Decision IG 17/15: "Action Plan for the Protection of the Coralligenous and other Calcareous Bio-concretions in the Mediterranean"

The 15th Meeting of the Contracting Parties,

Recalling Article 11 of the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean, hereinafter referred to as the "Protocol", on national measures for the protection and conservation of species,

Recalling Article 12 of the Protocol, on cooperative measures for the protection and conservation of species, and in particular its paragraph 3 on the formulation and implementation of action plans for their conservation and recovery,

Recalling further the recommendation adopted by the 14th Meeting of the Contracting Parties (Portoroz, November 2005) to formulate a Programme of work on protecting the coralligenous and other calcareous bio-concretions in the Mediterranean,

Noting with satisfaction the work accomplished by the Meeting of the ad hoc group of Mediterranean experts, held in Tabarka (Tunisia) in May 2006, for drafting the Programme of work on protecting the coralligenous and other calcareous bio-concretions in the Mediterranean,

Confirming the request from the Eighth Meeting of National Focal Points for SPAs (Palermo, June 2007) for establishing a specific Action Plan for the Protection of the Coralligenous and other Calcareous Bio-concretions, distinct from the Action Plan for the conservation of Marine Vegetation,

Decides to adopt the "Action Plan for the Protection of the Coralligenous and other Calcareous Bio-concretions in the Mediterranean", as contained in the Annex to this Decision;

Requests to the Contracting Parties to take the necessary measures for the implementation of this Action Plan within the time limits set out in its implementation timetable, and report on its implementation according to the cycle and format of the MAP reporting system.

ANNEX

Action Plan on Protecting the Coralligenous and other Calcareous Bio-Concretions in the Mediterranean

Foreword

An adhoc meeting, organized in Tabarka by RAC-SPA took place during 6th and 7th May 2006 with the aim to propose the guidelines for a Work Programme on the Protection of coralligenous assemblages and other calcareous Mediterranean biotic frameworks. In this document, the content of the Work Programme is developed.

Experts in Tabarka decided not to include bathyal assemblages of white corals, but they considered that it was worthy to include calcareous frameworks from shallow (or even littoral) waters such as the *Dendropoma petraeum* rims or the *Lithophyllum byssoides* rims. Nevertheless, not the project of the Work Programme nor the work made in Tabarka, reflected this intention, as coralligenous assemblages monopolized all the attention. Moreover, it is very difficult to make a common programme devoted to protect habitats or assemblages that (1) thrive in completely different environments, (2) have absolutely different species composition, (3) display different dynamics and (4) are subjected to completely different stressors, even if they are morphologically similar. Therefore, here we will focus exclusively on coralligenous assemblages. Moreover calcareous assemblages such as *Dendropoma petraeum* rims and *Lithophyllum byssoides* “trottoirs” are already included in the Action Plan for the Conservation of the Marine Vegetation and do not need further attention. Deep-water *Cystoseira* species, even if they have also been sometimes included or considered as special facies of coralligenous assemblages, they are also taken into account by the Marine Vegetation Action Plan, and thus will not be considered here again. Maërl beds are in a very different situation, as they are calcareous formations, that even if they lack of a real calcareous framework, carbonate production is their main constitutive characteristic. Moreover, they are not usually considered in the Marine Vegetation Action Plan and, at least in the Mediterranean, they thrive in the same places where coralligenous assemblages are found. Therefore, even if this Work Programme is mainly devoted to the conservation of coralligenous assemblages, maërl beds will be included, not as a special facies of the coralligenous, but as carbonate environments also developing in dim light conditions and meriting almost the same conservation measures and management than coralligenous frameworks.

In this programme of work, the coralligenous is considered as a typical Mediterranean underwater seascape comprising coralline algal frameworks that grow in dim light conditions and in relatively calm waters (Ballesteros, 2006). Mediterranean maërl beds should be considered as sedimentary bottoms covered by a carpet of free-living calcareous algae (Corallinales or Peyssonneliaceae) also developing in dim light conditions.

Current situation of coralligenous assemblages

Current knowledge

Although there is a general knowledge on the composition and distribution of coralligenous assemblages and maërl beds there are several lacks. Regarding the distribution, coralligenous buildups seem to be common all around the Mediterranean coasts, even in the easternmost coasts (Bitar and Ramos, pers. comm.). However this is the picture at a large scale (in the order of hundreds of km) but what is really important is to know the distribution of coralligenous buildups at much smaller scales, which is important for an appropriate management of these structures. Regarding the composition of coralligenous and maërl assemblages, most of the information is based on data obtained in the northwestern Mediterranean, with also some data collected in southern Italy and the Alboran Sea. Therefore the available lists of species, as well as the main engineering species, are known from these areas, and they cannot be considered to be constant in the rest of the Mediterranean. However, nothing is known for sure.

In order to gather all the scientific information available, the first step of this Work Programme would be to make a list of references dealing with coralligenous assemblages and maërl beds, with indication of the topics they cover (e.g. biodiversity and taxonomy, descriptive ecology, functional ecology, composition, environmental factors, cartography, conservation, disturbances).

Distribution

One of the major gaps concerning the current state of knowledge of the coralligenous habitat and maërl beds is the absence of cartographical data. Some cartographical data have been published on given locations, such as the Banyuls sur Mer area (capes l'Abeille and Oullestreil), Medes Islands, Tabarca or Port-Cros. Geographical as well as depth distributional data are essential in order to know the real extent of these assemblages in the Mediterranean Sea as well as to implement appropriate management measures to guarantee their conservation. In order to improve this situation the following actions are proposed:

- To compile all existing information at all levels and scales on the distribution of coralligenous assemblages and maërl beds. Besides easily available (published) information on the distribution of these assemblages in some MPAs (e.g. Gili & Ros, 1987; Belsher *et al.*, 2005; Ramos, 1985; Garcia Carrascosa, 1987; Templado and Calvo, 2002, 2006), other unpublished reports gather a lot of information. Collaboration of MPAs managers is needed. Contacts with main marine agencies (e.g. IFREMER, IEO, ICRAM), universities and marine science research institutes are also suggested, as they have a lot of unpublished information regarding the distribution of coastal benthic communities. In Mediterranean countries lacking long-tradition marine science institutes, collaboration with fishermen and divers (professional/sport) can probably be the only information source.

- Punctual field missions have to be envisaged in potential places to host extensive and mostly unknown coralligenous assemblages and maërl beds. Eastern Mediterranean should be extensively scanned.

Composition

Coralligenous concretions are the result of the building activities of algal and animal builders and the physical as well as biological eroding processes. The final result is a very complex structure composed of several microhabitats. Environmental factors (i.e., light, water movement and sedimentation rates) can vary by orders of magnitude in parts of the same concretion situated very close to each other. This great environmental heterogeneity allows several different assemblages to coexist in a reduced space. Assemblages situated in open waters (from horizontal to almost vertical surfaces) can be easily distinguished from those situated in overhangs and cavities.

Algae usually dominate in horizontal to sub-horizontal surfaces although their abundance decreases with decreasing irradiance. Two main algal communities have been distinguished in the western Mediterranean: an assemblage dominated by *Halimeda tuna* and *Mesophyllum alternans* (*Lithophyllo-Halimedetum tunae*), thriving in relatively high light levels, and an assemblage dominated by encrusting corallines (*Lithophyllum frondosum, L. cabiochae, Neogoniolithon mamillosum*) and *Peyssonnelia rosa-marina* (*Rodriguezelletum strafforelloi*), and receiving low light levels. Animal assemblages can greatly differ according to light levels reaching the coralligenous outcrop but also according to current intensity, sedimentation rates and geographical areas. In the richest, relatively more eutrophic zones, with rather constant and low water temperature, gorgonians usually dominate the community, but they are completely absent or rare in the more oligotrophic or low-current areas with rather high or seasonally variable temperature, being replaced by poriferans, bryozoans or ascidians.

Maërl beds are also very diverse. Even if corallines are the main constituents (S*pongites fruticulosus, Lithothamnion corallioides, Phymatolithon calcareum, Lithothamnion valens, Lithothamnion minervae, Litophyllum racemus, Lithophyllum frondosum*, and others), Peyssonnelia species (mainly *Peyssonnelia rosa-marina*) can also be very important. The cover of erect algae depends on each particular site, displaying several facies (*Osmundaria volubilis, Phyllophora crispa*, Kallymeniales, *Laminaria rodriguezii*). Ascidians can also constitute facies and, in some cases, gorgonians and/or bryozoans can be relatively abundant.

The group of experts in Tabarka suggested using the Reference List of Habitat types appearing in the Standard Data Entry Form (SDF) for National Inventories when looking for the composition of coralligenous assemblages.

The suggestion when describing the composition of the coralligenous assemblages or the maërl beds would be to make these descriptions as accurate as possible, introducing the names of the main species of algae involved in the construction of the algal framework or being the dominant species in the maërl beds, together with the erect algae and invertebrates that are more conspicuous. Probably, the best way to do it would be listing the species in situ by trained biologists, quantified following the Braun-Blanquet (1979) methodology (Cebrian & Ballesteros, 2004). Alternatively, the algal assemblage can be identified considering the two main associations described for the coralligenous assemblages, which are the *Lithophyllo-Halimedetum tunae* and the *Rodriguezelletum straforelloi*, and the names of the most prominent sponges, cnidarians or bryozoans. In maërl beds, description is also possible naming the main maërl species and erect algae, as well as the main macroinvertebrates.

Main algal builders to be distinguished are:

- *Mesophyllum alternans*
- *Mesophyllum expansum*
- *Lithophyllum frondosum* (= *L. stictaeforme*)
- *Lithophyllum cabiochae*
- *Neogoniolithon mamillosum*
- *Peyssonnelia rosa-marina*
- *Lithothamnion philippii*
- *Spongites fruticulosus*
- *Lithothamnion corallioides*
- *Litothamnion valens*
- *Lithothamnion minervae*
- *Lithophyllum racemus*
- *Phymatolithon calcareum*

Main algae and invertebrates that can make facies are, at least, in the western Mediterranean:

Algae:

- *Halimeda tuna*
- *Flabellia petiolata*
- *Laminaria rodriguezii*
- *Phyllariopsis brevipes*
- Laminar Red Algae

Invertebrates:

- *Spongia agaricina*
- *Axinella polypoides*
- *Hexadella racovitzai*
- *Aplysina cavernicola*
- *Agelas oroides*
- Massive sponges (*Faciospongia* spp., *Cacospongia* spp., Ircinidae, Geodididae)
- *Spirastrella cunctatrix*
- *Eunicella cavolinii*
- *Eunicella singularis*
- *Paramuricea clavata*
- *Alcyonium acaule*
- *Corallium rubrum*
- *Leptopsammia pruvoti*
- *Parazoanthus axinellae*
- Large bryozoans (*Hornera frondiculata*, *Pentapora fascialis*)
- Encrusting bryozoans (*Schizomavella* spp., *Parasmittina* spp.)
- Big ascidians

Other facies can also be found.

Data collection and inventories

Specific inventories

The coralligenous habitat includes several assemblages due to its great heterogeneity. There is a small-scale variation in environmental factors throughout the coralligenous outcrops that determine different micro-habitats containing different species. In the surface of coralligenous outcrops, coralline algae usually dominate, together with a variable amount of erect algae and of suspension-feeders. Holes and cavities within the coralligenous structure sustain complex communities without algae and dominated by suspension-feeders. Small crevices and interstices are inhabited by a diverse endofauna, while many vagile species swarm everywhere, thriving also in the small patches of sediment retained by the framework. One of the consequences of this great environmental heterogeneity is the presence of a high biodiversity and a wide array of organisms in each coralligenous outcrop.

Maërl beds are considerably less complex than coralligenous outcrops although they have some epiflora and epifauna that are more related to plants and animals usually found in rocky substrata, but also they harbour typically invertebrates from sedimentary bottoms.

A considerable amount of research has been done on the biodiversity hosted by coralligenous frameworks. Ballesteros (2006) estimates a preliminary account of up to 1666 species at the scale of the Mediterranean Sea that have been reported from these frameworks. However these estimates are far from real and it is, thus, necessary to make a reference list of species that are found in coralligenous outcrops. It is also necessary to evaluate the total number of species of some relatively well known locations, as well as the level of species similarity between these locations in order to have an idea of the amount of large scale variability. The same kind of work has to be done for maërl beds.

There are several ways to proceed in order to obtain this list. We propose the following way:

- To make preliminary lists (global and local scales) considering data obtained after consulting the available literature.
- To circulate the resulting lists amongst specialists of each taxonomic group, who may increase the lists according to the more specific taxonomic literature and his own expertise.
- To compile all the information giving the final species lists.

These lists should contain other interesting information such as:

- Precedence of the citation/citations (bibliography/taxonomist) to check the original source.
- Geographical area.
- Abundance (e.g. very abundant, abundant, common, rare, accidental).
- Fidelity to coralligenous outcrops (e.g. exclusive characteristics, elective characteristics, preferential characteristics, indifferent, accidental) (see Pérès & Picard, 1964; Cormaci *et al*., 2004).

Another interesting issue is the collection of new data. Several methodologies have been used in sampling rocky benthic systems and maërl beds (e.g. Bianchi *et al*., 2004) and all of them present advantages and disadvantages. Moreover, suitability of each sampling method depends on the purposes of the study and on the taxonomic group considered.
As no sampling methodology can be universally accepted, when making new inventories it is recommended to:

- Use quantitative or semi-quantitative surveys instead of qualitative surveys wherever possible.
- Clearly state the sampling and quantification methodology, including the period of

the year, in order that it could be repeated in the future by independent teams for further comparison of data.
- Samples have to be geographically positioned in the most accurate way.
- Sampling has to be representative. Therefore, sampling areas should be larger than minimal sampling areas. It has to be noted that different taxonomic groups must be sampled using completely different representative areas.

Sites of particular interest

The coralligenous and maërl being communities thriving in deep waters it is impossible to have an appropriate cover of all the sites. Thus, it is recommended that inventories and monitoring be performed in sites of particular interest. These sites have to be selected according to previous information on the extension and ecological quality of coralligenous and maërl communities. Amongst the criteria to be used in this selection, it is recommended the following ones:

- Existence of previous information on coralligenous assemblages or maërl beds at the site or, if there is no available information at all, sea bottom geomorphological features suitable for the development of coralligenous frameworks and/or rhodolits.
- Representativity of the coralligenous assemblages/maërl beds at a wide geographical area, whenever it is possible, according to present knowledge.
- Existence of control and/or management of anthropic activities at the site. In this sense, marine protected areas are suitable places to be selected.
- Especially healthy coralligenous and maërl communities are worth to be selected as reference points.
- Coralligenous communities and maërl beds under clearly recognisable direct or indirect anthropogenic disturbances are worth to be selected in order to assess the impact of these disturbances.

Specialized Institutions and researchers

A data base including specialists working in the coralligenous/maërl environments should be obtained. Every specialist should be identified by:
Fields of knowledge:

- Taxonomy, with indication of the group/groups of expertise
- Environmental factors
- Descriptive ecology
- Functional ecology
- Conservation
- Cartography
- Management

Monitoring activities

Even if changes in coralligenous/maërl communities proceed very slowly (Garrabou *et al*., 2002), at least in the absence of punctual catastrophic disturbances, the study of their dynamics in the long term is of great interest to explain their formation and to foresee their evolution, both naturally or when affected by a disturbance. Thus, monitoring is necessary to understand long-term dynamics and changes in the communities as well as the success in the implementation of management measures.

Types of monitoring

Monitoring should be addressed to answer questions concerning (1) the changes through time in the composition of coralligenous/maërl assemblages, (2) the viability of the populations of plants and animals thriving in these assemblages per se or (3) subjected to natural or anthropogenic disturbances, or (4) the selection of species that can be used as bioindicators. Every type of monitoring needs different methodological approaches.

Monitoring methods

Monitoring methodologies change according to the objectives of each study. A comprehensive summary can be found in Bianchi et al. (2004). Several important limitations are however present when working in coralligenous/maërl assemblages due to the usual deep water environment where diving is performed: time restrictions are severe due to long decompression times and diver performance outstandingly decrease due to nitrogen narcosis (Tetzaff & Thorsen, 2005; Germonpre, 2006). Another problem is the high small scale heterogeneity of coralligenous outcrops which implies a large sampling area to be representative (Ballesteros, 2006). Also, the high medium to large scale heterogeneity makes it difficult comparison among sites. However, the low dynamics of coralligenous assemblages (Garrabou *et al.*, 2002) allow sampling periodicity to be low in long-term studies.

For practical purposes, and when describing assemblages, semi-quantitative evaluations are the most rapid methodology usually providing enough information for a rough characterisation of the assemblages. Coverages or abundances can be easily estimated by indices in a scale of 3 to 6 values. We recommend the use of phytosociological indices (Braun Blanquet, 1979; Cormaci *et al*., 2004), which can be adequately transformed and used in further statistical ordination analysis.

However, monitoring usually needs the collection of precise quantitative data (e.g. densities, sizes, coverages). Both destructive and non-destructive methodologies are usually used. Destructive methodologies imply the collection of all organisms in an area by scraping a determined surface with a hammer and a chisel, sometimes with the help of a suction sampler (Boudouresque, 1971). This technique, feasible for punctual comparisons, offers excellent results for the flora and sedentary fauna. However it has the drawback of being destructive and, thus, it is not desirable for long term periodical monitorings. Two main methodologies are currently used in non destructive monitoring: photographic sampling and quadrats. Both of them do not require the removal of organisms and, as such, they are very suitable for long-term monitoring.

Photographic procedures consist in the photographic sampling of a defined area, previously delimited in periodical monitorings. Macro-lenses can be used to cover small areas (i.e. 400 cm^2) and wide-angle lenses are better used to cover areas of up to 1 m^2. However, with the introduction of digital cameras, with zoom lenses and auto-focusing, cover areas can be easily changed, even underwater. The use of external strobes greatly increases image quality. Photographs allow the estimation of species densities and abundances (cover) which can also be used to obtain data on community structure. Photographs repeated at regular time intervals in fixed sites allow the collection of information on population dynamics and demography of fauna and flora (Garrabou, 1998, 1999; Garrabou & Ballesteros, 2000; Garrabou & Zabala, 2001). Photography also allows the collection of a great number of samples (photographs) in a reduced period of time, excelling in the ratio between obtained information and diving time. The decrease in diver performance with depth due to nitrogen narcosis and the resulting lack of accuracy of measures is also greatly avoided. However, an important drawback in photography is that whilst it performs very well in 2D organisms and

structures, its application in 3D organisms (e.g. gorgonians, some sponges and bryozoans) is far much complicated and usually lacks of enough accuracy.

Quadrats, situated along a transect or haphazardly sampled, are largely used in benthos studies, both in benthic surveys and monitorings. In coralligenous assemblages they have been mainly used to estimate demographic parameters and to study the short and long term changes in gorgonian populations (*e.g*. Harmelin & Marinopoulos, 1994; Coma *et al.*, 2004; Linares *et al*., 2005; Linares *et al*., in press). Quadrats can be portable or can be permanent and fixed in the sea bottom by lines, following a transect. The size of the quadrat changes according to the objectives of the monitoring. Half to one square meter frames are recommended to monitor abundant large-sized organisms growing in coralligenous assemblages. Permanent quadrats are very useful to study the demography of the main species and the dynamics of the entire community, whilst non permanent quadrats are useful to study changes in sizes or abundances of one to several species. Quantification can easily be performed by individual counting (density measurements) in entire quadrats (e.g. Coma *et al*., 2006). Quadrats can be subdivided into grids of smaller quadrats and this allows divers to estimate abundances in percentage cover (*e.g*. Fraschetti *et al.*, 2001), or frequency evaluations (number of sub-quadrats where a species is present; *e.g*. Sala & Ballesteros, 1997).

Monitoring of individuals/colonies is easily performed when a site is selected, all individuals mapped and/or tagged and identified by a numbered code to facilitate its re-identification (*e.g.* Ballesteros, 1991; Linares *et al*., 2005). These permanent sites can be partitioned in quadrats of 10x10 to 50x50 cm (according to the size and distribution of monitored individuals) to facilitate mapping. The corners of each quadrat can be marked using PVC screws or steel climbing parabolas fixed to the substratum by putty (e.g. Linares *et al*., 2005).

Monitoring of some environmental variables is also needed if we want to relate changes in the coralligenous/maërl assemblages with disturbances. Amongst the most important variables to be monitored are: water temperature, sedimentation rates, nutrient concentration in seawater, particulate organic matter and water transparency.

A specific workshop should be carried out including most specialists currently working in the monitoring of coralligenous/maërl assemblages. Even if it is difficult amongst scientists to propose common standard methods for monitoring, it is always useful to make this kind of workshops in order to know which are the methodologies that are being used and try to adopt techniques that at least can be compared or intercalibrated. Main targets of this workshop should be devoted to methodologies addressed to:

- Large scale comparison of assemblages.
- Medium to long-term changes in assemblage composition and species abundances.
- Monitoring of engineering species (corallines, main algal stands, gorgonians, engineering bryozoans, main sponges).
- Monitoring of vagile species (fish, decapods, gastropods).
- Growth and erosion rates in coralligenous/maërl assemblages.
- Impact of main disturbances affecting coralligenous/maërl assemblages (trawling, mortality events, degradation by waste water, diving activities, invasive species, artisanal fishing, silting).

Research activities

Taxonomy

Coralligenous/maërl assemblages probably are two of the most important hot-spots of species diversity in the Mediterranean, together with *Posidonia oceanica* meadows (Ballesteros, 2006 ; BIOMAERL team, 2003). In comparison to the large amount of literature devoted to the study of *Posidonia oceanica* meadows, studies devoted to strengthen the knowledge of coralligenous/maërl biodiversity are very scarce. Therefore, due to the rich fauna, high heterogeneity at all scales, and complex structure of coralligenous/maërl assemblages, together with the paucity of studies dealing with coralligenous/maërl biodiversity, it can be assumed that at least coralligenous assemblages harbour more species than any other Mediterranean community. The check-list proposed in the second chapter of this Work Programme will probably mention all the species found to date in coralligenous/maërl communities. However research in taxonomy is also needed as a large amount of taxonomic groups absolutely lack not only of a comprehensive study but almost any study dealing with species which can be found in coralligenous outcrops or maërl beds.

Taking into account the current knowledge of biodiversity in coralligenous/maërl communities (Ballesteros, 2006), the following taxonomic groups need an important investment in research:

- Copepods
- Cumaceans
- Isopods
- Molluscs
- Mysids
- Nematods
- Nemerteans
- Ostracods
- Phyllocarids
- Polychaeta
- Pycnogonids
- Tanaidaceans

Further research in other groups is also acknowledged as it will surely provide new reports of species for coralligenous outcrops and maërl beds.

Long term evolution

Processes taking place in coralligenous communities usually proceed very slowly (Garrabou *et al.*, 2002). Functioning of outstanding and key species also show low growth rates and low population dynamics (see review in Ballesteros, 2006). Therefore, even if some of the patterns and processes that have been described so far occur in short time periods (*e.g*. mortality events; Cerrano *et al.*, 2000; Garrabou *et al*., 2001), evolution of coralligenous can only be understood from a long-term perspective. Maërl beds are even less known as there are no comprehensive revisions in this subject regarding Mediterranean rhodolits.

Monitored sites are recommended to be visited once a year. Even if seasonality in coralligenous/maërl communities is not as important as it is in shallower environments (Ballesteros, 2006), the monitoring is recommended to be always performed at the same period of the year in order to facilitate comparisons between years and sites. Summer and the beginning of autumn (July-October) is the best time period to undertake the surveys because diving in deep waters is more secure.

Sites should be selected according to (1) their representativeness at a large geographical scale, (2) their accessibility and (3) the logistical facilities that may contribute to guarantee the monitoring. Selection of reference sites are crucial to monitoring specifically addressed to determine the response of assemblages to particular disturbances.

The monitoring should be designed to be as simple as possible. No standard methods have been proposed and no environmental or ecological quality indexes have been established. A specific methodology for long-term studies devoted to look for the evolution of coralligenous/maërl communities can be suggested in the workshop to be conducted for monitoring activities.

Functioning

Special care is to be taken for the study of the functioning of particular associations and species. Specifically, long-lived plants and animals that usually are the engineering species of the coralligenous or the most abundant calcareous algae in maërl beds, need a detailed knowledge of their growth, demographic patterns, vulnerability to disturbances and recovery capacities. RAC-SPA should encourage these studies. Kinds of studies that merit specific attention are:

- Environmental factors and biological processes that determine specific composition and structure of coralligenous/maërl communities.
- Age determination and growth history of coralligenous concretions and maërl rhodolits.
- Growth requirements carbonate production rates, erosion rates, competence studies in corallines and *Peyssonnelia rosa-marina*. Effects of sewage and silting on these processes.
- Importance of excavating sponges, bivalves and annelids to the bioerosion of the coralligenous/maërl rhodolits. Differences between currently growing and subfossil coralligenous outcrops. Effects of sewage and silting in bioerosion rates.
- Effects of invasive algal species in coralligenous outcrops and maërl beds: changes in biodiversity, functional structure and long-term dynamics of populations and communities.

- Growth rates, ecophysiological features of structurally important soft algae: *Peyssonnelia* spp., *Flabellia petiolata*, *Halimeda tuna*, *Phyllariopsis brevipes*, *Laminaria rodriguezii*, *Osmundaria volubilis, Phyllophora crispa*.
- Contribution of bryozoans to coralligenous outcrops. Growth rates and carbonate production.
- Population dynamics of gorgonians and alcyonarians (*Paramuricea clavata, Corallium rubrum, Eunicella cavolinii, Alcyonium acaule* and others). Factors triggering mortality events. Species-specific responses and adaptations to stress and disturbances.
- Growth and population dynamics of specially relevant massive sponges (e.g. *Axinella polypoides, Axinella verrucosa, Spongia agaricina, Spongia officinalis*). Factors triggering mortality events.
- Growth and population dynamics of specially relevant massive ascidians (e.g. *Halocynthia papillosa, Pseudodistoma cyrnusense, Phallusia fumigata, Microcosmus* spp., *Aplidium* spp.). Factors triggering mortality events.
- Dispersion of species/populations and genetic fluxes between populations at the Mediterranean basin level.
- Development of physiological markers providing information about population health in response to different kinds of disturbances.

Conservation activities

Major Threats

Major threats affecting coralligenous/maërl communities roughly coincide with threats affecting Mediterranean marine biodiversity and are listed in the Strategic Action Programme for the Conservation of Biological Diversity (SAP BIO). However, due to its special habitat and features, not all the threats listed in the SAP BIO affect coralligenous/maërl communities, but some of them are specially relevant. It follows a brief description of the main threats.

Trawling

Trawling is probably the most destructive impact currently affecting coralligenous communities. Trawling is also completely destructive in maërl beds, being the main cause of maërl disappearance in large Mediterranean areas. The action of trawling gear over coralligenous/maërl assemblages leads to the death of most engineering, dominant and builder species, completely changing the environmental conditions of the coralligenous microhabitats and from the maërl environment. As most of these species are particularly long-lived, have low recruitment and complex demographic patterns, destruction of the coralligenous/maërl structure is critical as their recovery will probably take several decades or even centuries. Trawling has also a great impact on target species that, although not as vulnerable as most suspension feeders, they also suffer from this indiscriminate method of fishing. Finally, even the performance of trawling close to coralligenous outcrops or maërl beds affects negatively to algal growth and suspension-feeding due to an increase in turbidity and sedimentation.

Artisanal and recreational fishing

Certain fishes, mainly elasmobranchs, are severely decimated by artisanal fishing practices when fishing pressure is outstanding. This is the case, for example, of several small sharks such as *Scyliorhinus stellaris, Mustelus* spp. or *Squalus* spp. In several places, other species such as groupers and lobsters need the implementation of adequate fishery management.

Special care has to be taken with the commercial exploitation of red coral (*Corallium rubrum*), whose stocks have strongly declined in most areas. Adequate management of this extremely valuable and long-lived species is necessary. It is also important to remember that trammel nets and even nylon threads can exert an important impact on gorgonians and other erect species (e.g. *Laminaria rodriguezii, Axinella* spp., *Hornera frondiculata*) (Tunesi *et al*., 1991).

Anchoring

Anchoring has a very severe impact in coralligenous concretions, as most of the engineering organisms are very fragile and are easily detached or broken by anchors and chains. Coralligenous concretions of frequently visited sites by recreational fishing or diving activities are degraded by the destructive potential of anchors.

Invasive species

There is an absolute lack of knowledge on the effects that lessepsian species have on coralligenous/maërl communities in the Eastern Mediterranean. Currently, at least three algal species are threatening coralligenous/maërl communities in the Western Mediterranean: *Womersleyella setacea, Acrothamnion preissii, Caulerpa racemosa v. cylindracea* and *Caulerpa taxifolia*. All of them are only invasive in relatively shallow water coralligenous outcrops and maërl beds (<60 meters), where irradiance levels are sufficient to permit their growth. However, they are especially dangerous, because they completely cover the basal stratum of encrusting corallines and increase sedimentation rates which lead to a total shut down of coralligenous growth or the survival of rhodolits.

Global warming

Anomalous high water temperatures seem to trigger large scale mortalities of several suspension feeders growing in coralligenous assemblages (Cerrano *et al*., 2000; Pérez *et al.*, 2000). Thus, it is expected that if the current pattern of global warming continues, it will surely affect more frequently the populations of gorgonians and sponges thriving in coralligenous communities situated above the summer level of the thermocline, leading to their eventual total demise.

Waste water discharges

Waste waters profoundly affect the structure of coralligenous communities by inhibiting coralline algal growth, increasing bioerosion rates, decreasing species richness and densities of the largest individuals of the epifauna, eliminating some taxonomical groups and increasing the abundance of highly tolerant species (Hong, 1980, 1982; Cormaci *et al.*, 1985; Ballesteros, 2006). Although no information is available on the impact of eutrophication in Mediterranean maërl beds, the effects must be similar to those reported for coralligenous concretions.

Aquaculture

Although there are no studies on the impact of aquaculture facilities situated over or at the proximity of coralligenous outcrops, nor maërl beds, their effects should match those produced by waste water dumping.

Changes in land use and coastal infrastructure construction and urbanization
Most anthropogenic changes in coastal areas or at their vicinity involve an increase in water turbidity and/or sediment removal that affect coralligenous/maërl communities.

Recreational activities (excluding fishing)
Uncontrolled or over-frequentation of divers in coralligenous communities has been described to produce an important effect over certain large or fragile suspension feeders inhabiting coralligenous communities (Sala *et al.*, 1996; Garrabou *et al*., 1998; Coma *et al.*, 2004; Linares, 2006).

Mucilaginous and filamentous algal aggregates
Blooms of mucilaginous and filamentous algal aggregates can cause severe damage over erect suspension feeders (mainly gorgonians). These blooms are still not well understood but they are apparently caused by eutrophication.

Legislation and regulations

Coralligenous/maërl assemblages should be granted legal protection at the same level as *Posidonia oceanica* meadows. A first step would be the inclusion of coralligenous concretions and maërl beds as a priority natural habitat type in the EU Habitats Directive (92/43/EEC), which would enable EEC countries to undertake surveillance of the conservation status of coralligenous/maërl assemblages and also to set an ecological network of areas of conservation (LICs/ZECs) hosting coralligenous/maërl assemblages, which would ensure their conservation or restoration at a favourable conservation status. Although *Phymatolithon calcareum* and *Lithothamnion corallioides* are present in the Annex V of the Habitats Directive and as such they should be provided by management measures in case of exploitation (which is never the case in the Mediterranean), there is no specific protection for maërl beds. Similar actions should be encouraged in non-EEC countries through the existing tools of the Barcelona Convention.

Regarding again European countries, recently (21 December 2006), it was published a Council Regulation (EC) No 1967/2006 concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea, amending Regulation (EEC) No 2847/93 and repealing Regulation (EC) No 1626/94 which states that "**Fishing trawl nets, dredges, shore seines or similar nets above coralligenous habitats and maërl beds shall be prohibited"** (Article 4.2) and that this prohibition "**shall apply to all Natura 2006 sites, all special protected areas and all specially protected areas of Mediterranean interest (SPAMI) which have been designated for the purpose of the conservation of these habitats under either Directive 92/43/EEC or Decision 1999/800/EEC**" (Article 4.4).

National legislation for the protection of coralligenous assemblages is recommended to be promulgated as soon as possible.

Engineering and endangered species developing in coralligenous assemblages should get legal protection in order to control and, if necessary, to prohibit any type of destruction or disturbance of these species. Appropriate, scientifically-based, management plans have to be implemented for the exploitation of natural resources (e.g. fish, crustaceans, red coral, commercial sponges).

Anthropogenic activities being performed in or at the vicinity of coralligenous/maërl assemblages should be regulated in order to decrease the level of impact compatible with the sustainability of the assemblages and their populations. Specific measures aimed at protecting the coralligenous/maërl environments might include the following (Ballesteros, 2006):

- Waste water dumping should be banned over coralligenous/maërl bottoms, and in their vicinity.
- Trawling must be completely prohibited in areas with maërl beds and coralligenous outcrops and in their vicinity, the aim being to avoid not only the physical damage

caused by trawling over coralligenous/maërl assemblages but also the indirect effects due to increased turbidity and silting.

- Any other anthropogenic activity involving an increase in water turbidity and/or sediment removal (e.g. coastline modification, beach regeneration, dredging, aquaculture projects) should be avoided in the vicinity of coralligenous outcrops or maërl beds.
- Correct management of traditional and recreational fisheries must be implemented in order to prevent stock depletion of target fish and invertebrates. Fishing nets have to be avoided in places with populations of long-lived erect invertebrates (e.g. gorgonians, some sponges) and algae (e.g. *Laminaria rodriguezii*).
- The impact of diving must be compatible with the normal functioning and conservation of the coralligenous environment and their species.
- The enactment of suitable legislation concerning the introduction of alien species is urgently needed.

Guidelines for the assessment of environmental impact on coralligenous/maërl assemblages will have to be elaborated.

Creation of Marine Protected Areas

Most present Mediterranean MPAs are devoted to protect *Posidonia oceanica* meadows and other shallow water assemblages, in such a way that the percentage of coralligenous/maërl habitat currently protected in the Mediterranean is extremely low. Thus, it is necessary to establish marine protected areas (MPA) in order to protect representative coralligenous/maërl assemblages by applying the protection and management measures recommended by Articles 6 and 7 of the SPA/BD protocol. In fact, MPAs have to be established taking into account the seascape diversity and trying to include places with several relevant assemblages, as has been already applied in the creation and zonation of some MPAs (Villa *et al.*, 2002; Di Nora *et al*., 2007).

Countries have to identify and cartography as soon as possible sea bottoms covered by coralligenous outcrops and maërl beds in order to design a network of MPAs that enables the protection of coralligenous/maërl assemblages.

Seamounts situated far away from the coastline deserve special attention due to its isolated geographical position and, usually, lack of knowledge. In particular the following areas are of regional (Mediterranean) interest:

- Alboran Sea (Spain, Morocco)
- North and West coasts of Eivissa (Spain)
- North Minorca and the Channel between Minorca and Mallorca (Spain)
- Banc Emile Baudot, south of Cabrera (Spain)
- Banks from South East Iberian Peninsula: from Palos to San Antonio Cape (Spain)
- Marseilles region (France)
- Western coast of Corsica (France)
- Northwestern coast of Sardinia (Italy)
- Straits of Messina (Italy)
- Isole Eoli and Ustica (Italy)
- Isole Pelagie (Italy)
- Sicily Channel (Italy)
- Puglia coast (Italy)
- Hallouf Bank (Tunisia)
- Algerian coast (Algeria)
- Kykladhes Islands (Greece)

Those Mediterranean MPAs which contain coralligenous/maërl assemblages and for which management and monitoring plans have not yet been developed and implemented, must be provided with such plans as soon as possible.

Coordination of this Work Programme with other tools and initiatives

The Standard Data Form (SDF), developed by RAC SPA, can be used to identify potentially good sites for the establishment of MPAs devoted to protect coralligenous/maërl assemblages.

However the SDF is not appropriate to be used in the monitoring of coralligenous/maërl assemblages since it has been designed for the inventory of sites and habitats but not for an accurate assessment of multi-species population densities and their evolution. Annex B (habitat types) from the SDF should be slightly modified in the point IV.3.1 (Coralligenous biocenosis), according to current knowledge. Species appearing in Annex C should be slightly enlarged in order to include several engineering coralligenous species according to the adopted criteria for amendments of the Annexes (II & III) of the Protocol SPA-BD.

This Work Programme for the Conservation of Coralligenous and maërl assemblages should be included in the Action Plan for the Conservation of Marine Vegetation (VAP). Even if the VAP concerns plant dominated assemblages, it doesn't exclude animal assemblages and most of the priorities at national and regional levels as well as some of the objectives are nearly the same.

MPAs classified as SPAMIs and containing coralligenous/maërl assemblages inside their protected areas should develop management and protection plans to ensure their conservation.

Timetable

Taking into consideration all the observations stated above, the following actions can be considered:

Action	Time	who
Definition of what assemblages are to be included in this Work Programme: Coralligenous frameworks and maërl beds or circalittoral rocky bottom communities?	As soon as possible	SPA/RAC & Partners
To provide a check list of all the species that are able to thrive in coralligenous/maërl communities using published literature, unpublished reports and expert assessment. Species names (with authorities), citations, geo-referenced localities, abundances, and habitat features have to be included. This check-list has to be designed as a data base with an incorporated GIS.	1 year from adoption	SPA/RAC & Partners
To create a website as a part of the Mediterranean CHM on marine & coastal biodiversity to help in the taxonomical identification of the main species thriving in coralligenous/maërl assemblages, including : A bibliographic data base with all the information concerning coralligenous/maërl assemblages with indication of the topics they cover (e.g. biodiversity and taxonomy, descriptive ecology, functional ecology, composition, environmental factors, cartography, conservation, disturbances). A Data Base on coralligenous/maërl assemblages. Directory of • Taxonomists that could provide information on species thriving in coralligenous/maërl assemblages. • Scientists currently working in the coralligenous/maërl environment. • Research institution	Ongoing	SPA/RAC
To propose standard methodologies for the inventory and monitoring of coralligenous/maërl communities and their main species.	2 years from adoption	SPA/RAC & Partners
To support and/or encourage field missions devoted to increase the knowledge on the distribution, cartography and biodiversity of coralligenous/maërl assemblages. Special attention is to be paid in the Eastern Mediterranean and North of Africa.	Ongoing	SPA/RAC & Contracting Parties
To provide a geo-referenced list of all the sites known to harbour coralligenous/maërl communities, with indication of depth intervals and (if possible) coralligenous/maërl facies or more conspicuous species.	2 years from adoption	SPA/RAC
To propose the creation of MPAs in areas harbouring well developed coralligenous outcrops or maërl beds.	3 years from adoption	Contracting Parties
Organisation of a periodical Workshop devoted to coralligenous concretions and maërl beds (back to back with the symposium on marine vegetation)	Each 3 years	SPA/RAC
Organisation of practical training workshops in order to acquire good taxonomical skills and to learn monitoring methodologies.	As needed	SPA/RAC
To support and/or encourage taxonomic work to be made in some specially unknown groups.	Ongoing	SPA/RAC & Contracting Parties
To support and/or encourage scientific studies devoted to increase the knowledge on the functioning of coralligenous outcrops/maërl beds.	Ongoing	SPA/RAC & Contracting Parties
To promote the conservation of coralligenous/maërl assemblages	Ongoing	Contracting Parties
To foster the conservation of coralligenous/maërl assemblages situated in international waters (e.g. Alboran Sea, Sicily Channel).	4 years from adoption	SPA/RAC & Parties

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