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7.2. Action Plan for the Conservation of the Coralligenous and other Calcareous Bio-concretions in the Mediterranean Sea

Status of implementation of the Action Plan concerning for the conservation of the coralligenous and other calcareous bio-concretions in the Mediterranean Sea

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I. Introduction

The coralligenous and other calcareous bio-concretions assemblages are hard bottoms of biogenic origin that thrive under dim light conditions, and some of them represent an endemic habitat for the Mediterranean Sea (Ballesteros 2006). They are common all around the Mediterranean coasts (UNEP-MAP-RAC/SPA 2008). Coralligenous assemblages develop on rocky reefs and biodetritic bottoms from ~20 m down to 120 m depth, in relatively constant conditions of temperature, currents and salinity (Laborel 1987).

The coralligenous and other calcareous bio-concretions assemblages due to their biogenic (mainly calcareous algae but also sessile invertebrates) origin usually exhibit great structural complexity. This high habitat heterogeneity allows the availability of multiple habitats (from dim-light to complete dark conditions) in which a large array of species can develop. In fact coralligenous assemblages are considered as one of the most important hot-spot of species diversity in the Mediterranean jointly with *Posidonia oceanica* meadows (Ballesteros 2006). Bearing in mind the scarcity of studies on the coralligenous compared to the study of *Posidonia oceanica* meadows, it is likely that coralligenous assemblages harbor more species than any other Mediterranean habitat.

During the last decades there was an increasing interest from the scientific community and different management bodies at national and international level such as UNEP/MAP in the conservation of coralligenous and other calcareous bio-concretions assemblages in the Mediterranean Sea. Different initiatives have been developed to provide information on the distribution, composition, community and population dynamics, and the response to different sources of disturbance. In parallel to these initiatives, to acquire the needed basic knowledge on these assemblages, a great effort has been devoted to set the protocols for monitoring in view of assessing their conservation status in an efficient way.

Coralligenous assemblages are threatened by specific direct and indirect human activities, which affect the stability of this precious ecosystem and thus strongly compromise their future. These disturbances include direct and indirect impacts of fishing activities (e.g. trawling, exploitation of the red coral), degradation by wastewater, the colonization by invasive species and the effects of global climate change (Ballesteros 2006, UNEP RAC/SPA 2008). The effects of disturbances on the coralligenous habitat are still poorly known, however, the available data indicate long-lasting effects after impacts of acute events (e.g. mass mortalities linked to anomalous temperatures and severe storms; Linares et al. 2009; Teixido et al. 2013). After these events, the assemblages showed limited recovery capacity. Moreover, bearing in mind the life-history traits of most species thriving in the coralligenous habitat (long-lived species with slow population dynamics), the assemblages could be already following degradation trajectories under the effects of slow drivers of change (e.g. pollution, sedimentation). Despite of this, some positive effects of recovery have been also documented, such as recovery of fish stocks (e.g. groupers) after fishing prohibition (e.g. Garcia-Rubies et al. 2013).

The coralligenous assemblages, besides harboring a high biological diversity provide important ecosystem services and support valuable human activities in different socio economic areas such as fisheries, reservoir of bioactive natural substances, climate regulation (as carbon sink), habitat provision for many species, recreation and ecotourism (Ballesteros 2006, UNEP RAC/SPA 2008). The current trend of degradation of marine ecosystems could dramatically be affecting the conservation of these emblematic and important assemblages in the Mediterranean. Thus, effective actions should be taken to enhance the resilience of coralligenous and other bioconcretions assemblages. With the limited funding, it is necessary to build efficient coordination mechanisms in order to furnish relevant information to support the conservation actions of these precious assemblages at regional scale.

In the framework of the Convention on Biological Diversity (CBD), countries committed to protect by 2020 10% of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, and to ensure that they are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures (Aichi Target 11 of CBD). Overall, only about 1% of Mediterranean coastal waters susceptible to harbor coralligenous/maërl assemblages are protected. Most current Mediterranean Marine Protected Areas (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. In fact, MPAs have to be established taking into account the seascape diversity and trying to include sites 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).

In the same direction, among the General Obligations of the Protocol concerning specially protected areas and biological diversity in the Mediterranean (SPA/BD Protocol 1995) of the Mediterranean Action Plan, the Contracting Parties are engaged “to take the necessary measures to manage, preserve and manage in a sustainable and environmentally sound way areas of particular natural or cultural value...” (Article 3). In this context, the Contracting Parties have agreed on the Action Plan for the protection of the coralligenous and other calcareous bio-concretion in the Mediterranean Sea (UNEP-MAP-RAC/SPA 2008).

The aim of this document is to assess the status of the implementation of this Action Plan. Therefore the present document (i) provides a general overview in the progress in the knowledge of coralligenous and other calcareous bio-concretion in the Mediterranean Sea since the adoption of the Action Plan in 2008, and (ii) reviews the main regional activities carried out in compliance with the 2009-2014 timetable of the Action Plan.

II. Progress in increasing knowledge on coralligenous and other calcareous bio-concretion in the Mediterranean Sea.

The assessment of the progress in knowledge on coralligenous and other calcareous bio-concretions in the Mediterranean is mainly based in published peer-reviewed literature obtained through a search in the Web of Knowledge database and on the communications presented in the 2nd Mediterranean Symposium on the Conservation of coralligenous and other calcareous bio-concretions (Portorož, Slovenia, 29-30 October 2014).

During the period 2008-2015 more than 150 relevant papers have been published and during the Symposium about 50 communications were presented. The main topics of research were.

- a) Distribution
- b) Composition structure and dynamics
- c) Population dynamics of typical/key species
- d) Pressures and threats
- e) Development of protocols for the assessment of the Good Environmental Status

In the following paragraphs we provide a brief description on the new results obtained for each topic. We do not intend to provide an exhaustive review on all the information acquired, instead we focus on the main areas of advancement on each topic.

a) Distribution and composition

Recent studies have compiled information available on the distribution coralligenous and maërl beds (Giakoumi et al. 2013, Martin et al. 2014). These papers indicate that these assemblages are common all around the Mediterranean coasts, even in the easternmost coasts. The coralligenous habitats are abundant in the Adriatic, Aegean and Thyrrenian Seas as well as in the Algerian-Provençal Basin. The coralligenous is less abundant in the Levantine Sea and Tunisian Plateau/Gulf of Sirte (Martin et al. 2014). Overall, data available cover approximately 30% of the Mediterranean coasts while for the remaining 70% no information was found (Martin et al. 2014). Regarding the depth distribution, most information concern the 10 to 50 m depth areas, less information exists for the deeper range of distribution of coralligenous 50-200 m depth.

Besides these large-scale assessments on distribution, at local scale cartographical data have been acquired in some areas specially in marine protected areas (e.g. Réserve Naturelle de Scandola, Parc National de Zembra, Zakynthos Marine Protected Area) (e.g. Bonacorsi et al. 2014, Cerrano et al. 2014). Different new habitat mapping tools are being developed to increase our capacity to cover larger areas with higher resolution (e.g. Bonacorsi et al. 2014, Pitito et al. 2014)

A promising field of research is the improvement of habitat modeling methods which could provide predictive models very useful for cost-effective field surveys (Zapata-Ramirez et al. 2014, Martin et al. 2014).

b) Composition structure and dynamics

During the last few years several teams have devoted efforts in the collection of data on species composition and assemblage structure as well as temporal stability in different calcareous assemblages dominated by calcareous macroalgae (e.g. Cecchi et al. 2014, Ponti et al. 2011) and suspension-feeders (e.g. Deter et al. 2012, Casas et al. 2015), but also on mobile species (e.g. Garcia-Rubiés et al. 2013, Beldini et al. 2014) using different quantitative and semi-quantitative methods. Most of the studies concerned NW Mediterranean areas, although some studies have been carried out in the other Mediterranean areas (e.g. Ponti et al. 2011, Topcu & Ozturk 2015). The results seem to indicate robust patterns of species composition at regional level (>500 km) although with a high heterogeneity at site level (<1 km apart) and great temporal stability in absence of strong disturbances (e.g. 5 year period) (e.g. Kipson et al. 2011, Holon et al. 2014, Casas et al. 2015). The data collected is indispensable for understanding the variation of biodiversity at local and regional scale. Besides, the data collected are excellent baseline datasets for assessing potential changes associated with the anthropogenic threats and to assess the effectiveness of management measures.

c) Population dynamics of typical/key species

Studies devoted to population dynamics of typical/key species (e.g. calcareous algae, gorgonians, sponges, bryozoans) of coralligenous assemblages indicate that most species are very long-lived species displaying a very parsimonious population dynamics with low growth, mortality and recruitment rates (e.g. Teixidó et al. 2011). For instance the red coral *Corallium rubrum* displays growth rates around 0.25 mm / year in diameter (e.g. Bramanti et al. 2014) and large sized colonies can reach long-live spans up to 100 years or more. The species concerned for population dynamics were mainly anthozoans and sponges (e.g. Teixidó et al. 2011, Kersting et al. 2013, Turon et al. 2013, Bramanti et al. 2014). Besides characterizing the assemblages' key/typical species, recent studies are providing new insights on the important role for the functioning for the communities. For instance, Ponti et al. (2014) indicated significant effect of gorgonian forest at community level since the absence of gorgonians significantly decreases the recruitment of epibenthic species in the coralligenous.

Since coralligenous assemblages and maërl beds display a fragmented distribution across the Mediterranean, populations of typical/key species also display an even more fragmented distribution in response to the high heterogeneity in habitats colonized by each species. The application of genetic tools allowed elucidating the connectivity patterns in some species, mainly gorgonians (e.g. *Corallium rubrum*, *Paramuricea clavata*) but also in some sponges (e.g. Aurelle and Ledoux 2013, Constantini et al. 2010, Pérez-Portela et al. 2014). Overall the studies demonstrated a strong genetic structure of populations, in accordance with the restricted effective dispersal of this species (Ledoux et al. 2010) and enhanced the importance of local management action in view of the conservation of these populations.

d) Pressures and threats

A strong research effort was devoted to elucidate the effects of different disturbances on coralligenous assemblages during the last years. Most studies were devoted to analyze the impacts of disturbances acting at large scales such as climate change and invasive species, although other disturbances acting at local scale such as artisanal fishing and recreational diving have been also explored (e.g. de la Nuez-Hernandez et al. 2014). It is noteworthy the large body of literature devoted to analyze the effects of current warming trends (Garrabou et al. 2009, Linares et al. 2014, Cupido et al. 2008, 2009, 2012) since most large-scale mass mortality events were concomitant with anomalous temperature conditions (Crisci et al. 2011, Rivetti et al. 2014). Besides correlation evidences with field data, the role of warming has been proved in different

experimental setups (Linares et al. 2013, Kipson et al. 2012, references). Also related with climate change the negative effects of the water acidification have been demonstrated in some coralligenous species (Bramanti et al. 2013, Cerrano et al. 2013, Martin et al. 2013). Finally, the predicted increase in seawater temperature and stability of the water column due to climate change may promote more frequent formation and higher persistence of mucilaginous aggregates which can cause severe damage to coralligenous assemblages (Danovaro et al. 2009).

Regarding the invasive species there are some evidences showing significant negative impacts on recruits and adult survival rates of different organisms and abnormal reproductive cycles of recovered species (e.g. de Caralt & Cebrian 2013, Cebrian et al. 2012).

d) Development of protocols for the assessment of the Good Environmental Status

In 2008 the European Union adopted the Marine Strategy Framework Directive (MSFD 2008/56/EC) which requires to maintain European marine waters in “Good Environmental Status” (GES). This directive directly concerns biogenic structures such as the Mediterranean coralligenous. In line with the MSFD, the Contracting Parties to the Barcelona Convention set targets for achieving GES of the Mediterranean Sea and its coastal zone by 2020. The importance of applying the ecosystem approach (EcAp) to the management of human activities that may affect the Mediterranean marine and coastal environment, was recognized as a key factor in achieving these targets and in promoting sustainable development (UEP/MAP 2007).

To fulfill the requirements of the MSFD and of the EcAp process, different initiatives are underway to establish protocols to determine the GES of coralligenous habitats. Different sets of indicators are being proposed to assess indices (e.g. ESCA, CAI, COARSE indices) to evaluate GES (e.g. Kipson et al. 2011, Deter et al. 2012, Gatti et al. 2012, Gatti et al. 2015, Cecchi & Piazzini 2010). In summary, these protocols provide information on structural (species composition, habitat complexity), functional (indicators of bioerosion and bioconstruction) and current pressures (indicators of impacts of different disturbances).

III. Regional Activities carried out in accordance with the 2009-2014 timetable of the Action Plan

RAC/SPA conducted the following activities:

1. Reference list on coralligenous and other calcareous bioconcretions

Following the adoption by the Contracting Parties of the Action Plan for the Coralligenous and other Calcareous Bio-concretions in the Mediterranean (15th CoP Meeting; Decision IG 17/15) an inventory of published literature about coralligenous habitats distribution has been made in collaboration with ISPRA.

2. Organising the 1st Mediterranean Symposium on coralligenous and other calcareous bioconcretions (Tabarka 15-16 January 2009)

The RAC/SPA in collaboration with the RAMOGE Agreement and Okianos organized the 1st Mediterranean Symposium on coralligenous and other calcareous bioconcretions. It was held on 15-16 January 2009 in Tabarka (Tunisia), with 122 participants, representing 11 Mediterranean countries, 20 oral presentations and 36 posters.

The main Symposium’s recommendations were:

- Setup a network of experts working on coralligenous and other calcareous bioconcretions.
- Establish long-term monitoring sites
- Identify species that can act as biological indicators to determine potential shifts in the environmental conditions (temperature, nutrient increase, pollution)
- Raise awareness on the importance of coralligenous and other calcareous bioconcretions assemblages.
- Legislation measures should be adopted to protect of coralligenous and other calcareous bioconcretions assemblages

3. Directory of taxonomists, scientists and research institutions working on coralligenous and other calcareous bioconcretions

The 1st Symposium on coralligenous and other calcareous bioconcretions provided the opportunity to establish a directory of taxonomists, scientists and research institutions working on coralligenous and other calcareous bioconcretions as required in the timetable of the Action Plan.

4. Inventory of available data on geographic distribution of coralligenous and other calcareous bioconcretions assemblages

In 2009 the RAC/SPA undertook an updating and feeding of its Mediterranean Geographical Information System (MedGIS) in order to make it accessible online. RAC/SPA FPs participated actively in this process by providing available national georeferenced data on marine and coastal biological diversity features (e.g. protected areas, key-habitats distribution). In order to assist RAC/SPA and the Contracting parties, one Mediterranean partner organizations collaborated in the elaboration of bibliographical databases as well as GIS layers to be integrated into the MedGIS. In particular for coralligenous habitats the partners were ISPRA UNEP(DEPI)MED WG.331/Inf.61.

5. Defining and standardizing methods for monitoring assemblages of the coralligenous and others calcareous bio-concretions in the Mediterranean Sea

Within the framework of the implementation of the " Action Plan, RAC/SPA supported different actions in view of monitoring coralligenous and other Calcareous Bio-concretions:

- To develop standardized protocols for the monitoring for coralligenous and other Calcareous bio-concretions a synthesis was made on the basis of (i) a questionnaire sent to the main Mediterranean experts and (ii) the available literature. This synthesis was discussed at the meeting of experts of 7 and 8 April 2011 in Rome, Italy. The meeting's conclusions are presented in document UNEP(DEPI)/MED WG.359/52 and proposals for standardised methods for inventorying and monitoring of the coralligenous/maerl communities and their main species appear in document UNEP(DEPI)/MED WG.359/10.
- To establish a monitoring system of the coralligenous and other Calcareous Bio-concretions, based on mapping techniques, in the Eastern Aegean Sea in collaboration with the Archipelagos Institute (Greece).
- In 2010, during a campaign of mapping the coralligenous assemblages in Cap Corse, done at the AAMP's initiative, Tunisian scientists were trained on the relevant techniques and their implementation.
- A regional training on standardised methodology to monitor coralligenous assemblage in order to ensure their conservation was held in June 2012 (Fourni Island, Greece).

6. 2nd Mediterranean Symposium on coralligenous and other calcareous bioconcretions

The RAC/SPA in collaboration with the Institute of the Republic of Slovenia for Nature Conservation organized the 2nd Mediterranean Symposium on coralligenous and other calcareous bioconcretions from 29 to 30 October 2014 in Portoroz, (Slovenia).

The main Symposium's recommendations were:

- To build-up the Working Groups on coralligenous habitats. The overall aim of the Working Groups initiative is the conservation of coralligenous habitats. The proposal has as objectives: (1) to provide a framework to coordinate scientific efforts using comparable approaches and methodologies across the Mediterranean to fill the current gap of knowledge on the coralligenous habitats (2) to develop a

scientific platform to provide to the managers and policy makers with the appropriate information, based on the best available science, for the management and conservation of coralligenous towards a Mediterranean network.

- Review the list of key/typical species for on coralligenous and other calcareous bioconcretions
- Develop a communication plan to raise awareness on the importance of coralligenous and other calcareous bioconcretions assemblages.

IV. Projects

The adoption of the Action Plan has encouraged international and national funding agencies as well as private foundations to provide financial support to projects in relation to the conservation of coralligenous assemblages. The main aims pursued by these projects were to improve the methodological approaches available for the study of these assemblages and increase knowledge on the distribution, composition, functioning and response to the different pressures (e.g. COCONET, DEVOTES, CIGISMED ADACNI, CLIMCARES, Biorock).

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