). Skates were classified following the guidelines reported by Serena (in press), and the following measures were taken: total length (TL), body weight (TW), sex and maturity stage.

Fig. 1 - Female of *Leucoraja fullonica* caught in the South Adriatic Sea.
Femmina di Leucoraja fullonica *catturata nell'Adriatico meridionale.*

Results – During the two trawl surveys ten specimens of *L. fullonica* were caught in ten different hauls located on the western and eastern side of the South Adriatic Sea at 297-574 m depth (Tab. 1). Individual length and weight ranged from 230 to 760 mm and from 41 to 2300 g. Only three specimens were males, the other seven were females.

Conclusions – *L. fullonica* is generally distributed in the Western Mediterranean Sea and in the Atlantic Ocean from Iceland to Madeira and northern Morocco (Stehmann and Bürkel, 1984) In the Italian seas, this species was occasionally found in the Strait of Sicily (Ragonese *et al*., 2003), in the South Ligurian and North Tyrrhenian (Serena *et al*., 2003) and in the north-western Ionian Sea (Sion *et al*., 2003). No occurrence of *L. fullonica* was recorded in the South Adriatic Sea (Marano *et al*., 2003). This finding represents the first record in our area of *L. fullonica*, a species easily misidentified with *Leucoraja circularis* Couch, 1838 (Serena, in press). Both juveniles and adults were found at a bathymetric distribution similar to that reported by other Authors (Stehmann, 1990; Serena *et al*., 2010). Further morphometric and genetic analyses will be carried out to better elucidate the phylogenetics of *Leucoraja* species.

Tab. 1 - Information on the specimens of *Leucoraja fullonica* caught in the South Adriatic Sea. (* the measure refers to the disc length).

Informazioni circa gli individui di Leucoraja fullonica *catturati nell'Adriatico meridionale. (* la misura si riferisce alla lunghezza del disco).*

Geographic coordinates	Survey	Month	Year	Weight (g)	Length (mm)	SEX	Maturity	Depth (m)
42°10.32'N – 16°56.76'E	GRUNDS	December	2008	41	230	M	1	387
40°00.70'N – 16°59.75'E	MEDITS	June	2009	191	356	M	1	531.5
40°22.56'N – 18°36.91'E	MEDITS	June	2009	200	405	F	1	378
40°40.80'N – 18°59.69'E	MEDITS	June	2009	250	190*	F	1	522.5
40°32.98'N – 19°01.47'E	MEDITS	June	2009	280	400	F	1	520
40°37.88'N – 18°36.27'E	MEDITS	June	2009	350	416	F	1	574
41°06.07'N – 18°51.72'E	MEDITS	June	2009	765	530	F	1	297
40°34.69'N – 18°31.43'E	GRUNDS	December	2008	871	562	F	2	-
40°06.92'N – 17°00.39'E	GRUNDS	December	2008	1251	635	M	2	551.5
41°32.17'N – 17°09.78'E	GRUNDS	December	2008	2300	760	F	2	554.5

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Biol. Mar. Mediterr. (2010), 17 (1): 264-265

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BOTTLENOSE DOLPHIN PRESENCE IN A MARINE FISH FARM FROM THE NORTH WESTERN COAST OF SARDINIA

PRESENZA DEL TURSIOPE PRESSO UN IMPIANTO DI MARICOLTURA NELLA COSTA NORD OCCIDENTALE DELLA SARDEGNA

***Abstract** – The objective of this study was to determine the main variables that can influence presence and abundance of the bottlenose dolphin (*Tursiops truncatus *Montagu, 1821) near an offshore marine fish farm of the North western coast of Sardinia (Gulf of Alghero, Italy). Based on the results obtained in this study, we can evidence that same factors influence the seasonal presence of dolphins in offshore fish farm: water temperature, water transparency and anthropogenic impact (presence of recreational boats).*

***Key-words**: marine mammals, aquaculture, habitat use, behaviour.*

Introduction – Mariculture, in particular intensive fish farming, is an activity that has grown considerably in the Mediterranean sea over the last twenty years (UNEP/MAP/MED POL, 2004). As a consequence, new habitats have been created causing a dispersal of organic waste and nutrients that attract numerous predators. Several studies have examined the effects of inshore and offshore marine fish farms on bottlenose dolphin populations (Diaz Lopez *et al.*, 2005; Watson-Capps & Mann, 2005; Diaz Lopez & Shirai, 2007). The objective of this study was to identify the main variables that can influence presence and abundance of the bottlenose dolphin (*Tursiops truncatus* Montagu, 1821) in proximity of an offshore fish farm located in the Gulf of Alghero (North western Sardinia, Italy).

Materials and methods – This research was carried out from August 2008 to May 2009 using a 5.10 m motor boat at the fish farming facilities of "La Maricoltura Alghero s.n.c." located in the Gulf of Alghero (40°33.671' Nord - 008°16.144' Est; Fig. 1). Observations were carried out at intervals of 20 minutes for a total sampling effort of 100 hours. The variables considered were: dolphins presence/absence, water temperature (°C), water transparency (m), wind speed (m/s), recreational boats and gillnets. Data were analyzed with Non-Parametric Multivariate Analysis of Variance (NPMANOVA) to test if there were significant differences between presence and absence of the bottlenose dolphins in the neighbouring of the fish farm. Principal components analysis (PCA) was than used for finding variables which accounted for much of the variance. Statistical analyses were performed using Palaentological Statistics (PAST) Version 1.35.

Results – During this study 300 groups of observations (25 during the morning, 25 in the afternoon and 25 in the evening, corresponding to 75 samples ´ season) were selected at random among those carried out in total. Dolphins where observed year round during the study period in the 22% of the samples analyzed, but there was a clear seasonal trend in their occurrence. NPMANOVA detected significant differences and PCA showed that the presence of dolphins was related with lower values of water temperature, water transparency and number of recreational boats (source of anthropogenic impact).

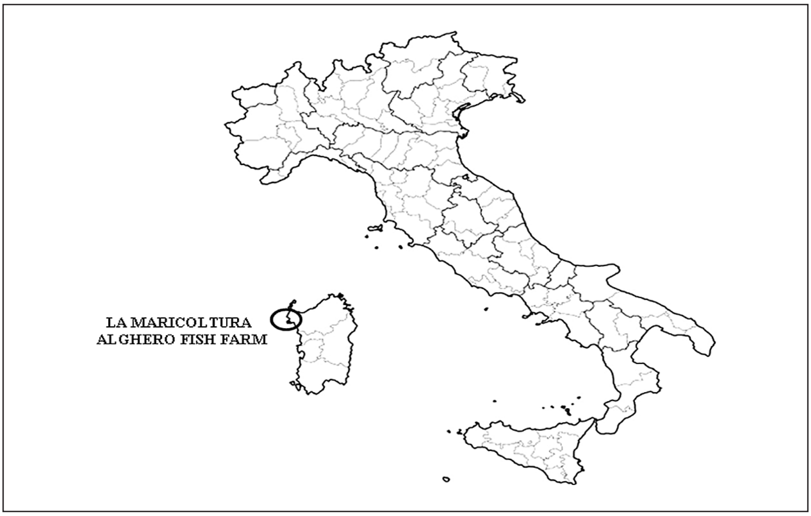

Fig. 1 - Marine offshore fish farm in the Gulf of Alghero.
Impianto di maricoltura offshore nel Golfo di Alghero.

Conclusions – This study evidenced the presence of bottlenose dolphins near an offshore fish farm in the Gulf of Alghero. Two main factors influenced the seasonal occurrence of *Tursiops truncatus* specimens in the neighbouring of the fish farm: environmental variables (i.e. temperature and transparency of the water) and anthropogenic impact (i.e. presence of recreational boats). The peak of dolphin abundance and their interaction with the fish farm observed during the fall-winter seasons could be related to the low availability of food in the Gulf of Alghero. On the other hand, higher marine traffic observed during the summer months could negatively influence the presence of dolphins in this area. These results can be compared with similar studies carried out along the North eastern coast of Sardinia once more confirming that bottlenose dolphins can frequently capitalize on aquaculture activities in Sardinia Island (Diaz Lopez *et al.*, 2005; Diaz Lopez & Shirai, 2007).

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Biol. Mar. Mediterr. (2010), 17 (1): 266-267

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CHANGES IN SOME PHYSIOLOGICAL PARAMETERS OF RED PORGY *PAGRUS PAGRUS* DURING A FASTING-REFEEDING EXPERIMENT

VARIAZIONI DEI PARAMETRI FISIOLOGICI IN PAGRUS PAGRUS *SOTTOPOSTO A DIGIUNO E RIALIMENTAZIONE*

***Abstract** – A fasting-refeeding experiment was carried out in red porgy,* Pagrus pagrus *(Teleostei, Sparidae) to assess the effect of a 21 day- starvation period on some physiological parameters. Both haematological and biochemical parameters and digestive enzyme patterns were considered. Results showed that starvation resulted in a general, although not significant, decrease of digestive enzyme levels, with a recovery to initial values after refeeding. No significant changes were observed in both haematological and biochemical parameters.*

***Key-words:** starvation, stress, enzymes,* Pagrus pagrus.

Introduction – Red porgy is a promising species for aquaculture diversification. It is known that unbalanced feeding or starvation can result in a stress condition, so the study of physiological responses to starvation in farmed species is interesting to develop proper management practices (Caruso *et al*., 2010). Different aspects of the physiology of red porgy are unexplored especially those related to stress and digestive physiology. This study aimed at investigating the physiological responses of red porgy to a short starvation period, followed by re-feeding. The conventional stress indicators (cortisol, glucose and haematocrit) and digestive enzymes were monitored up to 15 days after re-feeding, in order to evaluate the possible recovery of the physiological parameters to the pre-fasting levels.

Materials and methods – Adult red porgy (n=30) (mean weight: 366.0±36.1 g) were obtained by a Sicilian fish farm and kept at the IAMC aquaculture plant. After acclimation (21 days), fish were divided into two groups, one of which was kept starved while the other was fed "ad libitum" with commercial feed. At T0 and T1 (before and 10 days after starvation, respectively) three fish from each group were collected after euthanasia in a lethal dose of MS-222. The starved group was further re-fed up to 20 days; during this period, two other samplings were performed, 7 and 15 days after re-feeding (T2 and T3, respectively). At each sampling, blood was drawn from the caudal vein for the determination of serum cortisol and glucose by commercial kits based on ELISA immunoassay and enzymatic colorimetric method (GOD-POD), respectively; the haematocrit was determined by a microcentrifugation method. Enzyme activities (total proteases, pepsin, trypsin, chymotrypsin, carboxypeptidases A and B, amylase, lipase) were measured along the digestive tract (stomach, proximal gut, midgut and distal gut), excepting the stomach for lipase only (Caruso *et al*., 2009). Enzyme values were reported as specific enzyme activities (U/mg protein). All data were analysed by Student' t test.

Results and conclusions – Starvation caused a general, although not significant, decrease of digestive enzymes, with an earlier recovery (on T2) to initial values for total proteases in the midgut and delayed (on T3) for amylase and lipase (Tab. 1). Reversibility was also observed in Atlantic salmon (Krogdahl & Bakke-McKellep, 2005) and in sturgeon and in trout (Furné *et al*., 2008). No significant changes in haematological and biochemical parameters were observed. This suggested the good resistance of red porgy to short-term starvation.

Tab. 1 - Specific digestive enzyme activities (U/mg protein) of *Pagrus pagrus*.
Attività specifica (U/mg proteina) degli enzimi digestivi di Pagrus pagrus.

	Starved - refed group				Fed group			
Times	Stomach	Proximal gut	Midgut	Distal gut	Stomach	Proximal gut	Midgut	Distal gut
Total proteases								
T0	0,583	0,739	0,336	0,778				
T1	0,468	0,320	0,440	0,465	0,879	1,079	1,041	0,724
T2	0,617	0,266	0,668	0,430	1,936	1,155	1,145	1,997
T3	1,045	0,802	0,911	0,511	2,004	1,676	2,269	2,601
Amylase								
T0	0,129	0,205	0,026	0,061				
T1	0,021	0,063	0,034	0,007	0,124	0,104	0,040	0,025
T2	0,017	0,104	0,029	0,018	0,113	0,201	0,044	0,109
T3	0,031	0,186	0,026	0,065	0,230	0,297	0,049	0,147
Lipase								
T0		0,006	0,0008	0,0009				
T1		0,001	0,0002	0,0007		0,001	0,0007	0,0014
T2		0,001	0,0005	0,0011		0,003	0,0014	0,0071
T3		0,004	0,0007	0,0036		0,010	0,0101	0,0070

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SEDIMENT FEATURES AND HEAVY METAL LEVELS IN FOUR AREAS OF SARDINIA DEVOTED TO BIVALVE CULTURE

CARATTERISTICHE DEI SEDIMENTI E LIVELLI DI METALLI PESANTI IN QUATTRO AREE DELLA SARDEGNA IDONEE ALL'ALLEVAMENTO DEI BIVALVI

Abstract *– Sediment characteristics and Cd, Cu, Mn, Pb and Zn concentrations were assessed in the lagoons of Marceddì, Calich and Porto Pozzo, and in the inner part of the Gulf of Olbia. Sediment of the zones examined were quite similar, except for the Calich lagoon that showed the higher content of total organic carbon. High values of Cd, Pb and Zn were detected in the sediments of the Marceddì lagoon, while remarkable levels of Cu and Mn were found in the Calich lagoon and in the Gulf of Olbia.*

Key-words: *sediment pollution, heavy metals, mollusc culture, Mediterranean Sea.*

Introduction - Bivalve mollusc culture has greatly increased in Italy during the last years. Along the Sardinian coasts, besides natural bivalve populations of commercial interest, there are a number of areas historically devoted to the mussel (*Mytilus galloprovincialis*) culture (*e.g.* the Gulf of Olbia; Bussani, 1983), and several other zones in which the culture of other bivalve species has been tested (Rossi & Cannas, 1992). Due to the increasing importance of these aquaculture practices, the purpose of this study was to determine heavy metal concentrations in the sediments of some areas of Sardinia devoted to bivalve culture.

Materials and methods – Sediment from four zones in which bivalve molluscs are usually fished and/or cultured (*i.e.* the lagoons of Marceddì, Calich and Porto Pozzo, and the inner part of the Gulf of Olbia, respectively) were studied in July 2009. Three samples from each location were collected by driving a polycarbonate cylinder (Ø=5.5 cm) about 30 cm into the bottom soil and retrieving the sediment cores that were then frozen and stored for subsequent analysis. Particle size measurements were carried out following the method of Gee & Bauder (1986), the pH and electric conductivity (EC) values were determined in 1:25 ratio of sediment/distilled water, and total organic carbon (TOC) was assessed using the method of Walkley & Black (1934). The total concentration of selected heavy metals (*i.e.* Cd, Cu, Mn, Pb and Zn) was determined by drying the sediments overnight at 105 °C and digesting them with HNO_3 and HCl (ratio 1/3) in a microwave Milestone MLS 1200. The heavy metal concentrations were detected using a Perkin Elmer Analyst 600 flame atomic absorption spectrometer equipped with a HGA-600 graphite furnace.

Results – General features and heavy metal levels of the sediments examined are reported in Tab. 1. Soil features of the four zones were quite similar, except for the Calich lagoon that showed the higher values of EC and TOC, and a silty-sand texture. The higher concentrations of Cd, Pb and Zn were detected in the sediments of the Marceddì lagoon, followed by those observed in the Calich one. In this latter area, as well as in the Gulf of Olbia, remarkable levels of Cu and Mn were also found. Finally, in the sediments of the Porto Pozzo lagoon heavy metal concentrations were always low.

Tab. 1 - Sediment features and heavy metal levels (mean±SD) in the four areas examined.
Caratteristiche dei sedimenti e livelli di metalli pesanti (media±DS) nelle quattro aree studiate.

	Marceddì	Calich	Porto Pozzo	Olbia
pH	8.57±0.04	7.61±0.04	7.60±0.08	8.12±0.15
EC (mS cm^{-1})	5.59±0.69	18.10±0.79	8.75±0.45	6.67±0.49
TOC (% DM)	0.15±0.01	1.52±0.06	0.36±0.04	0.26±0.02
Texture	sandy-silt	silty-sand	sandy-silt	sandy-silt
Cd (mg kg^{-1} DM)	1.39±0.55	0.10±0.01	0.08±0.02	0.09±0.02
Cu (mg kg^{-1} DM)	2.63±0.72	9.56±0.76	1.42±0.39	4.23±0.35
Mn (mg kg^{-1} DM)	7.86±0.70	95.58±3.67	18.50±2.15	41.69±4.36
Pb (mg kg^{-1} DM)	17.10±3.12	9.86±0.79	2.24±0.51	5.96±0.88
Zn (mg kg^{-1} DM)	239.36±27.67	26.80±7.96	-	19.02±1.92

Conclusions – The results of this study evidenced different sedimentological conditions in four Sardinian areas devoted to bivalve culture. In particular, the sediments of the Calich lagoon showed the higher level of TOC and Cu, probably due to sludge accumulation from wastewater treatment and/or agricultural practices in adjacent zones (Ghiglieri *et al.*, 2009). Conversely, the higher concentrations of Cd, Pb and Zn recorded in the Marceddì lagoon were almost certainly caused by mine tailings and flotation sludges containing critical amounts of heavy metals from a neighbouring mining area (Garau *et al.*, 2007). Additional research is therefore needed to evaluate heavy metal levels in autochthonous burrowing bivalves of economic importance (e.g. *Ruditapes decussatus*) from these polluted areas.

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PROVE DI SOMMINISTRAZIONE DI ALIMENTO COMMERCIALE SU *MYTILUS GALLOPROVINCIALIS* IN FASE DI FINISSAGGIO

TESTS ON COMMERCIAL FEEDING MYTILUS GALLOPROVINCIALIS *DURING FINISHING*

Abstract *– The aim of this research was to obtain specific information about lipid and PUFA content in* Mytilus galloprovincialis *fed in captivity with commercially available products. The product used in the trial has been selected among the most commonly algae based feed used in the hatcheries of euryhaline fishes. The analyses conducted on the edible part concerned the pre and post feeding quantitative and qualitative aspects of lipidic profiles of mussel. The results of the analyses on the lipidic portion of the mussels showed a real ability of* Mytilus galloprovincialis *to digest and metabolize the administered food.*

Key-words: Mytilus galloprovincialis*, feeding experiments, lipids, PUFA.*

Introduzione – La molluschicoltura rappresenta la principale voce produttiva dell'acquacoltura nazionale ed è basata principalmente sull'allevamento di vongole (*Ruditapes decussatus* e *R. philippinarum*) e mitili (*Mytilus galloprovincialis*). Ad oggi, a livello commerciale, non è presente alcun mollusco bivalve che abbia una composizione nutrizionale pregiata, indotta con pratiche d'allevamento specifiche, tale da poterne favorire una collocazione su di un mercato che abbia target ben definito: quello dei consumatori di alimenti funzionali che risultano essere in continua espansione. In tale ottica, lo sviluppo di un prodotto ittico che in virtù delle proprie qualità possa incrementare il reddito del produttore risulta di estrema importanza. Le qualità a cui si fa riferimento sono soprattutto quelle di carattere nutrizionale e, nello specifico, al contenuto di quella classe di acidi grassi comunemente conosciuta come ω-3 (Garrido e Medina, 2002; Pagnucco *et al*., 1996). A tale proposito, la sperimentazione di seguito descritta si propone di mettere a punto una tecnica in grado di produrre *M. galloprovincialis* con caratteristiche nutrizionali esaltate, con riferimento al maggior contenuto di PUFA (acidi grassi polinsaturi) e in special modo di ω-3.

Materiali e metodi – Per la prova sono stati predisposti 2 impianti indipendenti di piccole dimensioni (capacità 300 l), costituiti ciascuno da 2 vasche in vetro della capacità di 150/cad,, un sistema di aerazione ed un sistema di ricircolo esterno. Le 4 vasche sono state collocate all'interno di un impianto più grande allo scopo di condizionare i molluschi alla medesima temperatura di stabulazione, pur mantenendoli in ambienti separati.

In ciascun acquario sono stati posizionati 5 kg di mitili (*Mytilus galloprovincialis*) mantenuti nelle medesime condizioni ambientali (Temperatura dell'acqua di 15 °C e salinità del 28‰) per un periodo di acclimatazione di 2 giorni. Successivamente, la sperimentazione ha previsto la somministrazione dell'alimento (1% p.v.) in 2 vasche (Gruppo A) mentre i mitili stoccati nelle 2 rimanenti (Gruppo C) sono stati mantenuti a digiuno per tutta la durata della prova. L'alimento somministrato è stato reperito in commercio orientando la scelta fra i prodotti a base algale ricchi di PUFA (proteine gregge 54%; grassi greggi 15%; HUFA n-3 20mg/g DW) usati dagli aquacoltori nei protocolli di alimentazione degli stadi larvali di pesci eurialini. Al termine della fase di acclimatazione, e ad intervalli di 12, 24 e 36 ore dalla somministrazione del prodotto commerciale, da tutte le vasche sono stati prelevati campioni di molluschi sui quali sono state effettuate analisi quali-quantitative della porzione edule. Nello specifico, è stata quantificata la frazione lipidica e, mediante gas-cromatografia (Pirini *et al.*, 2002, 2007), è stata effettuata la valutazione qualitativa del profilo in acidi grassi.

Risultati – I risultati delle analisi effettuate sulla porzione edule dei mitili hanno evidenziano un'effettiva capacità dei molluschi di assimilare l'alimento somministrato. Gli esemplari di *Mytilus galloprovincialis* alimentati (Gruppo A), infatti, rispetto agli animali di controllo hanno fatto registrare dopo 24 ore un sensibile incremento del contenuto lipidico, da 1.62% a 2.34% (pari al 45% circa), seguito nei periodi successivi da aumenti più contenuti, da 1.34% a 1.68% (pari al 25%) dopo 48 ore e da 1.15% a 1.53% (pari al 33%) dopo 36 ore.

Tuttavia lo spettro degli acidi grassi non mostra variazioni di rilievo per quanto riguarda le percentuali di acidi grassi polinsaturi a lunga catena come EPA e DHA, i cui valori pari rispettivamente a 11% e 21% si mantengono costanti nonostante i rilevanti apporti dietetici.

Ciò nonostante si può ritenere che, a seguito delle accresciute quote lipidiche presenti negli animali *in toto* sottoposti ad alimentazione col mangime suddetto, anche il quantitativo totale di questi acidi grassi abbia subito un proporzionale aumento, assicurando un arricchimento del prodotto importante per la salute umana.

Conclusioni – La sperimentazione effettuata, seppur di carattere preliminare, ha messo in evidenza come *Mytilus galloprovincialis* sia in grado di assimilare l'alimento commerciale somministrato in condizioni di cattività. La tesaurizzazione del contenuto lipidico, da cui verosimilmente possono scaturire nell'animale "in toto" maggiori quantitativi di PUFA, sembra pertanto rivelare come una tecnica di alimentazione controllata possa essere applicata su molluschi bivalvi allo scopo di ottenere alimenti funzionali sempre più richiesti dai consumatori maggiormente esigenti.

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HISTOLOGICAL EXAMINATION OF THE GONADS OF *PARACENTROTUS LIVIDUS* (LMK, 1816) FROM THE SOUTHERN ADRIATIC COAST

ANALISI ISTOLOGICA DELLE GONADI DI PARACENTROTUS LIVIDUS *(LMK, 1816) PROVENIENTI DALLE COSTE DELL'ADRIATICO MERIDIONALE*

Abstract *– The histological evaluation of the gonads of* Paracentrotus lividus *(Echinodermata: Echinoidea) has been carried out from April to November on specimens sampled along the mid-to-low Adriatic coast. The % of individuals with gonads in active gametogenesis never decreased until 50% also in summer months, when a resting period would be expected. This continuous presence of individuals with an active gametogenesis is very useful in order to set up rearing protocols for a short-term induction of gonad yield and gamete maturation.*

Key-words: *sea urchin,* Paracentrotus lividus*, gonad histology, Gonad Index, reproduction.*

Introduction - In the last years the interest in developing cost-effective ways of culturing sea urchins has increased as the world's wild stocks of many species have been affected by unregulated exploitation and by other anthropic activities (Guidetti *et al.,* 2003); this is particularly true for *Paracentrotus lividus* (Lmk, 1816), a macro-algivore sea urchin commonly living along the North Atlantic coasts and throughout the Mediterranean sea (Sánchez-España *et al.,* 2004), highly valued for its edible gonads and whose gametes and embryos are commonly used as a model in developmental biology research and as test-species in ecotoxicological bioassays. Rearing protocols for the short-term induction of gamete maturation need to take into account the different initial reproductive conditions of the sea urchin specimens. As the pattern of gonadal growth of *P. lividus* living in relatively contiguous areas has been reported to differ in relation to food availability (Byrne, 1990), aim of this work was the histological evaluation of the gonadal growth of *P. lividus* from the Southern Adriatic coast, in order to identify the period in which specimens having early developing gametes may be collected for an easier induction of the resumption of gametogenesis by manipulating food quality and quantity under controlled rearing conditions.

Materials and methods – Twenty *P. lividus* adult specimens (horizontal diameter >35 mm) were hand-collected with the aid of Scuba from the rocky seabed near Termoli (41°54'N; 16°10' E), on the southern Adriatic coast at 6 wk interval from April to November. On their arrival in laboratory, urchins were allowed to drip for 5min, weighed (0.2 mg accuracy) and then dissected; the gonads were extracted and fresh weighed for Gonad Index evaluation: GI = gonads wet weight (g)/urchin wet weight (g) ´100. One of the five gonads of each animal was fixed in 10% formalin, embedded in paraffin, sectioned at 7 µm and stained with Mayer's Haemalum/Eosin; the reproductive stage was assigned to each using the nomenclature of Spirlet *et al*., 1998: stage I (spent with relict gametes), stage II (spent empty), stage III (recovery), stage IV (growing), stage V (premature), stage VI (mature), stage VII (partly spawned), stage VIII (post spawned).

Results – As shown in Fig. 1A, the percentage of individuals with gonads in which developing gametes were found (stages III to VIII, grey background patterns) was more than 90% on April and never decreased until 50% also in summer, when a resting period would be expected; on September the percentages of pre-mature and mature individuals (V-VII) which had decreased on summer, increased again, being more than 70% on November. The Gonad Index (Fig. 1B) reflected the gonad conditions, being higher on April and September, when gonad ascini were filled of both nutritive phagocytes and mature gametes.

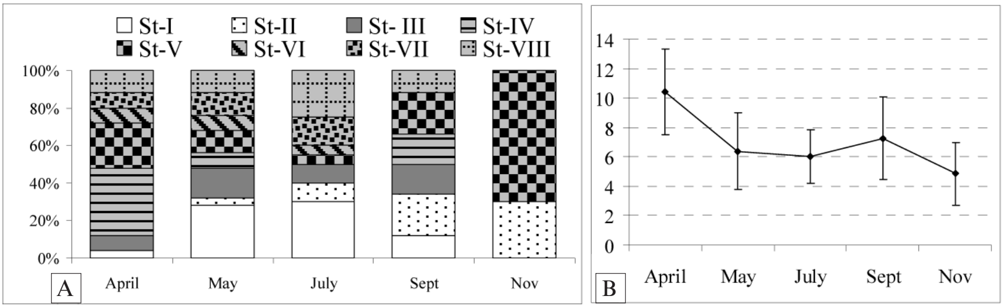

Fig. 1 - Gonad reproductive condition (A) and Gonad Index (B) for each sampling time.
Stadio riproduttivo delle gonadi (A) ed indice gonadico (B) ai vari tempi di campionamento.

Conclusions – The populations of *P. lividus* in the Mediterranean area remain mature all year, with a brief resting period (stages I-II) from July to September (Sánchez-España *et al.*, 2004), being able to "skip" the resting period in presence of high availability of food (Byrne, 1990; Spirlet *et al.*, 1998). The specimens here analyzed, taken from the mid-to-low Adriatic, exhibit a similar reproductive pattern; the almost continuous presence of individuals with an active gametogenesis and the ability of the sea urchin gonads in quick responding to abrupt variations in the availability and quality of food is of crucial importance in order to set up rearing protocols for a short-term induction of gonad yield and of gamete maturation in controlled conditions.

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REARING CONDITIONS AND WELFARE IN *DICENTRARCHUS LABRAX*: A COMPARISON BETWEEN SUBMERGED AND SURFACE CAGES

*VALUTAZIONE DEL BENESSERE IN SPIGOLE (*DICENTRARCHUS LABRAX*) ALLEVATE IN GABBIE DI SUPERFICIE E SOMMERSE*

***Abstract** – The aim of this study is to investigate growth, haematological, biochemical and immunological parameters of European sea bass,* Dicentrarchus labrax *(Teleostei, Moronidae) farmed in submersible and surface cages in order to compare physiological status under different rearing conditions. Results obtained suggest mariculture in submerged cages as a promising system that allows to minimize stress and that, hence, promotes fish welfare.*

Key-words: *aquaculture, submergence, sea-cage, fish welfare.*

Introduction – Offshore submersible cages play an important role for Mediterranean aquaculture expansion solving several of the substantial operational challenges that exist in surface-based fish farming, such as those related to heavy storms, algal and jellyfish blooms, sea lice infestations, unsuitable temperatures and biofouling of net cages. Moreover, the high concentration of fish confined in surface net cages causing repeated attacks by predators (*i.e.*, cormorants) determines death, injury and exposes fish to a stressful condition. Therefore, we expect submergence may have a positive effect on fish welfare.

Subsurface technologies have been tested in several production experiments but the growth and behaviour of fish in submerged cages relative to standard surface systems is however largely unknown; objective comparisons of fish performance in commercial-scale submerged cages *vs.* surface cages have only been undertaken for short-term, shallow submergences (Dempster *et al.*, 2008, 2009), or long-term in Atlantic salmon (Korsøen *et al.*, 2009).

The aim of this study is to investigate haematological, biochemical and immunological parameters of European sea bass (*Dicentrarchus labrax*) farmed in submersible and surface cages in order to compare physiological status under different rearing conditions and to validate the efficacy of submersible technology.

Materials and methods – The study was conducted from January to December 2008 in the Gulf of Castellammare (NW-Mediterranean Sea) in four fish cages (two submerged and two surface). The fish cages (2000 m^3) were filled, on January 2008, with 75.000 specimens of *D. labrax* (initial weight: 28.2±4.3 gr), for each cage. The fish were manually fed a commercial diet twice a day according to the estimated live weight and water temperature.

During the trial, fish were randomly collected on a monthly basis, and total and standard length and wet weight were immediately recorded for each specimen, to test growth performances, by calculation of the daily specific growth rate (SGRW%) and the relative condition factor (K_n, Le Cren, 1951). At three sampling times (February, June, September), samples of fish (n=40) were taken to investigate haematological, biochemical and immunological parameters. Individuals were taken from the cages and immediately anaesthetized using 0.1 g/l of tricaine methanesulphonate; careful netting and handling were adopted to minimize stress.

Biochemical parameters were carried out using commercial kits: cortisol: (ELISA method); glucose (GOD-POD method); lactate: (LOD-POD method). Haematocrit was determined by microhaematocrit capillary tube method by centrifugation at 14000 g for 5 min. Haemagglutinating activity against sheep erythrocytes was determined in serum samples according to Caruso *et al.* (2005). Lysozyme content was measured, on samples of mucus, plasma and kidney, according to plate diffusion method (Ossermann and Lawlor, 1966).

Results and conclusions – No significant differences were shown in specific growth rate between the two groups, even if fish cultured in submerged cages reached the largest size.

Main results of this study underline a clear relation between observed changes in physiological parameters commonly used as stress and immunocompetence indicators in fish (Weendelar Bonga, 1997; Tort *et al.*, 1996) and the cage type. Submergence seems to be a favourable condition for sea bass culturing, as evidenced by growth, haematological, biochemical and immunological parameters. Particularly, in submerged sea bass, serum cortisol, glucose and haematocrit values appear significantly lower than those of surface cages indicating a better welfare. Moreover fish of submerged cages also show significantly higher value in non-specific haemolytic activity and mucus lysozyme, highlighting a positive effect of submergence on some components of innate immune system.

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VARIATIONS OF BIOFOULING COMMUNITIES IN AN OFF-SHORE FISH CAGE FARM FROM NORTH-WESTERN SARDINIA

VARIAZIONI DEL BIOFOULING IN UN ALLEVAMENTO ITTICO IN GABBIE OFF-SHORE DELLA SARDEGNA NORD-OCCIDENTALE

Abstract *– Biofouling variations were studied in a fish farming facility near Alghero (Italy) between November 2007 and November 2008. Net panels suitable for the settlement of encrusting organisms were immersed in cages in which large and small gilthead seabream specimens were reared. Significant differences in biofouling biomass and coverage were observed between cages containing fish and controls. The results obtained revealed that gilthead seabream can exert a crucial role in controlling biofouling growth, independently from its size.*

Key-words: *fouling organisms, marine aquaculture,* Sparus aurata*, Mediterranean Sea.*

Introduction – Biofouling is a major problem for submerged surfaces (Wahl, 1989), in particularly in aquaculture activities (Porter, 1981). These encrusting organisms can also be considered as an indicator of fish farming impact (Sarà *et al.*, 2007), even if they can be predated (and consequently reduced in biomass and covering percentage) by some grazer species (Lodeiros & García, 2004). The present study, therefore, aimed to describe variations of biofouling on cage nets of an off-shore fish farm by comparing its growth in cages where gilthead seabream (*Sparus aurata*) specimens were reared. We postulated that the grazing activities of different-sized fish could affect the structure of biofouling.

Materials and methods – The study was carried out at a fish farming facility in Alghero Bay (North-western Sardinia, Italy), where custom-made panels (suitable for biofouling settlement) were installed on the nets of floating cages in which gilthead seabreams of different size were reared. The panels were immersed inside 4 fish rearing cages [2 of which containing large (*i.e.* >150 g, LF) and 2 containing small (*i.e.* <50 g, SF) fish], at a depth of 5 m. Two series of control panels (Cs) were also placed at the same depth level in empty cages. Overall, with the aim of sampling 3 panels per group every 3 months for a year (*i.e.* approximately every season), 72 panels (*i.e.* 3 panels × 3 experimental groups × 2 cages × 4 times) were positioned inside the cages using cable ties. Before being positioned *in situ*, each panel was weighed and photographed in its entirety. All the panels were positioned in November 2007, then they were removed from cages in February, May, August and November 2008, respectively. In the laboratory, panels were firstly weighed (to assess biomass increment), subsequently photographed again. Portions of 25′25 cm of digital images were processed with ImageJ software (Abramoff *et al.*, 2004) to estimate the percentage of mesh occluded by biofouling. Analysis of Variance (ANOVA) was used to test for differences in wet weight increment and coverage percentage of biofouling inside the cages containing LF, SF and Cs, and Student-Newman-Keuls (SNK) test was performed for *post-hoc* comparisons (Zar, 2009).

Results – ANOVA evidenced significant differences in wet weight increment of biofouling for 'Fish size' and 'Cage', as well as for the interaction of both these factors with 'Time' (Tab. 1). Furthermore, SNK test detected significant differences (p<0.05) between panels in gilthead seabream cages and controls. ANOVA showed significant differences for biofouling coverage percentage also, and, in particular, for 'Fish size', 'Time' and the interaction between these factors. Again, SNK test detected significant differences (p<0.05) among control panels and those positioned inside *Sparus aurata* rearing cages.

Tab. 1 - ANOVA results for wet weight increment and coverage percentage of biofouling.
Risultati dell'ANOVA per percentuali di incremento di peso umido e ricoprimento del biofouling.

		Wet weight increment (%)			Coverage (%)		
Source of variation	df	MS	F	*p*	MS	F	*p*
Fish size, FS	2	47732.34	11.50	**0.039**	1602.58	14.34	**0.029**
Cage, C(FS)	3	4149.76	9.52	**0.000**	111.72	1.91	0.141
Time, T	3	5098.82	3.33	0.070	570.54	8.01	**0.007**
FS ´ T	6	9752.44	6.37	**0.007**	582.73	8.18	**0.003**
T ´ C(FS)	9	1530.47	3.51	**0.002**	71.22	1.22	0.306
Residual	48	435.88			58.46		
SNK test		Cs>SF=LF			Cs>LF=SF		

Conclusions – This study evidenced significant variations of both biomass and coverage percentage of biofouling communities in an off-shore Mediterranean fish farming facility. In particular, the results obtained revealed that gilthead seabream can play a fundamental role in controlling the development of biofouling communities, independently from its size. Therefore, the presence of several specimens of *Sparus aurata* inside the rearing cages of a non-grazer fish species (*e.g. Dicentrachus labrax*) could be useful to mitigate the proliferation of biofouling organisms on the cage nets.

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ACCRESCIMENTO DI *APHIA MINUTA MEDITERRANEA* DE BUEN, 1931 IN CONDIZIONI DI LABORATORIO

GROWTH OF APHIA MINUTA MEDITERRANEA *DE BUEN, 1931 IN THE LABORATORY*

Abstract *– The transparent goby* Aphia minuta mediterranea *is a neritic species catched through special fishery and much in demand on the local market; for this reason, it was recently studied in order to ready rearing methodologies in laboratory conditions. In this paper the results obtained during a research carried out in the framework of the SFOP - innovative actions - Project are reported.* A. minuta *was observed to grow in captivity, and to reach gonad maturation starting from immature specimens; furthermore, the effectiveness of an experimental diet to support fish growth was verified.*

Key-words: Aphia minuta mediterranea*, growth, feeding experiments.*

Introduzione – *Aphia minuta mediterranea*, comunemente nota come rossetto, costituisce un'importante risorsa (La Mesa *et al*., 2005) per la piccola pesca costiera ligure (Relini *et al*., 1998). Questa specie compie il ciclo di sviluppo in acque neritiche (Iglesias e Morales-Nin, 2001) e viene catturata utilizzando una rete a maglia fine denominata "sciabica"; tale attività, che rientra tra le "pesche speciali", è autorizzata esclusivamente a livello locale e stagionale. L'elevato valore commerciale di *A. minuta mediterranea* ha stimolato recenti ricerche indirizzate alla messa a punto di metodologie per il suo allevamento in condizioni controllate di laboratorio (Hervás Reina e López Jaime, 2003; Pane *et al*., 2006), al fine di poter disporre di questa specie per un periodo di tempo più ampio rispetto a quello permesso dalla normativa ed anche allo scopo di ottenere forme giovanili a fini di ripopolamento.

Materiali e metodi – Gli esemplari di *Aphia minuta mediterranea* utilizzati nella sperimentazione sono stati catturati, con l'ausilio di imbarcazioni autorizzate, davanti alla costa di Sori (Golfo di Genova, Mar Ligure) alla profondità di circa 10 metri. I pesci sono stati successivamente trasferiti in laboratorio dove si è proceduto con la fase sperimentale di mantenimento degli esemplari sopravvissuti. Per il mantenimento dei rossetti sono stati approntati appositi acquari da 200 litri contenenti acqua di mare, la cui temperatura è stata gradualmente aumentata da 13±0,5 °C fino ad un massimo di 20±0,5 °C (valore prossimo all'*optimum* per la specie). Gli esemplari sono stati alimentati utilizzando inizialmente una dieta a base di fitoplancton (*Tetraselmis suecica*, *Chlorella minutissima*) e di mangime per acquacoltura (Fish Starter Diet P4, Æ=500-800 μm, Salt Creek City, Utah, USA). È stata inoltre sperimentata una dieta a base di nauplii del crostaceo fillopode *Artemia salina* ed adulti del copepode *Tigriopus fulvus*.

Risultati – Il trasporto dei rossetti in laboratorio ha causato un'elevata mortalità con una sopravvivenza a 10 giorni di circa il 10%; in particolare, due individui sono sopravvissuti 51 e 118 giorni rispettivamente. Per l'esemplare sopravvissuto 118 giorni è stato possibile apprezzare un significativo aumento della lunghezza totale da circa 3,7 a 4,1 mm e del peso umido da 0,120 a 0,199 g; l'incremento ponderale ha seguito quello della temperatura dell'acqua di allevamento. Per quanto riguarda l'alimentazione, il mangime commerciale impiegato è risultato idoneo per lo svezzamento e l'ingrasso degli avannotti mentre tra i crostacei solo i nauplii di *Artemia salina*, somministrati *ad libitum,* si sono dimostrati efficaci nell'alimentazione di *A. minuta mediterranea* che ha acquisito progressivamente la sua pigmentazione caratteristica. Non sono state osservate malformazioni né a livello della vescica natatoria (che ha mostrato un regolare sviluppo) né a livello della colonna vertebrale che è risultata normorettilinea con le caratteristiche vertebre "a clessidra" tipiche della specie. Per quanto riguarda la maturazione delle gonadi, l'esemplare sopravvissuto 118 giorni presentava gonadi maschili costituite da lobuli seminiferi ben organizzati e delimitati da tessuto connettivo e da piccoli vasi sanguigni; la presenza di numerosi spematogoni, spermatociti, spermatidi e di un ridotto numero di spermatozoi liberi nel lume dei lobuli indicava che le gonadi erano in via di maturazione.

Conclusioni – Gli individui mantenuti in allevamento hanno mostrato sempre un comportamento vivace ed attivo, per quanto riguarda la capacità natatoria e la ricerca del cibo, ed un soddisfacente accrescimento ponderale e dimensionale in funzione della temperatura dell'acqua di allevamento. Inoltre, si è confermata la possibilità di impiego di cibo vivo per lo svezzamento e si è dimostrata l'adeguatezza del cibo artificiale impiegato per la crescita (Hervás Reina e López Jaime, 2003).

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MORPHOLOGICAL AND BIOCHEMICAL RESPONSES TO ENVIRONMENTAL CONTAMINANTS IN FARMED AND WILD EUROPEAN SEABASS (*DICENTRARCHUS LABRAX)*

*RISPOSTE MORFOLOGICHE E BIOCHIMICHE A CONTAMINANTI AMBIENTALI IN SPIGOLA (*DICENTRARCHUS LABRAX*) ALLEVATA E SELVATICA*

***Abstract** – The presence of environmental pollutants in both wild and cultured fish is cause of concern. The European seabass (*Dicentrarchus labrax *L., Teleostei, Moronidae) represents one of the most diffused marine species cultured in the Mediterranean areas. Aim of this study was to investigate the relationships of polychlorinated dibenzo-p-dioxin and dibenzofuran (PCDDs and PCDFs), dioxin-like and non dioxin-like polychlorinated biphenyl (DL and NDL-PCBs) levels in the muscle of wild and cultured sea bass with morphological and enzymatic activities as biochemical biomarkers of exposure. In farmed fish, levels of contaminants were lower than those detected in other studies. The low level of contamination was confirmed both by enzymatic activities and by gonad, liver and gill morphology showing absence of chronic alterations.*

***Key-words:** environmental pollutants, biomarker, seabass, aquaculture.*

Introduction – Polychlorinated dibenzo-p-dioxins (PCDDs), dibenzofurans (PCDFs) and polychlorinated biphenyls (PCBs) are persistent contaminants widespread in the environment and animal tissues (Toft *et al*., 2003). The integrated use of chemical analysis and morphological/biochemical markers of exposure makes it possible to study the impact of anthropogenic contaminants and to compare the effects on wild and reared fish. The aim of this study was to investigate the relationships between PCDDs, PCDFs, DL-PCBs, NDL-PCBs levels, morphological endpoints in gonads, liver and gills and glutathione S-tranferase (GST) and Catalase (CAT) activities as biomarkers of exposure (Van der Oost *et al.,* 2003) in wild (Wsb) and farmed (Fsb) European sea bass, *Dicentrarchus labrax*, selected as bioindicator species

Materials and methods – Farmed *D. labrax* (n=20; 327.13±57.62 g) were collected, from an *off-shore* fish farm located in the Ligurian sea, while wild specimens (n=8, 714.7±58.3), were captured nearby the Cinque Terre National Park,both in February-March 2009. Fish were measured and weighted and the condition factor (CF: body weight (g) ×100/length^3 (cm)) and the hepatosomatic index (HSI; liver weight (in g)/ body weight (g) ×100) were calculated. Gonad, liver and gill fragments were Bouin's fixed and stained with haematoxylin-eosin. Two series of 4 µm thick sections were analyzed for presence/absence of alteration of connective stroma, granulocyte and melanomacrophage centres (MMCs) infiltration, haemorrhages, gamete atresia and oocytes in testis, for gonads; granulocyte and MMCs infiltration, and lipid deposit in hepatocytes, for liver; alteration of primary lamellae and respiratory lamellae, haemorrhages, and relative number of chloride cells and mucous cells, for gills. Chloride cells were identified by using the mouse raised monoclonal ab-Na, K-ATPase, 1:100. PCDDs, PCDFs, DL-PCBs and NDL-PCBs were measured in muscle with high resolution gas chromatography coupled with high-resolution spectrometry. GST and CAT activities were determined in liver (Ferreira *et al.* 2010).

Results – The sum of the six NDL-PCB indicators ($\Sigma_{6NDL\text{-}PCBs}$), was 6.28±1.67 and 2.64±2.48, ng/g whole weight (Ww) in Fsb and Wsb, respectively.

The TEQ $_{(2006)\ DL\text{-}PCBs}$ (pg/g^{-1} Ww) in Fsb and Wsb was 0.28±0.22 and 0.68±0.47, respectively. The $\Sigma_{TEQ\text{-}PCDD/F}$ (pg/g Ww) in Fsb and Wsb were 0.17±0.13. Mean CF (1.5±0.03) and HSI (2.38±0.46) values were higher in Fsb than in Wsb (0.98±0.03; 0.97±0.05). All tissues were well structured, even if weak increase of the connective stroma texture in the testis, moderate increase of lipid vesicles in the hepatocytes and areas with reduction of respiratory lamellae in the gills were described in Fsb. Catalase activity measured in Fsb was 93 µmol/min/mg protein, higher than in Wsb. No significant differences were described for GST among Fsb and Wsb (77.64 and 68.35nmol/min/mg protein, respectively).

Conclusions – The PCB concentrations in Fsb were in the range of those detected in other investigations in the Mediterranean Sea. TEQ $_{(2006)\ DL\text{-}PCBs}$, values were significantly lower than the maximum levels allowed by the European Commission (EC, 2006) and lower than those measured in Carubelli *et al.* (2007), whereas the $\Sigma_{6NDL\text{-}PCBs}$ were comparable. $\Sigma_{TEQ\text{-}PCDD/F}$ were of the same order than that measured in Çakıroğulları *et al.* (2010). CF and HSI were higher in Fsb than in Wsb as expected, while no significant differences were described for morphological parameters in Fsb in off-shore cages. GST activity in Fsb was not significantly different from that measured in Wsb but significantly higher than in other farmed sea bass (Ferreira *et al.*, 2010). CAT activity in Fsb was higher than that measured in other farmed sea bass (Ferreira *et al.,* 2010), denoting an efficient antioxidant answer. All together, these data confirm that currents and water deep are the key factors that increase the quality of the rearing environment, facilitating water exchange inside the cages, reducing the organic matter sedimentation under the farm and avoiding self-pollution.

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BETA-DIVERSITY ON TARDIGRADE FAUNA OF MALDIVIAN ISLANDS

BETA-DIVERSITÁ SULLA FAUNA A TARDIGRADI DELLE ISOLE MALDIVE

Abstract *–The present study was carried out with the aim of improving the knowledge on tardigrade fauna of Maldives Archipelago through the analysis of beta diversity. The present results show that Maldivian Islands represent an interesting study area for the very rich tardigrade fauna represented by a total record of 28 species. The estimation of beta-diversity highlights a high turnover of diversity in the atolls of the Maldives and confirms that sediments type may play a key role in determining the species composition of the tardigrade fauna.*

Key-words: *meiofauna, Tardigrada, beta-diversity, Maldives.*

Introduction – A joint research project on the biodiversity and ecology of meiofauna from Maldive Islands has been carried out since 2004 with the aim of widening their scanty and fragmentary knowledge (Gallo *et al.*, 2007; Sandulli *et al.,* 2009; Semprucci *et al*., 2009 and references therein). Beta-diversity estimate is largely applied for macrofauna assemblages, but quite neglected for the meiofauna ones (Gray, 2000). In this study we report the results of a first survey of the beta-diversity of the Maldivian tardigrades in order to estimate the turnover in the diversity composition at different level (i.e. between the different atolls and sediment types).

Materials and methods – Overall, 32 stations were sampled at North Ari and South Malé Atolls from 0.5 m to 53 m depth. Samples were collected by means of SCUBA-divers via hand-coring (corer surface area: 6.2 cm^2). Meiofauna were anaesthetized with a $MgCl_2$ solution and preserved with 5% neutralized formalin-seawater. Animals were extracted from the sediment by decantation technique and all individuals were sorted and counted per taxa under a stereomicroscope. Tardigrades were individually studied under a compound microscope. The β-diversity (i.e. turnover diversity, estimated as % Bray-Curtis dissimilarity; Gray 2000) was calculated using SIMPER test (cut-off 50%) and the significance of the differences detected was analysed using the Analysis of Similarities (ANOSIM).

Results and conclusions – Overall, 28 species of tardigrades belonging to 4 families and 14 genera were found. ANOSIM showed a significant difference between the assemblages of tardigrades of the two atolls (R^2=0.28; p=0.001) with an overall dissimilarity value of 83% (SIMPER). The species that mainly contributed to the differences between atolls were *Halechiniscus greveni*, *Batillipes philippinensis*, *Dipodarctus subterraneus*, *Florarctus hulingsi* and *Styraconyx nanoqsunguak*, which were more abundant at South Malé, whereas *Batillipes* n. sp. and *Florarctus* n. sp were only found at Ari North. Significant differences were detected also when the sediment types were considered (ANOSIM, R^2=0.15; p=0.02): in particular the pairwise comparisons showed significant differences only between medium-fine *vs.* coarse sands (R^2=0.20; p=0.02) and fine *vs.* coarse sands (R^2=0.20; p=0.04). The species that contributed mainly to the differences between fine *vs.* coarse sands were *B. philippinensis*, *S. nanoqsunguak*, *H. greveni* (more abundant in fine sands) and *D. subterraneus,* and *Florarctus* n. sp. (more abundant in coarse sands). In this study, fine sands, that normally does not show very high number of species and individuals, showed an unexpected abundance of tardigrades. Instead, the species that especially contributed to the differences between medium-fine *vs.* coarse sands were *Batillipes* n.sp. (more abundant in medium-fine sands), *H. greveni*, *D. subterraneus*, *Florarctus* n.sp (more abundant in coarse sands). The finding of *H. greveni* in all types of sediment confirms that this species has a wide adaptability. These results show clearly that the β–diversity of tardigrades is more influenced by larger spatial scale than other meiofaunal groups such as free-living nematodes (Raes *et al*., 2007). Conversely, tardigrades appeared less affected by small sedimentological variations than nematodes, even if significant differences of species composition in relation to this environmental parameter were found (Semprucci *et al*., 2008). The first record of *Pseudostygarctus rugosus, Tanarctus helleouetae, B. philippinensis, B. dicrocercus* and *B. similis* in the Indian Ocean is very remarkable.

The results of this study show that the composition of tardigrade fauna of Maldive Archipelago was generally comparable to those observed in previous studies. These islands represent an interesting study area with a total of 28 species found until now. Furthermore, β-diversity analysis highlights a high turnover of diversity in Maldive Islands and confirms that sediment type may play a key role in determining the species composition of the tardigrade fauna.

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SPATIAL AND TEMPORAL VARIABILITY OF CRUSTACEA ASSEMBLAGES OF *POSIDONIA OCEANICA* MEADOWS OF NORTHERN TUSCANY

VARIABILITÀ SPAZIALE E TEMPORALE DEI POPOLAMENTI A CROSTACEI DELLE PRATERIE DI POSIDONIA OCEANICA *DELLA TOSCANA SETTENTRIONALE*

Abstract *– The present paper reports data about a study carried out along the northern coasts of Tuscany. Crustacea assemblages were sampled four times throughout one-year period at two depths. Results showed an interaction between depth and date to determine the composition and abundance of assemblages.*

Key-words: *Crustacea, depth,* Posidonia oceanica*, Tuscany.*

Introduction – Vagile fauna represents an important component of seagrass ecosystem (Ledoyer, 1966, 1968). In fact, meadows offer refuge and nutriment to a lot of taxa that contribute to create complex trophic nets. Vagile fauna could be highly variable in space and time. In fact, vagile fauna normally shows a temporal dynamic related both to life cycles of organisms and to changes in the structure of meadows. Patterns of spatial variability may be related to depth or other gradients of environmental factors acting in the meadows. Crustacea are one of the main taxa of vagile fauna associated to seagrasses (Mazzella *et al*., 1989). The aim of the present paper is to show results of a study performed to evaluate patterns of spatial and temporal variability of Crustacea assemblages of *Posidonia oceanica* (L.) Delile meadows of Tuscany.

Materials and methods – The study was carried out along the northern coasts of Tuscany, (north-western Mediterranean Sea). Two depth ranges were considered: 5-10 m (corresponding to the upper limit of meadows) and 20-25 m (corresponding to the lower limit of meadows). Samplings were carried out at 4 dates during one-year period. For each depth and date, 3 sites were sampled and 3 replicated samples were collected in each site. Organisms were sampled by hand-towed net (Gambi & Dappiano, 2003). For each sample, taxa were determined and the abundance of each taxon was expressed as number of organisms. Data were analyzed by PERMANOVA analysis (Anderson, 2001) with Depth (shallow vs. deep) as fixed factor, Date (4 levels) as random factor crossed to Depth, Site (3 levels) as random factor nested in the interaction between Depth and Date. SIMPER test was used to detect species responsible to multivariate patterns.

Results – A total of 85 taxa of Crustacea was found in the meadows. PERMANOVA analysis showed a significant interaction between Depth and Date (pseudo-F=2.256, P(perm)=0.007). In fact, differences between depths were significant only in spring-summer dates and differences between dates were significant only in shallow assemblages. The SIMPER test showed that *Hippolyte inermis*, *Gnathia maxillaris*, *Palaemon xiphias,* Copepoda and Misidiacea were the main taxa contributing to separate shallow and deep meadows and to create differences between dates. Values of the total abundance of organisms per sample were higher in shallow meadows only in dates corresponding to spring-summer period; in deep assemblages, no important differences were detected among dates.

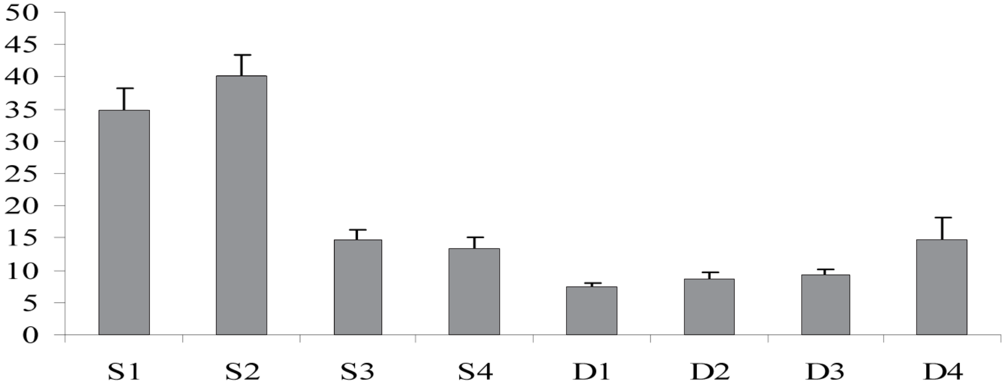

Fig. 1 - Abundance of Crustacea in *P. oceanica* medows. S=shallow, D= deep; numbers are referred to the sampling dates.

Abbondanza di crostacei nelle preterie di P. oceanica. *S=limite superiore, D=limite inferiore; i numeri si riferiscono alle date di campionamento.*

Conclusions – The present study confirms the importance of Crustacea assemblages in the vagile fauna of *Posidonia oceanica* meadows. Results showed that assemblages changed in relation to a depth gradient, in agreement with previous studies carried out in different geographical areas (Mazzella *et al*., 1989; Gambi *et al*., 1992); however, this pattern was not consistent among different periods within one year. Moreover, deep assemblages appeared steady throughout the year, while significant differences in species composition and abundance were highlighted in shallow assemblages.

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POPULATION BIOLOGY OF THE HERMIT CRAB *CESTOPAGURUS TIMIDUS* IN TWO *POSIDONIA OCEANICA* BEDS

BIOLOGIA DI POPOLAZIONE DEL PAGURO CESTOPAGURUS TIMIDUS *IN DUE PRATERIE DI* POSIDONIA OCEANICA

Abstract *– Two populations of the hermit crabs* C. timidus *were analyzed as regards population structure, sex ratio, size, presence of ovigerous females and juveniles. The specimens were collected in two beds, one off Punta Manara (Ligurian sea), the other off Capo Stella (Elba Island), in three periods of the year and at seven depths. A direct connection between the status of the bed and the structure of the population is hypothesized. The hermit crabs live preferentially in the shallower stations and occupy* Bittium latreillii *shell.*

Key-words: *decapods, seagrass bed, population structure, Ligurian Sea, Elba Island.*

Introduction - Inside the hermit crab group living associated with the foliar stratum of *Posidonia oceanica* bed, *Cestopagurus timidus* (Roux 1830) is considered the most abundant species (Borg & Schembri, 2000), even if this little crab lives also on rocky bottoms. The relationships between the hermit crab and the *P. oceanica* environment have been already studied by Zupo *et al.* (1989) and Belci *et al.* (2010). The aim of this work is to analyze the population biology of *C. timidus* in two posidonia beds, similarly exposed but in a different status of health and conservation.

Materials and methods – The hermit crabs were collected in a *P. oceanica* bed off Punta Manara (P.M.) (Ligurian Sea) and in another off Capo Stella (C.S.) (Elba Island), by means of the hand-towed net semi-quantitative technique, in three periods (early spring, ES; late spring, LS; autumn, AU), at 7 different depths (from the upper to the lower limit). In each station, a sample and its replicate were collected.

Results – Actually the P.M. bed extends from -5 to -21 m, showing a strong reduction of the surface and the withdrawal of the lower limit, now of regressive type. Shoot density values are low along the bed, which shows zones of dead *matte* and increasing turbidity. On the contrary, C.S. bed, extending from -5 m to -30 m, shows a progressive lower limit and good values of shoot density, especially at the upper limit and the intermediate zone. In P.M. bed, 738 specimens were collected, 354 adults (47%), and 384 juveniles (sex not detectable, 53%). The adult population is made mainly by non-ovigerous females which in AU reach the 87% of the collected hermit crabs; the ovigerous females are present in LS (41% of the hermit crabs) and AU and on the whole represent the 11% of all the specimens collected. The males (on the whole representing 7% of both communities) are almost absent in ES and LS. In respect to depth, the hermit crabs are numerous at -5, -9 (shallower stations) and -15 m (intermediate zone of the bed), almost absent near the lower limit (-21 m). The non-ovigerous females have the least mean size (cephalotoracic shield length) (1.02 mm, n=291) compared with males (1.12 mm, n=25) and the ovigerous females (1.30 mm, n=38); the size differs significantly among the three groups of adults (ANOVA, F=38.99, d.f.=2, $p<0.001$). In C.S. bed 1199 specimens were collected, only 1% of which are juveniles. Males and ovigerous females form respectively the 36 and 37% of the adult population; the latter are very numerous, like the other groups of adults, in LS but also in ES (49% of the ES specimens). The 65% of the population is concentrated in the shallower stations (especially at -5m); the hermit crabs are fairly numerous in the intermediate zone of the bed and they disappear almost near the lower limit (-30 m). The mean size differs significantly among the three groups of adults (ANOVA, F=30.81, d.f.=2, $p<0.001$); the males are the greatest specimens (mean size: non-ovigerous females, 1.26 mm, n=325; ovigerous females, 1.34 mm, n=436; males, 1.39, n=425). In both the beds, quite the totality of *C. timidus* specimens occupied the shell of *Bittium latreillii*.

Conclusions – In respect to the population structure, the communities of *C. timidus* sampled in the two examined beds show some remarkable differences both between each other and in comparison with the populations examined in other sites. Differences regard mainly the scarcity of males at P.M., very numerous in C.S. bed (sex ratio: males/females, respectively, 0.07 and 0.55), the high percentage of ovigerous females in LS (at P.M.) and in ES (at C.S.). Considering the year of sampling (2006), it is possible to hypothesize a direct connection between the good quality of C.S. bed and its well structured population of hermit crabs as well as between the environmental trouble of the P.M. bed and its explosive, concentrated, and small-sized population. The explosion of juveniles in the P.M. bed and their scanty presence in C.S. bed should be connected with the presence of surface currents which should import into the bed planktonic megalopae from populations of the hermit crab living on the near rocky bottom and *vice versa*. In respect to the bathymetric distribution, Borg & Schembri (2000) find *C. timidus* from -6 to -21 m whilst, according to Gambi *et al.* (1992), the species is typical of the intermediate-deep (-25 m) stations. In two examined beds, *C. timidus* specimens were found very abundant in the shallow-intermediate depths where they have at their disposal a lot of *B. latreillii* shells which they can occupy thanks to their small size.

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Biol. Mar. Mediterr. (2010), 17 (1): 290-291

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PRELIMINARY STUDY ON THE EPIPHYTIC COMMUNITY OF TRANSPLANTED *POSIDONIA OCEANICA* (L.) DELILE SHOOTS

STUDIO PRELIMINARE DELLA COMUNITÀ EPIFITA DI FASCI TRAPIANTATI DI POSIDONIA OCEANICA *(L.) DELILE*

Abstract *– In October 2006 an experiment on* Posidonia oceanica *(Angiospermae) cuttings was undertaken. In March 2009, several transplanted cuttings were removed to study if the epiphytic community of transplanted shoots and autochthonous shoots seemed different. In this paper we show the preliminary results.*

Key-words*: epiphytic community,* Posidonia oceanica*, restoration.*

Introduction - In October 2006, an experiment on new materials for marine restoration with *Posidonia oceanica* (L.) Delile was undertaken. Several transplantation devices were placed in Cavo Bay (Elba Island), for each device about 20 cuttings of *P. oceanica* were taken away from the nearby natural meadow and placed overtop (Cinelli *et al*., 2007).

Materials and methods – In March 2009, several transplanted cuttings of *P. oceanica* were removed to study in the laboratory the shoots' epiphytic community and to verify if the epiphytic community of transplanted shoots and autochthonous shoots were different.

In the same site at 7 m deep, 6 areas were selected at random: 3 areas in natural meadow of *P. oceanica* and 3 areas in the transplantation devices. In each area, 3 vertical shoots were collected at random by SCUBA diving and preserved in 4% formalin seawater until the time of examination in the laboratory.

The whole internal and external faces of the two external leaves per shoot were observed utilizing a dissecting microscope and a binocular stereomicroscope.

All the organisms (both animal and vegetal ones) were identified at species level where possible and the coverage for each species was expressed as percentage cover.

Analysis of variance (2 way ANOVA) was used to test the hypothesis that the percentage cover of the most abundant species (percentage cover >1%) and richness of species differed between transplanted shoots and autochthonous shoots.

Multivariate analysis of variance based on permutations (PERMANOVA) (Anderson, 2001) was used to test the hypothesis that epiphytic assemblages differed between transplanted shoots and authocthonous shoots. A graphical representation of multivariate patterns was obtained by non-metric multidimensional scaling (nMDS).

Results - A total of 34 macroalgae (7 Heterokontophyta, 3 Clorophyta, 24 Rhodophyta) and 23 sessile animal taxa (3 Anellida, 3 Foraminifera, 7 Cnidaria, 8 Bryozoa, 1 Tunicata, 1 Porifera) were found.

The most abundant macroalgae species were the Phaeophyceae *Ascocyclus orbicularis* (J. Agardh) Kjelman and *Sphacelaria* sp., the Rhodophyta *Acrothamnion preissii* (Sonder) E.M. Wollaston and *Gayliella flaccida* (Harvey ex Kutzing) T.O. Cho & L.J. McIvor; the most abundant species among the fauna were the Hydrozoa *Plumularia obliqua* (Johnston, 1847), the Bryozoa *Electra posidoniae* (Gautier, 1957), *Fenestrulina malusii* (Audouin, 1826) and *Tubulipora flabellaris* (O. Fabricius, 1780) and the Foraminifera.

Concerning the red encrusting algae, it was very difficult to define the percentage cover of each present species (*Hydrolithon boreale* (Foslie) Y.M. Chamberlain*, Hydrolithon cruciatum* (Bressan) Y.M. Chamberlain*, Hydrolithon farinosum* (J.V. Lamouroux) D. Penrose & Y.M. Chamberlain*, Pneophyllum fragile* (Kutzing, 1843), so we defined one group (*Hydrolithon-Pneophyllum* spp.) which included all species of both genera (Giovannetti *et al.*, 2006).

The results showed that the macroalgal epiphytic assemblage (specific percentage cover) is more developed on transplanted shoots than on natural shoots; the result was opposite for the animal epiphytic assemblage. Concerning the epiphytic assemblage in its totality, the results highlighted that the specific richness was more abundant on transplanted shoots.

ANOVA analysis showed a significant difference between natural and transplanted shoots only for Foraminifera and *Electra posidoniae*.

PERMANOVA analysis showed a significant difference among natural and transplanted shoots and the nMDS ordination of epiphytic assemblage showed 2 separate groups.

Conclusions – The results illustrated a possible difference in the structure of assemblages of *P. oceanica* epiphytes between natural and transplanted shoots. However, it is necessary to highlight the different shoot density in the two studied conditions. Competition for light plays an important role in structuring marine communities and there is circumstantial evidence to indicate that light is a primary factor influencing algal recruitment and growth (Trautman & Borowitzka, 1999): it is likely that the reduced shoot density of artificial meadow (20 shoots/m^2) has permitted a higher irradiation on the transplanted shoots, which may have influenced the epiphytic algal community's abundance and composition.

The results obtained suggest that future studies aimed at detecting epiphytic community's difference between natural and transplanted shoots should specifically be focused on density shoots and seasonality of sampling.

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DISTRIBUTION AND DENSITY OF THE BENTHIC MICROALGA *CHRYSOPHAEUM TAYLORII* LEWIS & BRYAN FROM NORTHERN TO CENTRAL-EASTERN SARDINIAN COASTS

DISTRIBUZIONE E DENSITÀ DELLA MICROALGA BENTONICA CHRYSOPHAEUM TAYLORII *LEWIS & BRYAN DALLE COSTE NORD A QUELLE CENTRO ORIENTALI DELLA SARDEGNA*

***Abstract** – In August 2009 the distribution and density of the alien microalga* Chrysophaeum taylorii *Lewis & Bryan (Pelagophyceae) were investigated on hard benthic substrates in seventeen sites from northern to central-eastern Sardinia, in order to estimate the distribution and abundance of this species in the area.*

***Key-words**: algal blooms, distribution, introduced species, phytobenthos.*

Introduction – *Chrysophaeum taylorii* Lewis & Bryan is a benthic microalga, typical of coral reefs (Schaffelke, 2004), responsible for the production of mucilaginous material. In the summer of 2007 hard benthic substrates in Tavolara-Punta Coda Cavallo Marine Protected Area (TPCC MPA) and in La Maddalena Marine National Park (LM NP) were affected by the first *C. taylorii* bloom recorded in the Mediterranean Sea (Lugliè *et al*., 2008). Although monitoring activities carried out in 2008 at TPCC MPA confirmed the presence of the species in this area (Caronni *et al*., 2009), no data were available for the rest of the coast, LM NP included. The aim of this study is to estimate the occurrence of *C. taylorii* across several hundreds of kilometres of coasts, from LM NP southward along the central-eastern costs of Sardinia.

Materials and methods – In August 2009, seventeen sites were selected along the coast from La Maddalena Archipelago to Arbatax Gulf. At each site two microbenthos samples were collected by sucking water and biological material with a cut-off syringe from a rocky surface (15 cm^2), according to Abbate *et al.* (2007). All samples were collected at 1,5 m of depth, where the highest *C. taylorii* cell density had been previously recorded, and fixed with Lugol's solution. Cells identification and count were performed in two subsamples for each sample according to Utermöhl's sedimentation method (Abbate *et al*., 2007). A two-way ANOVA (GMAV 5) was used to investigate for differences due to the site (17 levels) and to the sample (2 levels) nested within site (n=2).

Results – *C. taylorii* was found in thirteen of the seventeen investigates sites. The microalga was not found in Santo Stefano, Capo Comino, Isolotto Ogliastra and La Caletta samples while the highest average densities of the species were recorded in Moneta, Porto Ottiolu and Sos Aranzos samples (98343 cells cm^{-2}; 80045 cells cm^{-2}; 77937 cells cm^{-2} respectively). Data about distribution and density of *C. taylorii* in the study area are reported in detail in Tab. 1.

The performed two way ANOVA showed statistically significant differences in the microalgae cell densities both between samples (ANOVA, $F_{17,34}$=6.5 P<0.05) and among different study sites (ANOVA, $F_{16,17}$=270817.73 P<0.05).

Tab. 1 - *C. taylorii* densities in the two analysed subsamples (SS) of each sample (S) collected in the seventeen study sites.

Densità di C. taylorii *nei due subcampioni (SS) analizzati di ciascun campione (S) raccolto nei diciassette siti di campionamento.*

	C. taylorii densities (cells cm^{-2})			
	S1		S2	
Study site	SS1	SS2	SS1	SS2
Moneta	98251	98134	98511	98476
Cala Coticcio	34072	34105	33892	33929
Santo Stefano	-	-	-	-
Porto Palma	943	961	902	913
Isola delle Bisce	3497	3484	3521	3539
Li Nibari	21978	21956	21991	21971
Scoglio dei poveri	6310	6286	6234	6335
Mortorio	34822	34846	34986	34932
Marinella	58212	58236	58148	58364
Sos Aranzos	77983	77948	77895	77921
Porto San Paolo	6732	6751	6521	6601
Porto Ottiolu	80104	80158	79821	80095
La Caletta	-	-	-	-
Capo Comino	-	-	-	-
Cala Gonone	91	85	78	86
Cala Luna	411	427	459	442
Isolotto Ogliastra	-	-	-	-

Conclusions – The significant differences in *C. taylorii* densities between samples in the same site highlight the variability of this microalga abundance between close areas, as already suggested in other studies (Caronni *et al*., unpublished data). The presence of *C. taylorii* at both LM NP and TPCC MPA two years after the first record suggests that this species has been settling steadily along the north-east Sardinian coast, confirming its "identity crisis" (Sparrow & Heimann, 2007). *C. taylorii* abundance was significantly variable among sites; remarkable densities were found in most of the northern investigated sites, while among the central-eastern sites high abundances were registered only in Porto Ottiolu, thus indicating that *C. taylorii* is expanding its distribution along this coast, as hypothesized by Luglié *et al.* (2008).

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DENSITY AND SIZE OF THE FAN MUSSEL *PINNA NOBILIS* (LINNEO, 1758) IN TWO DIFFERENTLY PROTECTED ZONES OF TAVOLARA-PUNTA CODA CAVALLO MARINE PROTECTED AREA

DENSITÀ E TAGLIA DEL BIVALVE PINNA NOBILIS *(LINNEO, 1758) IN DUE ZONE DIVERSAMENTE PROTETTE DELL'AMP DI TAVOLARA-PUNTA CODA CAVALLO*

***Abstract** – In the summer months of 2009 the abundance and the total shell size of the endangered bivalve* Pinna nobilis *(Linneus, 1758) (Mollusca: Bivalvia) were investigated in a partial reserve zone and in a general reserve one of the marine protected area of Tavolara-Punta Coda Cavallo (N-E Sardinia) in order to assess the usefulness of stricter environmental protection.*

Key-words: *environmental protection, marine parks, rare species, marine molluscs, density.*

Introduction – During the last decades the population of *Pinna nobilis* (Linneo, 1758), the largest Mediterranean bivalve, has been consistently declining (Vicente and Moreteau, 1991) as a result of collection by divers (Zavodnik *et al*., 1991) and incidental killing by trawling and anchoring (Centoducati *et al*., 2007). Consequently this fan mussel has been listed as an endangered species and is nowadays under protection, according to the European Council Directive 92/43/EEC. The aim of this work is to improve the knowledge on the distribution of *P. nobilis* in the Tavolara-Punta Coda Cavallo Marine Protected Area and to verify if stricter protection rules positively affect the density and the size of this species.

Materials and methods – Two areas of approximately 500 m^2 near Molara and Isolotto Rosso islands, situated respectively in a partial reserve zone (B) and in a general reserve (C) one, were chosen for the study because of substrate similarities. In each site a 100 m long transect line was drown from the shore perpendicularly to the shoreline (Šiletić and Peharda, 2003) and all bivalves in two 2,50 m corridors on either side of the transect line were recorded. For each specimen the unburied length and the width at sediment level were measured with a multi-calliper similar to the one proposed by García-March *et al*. (2002) and total shell lengths were estimated with García-March and Ferrer's equation (1995). Statistical analyses (MINITAB Student Release 12) allow the comparison between the recorded specimens in the two sites.

Results – In both study sites *P. nobilis* specimens were found on sandy and cobbled substrates, in particular among sea grass *Posidonia oceanica* (L.) Delile patches. In the summer months of 2009, 29 bivalves were totally counted in the study area; 11 along the transect near Isolotto Rosso island (RI) and 18 along the one near Molara island (MI). Data about density and total shell length of specimens along the two transects are shown in Tab. 1.

Statistically significant differences in number and in total shell length of *P. nobilis* specimens along the surveyed transects were shown by the performed unpaired T-test (T=-3,36, df=27, P=0,010 and T=2,23, df=27, P=0,034 respectively).

Tab. 1 - Sample size (N), density (*D*), minimum, maximum and mean (with standard deviation) total shell length (L_t) of recorded specimens along transects RI (Isolotto Rosso island) and MI (Molara island).

Numero (N), densità (D), lunghezza totale (L_t) minima, massima e media (con deviazione standard) dei bivalvi individuati nei due transetti RI (Isolotto Rosso) e MI (Isola di Molara).

Transect	N	D (ind/m^2)	L_t min (cm)	L_t max (cm)	L_t mean ± st. dev. (cm)
RI	11	0,02	8,70	47,33	19,23 ± 11,37
MI	18	0,04	8,86	50,14	31,32 ± 15,60

Conclusions – The presence of juveniles - specimens with a total shell length ≤20 cm (Richardson *et al*., 1999) - proved that *P. nobilis* recently reproduced successfully in both the investigated sites. The statistically significant differences in number and in total length of *P. nobilis* specimens between the partial reserve zone transect (18) and the general reserve zone one (11), where the degree of protection is lower, underlined that the conservation of this endangered species population seems to be positively related to the level of protection, as already noticed by Maliao *et al.* (2004) for *Haliotis asinina* (Linneo, 1758). The average density of *P. nobilis* in the study area (0,02 and 0,04 ind/m^2 respectively) was higher then the one (0.01 ind/m^2) usually recorded in the Mediterranean Sea (Centoducati *et al*., 2007), thus proving the usefulness of protection.

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CONDIZIONE ECOLOGICA DI *RUDITAPES DECUSSATUS* (VENERIDAE) E SUA PRESENZA IN AREE DI RACCOLTA NEL GOLFO DI OLBIA

ECOLOGICAL STATUS AND OCCURRENCE OF RUDITAPES DECUSSATUS *(VENERIDAE) IN HARVESTED SITES WITHIN THE GULF OF OLBIA*

***Abstract** – A pilot study was performed in order to evaluate the ecological status of the clam* Ruditapes decussatus *and its occurrence in specific harvested areas within the Gulf of Olbia. Indeed, since 1998, stocks of this clam seems to be decreased, due to intense human harvesting.*

Key-words: Ruditapes decussatus*, harvesting.*

Introduzione - Nel Golfo di Olbia lo sfruttamento del lamellibranco fossorio, *Ruditapes decussatus* è sempre stato considerato un lavoro marginale (Chessa *et al.,* 2005). Con rare eccezioni "l'arte del rampino" non ha mai ricondotto ad una regolare professione, bensì ad una estensione al mezzo acqueo di quell'effimera economia di raccolta, che, impegnando un'apprezzabile quantità di lavoratori, nella città ha contribuito a caratterizzare e consolidare il tessuto sociale. Dal 1998, gli operatori del settore (arsellatori), lamentano un progressivo calo nei prelievi, attribuendo le cause al sovrasfruttamento relativo all'eccessiva presenza nel numero delle unità operatrici in situ.

A questo proposito, viene qui descritto uno studio preliminare effettuato per stimare la condizione ecologica di *R. decussatus* e la sua presenza relativa alle specifiche aree di arsellatura nel Golfo di Olbia.

Materiali e metodi – Sono state considerate le storiche 21 aree di prelievo del Golfo interno di Olbia a partire dall'estremità della fascia costiera nord, seguendo un percorso antiorario verso sud.

Le osservazioni effettuate e i dati raccolti, affrontano l'argomento su due fronti. Il primo considera l'intervallo di tempo che dal 1987 si conclude nel 1990. Il secondo fronte di indagine è invece relativo al 2009. Ogni area è stata misurata a definire:

- le presenze delle unità operatrici sia storicamente che attualmente (arsellatori)
- la quantità storica (1987-1990) prelevata in un'ora di lavoro
- la quantità attuale (2009) prelevata in un'ora di lavoro

La raccolta delle arselle è stata effettuata, mediante l'uso manuale del rastrello (rampino), con maglia rettangolare 2×1 cm. I dati raccolti, suddivisi in modo da considerare 14 giornate (repliche) di ogni mese per ciascun anno considerato, sono utilizzati per valutare un eventuale calo della popolazione di *R. decussatus* nelle aree soggette a prelievo. A tale scopo è stata fatta una ANOVA a due fattori (random) "mese" e "anno" e un'altra ad un fattore "anno" (4 livelli) per valutare differenze nell'abbondanza di *R. decussatus* nel mese di settembre tra le serie storiche con quella più recente.

Risultati – Dalle analisi effettuate per le serie storiche è emersa una differenza significativa tra anni ($F_{3,16}$=5,40 p=0,000) e tra mesi (ANOVA, $F_{16,260}$=14,36, p=0,000) anche se test a posteriori non hanno evidenziato ipotesi alternative. Al contrario, nel confronto dell'abbondanza della specie nei mesi di settembre tra anni è emersa una significativa differenza (ANOVA, $F_{3,52}$ =62,14, p=0,0000) supportata poi da un test SNK che ha evidenziato una significativa diminuzione nell'ultimo anno considerato.

Conclusioni – Le osservazioni anche se preliminari effettuate in questo studio, suggeriscono che il progressivo decremento nei prelievi di *R. decussatus* nel golfo interno di Olbia, presenta in realtà un quadro estremamente complesso manifestante la presenza di numerosi fattori disturbanti che persistono negli anni. Più che nell'eccessivo numero di arsellatori, le osservazioni implicano gli impatti nelle discutibili attività umane che hanno alterato l'aspetto della ria, realizzando nel tempo una conformazione tendente alla riduzione degli spazi acquei. Inoltre, la cospicua sedimentazione, apportata dai dragaggi del canale naturale che determina la zona assiale del Golfo e alla realizzazione di numerosi banchinamenti, aumentando la concentrazione nell'acqua di materiale sospeso, hanno comportato un ulteriore mutamento della quantità della luce che raggiunge i fondali con effetti negativi sul pabulum. La presenza della specie alloctona ed antagonista *R. philippinarum*, la cui presenza è stata rinvenuta in tutte le aree di studio con una percentuale media del 4%, è ritenuta un ulteriore fattore biotico di disturbo unitamente (Chessa *et al.,* 2005), a *Musculista senhousia* (Mytilidae) bivalve, anch'esso alloctono (Munari *et al*., 2004).

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GASTROPODS AND POLYCHAETES IN THE UPPER INFRALITTORAL ZONE OF ENFOLA ISTMUS (ELBA ISLAND): NEW RECORDS AND REVIEW OF NOMENCLATURE

GASTEROPODI E POLICHETI NELL'INFRALITORALE DELL'ISTMO DELL'ENFOLA (ISOLA D'ELBA): NUOVE SEGNALAZIONI E REVISIONE DELLA NOMENCLATURA

***Abstract** – Two species of Gastropods,* Alvania pagodula *and* Rissoa decorata*, never reported in Northern Tirrhenyan Sea, have been collected at Enfola istmus (Elba island) on hard substratum (meso- and upper infralittoral). Besides, the work proposes the review of the nomenclature in regard to the Polychaetes* Eulalia viridis *and* Nereis zonata.

***Keywords:** Gastropods, Polychaetes, biodiversity, Elba Island.*

Introduction – Enfola Promontory is connected to Elba Island by an istmus, with sides arranged in direction N-S. The aim of the work is the census of Gastropods and Polychaetes of the benthic community in mesolittoral and upper infralittoral of northern and southern sides of the istmus.

Materials and methods – The methodology used for the study of the hard bottom benthic communities is the scraping sampling on a standard area (400 cm^2). A sample and its replicate were collected at a maximum depth of 1 m, in 4 stations, in May and September 2008, in the northern and southern side of the itsmus obtaining on the whole sixteen samples (and 16 replicates).

Results – The northern area is facing directly the open sea (high hydrodinamism); the southern one is located into Viticcio Gulf (low hydrodinamism).

In the hard bottom biocoenosis of photophilous algae, 37 species of Mollusca and 49 of Polychaetes for the northern area and 63 species of Mollusca and 73 of Polychaetes for the southern one were collected.

In the northern area the finding of 3 specimens of *Alvania pagodula* (September) and 2 of *Rissoa decorata* (September) is noticeable: the species are not present in the checklist of the Italian marine fauna (Oliverio *et al.,* 2008) for the biogeopraphical sectors 1 and 2. The specimens belonging to the two species were photographed and measured (L=length, w=width; sL=stoma length; sw=stoma width).

Alvania pagodula Philippi 1846. Specimen 1: L=2.0 mm, w=1.1 mm, sL=0.8 mm, sw=0.5 mm. Specimen 2: L=2.4 mm, w=1.0 mm, sL=0.7 mm, sw=0.6 mm. Specimen 3: L=2.1 mm, w=1.0 mm, sL=0.8 mm, sw=0.7 mm.

Rissoa decorata (Bucquoy, Dautzenberg & Dollfus, 1884). Specimen 1: L=2.8 mm, w=1.1 mm, sL=1.2 mm, sw=0.9 mm. Specimen 2: L=2.0 mm, w=1.1 mm, sL=0.8 mm, sw=0.6 mm.

In September 2008 also 6 specimens of the Polychaete Phyllodocide *Eulalia viridis* (*sensu* Fauvel, 1923) were found, 3 in the northern area, 3 in the southern one. This species is absent in the checklist of the Italian marine fauna (Castelli *et al.*, 2008) in the sectors 1 e 2. The species has been already reported in Elba area, for instance by Bianchi *et al.* (2003) and Lardicci *et al.* (1990). According to Bonse *et al.* (1996)

Eulalia viridis proved to be a complex of semispecies: *E. viridis*, *E. clavigera* and *E. aurea*. The careful observation of the Enfola specimens allows to attribute them to *E. clavigera*, a Mediterranean species: on the contrary *E. viridis* is considered typical of the Northern Europe seas.

Five specimens of the Nereididae *Nereis zonata* were sampled in the northern area and 44 in the southern one, in May and September. This species is considered today a synonym of *Nereis pulsatoria* (Viétez *et al.*, 2004), absent instead in the checklist of the Italian marine fauna (Castelli *et al.*, 2008).

Conclusions – As regards the two species of Gastropods, their presence in northern sector of the Mediterranean sea can be attributed to the temperature increase of the shallow waters.

With respect to the Polychaetes the review of nomenclature and the adjustment of the checklist of the Italian marine fauna would be advisable, to avoid possible confusion.

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SEGNALAZIONE DI MACROALGHE NON-INDIGENE NEL PORTO DI ANCONA (MEDIO ADRIATICO)

RECORDS OF NON-INDIGENOUS MACROALGAE IN THE ANCONA HARBOUR (MIDDLE ADRIATIC)

***Abstract** – The first record of* Antithamnion hubbsii *E.Y. Dawson,* Grateloupia turuturu *Yamada and* Sargassum muticum *(Yendo) Fensholt in the Ancona Harbour (Middle Adriatic) is reported. These non-indigenous macroalgae have colonized the hard substrata of the harbour, probably introduced by international shipping, in the ballast water or by hull-fouling. At the moment there is not evidence of their occurrence on surrounding natural rocky substrata.*

***Key-words:** non-indigenous species,* Antithamnion hubbsii*,* Grateloupia turuturu*,* Sargassum muticum*, Middle Adriatic.*

Introduzione - Il rinvenimento di specie non-indigene (NIS) in ambienti confinati e aree portuali è una forma di inquinamento biologico ormai ricorrente in tutto il mondo (Zenetos *et al*., 2005). I principali vettori di introduzione sono il trasporto navale, l'acquacoltura e il ripopolamento e le conseguenze associate alla loro introduzione sono la riduzione della biodiversità e le alterazioni del funzionamento degli ecosistemi e delle attività produttive (Boudouresque e Verlaque, 2002).

Nel presente lavoro viene riportata la segnalazione di tre NIS nuove per il Medio Adriatico: *Antithamnion hubbsii* E.Y. Dawson, *Grateloupia turuturu* Yamada e *Sargassum muticum* (Yendo) Fensholt. Queste specie sono state segnalate per la prima volta in Italia nella laguna di Venezia, rispettivamente da Curiel *et al*. (1996) come *A. pectinatum* (Montagne) Brauner *ex* Athanasiadis *et* Tittley, Solazzi *et al*. (1991-1994) come *G. doryphora* (Montagne) M. Howe e Gargiulo *et al*. (1992), e sembra che abbiano come principale vettore di introduzione la molluschicoltura (Cormaci *et al.,* 2004). Finora la loro distribuzione è stata limitata alla Laguna veneta, ad eccezione di *G. turuturu* recentemente segnalata anche nel Mar Piccolo di Taranto (Cecere e Petrocelli, 2007).

Materiali e metodi – Nel maggio 2009, nell'ambito di uno studio di caratterizzazione del Porto di Ancona, sono stati effettuati rilievi biologici mediante grattaggi (20×20 cm), presso 8 banchine scelte in modo casuale. A seconda della profondità, sono stati raccolti campioni in uno o due siti per banchina, conservati in formaldeide diluita al 5%.

Risultati – In totale sono stati censiti 39 taxa macroalgali (26 Rhodophyta, 7 Ochrophyta e 6 Chlorophyta); tra questi viene segnalata per la prima volta nel Medio Adriatico la presenza di *A. hubbsii*, *G. turuturu*, e *S. muticum*. Gli esemplari di *A. hubbsii* sono stati campionati in 4 stazioni a profondità compresa tra -0,2 e -4 m. I talli di *G. turuturu* sono stati raccolti su gusci di mitili e substrati duri in una stazione riparata del porto a -1 m di profondità. Gli esemplari, pur presentando elevato polimorfismo, erano caratterizzati da lamine a margini interi o comunque con poche proliferazioni e dimensioni medie di 30 cm. I talli di *S. muticum,* alcuni dei quali densamente epifitati, sono stati ritrovati su un fondo fangoso, tra i massi di una scogliera di un molo esterno, alla profondità -9 m. Non sono stati osservati talli fertili.

Conclusioni – Il ritrovamento di queste NIS nel Porto di Ancona, dove probabilmente sono state introdotte mediante le carene di imbarcazioni e le acque di zavorra, sembra indicare un ampliamento dei loro areali di distribuzione. Sarebbe interessante valutare se la presenza di queste specie è limitata ad ambienti confinati e aree portuali o se sono più ampiamente diffuse in aree limitrofe il porto o sui substrati naturali del Conero. L'assenza di studi floristici recenti ed estensivi nel Medio Adriatico non consente di affermare o escludere con certezza tale ipotesi. Ulteriori indagini sono dunque necessarie per comprendere se queste specie siano stabilmente insediate nel bacino portuale e/o nelle aree limitrofe e per studiarne la fenologia morfologica e riproduttiva.

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ANTEDON MEDITERRANEA (ECHINODERMATA: CRINOIDEA) AS HOST OF COMMENSAL *SUBADYTE PELLUCIDA* (ANNELIDA: POLYCHAETA)

ANTEDON MEDITERRANEA *(ECHINODERMATA: CRINOIDEA) OSPITE DEL COMMENSALE* SUBADYTE PELLUCIDA *(ANNELIDA: POLYCHAETA)*

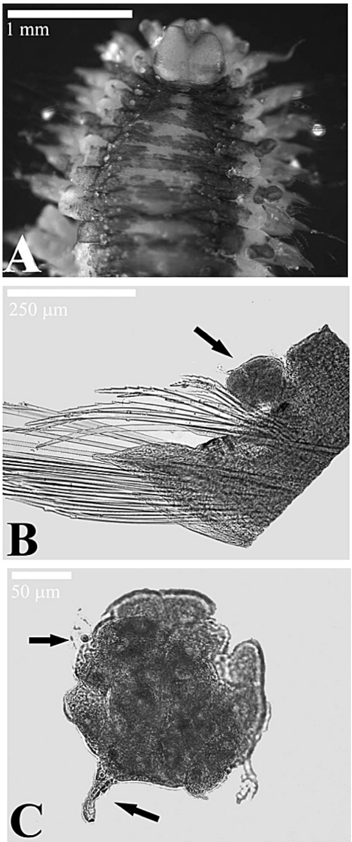
Abstract *– The Mediterranean endemic comatulid* Antedon mediterranea *(Crinoidea: Comatulidae) is herein reported as host for symbiotic* Subadyte pellucida *(Polychaeta: Polynoidae). Three adult specimens were found on two crinoids, positioned on the oral surface or on the brachial pinnules. A mating couple was confirmed by presence of cohesive egg masses in the mid parapodial region of the smaller specimen; some potential implications of reproductive strategy for this ectosymbiotic scaleworm are discussed.*

Key-words: *Polynoidae, Comatulidae, symbiosis, Mediterranean Sea.*

Introduction – Symbiotic relationships involving echinoderms are well known and supported by a wide litterature. Physical protection, exploitation of new substrates and alternative trophic pathways related to the different habitats of the hosts may favour the establishment of these associations (Coppard and Campbell, 2004). Although *Asterophylia*, *Hololepidella*, *Paradyte* and *Subadyte*, are known to be associated to crinoids (Barel and Kramer, 1977; Martin and Britayev, 1998), the knowledge of these associations in the Mediterranean Sea is scanty. In this paper some information on *Antedon mediterranea* (Lamarck, 1816) and *Subadyte pellucida* (Ehlers, 1864) association, from the Southern Tyrrhenian Sea, were reported.

Materials and methods – Four *A. mediterranea* were collected off Capo d'Orlando (Sicilian coasts, South Tyrrhenian Sea) by trammel net at 59 meters depth in autumn 2008 and two of them were found hosted by *S. pellucida*. The crinoids were fixed with ethanol 70°. The life position of scaleworm specimens on the crinoid host and their main morphological characters were subsequently assessed by means of light microscope equipped with micrometric ocular.

Results – Three adults of *S. pellucida* were found on two *A. mediterranea*. Two incomplete polynoids (18 and 11 segments respectively) were found on the same host at the level of pinnules. The larger specimen showed a marked colour pattern (Fig. 1A); the smaller was an ovigerous female, with compact sub-spherical egg masses attached on the dorsal parapodial surface, beneath the elytrae (Fig. 1B and **C**) at least on some parapodia. The two individuals probably constituted a mating couple. The third smaller specimen was recorded alone on its host, positioned on its oral surface; it was also incomplete (30 segments) and almost colourless. The occurrence of a mature couple is a not common feature in polychaetes, and in polynoids particularly (Martin and Britayev, 1998). Some polynoids are known to bring embrios beneath elitrae (Daly, 1972). The peculiar external position of egg mass let to suppose that fertilized eggs may be precociously brooded by females, but this hypothesis needs more accurate investigations on live specimens, also to exclude possible artefacts of sampling and preservation. This aspect besides demonstrated that crinoids behave not as simple support for feeding or mimetic refuge, but as a basibiont wherein facultative or more specialized symbiotic worms develops their own biological cycle.



(photo Andrea Potoschi)

Fig. 1 - *Subadyte pellucida*: A. Colour pattern of the larger specimen. B. Egg mass attached to the upper notopodial surface (female, XII chaetiger;). C. Magnification of the egg mass showing an oocyte nucleus (top arrow) and the attaching 'peduncle' (down arrow).

Subadyte pellucida*: A. Colorazione caratteristica dell'esemplare più grande. B. Massa ovigera attaccata alla superficie superiore dei notopodi (femmina, XII setigero). C. Ingrandimento della massa ovigera che mostra un nucleo dell'ovocita (freccia in alto) ed il peduncolo d'attacco (freccia in basso).*

Conclusions – This is the first record of the association between *Antedon mediterranea* and *Subadyte pellucida* regarding the Italian seas. Moreover, this note aims to emphasize the presence of a reproductive couple of the polynoid *S. pellucida* on the same *A. mediterranea* host. The possible external brooding of fertilized eggs may constitute an adaptation for a more specialized ectosymbiotic life habit.

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LEPTOMETRA PHALANGIUM (J. MÜLLER, 1841) FIELDS FROM THE SOUTHERN TYRRHENIAN SEA: PRELIMINARY DATA ON THE ASSOCIATED FAUNA

FAUNA ASSOCIATA AI CAMPI A LEPTOMETRA PHALANGIUM *(J. MÜLLER, 1841) NEL MAR TIRRENO MERIDIONALE: DATI PRELIMINARI*

Abstract – *The crinoid* Leptometra phalangium *(Echinodermata: Crinoidea) is considered as an indicator of highly productive areas along the continental shelf capable to sustain large biomasses of benthopelagic fish. The presence of* L. phalangium *fields was recently recorded in the Southern Tyrrhenian Sea and the demersal associated fauna was identified. These results, according to other Authors, provide further evidence on the importance of this facies in structuring demersal communities and in enhancing the habitat heterogeneity, confirming the importance of* L. phalangium *field as essential fish habitat.*

Key-words: Leptometra phalangium*, demersal fauna, southern Tyrrhenian Sea.*

Introduction – The suspension feeder crinoid *Leptometra phalangium* (J. Müller, 1841) represents a typical component of the Mediterranean benthic community of the continental shelf (DL, Pérès and Picard 1964), where can locally reach very high density (Kallianotis *et al*., 2000; Colloca *et al*., 2003). The aggregation zones of this species are considered able to sustain large biomasses of benthopelagic fish also playing an important role for their recruits (Colloca *et al*., 2004). In this note some information on demersal species associated with *L. phalangium facies* in the Southern Tyrrhenian Sea are reported.

Materials and methods – Data were collected during a trawl survey carried out with CNR vessel "Dallaporta" in the Southern Tyrrhenian Sea in spring 2009. The hauls were performed using a trawl net having a 20 mm mesh size cod-end between 20 and 133 meters of depth from Brolo (ME) to Capo Raisigerbi (PA). All species collected were identified, counted and weighed. Data were elaborated in accordance with swept area of each haul to obtain the Density (n/km^2) and Biomass (kg/km^2) indices.

Results – The presence of *L. phalangium* in *facies* was recorded in two localities: off Santo Stefano di Camastra (ME) from 128 to 133 meters, presenting a density of 1650 ind./Km^2 and off Finale di Pollina (PA) from 113 to 117 meters, with density of 2220 ind./km^2. A total of 33 demersal species was collected: 23 Osteichthyes, 1 Chondrychthyes, 8 Mollusca and 1 Crustacea. The most abundant species (>3%) are reported in Tab. 1.

In this bottom we found typical demersal species already known for the *L. phalangium* fields from other areas of the Tyrrhenian Sea (Colloca *et al*., 2004; Reale *et al*., 2005).

Conclusions – Although the *L. phalangium* bottoms are not rare in the Tyrrhenian Sea, this is the first official record of this *facies* along the Sicilian Tyrrhenian coasts.

Our results are not comparable with other *L. phalangium* fields, from other areas, in term of occurrence, density and extension, nevertheless the associated demersal species seem to be very similar. These preliminary results provide further evidence on the importance of this *facies* in structuring demersal communities and in enhancing the habitat heterogeneity (Gili and Coma, 1998; Colloca *et al*., 2004). Moreover, the knowledge about an essential fish habitat, as *L. phalangium* field, should be considered priority in fisheries management of the Southern Tyrrhenian Sea.

Tab. 1 - List of most frequent species and their density and biomass values in the 3C and 31C stations.

Lista delle specie più frequenti e loro valori di densità e biomassa nelle stazioni 3C e 31C.

	3 C		**31 C**	
SPECIES	**kg/km^2**	**n/km^2**	**kg/km^2**	**n/km^2**
Aspitrigla cuculus (Linnaeus, 1758)	0,25	33,33	3,20	60,00
Boops boops (Linnaeus, 1758)	8,67	100,00	1,20	20,00
Cepola macrophthalma (Linnaeus, 1758)	1,00	50,00	0,20	20,00
Lepidotrigla cavillone (Lacepède, 1801)	0,17	16,67	24,80	2140,00
Lophius budegassa (Spinola, 1807)	0,00	0,00	10,00	60,00
Macroramphosus scolopax (Linnaeus, 1758)	0,17	83,33	0,00	0,00
Merluccius merluccius (Linnaeus, 1758)	33,33	1766,67	12,40	440,00
Mullus barbatus (Linnaeus, 1758)	3,33	83,33	43,20	760,00
Pagellus acarne (Risso, 1826)	8,00	116,67	0,00	0,00
Pagellus erythrinus (Linnaeus, 1758)	10,83	50,00	0,00	0,00
Phycis blennoides (Brünnich, 1768)	2,67	33,33	0,80	20,00
Serranus hepatus (Linnaeus, 1766)	0,17	33,33	0,00	0,00
Spicara flexuosa (Rafinesque, 1810)	12,67	283,33	14,80	180,00
Spicara smaris (Linnaeus, 1758)	0,00	0,00	3,20	100,00
Trachurus trachurus (Linnaeus, 1758)	63,33	1550,00	19,00	2100,00
Zeus faber (Linnaeus, 1758)	0,33	16,67	0,00	0,00
Parapenaeus longirostris (Lucas, 1846)	0,25	50,00	16,00	40,00
Alloteuthis media (Linnaeus, 1758)	15,00	1133,33	7,60	800,00
Alloteuthis subulata (Lamarck, 1798)	0,08	33,33	0,40	160,00
Eledone cirrhosa (Lamarck, 1798)	0,42	100,00	0,00	0,00
Illex coindetii (Verany, 1839)	31,67	116,67	2,40	20,00
Scaeurgus unicirrhus (Orbigny, 1840)	0,00	0,00	0,40	40,00
Sepia elegans (Blainville, 1827)	0,50	66,67	0,40	100,00
Sepia orbignyana (Férussac, 1826)	0,25	66,67	0,00	0,00

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TAGGING *OCTOPUS VULGARIS* (OCTOPODA: OCTOPODIDAE) IN AN AREA OF CENTRAL WESTERN SARDINIAN WATERS

MARCATURA DI OCTOPUS VULGARIS *(OCTOPODA: OCTOPODIDAE) IN UN'AREA DELLA SARDEGNA CENTRO OCCIDENTALE*

Abstract *– Preliminary data on growth and movements of* Octopus vulgaris *wild populations of the Mediterranean Sea recorded during a tagging program in the central western Sardinian waters were reported and compared with literature.*

Key-words: Octopus vulgaris*, tagging, growth, movements, Mediterranean Sea.*

Introduction - *Octopus vulgaris* Cuvier, 1797 has a world-wide distribution in tropical, subtropical and temperate waters of the Atlantic, Indian, Pacific oceans and Mediterranean Sea (Guerra, 1992). It inhabits continental shelf and slope waters, occupying diverse habitats (Guerra, 1992). Age and growth of *O. vulgaris* were studied using indirect or direct methods (Semmens *et al*., 2004). In particular, within direct methods, mark-recapture experiments in wild represented useful tools to estimate age, growth, and lifespan and also to obtain information on the movements of the species (e.g. Domain *et al*., 2000; Nagasawa *et al.,* 1993). Taking into account this, for the first time in Mediterranean an experimental tagging program for *O. vulgaris* was performed in the central western Sardinian waters. In this note, preliminary results on growth and movements of *O. vulgaris* were reported.

Materials and methods - *Octopus vulgaris* specimens caught from May to October 2009 by crab-traps off the central western Sardinia coast at depth of 20 to 40 m were tagged with Petersen discs on 3rd left arm and release into the same fishing areas. For each specimen dorsal mantle length (ML, to the nearest mm), total weight (TW, to the nearest g) and sex were recorded before release and after recapture. Maturity stage was determined in the recaptures, using for both sexes, the scale of Silva *et al.* (2002) modified (1, immature; 2, maturing; 3, mature; 4, spawning; 5, post-spawning). Geographical positions of release and recapture were recorded and the straight distance between release and recapture was calculated. Interval of freedom (DF, in days) and specific growth rates (SGR) according to Domain *et al.* (2000) were also determined.

Results - On the whole 132 males (ML: 32.0-130.0 mm; TW: 30-1400 g), 137 females (ML: 32.0-145.0 mm; TW: 30-1230g) and 16 undetermined (ML: 18.0-64.0 mm; TW: 20-350 g) of *Octopus vulgaris* were tagged. Overall, 9 octopuses tagged were recaptured by traps and 2 tags were found attached in a trammel net for lobster fishing, both during the commercial fishery (Tab. 1). Four SGR positive values were recorded for octopuses recaptured after 8-25 days. As shown in Table 1 the remaining 5 recaptures (DF: 18-30) had null or negative SGR-values. The straight distance between release to recapture ranged from 411 to 1200 meters for males and was 20 meters for the only female recovered.

Tab. 1 - *Octopus vulgaris*: data of the specimens recaptured (*tags recovered in trammel nets).
Octopus vulgaris*: dati relativi agli individui ricatturati (*marche rinvenute nei tramagli).*

Specimens Code	Weight at release (g)	Weight at recapture (g)	DF	Sex	Maturity stage	SGR	Straight distance from release to recapture (meters)
146	600	900	25	Male	3	0.0162	520
213	520	600	8	Male	3	0.0179	1200
238	259	400	12	Male	3	0.0241	1200
204	329	455	20	Female	1	0.0162	20
183	620	620	18	Male	4	0.0000	1200
223	470	460	20	Male	4	-0.0011	510
180	390	370	30	Male	4	-0.0018	510
191	690	630	30	Male	4	-0.0030	1200
196	590	530	30	Male	4	-0.0036	1200
157*	700	-	42	Male	-	-	616
163*	1000	-	42	Male	-	-	411

Conclusions – The low number of recaptures highlights the need to carry out this kind of experiment in fishing banned areas, probably with greater success. This could also avoid that specimens tagged may lose their tag in an attempt to wriggle by the nets, as we have observed. However, even if preliminary, our data are the first for the Mediterranean. The SGR_s recorded are in agreement with the high rates of growth and within the large variability of this species, as well as zero or negative rates are due the weight loss linked with the senescence (Domain *et al.*, 2000). The recorded movements do not seem linked with days of freedom but could be due to available food, and or to the need to choose safe shelters where to spend daylight hours. However, they suggest for the species, a more sedentary behavior in our area than that reported for Japan Sea (48 km, see Nagasawa *et al.*, 1993).

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SIZE EVALUATION OF *DELECTOPECTEN VITREUS* (MOLLUSCA, BIVALVIA) FROM SANTA MARIA DI LEUCA DEEP-WATER CORAL SITE (IONIAN SEA)

OSSERVAZIONI SULLA TAGLIA DI UNA POPOLAZIONE DI DELECTOPECTEN VITREUS *(MOLLUSCA, BIVALVIA) PROVENIENTE DAL SITO A CORALLI PROFONDI DI SANTA MARIA DI LEUCA (MAR IONIO)*

Abstract *– The size of a Mediterranean population of the deep sea pectinid* Delectopecten vitreus *(Mollusca, Bivalvia) is discussed with respect to Atlantic counterparts. The Mediterranean specimens collected in the Ionian Sea at the Santa Maria di Leuca deep water coral site are characterized by a size smaller than Atlantic stocks.*

Key-words: Delectopecten vitreus*, population, deep coral epifauna.*

Introduction – *Delectopecten vitreus* (Gmelin, 1791) is a quasi-cosmopolitan pectinid bivalve distributed in the Atlantic, Indian and Pacific Ocean, from infralittoral down to abyssal depths (e.g., Schein, 1989). *D. vitreus* is characterized by a planktotrophic development (Dijkstra and Gofas, 2004) and its long-lasting meroplanktonic life ensures its wide geographic dispersion. The species is rather frequent in the Mediterranean Sea and living specimens were found byssate on a variety of substrates (e.g, Smriglio, 2005; Mastrototaro *et al.*, 2010). *D. vitreus* commonly occurs in the deep-water Pleistocene record of the Mediterranean basin and this includes also submerged situations datable to the last glacial epoch (Taviani and Colantoni, 1984; Di Geronimo *et al.*, 2005). The biology and population structure of Mediterranean *D. vitreus* stocks are poorly known. In this contest the size distribution of *D. vitreus* specimens collected alive in the Santa Maria di Leuca (SML) deep water coral site (Ionian Sea) is discussed.

Materials and methods – All live specimens considered in this study were sampled during various missions of RV *Urania* and *Universitatis*, devoted to the study of the SML coral site (Mastrototaro *et al.*, 2010); they were measured with an electronic calliper (Total length=TL and total height=TH in mm). The size-frequency distribution was elaborated considering size classes of 2 mm. The relationship between total length and total height was tested by means of linear regression. Stereomicroscopic observations of the external shell morphology were aimed at examining microsculpture features.

Results – A total of 181 specimens were living-collected, from 451 to 1100 m depth, either on both artificial substrates (mostly entangled fishing lines or plastic litter) or dead on scleractinian coral colonies off the Santa Maria di Leuca (SML) deep water coral site. Such shells are equipped with fragile valves marked by concentric rows of small scales and vesicles as reported by Schein (1989) as typical for the subspecies *D. vitreus vitreus*. The TL ranged from 6 to 16 mm. The length and height were highly correlated (Fig. 1a). The size distribution (TL) showed a bimodal trend with a modal component of 9-10 mm (19% of the specimens collected) and another of 13-14 mm (16%) (Fig. 1b).

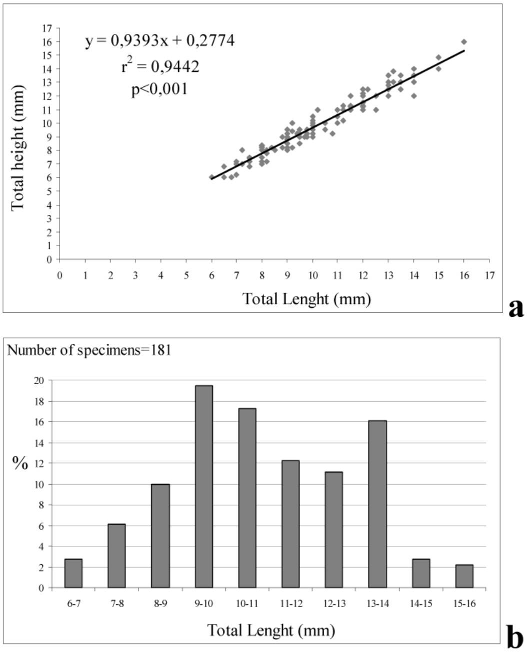

Fig. 1 - a) Relationship between Total length and Total height of specimens of *D. vitreus* collected in SML deep water coral site. b) Size-frequency distribution of *D. vitreus* collected in SML deep water coral site.

a) Relazione tra la lunghezza totale e la larghezza totale degli esemplari di D. vitreus *provenienti dal sito a coralli profondi di S. Maria di Leuca. b) Distribuzione lunghezza-frequenza degli esemplari di* D. vitreus *rinvenuti nel banco a coralli profondi di S. Maria di Leuca.*

Conclusions – The SML population showed a size smaller than the Atlantic one (mean size of 20 mm) (Shein, 1989). The observed smaller size could be possibly result from a response of *D. vitreus* to the higher bottom temperatures of the bathyal Mediterranean (ca 13-14 °C) or perhaps to differences in the trophic regimes.

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DISTRIBUTION OF THE MAIN BIOCENOTIC COMPONENTS OF THE GIARDINI NAXOS GULF (MEDITERRANEAN SEA)

DISTRIBUZIONE DELLE PRINCIPALI COMPONENTI BIOCENOTICHE NEL GOLFO DI GIARDINI NAXOS (MAR MEDITERRANEO)

Abstract *– In this paper the biocenotic map of the Giardini Naxos Gulf and its nearby (Strait of Messina) is reported. Data were collected using exclusively non-destructive sampling methods. A heterogeneous area probably due to the interaction of a lot of factors was highlighted.*

Key-words: *biocoenoses, benthos, GIS, Side Scan Sonar.*

Introduction – The distribution of the main marine biocoenoses can play a fundamental role in the conservation, monitoring and management of the coastal marine environment (Somaschini *et al.*, 1998; Diviacco *et al.*, 2000; Piazzi *et al.*, 2000). In these contexts, the possibility to draw a bionomical map using non destructive sampling methods is to considered preferable. This paper provides a bionomical map of the benthic communities from the Giardini Naxos Gulf (Strait of Messina).

Materials and methods – The survey was carried out in the Giardini Naxos Gulf and its nearby (Strait of Messina, Mediterranean Sea) from 2 to 183 m of depth in the framework of a regional project (SFOP 2004 - POR 2000-2006). Data were collected by Side Scan Sonar (SSS) and by direct and indirect *Visual census* methods (Scuba diving, ROV) and were put into a GIS to produce the cartography of the area.

Results – A map at 1:20.000 scales of the investigated area, reporting the main biocenotic features, was produced (Fig. 1). The most part of the area consisted of soft bottoms, mainly represented by muddy biodetritic bottoms (DE, Pérès and Picard, 1964), most abundant off the Gulf and at the deeper depths, and by SFBC biocoenoses (*sensu* Pérès and Picard, 1964), well-represented into the Gulf, within 50 m of depth. As shown in the figure, zones characterized by AP-HP, PE and VTC biocoenoses (*sensu* Pérès and Picard, 1964) were also observed. Furthermore, the presence of wide local aggregations of Pennatulaceans, Cidarids and *Ditrupa arietina* (O.F. Müller, 1776) (Annelida: Polychaeta) was recorded.

Conclusions – The studied area appeared considerably heterogeneous probably as a consequence of the interaction of a lot of factors. In fact, the area is affected by strong bottom currents, irregular continental input and abundant suspended particles captured by suspension feeders which locally can reach high biomasses, as also witnessed by the pennatulacean aggregations (AA.VV., 2007).

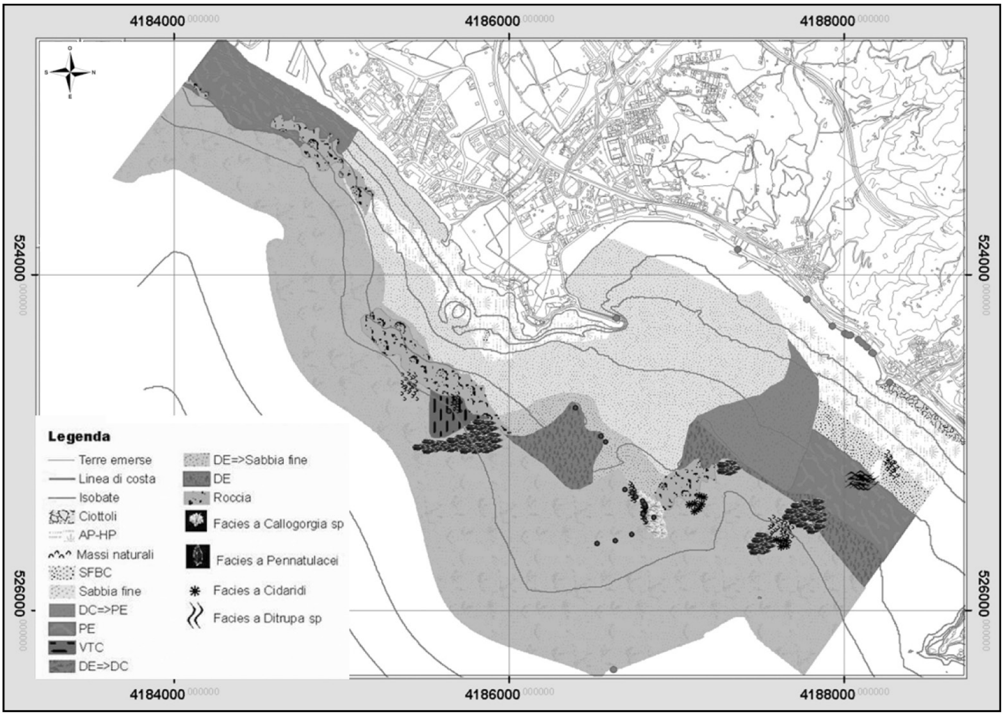

Fig. 1 - Biocenotic map of the Giardini Naxos Gulf.
Mappa biocenotica del Golfo di Giardini Naxos.

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SYMBOLS TO REPRESENT MEDITERRANEAN SEABED TYPOLOGIES AND FOCAL BENTHIC SPECIES

SIMBOLI PER RAPPRESENTARE LE TIPOLOGIE DI FONDALE E LE SPECIE BENTONICHE COSPICUE

Abstract *- A set of effective symbols, suitable to represent 11 substrata typologies, 68 focal taxa and mucilage aggregates distribution, both on 2D/3D maps and along seabed profiles, was provided.*

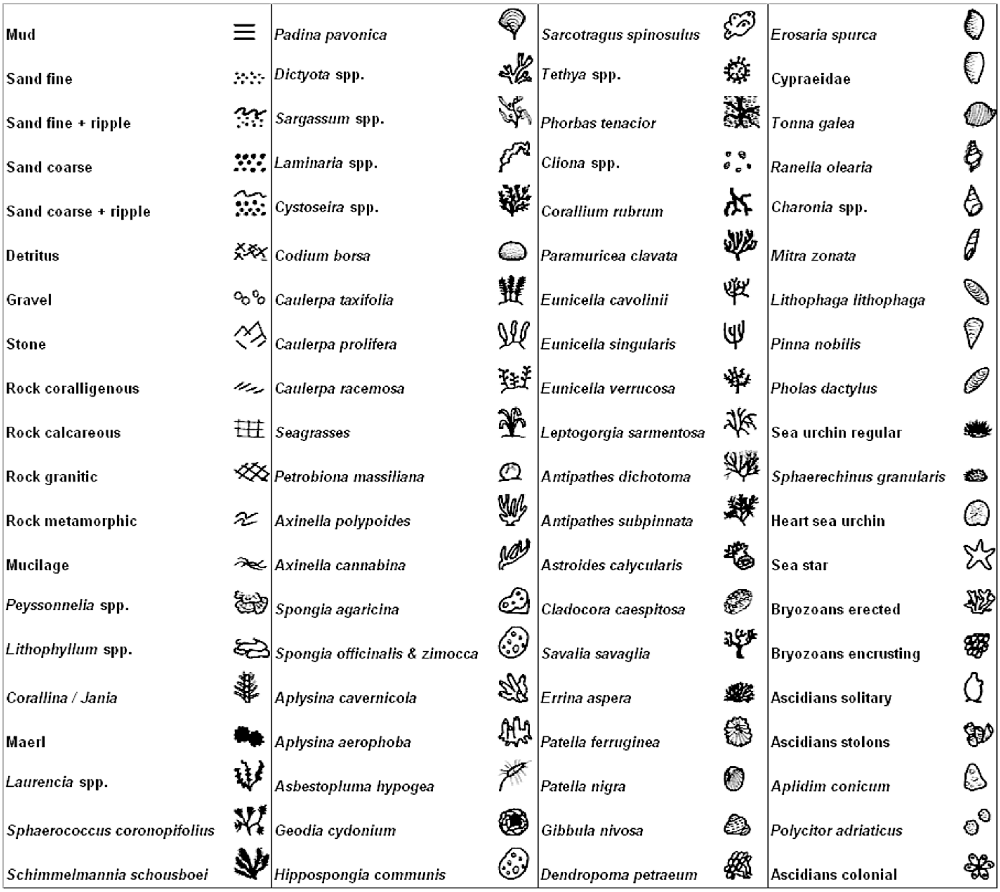
Key-words: *marine benthos, habitat monitoring, sea bottom, biocoenosis, Mediterranean Sea.*

Introduction - Understanding diversity and ecological processes occurring in coastal marine habitats, as well conservation and management of marine biological resources and natural heritages, require proper representation of seabed typologies, biocoenosis, and benthic species distribution at a wide range of spatial scales. Most of the attention is generally paid on focal species, which include indicators, keystones, umbrellas, and flagships species (for definition see Zacharias and Roff, 2001). The distribution of these taxa can be obtained by scientific SCUBA divers along transects (Bianchi *et al.*, 2004) and reproduced as graphic profiles which describe, for examples, changes along gradients. Benthic cartography (including maps of the biocoenoses, emergencies, degradations and risks), requires standardised symbols (Meinesz *et al.*, 1983) and/or textual codes (Bianchi, 2007). The aim of the present study was to provide a set of effective symbols, suitable to represent Mediterranean substrata typologies and focal species distribution both on 2D/3D maps and along seabed profiles.

Materials and methods - Main substrata typologies and focal taxa list were obtained reviewing the literature on Mediterranean habitats classification (see RAC/SPA, 2006 and references therein), European Community directives and international conventions. Taxa list were reduced unifying species with similar shape, reproducible by the same symbol but different colours and/or size. For each selected typology and taxon the stylised shape was freehand drawn. All the freehand drawing were digitalised and converted in a custom font using dedicated software. The effectiveness of digitalised symbols was tested on thematic maps and transects profiles based on field data.

Results - 80 symbols, representing 11 bottom typologies, 68 taxa and mucilage aggregates, were drawn and stored in a custom font. These symbols were effectively used to represent focal species distribution within the "Secche di Tor Paterno" marine protected area.

Conclusions - Simple and easily distinguishable symbols are useful for both benthic cartography and graphic profile which could allow spatial and temporal analyses.



Mud	*Padina pavonica*	*Sarcotragus spinosulus*	*Erosaria spurca*
Sand fine	*Dictyota* spp.	*Tethya* spp.	Cypraeidae
Sand fine + ripple	*Sargassum* spp.	*Phorbas tenacior*	*Tonna galea*
Sand coarse	*Laminaria* spp.	*Cliona* spp.	*Ranella olearia*
Sand coarse + ripple	*Cystoseira* spp.	*Corallium rubrum*	*Charonia* spp.
Detritus	*Codium borsa*	*Paramuricea clavata*	*Mitra zonata*
Gravel	*Caulerpa taxifolia*	*Eunicella cavolinii*	*Lithophaga lithophaga*
Stone	*Caulerpa prolifera*	*Eunicella singularis*	*Pinna nobilis*
Rock coralligenous	*Caulerpa racemosa*	*Eunicella verrucosa*	*Pholas dactylus*
Rock calcareous	*Seagrasses*	*Leptogorgia sarmentosa*	Sea urchin regular
Rock granitic	*Petrobiona massiliana*	*Antipathes dichotoma*	*Sphaerechinus granularis*
Rock metamorphic	*Axinella polypoides*	*Antipathes subpinnata*	Heart sea urchin
Mucilage	*Axinella cannabina*	*Astroides calycularis*	Sea star
Peyssonnelia spp.	*Spongia agaricina*	*Cladocora caespitosa*	Bryozoans erected
Lithophyllum spp.	*Spongia officinalis & zimocca*	*Savalia savaglia*	Bryozoans encrusting
Corallina / Jania	*Aplysina cavernicola*	*Errina aspera*	Ascidians solitary
Maerl	*Aplysina aerophoba*	*Patella ferruginea*	Ascidians stolons
Laurencia spp.	*Asbestopluma hypogea*	*Patella nigra*	*Aplidim conicum*
Sphaerococcus coronopifolius	*Geodia cydonium*	*Gibbula nivosa*	*Polycitor adriaticus*
Schimmelmannia schousboei	*Hippospongia communis*	*Dendropoma petraeum*	Ascidians colonial

Fig. 1 - Proposed symbols for the most relevant seabed typologies and benthic taxa.
Simboli proposti per le tipologie di fondale e per i taxa bentonici più rilevanti.

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UN TASSO DI SCONTO PER LE PRATERIE DI *POSIDONIA OCEANICA*

A DISCOUNT RATE FOR THE POSIDONIA OCEANICA *MEADOWS*

Abstract *– The discount rate for ecosystem services should be low. In this study we propose a model for identifying an appropriate discount rate for the* Posidonia oceanica *(L.) Delile services on the basis of the speed of growth of a* Posidonia *meadow. Our results show that a low discount rate could be justified.*

Key-words*:* Posidonia oceanica*, economic analysis, environmental protection.*

Introduzione – La biodiversità sta andando incontro, su scala globale, a una progressiva riduzione. Con lo scopo di arginare la perdita della biodiversità risulta sempre più necessario integrare ecologia, economia e etica ambientale, con l'obiettivo di implementare concettualizzazioni e strumenti diretti a supportare decisioni che consentano di gestire gli ecosistemi in modo sostenibile.

Il proposito di questo lavoro è di presentare un modello volto a individuare un opportuno tasso per l'operazione di sconto da applicare al valore economico dei servizi ecosistemici forniti dalle praterie di *Posidonia oceanica*. Quando si considera il valore monetario dei servizi ecosistemici è necessario tenere presente che essi rappresentano soltanto il ritorno annuale dai relativi processi ecosistemici. Dal momento che un ecosistema fornisce i servizi in modo perpetuo è opportuno considerare, nel calcolo del valore economico della biodiversità, anche i benefici futuri dei servizi. Per questa ragione è necessario applicare ai valori annuali l'operazione di sconto. Il tasso di sconto tiene conto dell'orizzonte temporale considerato. Quando l'operazione di sconto viene applicata ai servizi ecosistemici deve essere scelto un tasso opportunamente basso, in conformità con il tempo necessario all'ecosistema per raggiungere il climax (de Groot, 1994). Nel nostro studio abbiamo sviluppato un modello volto a definire un tasso di sconto appropriato per le praterie di *Posidonia oceanica*, sulla base della capacità delle praterie di recuperare dalle perturbazioni indotte dall'attività antropica.

Materiali e metodi – Abbiamo preso in considerazione una ricerca di Meinesz e Lefevre sulla rigenerazione di una prateria distrutta da una bomba (Meinesz e Lefevre, 1984). Nel loro lavoro i due autori descrivono, sulla "matte" morta, numerose superfici di prateria in accrescimento orizzontale. Per il nostro modello ipotizziamo che vi sia una sola superficie di prateria in accrescimento della dimensione di un ettaro, e che non avvengano nuove colonizzazioni di talee.

Risultati – Se poniamo la condizione teorica che una prateria si accresca orizzontalmente, a partire da un punto, in modo uniforme in tutte le direzioni, descrivendo una superficie di geometria circolare che si incrementa col tempo, possiamo definire il seguente *tasso di accrescimento*:

$$i = \frac{S_{t+1} - S_t}{S_t}$$

Se: $S_t = (3{,}14)\,(r_t)^2$; $S_{t+1} = (3{,}14)\,(r_{t+1})^2$ e chiamiamo k l'*accrescimento orizzontale medio annuo*: $r_{t+1} = r_t + k$, si ottiene la seguente:

$$\mathbf{i} = \frac{\mathbf{2\,(r_t)\,(k) + (k)^2}}{\mathbf{(r_t)^2}}$$

Dallo studio di Meinesz e Lefevre sappiamo che la crescita media orizzontale di una prateria è di 3,75 cm yr^{1} (k = 0,0375 m yr^{1}) (Meinesz e Lefevre, 1984). Se ipotizziamo che la superficie distrutta (circa 2,5 ha) si ricostituisca a partire da una prateria intatta di 1 ha (r_t = 56,43 m), il tasso che si ottiene è: $\mathbf{i_1 = 0{,}13\%}$.

Quando alternativamente consideriamo un raggio di 1 m o un raggio di 89,23 m (2,5 ha) si ottiene un tasso rispettivamente $i_2 = 7{,}6\%$ e $i_3 = 0{,}084\%$.

Sulla base delle considerazioni compiute è possibile applicare con un tasso appropriato l'operazione di sconto al valore economico dei servizi ecosistemici forniti dalle praterie, come il servizio di prevenzione dell'erosione costiera (309 € m^{-2} yr^{-1}) (Blasi, 2009). Utilizzando il tasso i_1 e considerando che una superficie distrutta di una prateria di 2,5 ettari impiega per essere nuovamente colonizzata 120 anni (T = 120) (Meinesz e Lefevre, 1984), si ottiene un valore capitale attualizzato del servizio di 34 621 € m^{-2}.

Conclusioni – Il nostro modello rappresenta uno studio innovativo in questo campo. Esso mostra che, nella prospettiva dell'antropocentrismo debole, è eticamente giustificabile l'uso di un tasso di sconto basso per i servizi ecosistemici delle praterie di *Posidonia oceanica*, in ragione del tasso al quale le praterie recuperano dalle perturbazioni.

Il modello proposto, che consente di tenere conto del valore delle praterie a una scala temporale significativamente ampia, può rappresentare un utile contributo agli strumenti di decisione, al fine di conservare la biodiversità degli ecosistemi marini costieri a favore delle generazioni future.

Ringraziamenti - Lo studio rappresenta la sintesi di una parte della tesi di laurea in Scienze Ambientali presso l'Università di Genova. Desidero ringraziare i relatori: Prof. Giulio Relini e Prof. Barbara Cavalletti.

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FISH FAUNA OF MARINE CAVES IN FOUR ITALIAN MARINE PROTECTED AREAS

FAUNA ITTICA DI GROTTA IN QUATTRO AREE MARINE PROTETTE ITALIANE

Abstract *– In this study the fish fauna associated with submerged caves was investigated using visual census in 14 marine caves located within 4 Marine Protected Areas. Species richness varied between 21 and 5 species within each cave, which could reflect the non negligible variability among the investigated caves in terms e.g. of morphology, length and presence/absence of light in the innermost portions. This study stresses that fish assemblages hosted inside marine caves are fairly variable, but they often contribute to increase local diversity.*

Key-words*: fish fauna, caves, biodiversity, marine parks, Mediterranean Sea.*

Introduction - Marine caves are among the few marine habitats protected by the European Community (Habitat Directive 92/43EEC) due their uniqueness and fragility (see Cicogna *et al.*, 2003; Bussotti *et al.*, 2006; Parravicini *et al.*, 2010). Mediterranean marine caves host several fish species (e.g. Abel, 1959; Riedl, 1966; Bussotti & Guidetti, 2009) that include both cryptic and shy species typical of caves, and species that are also associated with rocky reefs outside. This study aims at evaluating 1) the variability in fish species richness in 14 marine caves at 4 Italian Marine Protected Areas (MPAs) and 2) the contribution of such environments to local fish diversity.

Materials and methods - Fish sampling was carried in September-October 2009 in 14 submerged caves at 4 MPAs: Capo Caccia (SS), 6 caves (between ~5 and 18 m depth); Lampedusa (AG), 2 caves (~10-19 m depth); Plemmirio (SR), 4 caves (~18-30 m depth); Porto Cesareo (LE), 2 caves (~8-10 m depth). The investigated caves were blind or with several openings and varied remarkably in terms of morphology and length, presence/absence of the ceiling and characteristics of the bottom (e.g. rocky *vs* muddy). Fish abundances and size were estimated using a modified transect visual census method (Bussotti & Guidetti, 2009): transects were 10 to 35 m long (in relation to shape and morphological discontinuities of each cave, like walls, ceiling, bottom) and 2 m wide.

Results and conclusions - A total of 37 species was recorded considering all 14 investigated caves: 27 species at Capo Caccia, 18 at Porto Cesareo, 16 at Plemmirio and 15 at Lampedusa. The highest number of species (n=21) was found inside the Nereo cave at Capo Caccia MPA and the lowest number (n=5) at Plemmirio MPA inside the Mazzare cave (Fig. 1). A higher number of species was usually associated to cave walls compared to ceilings or bottoms. The complete darkness in the innermost cave portions was a condition necessary but not sufficient to host the strictly speleophilic fish *Grammonus ater*. *Apogon imberbis* was found in all caves. The speleophilic gobids *Corcyrogobius lichtensteini* and *Thorogobius ephippiatus* were recorded in 12 caves, while *Gammogobius steinitzi* and *Didogobius splechtnai* in 7 and 4 caves, respectively. It is worth noting the presence, inside some caves, of fish inserted in the IUCN Red List (http://www.iucnredlist.org), like *Epinephelus marginatus* and *Dasyatis centroura* (exclusively found at the Lampedusa MPA).

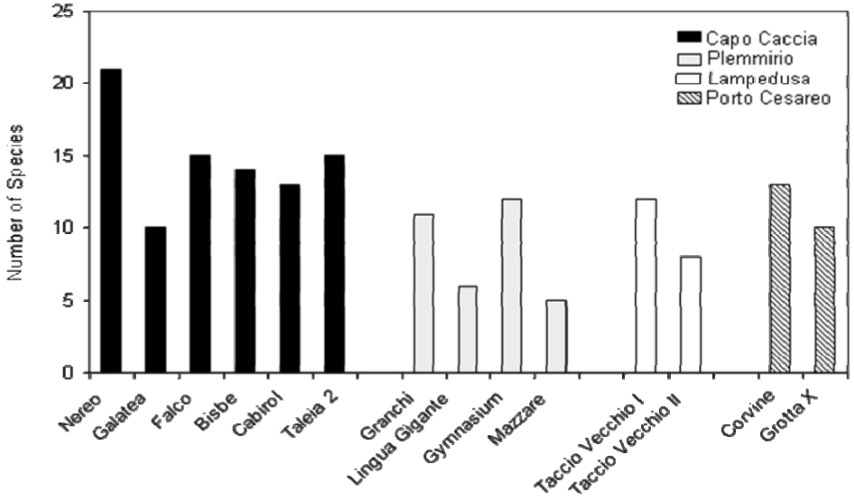

Fig. 1 - Number of species of fish species inside each cave at the four MPAs.
Numero di specie ittiche all'interno di ciascuna grotta nelle quattro AMP.

This study suggests that: 1) differences in morphology and other structural characteristics of marine caves may remarkably affect the species richness and composition inside them and, therefore, 2) it is quite difficult to define a 'typical' fish assemblage of cave habitats. Fish living in marine caves (e.g. speleophilic gobids or threatened species) may actually contribute to local diversity, with implications for conservation and management.

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INSEDIAMENTO DI *RUDITAPES PHILIPPINARUM* (ADAMS & REEVE) NEL GOLFO DI OLBIA (SARDEGNA, ITALIA) E DISTRIBUZIONE IN RAPPORTO A *RUDITAPES DECUSSATUS* (L.)

SETTLEMENT OF RUDITAPES PHILIPPINARUM *(ADAMS & REEVE) IN THE OLBIA GULF (SARDINIA, ITALY) IN RELATION WITH* RUDITAPES DECUSSATUS *(L.)*

Abstract *– In the Olbia Gulf (Sardinia, Italy) lives the native species* Ruditapes decussatus *and the allochthonous species* Ruditapes philippinarum *(Mollusca: Bivalvia) recently appeared (2008). The rate of* R. philippinarum *changes in the different seasons between 12% and 19% of the two species total abundance. The length distribution is heterogeneous for both species.*

Key-words*: population abundance, molluscs, Sardinia, settlement.*

Introduzione – Il Golfo di Olbia è tradizionalmente utilizzato per lo sfruttamento dei banchi naturali di vongola verace *Ruditapes decussatus,* attualmente sottoposti ad una pesca indiscriminata. Nel corso di questa ricerca si è riscontrato l'insediamento della specie alloctona *Ruditapes philippinarum,* come già avvenuto nel mare Adriatico (Breber, 1985). In questo studio si riportano i risultati preliminari sulla distribuzione delle due specie.

Materiali e metodi – I campionamenti sono stati compiuti stagionalmente nel 2008-2009 in 8 stazioni (5 repliche casuali) nelle principali aree di raccolta dei molluschi (Fig. 1). Il prelievo avveniva con un rastrello manuale per molluschi munito di una rete di 3 mm di lato capace di raccogliere 14 l di sedimento su una superficie di 11 dm^2. Il sedimento raccolto veniva lavato in laboratorio utilizzando setacci a maglia decrescente e le vongole presenti sono state classificate e misurate (lunghezza asse oro-aborale).

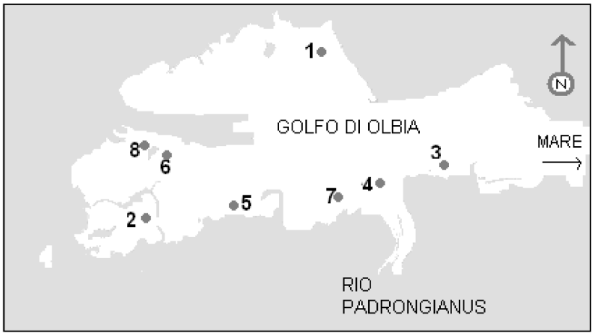

Fig. 1 - Golfo di Olbia: stazioni di prelievo di *Ruditapes decussatus* e *Ruditapes philippinarum.*
Olbia Gulf: sampling stations of Ruditapes decussatus *and* Ruditapes philippinarum.

I dati sono stati sottoposti ad analisi statistica applicando il test binomiale e il test di Kruskal-Wallis. Per *R. philippinarum* sono state utilizzate le sole stazioni con n.>10.

Risultati – Le due specie sono presenti in tutte le stazioni; sono stati rinvenuti complessivamente 2004 *R. decussatus* e 374 *R. philippinarum*. *R. decussatus* è più abbondante nella stazione 8, la più interna del golfo, mentre *R. philippinarum* si distribuisce in modo diverso nelle varie stagioni privilegiando, tranne che nel periodo estivo, le stazioni più lontane dal mare. Il numero di *R. philippinarum* è variato, rispetto al totale delle due specie, tra il 12% in primavera e il 19% in autunno. Solo in primavera questo valore risulta essere significativamente diverso rispetto a quelli nelle altre stagioni (Test binomiale, $P<0.05$). La massima densità si è rilevata in primavera, pari, per *R. decussatus* a 487 esemplari m^{-2} e per *R. philippinarum* a 106 esemplari m^{-2} (Tab. 1).

Le lunghezze minime sono state pari a 4,1 mm per *R. decussatus* e 4,6 mm per *R. philippinarum*, mentre la massima è stata di 51 mm per entrambe le specie. Il test di Kruskal-Wallis ha dimostrato l'eterogeneità delle taglie nelle diverse stazioni ($P<0{,}05$), esclusi i campioni invernali di *R. philippinarum* ($P=0{,}46$, $H=4{,}62$).

Tab. 1 - Densità (n. *m$^{-2)}$ di *R. decussatus* (Rd) e *R. philippinarum* (Rp) (nr: non rilevato).
*Densities (n.*m^{-2}) of* R. decussatus *(Rd) and* R. philippinarum *(Rp) (nr: undetected).*

	AUTUNNO		INVERNO		PRIMAVERA		ESTATE	
Staz.	**Rd**	**Rp**	**Rd**	**Rp**	**Rd**	**Rp**	**Rd**	**Rp**
1	72 ± 70	1 ± 3	55 ± 60	2 ± 3	226 ± 159	26 ± 12	63 ± 21	9 ± 11
2	132 ± 223	-	252± 369	26 ± 53	363 ± 237	106 ± 83	148 ± 39	11 ± 15
3	42 ± 14	9 ± 6	28 ± 23	6 ± 12	109 ± 72	13 ± 8	157 ± 102	50 ± 44
4	76 ± 342	17 ± 10	87± 179	11 ± 20	122 ± 56	9 ± 11	256 ± 103	76 ± 46
5	108 ± 138	8 ± 12	80 ± 27	7 ± 12	128 ± 103	11 ± 12	13 ± 11	-
6	95 ± 64	87 ± 88	55 ± 58	60 ± 44	31 ± 32	6 ± 8	46 ± 57	6 ± 12
7	nr	nr	41 ± 34	4 ± 8	41 ± 19	-	22 ± 25	4 ± 5
8	nr	nr	17± 28	6 ± 8	487 ± 368	41 ± 43	24 ± 14	6 ± 5

Conclusioni – La presenza di reclute evidenzia che il *R. philippinarum* si è acclimatato nel Golfo di Olbia e convive con la specie autoctona *R. decussatus*; quest'ultima è ancora nettamente prevalente. Le popolazioni delle due specie mostrano una notevole eterogeneità delle taglie nelle diverse stazioni. La stessa situazione è stata documentata per *R. decussatus* da Chessa *et al.* (2003) nello stagno del Calich (Alghero).

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IMPLEMENTATION OF A GEOREFERRED UNDERWATER TOWED CAMERA SYSTEM IN A METHODOLOGICAL APPROACH TO THE MONITORING OF *POSIDONIA* MEADOWS IN LIGURIA, ACCORDING TO THE WATER FRAMEWORK DIRECTIVE (WFD) 2000/60/EC

IMPLEMENTAZIONE DI UN SISTEMA BASATO SU TELECAMERA SUBAQCUEA GEORIFERITA NELL'APPROCCIO METODOLOGICO AL MONITORAGGIO DELLE PRATERIE DI POSIDONIA *IN LIGURIA, AI SENSI DELLA DIRETTIVA QUADRO SULLE ACQUE 2000/60/CE*

Abstract *– In the last two years (2008-2009) a new instrument based on a georeferred underwater towed camera system, called Tritone, was applied coupled with traditional scuba diving methods for the monitoring program of* P. oceanica *meadows in Liguria according to the WFD. This innovative approach allowed for the collection of all data, that the application of the most biological quality indices requires, with less work time and staff effort.*

Key-words: Posidonia oceanica*, underwater towed camera, georeferenced video transects, biological quality element, water framework directive.*

Introduction – Referring to Water Framework Directive 2000/60/CE (WFD) criteria, each water body has to be classified, using information from monitoring, and management politics have to be adopted, in order to achieve or maintain a good water status by 2015.

The ecological status required by the WFD is defined by some Biological Quality Elements (BQE) and *Posidonia oceanica*, because of its sensitivity to anthropogenic pressures, was chosen for the Mediterranean area as the angiosperm BQE. In Liguria *P. oceanica* meadows are present in 16 water bodies on the whole 26 considered by the marine environment monitoring program, according to the WFD. Two different but integrated ways of monitoring meadows are applied: traditional, based on visual observations and sampling by scuba divers; innovative, based on the recording of images of *P. oceanica* meadows by an underwater towed camera, called "Tritone System". This double method allows for the recovery of the major pieces of information with no excessive economic and resources effort. Although underwater video-cameras were often implemented in sea-grass and benthic monitoring (Bianchi *et al*., 2003; Rooper & Zimmermann, 2007), also in the Ligurian Sea (Piazzi *et al.,* 2000; Diviacco & Coppo, 2006), this is the first attempt for a standardization of a such technology in a regional activity of water classification.

Materials and methods – Tritone is a new integrated system developed by OLPA-RSTA with the purpose of conceiving a fast methodology to investigate coastal sea-bottom and benthos assemblages, integrating Eco-sounder information and DGPS positioning technology to georeferencing filmed transects in real time. Tritone was developed, in relationship with the project "Interreg IIIB: "POSIDONIA", with the objective of elaborate the products of traditional underwater video-cameras monitoring systems in order to be consulted and queried by GIS software. After the cartographic elaboration, performed using GIS MapInfo®, a specific video-player software allows surfing interactively trough the map and get information of the meadows, by the videos. In summers '08 and '09, respectively 9 and 2 water bodies were monitored (on the 5 expected in 2009, survey in progress). Tritone system was applied carrying underwater videos conducted along transects perpendicular to the shoreline and crossing the sampling points and the lower limit. Video-transects have been settled down in order to implement traditional data, acquired by scuba divers (operating in 2 points settled at 15 m depth in each meadow) and to obtain data on lower limit descriptors, such as limit type and limit depth.

Results – Tritone was applied in 19 transects in 2008 and 3 transects in 2009, concerning respectively 13,000 m and 3,500 m total length, (part of 7,000 m planned for 2009). The whole recording time, considering all videos, is about 4 hrs, so the average velocity is about of 2.2 knt. On the whole the mean depth for the lower limit is 21 m, with the shallower one obtained at Cogoleto (18.1 m) and the deepest obtained at Imperia (32.1 m). Among the 18 meadows monitored in the 11 water bodies, 9 meadows had sharp limit, 5 regressive and 4 progressive.

Conclusions – The Tritone System provides information about lower limit, for deeper and wider surface as well, where scuba diving study is critical and too expensive. It allows also getting more data at 15m depth, in addiction or correction to data acquired by diving. This new approach, coupled with traditional monitoring activities, allows in less time and money, the collect of the data required for the application of all biological indices, actually proposed by scientific institutions, such as the PosWare (Buia *et al.*, 2005), the BiPo (Lopez Y Royo, 2008) and the PREI (Gobert *et al.*, 2009). One of them should be chosen as the official one, to be applied by Italy and maybe by other Mediterranean European countries, for future monitoring activities.

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ANALYSIS OF THE GENETIC VARIABILITY OF *PATELLA FERRUGINEA* GMELIN, 1791 (GASTROPODA: PATELLIDAE) POPULATIONS FROM THE NORTH-EAST SARDINIA

ANALISI DELLA VARIABILITÀ GENETICA IN POPOLAZIONI DI PATELLA FERRUGINEA *GMELIN, 1791 (GASTROPODA: PATELLIDAE) PROVENIENTI DALLA SARDEGNA NORD-ORIENTALE*

Abstract *- The mollusc* Patella ferruginea *(Gastropoda, Patellidae), endemic to the Mediterranean, is the most endangered marine species on the list of the European Council Directive 92/43/EEC and it is presently under serious risk of extinction. This research was aimed to unravel the genetic variability of some Sardinian populations sampled on the North-Eastern coast, in order to shed light on their status of conservation.*

Key-words: *rare species, exploitation, population genetics.*

Introduction - Human impact on coastal habitats have led to the extinction of local populations of invertebrates (Little and Kitching, 1996). The intertidal zone is being progressively squeezed between encroaching onshore developments (Raffaelli and Hawkins, 1996) and consequently many sedentary species inhabiting rocky shores may disappear. Among them, the limpet, *Patella ferruginea*, endemic to the Mediterranean Sea, is the most endangered marine species on the list of the European Council Directive 92/43/EEC on the conservation of Natural Habitats and of Wild Fauna and Flora, 1992 (Ramos, 1998), and it is presently under serious risk of extinction (Templado and Moreno, 1997). This work, performed by Inter-Simple Sequence Repeat (ISSR) markers, was aimed to shed some light on the genetic variability and level of gene flow among samples from different protected and non-protected sites, subjected to high level of onshore development from the Sardinian North-Eastern coasts.

Materials and methods – 37 specimens were collected from North-East Sardinia, in Cala Greca (CGR, n.8), Pittulongu (PIT, n.6) and Punta li Francesi (PLF, n.10), and from two sites located in the National Park of Arcipelago di La Maddalena (Madonnetta, MAD, n.10, and Nido d'Aquila, NAQ, n.3). The non-lethal protocol of tissue sampling, sequence of the 7 ISSR primers used (IT1, IT2, IT3, SAS1, SAS3, UBC811, UBC827), PCR reaction mixtures, amplification program, electrophoresis conditions and gel staining are reported in Casu *et al.* (2006). Genetic relationships at interpopulation level were investigated using the software Splitstree (available on-line), performing a maximum parsimony analysis with a heuristic search with TBR (Tree bisection–reconnection) branch swapping and random addition of sequences, and building a consensus network from the equally parsimonious trees. The software Genalex (available on-line) was used to perform the analysis of molecular variance (AMOVA, 1,000 permutation) and calculate the value of Φ_{PT}. The partitioning of genetic variation (ΔK) was estimated applying the Bayesian method implemented in the software BAPS (available on-line).

Results - Network analysis based on 32 polymorphic loci, evidenced two main clusters without any evident geographical structuring (NAQ+PLF and CGR+MAD+PIT). Consistently, i) AMOVA pointed out that the differentiation among these clusters is significant, with a value of $\Phi_{PT} = 0.287$ ($P < 0.001$), and ii) Bayesian analysis assumed the best partition with $\Delta K = 2$, with two groups comprising NAQ and PLF, and CGR, MAD and PIT, respectively.

Conclusions – Results obtained evidenced that - notwithstanding the closeness of the samples analysed - the *P. ferruginea* populations from North-East Sardinia cannot be regarded as a genetically homogeneous unit. Although two out of the five sites sampled are located within a protected area (Arcipelago of La Maddalena), the high onshore developments and the consequent high human pressure - mainly due to summer recreation activities on the coastline - probably make the *P. ferruginea* populations vulnerable to effects of disturbance, which reflect on the genetic drift observed in that area. If the genetic divergence will not be stopped throughout an active recovering plan for this species, the future of these populations may be the progressive loss of genetic variability (the so-called "genetic erosion"), which may culminate with local extinction (see Casu *et al.*, 2006; Lai *et al.*, 2010).

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VALUTAZIONE TOSSICOLOGICA MEDIANTE BATTERI BIOLUMINESCENTI DELLE FOCI DELLA COSTA CROTONESE: RISULTATI PRELIMINARI

TOXICOLOGICAL APPROACH USING BIOLUMINESCENT BACTERIA OF CROTONESE COAST: PRELIMINARY RESULTS

Abstract *- In this work we have reported the analytical results of the toxicological tests (bioassay with* Vibrio fischeri *Lehmann & Neumann 1986) performed on marine sediments and on the water of the river's mouths which flow along the coast side of the province the Crotone. The results show high values of toxicity in the sediments in all the studied mouths.*

Key-words*:* Vibrio fischeri*, sediments, toxicity, Ionian Sea.*

Introduzione - La presente indagine, di durata annuale ed articolata in quattro campagne stagionali, si inquadra nell'ambito delle attività di controllo e monitoraggio condotte dall'ARPACAL in applicazione dei dettami previsti dal D.Lgs. 152/06 "Testo unico ambientale". Lo scopo del lavoro è quello di presentare i risultati preliminari relativi alla campagna invernale (dicembre 2009/febbraio 2010) di uno studio di valutazione dello stato tossicologico delle foci degli 8 corpi idrici superficiali presenti lungo la fascia costiera della Provincia di Crotone, mediante saggio biologico con *Vibrio fischeri* condotto su sedimenti marini ed acque.

Materiali e metodi - Lungo la fascia costiera della Provincia di Crotone sono state individuate, per ciascuna foce, tre stazioni di campionamento: acqua centro foce (ACF), sedimento superficiale argine destro (SDX) e sedimento superficiale argine sinistro (SSX) per un totale di 72 campioni. I sedimenti sono stati prelevati mediante l'uso di box corer mentre per i campioni d'acqua si è fatto ricorso alla bottiglia di Niskin. Per la determinazione della tossicità acuta con batteri bioluminescenti sono stati utilizzati i test Microtox® Solid-Phase-Test per il sedimento centrifugato e Basic Test per elutriato e acqua (Azur Environmental, 1994). I risultati del saggio SPT sono stati espressi in TU (Toxicity Units), quale reciproco aritmetico della EC_{50}, al fine di consentire una correlazione diretta tra tossicità e concentrazione del campione. I risultati dei saggi condotti sulle matrici acquose sono stati espressi come % di effetto misurato alla massima concentrazione. Per l'elaborazione dei risultati del presente lavoro si è fatto riferimento ai livelli di tossicità proposti nella Appendice 2 – Valutazione della tossicità naturale nel saggio Microtox® in fase solida: la normalizzazione pelitica – Metodologie analitiche di riferimento – ICRAM (2001).

Risultati - In Fig. 1 è riportato il valore medio percentuale di effetto misurato alla massima concentrazione nella matrice acquosa (acqua centro foce ed elutriato) per singola foce; i risultati mostrano livelli di tossicità assente per 2 foci (Nicà ed Esaro), assente/lieve per 1 foce (Lipuda), lieve per 4 foci (Neto, Passovecchio, Vorga e Tacina) e lieve/media per 1 foce (Puzzofieto). In Fig. 2 è riportato il valore medio di TU_{50} della fase solida (sedimento centrifugato) per singola foce; i risultati mostrano livelli di tossicità equamente distribuita tra le classi molto tossico (Nicà, Lipuda, Neto e Passovecchio) ed estremamente tossico (Esaro, Vorga, Puzzofieto e Tacina).

I risultati ottenuti per la fase solida mostrano l'esistenza di un gradiente di

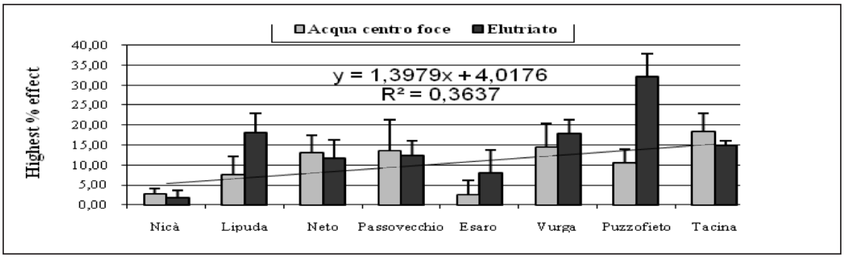

Fig. 1 - Valore medio % di effetto misurato alla massima concentrazione nella matrice acquosa (acqua centro foce ed elutriato) per singola foce.
Average value of highest % effect in the Liquid Phase (water middle mouth) for each mouth.

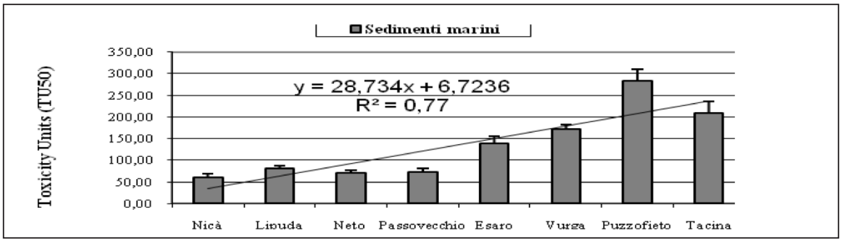

Fig. 2 - Valore medio di TU_{50} nella fase solida (sedimento centrifugato) per singola foce.
Average value of TU_{50} in the Solid Phase (centrifuged sediment) for each mouth.

tossicità dei sedimenti lungo l'asse Nord- Sud della costa, con un deciso incremento a partire dall'area urbana di Crotone.

Conclusioni - A differenza della matrice acquosa che ha presentato valori di tossicità assente o lieve, le prove effettuate sulla fase solida mostrano una situazione generale di evidente tossicità, interessando la totalità dei campioni analizzati. Ciò descriverebbe un'area fortemente compromessa per la probabile presenza di miscele di contaminanti biodisponibili e potenzialmente mobili verso la colonna d'acqua. È ragionevole presupporre che i contaminanti, verosimilmente presenti nei sedimenti in elevate concentrazioni, restino legati al sedimento per la loro natura chimica, idrofobicità, adsorbimento e grado di complessazione con la sostanza organica (Ennas *et al.,* 2002). Di sicuro interesse e possibile riscontro saranno gli esiti delle indagini ecotossicologiche, già programmate per le successive campagne stagionali, nel corso delle quali saranno determinati i contaminanti chimici presenti nei sedimenti (metalli pesanti, IPA, PCB, composti organo clorurati e pesticidi).

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VALUTAZIONE DEI BANCHI NATURALI DI MOLLUSCHI BIVALVI EDULI (TELLINE, *DONAX TRUNCULUS* E CANNOLICCHI, *ENSIS SILIQUA*) LUNGO LA FASCIA COSTIERA DELLA PROVINCIA DI LATINA E INDICAZIONI GESTIONALI PER UNA PESCA SOSTENIBILE

EVALUATION OF NATURAL BIVALVE STOCKS (TRUNCATE DONAX, DONAX TRUNCULUS*, AND SWORD RAZOR SHELL,* ENSIS SILIQUA*) ALONG THE PROVINCE OF LATINA COASTAL ZONE AND THEIR MANAGEMENT FOR SUSTAINABLE FISHERIES*

Abstract - *The study investigated the status of bivalve stocks in the Province of Latina, central Tyrrhenian Sea, following the creation of the new management consortium Co.Ge.Mo. of Gaeta and the resumption of commercial fishing on truncate donax resource in the northern area. It has 'been implemented the new classification of health areas for harvesting of bivalve shellfish according to the Regional Control Plan.*

Key-words: *Bivalve, stock assessment, Tyrrhenian Sea, sustainable fisheries.*

Introduzione - Il litorale della provincia di Latina si estende per una lunghezza di circa 150 Km, dalla località di Foce Verde (nord) fino alla foce del fiume Garigliano (sud), al confine con la Regione Campania, ed è in gran parte caratterizzato da fondali sabbiosi e fango-sabbiosi idonei per la vita dei molluschi bivalvi fossori in banchi naturali. In questo tratto di costa il crollo delle rese di pesca per il cannolicchio e per la tellina (Costa *et al*., 1987; Mariani *et al*., 2002) è stato seguito da situazioni di instabilità dei popolamenti, che non hanno mai più recuperato quella consistenza numerica che negli anni passati consentiva l'operatività di numerose imbarcazioni professionali. Il presente studio ha inteso valutare la consistenza dei popolamenti dei due principali bivalvi eduli di interesse commerciale lungo il litorale di Latina, a seguito della costituzione del nuovo Consorzio di Gestione Molluschi Co.Ge.Mo. di Gaeta e della ripresa della pesca alla risorsa tellina nell'area a nord della provincia di Latina. Si è proceduto, inoltre, alla nuova classificazione delle zone destinate alla raccolta dei molluschi bivalvi per il consumo umano, secondo quanto indicato nel Piano di Controllo Regionale.

Materiali e metodi – Il disegno di campionamento è stato definito individuando le aree di interesse, in base alle indicazioni fornite dai pescatori ed all'inventario delle fonti inquinanti di origine umana e animale presenti lungo la fascia costiera: queste ultime costituiscono una potenziale fonte di pericolo per il prodotto pescato per il consumo umano diretto. L'insieme dei dati raccolti ha consentito di definire 6 differenti aree di pesca, 2 per la risorsa tellina e 4 per il cannolicchio, per complessivi 24 transetti perpendicolari alla costa sui quali sono state effettuate, tra luglio 2008 e gennaio 2009, un totale di 123 pescate con turbosoffiante tipo "cannellara". I dati acquisiti sono stati trasferiti su un GIS per la rappresentazione cartografica.

Risultati – L'attività sperimentale ha evidenziato una discontinuità dei rendimenti di pesca in senso spaziale, con presenza dei cannolicchi nell'area sud tra Terracina e Scauri-Minturno, rese comprese tra 2 e 14 g/m^2, mentre banchi naturali di telline sono stati segnalati nell'area nord tra Sabaudia e Latina Lido, con rese comprese tra 2 e 6 g/m^2. Le analisi microbiologiche, condotte sui molluschi raccolti, hanno consentito di classificare come Zona Classe "A" ampi tratti di costa da destinare alla raccolta di molluschi per il consumo umano. In diversi tratti di costa si sono evidenziati impatti negativi sui banchi naturali dovuti alle azioni di ripascimento delle spiagge.

Conclusioni – I dati hanno evidenziato un generale decremento dei banchi naturali rispetto a quelli rilevati da Mariani nel 2001 (Mariani *et al*., 2002). Le analisi sul prodotto hanno posto in evidenza la necessità di controlli in concomitanza con condizioni meteo marine sfavorevoli, soprattutto in concomitanza a piogge persistenti, in grado di riversare potenziali inquinanti dall'entroterra verso le zone classificate. Infine il confronto tra consistenza dei banchi naturali e le azioni di ripascimento delle spiagge ha evidenziato forti alterazioni ambientali anche a carattere persistente (presenza di breccia e ghiaia), con gravi conseguenze sulla risorsa molluschi bivalvi e la biocenosi delle sabbie fini ben calibrate (SFBC).

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NEW INSIGHT ON CLAM POPULATION (*CHAMELEA GALLINA*) IN THE CHIOGGIA DISTRICT: MORPHOMETRIC AND PHYSIOLOGICAL DATA

CHAMELEA GALLINA *NEL COMPARTIMENTO MARITTIMO DI CHIOGGIA: DATI MORFOMETRICI E FISIOLOGICI DI POPOLAZIONE*

Abstract *– The population of the clam* Chamelea gallina *(Mollusca, Bivalvia) was studied in two sites of the Chioggia district, Caleri and Chioggia, from June 2009 to February 2010. Some preliminary results concerning spatial and temporal distribution, mortality, physiological and reproductive condition, recruitment and growth rate are presented.*

Key-words: Chamelea*, Chioggia, North Adriatic, fisheries.*

Introduction – In the early 1980's, *Chamelea gallina* landings were up to 100,000 t/yr along the western Adriatic Sea coasts (Froglia, 1989). Overexploitation, recruitment failure and mortality outbreaks have severely depleted clams stocks, leading to a reduction in total catches in Chioggia district, from almost 3000 t in 2007 to about 850 t in 2009 (CO.GE.VO., unpubl.). In this context, the research project "CLODIA" (Sviluppo sostenibile degli ambienti costieri) funded by Regione Veneto aims at providing new insight on spatial and temporal distribution, mortality, physiological and reproductive condition, recruitment and growth rate of the species, potentially useful for resource restocking and management. Some preliminary results are presented.

Materials and methods – Clams were monthly sampled (from June 2009 to February 2010) along a 250 m transect parallel to the coast at Caleri (45°06.214 N; 12°20.660 E) and Chioggia (45°10.590 N; 12°19.670 E). A conventional dredge provided with a bag-shaped sampling mesh with a rigid mouth (40 cm width, 20 cm height) and a 9 mm mesh size was used to collect both juveniles (<25 mm shell length) and commercial size clams (>25 mm). Size frequency distribution in the dredged area was obtained measuring (antero-posterior axis), counting and weighting clams. Clam mortality was tentatively estimated by measuring weight percentage of empty shells. Percentages of mature animals were obtained by microscopic observation of smears of gonadal tissue. The condition index (CI), expressed as meat dry weight x 100/shell dry weight, was determined, and the survival-in-air test was performed.

Results – In Tab. 1, *C. gallina* morphometric data are reported. On average, juveniles were more abundant at Caleri (49 clams per m^2) than at Chioggia (18 clams per m^2), whereas commercial size clams were less than 10 animals per m^2 at Caleri, and 5 animals per m^2 at Chioggia. A new age class (0+, mode=5 mm) was recruited at Caleri starting from September, with a mode shift to 7 mm in February. Clams of 15-22 mm shell length were the most abundant at Chioggia (1+, putatively). Average percentages of empty shells were 27% at Caleri and 33% at Chioggia, with a peak for both sites in January (53%). As for CI, no influence of the sampling site was recorded (mean CI=5.5), whereas a statistically significant influence of the sampling time (Kruskall-Wallis, $p<0.001$) was observed. In survival-in-air test, LT_{50} values were generally similar for clams from both sites, except for animals collected in July (Gehan-Wilcoxon test, p<0,001). The lowest LT_{50} values were recorded in June (5 and 6 days at Caleri and Chioggia, respectively) and in February (6 days at both sites). The highest percentage of ripe clams was detected in summer (June-July, 100%) and winter (Dec-Feb, 67-95%), whereas clams collected in September were in the resting phase, on the basis of observation of gonadal smears at least.

Tab. 1 - *C. gallina* morphometric parameters and total abundance at Caleri and Chioggia. L_{mean}, L_{max} and L_{min}: mean, maximal and minimal length; MaxFreqClass: maximal frequency length class; TA: total abundance.

Parametri morfometrici e abbondanza totale di C. gallina *a Caleri e a Chioggia.* L_{mean}, L_{max} *e* L_{min}: *lunghezza media, massima e minima; MaxFreqClass: classe di lunghezza di massima frequenza; TA: abbondanza totale.*

	CALERI					**CHIOGGIA**				
	L_{mean} mm	**L_{max} mm**	**L_{min} mm**	**MaxFreqClass mm (clams m^{-2})**	**TA (clams m^{-2})**	**L_{mean} Mm**	**L_{max} mm**	**L_{min} mm**	**MaxFreqClass mm (clams m^{-2})**	**TA (clams m^{-2})**
June09	16	27	4	12 (6.1)	76	18	27	7	18, 21 (4.2)	38
July09	17	27	7	14 (8.3)	82	18	27	4	19 (3.7)	38
Aug09	16	28	5	16 (2.9)	23	17	27	6	20 (2.4)	26
Sept09	13	26	1	5 (10.7)	81	18	27	3	20 (4.7)	41
Oct09	11	26	2	7 (16.2)	65	17	26	3	19 (4.2)	40
Nov09	11	24	1	7 (43.4)	202	18	27	3	20 (3.5)	32
Dec09	10	25	2	7 (62.0)	231	16	27	2	17 (5.3)	55
Jen10	9	27	2	6 (21.3)	83	16	25	2	20 (2.6)	23
Feb10	11	25	1	8 (9.8)	51	16	27	2	18 (4.1)	36

Conclusions – Distributions of *C. gallina* size classes differed between the two sampling sites, accordingly to previous reports concerning the Chioggia district (Prioli *et al*., 1998) and Venice district (Pellizzato *et al*., 2009). Although at the present it is difficult to provide an exhaustive explanation, the recruitment of new age classes occurred at Caleri only. This seems to be unrelated to differing conditions of adults, being CI values and survival in air responses similar at the two sites and in agreement with those already reported for *C. gallina* (Moschino and Marin, 2006). In this study a very short sexual resting phase was found, and relevant percentages of ripe clams were present also in the late autumn.

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FIRST RECORD OF *STOLOTEUTHIS LEUCOPTERA* (CEPHALOPODA: SEPIOLIDAE) IN THE SARDINIAN WATERS

PRIMO RINVENIMENTO DI STOLOTEUTHIS LEUCOPTERA *(CEPHALOPODA: SEPIOLIDAE) NELLE ACQUE SARDE*

Abstract *– Morphometric and meristic data of two mature females of* Stoloteuthis leucoptera *(Cephalopoda: Sepiolidae) from the Sardinian waters are reported. These are the first records of the species in the Sardinian seas and they add important information to our still poor knowledge on the species in the Mediterranean Sea.*

Keywords: Stoloteuthis leucoptera*, Mediterranean Sea, Sardinian seas, bottom trawling, fishery surveys.*

Introduction - The leucoptera bobtail squid, *Stoloteuthis leucoptera* (Verril, 1878), is distributed in the Western Atlantic Ocean from the Gulf of St Lawrence to the Straits of Florida and in the Eastern Atlantic, in the Bay of Biscay and in the Benguela Current off Namibia (Reid and Jereb, 2005). Only a few records exist for the Mediterranean Sea, where the species may be of recent introduction (Orsi Relini and Massi, 1991). As for the Italian waters, *S. leucoptera* was caught in the Ligurian Sea, in the northern and southern Tyrrhenian Sea and off the Gorgona Island (Reid and Jereb, 2005). Here, the first findings of the species in the Sardinian waters are reported and some morphometric and meristic data are presented.

Materials and methods - *Stoloteuthis leucoptera* specimens were collected during the scientific trawl surveys MEDITS (Bertrand *et al.*, 2000) and GRUND (Relini, 1998) carried out in the Sardinian waters during summer 2005 and winter 2007, respectively. Fresh specimens were measured (ML, to the nearest 1 mm) and weighted (TW, to the nearest 0.01 g); sex was determined and maturity stages were established using a 3 stages maturity scale (Bertrand *et al.*, 2000). Measurements and abbreviations used are those given in Roper and Voss (1983). The mandibles were removed and for each one, the upper crest (UCL), upper hood (UHL), upper rostral (URL), lower crest (LCL), lower hood (LHL) and lower rostral (LRL) measurements were taken (Clarke, 1986). Oocytes and spermatangia were measured along their major axis.

Results - Two specimens of *S. leucoptera* (ML: 10.4 and 14.5 mm) were recorded, in the north-eastern Sardinian waters (N41°12,720’ E9°55,880’-N41°12,830’ E9°55,800’) at a mean depth of 550 meters, and in the Gulf of Cagliari (N39°08,020’ E9°20,780’-N39°06,800’ E9°24,000’) at 360 meters, along with other sepiolids. Both were mature females; their mantle cavity was filled mostly by the ovary and the white creamy nidamental glands. Oocytes in the ovary were reticulate and ranged in length between 0.1 and 3.5 mm; oocytes in the oviducts were smooth, their size ranging between 3.5 and 3.8 mm. Six spermatangia of about 0.5 mm length were found on one female (ML 14.5 mm), embedded in the tissue above the left eye. Main morphometric and meristic data of the two specimens are given in Tab. 1.

Tab. 1 - *Stoloteuthis leucoptera*: details of captures and measurements of the two mature females.
Stoloteuthis leucoptera: *dettagli sulle catture e misure delle due femmine mature.*

	Specimen 1	**Specimen 2**		**Specimen 1**	**Specimen 2**		**Specimen 1**	**Specimen 2**
Data	29/06/2005	20/02/2007	**HL (mm)**	9.6	11.1	**UCL (mm)**	3.99	4.68
Depth (m)	529–558	280–401	**HW (mm)**	13.4	15.3	**UHL (mm)**	2.22	2.93
ML (mm)	10.4	14.5	**FL (mm)**	9.8	12.9	**URL (mm)**	1.11	1.40
VML (mm)	13.1	19.3	**FW (mm)**	6.7	9.8	**LCL (mm)**	2.36	2.74
MW (mm)	12.2	18	**TtL (mm)**	41.7	56.2	**LHL (mm)**	1.03	1.31
TW (g)	1.66	3.92	**TL (mm)**	61.7	81.8	**LRL (mm)**	0.93	0.99

Conclusions - The finding of *S. leucoptera* in the Sardinian waters allows to update the cephalopods checklist in this area (Cuccu *et al.*, 2003) and widens the fragmentary geographical distribution known for the species in the Mediterranean Sea. The depth of capture is in agreement with the bathymetric distribution reported for the species (Reid and Jereb, 2005), and both specimens were collected along with other sepiolids, as observed in other Mediterranean areas (in Boletzky, 1995). The fact that both specimens captured were mature may indicate an extended reproductive period. The combined presence of oocytes of different size, only the larger and smooth of which were found in the oviducts, suggests that *S. leucoptera* is a multiple spawner. The presence of spermatangia deeply implanted into unmodified tissue of the females, as occurs in other deep-waters cephalopods, supports a sperm storage strategy useful to prolonged spawners. Present observations are in favour of the existence of stable populations of this species in the Mediterranean Sea, as future findings on reproductive aspects may confirm.

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SEXUAL MATURITY OF THE HORNED OCTOPUS *ELEDONE CIRRHOSA* (LAMARCK, 1798)

MATURITÀ SESSUALE DEL MOSCARDINO BIANCO ELEDONE CIRRHOSA *(LAMARCK, 1798)*

Abstract *– Data collected from the commercial landings in the central-southern Tyrrhenian Sea (GSA 10) and in the South Adriatic Sea (GSA 18) allowed to estimate the size at first maturity of both sexes of* Eledone cirrhosa *(GSA10: female 9.1±0.11 cm; male 8.8±0.09 cm, GSA18: male 7.8±0.05 cm, female 9.7±0.06 cm). Analyses of the maturity cycle in the GSA 18 indicated that the reproduction period was occurring in the summer season.*

Key-words: E. cirrhosa*, maturity, South Adriatic, central-southern Tyrrhenian.*

Introduction – The horned octopus *Eledone cirrhosa* (Lamarck, 1798) is common in whole Mediterranean Sea, where it represents one of the most important resource of the demersal fisheries mainly caught by bottom trawlers. This species shows a very wide bathymetric distribution with a higher occurrence within 300 m depth (Belcari *et al.*, 2002). The reproductive biology is characterized by a single reproductive event during the whole life span (semelparous species) (Cuccu *et al.*, 2003; Orsi Relini *et al.*, 2006).

Materials and methods – Samples of *E. cirrhosa* were collected during the Data Collection Framework (DCF, EU Reg. 1543/2000, 1639/2001 and 1581/2004) in two geographical sub-areas: the central-southern Tyrrhenian Sea (GSA 10; data series: 2006-2008) and the south Adriatic Sea (GSA 18; data series 2007-2008). In each specimen mantle length (ML, in cm) and sex were recorded; the maturity stage was determined following the MEDITS maturity scale (Relini *et al.*, 2008). In order to estimate the length at first maturity of females (GSA 10, n= 473; GSA 18, n= 1845) and males (GSA 10, n= 497; GSA 18, n= 1453), the specimens were considered mature whether classified as 2b, 3a and 3b, whilst immature ones were those classified as 1 and 2a. The length at first maturity ($ML_{50\%}$) and the maturity range ($MR= ML_{75\%}-ML_{25\%}$) were estimated using an ogive model: $M(L)= [e^{(a+bL)}/ 1+e^{(a+bL)}]$; where M(L) is the proportion of mature individuals and L the length class. To fit the model to the data the coefficients *a* and *b* of the logistic curve were first obtained from a linear regression: $\ln[M(L)/ 1 - M(L)]= a + b(L)$ and then used as seed values to maximize the *ln*-likelihood estimator: $\Sigma \{n_{L1} \ln (M(L)) + n_{L2} \ln[1 - M(L)]\}$. The monthly distributions of the maturity stages for both females and males were calculated only for GSA18, where data were more regularly distributed along the year.

Results – The monthly percentages of maturity stages in the South Adriatic Sea showed the dominant presence of immature individuals during the autumn-winter period (62-100% from October to May for females; 66-95% from October to January for males), while in spring-summer the occurrence of mature or maturing individuals was higher (89-100% from June to August for females; 74-97% from March to August for males). The lengths at first maturity of females and males were respectively 9.1±0.11 (MR= 0.9±0.11 cm) and 8.8±0.09 cm (MR= 1.2±0.12 cm) in the central-southern Tyrrhenian Sea, whilst in the south Adriatic the estimates for females and males were respectively 9.7±0.06 (MR= 1.5±0.07 cm) and 7.8±0.05 cm (MR= 1.4±0.07 cm) (Fig. 1).

Conclusions – The reproductive period observed in this work is in accord with the findings in other Mediterranean areas (e.g. Cuccu *et al.*, 2003; Orsi Relini *et al.*, 2006). The sexual maturation (stage 2b onwards) occurs early in males (from November) than in females (April). The peak of spawning takes place in summer, while during autumn there are few mature and large specimens defined as "*late spawner*" (Cuccu *et al.*, 2003; Orsi Relini *et al.*, 2006). The size at first maturity estimated for the GSA10 is greater than that reported by Cuccu *et al.* (2003), whilst the ML$_{50\%}$ estimated in the GSA 18 is smaller than that reported by Soro and Piccinetti Manfrin (1989). These differences might be ascribed to the diverse methods applied for the size at first maturity estimation. Due to the semelparous sexual biology of this species, it is important to take into account not only the size at first maturity, but also the Maturity Range, in order to assess the percentage of spawning biomass to be preserved for a sustainable management of this resource.

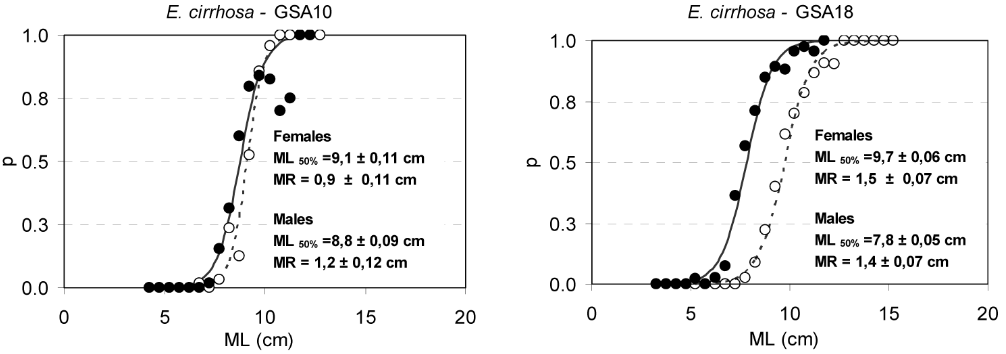

Fig. 1 - Maturity ogives of females (---; ○) and males (–;●) of *E. cirrhosa* (GSA10 and GSA18).

Ogive di maturità di femmine (---; ○) e maschi (–;●) di E. cirrhosa *(GSA10 and GSA18).*

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DIFFERENCES IN GROWTH OF COMMON PANDORA, *PAGELLUS ERYTHRINUS* (L., 1758) (PISCES: SPARIDAE), CAUGHT BY DIFFERENT FISHING GEARS IN THE STRAIT OF SICILY

DIFFERENZE NELLA CRESCITA DEL PAGELLO FRAGOLINO, PAGELLUS ERYTHRINUS *(L., 1758) (PISCES: SPARIDAE), CATTURATI DA DIVERSI ATTREZZI DA PESCA NELLO STRETTO DI SICILIA*

Abstract *– The von Bertalanffy growth curves (VBGC) of Common pandora,* Pagellus erythrinus *(L., 1758) were estimated using data from commercial trawling and artisanal fisheries. The difference in VBGC checked by the Chen's test was significant, confirming that the two métiers exploit different fractions of the stock. This difference suggests to be cautious in adopting growth parameters for stock assessment purposes and in integrating information coming from different sources in a proper way.*

Key-words: *Common pandora, growth, fishing gears, Strait of Sicily.*

Introduction - The Common pandora, *Pagellus erythrinus* (L., 1758), is one of the most important demersal resources in the Strait of Sicily (GSA 16). According to IREPA data, during the last three years the mean annual yields amount to 43 t and 467 t, by artisanal and trawl fisheries respectively. Andaloro & Giarritta (1985) described firstly the growth of the species in the area on the basis of trawling catches. Orsi Relini & Romeo (1985) reported difference in growth patterns between specimens caught by trawling and those caught by long lines. Therefore one of the aims of this study is to check the existence of differences in growth curves of *P. erythrinus* in GSA 16 based on data from commercial trawling and artisanal fisheries (trammel net and long lines).

Materials and methods – Biological sampling of landings were carried out monthly from 2002 to 2008 in GSA 16 (Italian National Program of DCR - Module H). Each specimen was measured as total length (TL, cm) and total weight (g) and the sex was assigned. A total of 2647 otoliths (1703 from trawling; 944 from artisanal fisheries) was sampled. Age was estimated by readings of whole sagitta under transmitted light. Since this species is a protogynous hermaphroditic species (Giordano *et. al.,* 1999), the von Bertalanffy growth curves (VBGC) were estimated by combined sex and separate métiers using the "Length at Age" routine as implemented in Fisat II. Differences in growth curves between métiers were checked by means of the Chen's test (Chen *et al.*, 1992), which is based on the analysis of the residual sum of the squares (ARSS).

Results and conclusions – The difference in VBGC by métier (Tab. 1) was significant ($p<0.05$; F=55.35) and specimens caught by artisanal gears were larger at a given age than those caught by trawling (Fig. 1). This difference suggests to be cautious in adopting growth parameters for stock assessment purposes and in integrating information coming from different sources in a proper way.

Tab. 1 - Growth parameters of *P. erythrinus* by single and combined métiers.
Parametri di crescita di P. erythrinus *per sistemi di pesca singoli e combinati.*

Growth parameters	Trawling	Artisanal	Combined métiers
N	1703	944	2647
L_∞	23.23	49.57	46.69
$se(L_\infty)$	0.91	6.07	9.37
k	0.52	0.1	0.1
$se(k)$	0.18	0.03	0.06
t_0	-1.0	-2.0	-2.36
$se(t_0)$	0.78	0.76	1.67

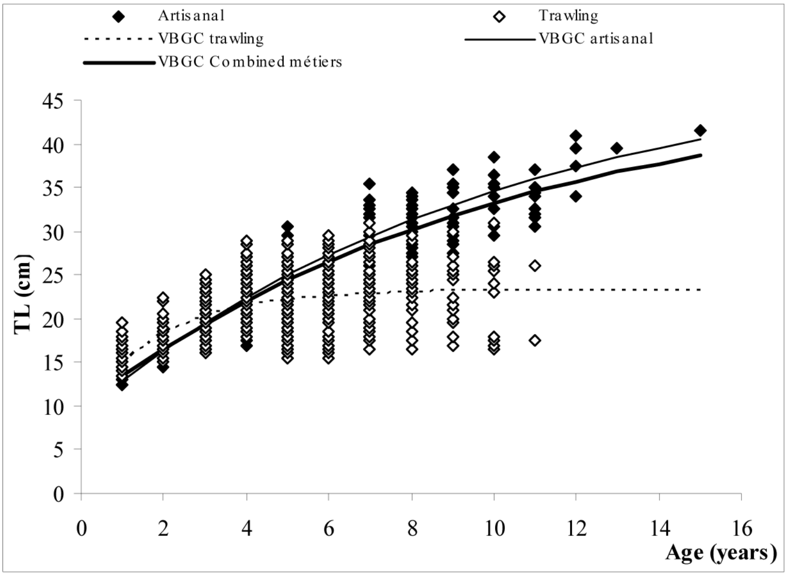

Fig. 1 - Length at age and VBGC of *P. erythrinus* by single and by combined gears.
Lunghezza – età e VBGC di P. erythrinus *per mestieri di pesca singoli e combinati*

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FISHING EFFORT AND CATCH COMPOSITION ON THE BOUNDARIES OF SANTA MARIA DI LEUCA DEEP-WATER CORAL BANK

SFORZO DI PESCA E COMPOSIZIONE DELLE CATTURE AI MARGINI DEL BANCO A CORALLI PROFONDI DI SANTA MARIA DI LEUCA

Abstract *- As part of EU-FP7 CoralFISH project, the "Observers' Program" activity has been carried out to investigate on the fishing effort and catch composition from longline and bottom trawl fishing carried out near the Santa Maria di Leuca (SML) coral bank (North Western Ionian Sea).*

Key-words: *fishing effort, catch composition, deep-water coral reefs, Mediterranean.*

Introduction - The Santa Maria di Leuca (SML) coral bank is characterized by living *Lophelia*-*Madrepora*-bearing coral mounds, widespread in an area of about 900 km^2, between 350 and 1100 m depth, in the northern Ionian Sea (southern Italy) (Taviani *et al*., 2005, D'Onghia *et al*., 2010). The bank represents a Mediterranean deep-water biodiversity "hotspot" (Mastrototaro *et al*., 2010) which could also play an important role as nursery and spawning area for demersal species (D'Onghia *et al*., 2010). In this work, information on fishing effort and catch composition observed on the boundaries of this deep-water coral bank is provided.

Materials and methods - Data were collected from June to October 2009 within the Observer Program, carried out in the framework of the EU-FP7 CoralFISH project. Fishing effort and catch composition data were collected from longline and bottom trawl. In particular, the following data were recorded: date and hour of fishing, set time and number of hooks (if longliner), haul time (if trawler), sea-weather conditions; fishing zone with indication of depth, latitude and longitude; catch composition (both commercial and discard species) with number and weight; by-catch of corals and sponges (and other invertebrates).

Results - Seven trawlers and one longliner usually fished on the boundaries of SML deep-water coral bank. Both the number of fishing days per month (Tab. 1) and geographic distribution of fishing hauls (Fig. 1) varied largely throughout the investigated period according to the sea-weather conditions. Sometime trawlers fished inside the northward limit of the coral area. Catches from trawling mostly consisted in *Merluccius merluccius*, *Illex coindetii*, *Aristaeomorpha foliacea* and *Aristeus antennatus* while those from longline were mainly made of *Chelidonichthys lucerna*, *M. merluccius* and *Conger conger* (Fig. 2).

Tab. 1 - Fishing days per month and gear recorded in SML fishery during the "Observer Program".
Giornate di pesca per mese e attrezzo registrate nella marineria di SML durante l'Observer Program.

	June 2009	July 2009	August 2009	September 2009	October 2009
trawl net	32 (4)	46 (7)	29 (6)	closed season	18 (3)
longline	16 (1)	12 (1)	8 (1)	15 (1)	5 (1)

(*) in brackets the number of recorded vessels.

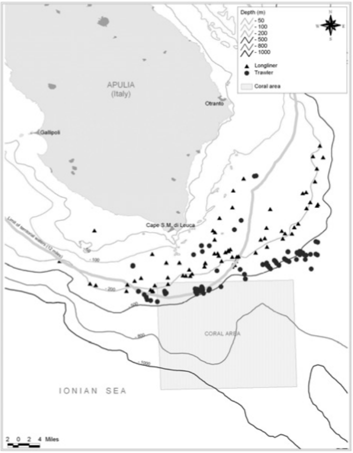

Fig. 1 - Distribution of the fishing hauls recorded in SML fishery during the "Observer Program".

Distribuzione delle cale di pesca registrate nella marineria di SML durante l'Observer Program.

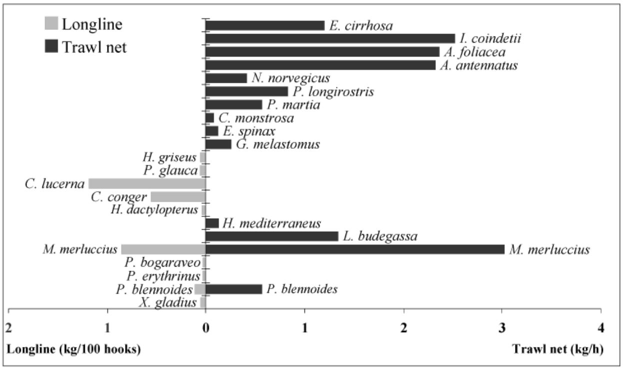

Fig. 2 - Catch composition from longline and trawl net recorded in SML fishery during the "Observers' Program".

Composizione delle catture ottenute con palangaro e strascico nella marineria di SML durante l'Observer Program.

Conclusions - Fishing operations of both longliner and trawlers occurred close or even inside the northward limit of the coral area, indicating the occurrence of the "fishing the line" phenomenon (Roberts and Hawkins, 2000). This occurs with the aim of obtaining greater catches and larger specimens. Catch composition showed that, apart from *M. merluccius* and *P. blennoides,* the two types of gears select different resources. *C. lucerna*, fished with the greatest abundance by longline, was never collected inside the coral area being distributed in shallower waters. Some other species, such as *M. merluccius, P. blennoides* and *H. dactylopterus*, were collected with greater abundance inside the coral bank than outside (D'Onghia *et al.*, 2010). For some of them a spill-over effect, providing benefit to SML fishery, might occur. Although the present results did not show any particular fishing pressure on this Mediterranean coral habitat, a fishermen self-regulation appears to be fundamental even considering the new legal category of "Deep-sea fisheries restricted area" created by the GFCM for the SML deep-water coral bank.

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PRELIMINARY OBSERVATIONS ON THE GROWTH OF *ENGRAULIS ENCRASICOLUS* (LINNAEUS, 1758) IN THE WESTERN IONIAN SEA

OSSERVAZIONI PRELIMINARI SULLA CRESCITA DI ENGRAULIS ENCRASICOLUS *(LINNAEUS, 1758) NEL MAR IONIO OCCIDENTALE*

Abstract *– Sagittae of European anchovy (*Engraulis encrasicolus*) have been collected from fish sampled in the Western Ionian Sea (GSA 19) and aged to estimate the parameters of the von Bertalanffy growth curve (VBGC). The VBGCs of females and males were not significantly different, thus a combined curve was estimated with the following parameters:* L_{∞}*=174.13 mm, k=0.31;* t_0*=-1.76.*

Key-words: *European anchovy, von Bertalanffy, otoliths, back-calculation.*

Introduction - The European anchovy (*Engraulis encrasicolus*) is a widely distributed fish (North eastern and Central Atlantic, Mediterranean and Black Seas), mostly captured by purse seine and pelagic trawls along the Italian coasts. In the western Ionian Sea (GSA 19), it is also caught by the artisanal fishery using a small net named "*menaide*". Despite the importance of the European anchovy fishery (Basilone *et al.*, 2003) there is no information available on the length-age key and growth in the study area.

Materials and methods – The sampling has been carried out from the commercial landings in 2007 and 2008. Total length (TL), nearest 0.5 cm, was measured and sex determined for each fish. Unsexed specimens were split according to the sex ratio estimated by length class, using the value of the first fully sexed class (9.0 cm). Sagittae were removed from a sub-sample of five specimens for each 0.5 cm length class by sex. The ageing was conducted on 322 pairs of sagittae, using the criteria reported in Giannetti & Donato (2003): the birthday was set at June 1st, consequently the age assigned to the fish caught in the first part of year was equal to the observed number of hyaline rings (excluding the edge) plus 0.5, whereas for the fishes caught during the second part of the year the age corresponded to the number of hyaline rings. For the back-calculation the following metrics for each sagitta (295 measurements) were registered: total length (AB), length of *antirostrum* (AO) and the distance between the core and each hyaline ring in the *antirostrum* area. Morphometric relationships AO *vs* AB and AB *vs* TL were used to back-calculate the length at hyaline ring deposition considered for the aging (Hunt, 1979). The linear relationships were then tested by the analysis of variance of the regression. Length-at-age obtained by the back-calculation were compared with observed age-at-length only of the specimens (n=178) caught during the winter (deposition period of hyaline ring) to corroborate the estimated age (Morales-Nin, 2000). Growth parameters of females and males were estimated using the von Bertalanffy growth function. The growth curves (VBGC) were fitted using length at age pairs and minimizing the sum of the squared residuals between observed and expected values (solver, Microsoft Excel®). The two VBGCs were compared using the Chen test (Chen *et al.*, 1992).

Results - The 322 analyzed sagittae were collected from specimens ranged between 7.5 to 16 cm (respectively 0.5-5.5 years old), caught all year round. Sagitta growth was proportional and significantly correlated ($p<0.05$) to length. Morphometric relationships among the sagitta metrics (AB and AO, in mm) and the individual total length (TL, in mm) are: TL=47.92×AB–12.289 (R^2= 0.83; $F_{observed}$ =1477.53 > $F_{0.05}$=3.87); AB=1.8123·AO+0.2822 (R^2= 0.92; $F_{observed}$=3486.43 > $F_{0.05}$=3.87). The mean length at age obtained by direct age readings and that back-calculated are reported in the Table 1. The growth parameters, estimated for females and males are respectively: L_∞=177.55 mm, k=0.31, t_0=-1.69; L_∞=171.87 mm, k=0.3, t_0=-1.83. According to the Chen test, the two VBGCs were not significantly different (p>0.05). A combined curve was thus derived using the pooled data: L_∞=174.13 mm, k=0.31, t_0=-1.76.

Tab. 1 - Mean length, standard deviation (SD) and number of specimens (n) for each age class (observed and back-calculated).

Lunghezza media, deviazione standard (SD) e numero di individui (n) per classe di età in base all'età osservata e alla back-calculation.

Age	**Observed**			**Back-calculated**		
	Length (mm)	**SD**	**n**	**Length (mm)**	**SD**	**n**
0.5	86.85	10.20	27	86.56	5.22	295
1.5	109.46	8.32	28	106.53	4.85	205
2.5	124.38	9.38	48	121.52	4.96	118
3.5	140.13	6.73	38	130.91	5.93	49
4.5	148.97	6.18	37	135.06	7.20	3

Conclusions – The growth pattern did not show significant differences between sexes. The high value of t_0 is the consequence of the lack of aged 0 fish in our sample. Both the length observed and that obtained by the back-calculation were very close for the ages from 0.5 to 2.5, whilst the differences in length observed in the older individuals might be due to different causes as the low number of measurements, the reading difficulties in order to recognize univocally the rings and finally the divergence between somatic and otolith growth (Panfili & Tomás, 2001) in the older hyaline ring. The growth parameters obtained for sex combined were comparable with those reported by Basilione *et al.* (2004) for the southern Sicilian coasts (L_∞=18.6 cm; k=0.3; t_0=-1.81).

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APPLICAZIONE DELL'INDICE DI ARGENTINIZZAZIONE IN DUE LAGUNE ITALIANE COME STRUMENTO DI MONITORAGGIO E TUTELA DELLO STOCK DI ANGUILLE

APPLICATION OF SILVERING INDEX IN TWO ITALIAN LAGOONS AS MONITORING INSTRUMENT FOR CARE OF EEL'S STOCK

Abstract *– The European Eel stock is undergoing a dramatic decline: nowadays it's probably outside of biological limits. We provide a characterization of size, age structure, sex ratio and somatic growth for eels' population in two north-east Italian lagoons. Effects of silvering process were tested on a large number of eels in order to find a no-killing tool to assess the eels' population composition.*

Key-words: Anguilla anguilla*, Italy, lagoon, valliculture.*

Introduzione – Dati recenti evidenziano scenari drammatici per gli stock selvatici di anguilla europea, *Anguilla anguilla L.*, 1758 (EelReport, 2005) ,con riduzioni fino al 90% per tutti gli areali tipici, tanto che l'anguilla è stata inserita nella Lista Rossa IUCN (Freyhof e Kottelat, 2008). Nel presente lavoro è stato applicato il *Silvering Index* SI (Durif *et al.*, 2005), come nuovo strumento di monitoraggio no-kill per studiare popolazioni di anguille residenti in due lagune italiane (Valli di Comacchio VC, in Emilia Romagna e Val Noghera VN, in Friuli Venezia Giulia). Il processo d'argentinizzazione corrisponde ad una metamorfosi graduale che avvia la pubertà, provocando modificazioni fisiologiche e morfologiche necessarie per il ritorno al mare e poi la migrazione.

Materiali e metodi – I prelievi sono stati effettuati nei periodi tipici di pesca (Natale e Quaresima) dal 2008 al 2010: in inverno è stato utilizzato il lavoriero (strumento di pesca tradizionale), in primavera sia le reti che il lavoriero. In totale sono state pescate 235 anguille in VN e 169 in VC. Tutti i soggetti, previa anestesia, sono stati misurati per rilevare le biometrie necessarie al calcolo del SI: peso totale (PT), lunghezza totale (LT), diametro dell'occhio (DO), diametro del corpo (DC), lunghezza della pinna pettorale (LP). Il SI divide il processo argentino in stadi, 5 per le femmine (FI–FV) e 2 per i maschi (MI, MII), basandosi su parametri morfologici (Durif *et al.*, 2006) ed è calcolato attraverso specifici algoritmi, che prendono in considerazione le misure biometriche sopra menzionate. L'età, determinata tramite l'analisi delle scaglie, è stata validata tramite l'analisi degli otoliti. L'integrazione dell'età delle anguille con lo stadio di SI, è utile per individuare quando un esemplare è pronto per la migrazione e per completare la maturazione sessuale (Durif *et al.*, 2005).

Risultati – Le misure morfometriche con le quali è stato possibile calcolare il SI sono riportate in Tab. 1. Il SI è stato calcolato per ciascun individuo campionato e misurato.

Sulla base dei risultati ottenuti con l'applicazione del SI, per le sole femmine, il popolamento di anguille argentine di VC nell'inverno 2008 era costituito dal 62,8% di migranti, caratterizzate da grandi dimensioni e dal 37,2% di pre-migranti; il popolamento di VN nella primavera 2009 era composto da migranti solo per il 30,44% e dal 69,56% di anguille in stadio pre-migratorio (con le reti si è raccolto

Tab. 1 - Valori medi delle misure biometriche (± dev. st.) con le quali è stato calcolato il SI.
Mean values (± st.dev) of the biometric parameters used to calculate the SI.

Sito/anno	**LT (cm)**	**PT (g)**	**DO (cm)**	**DC (cm)**	**LP (cm)**	**Sesso**	**Stagione**	**Metodo pesca**
VC 2008	79,92±5,56	1155,30±23,67	1,04±0,09	2,80±0,16	3,87±0,37	♀	inverno	lavoriero
VC 2008	41,24±3,05	117,25±17,26	0,67±0,07	2,05±0,13	2,21±0,18	♂	inverno	lavoriero
VN 2009	67,72±6,03	458,84±19,92	0,84±0,16	2,31±0,17	3,31±0,37	♀	primavera	reti+lavoriero
VN 2010	64,67±5,84	461,79±16,95	0,86±0,15	2,98±0,20	3,46±0,28	♀	primavera	reti+lavoriero
VN 2010	42,31±2,80	21,80±16,55	0,79±0,13	2,13±0,18	2,67±0,19	♂	primavera	lavoriero

qualche esemplare in stadio residente). Nella primavera 2010, il popolamento di VN, pescato con lavoriero, è apparso completamente diverso: 80% di migranti e solo il 13% di pre-migranti. Per le anguille migranti l'età era compresa tra 8 e 13 anni, per quelle pre-migranti è tra 6 e 9 anni.

Conclusioni – Il fatto di aver trovato quasi esclusivamente anguille femmine e pochi maschi evidenzia le modificazioni ecologiche in atto negli ambienti vallivi dove esse si accrescono. Le anguille di VN mostrano un buono-sufficiente stadio argentino (EelReport, 2005a,b), nonostante le dimensioni medie ridotte rispetto quelle di Comacchio. Le anguille di VC hanno un ottimo stadio argentino e dimensioni talvolta considerevoli, perciò mature sessualmente e pronte alla migrazione. In inverno, il popolamento prelevato con lavoriero mostra percentuali maggiori di esemplari argentini, dato che i pesci cercano la strada per il mare spontaneamente, mentre con le reti si possono prelevare anguille non ancora pronte. Si elegge, quindi, il lavoriero come strumento idoneo al prelievo scientifico in quanto permette una pesca selettiva. Si sottolinea inoltre l'utilità del SI come strumento di analisi no-kill del popolamento di anguille, in grado di mettere in evidenza la condizione di maturità sessuale e una stima estrapolabile riguardo il flusso migratorio.

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ELLIPTIC FOURIER ANALYSIS OF OTOLITHS OF TRIGLIDAE IN THE NORTH-MIDDLE ADRIATIC SEA

ANALISI ELLITTICA DI FOURIER DEGLI OTOLITI DEI TRIGLIDI IN ALTO-MEDIO ADRIATICO

Abstract *- The sagittal otoliths of specimens belonging to seven species of triglids collected in the north-middle Adriatic Sea were investigated by means of the Elliptic Fourier Analysis method (EFA). The EFA method was proved to be a suitable tool for the separation of species showing intra-interspecific differences. Thus, it could provide useful information in phylogenetic and eco-morphological studies.*

Key-words: *otolith, shape analysis, Elliptic Fourier Analysis, Triglidae, Adriatic Sea.*

Introduction - Fish otolith shape analysis is an important way for describing and characterizing mathematic otolith outlines. It is used with multiple goals, for example, species phylogeny and stock discrimination (Lombarte *et al.*, 2006). In particular the Elliptic Fourier Analysis (EFA) represents one among the most valuable and time-efficient method since data are automatically normalised in relation to the first harmonic and consequently they become invariant to size, rotation, and starting point (Iwata and Ukai, 2002). In this study the EFA method was applied on otoliths collected from 7 species of triglids (*Aspitrigla cuculus, Chelidonichthys lastoviza, C. lucerna, Eutrigla gurnardus, Lepidotrigla cavillone, L. dieuzeidei and Trigla lyra*) (Teleostei, Scorpaeniformes) distribuited in the north-middle Adriatic Sea. The aim of this study is to verify the existence of intra and interspecific differences associated with endogenous and exogenous factors.

Materials and methods - A total of 240 specimens were selected from samples collected during bottom trawl surveys carried out in 2007 and 2008 along the Italian coasts from the Gulf of Trieste to the Tremiti Islands. For each specimen total length (TL, mm), weight (W, g) and sex were recorded. The left sagitta was removed, cleaned in ultrasounds bath and kept dry for later analysis. For each species otoliths selected from adult (males and females) individuals and from juvenile (undetermined) ones were analyzed. Digital images were collected using a NIKON P5100 digital camera linked to a Leica MZ6 stereomicroscope. Each sagitta was photographed with the *sulcus acusticus* facing up and the *rostrum* to the right. The SHAPE program was used to extract the contour shape of the sagitta and to assess the variability of shapes by means of the study of principal component analysis (PCA). The statistical analysis of the collected data was carried out by means of the R software (R Development Core Team, 2010).

Results - About 99% of variation in otolith shape was explained by a maximum of 20 harmonics. The first 4 discriminated over 80% of the variance. In most samples, the first component discriminated better the different widths of otoliths; the second was better related to different shape of *excisura ostii*; the third and fourth were better related to different shape of *rostrum* and *antirostrum*. The interspecific comparison of adult specimens showed the Genus *Lepidotrigla* and *C. lastoviza* phylogenetically close, while *L. dieuzeidei* was discriminated by the Genera *Aspitrigla* and *Eutrigla.*

The interspecific variability of juvenile specimens showed that *C. lucerna* and *T. lyra* were widely discriminated. This finding is probably due to individual genetic factors (Gauldie and Crampton, 2002) and to the different depths of their trophic niches. In fact, during their life cycle, triglids in Adriatic show a differential migration pattern to greater depths and away from the Italian to the Croatian coast (Montanini *et al*., 2008). The intraspecific variability of adult specimens was higher for *C. lucerna* and *E. gurnardus* while it was lower for the Genera *Aspitrigla* and *Lepidotrigla.* Intraspecific comparison between juveniles and adults showed that in all species there was an increase in otolith shape variability linked to growth and to environmental conditions.

Conclusions - According to these results, the EFA method was proved to be a suitable tool for supporting phylogenetic and eco-morphological investigations and assessing affinities among the investigated triglids species. It allowed to find similarity between *Lepidotrigla* sp. and *C. lastoviza*; distance between *C. lucerna* and *T. lyra* and an increase in the variability of otolith shape from juveniles to adults. However, in order to facilitate correct biological interpretation of data, the EFA method should be correlated with appropriate sampling plans (Farias *et al*., 2009; Stagioni *et al*., 2009).

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MEDUSIVOROUS FISHES OF THE MEDITERRANEAN. A COASTAL SAFETY SYSTEM AGAINST JELLYFISH BLOOMS

PESCI MEDUSIVORI DEL MEDITERRANEO. UN BALUARDO CONTRO LE MEDUSE

Abstract *– More than twenty species of medusivorous fishes are present in the Mediterranean Sea: they can be grouped in a coastal and an offshore assemblage. Seven species of the former group resulted as top species in terms of CPUE (catches per fishery season) at the Camogli tuna trap since a long time; given their relevance as biomass, we consider these species as a "safety system" against jellyfish invasions. Offshore medusivorous fishes are less known. During recent blooms of* Pelagia noctiluca *we have observed the jellyfish consume in five species (three of the coastal group) in which the gut was coloured by medusa pigments.*

Key-words: *medusae, pigments, fish predation, Ligurian Sea.*

Introduction – Jellyfish blooms being in the spotlight (see for instance JMBA Global Marine Environment issue 11, 2010), we consider worth of attention a related subject, that is medusivorous fish. Investigating the reason of the blooms, attention to predators and/or competitors of medusae, helps to indicate gaps of knowledge and subjects for future research. The present note correlates the general subject of the fishes which occasionally or regularly feed on medusae with observations carried out monitoring fishing activities in the Ligurian Sea: the result underlines the importance of medusivorous fish.

Results and conclusions - From general reviews about jellyfish consumers including medusivorous fishes (Ates, 1988; Arai, 1988, 2005) we have selected the species living in the Mediterranean. Adding some cases observed in the Ligurian Sea (Orsi Relini, 2010; Orsi Relini *et al.,* 2010a), a total of twenty species, plus some casual ones, can be listed (Tab. 1). A first group (1-11) are deep living fish, both demersal on the slope or mesopelagic in their adult phase. A second group of species (12 onward) live in neritic coastal waters and in the Ligurian Sea was studied in temporal series of catches at the Camogli tuna trap. This trap, located on the western side of the Portofino Promontory, on a water column of about 40 m, produces about 50 t of landings per fishing season (April-September), including more than 40 species. Annual total landings are considered CPUE as for large tuna traps, that is proxies of abundance indices. Temporal series of such data are available for the periods 1950-1974 and 1996-2000 (Balestra *et al.,* 1976; Relini, 2001) and regard the ten species most important in terms of biomass (called also ten top species); in the above indicated periods they included the sunfish *Mola mola* (Orsi Relini *et al.*, 2010b), which was later on banned as food by EC; at present this fish, if caught, is released alive. It is easily verified that the top ten species coincide, in 7 cases of 10, with medusivorous species, those numbered 12 to 18 in Tab. 1. The quantitative pattern of catches (CPUEs) and the persistence of the listed fish assemblage during at least half century, allow us to indicate such assemblage as a safety system against jellyfish blooms.

During recent blooms of *Pelagia noctiluca*, one of the most studied jellyfish in the world, also on the basis of a two centuries time series (Goy *et al.*, 1989), some of

Tab. 1 - Medusivorous fishes in the Mediterranean (*alien fish of occasional presence).
*Pesci medusivori del Mediterraneo (*pesci alieni di presenza occasionale).*

Condrichthyes	1	*Squalus acanthias*	**Osteichthyes**	12	*Scomberesox saurus*
	2	*Etmopterus spinax*		13	*Boops boops*
	3	*Centroscymnus coelolepis*		14	*Oblada melanura*
Osteichthyes	4	*Alepocephalus rostratus*		15	*Trachurus trachurus*
	5	*Luvarus imperialis*		16	*Scomber colias*
	6	*Centrolophus niger*		17	*Scomber scombrus*
	7*	*Hyperoglyphe perciformis*		18	*Mola mola*
	8	*Schedophilus medusophagus*		19	*Coryphaena hippurus*
	9	*Psenes pellucidus*		20	*Sparus aurata*
	10	*Cubiceps gracilis*		21	*Stromateus fiatola*
	11*	*Cubiceps capensis*		22	*Ranzania laevis*

the listed fish species (Tab. 1; numbers 6, 8, 14, 15, 16) showed evident signs of the massive consume of *P. noctiluca*, having the gut coloured by the jellyfish pigments (Avian and Rottini Sandrini, 1988; Orsi Relini *et al*., 2010a; Garibaldi & Orsi Relini, 2010). Such observation occurred by chance, in the framework of routine biological sampling (CAMPBIOL) and/or fish purchase for personal use. Having not planned such observations, we don't know if other fish species had the same behaviour. There is a large amount of work for the next jellyfish bloom, in particular regarding specificity, if any, of jellyfish consume.

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EVOMED PROJECT: FISHERMEN INTERVIEWS AS SOURCE OF INFORMATION TO RECONSTRUCT THE EVOLUTION OF THE MEDITERRANEAN FISHERIES IN THE 20TH CENTURY

PROGETTO EVOMED: INTERVISTE AI PESCATORI COME FONTE DI INFORMAZIONE PER RICOSTRUIRE L’EVOLUZIONE DELLA PESCA MEDITERRANEA NEL CORSO DEL XX SECOLO

***Abstract** – The fishermen interviews performed through EVOMED project constituted the first attempt to collect information in such a way on a wide geographical scale in the Mediterranean. A total of 107 interviews have been carried out in the investigated areas applying a common methodology. Interesting results have been collected on the fishing capacity indicators, fishing capacity and fishing pattern. Quantitative variations over time in the commercial landing, abundance of benthic and critical species have been even investigated.*

***Key-words:** Mediterranean fisheries, management, development, baseline studies, historical account.*

Introduction – The present picture of the state of fisheries and marine resources in the Mediterranean is essentially based on the quantitative information of the last twenty-five years; the knowledge on the historical evolution of the exploited populations and marine ecosystems in the last century is still scarce and limited to restricted areas.

It is difficult to generate realistic hypotheses about the dynamics of fisheries only from the understanding of the present, since all ecosystems have likely changed over time. Identifying baselines is fundamental to set up correct recovery strategies, not only directed at biological and ecological goals but also at the preservation and the improvement of the socio-economic benefits and ecosystem goods and services. The historical evolution knowledge of the exploited marine populations is fundamental to reduce the risk of a shifting baseline for management (Pauly, 1995). Defining a baseline for the Mediterranean resources is a difficult task as exploitation has endured for millennia, even though its intensive development fully started after the Second World War.

The main objective of EVOMED project (EU Contract. N° SI2 539097) is to provide information on the evolution, over the past 100 years, of the Mediterranean demersal fisheries and exploited populations. One of the main tasks of this study is to collect, from old (mainly retired) fishermen, information on fishing patterns, as well as on yields and discards and to evaluate its reliability. According to Freire and Garcia Allut (1999), fishermen’s traditional ecological knowledge (TEK) should constitute a complementary source to get new knowledge in fisheries biology and marine ecology.

Materials and methods – Particular attention has been devoted to the preparation of the questionnaire used to register all the information coming from the interviews. Appropriated and targeted questions have been selected, in order to extract the more reliable information possible. If interviews are performed following a standardised approach with well structured questionnaire, both qualitative information and quantitative or semi-quantitative data could be obtained (Bergmann *et al.,* 2004). The main contents of the questionnaire concerned fishing practices and fishing grounds, as well as characteristics of vessels and gears, main target species, catches and discards. Specific questions dedicated to species of particular interest (marine mammals and elasmobranches) have been included. The questionnaire was planned to collect information for three main time periods: 1940's - 1960's, 1960's - 1980's, and 1980's - present.

Results and conclusions - 107 interviews have been carried out in the investigated areas (Catalan Sea, Ligurian and Tyrrhenian Sea, Adriatic Sea and Ionian and Aegean Sea). The aspect that more clearly emerged is the notable increase over time of all the indicators of fishing capacity. The vessels used at present are notably different in size and in technological equipment to those employed in the past. Technological innovations have improved the fishing efficiency and the working standards. The high frequency of problems with the gear and the large amount of time for maintenance and preparation of the gear were other factors which decreased the fishing capacity in the earlier period.

Another aspect emerging from the interviews is the reduction observed in the catches over time of some faunistic groups, principally Elasmobranches. Another indicator of changes occurred over time in the marine environment was the decrease of the benthic species in the catch. Also for cetaceans, Monk seal and sea turtles, a general decrease, even though in lesser extent, of incidental catches and sightings over time was noticed.

The questions about the quantitative estimation of the catch has undoubtedly been the more difficult, in order to obtain realistic estimates. The perception about the amount of the catch over time could be biased by several factors, as the different discard rate throughout the years and the different gear selectivity. Probably the most important factor that embedded such perception is the confounding of the evolution in fishing power of the trawl vessels. The interviews performed through EVOMED project constituted the first attempt to collect information in such a way on a wide geographical scale in Mediterranean. It is natural that both the interview protocol and the questionnaire structure require a revision to be improved in the future, to increase the data standardisation and to obtain the more realistic possible results. However, the collected results are an important starting point of information, with several interesting aspects for many kinds of future applications.

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Biol. Mar. Mediterr. (2010), 17 (1): 352-353

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CONSIDERATIONS ON MINIMUM COMMERCIAL SIZE OF *CHAMELEA GALLINA* (L.)

CONSIDERAZIONI SULLA TAGLIA MINIMA COMMERCIALE DI CHAMELEA GALLINA *(L.)*

***Abstract** – Sorting sieve selectivity experiments were carried out on a hydraulic dredge fishery exploiting the clam,* Chamelea gallina *(Mollusca: Veneroida, Linneus, 1758). Six sieves (from 20 to 23 mm) were tested. The material collected shows that all sieves capture undersized clams. As it is impossible, with current sorting techniques, to avoid presence of undersized clams, the alternative approach "number per kilogram" has been proposed. The result of the study shows in 220 the allowed number of clams per kilogram.*

Key-words: Chamelea gallina*, clam fisheries, size-limit regulations, imaging techniques.*

Introduction – The clams fishermen complain about the practical impossibility to observe the minimum landing size in force for *Chamelea gallina*, 25 mm of maximum diameter (Annex IV art. 15 EC Reg. 1967/06). Therefore the Laboratory of Marine Biology and Fisheries of Fano carried out experimental surveys to evaluate selectivity of sieves with different diameter used by the local hydraulic dredge fishery.

Materials and methods – *C. gallina* samples were collected on February 4th and 9th 2010 onboard of a commercial hydraulic dredger, in the maritime compartment of Pesaro, Adriatic sea. During the experimental survey three vibrating and sorting sieves per day were tested, on three different hauls: 20.5, 21.5, 23 mm the first day; 20, 21, 22 mm the second day. Subsamples of clams collected from each sieve (about 10 kg) were taken to laboratory and immediately weighed (1 g), sorted to remove bycatch, broken shells and onshell epifauna, photographed by backlight illumination, counted and measured with magnification of 10 pixel/mm (0.1 mm) by proprietary macro image analysis program developed on ImageJ (Rasband 2010). A further set of tests considered the weight loss of 5 kg subsample for three sieves (20, 21, 22 mm), since arriving in the laboratory after fishing for three days, storing at 5 °C and re-weighting every day.

Results – Results are summarized in Tab. 1. The selection curves (not showed) show that there is always a capture range of clams less than 25 mm, albeit with low percentage. The weight loss after three days storage reaches a maximum of 2% and ANOVA analysis on transformed data (arcsine of root percentage) do not shown significant differences between sieves ($F_{2,6}$=0.22 p=0.8088), but shows significant differences between hauls ($F_{2,6}$=8.9913, p=0.01566).

Conclusions – In all tests (at the ideal slope of the vibrating sieve and with calm sea), the regular dredges carry on a large number of undersized clams. Using the dredge prescribed by the current law, high rates of undersized clams are caught, according to Froglia, 1981. An average size greater than 25 mm was obtained with sieves ^{3}21.5 mm, but the presence of undersized clams was however detected, its importance varying according to the different fishing grounds. As it seems not feasible to avoid the catch of undersized clams, in order to comply with the EC

Reg. 1967/06, a “number per kilogram” system, like that in use for anchovies and sardines, can be proposed. Taking into account the average weight at different sizes (not shown), as well as the 21 mm sieve selectivity and the weight loss before sale, it could be established in 220 specimens per kg the allowed landing value. Another indication could be the use of sieves with 21.5 mm minimum holes. Digital image acquisition and processing is sufficiently precise (Vaccarella, 1998) and fast, allowing the processing of approximately 20,000 clams per person per day.

Tab. 1 - Summary results of caught clams. CFS = cumulative frequency size.
Riassunto dei dati delle vongole catturate. CFS = taglia della frequenza cumulata.

Haul	**Sieve mm**	**Gross weight kg**	**Discard kg**	**Net weigth kg**	**N**	**N/kg**	**Min size mm**	**Mean size mm**	**Max size mm**	**CFS 25% mm**	**CFS 50% mm**	**CFS 75% mm**
1	20.0	12.400	0.178	12.222	3044	249	19.2	23.9	27.8	23.5	23.9	24.4
2	20.0	11.400	0.115	11.285	2715	241	19.9	23.7	27.9	23.2	23.7	24.2
3	20.0	8.500	0.241	8.259	2029	246	17.7	23.5	28.3	23.0	23.6	24.0
1	20.5	10.510	0.110	10.400	2509	241	16.2	24.2	30.0	23.6	24.4	25.0
2	20.5	9.690	0.170	9.520	2304	242	18.9	23.9	27.7	23.2	24.0	24.7
3	20.5	9.520	0.120	9.400	2190	233	18.3	24.2	27.7	23.7	24.3	24.9
1	21.0	12.300	0.156	12.144	2639	217	20.0	25.0	32.3	24.4	25.0	25.6
2	21.0	11.800	0.085	11.715	2492	213	22.3	25.0	30.3	24.4	24.9	25.5
3	21.0	10.200	0.226	9.974	2140	215	20.8	24.8	31.7	24.2	24.8	25.4
1	21.5	11.700	0.200	11.500	2431	211	19.4	25.3	33.7	24.6	25.5	26.2
2	21.5	9.220	0.100	9.120	1807	198	20.1	25.7	29.5	25.1	25.8	26.4
3	21.5	9.260	0.110	9.150	1850	202	19.3	25.3	30.3	24.7	25.4	26.1
1	22.0	13.300	0.136	13.164	2348	178	23.6	26.8	37.0	26.0	26.7	27.4
2	22.0	11.500	0.075	11.425	2074	182	22.7	26.5	32.6	25.7	26.4	27.2
3	22.0	11.400	0.163	11.237	1943	173	23.0	26.9	34.1	25.9	26.8	27.8
1	23.0	7.000	0.070	6.930	1069	154	23.3	28.2	35.0	27.3	28.1	28.8
2	23.0	8.380	0.050	8.330	1333	160	24.5	27.8	34.2	27.1	27.7	28.4
3	23.0	12.660	0.110	12.550	2012	160	24.6	27.7	34.4	26.9	27.6	28.4

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COMPARATIVE MORPHOLOGY OF TRIGLIDAE OTOLITHS FROM THE NORTH-MIDDLE ADRIATIC SEA

MORFOLOGIA COMPARATIVA DEGLI OTOLITI DEI TRIGLIDI IN ALTO-MEDIO ADRIATICO

***Abstract** – The sagittal otoliths of Triglidae family from the Adriatic Sea (north-eastern Mediterranean) were described using morphological and morphometric characters. The morphological descriptions were based on the otolith shape, outline and* sulcus acusticus *features. The morphometric parameters determined were expressed in terms of 5 shape indices. Otolith shape intra-inter specific changes have been described providing informations about species identification, fish size, sex and phylogenesis.*

***Key-words:** otolith reading, shape, Triglidae.*

Introduction - Triglidae (Teleostei, Scorpaeniformes) are known for their sound producing ability in agonistic contexts related to territorial defense, reproduction and competitive feeding (Amorim *et al*., 2004). In the Adriatic Sea (north-eastern Mediterranean) triglids are represented by 7 species: *Aspitrigla cuculus (ASPICUC), Chelidonichthys lastoviza (TRIPLAS), C. lucerna (TRIGLUC), Eutrigla gurnardus (EUTRGUR) Lepidotrigla cavillone (LEPTCAV), L. dieuzeidei (LEPTDIE), Trigla lyra (TRIGLYR*), poorly discussed for the Mediterranean Sea (Vallisneri *et al*., 2010). Otolith shape and *sulcus acusticus* features, related to genetic and environmental factors, might be an important key for species identification. The aim of this study was to analyze interspecific and intraspecific shape differences in sagittal otoliths of triglid species.

Materials and methods – Samples of seven Triglidae species were collected during several bottom trawl surveys in the north-middle Adriatic Sea, from the Gulf of Trieste to the Tremiti Islands in 2007 and 2008. For each specimen total length (TL, mm), weight (W, g) and sex were recorded. A total of 634 sagittal otoliths were removed, washed and weighed to 0.01 mg. The sagittae were photographed under a microscope (Leica MZ6-Nikon P5100). The images were processed with ImageJ (Rasband, 2008) to calculate five shape indices (aspect ratio, roundness, rectangularity, ellipticity, circularity). Shape indices for which "species-length" interactions were significant ($P<0.001$) were normalised. The data were processed with R (R Development Core Team, 2010). For the same fish length range, a sample of sagittae were analyzed ultrastructurally by scanning electron microscopy.

Results - 1) UNIVARIATE ANALYSIS (ANOVA): Interspecific comparison, analized by univariate analysis, were tested by Kruskal-Wallis and Tukey tests. About shape indices, major shape variation were respectively: for "aspect ratio" *LEPTDIE-TRIGLUC*; *LEPTCAV-TRIGLUC*; *LEPTCAV-TRIGLYR*; for "roundness" *TRIGLUC-LEPTCAV.*; for "rectangularity" *ASPICUC-LEPTCAV.*; for "ellipticity" *LEPTDIE-TRIGLUC*; *LEPTCAV-TRIGLUC*; *TRIPLAS-TRIGLUC*; *LEPTCAV-TRIGLYR*; *LEPTDIE-TRIGLYR.;* for "circularity" *LEPTDIE-LEPTCAV*; *LEPTDIE-TRIPLAS*; *LEPTCAV-TRIPLAS*. Otoliths morphologically more different, defined by three shape indices, were those belonging to *L. cavillone* and *C. lucerna*. The results were in agreement with the analytical key about the family (FAO, 1987) that placed these two species at the extremes. 2) MULTIVARIATE ANALYSIS (MANOVA): Intraspecific comparison were analyzed by multivariate analysis. The otolith outline shape indices changed with size (between juveniles and adult) and sex for some species. In particular, intraspecific comparison showed significant differences between juveniles and adults for *A. cuculus*, *C. lucerna*, *L. dieuzeidei* and between females and males for *L. dieuzeidei.* Therefore, about the intraspecific relationship, *L. dieuzeidei* was the species more diversified. 3) SCANNING ELECTRON MICROSCOPY (SEM): otolith shape of triglids were approximately oval. Preliminaries analyses showed interspecific variations in the morphology and ultrastructure of the *sulcus acusticus*, about shape, size, direction of crystalline arrangement and crystalline surface. Intraspecific variation appeared relate to growth and environmental factors. These results were in agreement to Tuset *et al.* (2003) and Jitpukdee (2009) for other families.

Conclusions - These results suggested: similarity between species belonged to the same genus; differences between species phylogenetically distant (e.g. *L. cavillone* and *C. lucerna*); intraspecific differences between juveniles and adults (e.g. *A. cuculus*, *C. lucerna*, *Lepidotrigla dieuzeidei*); similarity between species belonged to different genera (*Lepidotrigla* spp. and *C. lastoviza*). These methods (geometric morphometrics and ultrastructure analysis) constitute an important instrument for species identification using sagittal otoliths collected in feeding remains of bony fish predators, in fossiliferous layers, in archaeological sites.

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MANAGEMENT RECOMMENDATIONS FOR THE CONSERVATION OF THREATENED *APHANIUS FASCIATUS* NARDO POPULATIONS FROM TWO WETLANDS IN THE MALTESE ISLANDS

RACCOMANDAZIONI PER LA GESTIONE E LA CONSERVAZIONE DI DUE POPOLAZIONI DI APHANIUS FASCIATUS *NARDO DALLE ISOLE MALTESI*

Abstract *- The* Aphanius fasciatus *populations at the two Maltese wetlands of Simar and Ghadira were monitoired during the May-October 2008 period for signs of pathogenesis and in terms of sex ratio and individual morphology. The putative impact of a number of abiotic factors on populaiton structure was also assessed. The study concludes that the percentage of juveniles within the two killifish populations is highest during the July-August period, and that reproductive activity resumes in October at the end of the dry season which coincides with a stalling of reproductive activity and with a high juvenile mortality. Recommendations for the amplification of killifish-specific monitoring protocols are also made.*

Key-words*: wetlands,* Aphanius fasciatus*, Maltese Islands, pathogenesis, monitoring.*

Introduction - The euryhaline cyprinodontid *Aphanius fasciatus* Nardo is currently distributed in the saline coastal waters of the central and eastern Mediterranean, in salt flats and also occasionally in inland fresh water (Wildekamp, 1993). The species' distribution on the Maltese Islands has regressed in recent times, with the species having been extirpated from a number of locations due to a variety of anthropogenic pressures. Ghadira and Simar are the only two RAMSAR wetland sites from the Maltese Islands, being also designated as Special Areas of Conservation (SAC's, under the Habitats Directive) and as Special Protection Areas (SPA's, under the Birds Directive). The current study aimed to collect morphological, sex ratio and phenological data for the *A. fasciatus* populations from these two sites, pursuant to investigating the influence of the abiotic environment on the population structure and on the occurrence of pathogenesis in the species, with the ultimate aim of improving conservation and management strategies for the species.

Materials and methods - Sampling was carried out between May-October 2008 at two wetlands in the Maltese Islands. At the Simar wetland, quadrangular handheld sweep nets (40×40 cm, mesh size 8 mm) were used to sieve the water. Traps (40 cm in diameter, 8 mm mesh size) were used in the deeper areas of Simar and at the Ghadira site. The traps were baited and positioned two metres from the shoreline. After 15 minutes, the traps were opened and the fish were checked for any signs of pathogenesis. For each individual, the total length and sex were recorded *in situ*. All fish were then released back into the water body. Juveniles were defined as all killifish individuals up to a maximum size of 2.8 cm, below which the typical colouration of the adult fish was absent. A total of 1079 fish were monitored in this way.

Results - This study illustrates that, as the summer progressed, the two wetlands were exposed to extreme abiotic conditions, including a rapid increase in the salinity of the habitat, a decrease in oxygen concentration (down to 2.19 mg/l), a sharp increase in aquatic temperature (from 23.0 ºC at the end of May to over 33.0 ºC by the end of August) and a decrease in the depth of the water (50% decrease in water depth at the Ghadira wetland and a 25% decrease at Simar). Females were more abundant than males at both sites (3:1 at Ghadira and 2:1 at Salina, Zammit-Mangion *et al*, in press), with the overall number of males at the Ghadira site decreasing by 8.8% as the summer progressed. The results also showed that a significant number of the population were juveniles (75% and 46.3% of the populations at Ghadira and Simar respectively) (Zammit-Mangion *et al.*, in press). At the Ghadira site, juvenile abundances peaked in August, with juveniles exhibiting a fairly uniform mean size (mean length=26.3 mm, +/-1.8 mm). At Simar, the juvenile abundances peaked in June, exhibiting a mean length of 21.5 mm (+/-2.6 mm). Juvenile mortality was high, with juveniles showing sharp declines in abundance by the end of summer, with over 80% and 60% decline in juveniles at Ghadira and Simar, respectively. Abiotic stress during late July and early August had a negative effect on reproductive success, on the number of males recorded at Ghadira and on reproductive activity. However, once the water temperature decreased, and dissolved oxygen increased, the female killifish individuals resumed reproductive effort, with 33% of females studied in October at the Ghadira site exhibiting the swollen bellies characteristic of pregnant fish. No signs of pathogenesis were found on the particular sampling days.

Conclusions - This study indicated that the two *A. fasciatus* populations at the two wetlands, especially at the Ghadira site, were exposed to extreme abiotic conditions during the peak summer months. These factors, coupled with the physical and genetic isolation of the two populations, constitute perennial constraints to the long-term viability of the species and justify the need for a constantly high conservation priority being assigned to the species. The authors propose that targeted management measures should be adopted immediately if the populations at the two wetlands are to be effectively conserved. These include i) increasing protective measures during the reproductive and recruitment periods through late March to May ii) starting a re-introduction programme at sites previously known to support *Aphanius* species (strictly monitoring the haplotypes of introduced individuals) and iii) introducing a water monitoring programme.

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CATTURE DEL RONDONE DI MARE *CHEILOPOGON HETERURUS* (RAFINESQUE, 1810) (OSTHEICHTHYES, EXOCETIDAE) IN UN'AREA MARINA PROTETTA LUNGO LE COSTE SETTENTRIONALI DELLA SICILIA

CATCHES OF FLYING FISH CHEILOPOGON HETERURUS *(RAFINESQUE, 1810) (OSTHEICHTHYES, EXOCETIDAE) INSIDE A MARINE PROTECTED AREA OFF THE NORTHERN SICILIAN COAST*

Abstract *– The size structure, length weight relationship and gonado somatic index of specimens of* Cheilopogon heterurus *caught by an artisanal fishery targeting pelagic fishes in the MPA "Capo Gallo-Isola delle Femmine" (Northern Sicily) were presented. The catch was exclusively formed by adult and mature specimens with size. close to the maximum reported for the species.*

Key-words: Cheilopogon heterurus*, MPA, southern Tyrrhenian, artisanal fisheries, size structure, maturity.*

Introduzione – Il rondone di mare *Cheilopogon heterurus* (Rafinesque, 1810) è una specie subtropicale ed epipelagica che frequenta le acque costiere nella tarda primavera-estate in occasione della riproduzione. La marineria di Isola delle Femmine sita nella Area Marina Protetta "Capo Gallo-Isola delle Femmine", effettua una pesca tradizionale con due attrezzi da posta chiamati "pusticedda" e "palamitara" che combinano i vantaggi del tramaglio e della schietta. Le due reti, che differiscono esclusivamente per la larghezza della maglia, hanno come principale bersaglio individui adulti e maturi di specie pelagiche come la palamita *Sarda sarda*, il tonnetto *Euthynnus alletteratus*, l'aguglia maggiore *Tylosurus acus imperialis* ed il rondone di mare *Cheilopogon heterurus* (Fiorentino e Zava, 2007). In questa nota sono riportate le informazioni salienti sulla caratteristiche biologiche degli esemplari di *Cheilopogon heterurus* raccolti con i suddetti attrezzi di pesca.

Materiali e metodi - Quarantasette individui di *C. heterurus* sono stati raccolti presso la marineria di Isola delle Femmine nei mesi di giugno 2006 e giugno-luglio 2007. Trasportati in laboratorio gli esemplari sono stati misurati (LT, cm) e pesati (PT = peso totale, g; PS = peso somatico, g). Inoltre, sono stati inoltre rilevati il sesso, l'aspetto ed il peso delle gonadi (PG, g). L'indice gonado somatico è stato calcolato come IGS = PG/(PS-PG)*100, con PS=PT-PG.

Risultati e conclusioni – La distribuzione in taglia degli individui campionati è riportata in Fig. 1. Il range di taglia (LT) è stato 35-39 cm nei maschi e 34-41 cm nelle femmine. I parametri della relazione taglia-peso a sessi combinati sono risultati a=0,0022 e b=3,2735, con r^2=0,8301. Le gonadi apparivano in avanzato stato di maturazione. In particolare dieci femmine presentavano uova idratate distribuite su lunghe striature longitudinali e ben visibili attraverso la tunica ovarica (IGS medio delle femmine con uova idratate =18,68±4,87. Nessun maschio fluente è stato osservato nel campione. Le taglie e la condizione di maturità rilevate evidenziano che gli attrezzi utilizzati sono selettivi per la specie. Infatti, la taglia massima riportata in letteratura per questa specie è di 40-45 cm LT (Maigret e Ly, 1986; Parin, 2002).

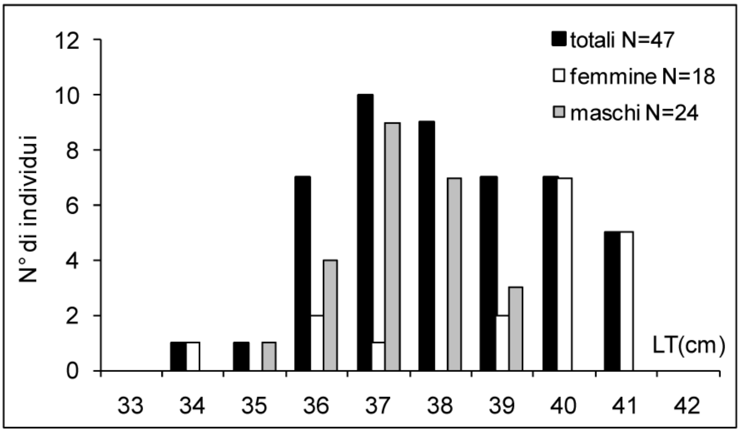

Fig. 1 - Distribuzione in taglia degli esemplari di *C. heterurus* campionati.
Length frequency distribution of C. heterurus.

Nella ricerca di nuove strategie di pesca sostenibile che valorizzino gli aspetti del sapere tradizionale delle marinerie siciliane, "i pusticeddi" e "'i palamitari" di Isola delle Femmine costituiscono un esempio di mestieri ecocompatibili da valorizzare per rilanciare la pesca in un contesto di nuovo sviluppo culturale e turistico dei borghi marinari.

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MONITORING OF TOXIC MICROALGA *OSTREOPSIS* (DINOFLAGELLATE) SPECIES IN MEDITERRANEAN COASTAL WATERS USING THE PCR BASED-ASSAY COMBINED WITH LIGHT MICROSCOPY

MONITORAGGIO DELLA MICROALGA POTENZIALMENTE TOSSICA OSTREOPSIS *(DINOFLAGELLATA) IN AREE COSTIERE MEDITERRANEE CON IL METODO MOLECOLARE DI PCR E MICROSCOPIA OTTICA*

Abstract *– A molecular PCR based-assay was developed and applied to macrophyte and seawater samples containing mixed microphytobenthic and phytoplanktonic assemblages in order to detect toxic* Ostreopsis *species in the Mediterranean Sea. The PCR allowed rapid detection of* Ostreopsis *cells, even if their abundances are below the light microscopy's detection limit. Species-specific identification was possible only by PCR-based assay, due to the inherent difficulty of morphological identification in field samples. During the monitoring of the toxic* Ostreopsis *blooms PCR based methods proved to be effective tools complementary to microscopy for rapid and specific detection of* Ostreopsis *in marine coastal waters.*

Key-words: *coastal waters, Mediterranean Sea, monitoring,* Ostreopsis*, PCR.*

Introduction – Harmful Algal Blooms (HABs) occur frequently in coastal waters throughout the world causing negative impact on environmental quality, human health and economical activities. HAB species include *Ostreopsis*, a benthic/epiphytic genus known to produce palytoxin-like compounds. Two *Ostreopsis* species, as *O. ovata* and *O.* cf. *siamensis*, are being found with increasing frequency in the Mediterranean Sea (Battocchi *et al.,* 2010; Totti *et al.,* 2010). Correct identification of these two species is quite difficult by microscopy analyses but it is particular important given that the two species can produce different toxins, which are a potential risk to humans and other organisms. In this study, an efficient PCR based assay was applied to environmental samples in order to monitor the presence of *Ostreopsis* species in Mediterranean coastal areas, and to compare molecular data with microscopy determinations.

Materials and methods – A total of 125 samples of macrophytes, net and surface water samples were collected from April to November 2007 at 20 sites distributed in northern Adriatic Sea and Catalan Sea where blooms of *Ostreopsis* have never been detected before or commonly occur, respectively. Subsamples were settled for 24h in Sedgwick-Rafter or Utermöhl chambers and *Ostreopsis* spp. were counted under inverted microscopes (Axiovert 40 CFL and Axiovert 135H, Zeiss, Germany or a Leitz DM-II, Germany) at 200× or 400× magnification on the half or entire sedimentation chamber. Pellets obtained from macrophyte and seawater samples were used for total DNA extraction and purification according to Battocchi *et al.* (2010). Genus and species-specific primers were designed in the 5.8S rDNA-ITS regions. PCR reactions were carried out directly using these primers or by following two steps: an initial

PCR using eukaryotic primers targeting the ITS-5.8S gene followed by a second PCR using genus- or species-specific primers (i.e. nested PCR) as described in Battocchi *et al.* (2010).

Results – All the environmental samples analyzed contained mixed microphytobenthic assemblages including target taxa. The PCR method detected the presence of *Ostreopsis* spp. cells even when target cells were not observed by microscopy examination. The positive detection by PCR assay was higher than microscopy determinations by 19% for the macrophye samples and 32% for the net and surface seawater samples. Moreover, the PCR-based assay identified the two species *O. ovata* and *O.* cf. *siamensis,* while species-specific identification of *Ostreopsis* cells was quite difficult using LM microscopy. Using the PCR based assay, *O. ovata* cells were detected at a rate of 67% and 66% in macrophyte and seawater samples, respectively, and *O.* cf. *siamensis* cells were detected at the lower rates of 16% and 29%, respectively (Fig. 1).

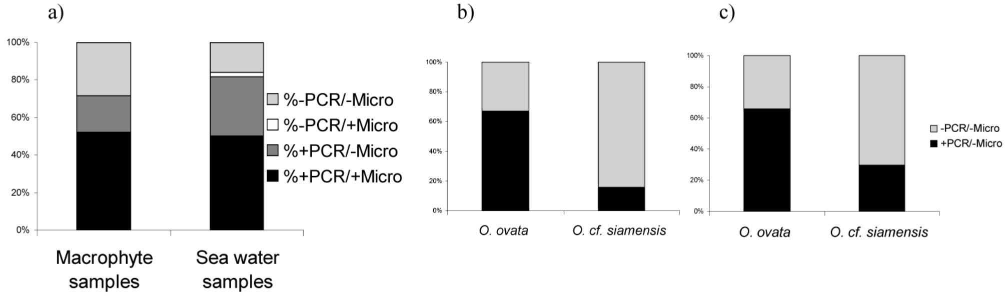

Fig. 1 - a) Analyses of positive and negative PCR amplifications of *Ostreopsis* spp. compared with the corresponding positive and negative microscopy analyses of the environmental samples collected in 2007. PCR analysis of macrophyte (b) and net and surface seawater (c) samples for detecting *O. ovata* and *O.* cf. *siamensis*. Data are expressed as percentages of the total PCR positive and negative determinations.

a) Confronto dei dati di positività e negatività ottenuti con le due diverse tecniche applicate a campioni ambientali raccolti nel 2007. Analisi di PCR dei campioni di macrofite (b) e retinate e acqua di mare superficiale (c) per l'identificazione di O. ovata *e* O. *cf.* siamensis. *I dati sono espressi come percentuale sul totale dei campioni analizzati.*

Conclusions – The PCR technique developed in this study efficiently identified both species of *Ostreopsis* and it was more sensitive in detecting *Ostreopsis* spp. than microscopy analyses. As for the statistical evidence, the proportions of false negatives by microscopy relative to PCR-based data were found to be significantly larger than the expectation under the hypothesis of equal power for microscopy and PCR-based identification, thus showing that the latter method is significantly more reliable.

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NUMERICAL ABUNDANCE AND NUMBER OF TAXA IN PHYTOPLANKTON SAMPLES: PRELIMINARY COMPARISON BETWEEN TWO DIFFERENT COUNTING STRATEGIES

DETERMINAZIONE DELLA DENSITÀ CELLULARE E DEL NUMERO DI TAXA IN CAMPIONI DI FITOPLANCTON: CONFRONTO PRELIMINARE TRA DUE STRATEGIE DI CONTEGGIO

Abstract *– The comparison between two different counting procedures for the analysis of phytoplankton samples was reported in this study. The comparison was made on 10 seawaters samples, collected monthly from October 2009 to December 2009 in the marine coastal waters of the Apulia region (southern Italy). The samples were analyzed according to the Utermöhl's method using two counting procedures of the sedimentation chambers: counting random field and counting sectors. The results showed significant differences between the two counting procedures.*

Key-words: *phytoplankton, counting procedures, Mediterranean Sea, Adriatic Sea, Ionian Sea.*

Introduction – Phytoplankton is one of the Biological Element considered suitable for the assessment of the environmental status of marine coastal waters, as it was stated by the Water Framework Directive (EC/2000/60) and other National Acts. As a consequence, the monitoring of phytoplankton guilds (abundance and composition) is currently carried out by the Regional Agency for the Environmental Protection and Prevention (ARPA) along the Apulia marine coastal areas. Phytoplankton guilds were analyzed following the Utermöhl's method (1958), currently certified by UNI-EN 15204 (2006). In this study, preliminary results about the statistical comparison between two different counting procedures are reported.

Materials and methods – Seawater samples were collected monthly from October 2009 to December 2009 in 7 stations, 5 located along the Adriatic coast (Ofanto river mouth, Bari, Monopoli, San Cataldo and Alimini lagoon mouth) and two along the coast of the Ionian Sea (Porto Cesareo and Ugento). Seawater samples were collected by means of a Niskin bottle in the sub-surface layer (0.5 m), kept in PET dark bottles, fixed with Lugol's solution and analyzed within one month from the sampling. The comparison of the two counting procedures was carried out only on 10 seawater samples collected for phytoplankton analysis. After cell settlement, in 25 ml or 10 ml sedimentation chambers, each sample was counted by means of two different counting procedures envisaged by the Utermölh's method: 1) counting on random fields; 2) counting on portions of the sedimentation chambers (sectors).

For the former counting procedure, a number of random fields were counted until a total of 400 cells were reached (corresponding to 5-10% accuracy). On the contrary, the second counting procedure is a modification of counting the whole chamber procedure, considered more appropriate for water samples with low phytoplankton densities (EN 15204). The whole sedimentation chamber was divided into 8 sectors. The cells were counted in a number of sectors until reaching at least 400 cells and, in any case, until the end of the sector or sectors included in the analysis. The cell densities was calculated according to the formula: $N=(n*1000/v)*f$, where: N = number of cells per unit volume; n= number of cells counted; v=volume of sedimentation chambers; f=total sectors/number of the counted sectors. In both procedures, rare species were counted on the whole chamber. The results of total cell density and number of taxa obtained using the two alternative methods were compared using the regression analysis.

Results – Cell density values showed significant differences between the two counting methods. Cell density values observed using the "fields" counting procedure appeared to be higher than those obtained by counting phytoplankton cells on "sectors". Regression analysis was positive and highly significant: $r=0.999$, $p<0.001$, $n=10$. The value of the slope (2.3±0.04) indicated that the data obtained with the "fields" method was about 2.3 times higher than those obtained with the "sectors" one. Also the number of the identified taxa was different using the two alternative counting procedures. The number of the taxa identified by the "sectors" counting procedure was more representative of the results obtained from the analysis of the whole sedimentation chamber ($r=0.917$, $p<0.01$ $n=10$), if compared with the "fields" counting procedure. In fact, the number of the identified taxa in random fields is smaller if compared with the analysis of the whole chamber as a rule; however, the relationship between number of taxa identified in random fields *versus* number of taxa identified on whole chamber is not significant.

Conclusions – The results underline some differences between the outputs deriving from the application of alternative phytoplankton counting procedures. With regard to the cell density estimation, the counting procedure using random fields overestimate more than twice the values observed with the counting procedure by sectors. Probably this method can overestimate the contribution of less abundant species; on the contrary, there is a loss of information related to the total number of taxa in the sample. According to the results, the counting method using sectors seems to be more appropriate for those samples collected in oligotrophic waters with a low concentration of cells, although it will be confirmed with new data.

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FIRST REPORT OF *OSTREOPSIS* CF. *OVATA* BLOOM IN THE GULF OF TRIESTE

PRIMA SEGNALAZIONE DI UNA FIORITURA DI OSTREOPSIS *CF.* OVATA *NEL GOLFO DI TRIESTE*

Abstract *–The first abundant occurrence of* Ostreopsis *cf.* ovata *was observed along the rocky coasts in the Gulf of Trieste at the end of September 2009. This species has been already sporadically recorded in this area since September 2006 but no toxic effect on human health has been registered yet. The maximum value reached in this period was 13×10*^{6} *cells l*$^{-1}$ *and it was found on rocks in shallow waters. The results of sampling carried on macroalgae in two coastal sites were also reported in order to compare the growth on different substrata.*

Key-words: *benthic dinoflagellate, Gulf of Trieste,* Ostreopsis *cf.* ovata*, toxic species.*

Introduction – The Italian coasts have been seasonally interested by plankton blooms since 1970 and bloom events caused by benthic dinoflagellate *Ostreopsis ovata* have been recently recorded in 2005 along Ligurian coasts (Abbate *et al.,* 2007; Mangialajo *et al.,* 2008). This toxic species lives on different substrata, such as macroalgae and rocks. *Ostreopsis* cf. *ovata* was observed in the Gulf of Trieste in September 2006 (Monti *et al.,* 2007), while the first bloom was recorded in September 2009 along the rocky coast in shallow waters. In this study, we report the first bloom of *O. ovata* and the results of a monitoring programme of the associated microphytobenthic community.

Materials and methods - From May to October 2009 three samples from two macroalgal species with their surrounding water were collected at the depth of about 2m in a sheltered site (SCI) and in an exposed one (SCE). To check the presence of *Ostreopsis,* the rinsing water from dripped thalli was fixed with neutralised formalin and analyzed according to Utermöhl method. In order to express the concentration of benthic dinoflagellate in cells g^{-1} fw, cells g^{-1} dw as well as in cells cm^{-2}, the fresh and dry weight of the thalli and the thallus surface were determined according to Totti *et al.* (2010). In both stations, water samples were collected by net, and fixed and analyzed to evaluate the distribution of all toxic dinoflagellates along the water column. Environmental parameters (T, salinity, PAR, dissolved oxygen) were determined to characterize both sites. From September 29th to October 8th in another site, 900 m far from the monitored sites along the shore, samples of waters containing visible mat were collected through syringe to assess the abundance of *Ostreopsis ovata* in the benthic community (method under investigation).

Results and conclusions - From May to August the benthic toxic dinoflagellates *Prorocentrum lima*, *Coolia monotis* and *Amphidinium cartarae* were reported on macrophyte samples at low concentrations: at the SCI they were always lower than 5000 cells g^{-1} fw, while in the SCE they were always lower than 8000 cells g^{-1} fw. *O.* cf. *ovata* was observed since the beginning of September in both coastal sites on *Dictyota dichotoma* and *Padina pavonia*. The highest concentration in SCE (Fig. 1) was recorded in the sample collected on September 21st when it reached 3.3×10^5 cells g^{-1} fw (corresponding to 1.6×10^6 g^{-1} dw and 5.2×10^3 cm^{-2}), while in SCI (Fig. 1)

O. cf. *ovata* was observed on October 5th at lower abundance (2.8×10^5 cell g^{-1} fw corresponding to 1.4×10^6 g^{-1} dw and 2.6×10^3 cm^{-2}).

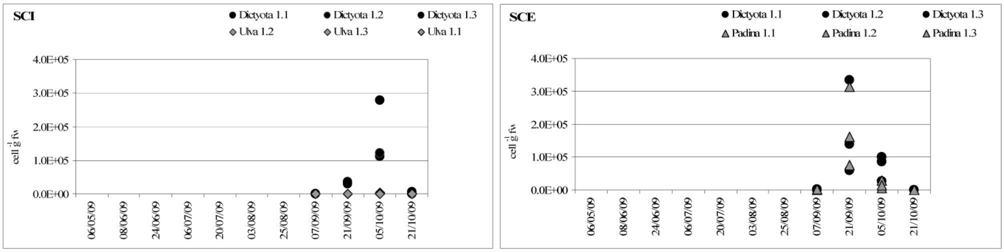

Fig. 1 - Abundance of *Ostreopsis* cf. *ovata* on thalli expressed as cells g^{-1} fw in SCI and SCE sites.
Abbondanza di Ostreopsis ovata *sui talli espressa come cells* g^{-1} *pf nei siti SCI e SCE.*

Along the water column, *O.* cf. *ovata* was recorded at both stations with a concentration of 120-280 cells l^{-1} on September and October. On September 29th in an enclosed bay, 900 m far from the regular monitoring sites, a bloom event of *O.* cf. *ovata* occurred on rocks in absence of macrophytes. In the mat covering the rocks along the littoral, *O.* cf. *ovata* was present with a maximum of 13×10^3 cells ml^{-1}(syringe sample). The day after, the concentration of *O.* cf. *ovata* in the mat decreased to 3×10^3 cells ml^{-1} and it gradually lowered until October 8th when it was absent. During the bloom event, temperature and salinity of the water were 22.5 °C and 36.6, respectively; on October 7th both values decreased to 20.9 °C and 30.6. In conclusion, in the Gulf of Trieste, *O.* cf. *ovata* confirms its occurence in late September. In the same period of the bloom on the mat, *Ostreopsis* was also associated with *Dictyota dichotoma* and *Padina pavonia*. From these preliminary observations, the bloom seemed gradually to disappear with the decrease of temperature and salinity. In the Gulf of Trieste, as well as in the Conero Riviera (Totti *et al.,* 2010), hard substrata, sheltered conditions and scarce hydrodynamism seem to favour the bloom of *Ostreopsis*. Anyway, in the Gulf of Trieste noxious effects on human health were not associated with the bloom. The monitoring of this benthic species may be considered a basic parameter, which should be integrated in future water quality programme considering that the investigated area is a recreational site during the summer.

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COUPLING TAXONOMIC AND CHEMICAL ANALYSES TO MONITOR HARMFUL ALGAE OCCURRENCE IN LAGOONS (VENICE AND PO DELTA SYSTEM, ITALY)

ANALISI TASSONOMICHE E CHIMICHE PER IL MONITORAGGIO DELLE ALGHE TOSSICHE NELLE LAGUNE (VENEZIA E DELTA DEL PO)

Abstract *– Harmful algae occurrence was monitored in the Venice lagoon and in the Po Delta lagoons by taxonomic identification with optical microscopy, and chemical determination of toxins by HPLC coupled with High Resolution Time-Of-Flight Mass Spectrometry (HR-TOF-MS). These techniques were coupled in order to verify the potential of a developing protocol overcoming the current anti-ethical and expensive Yasumoto test on mice. The abundance of potentially toxic cells resulted negligible, but toxins were anyway analytically detected and structurally confirmed by the high accuracy of the MS detector employed.*

Key-words: Dinophysis*, harmful algae, biotoxins, lagoons.*

Introduction – The risks due to Harmful Algae (HA) proliferation are well known worldwide and numerous research and sanitary institutions are currently involved in the monitoring of their occurrence. The methods dedicated to the identification of HA are numerous and involve different approaches (taxonomy, genetics, toxicology, chemistry, biochemistry). However, the method, the one recognized by national regulations to prevent risk to human health, is the Yasumoto's test on mice. It is often coupled with taxonomic identification, but it results anti-ethic, poorly accurate and rather expensive. To overcome such limitations our research group is proposing to integrate the taxonomic investigation with analytical chemistry analysis in order to correctly identify and quantify the toxin presence and occurrence. As already reported by literature, the presence of such harmful species is not necessarily correlated to the occurrence of poisoning events, so this approach wants to combine routine taxonomic monitoring activity with accurate chemical identification of toxins (Okadaic Acid, DTX1, DTX2, Domoic Acid, PTX2) to highlight the real risk for human health due to the microalgal proliferations.

Materials and methods – Seawater samples were collected 12 times from June to August 2009 in the Venice lagoon and in a couple of lagoons in the Po Delta system, where clam farming is the main economical resource. Phytoplankton cell abundance and taxonomic composition were determined under the inverted light microscope according to the Utermöhl's method (1958), settling 25 ml of sample in order to identify also species-specific low abundances. Qualitative observations were carried out on 20 μm mesh net samples. Seawater was filtered on GF/F Whatman filters to extract toxins from microalgal cells. Solvent mixture (80:20 vol methanol:water) was sonicated, and then 10-times concentrated to 1 ml by evaporation and centrifugation (Blanco *et al.,* 2007; Fernández *et al.,* 2006). Aliquots of 10 μl of the supernatant were injected in an Agilent 1200 High Performance Liquid Chromatography system using an Agilent G1329B autosampler. The chromatographic separation of lipophilic toxins (Okadaic Acid, DTX1, PTX2) was performed using a Fusion stationary phase (100×2 mm, 1.8 μm) by Phenomenex (Torrance, CA, USA), while analysis of domoic acid in samples extracts was instead performed on a 150×2 mm, 2.5 µm Phenomenex Gemini reversed-phase stationary phase. Detection and quantification of toxins were performed using an Agilent G1969A High Resolution Time of Flight Mass Spectrometer. Analytes were identified automatically by means of the Data Analysis software Mass Hunter®.

Results – Total phytoplankton abundance varied between 1.0 to 5.0×10^6 cells l^{-1}. Except for a sporadic occurrence of *Noctiluca scintillans*, among potentially HA, only *Dinophysis caudata*, *D. mitra* and *D. sacculus* were recorded in the areas where the influence of seawaters was the most direct. On the sea side of the Lido inlet (Venice lagoon) the cell abundance of *D. sacculus* was 100 cells l^{-1}, but it decreased below 40 cells l^{-1} moving toward the lagoon waters and completely disappeared in the inner stations, where the residence time and the water turbidity are generally higher. The HPLC-MS determination highlighted the presence in trace of PTX2 molecule in cell extracts collected at the Lido inlet. Due to the *Dinophysis* low abundance and PTX2 trace concentration, it was not possible to correlate the species occurrence with the toxin. However, no other potentially HA was recorded in the site where PTX2 was detected. In the Po Delta system lagoons, the results were quite similar, as *Dinophysis* spp. were recorded only in seawaters, with abundances even lower (<20 cells l^{-1}). Toxins were not detected in such areas, probably due to the low abundance or to unfavorable environmental conditions (Lindahl *et al.,* 2007).

Conclusions – The preliminary taxonomic identification with microscopy allowed to address the chemical analysis in order to chose the correct protocol in relation to toxin molecular characteristic. The approach resulted to be useful for a rapid screening of the toxin occurrence in water samples. In the studied lagoons, poisoning events were never recorded, but the oncoming climate changes may favor in the next future the proliferation of harmful species and this poses needs to be prepared to prevent potential risk for human health and these coastal ecosystems.

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LUMINOUS MARINE BACTERIA AND WATER MASSES DISTRIBUTION IN THE CENTRAL MEDITERRANEAN SEA (CRUISE SICILY09)

DISTRIBUZIONE DI BATTERI LUMINOSI E MASSE D'ACQUA NEL MAR MEDITERRANEO CENTRALE (CROCIERA SICILY09)

Abstract *– To evaluate quantitative and qualitative luminescent bacteria (LB) distribution, 421 seawater samples from 38 stations of the Central Mediterranean Sea were analysed during November 2009. LB plate counts showed a patchiness bacterial distribution with increase near the bottom. An ARDRA analysis on isolated strains was carried out to evaluate the microbial diversity of the luminous communities.*

Key-words: *bacteria, distribution, luminous organisms, water masses.*

Introduction - To date, a wide literature on the systematic, metabolic features, biochemical pathways and ecology of luminous bacteria (LB) is available. Conversely, their distribution and role in marine environment show a lack of knowledge. During last years, we have deeply studied marine LB in different basins of the Mediterranean Sea by using various approaches, as viable counts, phenotypic assays and genotypic techniques (De Luca *et al.*, 2009; Gentile *et al.*, 2009). Marked differences in viable counts and bacterial genera distribution, in the surveyed areas of the Mediterranean Sea, were observed. De Luca *et al.* (2009) found higher values on surface waters (0-200 m) in the western Mediterranean Sea and at 800-1200 m depth in all Mediterranean surveyed areas. Genera distribution also varied with depth. The Central Mediterranean Sea hydrology is characterised by a really complex bottom topography directly influencing water exchanges between E and W Mediterranean basins. The Sicily Strait is characterised by two narrow passages giving strong limits to the exchanges with the E Mediterranean Sea. The Tyrrhenian Sea is linked with E Mediterranean Sea through a shallow channel permitting the inflow of Levantine Intermediate Water (LIW) and transitional Eastern Mediterranean Deep Water (tEMDW) that, sinking at the entrance of this sub-basin, origins the Tyrrhenian Deep Water (TDW), then moving over the Western Mediterranean Deep Water (WMDW), as referred by Astraldi *et al.* (2002).

Materials and methods – From 30/10 to 23/11/2009 a multidisciplinary cruise (SICILY09) was carried out on board the R/V Urania of the CNR in the Central and Western Mediterranean basins. Water samples were collected, from surface to 10m above the bottom, by a Rosette sampler equipped with 12L Niskin bottles. A CTD probe 911plus SeaBird was employed for conductivity, temperature, pressure, dissolved oxygen and fluorescence measurements. LB were counted on Millipore filters (0.45 µm) placed on Sea Water Complete (SWC) agar plates. Counts from various filtered volumes and duplicate plates, were normalized to 100 ml. ARDRA analysis were performed on a portion of isolated strains to evaluate diversity of the luminous microbial communities.

Results - We refer about 421 seawater samples from 38 stations along 5 key sections localized inside and on the board of the studied area. Along surveyed sections, abundance values ranged from 0 to 21 (Section 1: Sardinia-Sicily), 0-68 (Sec. 2: Sicily-Tunisia), 0-73 (Sec. 3: Sicily-Pantelleria-Tunisia), 0-117 (Sec. 4: Sicily-Malta-Libya) and 0-28 (Sec. 5: Ionian Sea) CFU 100 ml^{-1}, respectively. LB showed a wide range of values along the water column, whereas near the bottom they increased up to 117 CFU 100 ml^{-1}. Coastal samples near the bottom of Sicily Strait showed always the highest counts. From plates, 384 strains of LB were isolated and 122 (31.7%) grown under laboratory condition. ARDRA analysis, performed on 100 strains, showed 4 OTUs (Operational Taxonomic Units) for each of two restriction enzymes employed (HHAI and RSAI), according to previous research carried out in this area (De Luca *et al.*, 2007). Under the hydrological conditions, the area shows the typical 3-layer systems characterized by Modified Atlantic Water (MAW) at the surface (37.7-37.8 psu), LIW at intermediate depth (38.6-38.7 psu) and deep waters (tEMDW, TDW and WMDW) that occupy the areas below LIW or mix with LIW at the entrance of the Tyrrhenian Sea along Western Sicily coast.

Conclusions – The results obtained in this study were comparable with those previously reported for other areas of the Mediterranean Sea; LB show a patchiness distribution with an appreciable increase in viable counts generally observed near the bottom. LB values in the seawater samples from the Sicily Strait were higher than in the Tyrrhenian and Ionian samples and lower than in the Gibraltar Strait and Alboran Sea, probably due to richness of nutrients and organic matter. The distribution pattern of LB, as a function of depth and distance from the coast previously assumed for several areas of Mediterranean Sea (De Luca *et al.*, 2009), can be also confirmed for this area.

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SEASONAL AND SPATIAL DISTRIBUTION OF PHYTOPLANKTON IN THE VENETO LAGOONS (CAORLE AND PO DELTA LAGOONS, ITALY)

DISTRIBUZIONE STAGIONALE E SPAZIALE DEL FITOPLANCTON NELLE LAGUNE VENETE (LAGUNE DI CAORLE E DEL DELTA DEL PO)

Abstract *– Seawater samples were seasonally collected in 20 sites in the lagoons of the north western Adriatic Sea in order to determine the phytoplankton abundance and taxonomic composition. Data showed persistent blooming conditions (>10^7 cell l^{-1}) from February 2008 to August 2008 in the Po Delta lagoons and scarce abundance in the Caorle lagoons. Also community compositions appeared significantly different in the two lagoon systems.*

Key-words: *phytoplankton, diatoms, lagoons, Italy.*

Introduction – The north western coast of the Adriatic Sea is a complex system of wetlands and lagoons. Due to its historical and socio-economical importance, most of the studies have always focused on the Venice lagoon. Nevertheless, the Po Delta lagoon system covers an area of 786 km^2 only in the Veneto area and represents an important naturalistic oasis and an economical resource for more than 1500 employees in the aquaculture and clam farming. The scientific literature dedicated to such area and the Caorle lagoon is scarce and mainly focused on fish and birds. Even if phytoplankton has a key environmental role and represents the food basis for mussels and clams, no studies are available in such areas in terms of cell abundance and species composition. The need to know the ecological status and, hence, the trophic conditions of the considered areas, has recently gained relevance due to the regulations in the Water Framework Directive 2000/60 (WFD). As a consequence, the local authorities started to promote studies for all the water bodies, which ecological status should be at least "good" by 2015. The present paper describes the first seasonal surveys of phytoplankton distribution and taxonomic composition in the Caorle and Po delta lagoons.

Materials and methods – In February, May, August, October and November 2008, seawater samples were collected in 3 and 17 stations located in the Caorle and Po Delta lagoons, respectively. For each station, hydrological parameters were measured, and phytoplankton, nutrients and chlorophyll *a* samples were collected. The phytoplankton analysis was performed with inverted light microscope according to the Utermöhl's method (1958). Nutrients and chlorophyll *a* were measured according to Strickland and Parson (1972) and Holm-Hansen *et al.* (1965), respectively.

Results – On the basis of salinity values, two of the 3 sites in Caorle lagoon were classified as oligohaline (<18), whereas most of the Po Delta lagoons were classified as polyhaline (18-30). Both reactive phosphorus (RP) and dissolved inorganic nitrogen (DIN) concentrations displayed high values with minima in May and a significant increase in autumn (October - November 2008), when chlorophyll *a* concentrations were relatively low (0.5-7.6 µg l^{-1}). The highest value of chlorophyll *a* was measured in February (57.8 μg l^{-1}). The lagoon of Caorle showed always lower chlorophyll *a* values than the Po Delta lagoons, where, the concentrations were often >10 μg l^{-1} from February to August. In the Caorle lagoon, phytoplankton community was dominated by diatoms in May 2008, with the highest mean abundance (22.0×10^6 cells l^{-1}). Flagellates were dominant or abundant as diatoms, represented by the pennate forms, which are typical of benthic habitats. Centric diatoms were represented by the pelagic *Thalassiosira* spp., even if it has been frequently recorded in the sediments (Facca and Sfriso, 2007). Except for May 2008, during the other observations, the mean abundance did not exceed 4.0×10^6 cells l^{-1}. Conversely in the communities of the Po Delta lagoons centric colonial and pelagic diatoms often were found. The main bloom was recorded in February 2008 due to *Skeletonema marinoi* (up to 77.0×10^6 cells l^{-1}). However, so far in May and August 2008 the mean cell abundance remained in the order of 10^7 cells l^{-1}, even though the contribution was mainly due to *Chaetoceros* spp. (May and August) and *Cerataulina pelagica* (May). The only exception was a punctiform dinoflagellate bloom with value of 13.7×10^6 cells l^{-1} dominated by a mixture of armoured and naked forms. In autumn, the abundance drastically decreased being in the order of 10^6 cells l^{-1}. In such period, the contribution of diatoms became almost negligible and the community was mainly constituted by flagellates, such as cryptophytes.

Conclusions – Nutrient concentrations were high enough to guarantee phytoplankton blooms, which were mainly driven by temperature, light availability, water column turbidity and hydro-dynamism. Thus the enriched nutrient Po Delta lagoons, for most of the year, were in persistent blooming conditions, due to pelagic colonial diatoms, as it is normally observed in the coastal belt of the Adriatic Sea (Bernardi Aubry *et al.,* 2004), whereas the trophic level of the Caorle lagoon was generally lower and the community was dominated by resuspended benthic diatoms. Such data represented the first description of the phytoplankton in the area and may be used to verify the WFD requirements.

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EFFETTI IN VIVO DELLE ONDE SONORE (200 HZ 100 KHZ) SULL'ESPRESSIONE DELL'HSP70 NELLE CELLULE DEL SANGUE DI *CHROMIS CHROMIS* (PERCIFORMES)

IN VIVO EFFECT OF SOUND WAVES (200 HZ 100 KHZ) ON HSP70 EXPRESSION IN BLOOD CELLS OF CHROMIS CHROMIS *(PERCIFORMES)*

Abstract *– The widespread of anthropic activities and the technological development have increased in the last decades the exposure of organisms to noise pollution so evoking a great interest about their influence on biological and mainly in immune system. In the present work the expression of Hsp70 in* Chromis chromis *blood cells has been investigated following the exposure to 200, 300 Hz and pinger.*

Key-words: Chromis chromis*, Hsp70, noise pollution.*

Introduzione – È noto che negli ultimi 40 anni il disturbo sonoro in ambiente marino è aumentato di un fattore 10 e la causa sembra attribuibile all'intenso traffico commerciale e portuale. Gli ambienti di maricoltura sembrano essere particolarmente "rumorosi" a causa delle attività legate alle pratiche di allevamento. In tali ambienti, la fauna ittica è caratterizzata da specie come la castagnola (*Chromis chromis*), particolarmente abbondante nel Mediterraneo. Le condizioni di disturbo sonoro possono indurre uno stato di stress nelle specie ittiche sia selvatiche sia in quelle di allevamento. Questo effetto è stato evidenziato con lo studio della Hsp70, che come noto in letteratura (Basu *et al*., 2002; Iwama *et al*., 1998), rappresentano un valido indice per studiare lo stress cellulare e vengono considerate bioindicatori molecolari di stress. Il ruolo fondamentale della Hsp70 è quello di riparare i danni alle proteine a seguito di stress acuto, svolgendo così un ruolo chiave nella citoprotezione. Nei pesci l'induzione di Hsp dovuta a stress è stata studiata in linee cellulari e in vari organi da animali stressati. In questo studio, è stata valutata l'espressione della Hsp70 di *Chromis chromis*, specie frequente attorno alle gabbie di maricoltura, al variare di suoni somministrati simili a quelli originati dall'azione antropica.

Materiali e metodi – Nell'estate del 2008, nei mesocosmi dello IAMC-CNR di Capo Granitola sono state effettuate varie sessioni sperimentali con gruppi indipendenti di circa 20-35 esemplari *Chromis chromis* a cui venivano somministrati suoni con una frequenza di 200 Hz e 300 Hz, e con un pinger suoni compresi tra i 70 e 150 kHz. Gli esperimenti hanno previsto una fase di acclimatazione, quindi lo start sperimentale cui seguivano due fasi: la fase pre-somministrazione sonora (controlli), e la fase post. La misurazione dei livelli di espressione della Hsp70 è stata valutata nelle cellule del sangue intero. I prelievi di sangue per puntura cardiaca sono stati effettuati su 5 individui di controllo, e 5 individui della fase post-somministrazione (200, 300 Hz e pinger). Per l'SDS-PAGE, sono sati utilizzati 20 µg di ciascun campione. Dopo la migrazione, il pattern proteico è stato analizzato tramite la tecnica del western-blot (Towbin, 1979) utizzando un antisiero monoclonale specifico per la Hsp70. L'analisi dei pesi molecolari e la densitometria sono state condotte con il software AlphaEaseFC. I dati di densitometria sono stati espressi come la media dei valori di tre differenti esperimenti e indicati come valore di densità integrata (IDV arbritary unit).

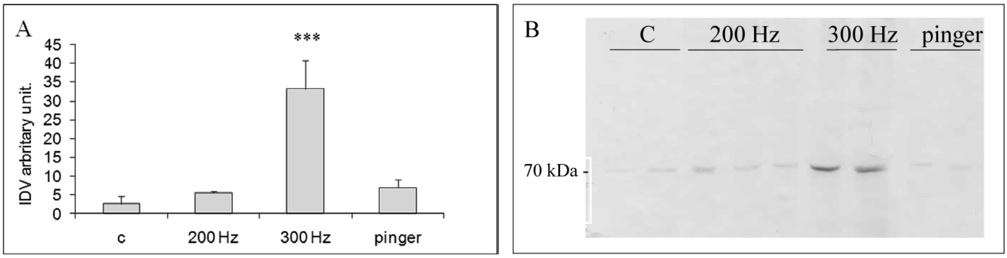

Fig. 1 - A) Livelli di espressione di Hsp70 (% IDV) nelle cellule del sangue di *Chromis chromis* in funzione del disturbo acustico 200, 300 Hz e pinger dopo 2 ore di trattamento. I valori sono le medie ±SD di tre esperimenti separati. Valori significativi comparati ai controlli (***=p<0,001); B) Tipica analisi di western-blot con supernatante del lisato di cellule del sangue, trattato con anti-Hsp70.

A) Expression level of Hsp70 (% IDV) in Chromis chromis *blood cells as a function of noise disturb after 200, 300 Hz and pinger treatment. Values are the means ±SD from three separate experiments. Significant values compared to control (***=p<0,001). B) Tipical western blot analysis of blood lysate supernatant, treated with anti-Hsp70.*

Risultati - I risultati mostrano una correlazione significativa tra l'espressione della Hsp70 e l'intensità dello stress (300 Hz). Nessun effetto viene invece registrato per intensità sonore a 200 Hz e a quelle prodotte dal pinger.

Conclusioni – Questo studio mette in evidenza come il disturbo sonoro sia in grado di interagire con i meccanismi biochimici inducendo lo stress nei pesci come dimostrato dalla modulazione della Hsp70. Ciò apre ampi spazi di ricerca sugli effetti del disturbo sonoro, sia a livello comportamentale che cellulare, nelle specie selvatiche con la conseguenza di rivolgere una maggiore attenzione alla riduzione dei disturbi acustici in ambiente marino.

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VARIAZIONI SESSO-DIPENDENTI NELL'ATTIVITÁ CITOTOSSICA DEI CELOMOCITI DI *PARACENTROTUS LIVIDUS* (ECHINOIDEA)

SEX-DEPENDENT VARIATIONS IN THE CYTOTOXIC ACTIVITY OF PARACENTROTUS LIVIDUS *(ECHINOIDEA) COELOMOCYTES*

Abstract *– The coelomic fluid from the echinoderm contains several coelomocyte types involved in immune defences. In this article we report a study of some activity involved in immune response of the sea urchin* Paracentrotus lividus*. Correlative studies indicate that in this species a cytotoxic and hemoagglutinating activity is present in a manner sex-dependent.*

Key-words: *immunity, coelomic fluid, sex.*

Introduzione - Alcuni studi effettuati sul sistema immunitario dei vertebrati fanno emergere una relazione tra sesso ed immunità, in generale le femmine sembrano possedere una maggiore reattività immunitaria rispetto ai maschi (Stoehr e Kokko, 2006). Tra gli invertebrati la situazione è molto meno chiara. Nel presente lavoro abbiamo studiato l'immuno-reattività di esemplari di entrambi i sessi dell'echinoderma *Paracentrotus lividus* esaminando alcune reazioni immunitarie di tipo umorale e cellulare. In particolare nella specie in esame recentemente è stata mostrata un'attività citotossica calcio–dipendente in grado di lisare gli eritrociti di coniglio e le cellule tumorali della linea K562 in seguito al rilascio di sostanze litiche ad opera degli sferulociti non colorati (S-CLS) (Arizza *et al.,* 2007).

Materiali e metodi – I saggi biologici sono stati condotti analizzando in totale campioni preparati singolarmente da 100 individui maschili e 100 femminili. È stata analizzata l'attività citotossica ed emoagglutinante del fluido celomatico (CF) e del supernatante del lisato degli S-CLS. *Saggio di citotossicità:* 200 µl di campione sono stati diluiti serialmente e miscelati con 200 µl di sospensione di eritrociti di coniglio (8×10^6 cell) in ISO-Ca^{2+} (20 mM Tris, 0.5 M NaCl, 10 mM $CaCl_2$ pH 7.5) e incubati per 1 ora a 37 °C. Il rilascio dell'emoglobina è stato determinato attraverso la lettura dell'assorbanza a 541 nm. *Saggio di emoagglutinazione:* 25 µl di campione sono stati diluiti serialmente in ISO-Ca^{2+} e miscelati con 25 µl di sospensione eritrocitaria all'1% in ISO-Ca^{2+} contenente gelatina allo 0,1% e incubati per 1 ora a 37 °C in piastre a 96 pozzetti con fondo a U (Microtiter-SIGMA).

Risultati - Dai dati finora ottenuti si è potuto apprezzare, per la prima volta, che gli individui di *P. lividus* hanno una differente capacità immunitaria dipendente dal sesso. In particolare dal confronto dell'attività citotossica ed emoagglutinante esibita da individui maschili e femminili è emerso che queste ultime appaiono più immunoreattive rispetto ai maschi. Infatti l'attività citotossica del fluido celomatico (CF) della femmina risulta essere di circa il 65% in più alla massima concentrazione proteica rispetto a quella presentata dal maschio (Fig. 1a). Inoltre il lisato degli sferulociti non colorati S-CLS della femmina ha una capacità emolitica del 50 % circa superiore rispetto a quella del maschio (Fig. 1b). Infine le femmine hanno mostrato una maggiore attività emoagglutinante del CF e dell' S-CLS evidenziando una maggiore risposta nei confronti del target rispetto ai maschi, come visto per la citotossicità (Fig. 1c).

Conclusioni – I risultati ottenuti in questo studio hanno evidenziato variazioni

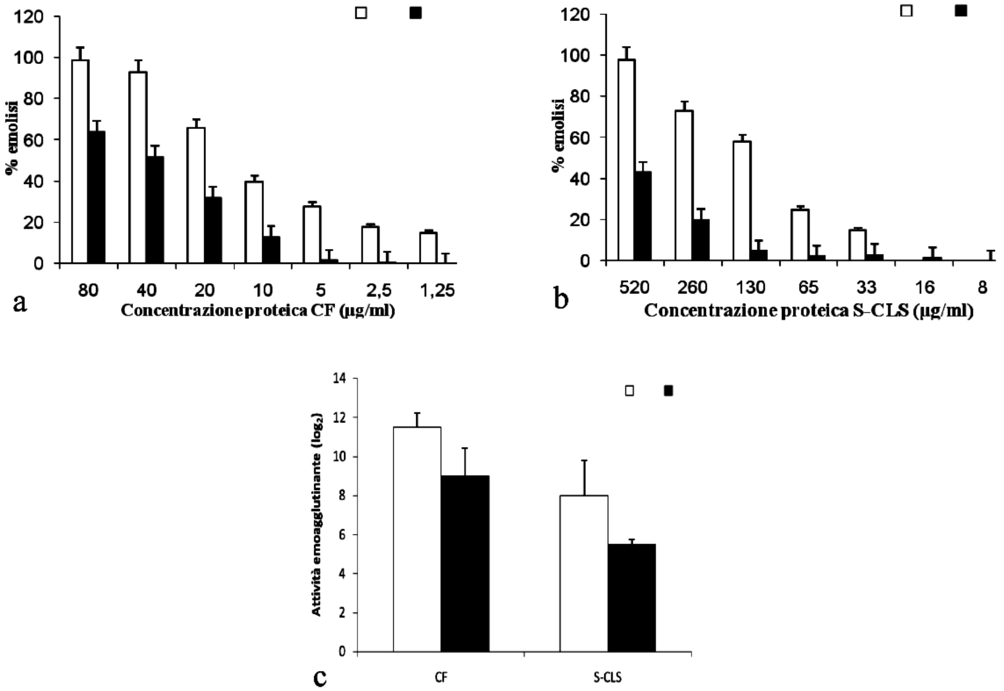

Fig. 1 - Attività citotossica di CF (a) e S-CLS (b) di *P. lividus* femmina e maschio verso eritrociti di coniglio. Attività emagglutinante del CF e del S-CLS di *P. lividus* femmina e maschio contro eritrociti di coniglio (c). I valori sono le medie ±SD di tre esperimenti separati. I valori tra i sessi sono significativi per $P<0{,}001$.

Cytotoxic activity of CF (a) and S-CLS (b) of P. lividus *female and male against rabbit erythrocytes. Hemagglutinanting activity of male and female CF and S-CLS assayed with rabbit erytrhocytes. Values are the means ±SD of three separate experiments. Values between sex are significant for* $P<0.001$.

sesso-dipendenti nell'attività citotossica ed emoagglutinante dei celomociti della specie *Paracentrotus lividus.* Infatti gli individui maschili e femminili hanno mostrato una differente capacità immunitaria, in particolare si è notato che, per ciascun saggio sperimentale, gli individui di sesso femminile hanno presentato una capacità immunoreattiva superiore rispetto agli individui maschili. Secondo alcuni autori esisterebbe una possibile connessione tra l'immunocompetenza e le strategie riproduttive attuate dai due sessi. Infatti i maschi delle specie che non mostrano selezione sessuale, investirebbero meno risorse nell'immunità a favore di una maggiore capacità riproduttiva (Stoehr e Kokko, 2006). Mentre nelle femmine avverrebbe l'esatto contrario, ovvero, una maggiore longevità è assicurata da una più alta resistenza ai patogeni garantendo una maggiore fitness. Ulteriori studi sono tuttavia necessari per meglio comprendere le differenze della risposta immunitaria nei due sessi.

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FECAL PELLET ANALYSIS OF *CARETTA CARETTA* OUTPATIENTS OF THE LINOSA ISLAND TURTLE RESCUE CENTER (SICILY, AG)

ANALISI DELLE FECI DI ESEMPLARI DI CARETTA CARETTA *PAZIENTI DEL CENTRO RECUPERO TARTARUGHE DELL'ISOLA DI LINOSA (SICILIA, AG)*

***Abstract** – Preliminary data on Loggerhead sea turtle fecal pellets analysis conducted on hosts of the Sea Turtle Recovery Center in Linosa Island (Agrigento Sicily) revealed strong impact of soft plastic floating debris on diet. Fecal pellets can also be a good indicator of origin and movement of turtles in relation to the habitat they have attended.*

***Key-words:** fecal pellets, animal nutrition, rare species, marine debris.*

Introduction – The Loggerhead sea turtle *Caretta caretta* is a protected species since 1973 (Endagered Species ACT- ESA). The Mediterranean Sea Turtle Recovery Center of Linosa Island "Hydrosphera" (Agrigento, Sicily) has been conserving a collection of dried fecal pellets from 60 turtles of 107 hosted in the center since 2006. Having the opportunity of analyzing such an unusually large data set - i.e. published literature reports similar analysis only for few specimens (Tomás *et al.*, 2001; Frick *et al.*, 2009) - we report preliminary considerations on how fecal pellet can be used as reliable indicator of diet, conservation status and habitat requirement for the species.

Materials and methods – A subsample of fecal pellet of 22 juvenile specimens of *C. caretta* (Straight line carapace length: 27-63 cm), hosted in the Linosa's Turtle Recovery Center from 07.07.-25.08.2007, was analyzed under a dissecting microscope (30×). Food and debris were classified in the following 11 categories (Fig.1): 1) fishes (F); 2) molluscs (M); 3) crustaceans (C); 4) other undigested material of animal origin (MA); 5) other undigested material of vegetal origin (MV); 6) hard plastic (HP); 7) soft plastic (SP); 8) wood (W); 9) feathers (FE); 10) fishing lines and hooks (FL); 11) other undigested material of anthropogenic origin (MAN). Each category was weighted using an analytical scale (dwt; 0.001 g) and related to the total weight of the fecal pellet. Moreover, plastic debris color was taken into consideration as a possible factor determining ingestion preference.

Results – Soft plastic was the most frequent category of debris found in fecal pellets (SP=91%) followed by undigested material of vegetal origin (MV=86%, mainly *Sargassum* sp) and wood (W=45%). Amongst food, fish residue was the most recurrent category (F=32%). Debris represented more than half of fecal pellets composition (59±33% dwt/tot dwt*100). Transparent and white were the most frequently color of plastic found in fecal pellet (25-30%). Most of the specimens (17 out of 22) were found to have ingested *Sargassum* sp. algae.

Conclusions – Transparent and white soft plastic debris was present in almost all *C. caretta* fecal pellets in agreement with findings of stomach content analysis (Tomás *et al.*, 2001). This type of debris is particularly dangerous for turtles, causing gut air clogging and buoyancy impairment. Moreover, soft plastic slows down nutrient gain in gut and growth (Hutchinson & Simmonds, 1991). Fish appeared to be the

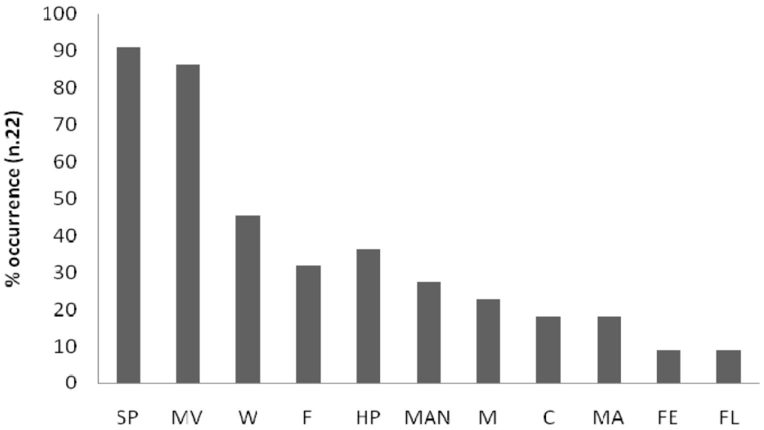

Fig. 1 - Percentage of occurrence of each category of food/debris found in 22 *C. caretta* specimens.
Percentuale di frequenza di ogni categoria di cibo/detrito presente nei 22 campioni di C. caretta.

most preyed food. *Sargassum* sp. was also frequent in fecal pellets showing that the origin of sample population was probably in an optimal post-hatching habitat of *Sargassum* beds. Location of this habitat and distance from the Sicily Channel should be investigated in relation to swimming speed and telemetry studies. In conclusion this preliminary results showed how fecal pellets analysis could be good indicator of loggerhead sea turtle ecology and a mean to assess its conservation status. The ongoing analysis of the whole fecal pellet (60 ind.) belonging to Hydrosphera collection will allow to statistically compare diet of *C. caretta* among years and specimens size/age in order to confirm our first conclusions.

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SPERMATOGENESIS AND SPERM STRUCTURE IN THE BLACK-STRIPED PIPEFISH *SYNGNATHUS ABASTER* (TELEOSTEI, SYNGNATHIDAE)

SPERMATOGENESI E STRUTTURA DEGLI SPERMATOZOI IN SYNGNATHUS ABASTER *(TELEOSTEI, SYNGHATHIDAE)*

Abstract *– The gonads of adult males of the black-striped pipefish* Syngnathus abaster *were observed during the reproductive season to describe mature sperm both quantitatively and qualitatively. The results show that: a) the sperms number is always very low and, does not vary significantly during the reproductive season; b) all mature sperms observed may be assigned to the introsperm-like type. These data suggest that the unique and functional sperm of Syngnathids pertain to the introsperm type typical of internally fertilizing teleostean bony fishes.*

Key-words: *introsperm, Syngnathids, testis.*

Introduction – Syngnathids species, provided with a closed and highly specialized brood pouch, (such as *Syngnathus* and *Hippocampus*) are considered internal brooders, whereas those species with an open pouch or without this structure (such as *Nerophis*) are external brooders. Hence, in literature, it is commonly accepted that eggs fertilization of external brooders occurs in the external environment for external brooders and inside the male pouch (or marsupium) in internal brooders, but both theories have gaps. Furthemore, data on sperm morphology are limited and, in some cases, contradictory (Kvarnemo and Simmons, 2004). Therefore, histological investigation on testis morphology, spermatogenesis and sperm structure and function could significantly contribute to better understand the fertilization strategies of Syngnathids.

Materials and methods – Adult males of *Syngnathus abaster* were collected in the Pond of Cabras (Sardinia, Italy) during the reproductive season (2007). Testes were dissected from 10 freshly killed fishes. Gonads of 2 males were fixed in Bouin's fixative, dehydrated in a graded ethanol series, cleared in toluene and embedded in paraffin. Sections (5 µm) were stained with Mallory's trichrome for observed general morphology. To examine contents of the male gonads and the number and morphology of the mature sperm fresh testes, in toto, of 9 males were gently squashed and observed with a Zeiss Axiophot light microscope.

Results - Each testis appears as hollow tube with a large central lumen surrounded by an external tunica albuginea and a thin internal germinal epithelium (Fig. 1a) organized in small and poorly developed cysts of few germ cells enveloped by Sertoli cells (Fig. 1b). The central lumen is occupied by floccular material among which three cells types are distinguished droplets-containing cells, large flagellate cells and mature sperm (Fig. 1c, d, e).

cells are spherical or irregular in shape (30.015±8.497 µm large). Many of the droplets-containing cells have small (1.392±0.304 µm) and numerous droplets and one, two or several large nuclei (9.044±0.643 µm) (Fig. 1b, c). However, like the droplets-containing cells, the flagellate cells are giant cells (25.969±9.188 µm large) of spherical, lobed or irregular shape. One, two or several nuclei are visible in their cytoplasm. Each nucleus is characterized by the basal fossa and the axoneme (Fig. 1d, e). These cellular type, are recognizable as developing spermatids. Young spermatids have large round nuclei (7.333±1.096 μm diameter) with uncondensed chromatin, except around the nuclear fossa (Fig. 1d). Spermatids in an intermediate developmental stage still have rounded nuclei but they are smaller (3.191±0.574 μm) and with condensed chromatin (Fig. 1e). Mature sperm are always elongated mononuclear cells of 79.565±7.965 μm in total length with a conical head (4.719± 0.415 μm length and 0.976±0.079 μm width) (Fig. 1c, insert) and a long tail (74.853±7.995 μm). For each male we counted 500 to 3000 sperm (1694.444±1068.423).

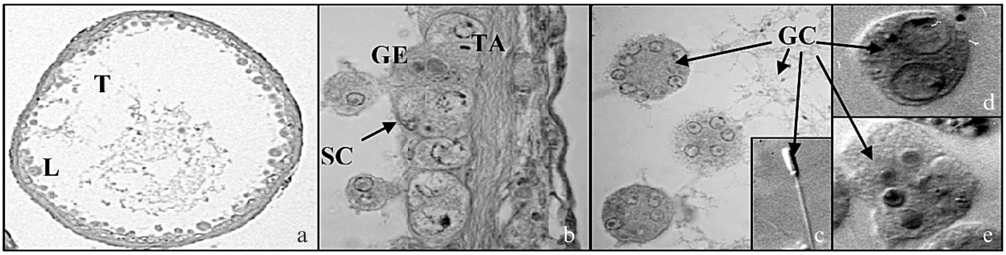

Fig. 1 - a-b) Transversal section of the testis; ×110, ×400. c-d-e) Germinal cells inside the lumen obtained by squashing testes; ×420, insert ×1000, ×800, ×800.
GC: Germinal Cells; GE: Germinal Epithelium; L: lumen; SC: Sertoli Cells; T: Testis; TA: Tunica Albuginea.

a-b) Sezione trasversale del testicolo; ×110, ×400. c-d-e) Cellule germinali all'interno del lume ottenute attraverso lo schiacciamento del testicolo; ×420, inserto ×1000, ×800, ×800.

Conclusions – The present data show that in *S. abaster*, the round cells mixed with mature sperm inside the lumen can be considered germ cells at different developmental stages. Moreover, except for mature sperm, all these cells, can have one or several nuclei, confirming that in *S. abaster* spermatogenesis is of semi-cystic and symplastic type (Carcupino *et al.*, 1999). The estimated number of sperm in *S. abaster* varies from 500 to 3000. The sperm concentration in this small family could be the lowest among fish. These data, together with the simultaneous presence of mature sperm and developing spermatids inside the testes of each male examined, suggest that sperm are formed continuously throughout reproductive season in *S. abaster.* Moreover, the semi-cystic and symplastic spermatogenesis of Syngnathids results in the presence of numerous giant round cells in the lumen, which may hide the few mature sperm produced and hamper a correct morphological interpretation of mature sperm. In fact, the other sperm types, reported for Syngnathids, could merely be developing germ cell.

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MICROBIOLOGICAL CHARACTERIZATION OF INTESTINAL FLORA OF GILTHEAD SEA BREAM (*SPARUS AURATA* L.) FROM TORTOLI LAGOON (EASTERN SARDINIA, ITALY)

*CARATTERIZZAZIONE MICROBIOLOGICA DELLA FLORA INTESTINALE DI ORATE (*SPARUS AURATA *L.) PROVENIENTI DALLO STAGNO DI TORTOLI (SARDEGNA ORIENTALE, ITALIA)*

Abstract *- Thirty sea bream were captured from a Sardinian lagoon (Italy) in January-February 2009 and their intestinal tracts were analysed by conventional microbiological methods. The mean counts of aerobic heterotrophic viable bacteria were estimated to be 1521 colony forming units (cfu/g), the mean numbers of Enterobacteriaceae and Coliforms were 409 cfu/g and 187 cfu/g respectively. A total of 100 pure colonies were studied by phenotipic tests. Gram negative bacteria were found to be dominant and* Vibrio *spp. proved to be present in greater numbers than* Pseudomonas *spp.*

Key-words: *intestinal microflora, gilthead sea bream, conventional microbiological methods, Sardinia.*

Introduction - *Sparus aurata* (Linnaeus, 1758) is an euryhaline species of the Sparidae family which is found in both marine and brackishwater environments (Moretti *et al.*, 1999). The study of the intestinal microflora of marine fish is important for characterising the product, in fact, the quantity and the quality of these bacteria are a reflection of different factors: the aqueous environment, seasonal variation, the diet and the gastrointestinal tract anatomy (Ringo *et al.*, 2006). The aim of this work was the microbiological characterisation of the intestinal flora of gilthead sea bream from lagoon in order to evaluate the quality of fish which reflects the hygienic conditions of the aqueous environment.

Materials and methods - Thirty sea bream (mean weight 349±41 g) were captured in January-February 2009 from Tortoli lagoon (eastern Sardinia, Italy: Lat 39°56' 854''N, Long 9°41'160''E). Water average chemical-physical parameters were as follows: temperature 12.6 (°C), salinity 30.14 (‰), dissolved oxygen 102 (%) and pH 8.2. The intestine between the pyloric caeca and the anus of each fish was removed, weighted off aseptically and homogenised in peptone saline solution (0.85% NaCl, 0.1 g peptone) in plastic bags by Stomacher® 400. Serial dilutions were seeded onto duplicate poured plates. Culture media, bacterial growth conditions and group of microorganisms detected were as follows: Plate Count Agar (PCA) was incubated at 30°C for 48 h and Nutrient Agar (NA) at 28 °C for 72h in order to count the aerobic heterotrophic viable bacteria, Violet Red Bile Glucose Agar (VRBGA) and Violet Red Bile Agar Mug (VRBA-MUG) were put at 30 °C for 24 h for enumerating Enterobacteriaceae, Coliforms and *Escherichia coli* respectively and de Man-Rogosa-Sharpe (MRS) agar was put at 28 °C for 7 days for counting probiotics. A total of 100 colonies from 10 intestinal samples (10 for each fish) were isolated randomly from NA plates, purified and stored at -80 °C in a 40% (v/v) glycerol-Nutrient broth solution. The isolates were reactivated and observed for cell shape, motility, Gram staining and catalase reaction. They were streaked on thiosulphate-citrate-bile salt agar (TCBS, Microbiol) and incubated at 28 °C and 40 °C for 24-48 h and on *Pseudomonas* agar F medium (Liofilchem) at 37 °C for 24 h in order to identify the presumptive genera *Vibrio* and *Pseudomonas* respectively. The colonies which grew on TCBS agar and showed a yellow or greenish colour were indicative for presumptive *Vibrio* species while the colonies which grew on *Pseudomonas* agar F medium, appeared surrounded by a yellow to greenish-yellow zone and produced a bright green colour which fluoresces under UV light, were considered to belong to the *Pseudomonas* spp.

Results - The microbiological quantitative analyses showed the following mean values: the counts of aerobic heterotrophic viable bacteria proved to be 1521 cfu/g (from 0 to 8550), Enterobacteriaceae were 409 cfu/g (from 0 to 4250) and Coliforms were 187 cfu/g (from 0 to 1405). As regards the counts of probiotics observed on MRS medium, only 6 out of 30 intestinal samples showed the presence of bacteria able to growth on this medium with a mean number of 5 cfu/g (from 0 to 6). The qualitative characterisation of 100 colonies by basic phenotypic tests, indicated that the dominant microflora was constituted of 77 Gram negative microorganisms (75 rod-shaped bacteria and 2 coccal shaped ones). Twenty-three out of 100 isolates proved to be Gram positive (17 rods, 6 cocci and 1 spore forming rod-shaped microorganism). Most of the isolates were catalase positive. On the base of the growth, the diameter and the colour of the colonies observed on selective media used, we found one group of presumptive *Vibrio* (27%) which merged both mesophylic (21%) and thermophylic bacteria (6%), a second group of *Pseudomonas* spp. strains (7%) and an unidentified group (39%).

Conclusions - The quantitative microbiological analyses of the intestine of *Sparus aurata* examined evidenced higher values of bacteria than what found in the intestine of sea bream reared in floating cages (Floris *et al*., 2009). However, these values proved quite low if compared with other studies performed on a different fish species (Al-Harbi *et al*., 2004). These results demonstrate how the bacterial flora is influenced by various factors which are worth to be monitored. The qualitative analyses of intestinal microflora showed a dominance of Gram negative bacteria. The bacterial intestinal load detected in this study indicates the good quality of both fish and the water where the sea bream live. Further studies are being conducted by means of 16S rDNA analysis in order to identify all the bacterial isolates at species level.

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IMMUNOHISTOCHEMICAL DISTRIBUTION OF NMDAR1 RECEPTOR IN THE CYPRID OF *BALANUS AMPHITRITE* (=*AMPHIBALANUS AMPHITRITE*) (CRUSTACEA, CIRRIPEDIA)

DISTRIBUZIONE IMMUNOISTOCHIMICA DEL RECETTORE NMDAR1 NELLA CIPRIS DI BALANUS AMPHITRITE *(*=AMPHIBALANUS AMPHITRITE*)* *(CRUSTACEA, CIRRIPEDIA)*

Abstract – *In this work, we used immunochemical methods to investigate the occurrence of the NMDA ionotropic glutamate receptor (NMDAR1) in the cypriд of* Balanus amphitrite *(*=Amphibalanus amphitrite*). Immunoreactivity was detected out of the central nervous system in neuronal and non-neuronal sites. In fact, NMDAR1 immunoreactivity was seen in thoracic appendages, at level of neuromuscular junctions, as previously demonstrated in crustaceans, and in antennules. Positive responses were also detected in ommatidum cells, maybe with non visual function, and in the tegumentary system, probably with non neural functions.*

Key-words: *Barnacle cyprid, Glutamate, NMDA receptors, neuromuscular junctions.*

Introduction - The ontogenetic cycle of the barnacle *Balanus amphitrite* (Darwin, 1854) includes a cyprid that binds submerged surfaces by its antennulae and the secretory product of a cement gland, metamorphosing into a sessile adult. Recently γ-aminobutyric acid (GABA) and GABAergic receptors have been localized in the *B. amphitrite* cyprid (Gallus *et al.*, 2010). The thoracic occurrence of immunoreactivity at level of striated muscular fibers agrees with that reported for other crustaceans. According to data of Feinstein (2001) on crustacean muscle, both GABA and Glutamate, ionotropic and metabotropic receptors might be distributed in excitatory as well as inhibitory nerve terminals. Since Feinstein *et al.* (1998) have identified occurrence of NMDA-type glutamatergic receptors in crayfish neuromuscular junction, we have investigated the presence of such molecules receptors in the whole *B. amphitrite* cyprid. The occurrence of NMDA receptors might indicate a role for glutamate in the neuromuscular control in *B. amphitrite* cyprids.

Materials and methods – Two hundred cyprids from laboratory cultures were anesthetized with Sandoz-222 (Sigma, USA) (1:1000), fixed, rinsed, dehydrated, embedded in paraplast and sectioned. Primary Ab was a polyclonal: rabbit Ab, anti NMDA receptor 1 (NR1-pan) (Millipore, USA). The secondary Ab was a goat anti-rabbit conjugated with Alexa Fluor 488 (Green fluorescence - Molecular Probes, USA). Nuclei were counterstained with propidium iodide (Red fluorescence – Molecular Probes, USA). The sections were observed by a CLSM DMI6000B-CS CLSM with a TCS-SP5 AOBS scanning head, (Leica, Germany). Controls: preabsorption of the I Ab with cyprids crude extract and omission of I Ab. No immunostaining was detected in controls.

Results - In thoracic muscles (Fig. 1), NMDA R1 immunoreactive (IR) nerve terminals were localized on muscle cells and ramified in proximity of the nuclei. In the compound and naupliar eyes ommatidia, the cytoplasmic granules appeared also IR (not show). It was not determine whether these granules belonged to retinular cells and/or to pigment cells. The rhabdom of the retinular cells were not IR. Weak IR fibers were localized within the antennules and finally NMDA R1 immunoreactivity was also observed in the cytoplasm of epidermal cells (Fig. 2).

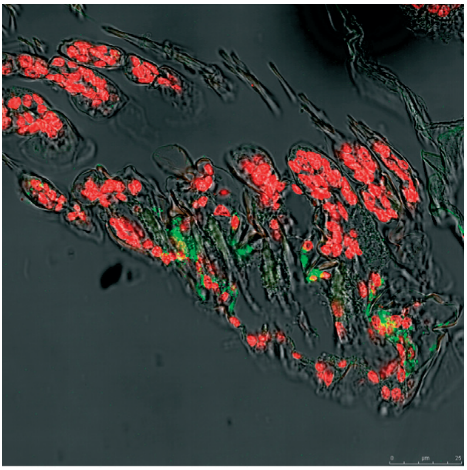

Fig. 1 - IR muscle cells in the thoracic segment.
Immunoreattività nel torace.

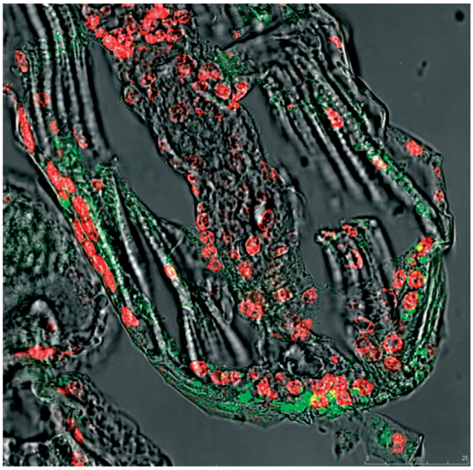

Fig. 2 - IR terminals: muscles and epidermis.
Immunoreattività in muscoli ed epidermide.

Conclusions – Considering our results as well as the literature, the *B. amphitrite* cyprid neuromuscular junctions should posses NMDA R1 receptors together to GABAergic receptors, as suggested for crustacean muscular innervations (Feinsten, 2001). Nerve fibers involved possibly originate from GAD65/67 IR neurons localized in the posterior ganglion (Gallus *et al.,* 2010). Occurrence of NMDA R1 IR sites in the eyes and in the epidermal cells agree with the hypothesis that GABA molecules play a role in non visual eye functions, since the photoreception neurotransmitter appears to be histamine. Furthermore GABA may be involved in non neural functions of tegument cells.

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SCREENING FOR BIOSURFACTANT PRODUCTION BY ANTARCTIC MARINE BACTERIA

SCREENING PER LA PRODUZIONE DI BIOSURFATTANTI AD OPERA DI BATTERI MARINI ANTARTICI

***Abstract** - This study was carried out on 403 Antarctic marine bacteria. Hemolytic and emulsification activities, production of stable emulsion, surface tension reduction and CTAB assay were used to select biosurfactant-producing bacteria. Acinetobacter sp. 11/4 resulted the best promising strain with 56.60% of a stable emulsion value when growing at 15 °C in presence of soybean oil as carbon source, and 10.9 mN/m of surface tension at 15 °C on tetradecane.*

***Key-words:** biosurfactants, emulsifiers, hydrocarbon degradation, bioremediation.*

Introduction - Research on microbial emulsifying agents has been mainly focused on mesophilic bacteria. Conversely, few publications report on emulsifiers and surfactants produced by psychrophilic and psychrotrophic bacteria (Lo Giudice *et al*., 2010). Isolation of indigenous cold-adapted microorganisms, which produce specific molecules that increase emulsification of hydrocarbons, could have promising applications for bioremediation purposes. In addition, the introduction of non-native species to Antarctica is forbidden by the Antarctic Treaty and, therefore, the eventual utilization of autochthonous microrganisms is requested. Microbes adapted to Antarctic conditions may be valuable as bioaugmentation agents also in other cold climates.

In this context, the aim of the present work was to investigate the capacity of native Antarctic bacteria to produce biosurfactants under different conditions of temperature and substrate.

Materials and methods - This study was carried out on 403 bacterial strains belonging to the Italian Collection of Antarctic Bacteria (CIBAN) of the National Antarctic Museum (MNA) "Felice Ippolito" kept in our laboratory at the University of Messina. Bacterial strains were preliminary grown at 4 °C in a mineral medium supplied with crude oil (Arabian Light, Sigma) as a sole carbon source. Oil-degrading isolates were selected for further analyses aimed at individuating biosurfactant producers, as follows. Strains were inoculated in a mineral medium with soybean oil (2%) and incubated by shaking under aerobic conditions for two weeks at 15°C. pH values and bacterial growth were measured during the assay. During all the growth phase, cell suspensions were tested for the eventual presence of biosurfactants by using the emulsification assay (EA), the detection of E24 index (Tuleva *et al.,* 2002), the measure of the surface tension (ST) according to the Wilhelmy method with a digital tensiometer TSD (Gibertini), the CTAB and Blood Agar (BA) assays (Fiebig *et al.,* 1997). Strains identification was carried by the 16S rDNA sequencing according to Michaud *et al.* (2004). The most promising isolate were than tested to evaluate the biosurfactant production during their growth at 4 and 15 °C in the presence of soybean oil or tetradecane as a carbon source.

Results - A total of forty-two bacterial isolates showed visible crude oil degradation. Among them, thirteen isolates were screened for biosurfactant production. ST reduction was displayed before appearance of the maximum emulsion value and E24 rate, which were obtained during the exponential growth phase for the majority of the strains. All of them were able to produce emulsion, but only four strains gave more than 20% of E24 index. Hemolytic activity on BA plates was observed for five strains. Moreover, three strains produced dark blue halos on CTAB agar plates, thus suggesting the anionic nature of such biosurfactants.

Based on the phylogenetic affiliation, among biosurfactant producers strains related to *Rhodococcus* spp. resulted predominant, followed by *Psychrobacter* and *Micrococcus*. *Acinetobacter* sp. 11/4 seemed to be the best emulsion producer as shown by both the E24 index (43.30%) and the surface tension (21 mN/m) values. For this reason such a strain was chosen to investigate the effect of temperature and substrate on the biosurfactant production. During its growth with soybean oil as carbon source, the emulsion index resulted 46.6 and 56.60% at 4 and 15 °C respectively, the highest values recorded. Finally, *Acinetobacter* sp. 11/4 displayed the lowest ST values (10.9 mN/m) at 15 °C on tetradecane.

Conclusions – To date, strains belonging to the genus *Acinetobacter* have never been reported as biosurfactant producer in Antarctic environment. The best combination of stable emulsion production and surface tension reduction by *Acinetobacter* sp. 11/4 was shown by using soybean oil as carbon source and an incubation temperature of 4 °C.

This finding suggests that biosurfactant producer can be also isolated from Antarctica and that they could be exploitable in bioremediation events both in their native habitat and in other cold environments.

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IMMUNOREACTIVITY TO HSP70 INDUCTION IN LARVAE OF *DICENTRARCHUS LABRAX* (L.) TREATED WITH LPS

INDUZIONE DI IMMUNOREATTIVITÀ ALLA HSP70 IN LARVE DI DICENTRARCHUS LABRAX *(L.) TRATTATE CON LPS*

Abstract *– The immunoreactivity to HSP70 was tested in 24 day-old larvae of sea bass both controls and after treatment with LPS. This stress rouses an induction of immunoreactivity in several tissue, such as skin, gills, gut, liver, renal tubules and hypophysis. The possible role of HSP70 in earlier mechanisms of stress response was discussed.*

Key-words*: sea bass, stress, Heat Shock proteins, bacterial antigens.*

Introduction – From several years we are carring out immunohistochemical studies about the appearance and distribution of regolative molecules during the larval stages of the sea bass, a fish very studied for its commercial value. In previous research (Mola *et al.,* 2005, 2009; Pederzoli *et al.*, 2007) we hypothesized an active role in the earlier immunological responses for some well-known molecules involved in responses to stress, such as ACTH, nitric oxide and CRF. These molecules work before complete differentiation of lymphocytes associated to gut (GALT), with autocrine/paracrine ways. In this work we report the results of localization, both in control and in treated with bacterial antigens animals, of immunoreactivity (IR) to HSP70, a protein of Heat Shock Protein family, involved in responses to various types of stress.

Materials and methods – Larvae (24 day-old) of *Dicentrarchus labrax* were treated with LPS (Lipopolysaccharide from *Escherichia coli* serotype 055:B5, Sigma). Twenty of these larvae were maintained in a tank containing 10 U/ml LPS. After 1 h, ten specimens were immediately fixed, while the remaining ten animals were transferred to normal tap water for another 1 h and then fixed. All these specimens, together with ten untreated larvae utilised as controls, were fixed *in toto* in Bouin fluid, embedded in paraffin and cut in 7mm transversal sections. Subsequently, the immunocytochemical procedure was performed. The slides were processed with the biotin-avidin immunohistochemistry technique (BAS) utilising the polyclonal antibodies from rabbit anti-Heat Shock protein 70 (HSP70) (d-40) (Santa Cruz, Biotecnology, California, U.S.A.), titer 1:100.

Results – Untreated specimens showed the presence of a few immunopositive cells in the skin of the entire body and in the gill epithelium. The apical border of medium and posterior intestinal epithelium was covered by a thin positive stripe and rare positive epithelial cells were present in the same regions. A moderate number of positive hepatocytes and some clusters of positive cells in the hypophysis were observed.

The larvae treated for 1 h with LPS and immediately fixed showed the presence of many immunopositive cells in the skin and gills. Numerous positive cells were also present in the epithelium of medium and posterior gut and in the rectal valve. In the same intestinal regions the apical border of epithelium was covered by a strong positive stripe. Moreover the liver showed an increased number of positive cells. An intense IR was observed in all pituitary cells. The IR appeared also in the renal proximal tubules around the lumen. In the larvae fixed 1 h following LPS treatment the IR pattern was comparable to that described for larvae immediately after treatment fixed, even if the IR disappeared in the pronephros tubules and was less intense in the hepatocytes.

Conclusions – Our results showed a different IR pattern in treated and untreated larvae. Indeed, we observed an IR induction of HSP70 in a greater number of cells and in some tissues after treatment with LPS, particularly in a short time (1 h).

Most of the evidences about how the generalized stress response and HSPs expression may be related comes from mammals studies. Hypophysectomized rats did not show the HSP gene expression in response to stress and addition of ACTH to those rats induced HSP expression in the adrenals glands. These data support the idea of a functional relationship between HSP expression and hypothalamus-pituitary-adrenal axis (Iwama *et al*., 1999). Some data are available for fish, showing the increase in HSPs (60, 70, 90 kDa) in various tissues of different species subjected to stressors, such as heat shock, environmental contaminants and bacteria. Liver, kidney and gills seem to be the most sensible tissues to HSPs response (see Iwama *et al*., 1999). In the sea bass larvae the involved organs are liver, pronephros tubules, gut, skin, gills and hypophysis. This suggest that the HSP response involves a greater number of organs in larvae than in adults fish.

The IR to HSP70 in 24 day-old larvae LPS treated are very similar to those described previously for ACTH-IR in the same larval stages (Mola *et al*., 2005). This may indicate that HSP70 also belongs to the pool of molecules involved in the early immune responses of sea bass larval stages.

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EVALUATION OF DIFFERENT CARBON SOURCE FOR BIOSURFACTANT PRODUCTION

UTILIZZO DI DIFFERENTI FONTI DI CARBONIO PER LA PRODUZIONE DI BIOSURFATTANTI

Abstract *– A study was carried out to investigate biosurfactant production under different growth conditions by oil degrading bacteria isolated from oil contaminated water samples of Mediterranean Sea. Two strains of* Pseudomonas *sp. and a strain of* Acinetobacter calcoaceticus *were inoculated in mineral medium (ONR 7a) with three different type of carbon sources in order to detect the use of different substrate for biosurfactant and bioemulsifiers production. Both hydrocarbon and vegetable oil substrate were useful for biosurfactant production showing specificity with each strain.*

Key-words: *Biosurfactants, emulsifiers, hydrocarbons, bioremediation.*

Introduction – Biosurfactants (SURFace ACTive ageNTS) are complex polymers produced on living surfaces, mostly microbial cell surfaces, with amphiphilic molecular structure, consisting of a hydrophilic and a hydrophobic domain. Due to their molecular structure, biosurfactants have the properties of reducing surface tension, stabilizing emulsions, promoting foaming (Georgiou *et al*., 1992; Desai, 1997). In recent years natural biosurfactant have attracted attention because of their low toxicity, biodegradability, ecological acceptability and therefore potential application in environmental protection.

Hydrocarbon-contaminated sites are the most promising for the isolation of biosurfactant producing microbes, because they synthesize surface active agents during growth on water-insoluble substrates. When microorganisms are cultivated on n-alkanes or other hydrocarbons, biosurfactant are accumulated in the culture medium. Their activity as emulsifiers may facilitate mass transfer on the surface of microorganism (Kitamoto *et al*., 2002). Biosurfactants can be produced by microbial fermentation processes using cheaper agrobased substrates and waste materials (Mukherjee *et al*., 2006). This aspect is very important because the production of microbial surfactants on a commercial scale has not been realized because of their low yields and high production costs.

The aim of this work was to analyze three different bacterial strains for their ability to produce biosurfactants when grown under different carbon source conditions.

Materials and methods – Two strains of *Pseudomonas* sp. and 1 strain of *Acinetobacter calcoaceticus* (isolated from oil contaminated water samples of Mediterranean Sea) were inoculated in mineral medium (ONR 7a) with three different type of carbon sources: tetradecane, glucose and soybean oil. The growth was recorded and measured spectrophotometrically as values of OD_{600}. Several independent tests were used for the detection of biosurfactants (rhamnolipids) or bioemulsifiers. Qualitative biosurfactant activity assay was performed using a preliminary emulsification test; then a larger emulsification test was performed to detect E_{24} index. Reduction of surface tension (ST) was determined with a digital tensiometer TSD (Gibertini), according to Wilhelmy method. Further techniques were performed as Bacterial Adhesion To Hydrocarbons (BATH) assay, hemolysis of erythrocytes by rhamnolipids (Blood Agar Test). Finally C-TAB Agar Plate Assay was performed to all strains, a semi-quantitative assay for detection of extracellular glycolipids or other anionic surfactants production.

Results – *Pseudomonas* strains showed best growth on glucose and vegetable oil as carbon source. Corresponding to the maximum value of OD_{600} on glucose as carbon source, 100% of emulsifying activity was measured, and an E24 index value of 30% was detected. Lower values of OD_{600} were observed on tetradecane and soybean oil as substrates in relation to a lower emulsifying activity (75 and 60% respectively). *Acinetobacter* strain gave better results on soybean oil and tetradecane, showing values of emulsifying activity between 80 and 40%, accompanied by a reduction of surface tension after only 48 hours with a value of 19.7 mN/m on soybean oil. *Pseudomonas* strains had a higher hydrophobicity (BATH) in comparison to *Acinetobacter*. Biosurfactants produced by every tested strains had hemolytic activity, confirmed by a clear or green zone (β or α-hemolysis) on a blood agar plate. The only positive result recorded on C-TAB Agar Plate Assay was obtained by a *Pseudomonas* sp. strain grown with vegetable oil as carbon source.

Conclusions – The production of the biosurfactant was found to be a function of cell growth, with maximum production occurring during the exponential phase.

All the strains produced emulsion, but only a *Pseudomonas* sp. was able to gave a stable emulsion. *Acinetobacter* sp. was the better strain for biosurfactant production but was unable to metabolize glucose, while *Pseudomonas* strains degrade in an optimal way all the substrates, as confirmed by the BATH test results. Biosurfactants showed hemolytic activity, and a *Pseudomonas* sp. strain gave positive result for anionic surfactant production. Finally, we can assume that use of soybean oil as substrate in the culture medium represents a good alternative at lower cost to improve further application. However, could be useful increase studies in this field.

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SEASONAL VARIATION IN PAHs CONCENTRATION IN THREE SPECIES OF TALITRID AMPHIPODS (CRUSTACEA)

VARIAZIONE STAGIONALE DELLA CONCENTRAZIONE DI IPA IN TRE SPECIE DI ANFIPODI TALITRIDI (CRUSTACEA)

Abstract *– We evaluated the possibility that seasonal changes in PAHs environmental availability may affect the concentrations of those contaminants in three species of talitrid Amphipods.* Talitrus saltator *and* Orchestia montagui *seem to preferentially accumulate PAHs in the summer, instead* Platorchestia platensis *shows an opposite trend. PAHs accumulation in these animals is probably influenced by the season, nevertheless supralittoral amphipods could be promising bioindicators of PAHs contamination.*

Key-words: *talitrid amphipods, PAHs, seasonal variation.*

Introduction – The use of various organisms as bioindicators of Polycyclic Aromatic Hydrocarbons (PAHs) contamination in the marine environment has been assessed in many studies (Meador *et al.*, 1995; Baumard *et al.*, 1998). One of the factor which could influence the PAHs environmental availability and the concentration of these contaminants in the animals could be the season. Recent studies on talitrid amphipods showed that these crustaceans could accumulate PAHs (Somigli *et al.*, 2008). In this paper we evaluated the possibility that the seasonal changes in these organic compounds availability in the supralittoral zone may affect the concentration of PAHs in sandhoppers and beachfleas living on supralittoral soft and hard substrata.

Materials and methods – Adult individuals of *Talitrus saltator*, *Orchestia montagui*, *Platorchestia platensis* (Crustacea, Amphipoda), sand and stranded organic material (mainly *Posidonia oceanica*) were collected during one summer (September 2008, June 2009) and one winter season (early March 2009) in different localities (shores of Tuscany, Elba Island and Corsica). *T. saltator* were collected at 12 localities, *O. montagui* at 7 sites, while *P. platensis* at two localities. Samples were freezed, dehydrated at 25° and then freeze-dried. The qualitative and quantitative determination of the 16 polycyclic aromatic hydrocarbons from the US EPA (United States Environmental Protection Agency) priority pollutants list was performed using an HPLC with UV (Waters® PDA 996) and fluorescence (Waters® 474 Scanning Fluorescence Detector) detectors.

Results – The Fig. 1 shows the biota-sediment accumulation factor, BSAF (BSAF=PAHs concentration in the animals/PAHs concentration in the substratum), of the 16 PAHs divided per group of aromaticity in the three species of talitrid Amphipods during the summer and winter period. *T. saltator* seems to accumulate heavier compounds (penta- and hexa-aromatics) during the summer, while during the winter BSAF results >1 (1,05) only for PAHs with 2 or 3 aromatic rings. In the summer, the biota-sediment accumulation factor of *O. montagui* is >1 for tetra-, penta- and hexa-aromatics PAHs, whilst in winter this beachflea accumulates only organic compounds with less than 3 aromatic rings. In March the BSAF for the beachflea *P. platensis* is >1 for PAHs with 2, 3, 4 and 5 aromatic rings, in June for PAHs penta-aromatics or having less than 3 aromatic rings.

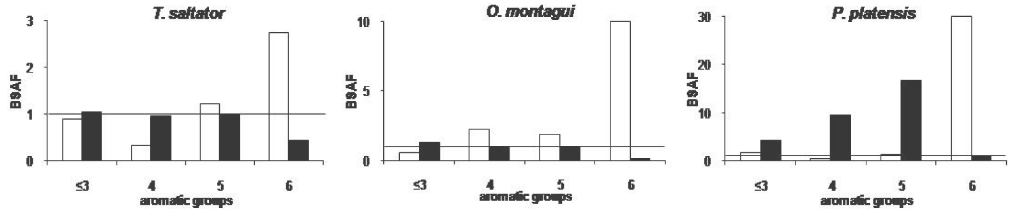

Fig. 1 - BSAF of PAHs per groups of aromaticity (≤3, 4, 5 and 6 aromatic rings) in *T. saltator*, *O. montagui* and *P. platensis* during the summer (white bars) and winter (black bars) period. Black line: BSAF=1 value.

BSAF degli IPA divisi per gruppi aromatici (≤3, 4, 5 e 6 anelli aromatici) in T. saltator, O. montagui *e* P. platensis *nel period estivo (barre bianche) e invernale (barre nere). Linea nera: valore di BSA =1.*

Conclusions – Our results confirm that sandhoppers and beachfleas seem to accumulate PAHs. Furthermore there is a tendency to accumulate the heavier molecular weight PAHs (with more aromatic rings) differently from other marine crustaceans (Baumard *et al.*, 1998). The higher concentration of PAHs during the winter period in *P. platensis* is in line with other studies (Baumard *et al.*, 1999). The concentration of these organic pollutants in *T. saltator* and *O. montagui,* instead, is higher in summer when the environmental availability is lower than in the winter period, because of the most intensive summer degradation due to the direct action of sun radiation and UV-rays. Therefore, these Amphipods could be good bioindicators of PAHs contamination for the supralittoral zone and seasonal variation of PAHs concentrations in these animals indicates that season and temperature are factors which need to be considered using Amphipods as PAHs bioaccumulators.

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EFFECT OF SAND CONTAMINATION ON LOCOMOTOR ACTIVITY OF *TALITRUS SALTATOR* (MONTAGU)

EFFETTO DELLA CONTAMINAZIONEDELLA SABBIA SULL’ATTIVITÀ LOCOMOTORIA DI TALITRUS SALTATOR *(MONTAGU)*

Abstract *– The aim of this study was to assess the influence of sand contamination with Cu on locomotor activity of* Talitrus saltator*, a well-known biomonitor of trace metals of sandy beaches. Results show that the effect of Cu contamination on locomotor activity of sandhoppers varies according to the exposure concentration. Moreover, the analysis of Cu concentration reveals that sandhoppers accumulate Cu from sand in a dose - dependent way.*

Key-words: *Amphipods, trace metals, behavioural biomarkers, locomotor activity.*

Introduction - Changes in animal behaviour induced by the exposure to contaminants have been used as biomarkers fairy recently despite their ecological relevance (Amiard-Triquet, 2009). The control of the spatio-temporal aspects of various activities is essential in many animal species and is associated with complex physiological and behavioural mechanisms. The sandhopper *Talitrus saltator*, a well-known biomonitor of trace metals contamination sandy shores (e.g. Ugolini *et al*., 2004), is a good biological model for the study of the effect of pollutants on locomotor activity. In fact, the activity rhythm of sandhoppers has been extensively studied and presents a circadian (nocturnal) periodicity influenced by the photoperiod (Williams, 1980). In this study we evaluate the effect of exposure to Cu contaminated sand on the locomotor activity of *T. saltator*.

Materials and methods – Adults individuals of *T. saltator* were collected on the beach of Fiume Morto Vecchio (Pisa, Italy) in summer 2008. In laboratory groups of 15 adults sandhoppers were kept for 7 days, in artificial moist sand, contaminated with different concentrations of Cu (10 and 20 ppm) and control (uncontaminated sand). Experiments were carried out in a thermostatically controlled room (20°±1) with a light: dark (L:D) cycle 12:12. The locomotor activity was recorded by a microwave radar (Guardall MX950, 24 Ghz) connected to a computer provided with appropriate software and already employed to monitor activity rhythm in *T. saltator* (Ugolini *et al*., 2007). The comparison between the locomotor activity recorded, for each concentration tested, during the hours of darkness and light was made using the Sign-test. The content of Cu in sandhoppers at the end of the trials was measured by ICP-OES (see Ugolini *et al*., 2004).

Results - Sandhoppers tested in the presence of 10 ppm Cu exhibited an increase in activity (23631 bounds) than the control (14266 bounds) (Fig. 1). In contrast, amphipods exposed to 20 ppm of Cu showed a noticeable reduction of total locomotor activity (506 bounds) and, furthermore, respect to controls and animals exposed to 10 ppm, the activity was not concentrate during the hours of darkness (Fig. 1). The analysis of Cu content in tissues of amphipods raise with increasing of the exposure concentration (56 ppm in controls, 105 and 136 ppm in animals exposed, respectively, to 10 and 20 ppm of Cu).

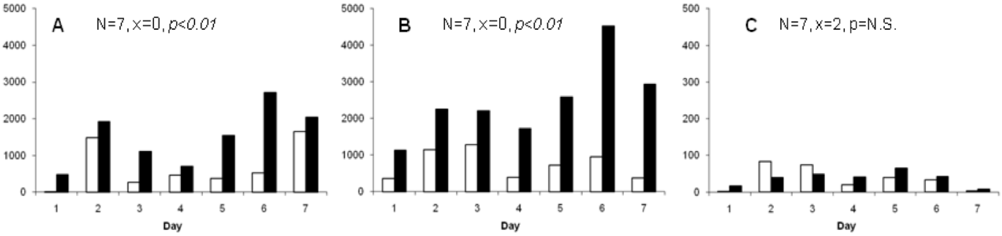

Fig. 1 - Daily locomotors activity of control sandhoppers (A), exposed to 10 ppm (B) and 20 ppm of Cu (C) recorded during the hours of darkness (black bars) and the light (white bars). In each graph the values of Sign-test are also reported. In C the scale has been changed for graphical reasons.

Attività locomotoria giornaliera registrata nei talitri di controllo (A), esposti a 10 ppm (B) e a 20 ppm di Cu (C) durante le ore notturne (barre nere) e diurne (barre bianche). In ogni grafico è riportato il valore del Sign-test. Nella fig. C la scala è stata cambiata per esigenze grafiche.

Conclusions – The behavioural responses observed in our study have also been reported in the freshwater amphipods *Gammarus pulex* exposed to different concentrations of Cu in water (Mills *et al.*, 2006). Moreover our findings are also supported by the LC_{50} (Ungherese and Ugolini, 2009) for *T. saltator*. In fact, at lower concentration (10 ppm) than LC_{50} (13.28 ppm), sandhoppers increase their locomotor activity. In contrast, amphipods exposed to higher concentration (20 ppm) than LC_{50} show a noticeable decrease of locomotor activity as possible consequence of toxicity of Cu. In conclusion our data demonstrate that the system utilized can detect modifications in locomotor activity pattern between amphipods exposed to clean and Cu contaminated sand and the observed difference could be used as exposure biomarkers. Moreover, our results demonstrate that sandhoppers take up Cu from sand in a dose - dependent way.

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RETE ISPRA DI MONITORAGGIO DEI CETACEI DA TRANSETTO FISSO IN TIRRENO E MAR LIGURE

ISPRA CETACEAN MONITORING NETWORK ALONG FIXED TRANSECT

***Abstract** - As most EU countries, Italy is required to monitor trends in cetacean status, although there is a gap between policy need and the availability of information and funding. Ferry and other fixed transect survey platforms survey data has considerable potential as a low-cost tool to inform conservation research and policy. From 2007 ISPRA networked a monitoring program, using ferries as a research platform.*

***Key-words**: cetology, methodology, monitoring, international policy.*

Introduzione - La tutela e conservazione delle specie di cetacei che compiono il loro ciclo vitale o passano occasionalmente nei mari di riferimento dell'Italia è regolata da leggi nazionali e da accordi e direttive internazionali. Questi obblighi normativi, seppur con alcune differenze fra loro, richiedono la conoscenza ed il monitoraggio dello stato delle popolazioni come base informativa su cui impostare azioni specifiche di tutela e conservazione. Molti problemi sono però legati all'attuazione di programmi di monitoraggio sui cetacei, quali la necessità di ottenere una visione di larga scala, la ripetibilità dei surveys nel tempo per la valutazione dei trend e le correlazioni con i potenziali fattori d'impatto, la raggiungibilità di aree di alto mare, i costi. Dal 2007 ISPRA, Dipartimento Difesa della Natura, ha attivato un network di enti per realizzare un progetto di monitoraggio dei cetacei in simultanea e su larga scala basato sul metodo del survey su rotta fissa (Fixed Line Survey approach - FLS). Il metodo è in uso in Atlantico dal '94 per il monitoraggio di larga scala e la valutazione dei trend delle popolazioni di cetacei (MacLeod *et al.*, 2007). In Mediterraneo è stato sperimentato a partire degli anni '80 (Marini *et al.*, 1997; Cottè *et al.*, 2009). Lo stesso metodo viene inoltre utilizzato per lo studio di altri taxa (LIPU, 2008). Scopo principale del progetto ISPRA è quello di testare la metodologia per un suo utilizzo nel Mediterraneo centrale al fine di rispondere agli obblighi di normativa in materia di conservazione delle popolazioni di cetacei.

Materiali e metodi - I FLS sono rotte singole, che possono essere ripetute nel tempo riducendo così i rischi di errori dovuti alla eterogeneità ambientale e permettendo quindi una più accurata stima di popolazione; in più, mantenendo costanti alcuni dei parametri ambientali fissi (es. profondità, distanza dalla costa, articolazione del fondale) permette di correlare con migliore approssimazione lo stato ed i trend delle popolazioni di cetacei con i parametri ambientali variabili (es. temperatura, clorofilla, correnti) ed i potenziali fattori di impatto antropogenico. Il transetto fisso può essere monitorato da una piattaforma di ricerca dedicata ma anche da qualsiasi imbarcazione che percorra periodicamente la rotta scelta, come ad esempio navi o traghetti di linea, riducendo così enormemente i costi del monitoraggio. Un maggior numero di transetti monitorati aumenta il potere di valutazione dei trend. Il network coordinato da ISPRA, in collaborazione con le Università di Genova, Pisa, Tuscia, Roma1, Catania, Fondazione CIMA, Accademia del Leviatano e Ketos, monitora ad oggi 5 transetti trans-regionali fissi che forniscono settimanalmente dati sul mar Tirreno e mar Ligure occidentale per un totale di quasi 900 Miglia Nautiche.

Risultati - A tre anni dall'inizio del progetto il metodo ha fornito interessanti risultati: tutte le otto specie di cetacei segnalate nel Mediterraneo sono presenti nell'area di studio anche se con delle differenze a volte notevoli in termini di presenza e abbondanza delle specie fra i diversi mari (Arcangeli *et al.,* 2009). La balenottera (*Balaenoptera physalus*), di cui altri studi hanno rilevato una generale diminuzione di presenza nel Mar Ligure negli ultimi decenni (Panigada *et al*., 2005, Lauriano, 2008), sembra invece aver modificato la sua distribuzione su larga scala (Arcangeli *et al.,* 2009) facendo registrate un aumento di presenza più a sud, nel Tirreno centrale (+200% rispetto ai dati di 20 anni fa) (Marini e Arcangeli, 2010). Le ragioni di questo cambiamento sono ora oggetto di nuovi studi per correlare presenza e distribuzione degli animali con i parametri ambientali e antropici che possono influenzare la biologia della specie. Fra le altre cose, lo studio conferma l'hot spot di presenza di cetacei nel Mar Ligure occidentale ed evidenzia l'esistenza di un'area ad elevata diversità e abbondanza di specie nel Tirreno centrale, area in cui non sono ancora presenti forme specifiche di protezione e che mette in luce la necessità di urgenti azioni specifiche di tutela e conservazione (Arcangeli *et al.,* 2009). I risultati ottenuti dimostrano l'utilità del metodo del transetto fisso per soddisfare buona parte delle richieste delle principali normative vigenti, soprattutto per quel che riguarda la valutazione dello stato ed il monitoraggio di distribuzione delle specie, abbondanza relativa e uso dell'habitat.

Conclusioni - Il FLS è risultato particolarmente utile per monitorare gli aspetti temporali della biologia delle specie e le variazioni temporali dello stato delle popolazioni e per correlare i dati spazio temporali delle popolazioni di cetacei con i fattori antropici ed ambientali. Tutte informazioni, queste, indispensabili per valutare lo stato di conservazione delle specie, i fattori e le modalità di impatto e per pianificare azioni mirate di tutela e conservazione, come richiesto dalle normative in materia.

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ESPERIENZA DI AGGREGAZIONE DI DATI TRAMITE L'UTILIZZO DI GIS: IL PROGETTO TURSIOPS PELAGOS

AN EXPERIENCE OF DATA AGGREGATION THROUGH GIS USE: THE TURSIOPS PELAGOS PROJECT

Abstract *- To investigate the ecological habits, the spatial behaviour and the abundance of the bottlenose dolphin (*Tursiops truncatus *Montagu, 1821, Delphinidae) in the Pelagos Sanctuary MPA, we collected data coming from 10 different research groups operating in the area from 1994 to 2007. We used GIS (ArcGis 9.3) software to aggregate and to analyze the georeferred data coming from the different research sub-areas.*

Key-words*: cetology, data collections, marine parks.*

Introduzione - Il tursiope (*Tursiops truncatus*) è un delfinide cosmopolita, con abitudini prevalentemente costiere, regolarmente presente nel bacino Mediterraneo. Il Santuario Pelagos è la più grande area marina protetta del Mar Mediterraneo (circa 87.500 km^2); è localizzato nella porzione nord occidentale del bacino e comprende acque italiane, francesi e monegasche (incluse le coste della Corsica e della Sardegna settentrionale). La presenza del tursiope nel Santuario Pelagos è ben documentata ma le sue abitudini ecologiche e la sua abbondanza sono poco note. Il presente lavoro di aggregazione dati intende fornire informazioni originali in relazione alle abitudini ecologiche, al comportamento spaziale e all'abbondanza del tursiope all'interno del Santuario Pelagos.

Materiali e metodi - Abbiamo raccolto e analizzato dati provenienti da 10 diversi gruppi di ricerca che hanno svolto attività nel Santuario Pelagos tra il 1994 e il 2007 (Tab. 1). Abbiamo utilizzato un software GIS (ArcGis 9.3) per aggregare e visualizzare tutti i tracciati di rilevamento effettuati dalle diverse piattaforme di ricerca e i relativi punti di incontro con la specie target. Per risolvere possibili *bias* dovuti alle diverse piattaforme utilizzate e alle diverse tipologie di rilevamento, una seconda specie di delfino (*Stenella coeruleoalba* Meyen, 1833) è stata utilizzata come controllo. Per indagare il comportamento spaziale del tursiope nell'area di studio, abbiamo confrontato i dati di foto-identificazione provenienti dalle diverse sotto aree di ricerca. Gli stessi dati sono stati utilizzati per stimare l'abbondanza del tursiope utilizzando la tecnica di cattura e ricattura fotografica (Schnabel, 1938; Wursig e Jefferson, 1990).

Risultati - Abbiamo aggregato in totale 170.000 km di tracciati di rilevamento che hanno prodotto 308 avvistamenti di tursiope e 3024 avvistamenti di stenella. Lo sforzo di ricerca risulta disomogeneo nello spazio (è maggiore sotto costa e tende a diminuire da ovest verso est e da nord verso sud); tale fenomeno è legato alla posizione degli enti di ricerca coinvolti e alle loro tradizionali aree di studio. Lo sforzo di rilevamento e il relativo successo di avvistamento tendono inoltre ad aumentare nel tempo, raggiungendo i valori massimi negli ultimi anni di ricerca considerati (2005, 2006, 2007). Abbiamo confrontato i cataloghi fotografici provenienti dalle diverse aree di campionamento, identificando in totale 670 diversi individui nell'intero periodo di ricerca. Tale lavoro ci ha permesso di ricostruire gli spostamenti degli animali all'interno dell'area di studio, identificare gli areali di popolazioni o sottopopolazioni e stimare la loro abbondanza.

Conclusioni - Il lavoro effettuato ha permesso di ottenere informazioni originali sull'ecologia e sullo stato del tursiope all'interno del Santuario Pelagos, a una scala solitamente inaccessibile a singoli enti di ricerca. Questo risultato ricompensa del lungo lavoro necessario per aggregare dati provenienti da istituti di diversa tradizione e nazionalità, non sempre standardizzati nelle metodologie di raccolta dati. Ci auguriamo che il nostro lavoro possa contribuire alla creazione di reti di ricerca sempre più organizzate e normalizzate al loro interno. Solo così, a nostro avviso, sarà possibile ricostruire un quadro esaustivo sullo stato dei Cetacei del Mediterraneo.

Tab. 1 - I gruppi di ricerca coinvolti nel progetto Tursiops Pelagos.
The research groups involved in the Tursiops Pelagos project.

ENTE DI RICERCA	PERIODO	PIATTAFORMA	AREA
Delfini Metropolitani [1]	2001-2007	gommone	Levante ligure
CE.TU.S. [2]	1997-2007	barca a vela	Versilia - Elba
Tethys Res. Institute [3]	1999-2007	barca a vela	Mar Ligure ovest
WWF Liguria [4]	2005	battello turistico	Mar Ligure centro
NURC [5]	1999-2006	nave da ricerca	Mar Ligure
GECEM [6]	1996-2007	barca a vela	Corsica
DIBIO [7]	2005-2007	gommone	Mar Ligure centro, Elba
CRC [8]	1999-2007	barca a vela	Mar Ligure ovest
EcoOcéan Institut [9]	1994-2007	barca a vela	Mar Ligure ovest
Ambiente Mare [10]	2004-2007	barca a vela	Arcipelago Toscano

[1] Delfini Metropolitani, Acquario di Genova, Genova, Italy
[2] Centro CE.TU.S, Viareggio (LU), Italy
[3] Tethys Research Institute, Milano, Italy
[4] WWF Liguria, Genova, Italy
[5] NURC, Nato Undersea Research Centre, La Spezia, Italy
[6] GECEM, Groupe d'Études des Cétacés en Méditerranée, Marseille, France
[7] DIBIO, Dipartimento di Biologia, Università di Genova, Genova, Italy
[8] CRC, Centre de Recherche sur les Cétacés, Marineland, Antibes, France
[9] écoOcéan Institut, Montpellier, France and collaborators (WWF-France, FNH, EPHE, SCS and Cybelle Planète)
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STIME DI DENSITÀ E DI ABBONDANZA: IL *LINE-TRANSECT DISTANCE SAMPLING* APPLICATO DA PIATTAFORMA AEREA

LINE-TRANSECT DISTANCE SAMPLING THROUGH AERIAL SURVEYS FOR DENSITY AND ABUNDANCES ESTIMATES

Abstract *– Systematic monitoring of density and abundance of large vertebrates is among the priority actions listed in the Pelagos Sanctuary Management Plan, ACCOBAMS and by the Specially Protected Areas and Biodiversity Protocol under the Barcelona Convention. This paper discusses the suitability of aerial surveys in studying cetaceans abundance and density, presenting data collected in two surveys conducted in the Pelagos Sanctuary in winter and summer 2009. Aerial surveys allow more robust estimates than ship-based surveys for both fin whales and striped dolphins. The data are the first ever provided for the entire Pelagos Sanctuary.*

Key-words*: aerial surveys, cetaceans, population distribution.*

Introduzione - La conservazione di una popolazione richiede la conoscenza delle sue dimensioni. Tuttavia, per i cetacei, stime di abbondanza sono note solo per alcune aree del Mediterraneo (*Tursiops truncatus* - Lauriano *et al*., 2003; Bearzi *et al.,* 2009; *Stenella coeruleoalba* - Fortuna *et al.,* 2007; Lauriano *et al.,* in stampa; Forcada *et al*., 1995; *Balaenoptera physalus* - Forcada *et al*., 1995). Tra le tecniche di indagine, il *line-transect distance sampling* è tra i metodi più validi per definire il numero e la densità degli esemplari in una popolazione (Buckland *et al.,* 2001). Il metodo è applicato su *taxa* terrestri e marini; in ambiente marino, in relazione all'estensione dell'area e delle specie da indagare, è applicato da piattaforma aerea o navale.

Metodo di studio - Il *line transect sampling* prevede una fase di *survey design* e di *data analisys,* entrambe supportate dal software dedicato Distance 6.0 (Thomas *et al.,* 2006). Nella fase di *survey design,* si definisce l'area di studio e con il software si disegnano transattile rotte su una mappa di *equal coverage probability,* onde assicurare che ciascun punto abbia la stessa probabilità di essere campionato. Per ottenere un valore di varianza accettabile, è preferibile percorrere un minimo di 10-20 transetti (Buckland *et al.,* 2001). La principale assunzione nel metodo è che tutti gli animali sul transetto vengano avvistati [g(0)=1] (Buckland *et al.,* 2001); tuttavia il loro comportamento può renderli indisponibili (*availability bias*) o l'avvistatore può non osservarli, per fattori meteo climatici o relativi alle proprie capacità (*perception bias*). Quest'ultimo errore si considera generalmente trascurabile per alcune specie di cetacei, soprattutto con l'impiego di osservatori esperti, mentre una correzione dell'*avaibility bias,* anche con i dati della telemetria, è necessaria. Il disegno di campionamento ottenuto per il Santuario Pelagos prevedeva 82 transetti spaziati di 10 km, per totali 8,852.56 km. Un bimotore Partenavia P 68 con finestre a bolla per l'osservazione sulla verticale, volava alla quota (h) di 750 piedi e alla velocità di 100 miglia nautiche orarie. Tre ricercatori esperti erano a bordo, 1 per l'inserimento dei dati in computer e 2 per l'osservazione. La specie, la posizione dell'avvistamento, la dimensione dei gruppi, l'angolo (α) di declinazione e l'osservatore sono i dati registrati all'avvistamento, mentre lo stato del vento (Scala Beaufort), le condizioni generali soggettive e il grado di riflesso sul mare venivano registrate all'inizio dei transetti e nel caso di cambiamenti. L'angolo α e l'altezza h permettono di calcolare la distanza perpendicolare (x) dell'avvistamento dalla verticale della rotta, misura essenziale nel calcolo dell'abbondanza e della densità.

Risultati - Un monitoraggio invernale e uno estivo sono stati realizzati per un totale di 16,638 km percorsi, 8,144 e 8,494 km rispettivamente in inverno in estate. In totale sono stati effettuati 467 (131 invernali, 336 estivi) avvistamenti di cetacei. La stima di abbondanza per la stenella è di 19,600 (95% CI=12,300–27,000), in inverno e 39,000 (95% CI=28,000–54,300) in estate. La stima estiva per la balenottera è di 147 esemplari (95% CI=86-250).

Conclusioni - Il *line-transect distance sampling* da aereo ha permesso di ottenere, per la prima volta nel Santuario Pelagos, robuste informazioni sulla presenza e distribuzione di alcune specie di cetacei oltre alle stime di abbondanza per la stenella e la balenottera. È stata riscontrata una riduzione numerica estiva della balenottera rispetto al censimento del 1992 (Forcada *et al.*, 1995), in linea con i risultati del 2008 (Lauriano *et al.*, in stampa). Le stime non sono corrette per il *perception* e l'*availability bias* e sono quindi delle sottostime. L'utilizzo del mezzo aereo ha permesso di applicare un cospicuo sforzo di ricerca in tempi ridotti e di sfruttare le zone con idonee condizioni meteo climatiche. Inoltre, dalla piattaforma aerea è possibile contare gli esemplari nel gruppo e non stimarne il numero, come invece avviene da nave, con conseguenti vizi nella stima. Tutto ciò, unitamente al minimo disturbo arrecato agli esemplari e all'assenza di reazioni alla piattaforma di ricerca (*responsive movements*), ha permesso di ottenere stime con I.C. e C.V. più bassi rispetto ai *survey* navali.

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Il Ministero dell'Ambiente e della Tutela del Territorio e del Mare ha finanziato le campagne di ricerca

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APPROCCI METODOLOGICI INTEGRATI NELL'ANALISI GEOSPAZIALE DELLE SPECIE DI CETACEI INTORNO ALL'ISOLA DI ISCHIA (ITALIA): *WORK IN PROGRESS*

INTEGRATED METHODOLOGICAL APPROACHES TO THE GEO-SPATIAL ANALYSIS OF CETACEAN SPECIES AROUND ISCHIA ISLAND (ITALY): WORK IN PROGRESS

Abstract *- Geospatial analysis and GIS are common techniques used in ecological studies to design predictive models. Here we develop a specific model to the study of cetacean species applying various open source tools (Grass and Q-GIS, Geo Server, R, Postgresql with Postgis) to handle behavioural, acoustical, photo-identification, and survey data collected over a ten-years period around Ischia Island (Italy).*

Key-words*: GIS, models, cetaceans.*

Introduzione - L'Analisi geospaziale riflette l'integrazione della più generale analisi spaziale con la recente generazione dei Sistemi Geografici Informativi (GIS). In termini concettuali l'analisi geospaziale identifica una serie di tecniche che possono essere applicate a dati georeferenziati localizzati sulla superficie terrestre e relazionabili a tutte le attività condotte su di essa. Molti sistemi GIS applicano il termine analisi (geo) spaziale in un contesto molto ristretto (ad es. sovrapposizione o "map overlay", costruzione di zone di rispetto o "buffering", etc), oppure nel caso di coperture raster, come è il caso delle immagini, spesso il termine (geo) spaziale coinvolge una serie di tecniche applicabili alle celle della griglia, quali il filtraggio e le operazioni algebriche. A queste tecniche di base devono aggiungersi le tecniche dell'analisi geospaziale quali lo studio di una distribuzione di punti e delle relazioni geografiche tra differenti variabili, l'analisi dei raggruppamenti, lo studio della correlazione spaziale, ed infine l'analisi geostatistica per la modellazione, la stima, la validazione e la simulazione di superfici in 2D e 3D.

L'obiettivo di questo lavoro, sviluppato in collaborazione con l'unità di ricerca Machine Learning, Bioinformatics and Geospatial Technologies della Fondazione Bruno Kessler di Trento, è quello di applicare tali tecniche attraverso un approccio innovativo e mirato, in grado di integrare le diverse tipologie di dati (comportamentali, acustici, di identificazione individuale, etc) collezionati durante survey a mare effettuati per studiare le popolazioni di cetacei che frequentano le acque dell'isola di Ischia. Dal 2000 vengono infatti condotte attività di ricerca sistematica con un veliero laboratorio specificamente attrezzato (GPS, sistema di idrofoni trainati, periferica audio, pc, macchine fotografiche con teleobiettivi e videocamere), con lo scopo di studiare spazio-temporalmente le specie di cetacei dell'area (home range, distribuzione e utilizzo dell'habitat anche in relazione alle principali variabili fisiografiche; abbondanza e struttura sociale; ecologia comportamentale legata all'alimentazione e alla riproduzione; bioacustica in relazione al contesto). La complessità e la quantità di informazioni raccolte durante i survey hanno determinato l'esigenza di organizzare, sistematizzare e integrare le diverse tipologie di dati, al fine di ottenere un modello per la rappresentazione complessiva e dinamica della situazione locale anche via web.

Materiali e metodi - La metodologia utilizzata per definire il modello ha seguito un approccio sequenziale:

1) Integrazione delle diverse collezioni di dati scientifici raccolte sul campo in un database relazionale postgresql normalizzato;
2) acquisizione di mappe geografiche e batimetriche relative all'area di studio (batimetria con risoluzione a 50 m. in formato DTM e mappa UTM WGS 84 con risoluzione a 250 m.);
3) calcolo di covariate fisse per cella (depth, slope, gradient, aspect, etc) e preparazione per l'acquisizione di variabili dinamiche da fonti istituzionali (temperatura, salinità, ph, clorofilla e altri parametri dell'ecosistema marino);
4) calcolo di indici dinamici globali e per specie (es. sforzo di monitoraggio e di avvistamento, dimensione e composizione dei gruppi avvistati, etc), anche nell'ambito di singole celle a risoluzione variabile e in relazione alle diverse covariate, con relative statistiche descrittive (frequenza, somma, frequenza, max, min, media, moda, mediana, deviazione standard, varianza, errore standard, coefficiente di variazione, skewness, kurtosi, intervalli di confidenza, etc);
5) creazione, in modalità parametrica, di query dinamiche spazio-temporali sul database, con messa a punto di un "cruscotto parametri" per l'analisi degli avvistamenti (risoluzione della griglia di analisi, periodo, fascia oraria, tipologie di comportamento, durata avvistamento, specie, tipologia e intensità di suono, dimensione dei gruppi, etc.) in relazione alle diverse covariate; per migliorare le performance dalle query vengono generati vettoriali Shape statici che consentono di rappresentare e pubblicare le analisi geospaziali mediante tools come Quantum Gis "Enceladus";
6) introduzione di filtri *ad hoc* per ignorare eventi in cui si raggiunge una predeterminata soglia (sforzo di avvistamento, sforzo di monitoraggio, numero di avvistamenti, etc);
7) applicazione dei principali metodi di analisi diffusi nella letteratura specialistica di settore (es. GAM e GLMs), sia attraverso il calcolo vettoriale geometrico con Postgis sia attraverso l'uso di strumenti di statistica open source come R;
8) applicazione di altri software utili (es. Socprog per l'analisi della struttura sociale).

Poiché questo progetto è ancora *in fieri*, è possibile che la metodologia utilizzata subisca successive lavorazioni, al fine di migliorare il processo di analisi dei dati e di produzione di risultati attendibili.

Risultati e prospettive - Le analisi preliminari effettuate per testare la funzionalità del modello sono altamente promettenti e sembrano adeguatamente rispondere all'obiettivo di integrazione delle differenti informazioni nelle diverse scale spazio-temporali, anche in relazione a covariate fisse e a parametri dinamici. Tuttavia è necessario considerare la diversità eto-ecologica delle specie di cetacei presenti nell'area di studio (balenottera comune, *Balaenoptera physalus*; capodoglio, *Physeter macrocephalus*; grampo, *Grampus griseus*; globicefalo, *Globicephala melas*; tursiope, *Tursiops truncatus*; delfino comune, *Delphinus delphis*; stenella striata, *Stenella coeruleoalba*) e l'impatto del disturbo antropogenico sulle popolazioni. In futuro, queste analisi geospaziali verranno rese disponibili in ambiente WAN tramite tool Geoserver con formato Geotiff.

Biol. Mar. Mediterr. (2010), 17 (1): 408-409

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STUDIO DELLA DISTRIBUZIONE DELLO ZIFIO (*ZIPHIUS CAVIROSTRIS*) ATTRAVERSO IL RILEVAMENTO E RICONOSCIMENTO DEI SEGNALI ACUSTICI EMESSI IN IMMERSIONE

*MAPPING OF THE DISTRIBUTION OF CUVIER'S BEAKED WHALES (*ZIPHIUS CAVIROSTRIS*) BY DETECTING THE ACOUSTIC SIGNALS THEY EMIT WHILE DIVING*

Abstract *- Cuvier's beaked whales* Ziphius cavirostris *(Cuvier 1823) are elusive animals whose acoustic signals have been discovered only recently by using digital tags. Passive acoustic techniques based on sub-surface towed arrays have been developed to map their presence underwater by detecting the echolocation pulses they emit while diving. Results obtained in the Alboran Sea show the efficacy of passive acoustic methods.*

Key-words*: beaked whales, acoustic detection, Mediterranean Sea.*

Introduzione - La specie *Ziphius cavirostris* (Cuvier 1823) è nota per ripetuti spiaggiamenti di massa in concomitanza con attività navali militari con uso di sonar (Frantzis, 1998; D'Amico *et al.*, 2009). In questo contesto il rilevamento acustico assume grande rilevanza ma i primi tentativi, effettuati a partire dal 1999, sono stati infruttuosi. Le vocalizzazioni sono state descritte solo di recente con i D-TAG (Johnson e Tyack, 2003), registratori non invasivi applicati sul dorso degli animali, che registrano anche i profili di immersione che possono raggiungere i 90 minuti con profondità prossime ai 2000 m (Johnson *et al.* 2004; Tyack *et al.*, 2006). Serie di click di ecolocalizzazione vengono emessi oltre i 400m di profondità, per individuare e catturare le prede; il click è un breve segnale sinusoidale a modulazione di frequenza con una durata di 200-300 μsec e una frequenza di massima ampiezza intorno ai 40 kHz, con larghezza di banda di 20-30 kHz a -10dB rispetto al picco; la pressione acustica frontalmente raggiunge i 214 dBpp riferiti a 1 μPa / 1 m mentre nelle altre direzioni può essere oltre 25 dB inferiore (Zimmer *et al.*, 2005, 2008). Per queste caratteristiche il segnale acustico che raggiunge la superficie è debole e discontinuo, rendendone il rilevamento difficoltoso.

Materiali e metodi - Nella crociera SIRENA08 (17/05–18/06/2008), organizzata dal NATO Undersea Research Center nel mare di Alboran con la NRV Alliance, è stato condotto un survey visuale e acustico su transetti predefiniti (19/05-6/06). Il rilievo acustico è stato condotto con una cortina di due idrofoni a banda larga (>70 kHz) e basso rumore, trainata con 150 metri di cavo alla velocità di 4.8 miglia/ora a circa 18-20 metri di profondità. L'acquisizione, la registrazione e l'analisi spettrografica sono stati gestiti con un PC, convertitori A/D a 192 kHz e il software CIBRA SeaPro 2.0 (Pavan *et al.*, 2004, 2009). Operatori addestrati hanno osservato 24h/24 la visualizzazione spettrografica per riconoscere i segnali delle varie specie attese e in particolare i segnali dello Zifio, considerando come criterio discriminante anche la variabilità dell'ampiezza dei click ricevuti e la presenza di una riflessione sulla superficie marina con spaziatura tale da collocare la sorgente acustica in un cono sottostante i sensori (Zimmer e Pavan, 2008; Zimmer *et al.*, 2008).

Risultati - Su circa 3300 km di transetto in ascolto solo circa 500 km sono stati adatti all'avvistamento (ore diurne e condizioni del mare inferiori a Beaufort 4). In 500 km sono stati avvistati 10 Zifi e 6 zifidi non determinati. Il rilevamento acustico in tempo reale ha prodotto 63 clusters di contatti. La successiva analisi in dettaglio dei singoli click ha confermato 59 contatti acustici con Zifi, singoli o in coppia; in alcuni clusters è stato possibile contare il numero di individui emettitori per un totale di 96 individui sicuramente diversi. La distanza di rilevamento è stata stimata in circa 2.8 km.

Conclusioni - Da questo studio risulta che l'approccio acustico consente un efficiente ed affidabile monitoraggio della presenza dello Zifio con una operatività continua nelle 24 ore anche in condizioni di mare proibitive per gli avvistamenti. È risultata una alta affidabilità di riconoscimento in tempo reale a cui si associa la possibilità di validazione a posteriori il che consente la registrazione senza operatori dedicati 24/24h. I dati visuali hanno fornito un risultato comparabile a quello acustico, ma limitato dalle condizioni meteomarine e dalla difficile verificabilità del dato ottenuto. L'integrazione delle due tecniche aumenta comunque affidabilità ed efficacia del survey.

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CICATRICI SULLA LIVREA DELLO ZIFIO (*ZIPHIUS CAVIROSTRIS*)

*CUVIER'S BEAKED WHALE (*ZIPHIUS CAVIROSTRIS*) NATURAL MARKING*

Abstract *- Mark types present on Cuvier's beaked whales in the Mediterranean sea were identified in order to assess natural marking reliable for long-term photo-identification studies. Results revealed that this specie is well marked (96% of population) showing up to ten different mark types, but only five mark types should be considered reliable marks.*

Key-words: *natural marking, lesions, cetology.*

Introduzione - Diverse specie di cetacei presentano delle variazioni nella livrea utili per l'identificazione dei singoli individui attraverso la foto-identificazione. L'identificazione attraverso l'uso dei segni naturali o cicatrici espone alla possibilità di errore: soventemente gli individui non sono sufficientemente distinguibili gli uni dagli altri, oppure l'apparenza delle cicatrici può variare nel tempo influenzando la probabilità di ricattura durante (Hammond *et al.*, 1990). Inoltre, gli animali marcati possono essere eterogeneamente distribuiti all'interno della popolazione, classi di età o sesso, limitando gli studi ad individui che non sono rappresentativi della popolazione totale (Gowans e Whitehead, 2001). Lo scopo di questo studio è quello di descrivere i segni presenti sulla livrea degli zifii identificando, in particolare, le cicatrici durature utili per studi di cattura-ricattura.

Materiali e metodi - Le fotografie degli animali sono state collezionate tra il 1998 e il 2008, durante 126 avvistamenti, nel Mar Mediterraneo nord occidentale. Le foto ottenute sono state suddivise in classi di qualità, da Q1 a Q6, in funzione della messa a fuoco, esposizione, l'angolo dell'animale relativo al sensore, indicando con Q6 la qualità migliore (Gowans e Whitehead, 2001). Gli individui (naturalmente) marcati, fotografati sullo stesso lato in almeno due anni consecutivi, sono stati selezionati per definire i tassi di comparsa e scomparsa delle cicatrici; questi tassi sono stati calcolati come indicato in Gowans e Whitehead (2001).

Risultati - 10 differenti tipologie di cicatrici sono state fotografate sulla livrea degli zifii campionati, indicate in Fig. 1. Il 96% degli individui fotografati ha presentato almeno una cicatrice sulla livrea. Tutte le tipologie di cicatrici incontrate hanno mostrato un accumulo, nel tempo, sulla livrea degli animali (Tab. 1). Solo 5 tipologie non hanno presentato scomparse sulla livrea, durante l'intero periodo di studio (10 anni), venendo quindi catalogate come cicatrici durature. Le cicatrici durature identificate sono: notch, scar, back indentation, medium scrape and large stripe (Tab. 1). Il 71% degli animali fotografati presentava almeno una cicatrice duratura.

Conclusioni - I risultati indicano che lo zifio è una specie adatta per studi di cattura-ricattura fotografica in quanto: i) sulla livrea degli individui di questa specie sono presenti delle cicatrici durature; ii) la percentuale degli individui marcati nella popolazione è molto alta.

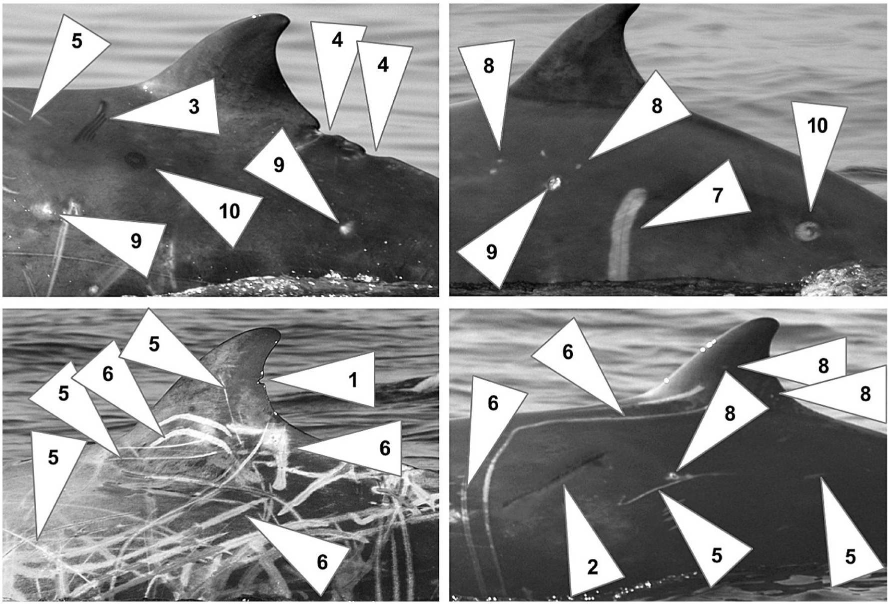

Fig. 1 - Le dieci tipologie di cicatrici identificate sulla livrea degli animali: (1) notch; (2) scar; (3) dolphin-tooth rake; (4) back indentation; (5) fine scrape; (6) medium scrape; (7) large stripe; (8) small white dot; (9) light patch; (10) attachment.

Mark types found on Cuvier's beaked whales: (1) notch; (2) scar; (3) dolphin-tooth rake; (4) back indentation; (5) fine scrape; (6) medium scrape; (7) large stripe; (8) small white dot; (9) light patch; (10) attachment.

Tab. 1 - Tassi di scomparsa (per cicatrice per anno) e comparsa (per individuo per anno) delle dieci tipologie di cicatrici identificate sulla livrea degli animali. Le cicatrici durature sono indicate in grassetto.

Gain rate and loss rate by mark types. Long-lasting marks are in bold.

	Rate of Loss (per mark per year)	Rate of Gain (per individual per year)
Notch	**0.000**	**0.019**
Scar	**0.000**	**0.019**
Dolphin-tooth rake	0.222	0.083
Back indentation	**0.000**	**0.009**
Fine scrape	0.020	2.741
Medium scrape	**0.000**	**0.741**
Large stripe	**0.000**	**0.028**
Small white dot	0.063	0.815
Light patch	0.023	0.815
Attachment	0.700	0.093

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