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The Mediterranean Biodiversity Centre
SPA / RAC

ECOLOGICAL CHARACTERIZATION OF POTENTIAL NEW MPAS IN LEBANON:

Batroun, Medfoun and Byblos

MedMPA Network Project

With the partnership of

IUCN

Universitat d'Alacant
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National Council for Scientific Research - CNRS, Lebanon

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Study required and financed by:

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FOREWORD

The present document has been elaborated within the framework of the regional project «Towards an ecologically representative and efficiently managed network of Mediterranean Marine Protected Areas» (MedMPA Network Project), which is 30-month project (2016-2018), financially supported by the European Union.

The project builds on the achievements of the Strategic Partnership for the Mediterranean Sea Large Marine Ecosystem (MedPartnership project), including the Regional Project, executed by SPA/RAC (2010 - 2015), for the Development of a Mediterranean Marine and Coastal Protected Areas (MPAs) Network through the boosting of MPAs Creation and Management (MedMPAnet project). It contributes to the implementation of the Barcelona Convention and its Specially Protected Areas and Biological Diversity (SPA/BD) Protocol.

The global objective of the MedMPA Network project is to support achieving a network of Marine Protected Areas (MPAs) in the Mediterranean which ensures the long-term conservation of key elements of the marine biodiversity and gives significant support to the sustainable development of the region.

In Lebanon, SPA/RAC activities focused on the ecological characterization of potential new MPAs in Lebanon, namely Batroun, Medfoun and Byblos. They were outlined in close consultation with the Ministry of Environment (MoE) following coordination missions undertaken which led to:

(i) prepare a rapid review of what has been undertaken in relation to marine protected areas, and

(ii) to identify the potential site(s) to be surveyed with clear rationale and justifications for their future establishment as Marine Protected Areas.

Thus, we have contributed to the first actions towards the implementation of the Marine Protected Areas Strategy in Lebanon, whose overall objective is to develop an effective Marine Protected Areas Network contributing to sustainable development by enhancing natural and cultural diversity.

To overcome challenging issues and to help a smooth implementation of the project activities, especially the field ones, a multilateral collaboration has been set up between the representatives of the Ministry of Environment of Lebanon, SPA/RAC, the University of Alicante and the Museo del Mar - Ceuta (Spain), the Lebanese University, the Lebanese National Centre for Marine Research (CNRS) and the IUCN Regional Office for West Asia (IUCN-ROWA). They have joint their efforts and formed a multidisciplinary team that:

(i) took part to the field surveys undertaken in Batroun, Medfoun and Byblos during 2016 and

(ii) elaborated the present report.

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1. INTRODUCTION

The Barcelona Convention and its Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (SPA/BD Protocol) recommends giving highest priority to promoting the management of the marine areas that are to be protected and to identifying sites that contain fragile, threatened or rare habitats, in order to set up Marine Protected Areas to protect:

- representative types of coastal and marine ecosystems, of a size that will guarantee their long-term viability and conserve their biodiversity;
- habitats that are endangered within their natural area of distribution in the Mediterranean or that have a reduced natural distribution area as a result of regression or because the area is itself restricted;
- habitats that are critical for the survival, reproduction and restoration of threatened, endangered or endemic species of flora or fauna;
- sites of particular importance because of their scientific, aesthetic, cultural or educational interest.

This is the context of this MedMPA Network project, financially supported by the European Union (EU), which aims among others, to protect important biodiversity at local, national, and Mediterranean levels and to promote economic development based on the sustainable management of marine and coastal natural resources.

The project activities in Lebanon were outlined in close consultation with the Ministry of Environment (MoE) following coordination missions undertaken which led to the running of a field survey in Batroun, Medfoun and Byblos in 2016, with the following objectives:

- rapid valorization of the marine natural habitats along the coast of the suggested areas (Enfeh, Chekaa and Raoucheh), for better appraisal;
- characterization of the ecology of threatened habitats with recommendations for possible development.

To supplement and enrich knowledge of this important Mediterranean area, the project's focused on discovering the distribution of the main marine habitats and setting up tools for monitoring the state of heritage species, enabling the effects of those protection and management strategies adopted to be appraised. Thus the field work has been organized in a manner to:

- explore the suggested areas (between 0 and 55 meters down), locating and generally mapping the habitats;
- elaborate an updated inventory of the biodiversity of species and habitats, mainly targeting species with heritage value;
- characterize the habitats, mainly those that are to be protected, and define their conservation status.

Once collected, the information will serve to propose action/management plans to be elaborated for the Batroun, Medfoun and Byblos areas. These plans will include protection measures (Marine Protected Areas, natural monuments), suggestions for the rational management of fisheries (units, periods, areas and depths, fishing methods, species), as well as awareness and education strategies for users of the marine and coastal area.

The field survey was undertaken in September-October-2016 with extensive exploration of the above-mentioned areas. The present report brings together data from the field with a first ecological characterization of the areas, and recommendations for the possible development of them.

Furthermore, we tried to collect as much information as possible on the marine fauna and flora of these interesting parts of Lebanon's coast, especially with regards to the exotic species that have been successfully established in the area, making the inventorying of the biodiversity of this very special part of the Mediterranean.

Also, we have made a spot of the specific nature of the associations and facies that are a feature of this sector and to show how they differ from other parts of the Mediterranean. This obviously requires drawing attention of the absence of certain species and the presence of others, especially on the Levantine coast, due to either natural causes (such as higher temperature and salinity) or to human-origin causes (the Levantine basin's communication with the Red Sea via the Suez Canal, the discharge into the sea of waste water and solid waste).

Being aware of the particular forms of harm caused to the coastal environment by human activities (industry, fishing, sewers, human frequentation, etc.) could help making reflection towards the protection and the conservation of those area of interest and their preservation in a natural state.

2. REPORT OF THE MISSION

The present document has been prepared following the schedule for implementation that signals the output of a draft synthetic report of ecological characterization along with recommendations on the management outlines of the study areas, in the "Technical fiche of the mission to be carried out in Le banon in September-October 2016". This report represents the synthetic information about the mission carried out in the Lebanon on 29th September to 5th October 2016 about the littoral and sublittoral surveys (0-54m depth) of the Batroun, Medfoun and Byblos as potential future marine protected areas. The expected outputs of the mission have been:

- Rapid natural habitat assessment (phytobenthos, zoobenthos and fishes) along all the coastal and marine parts of the concerned areas, for their better assessment.
- Inventory of species (mainly, of patrimonial and fisheries interest), and mapping of benthic habitats.
- Ecological characterization, human impacts and previous evaluation of the zones, with recommendations of the management outlines of the studied areas.

2.1. PROSPECTED AREAS

This mission completes the study of marine areas proposed for protection by the Lebanese Ministry of the Environment (LME/IUCN, 2012), with the 2012 mission (Enfeh, Ras Chekaa and Raoucheh) and 2013 mission (Saida, Tyr, Nakoura). The prospected areas (Fig. 2.1.) lie all around (from North to South): Batroun (between 0 and 54 m depth); Medfoun (between 0 and 50 m depth); and the Byblos area (0-40 m depth), all at the central part of Lebanon.

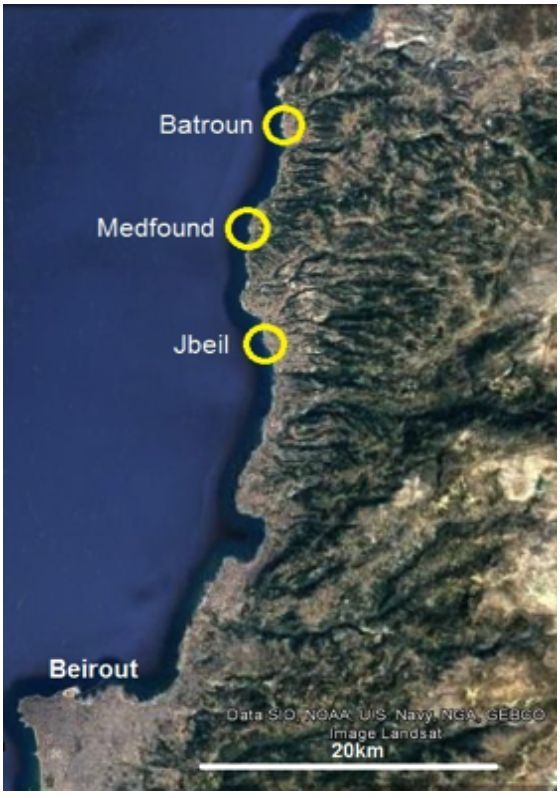


Figure 2.1. Location of prospected areas

2.2. CHRONOGRAM

The assignment lasted eleven days (28th September to 08th October 2016) as is shown in Table 2.1. The length of work was a 9- to 10-h/day, from 6.30 to 7 a.m. (leaving the hotel) until 5 to 6 p.m. (return to the hotel). The mission has been a success, working every day at sea.

Wednesday 28/09/2016

- Arrival of the Spanish team.

Thursday 29/09/2016

- Meeting to prepare the mission (team with Lebanon CNRS team and IUCN representative).
- Preparation of the mission (material, logistic, time planning).
- Tour of the coast of Batroun, Medfoun and Byblos.

Friday 30/09/2016

- Meeting with Cana crew.
- Hydroplane: 4 transects (1 diver/transect) in Batroun and Medfoun areas.
- Scuba diving plots: 4 dives (2 divers x 2 sites) in Batroun area.
- Hydrological station in front of Batroun
- Work progress meeting

Saturday 01/10/2016

- Hydroplane: 5 transects (1 diver/transect) in Byblos and Medfoun.
- Scuba diving plots: 2 dives (2 divers x 1 sites) in Byblos.
- Work progress meeting

Sunday 02/10/2016

- Scuba diving plots: 8 dives (2 divers x 4 sites) in Medfoun.
- Fish visual census: 4 dives (2 divers x 2 sites) in Medfoun.
- Work progress meeting

Monday 03/10/2016

- Scuba diving plots: 7 dives (1-2 divers x 4 sites) in Byblos.
- Fish visual census: 4 dives (2 divers x 2 sites) in Byblos.
- Hydrological station in front of Byblos
- Work progress meeting

Tuesday 04/10/2016

- Scuba diving plots: 4 dives (1-2 divers x 3 sites) in Batroun and Kfar Abida.
- Fish visual census: 4 dives (2 divers x 2 sites) in Batroun and Kfar Abida.
- ROV station in front of Batroun.
- Hydrological station in front of Kfar Abida.
- Work progress meeting.

Wednesday 05/10/2016

- Scuba diving plots: 4 dives (1-2 divers x 3 sites) in Batroun and Kfar Abida.
- Snorkelling: 1 dive (1 diver x 1 site) in Kfar Abida.
- Fish visual census: 4 dives (2 divers x 2 sites) in Batroun.
- Work progress meeting

Thursday 06/10/2016

- Meeting at the end of the mission
- Exchange of data and visual material.

Friday 07/10/2016

- Departure of a part of the Spanish team (Oscar, Carlos and Aitor).
- Meeting SPA/RAC, CNRS and University of Alicante with the Head of the Department of Ecosystems (Ministry of Environment of Lebanon) to present the results of the mission.

Saturday 08/10/2016

- Departure of the responsible of the Spanish team.

Table 2.1. Distribution of activities/day during the assignment

Activities/day (IX-X 2016)	28 W	29 Th	30 F	01 Sa	02 Su	03 M	04 Tu	05 W	06 Th	07 F	08 Sa
Travel	X								X		X
Work Meeting		X							X		
Batroun		X	X				X				
Medfoun				X	X						
Byblos				X		X					
Kfar Abida							X	X			
Ministry Meeting										X	

2.3 LOGISTICS

The workplace was reached on board the oceanographic vessel 'CANA' (Fig. 2.2a). Once in the area, the researchers moved to the diving site using the inflatable dinghy of the oceanographic vessel (Fig. 2.2a) and a traditional fishing boat from Batroun port (Fig. 2.2b).

Figure 2.2. The boats used in the 2016 mission

a. Cana' with its inflatable dinghy

b. the traditional fishing boat from Batroun

2.4. STAFF

Seven research divers took part in the assignment (Table 2.2.). For maximum efficiency of safety and time, the team was split up into two groups: coastal habitats (0-20 m depth) and deep water habitats (0-50 m depth).

We must mention the excellent collaboration with the crew of the Lebanese CNRS oceanographic vessel 'CANA' (Michel Youssef, Georges Nochal, Georges Touma and Bchara Karkafi); Elie Tarek, research assistant, from CNRS; Ali Badredinne, student from University of Lebanon; and, the efficient help of the fisherman Toufik Assal with their fishing boat support.

Table 2.2. Affiliation and tasks of participants in the September-October 2016 assignment in Lebanon

Name	Affiliation	Tasks
BITAR, Ghazi	Lebanese University	Benthos, habitats
SGHAIER, Yassine R.	SPA/RAC	Benthos, habitats
KALAF, Gaby	CNRS	CNRS Coordinator
FAKHRI, Milad	CNRS	Hydrology, ROV
FORCADA, Aitor	University of Alicante	Fish, cartography
OCAÑA, Oscar L.	Museum Mer Ceuta	Benthos, habitats
RAMOS, Alfonso A.	University of Alicante	Benthos, habitats
VALLE, Carlos	University of Alicante	Fish, cartography
SAMAHA, Ziad	IUCN	Diving support

3. MATERIAL AND METHODS

The material and methods of observation used differ according to type of dive (hydroplane transects, plot dives, fish visual census) and objective (mapping, characterization of habitats, fish counts).

In order to accomplish the study by a rational planning, and according to topographic and human pressure features, the prospected areas (Batroun, Kfar Aabida, Madfoun and Byblos) have been divided in two zones separated by about 5 km (Fig. 3.1):

- N) Batroun-Medfoun southern Selaata to Barbara (with Kfar Abida).
- S) Byblos: Hay Al Arab to Fidar.

3.1 STATIONS

Thirty-one stations were carried out (See Annex I, Fig. 3.2):

i) 26 diving stations (7 in Batroun, 4 in Kfar Abida, 7 in Medfoun and 8 in Byblos);

ii) 3 hydrological stations; and

iii) 1 ROV station. According to sector, the depths were between 0 and 54 meters (table 3.1).

All the stations were prospected by scuba diving, except one station where snorkeling and sampling by foot were used. In total, 57 dives were made, 1 of these with snorkel, which represents about 44 hours of underwater work.

Each researcher brought his own diving material, GPS and underwater cameras; bottles of 15 and 18 liters, sinkers and a hydroplane were provided by the CNRS. Also, the University of Alicante provided measuring tapes for the visual counting of fishes.

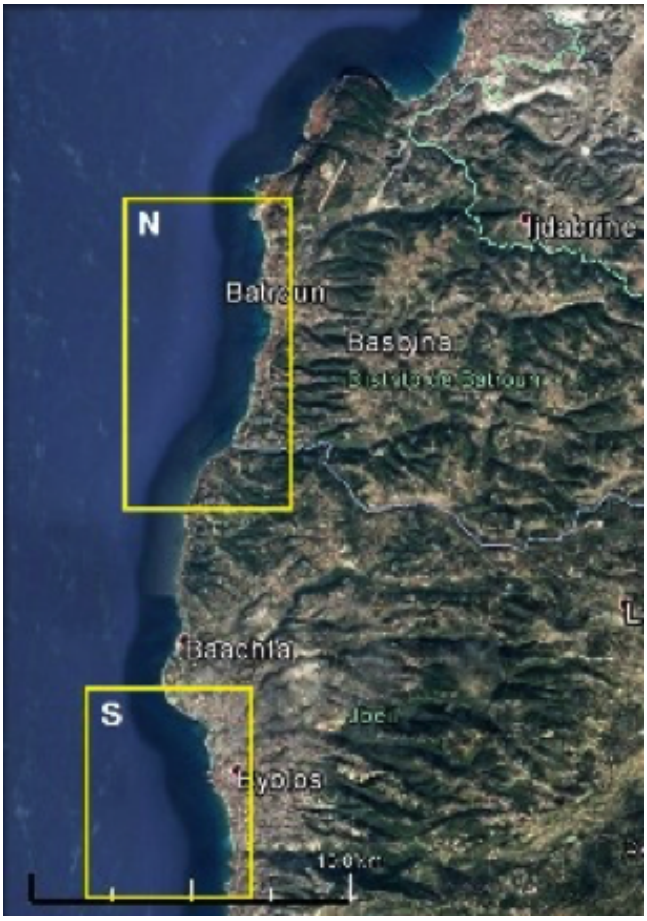


Figure 3.1. Studied areas: Batroun-Madfoun (north square); Byblos (south square) (image from Google Earth).

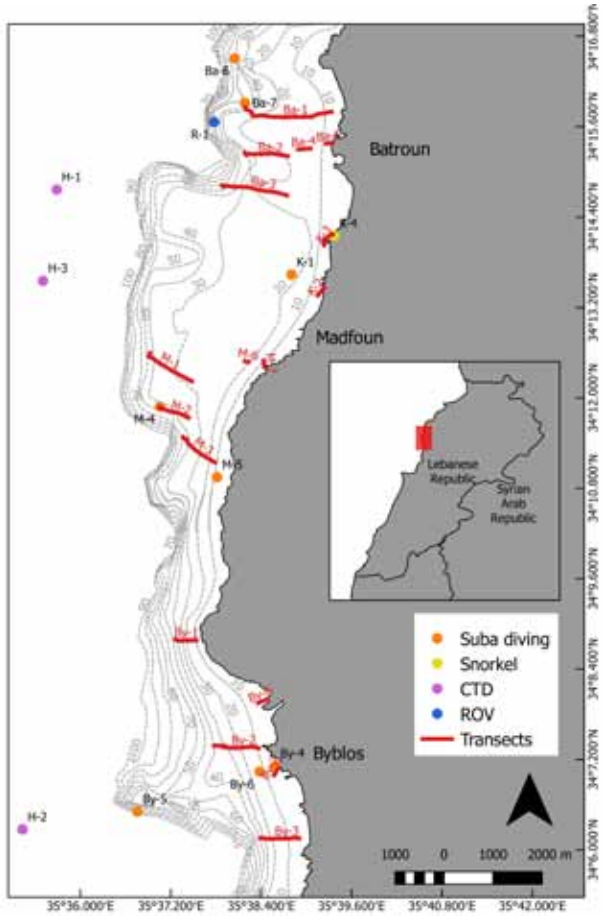


Figure 3.2. Repartition of the stations in the Batroun-Byblos by different methods.

Table 2.2. Affiliation and tasks of participants in the September-October 2016 assignment in Lebanon

Locality	Batroun	Kfar Abida	Medfoun	Byblos	Total
Depth range (m)	0-50 m	0-23 m	0-53 m	0-54 m	
Hydroplane transects	3 (3)	-	3 (3)	3 (3)	9 (9)
Scuba diving plots	5 (7)	4 (8)	4 (8)	5 (8)	18 (31)
Fish visual census	3 (6)	1 (2)	2 (4)	2 (4)	8 (16)
Snorkeling	-	1 (1)	-	-	1 (1)
Littoral	-	1	-		1
CTD Profiles	1	1	-	1	3
ROV	1	-	-	-	1
Total stations	13 (16)	8 (11)	9 (15)	11 (15)	41 (57)

3.2 OBSERVATION AND MAPPING

Different observation methods have been used during the 2016 mission in Lebanon. In addition to the hydroplane based transects, one of the main objectives of the mission has been to study the coralligenous community, so other methods have been used, such as the O/V CANA echosounder and the ROV 'Prometeo'.

a) Hydroplane: The seabed was mapped using a hydroplane (Fig. 3.3) that allowed extensive exploration of the concerned area (Ramos-Esplá, 1984). At the same time, these hydroplane observations permit the collection of information about the bathymetric range of the target species.

It had a 100-metre rope and a 3-metre chain and was pulled by the inflatable dinghy. Once the diver is on the bottom, he records on a plastic plate his observations as to the habitats encountered; and he takes a transect record with a video-camera GoPro located on head. Aboard the inflatable dinghy, one person sailes the boat while two others note the position (using a GPS), depth (a hand-held echo sounder), time check and the diver's safety. The GPS data are to be downloaded later on a computer.

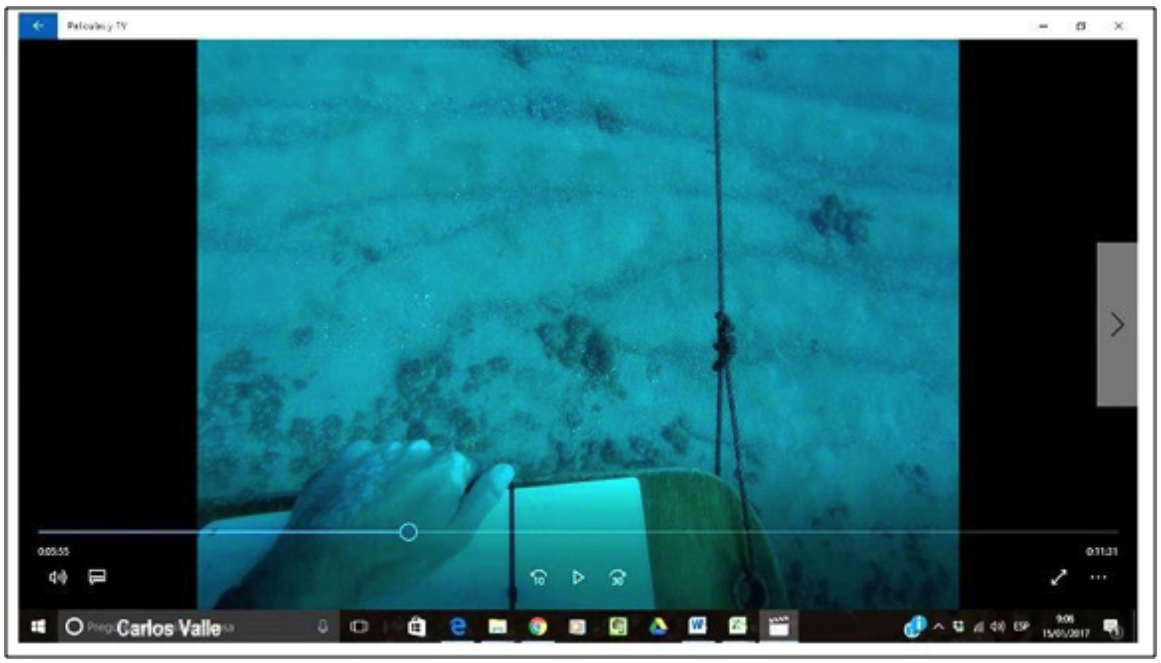


Figure 3.3. Image capture during a hydroplane transect, using a GoPro.

b) Echosounder: As we have commented, one of the objectives of the 2016 mission has been to observe and characterize the coralligenous biocenosis (between 42 and 54 m deep). In order to observe the seafloor at these depths, the GPS-plotter and the echo sounder EN-250 of the O/V 'Cana' (Fig. 3.4) were used, localizing irregular rocky zones that allowed us a study of this community by diving.

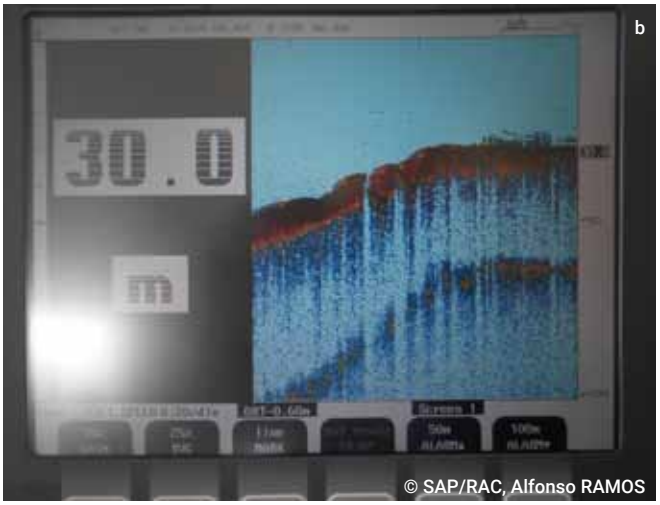


Figure 3.4. Bridge of the O/V 'Cana' with GPS-plotter (a) and echosounder (b) to locate the coralligenous (rocky outcrops, between 45-55 m depth).

c) Remote Operated Vehicle (ROV): For observations below 50 m depth was used the remote operated vehicle (ROV) 'Prometeo' of the O/V 'Cana' (Fig. 3.5a) equipped with 150 m of cable, which allows us to observe the depths between 50 and 100 m deep (Fig. 3.5b). In order to observe the bottoms around rocky outcrops, the ROV was used in the sector of Batroun.

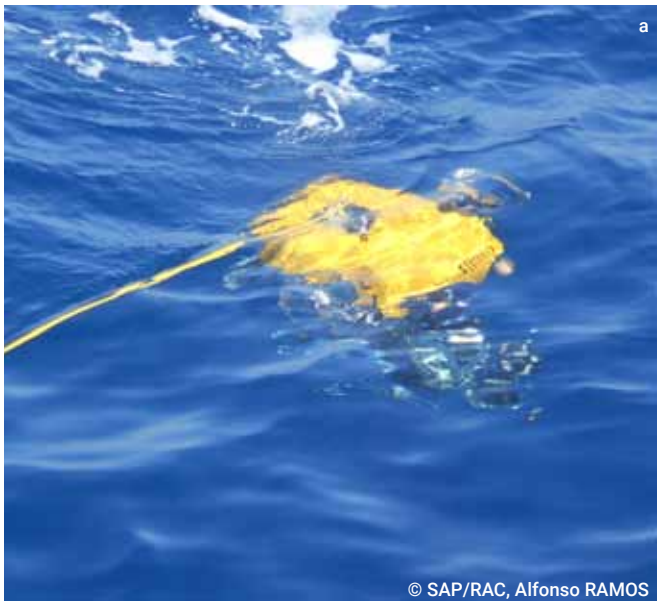


Figure 3.5. ROV 'Prometeo':
a) On the surface of the water before sinking;
b) display on deck showing the seafloor (73 m depth).

3.3 CHARACTERIZATION OF HABITATS AND SPECIES

A direct, non-destructive and semiquantitative methodology has been used. Using one-off dives, taking underwater photographs and noting down depth, type of seabed, fauna and flora species on a plastic plate with polyester paper, and some species were photographed and/or sampled for taxonomical determination (fig. 3.6). Each station was located using GPS.

To characterize the habitats, we have followed Pérès & Picard (1964), Bellan-Santini *et al.* (1994) and the 'Handbook for interpreting types of marine habitat for the selection of sites to be included in the national inventories of natural sites of conservation interest' (UNEP/MAP-RAC/SPA, 1998, 2002). With regard to the species, only the fraction of the mega-organisms (ø > 10 mm) has been considered (visual observation); and three levels of a semi-quantitative value has been done: (3) very common; (2) common, (1) less common.

Figure 3.6. Observation, sampling and photography during the diving plots.

3.4 VISUAL FISH CENSUS

Fish visual census is an excellent method to assess and make best use of the protection/exploitation effect (Bayle & Ramos, 1993). This non-destructive method by scuba diving (Fig. 3.7) was used for the characterization of ichthyofauna to assure that the fish community is not affected by sampling, and to avoid interference with subsequent evaluations of the reserve effect in the future if finally these areas are protected. For this reason, fish assemblages were visually surveyed using SCUBA diving (Harmelin-Vivien & Harmelin, 1975). Abundances and individual sizes (total length in classes of 2 cm) for each species encountered were recorded.

The sampling procedure focused on the visually observable fraction of the fish assemblage, whereby we ignored small-sized and/or cryptic fish species with strictly benthic habits (Gobiidae, Callyonimidae, Bleniidae, Tripterygidae, Gobioesocidae, Syngnathidae, Scorpaenidae, Pleuronectiformes…), which would have required a separate distinct sampling protocol (Harmelin-Vivien *et al*., 1985). Visual censuses underestimate the abundance of small and cryptic fish taxa and this problem can only be solved using enclosed rotenone stations; however, biomass estimates obtained with this method increase by less than 1% (Ackerman & Bellwood, 2000). Although these taxa of can play an important role in littoral processes, their contribution to total fish abundance and biomass is quite low.

A total of seven stations along the studied area (Annex I) Batroun (Ba-6, Ba-7), Kfar Abida (K-1),.Medfoun (M-4, M-5), and Byblos (By-5 and By-6). In each station were conducted, between 4 and 16 underwater visual censuses. These censuses were recorded by a SCUBA diver within a 25*5 m transect. A total of 56 samples were conducted. Transects were carried out in different habitats and ranged between 9 and 54 meters depth (Table 3.1). Each observation was assigned to one of nine predetermined abundance classes proposed by Harmelin (1987), the limits of which coincide approximately with the terms of a base 2 geometric series. Geometric means of each fish abundance class were used for calculations. This procedure is quite precise after a training period (Bell *et al*., 1985). All censuses were done between 9 and 15 h, and with optimal and similar seawater conditions of turbidity and swell.

Figure 3.7. Visual counting of fish per transect using a measuring tape

3.5 HYDROLOGY

To round off the information on the marine ecosystem, hydrological profiles (temperature, salinity) were made on board the oceanographic boat 'Cana' using a TCD (Fig. 3.8). Three stations (see Annex I) were carried out front Batroun, Kfar Abida and Byblos, between 1 and 100 m depth.

Figure 3.8. Launching the TCD
off the stern of the oceanographic boat 'Cana'.

3.6 PROCESSING THE SAMPLES AND DATA

a) Samples: Some specimens, about whom there were taxonomical doubts or not identified, were collected to be identified on board the 'Cana' (Fig. 3.9 right) or taken to laboratories to classify them. On board, the specimens collected were placed in bowls filled with seawater, observed using a low power stereo microscope, photographed (Fig. 3.9, left) and/or anaesthetized, fixed in 10 % formalin in seawater or 70º ethanol, labelled, and stored for the subsequent transport to the laboratories.

b) Data analyses: At the same time, the underwater observations in the plastic plates were transferred to the note-book, and latterly to the Excel files. The determined taxa (at the lowest possible taxonomic level: species, genus or family) have a semiquantitative value (3, abundant, 2, common, 1, scarce) which allows us to apply the Margalef index, using the PAST program (https://folk.uio.no/ohammer/past/). For fish visual census data, the Ecocen program is applied (Bayle *et al*., 2002).

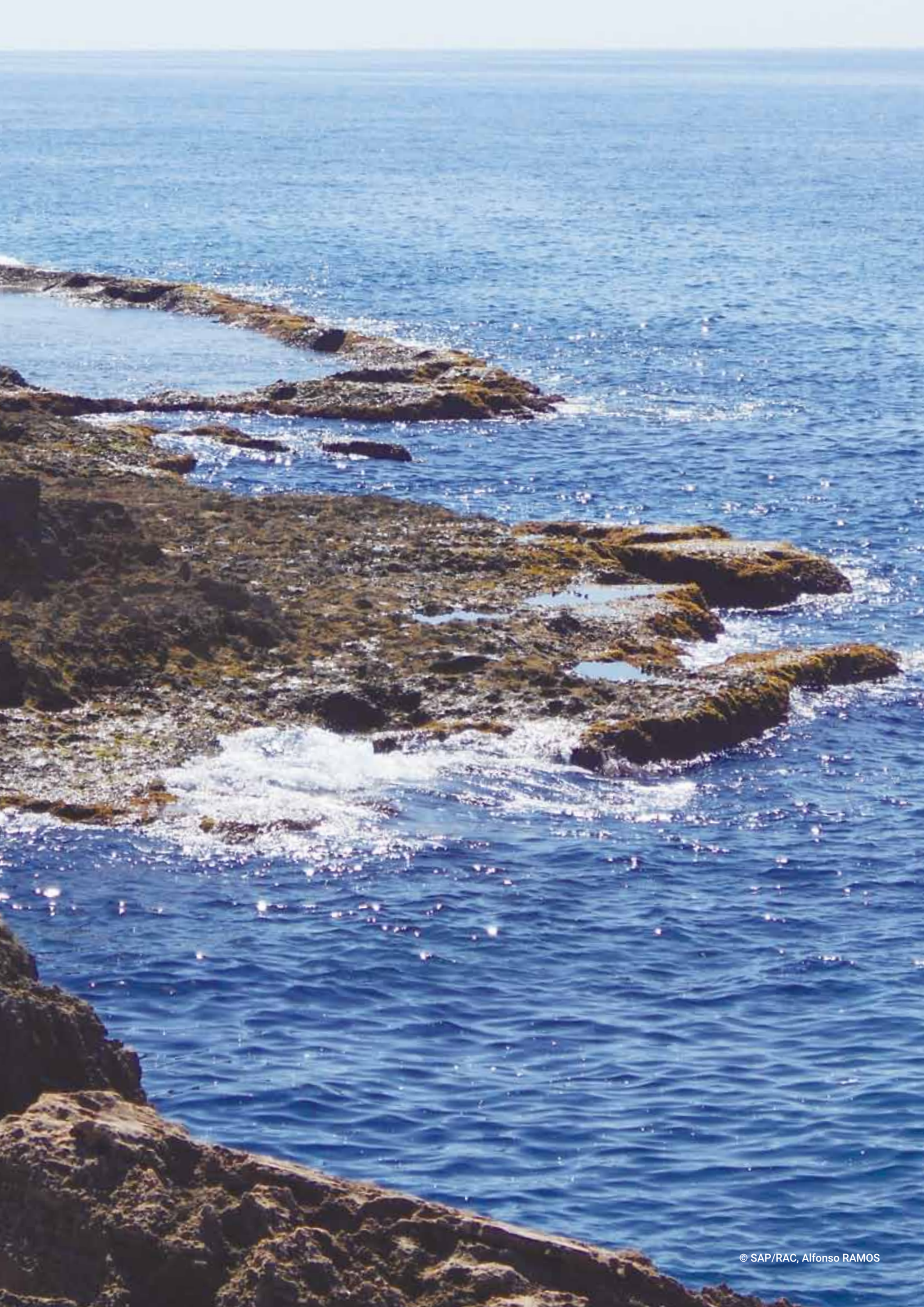
With regard to the bibliography, aside from the Mediterranean bibliography, some papers from Lebanon have been consulted:

- Flora and fauna: Bitar & Kouli-Bitar (2001). Bitar *et al*. (2017).
- Porifera: Perez *et al*. (2004); Vacelet *et al*. (2007, 2008); Vacelet & Perez (2008).
- Cnidaria: Zibrowius & Bitar (1997); Morri *et al*. (2009).
- Polychaeta: Lakkis & Novel-Lakkis (2005); Aguado & San Martin (2007).
- Crustacea: Young *et al*. (2003); Bariche & Trilles (2005); Castelló (2010).
- Mollusca: Crocetta *et al*. (2013a, 2013b, 2014); Bitar (2014).
- Bryozoa: Harmelin *et al*. (2007, 2009, 2011)
- Brachiopoda : Logan *et al*. (2002).
- Ophiuroidea: Stöhr *et al*. (2009)
- Pisces : Harmelin-Vivien *et al*. (2005).
- Non indigenous species: Zibrowius & Bitar (2003), Lakkis & Novel-Lakkis (2005), Bitar (2010); Katsanevakis *et al*. (2011); Bitar *et al*. (2017).
- Habitats: Bitar & Bitar-Kouali (1995a, 1995b), Bitar *et al*. (2007), Bitar (2010).

The up to date of the species scientific name has been consulted the World Register of Marine Species (www.marinespecies.org)

Regarding the fish assemblage structure, it was described by species richness (nº. of species/125 m^{-2}), total abundance (no. of individuals/125 m^{-2}) and total biomass (gr/125 m^{-2}). Fish species biomass was estimated using length-weight relationships calculated from data obtained from different parts of the Mediterranean Sea. We used multivariate techniques that are suited for ecological data because this allowed the production of a diagnostic on the change of the entire fish assemblage. Therefore, non-parametric approaches were selected by combining non-metric multidimensional scaling (MDS) and SIMPER (Clarke, 1993; Clarke and Warwick, 2001), to assess differences in the abundance and biomass of the structure of the community within each station by survey year.

Figure 3.9. Treatment of samples, photography and identification of species
on the desk of O/V 'Cana'.



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4. PHYSICAL ENVIRONMENT

4.1 GEOMORPHOLOGICAL FEATURES

The rocks predominate in the shore of the studied areas, with scarce sandy beaches (exc. Byblos), are mainly sandstones with some sectors of limestones. This type of rock allows the profile of the low rocky shore (Fig. 4.1) and irregular with a wide variety of biotopes (ample littoral platforms, littoral caves, small coves ...).

Figure 4.1. Types of rocky coast in the studied sector:
a) low rocky shore with sandstones (Medfoun); b) middle rocky shore with limestones (south of Byblos).

The continental shelf is narrow, varying between 1500m in front of Ras Amchit and 4000m in front of Ras el Berbera (Fig. 4.2), which means a slope varying between 5 and 13%.

The varied terrestrial topography is continued in the marine environment with the canyons front Selaata and Byblos, escarpments rocky and numerous outcrops (Fig. 4.3). Some of them with submarine caves.

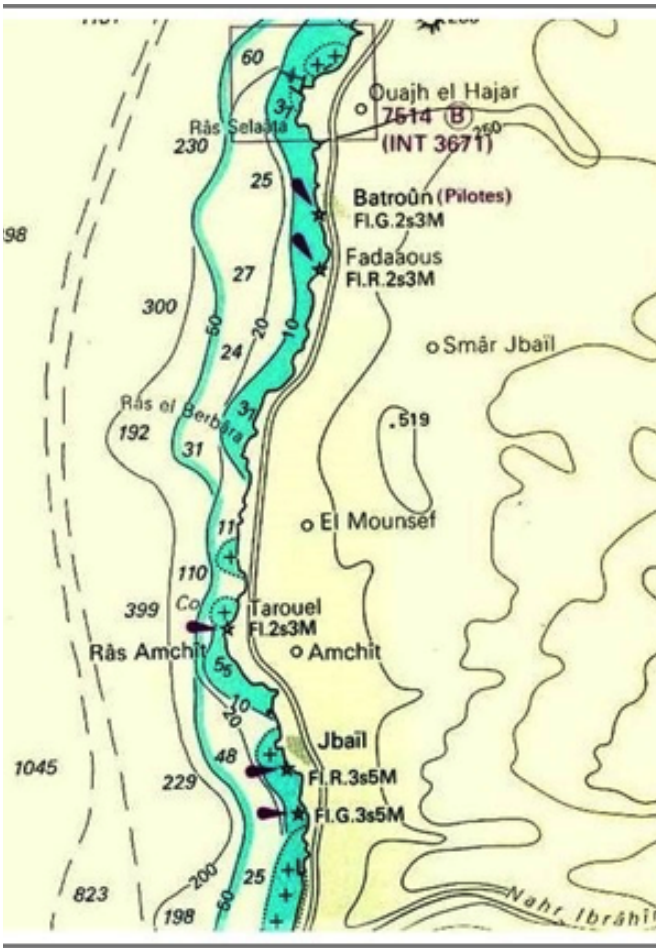

Figure 4.2. Studied areas: Batroun-Madfoun (north square); Byblos (south square) (images from Google-Earth and maritime chart INT 3606, 7255).

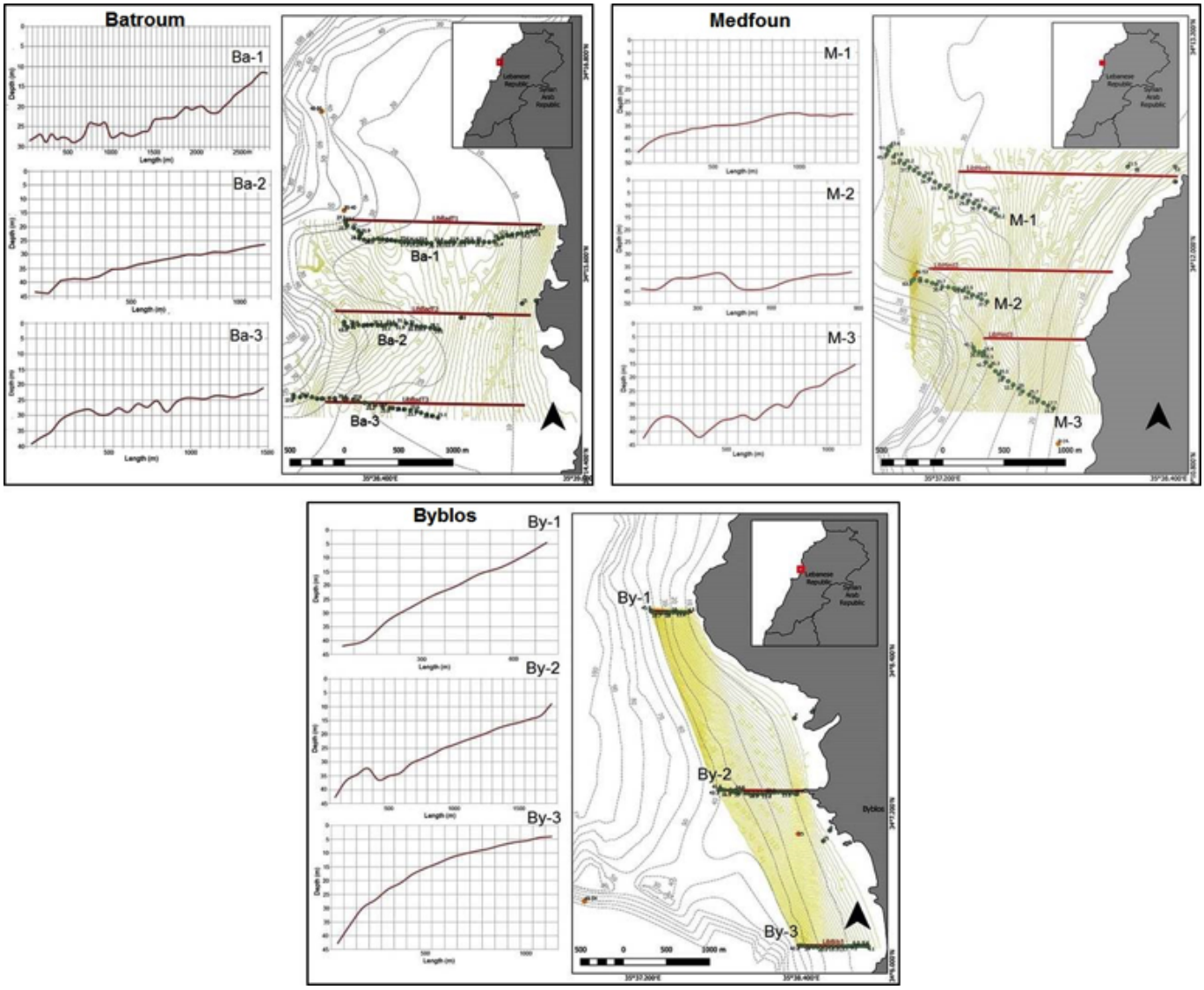

Figure 4.3. Bathymetry of the Batroun, Medfoun and Byblos areas with the profiles of hydroplane transects.

4.2 TYPES OF SUBSTRATA

A great variety of substrate types (hard and soft) have been observed, between 0 and 50 m deep (Figs. 4.4 and 4.5).

a) Littoral rock (0-2 m depth)

As mentioned above, the sandstone and limestone rocks suffer important erosion, which implies an irregular coast with wide abrasion platforms, coastal caves, coves, big blocks, etc. (Fig. 4.4).
This provides a high variety of biotopes (exposed, sheltered, photophilic, sciaphilic) with its associated flora and fauna.

b) Sublittoral seafloor (0-50 m depth)

The seafloor of the area is varied with predominance of soft bottoms (Fig. 4.5d-f):

i) fine sand (0-15 m depth);

ii) gravel and coarse sand (10-50 m depth); and muddy sand (15-50 m depth).

The free calcareous algae on gravel bottoms (Fig. 4.5d) become frequent from 23 m deep.

However, rocky bottoms are also frequent in some areas (front to Batroun and Medfoun), predominating low rock, with high rocky outcrops (Fig. 4.5a,b). Calcareous algal concretions (*Mesophyllum, Neogoniolithon, Lithophyllum*) are frequent from 40 m deep (Fig. 4.5c).

Figure 4.4. Morphological features of the littoral rock:
(a) coves (Kfar Abida); (b) littoral platforms (Byblos); (c) littoral fringe;
(d) rock and soft bottom; (e) big blocks; (f) littoral cave (Kfar Abida).

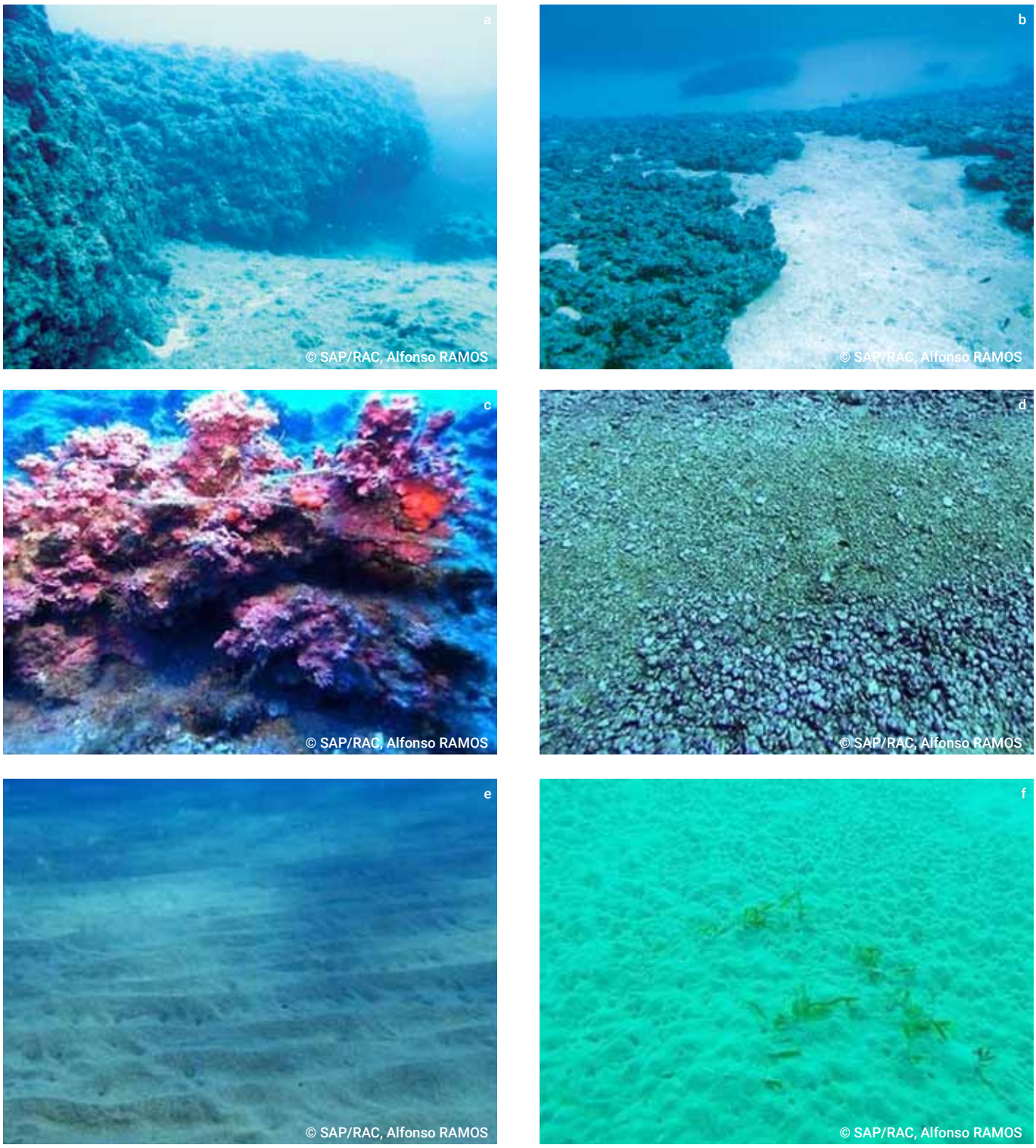

Figure 4.5. Morphological features and substrate types:
(a) rocky outcrops; (b) low rock (<1m) with gravel channels;
(c) biogenic concretion (>40 m deep); (d) gravel and coarse sand; (e) fine sand; (f) muddy sand

4.3 HYDROLOGY

The temperature and salinity profiles in early autumn (30/09-04/10/2017) show a relative hydrological homogeneity (25-27ºC, 39.2-39.4 psu) in the first 35m depth (Fig. 4.6).

a) Temperature: Regarding the depth of the thermocline, there are differences between the areas. While in front of Byblos (H-2) appears between 35-50 m depth, it deepens towards the North, reaching 42-50 m in front of Kfar Abida (H-3) and 50-60 m in Batroun (H-1). In Kfar Abida and Byblos from 60 m depth the temperature < 20 ºC; while in Batroun begins on the 80 m depth.

The vertical distribution of the temperature is an important factor to know the bathymetric spread of the lessepsian species. Based on the profile of the thermocline which descends, between 40 and 60 m depth, from 25 to 21 ºC. We can assume that from 60m deep, the fauna is typically Mediterranean, this has been corroborated by the MedKeyHabitats project campaign on Lebanon deep-sea communities.

b) Salinity: The vertical distribution of salinity is similar to the temperature. There is a marked change between. 35-60 m depth (39.4-38.6 psu) in front of Byblos and Kfar-Abida; while in front of Batroun, this marked change appears between 55-65 m depth

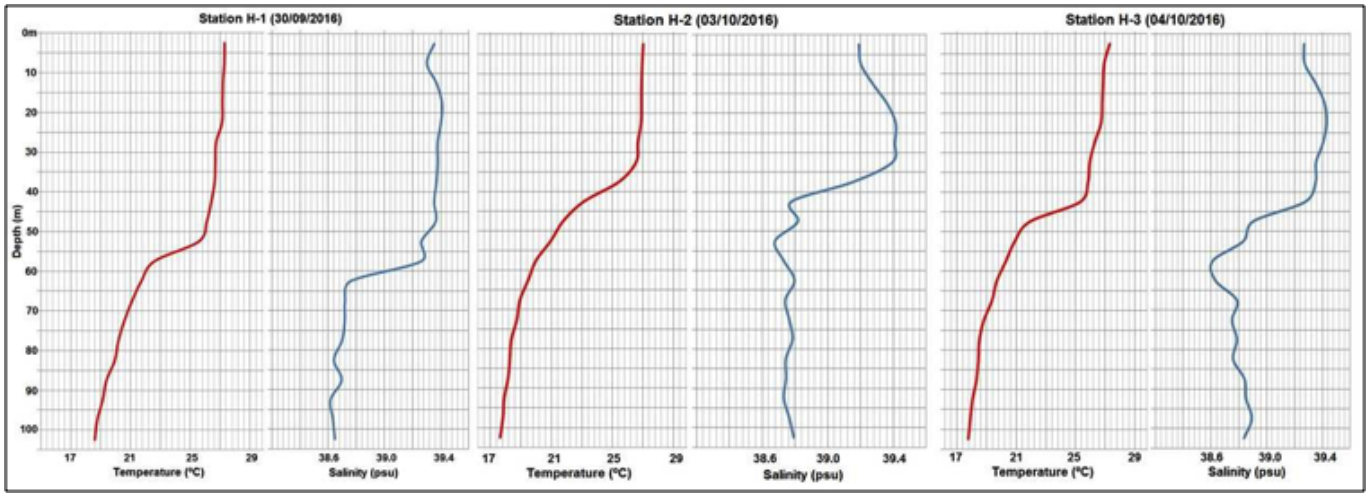

Figure 4.6. Temperature (T°C) and salinity (psu) profiles in front of Batroun (H-1), Byblos (H-2) and Kfar Abida (H-3).

5. MARINE BIODIVERSITY

5.1 TAXA

About three hundred thirty-nine taxa (320 at lower level: family, genus, species; and 9: at higher level: class, order), belonging to twenty six higher taxons (phyla, classes), have been observed (see Annex II; Fig. 5.1). The main group has been the Mollusca, with 62 taxons (18,8 %), followed by 'Pisces' (59 taxons, 17,9 %) and Porifera (57 taxons, 17.3 %). It is worth noting the low representation of Echinodermata with only 9 taxons (2.7 %). Unlike other campaigns in Lebanon (RAC/SPA-UNEP/MAP, 2014), and despite extensive exploration (0-54 m depth), the species *Echinaster sepositus, Paracentrotus lividus* and *Arbacia lixula* have not been observed.

With regard to macroalgae, Rhodophyta with 39 taxa (11.8 %), followed by Chlorophyta (15 taxa, 4.5 %). Highlight, the low presence of Ochrophyta (8 taxa, 2.4 %).

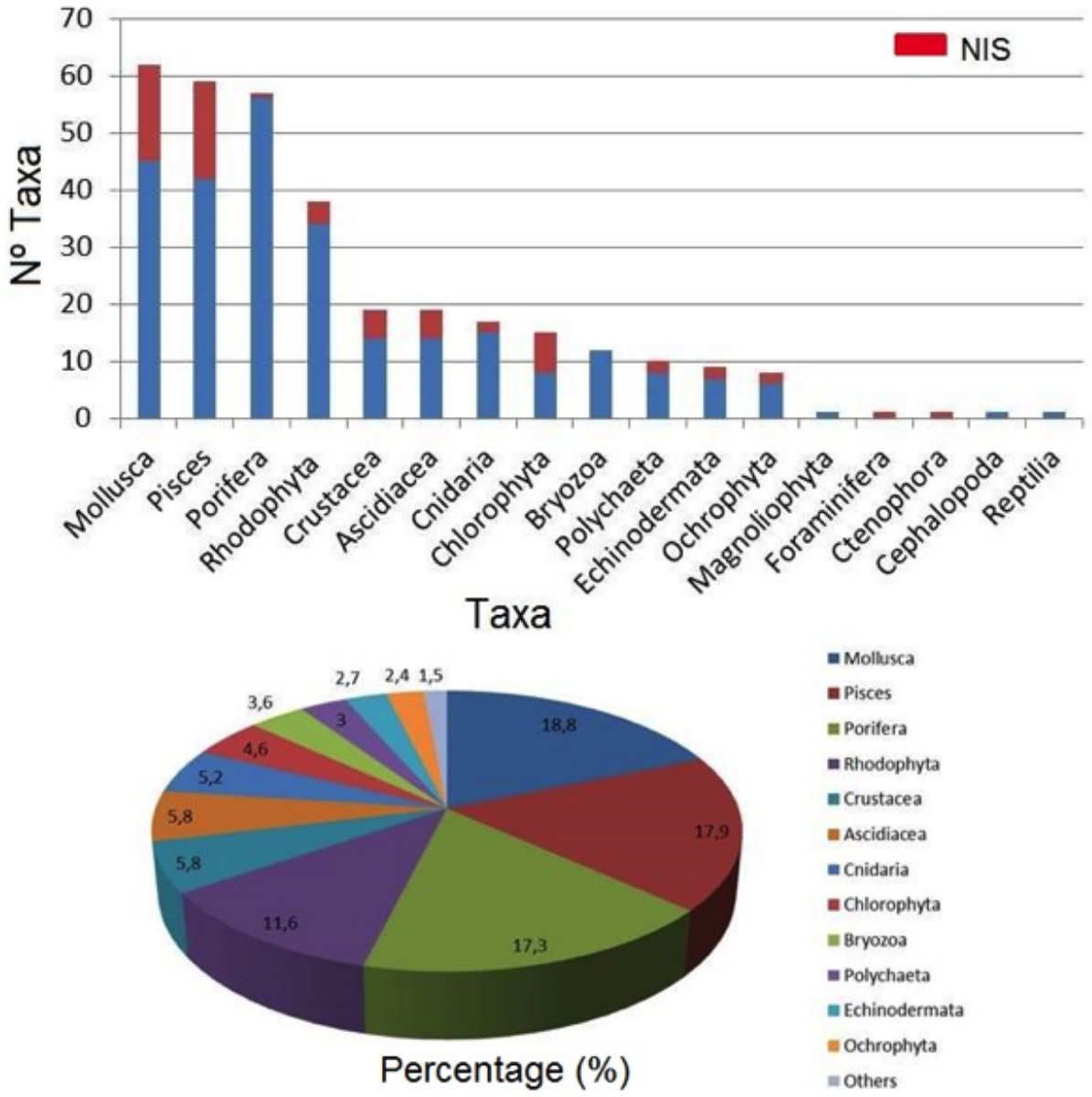

Figure 5.1 Number of species/taxa (in red NIS species) and percentage (%) of the main taxa.

5.2 SPECIES WITH PATRIMONIAL AND INTEREST VALUE

In this paragraph we include the protected species that have been observed during the mission-2016 (see Annex II). Each species is presented by the common synonymies, status of protection, geographical distribution, habitats, threads and Lebanon distribution with some observations about them. The protection degree of the different Conventions and Directives:

- Barcelona Convention 1995 / Protocol concerning Specially Protected areas and Biological Diversity in the Mediterranean (with the Marrakech-2009 and Istanbul-2013 amendments):
  - Annex II. Endangered or threatened species.
  - Annex III. Species whose exploitation is regulated.
- Bern Convention (1996, 1998) :
  - Annex I. Strictly protected flora species
  - Annex II. Strictly protected fauna species
  - Annex III. Protected fauna species
- Directive Habitat 92/43 CE on the conservation of natural habitats and of wild fauna and flora, European Commission:
  - Annex I. Natural habitat types whose conservation requires the designation of special areas of conservation.
  - Annex II. Species requiring designation of Special Areas of Conservation.
  - Annex IV. Species in need of strict protection.
  - Annex V. Species whose taking from the wild can be restricted.
- Washington Convention. Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES):
  - Appendix I Species that are the most endangered with extinction CITES.
  - Appendix II. Species that are not necessarily now threatened with extinction but that may become so unless trade is closely controlled.
  - Appendix III. Species included at the request of a Party that already regulates trade in the species and that needs the cooperation of other countries to prevent unsustainable or illegal exploitation.
- Mediterranean Flora 'Red Book' (UNEP/IUCN/GIS-Posidonia, 1990)

In addition to these species, we have included other ones of economic interest (large Sparidae and Serranidae) observed in the two Lebanon missions (2012, 2013).

5.2.1 Macrophyta

The main important marine macrophytes for the protection, and observed in 2016 mission in Lebanon are indicated in the table 5.1.

Table 5-1. Marine Macrophyta of special interest and observed in Lebanon-2016 mission.

MACROPHYTA	MRB	EU	BaC	BeC
Ochrophyta				
Cystoseira foeniculacea	+	-	II	-
Rhodophyta				
Lithothamnion corallioides	+	V	-	-
Magnoliophyta				
Cymodocea nodosa	+	-	II	I

Legend: (MRB) Mediterranean Flora Red Book; (EU) Habitat Directive European Union (1992); (BaC) Barcelona Convention (1995); (BeC) Bern Convention (1996-98).

a) Ochrophyta

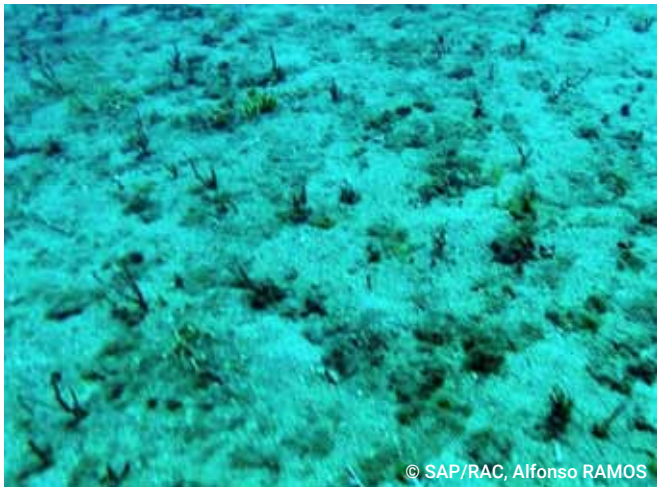

Figure 5-2. *Cystoseira* cf. *foeniculacea* thali sparse on rocky bottom cover by coarse sand, -27 m depth (st. Ba-1).

Cystoseira* cf. *foeniculacea (Linnaeus) Greville, 1830

Common synonymies: *C. abrotanifolia* (Linnaeus) C. Agardh, 1820; C. *discors* (Linnaeus) C. Agardh, 1828; C. *ercegovicii* Giaccone, 1973.

Protection status: Endangered or threatened species (Barcelona Convention, Annex II, Marrakech 2009 amendment). European Union proposal (COM (2009) 585) to include it in the list of endangered or threatened species. Mediterranean Flora 'Red Book' (UNEP/IUCN/GIS-Posidonia, 1990).

Geographical distribution: Atlanto-Mediterranean species. NE-Atlantic (southern Spain to Canary islands) and Mediterranean sea (Cabioch *et al*., 1995; Ribera *et al*., 1992).

Habitat: Infralittoral species on rocky substratum, from calm shallow waters (littoral pools) to sciaphilic lower horizon, 0-50 m depth (UNEP/IUCN/GIS Posidonie, 1990; Cabioch *et al*.,1995; Gómez-Garreta, 2001).

Threats: Sediment dumping, hyper-sedimentation, organic pollution, land reclamation, littoral dynamic alterations (marinas, ports).

Observations: Relatively common in Batroun, between 25-28 m depth (st. B-1). Attached on the flat rock and cobbles; cover by coarse sand and gravel (intense bottom current) where it forms sparse 'forests'.

b) Rhodophyta

Figure 5.3. A rhodolith from *Lithothamnion corallioides* (Nakoura, st. 15, 43 m depth).

Lithothamnion corallioides P. L. Crouan & H.M. Crouan, 1867

Common synonymies: *Lithothamnium fruticulosum* f.*soluta* Foslie (1905); *Lithothamnium solutum* Foslie (1908); *Lithophyllum solutum* (Foslie) Lemoine (1915), *Mesophyllum corallioides* (Crouan&Crouan) Lemoine.

Protection status: The maerl beds (including *L. corallioides*) have been included in the Mediterranean Action Plan for the Conservation of the Coralligenous and Other Calcareous Bio-concretions. Species whose taking from the wild can be restricted (Annex V, EU Habitats Directive 92/43); however, in the Mediterranean must be a priority habitat for conservation (Barberá *et al*., 2003). Mediterranean Flora 'Red Book' (UNEP/IUCN/GIS-Posidonia, 1990) as maerl habitat.

Geographical distribution: Atlanto-Mediterranean species. Eastern Atlantic (from Ireland to Cabo Verde Islands) and Mediterranean Sea (www.algaebase.org).

Habitat: Circalittoral maerl forming species on coarse sand and fine gravel, and low muddy fraction subject to bottom currents; also on lower infralittoral (Bressan & Babbini, 2003).

Threats: Sediment dumping, hyper-sedimentation, pull up by fixed bottom nets, trawling.

Observations: Rare in the area, localised only in Medfoun at 45-53 m depth. (st. M-4).

c) Magnoliophyta

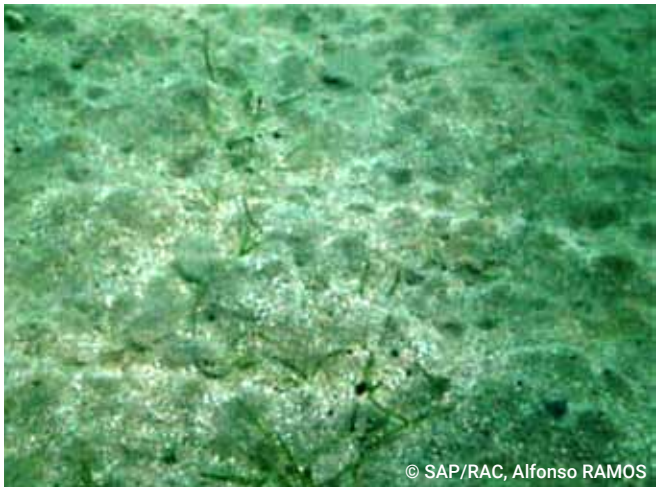

Figure 5.4. Sparse plants of *Cymodocea nodosa* meadow in Byblos, -27 m depth (st. B-3).

Cymodocea nodosa (Ucria) Ascherson, 1870

Common synonymies: None.

Protection status: Endangered or threatened species (Annex II, Barcelona Convention, Marrakech-2009 amedment); strictly protected flora species (Annex I, Bern Convention 1996-98). Also, the *Cymodocea meadows* are located in the natural habitats of community interest (Annex I, Habitat Directive 92/43): sandbanks which are slighly covered by sea water all the time (1110); and large shallow inlets and bays (1160).

Geographical distribution: Atlanto-Mediteranean species. NE-Atlantic (Southern Spain to Mauretania) and Mediterranean Sea (Cabioch *et al.*, 1995).

Habitat: Infralittoral species on sand and muddy sand bottoms, from shallow waters to 50m depth; and coastal lagoons (Pergent, 2009; Rodriguez-Prieto *et al.*, 2013).

Threats: Sediment dumping, hyper-sedimentation, organic pollution, land reclamation, littoral dynamic alterations (marinas, ports).

Observations: Very rare, only reported from Byblos (st. By-3), between 27-29 m depth. *C. nodosa* has colonized the muddy sand bottoms with very sparse small plants (Fig. 5.4).

5.2.2 Invertebrata

The important marine invertebrates for the protection, and observed in the 2016 mission in Lebanon, are indicated in the table 5.2.

Table 5.2. Marine invertebrata with special interest and observed in the 2016 mission in Lebanon

INVERTEBRATA	BaC	BeC	HD	WC
Porifera				
Aplysina aerophoba	II	II	-	-
Aplysina sp. plur.	II	II	-	-
Axinella polypoides	II	II	-	-
Hippospongia communis				
Spongia officinalis	III	III	-	-
Cnidaria				
Cladocora caespitosa	II	-	-	II
Phyllangia americana mouchezii				II
Mollusca				
Dendropoma petraeum	II	II	-	-
Tonna galea	II	II	-	-
Lithophaga lithophaga	II	II	IV	II

Legend: (BaC) Barcelona Convention (1995, 2009, 2013); (BeC) Bern Convention (1996-98); (HD) Habitat Directive European Union (1992); Washington Convention or CITES (2013).

a) Porifera

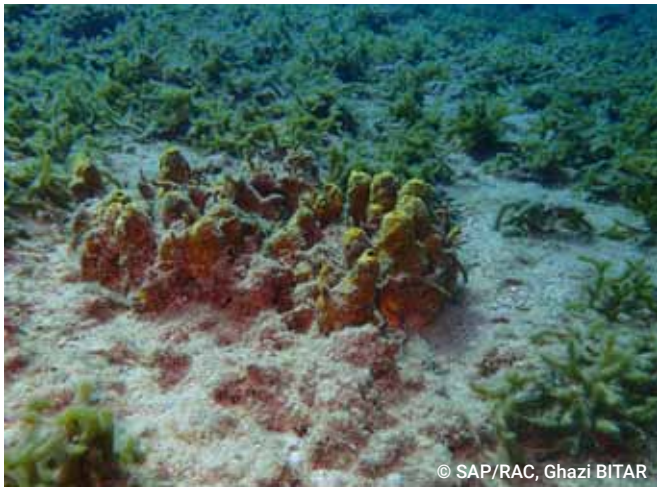

Figure 5.5. *Aplysina aerophoba* on rocky substratum in Batroun, -15 m (st. Ba-4).

Aplysina aerophoba Nardo, 1833

Common synonymies: *Verongia aerophoba* (Nardo, 1843); *Aplysina carnosa* Schmidt, 1862.

Protection status: Endangered or threatened species (Barcelona Convention, Annex II); strictly protected fauna species (Annex II, Bern Convention 1996-98). European Union proposal (COM (2009) 585) to include it in the list of endangered or threatened species *Aplysina* spp. plur.

Geographical distribution: Atlanto-Mediterranean species. Eastern Atlantic (from Southern Portugal to Cabo Verde, Canary and Madeira islands), Mediterranean Sea (Moreno *et al*., 2008).

Habitat: It is a photophilic species that lives on infralittoral rocky bottoms, preferably in shallow waters, although it has been cited at 40 m depth. (Moreno *et al*., 2008).

Threats: Sediment dumping, anchoring, collection by divers.

Observations: Common species in Batroun (st. Ba-1, Ba-4, Ba-5, Ba-6, Ba-7) and Byblos (st. By-4), A. aerophoba has been observed on photophilic/hemi-sciaphilic rocky substrata, between 2 to 40 m depth, mainly in shallow waters (< 15 m depth).

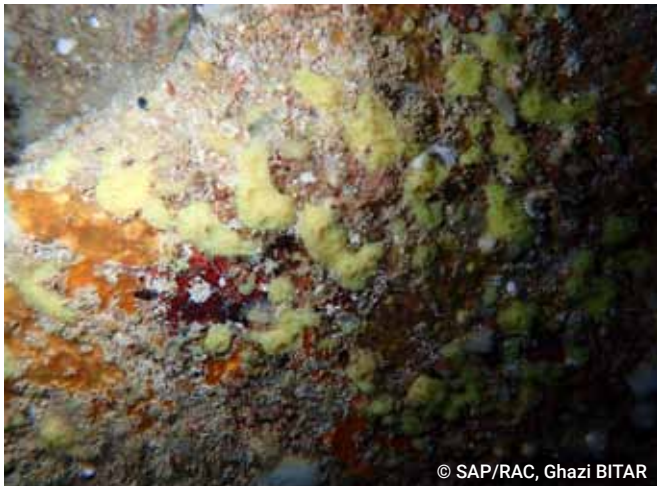

Figure 5.6. *Aplysina* sp. inside a cave of Medfoun, -3m (st. M-7)

Aplysina sp.

Protection status: Endangered or threatened species (Barcelona Convention, Annex II); strictly protected fauna species (Annex II, Bern Convention 1996-98). European Union proposal (COM (2009) 585) to include it in the list of endangered or threatened species *Aplysina* spp. plur.

Geographical distribution: At present, only observed in Lebanon.

Habitat: This species has only sampled in shallow caves.

Threats: Organic pollution, erosion by diving, land reclamation, littoral works (marinas, ports).

Observations: The species has only been observed in very located shallow caves (st. M-7), where it has been abundant.

Figure 5.7. *Axinella polypoides* on a rocky outcrop front to Batroun, at 51 m depth (st. Ba-6).

Axinella polypoides Schmidt, 1862

Common synonymies: None.

Protection status: Endangered or threatened species (Barcelona Convention, Annex II); strictly protected fauna species (Annex II, Bern Convention 1996-98). European Union proposal (COM (2009) 585) to include it in the list of endangered or threatened species .

Geographical distribution: Atlanto-Mediterranean species. NE-Atlantic (Southern United Kingdom to Mauretania, Azores, Madeira and Canary islands) and Mediterranean Sea (Moreno *et al.*, 2008).

Habitat: Typical circalittoral species that colonizes horizontal and vertical surfaces on rocky substrata. Also, the species is present in infralittoral enclaves on behalf of crevices and overhangs. The bathymetric range is from 15 to >300 m depth (Moreno *et al*., 2008), although it is more abundant in the upper circalittoral horizon (40-50 m depth).

Threats: Sediment dumping, pull up by fixed bottom nets, trawling, anchoring, erosion and/or collection by divers.

Observations: A. polypoides has been common in Batroun (st. Ba-6), Mefoun (st. M-4) and Byblos (st. By-5), mainly in the coralligenous community on horizontal and vertical surfaces, between 42-55 m depth.

Figure 5.8. *Hippospongia communis* front to Byblos, at 40 m depth (st. By-5).

Hippospongia communis (Lamarck, 1814)

Common synonymies: *Hippospongia equina* Schmidt, 1862; *H. elastica* Lendenfeld, 1889.

Protection status: Species whose exploitation must be regulated (Annex III, Barcelona Convention, 1995); protected fauna species (annex III, Bern Convention, 1996). European Union proposal (COM (2009) 585) to include in the Annex V (species whose exploitation must be regulated).

Geographical distribution: Endemic species of the Mediterranean Sea. Reported in the Red Sea (R. van Soest: www.marineespecies.org/porifera).

Habitat: Infralittoral and circalittoral species on rocky substrata, seagrass meadows, coastal detritic and muddy detritic, between 0.5 to 80 m depth in Libya (Vacelet, 1987).

Threats: Siltation, hyper-sedimentation, pull up by fixed nets, trawling, recollection unregulated.

Observations: The species seems very rare in the Lebanon. During the mission, only one specimen has been observed front to Byblos at 40 m depth (st. By-5).

Figure 5.9. *Spongia officinalis*, dead specimen from south of Byblos, at 5 m depth (st. By-4)

Spongia officinalis Linnaeus, 1759

Common synonymies: *Euspongia officinalis (*Linnaeus, 1759)*; Spongia adriatica* Schmidt, 1862 *; Spongia mollissima* Schmidt, 1862.

Protection status: Species whose exploitation must be regulated (Annex III, Barcelona Convention, 1995); protected fauna species (annex III, Bern Convention, 1996). European Union proposal (COM (2009) 585) to include in the Annex V (species whose exploitation must be regulated).

Geographical distribution: Species of temperate-warm affinities with a wide range of geographical repartition (Mediterranean, Eastern and Western Atlantic, Indian Ocean) (Templado *et al*., 2004)

Habitat: On rock (normally in walls, overhangs and cave entrances), seagrass beds and coarse sandy bottoms, from shallow waters to 40 m depth (occasionally, some exemplars have been caught from 200-300 m depth (Templado *et al*. 2004).

Threats: Siltation, hyper-sedimentation, fixed nets, trawling, recollection unregulated.

Observations: *S. officinalis* is not a common species, but spreads in the area: Batroun (st. Ba-5, Ba-6), Kfar Abida (st. K-2, K-3), Medfoun (st. M-7) and Byblos (st. By-7, By-8). It has been observed in shallow and deep waters (3-40 m depth) and, normally, in overhangs and rocky crevices.

b) Cnidaria: Anthozoa

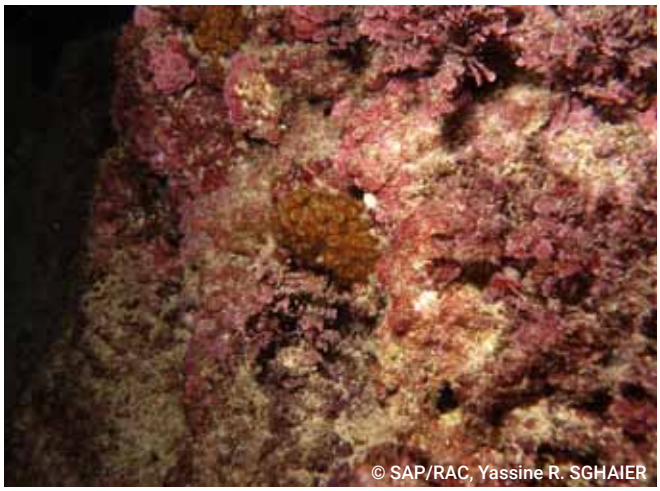

Figure 5.10. The hermatypic coral *Cladocora coespitosa* in Medfoun at 3m depth (st. M-7).

Cladocora caespitosa (Linnaeus, 1767)

Common synonymies: *Madrepora flexuosa* Pallas, 1766; *Cladocora stellaria* Milne Edwards & Haime, 1849. *Hoplangia pallaryi* Joubin, 1930.

Protection status: Endangered or threatened species (Annex II, Barcelona Convention, Istanbul 2013); Appendix II CITES (Washington Convention, 2013).

Geographical distribution: Endemic species of Mediterranean Sea. The species has also signaled in NE Atlantic from southern Portugal to Agadir (Morocco) (Zibrowius, 1980).

Habitat: Hermatypic coral that live in photophilic infralittoral bottoms (0-25 m depth), although it can reach 50 m depth in very clear waters. On rocky substrata, *Posidonia* rhizomes and coastal detritic (Moreno *et al.*, 2008).

Threats: Hyper-sedimentation, sediment dumping, trawling, recollection by divers, competition with *Oculina patagonica*.

Observations: Very rare species in the area, only one colony has been observed in Medfoun (st. M-7, 0-13 m depth).

Figure 5.11. *Phyllangia americana mouchezii* from Batroun at 50 m depth (st. Ba-6).

Phyllangia americana mouchezii (Lacaze-Duthiers, 1897)

Common synonymies: *Coenocyathus apertus* (Doderlein, 1913).

Protection status: Appendix II CITES (Washington Convention, 2013).

Geographical distribution: Eastern Atlantic (from Portugal to Senegal, Azores, Madeira and Canary islands) and Mediterranean Sea (Zibrowius, 1980).

Habitat: Ahermatypic coral that live in sciaphilic infralittoral and circalittoral bottoms (0-70 m depth) (Moreno & López-González, 2008).

Threats: Erosion and collection by divers, mooring on circalittoral rocky bottoms, pollution in the caves.

Observations: Common species in the area, from 3 to 50 m depth, mainly on coralligenous and caves habitats in Batroun (st. Ba-6), Kfar Abida (st. K-3) and Medfoun (st. M-4)

c) Mollusca

Figure 5.12. Bioconstruction of *Dendropoma petraeum* covered by the algae from Kfar Abida in the station K-4 (up). Vermetid reef from Batroun (bottom).

Dendropoma petraeum (Monterosato, 1884)

Common synonymies: *Vermetus glomeratus* Bivona-Bernardi, 1832, *Vermetus cristatus* f. *minor* Monterosato, 1892.

Protection status: Endangered or threatened species (Barcelona Convention, Annex II); strictly protected fauna species (Annex II, Bern Convention 1996-98). European Union proposal (COM (2009) 585) to include it in the list of endangered or threatened species.

Geographical distribution: Endemic species of Mediterranean Sea, from Gibraltar Strait to Lebanon; also, in the near Atlantic coasts from Spain and Morocco (Templado *et al*., 2004).

Habitat: The species forms dense aggregates on rocky substratum, joint to the corallinacea *Neogoniolithon brassica-florida*, normally in the exposed littoral fringe (Templado *et al*., 2004). Also, on infralittoral photophilic rock at 3 m depth (as Tabarca Marine Reserve, pers. observ.).

Threats: Sediment dumping, organic pollution, trampling, bait collection (destruction of the biogenic formations), littoral works (marinas, ports).

Observations: Present in the littoral fringe from Batroun to Byblos. However, the life formations are not abundant, perhaps due to pollution or trampling.

Figure 5.13. Piece of shell of *Tonna galea* collected in front of Medfoun (st. M-6).

Tonna galea Linnaeus, 1758

Common synonymies: *EDolium galea.* (Linnaeus, 1758); *Buccinum olearium* Linnaeus, 1758.

Protection status: Endangered or threatened species (Barcelona Convention, Annex II); strictly protected fauna species (Annex II, Bern Convention 1996-98). European Union proposal (COM (2009) 585) to include it in the list of endangered or threatened species.

Geographical distribution: Species with warm affinities. Eastern Atlantic (from southern Portugal to South Africa), Western Atlantic (from northern Carolina de la Caroline to Brazil), Mediterranean Sea (Templado *et al*., 2004).

Habitat: Mainly in sandy bottoms near to detritic substrata and coralligenous communities on the continental shelf, usually from 15 to 80m depth (Templado *et al*., 2004).

Threats: Trawling, collection by divers.

Observations: Very rare in the area, only one empty shell has been sampled in Medfoun, between 13 to 22 m depth (st. M-6).

Figure 5.14. The 'sea date' (*Lithophaga lithophaga*) from Batroun (st. Ba-5). .

Lithophaga lithophaga (Linnaeus, 1758)

Common synonymies: *Lithodomus lithophagus* (Linnaeus, 1758), *Lithophaga mytuloides* Röding, 1798; *Lithodomus dactylus* Cuvier, 1817; *Lithodomus inflatus* Réquien, 1848.

Protection status: Endangered or threatened species (Barcelona Convention, Annex II); strictly protected fauna species (Annex II, Bern Convention 1996-98). Species of community interest in need of strict protection (Annex IV, Habitat Directive 92/43 European Union). Species that are not necessarily now threatened with extinction but that may become so unless trade is closely controlled (Appendix II, CITES, 2013).

Geographical distribution: Eastern Atlantic from southern Portugal to Angola (also, Canary and Madeira Islands), Mediterranean Sea; also cited in the Red Sea (Templado *et al.*, 2004).

Habitat: Endolithic species in calcareous substrata (rock, corals, biogenic formations), from 0 m to 50 m depth; more frequent in shallow waters (0-5 m depth) (Moreno *et al.*, 2008).

Threats: Very appreciated resource whose recollection suppose the destruction of the rocky substratum by divers.

Observations: Although, two specimens have only been observed in Batroun (st. Ba-5) and Byblos (st. By-4), the species seems common in the area.

5.2.3 Vertebrata

The important marine vertebrata for the protection and observed in Batroun-Byblos area are indicated in the table 5.3.

Table 5.3. Marine vertebrata of special interest and observed in Lebanon during the missions 2016

MARINE VERTEBRATA	BaC	BeC	EU	WC
Actinopterygii				
Epinephelus marginatus	III	III	-	-
Reptilia				
Chelonia mydas	II	II	IV	I

Legend: (BaC) Barcelona Convention (1995); (BeC) Bern Convention (1996-98).

a) Actinopterygii

Figure 5.15. A juvenile of 'dusky grouper' (*Epinephelus marginatus*) from Ras-Chekaa at 12 m depth

Epinephelus marginatus (Linnaeus, 1758)

Common synonymies: *Epinephelus guaza* (Linnaeus, 1758), *E. gigas* (Brünnich, 1768).

Protection status: Species whose exploitation must be regulated (Annex III, Barcelona Convention, 1995); protected fauna species (annex III, Bern Convention, 1996). European Union proposal (COM (2009) 585) to include it in the Annex V whose taking from the wild can be restricted list of endangered or threatened species. Endangered species (IUCN Red List, 2004).

Geographical distribution: Amphi-Atlantic species. Eastern Atlantic (Brittany Islands to South Africa), Western Atlantic (Bermuda's Islands to Brazil), Mediterranean Sea (Tortonese, 1986).

Habitat: Demersal species on hard bottoms and submarine caves, from 0 to 200 m depth (Tortonese, 1986).

Threats: Over-exploitation by spear-fishing on the great individuals (male populations).

Observations: *E. marginatus* seems rare in the area: Batroun (st. Ba-4), Kfar Abida (st. K-2) and Medfoun (M-7). Only 3 juvenile individuals have been observed at 5-20 m depth (st. Ba-4, M-7, K-2).

b) Reptilia

Figure 5.16. The green turtle (*Chelonia mydas*) at 26 m depth (st. By-3).

Chelonia mydas (Linnaeus, 1758)

Common synonymies: *Testudo viridis* Schneider, 1783.

Protection status: Endangered or threatened species (Barcelona Convention, Annex II); strictly protected fauna species (Annex II, Bern Convention 1996-98). Species of community interest in need of strict protection (Annex IV, Habitat Directive 92/43 European Union). Endangered species (IUCN Red List).Migratory species that need or would significantly benefit from international cooperation (Appendix II of Bonn Convention).

Geographical distribution: Widely distributed in tropical and subtropical waters, near continental coasts and around islands, rare in temperate waters (Marquez, 1990).

Habitat: Solitary nektonic animal that occasionally forms feeding aggregations in shallow water areas (beaches, bays, lagoons) with seagrass meadows; and it lay eggs on beaches (Marquez, 1990).

Threats: The destruction of the life cycle critic habitats (nesting beaches, feeding shallow seagrasses meadows), accidental catches by trawling, eggs collection, collision with vessels.

Observations: Only two individuals have been observed between 26 to 8 m depth, one in Kfar Abida (st. K-3) and one in Byblos (st. B-3), respectively.

5.2.4 Other species with interest

Then we have considered other target fish species with any protection status but of economic value that will be interesting to monitoring in marine protected areas and around them.

a) Large Serraridae

During the diving observations some juveniles of large Serranidae, a part from *Epinephelus marginatus*, have been reported: *E. costae* and *Mycteroperca rubra*. That means the importance of the area as nursery area of these species.

Figure 5.17. A juvenile of the 'golden grouper' (*Epinephelus costae*) in Medfoun (st. M-6).

Epinephelus costae (Steindachner, 1878)

Common synonymies: *Plectropoma fasciatus* Costa, 1844; *Cerna chrysotaenia* Döderlein, 1882; *Epinephelus alexandrinus* (Valenciennes, 1828), synonymy of *E. fasciatus* (Forsskål, 1775).

Protection status: None. Some Mediterranean countries (France, Spain) have regulated the minimum size to catch large serranids (> 45 cm).

Geographical distribution: Eastern Atlantic (from southern Portugal to Nigeria), Mediterranean Sea (exc. northern Adriatic Sea) (Tortonese, 1896).

Habitat: Demersal species on rocky and muddy bottoms, juveniles also in seagrass meadows; from shallow waters to 300 m depth (Tortonese, 1986b).

Threats: Over-exploitation by spear-fishing on the great individuals (hermaphrodite selective fishing on male populations).

Observations: Relatively frequent species in the area: Batroun (st. Ba-4) and Medfoun (st. M-6, M-7), between 2-23 m depth but only represented by juveniles exemplars (size <25 cm).

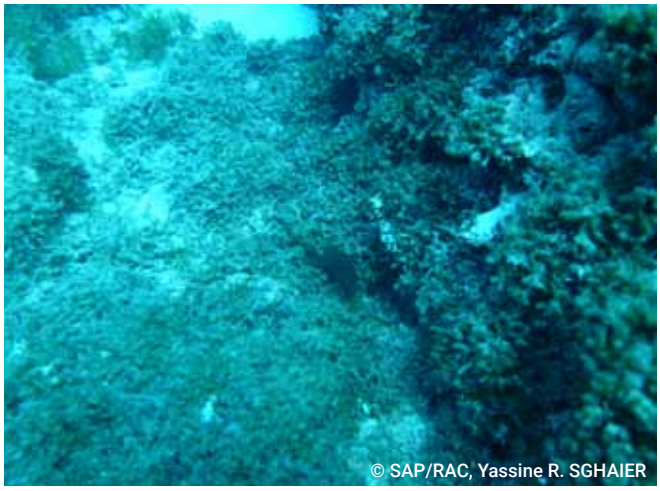

Figure 5.18. Juvenile of 'comb grouper' (*Mycteroperca rubra*) in Batroun (st. Ba-5)

Mycteroperca rubra (Bloch, 1793)

Common synonymies: *Epinephelus ruber* Bloch, 1793, *Mycteroperca scirenga* (Rafinesque, 1810), *Parepinephelus acutirostris* Valenciennes, 1828, *Serranus nebulosus* Cocco, 1833, *Serranus armatus* Osório, 1893.

Protection status: None. Some Mediterranean countries (France, Spain) have regulated the minimum size to catch large serranids (> 45 cm).

Geographical distribution: Amphi-Atlantic species. Eastern Atlantic (form Bay of Biscay to Angola), Western Atlantic (from Bermuda Islands to Brazil), Mediterranean Sea (Tortonese, 1986).

Habitat: Demersal species, on rocky and sandy bottoms at 15-200 m depth (Tortonese, 1986); juveniles in shallow waters.

Threats: Over-exploitation by spear-fishing on the great individuals (hermaphrodite selective fishing on male populations).

Observations: *M. rubra* has been the large serranidae species more frequent in the area: Batroun (st. Ba-4, Ba-5), Kfar Abida (K-4), Medfoun (M-7) and Byblos (By-4, By-7). Nevertheless, no adult has been observed; all of exemplars were juveniles (size < 25 cm).

b) Large Sparidae

During the diving observations, *Diplodus cervinus* and *D. sargus* have been common, whereas *D. puntazzo* and *Pagrus auriga* are been very rare. Other large sparids as *Dentex dentex*, *Pagrus pagrus* and *Sparus aurata* have not been observed. Among the observed species we can highlight, by the size that can reach (> 50cm): *D. crevinus*, *D. puntazzo* and *P. auriga*.

Figure 5.19. Two juveniles of the 'zebra sea bream' (*Diplodus cervinus*) in Byblos (st. By-7).

Diplodus cervinus (Lowe, 1838)

Common synonymies: *Diplodus trifasciatus* (Rafinesque, 1810).

Protection status: None.

Geographical distribution: Atlanto-Mediterranean species. Easter Atlantic (from Bay of Biscay to Cape Verde Islands, Madeira and Canary), Mediterranean and Black Seas (exc. Lion Gulf) (Bauchot & Hureau, 1986).

Habitat: Demersal species on rocky and muddy bottoms, from shallow waters to 300 m depth (Bauchot & Hureau, 1986).

Threats: Alteration of the juvenile habitats (inshore rocks) by organic pollution, siltation or littoral works; over-exploitation by spear-fishing.

Observations: *D. cervinus* has been a common species in the area: Batroun (st. Ba-5), Kfar Abida (K-2, K-3), Medfoun (M-7) and Byblos (By-7, By-8). Nevertheless, no adult has been observed; all of exemplars were juveniles (size < 25 cm).

Figure 5.20. *Diplodus puntazzo* on a rocky outcrop in front of Bylos, at 5m depth (st. By-4).

Diplodus puntazzo (Cetti, 1777)

Common synonymies: *Puntazzo puntazzo* (Cetti, 1777)

Protection status: None.

Geographical distribution: Atlanto-Mediterranean species. Easter Atlantic (from Bay Biscay to Sierra Leoneay of Biscay, and Cape Verde and Canary Islands), Mediterranean and Black Seas (Bauchot & Hureau, 1986).

Habitat: Demersal species on rocky bottoms, from shallow waters to 159m depth (Bauchot & Hureau, 1986).

Threats: Alteration of the juvenile habitats (inshore rocks) by organic pollution, siltation or littoral works; over-exploitation by spear-fishing.

Observations: *D. puntazzo* has been very rare in the area: Only an individual in Byblos, at 6m depth (By-4).

Figure 5.21. Juvenile of *Pagrus auriga* in the tunnel of Raoucheh, at 3m depth (2012 mission)

Pagrus auriga (Valenciennes, 1843)

Common synonymies: *Sparus auriga* (Valenciennes, 1843)

Protection status: None.

Geographical distribution: Atlanto-Mediterranean species. Eastern Atlantic (from Portugal to Angola), Mediterranean Sea, more frequent in the southern sector (Bauchot & Hureau, 1986).

Habitat: Demersal and coastal species on rocky and gravel bottoms, from shallow waters to 170 m depth; juveniles in shallow waters (Bauchot & Hureau, 1986).

Threats: Alteration of the juvenile habitats (inshore rocks) by organic pollution, siltation or littoral works; over-exploitation by spear-fishing.

Observations: The species seems rare, only one juvenile individual have been observed in deep waters, 40-50m depth in front of Batroun (st. Ba-6.1). Probably, like other large sparids, the species is subject to high fishing pressure.

5.3 NON-INDIGENOUS SPECIES (NIS)

With regards to the exotic species a total of 66 spp. has been recorded, 62 spp. are lessepsian and 4 spp. from Atlantic origin (*Paraleucilla magna, Oculina patagonica, Mnemiopsis leidyi and Percnon gibbesi*), that represents about the 20,2 % of the taxa observed. The Figures 5.22 and 5.23 shows the number and percentage of species by taxa, respectively, standing out the mollusks and fishes both with 17 spp. (42,2 % the total).

There is a marked decrease in NIS as a function of depth. It can be observed that it decreases approximately half of species per depth range (Fig. 5.23 left). It should be noted that the lessepsian fish *Pterois miles* has only been observed from 35 m depth (Fig. 5.23 right).

It is interesting to note the scarce presence or absence of non-indigenous species, abundant in other time and/or other areas, probably, due to space-time changes. This is the case of *Apogonichthyoides nigripinnis, Stypopodium.schimperi* and *Percnon gibbesii*, very rare in Batroun-Byblos area. Or l'absence of *Laurencia* cf. *chondroides* and *Lagocephalus sceleratus*, very common in the Saida-Nakoura area in 2013 (RAC/SPA - UNEP/MAP, 2013).

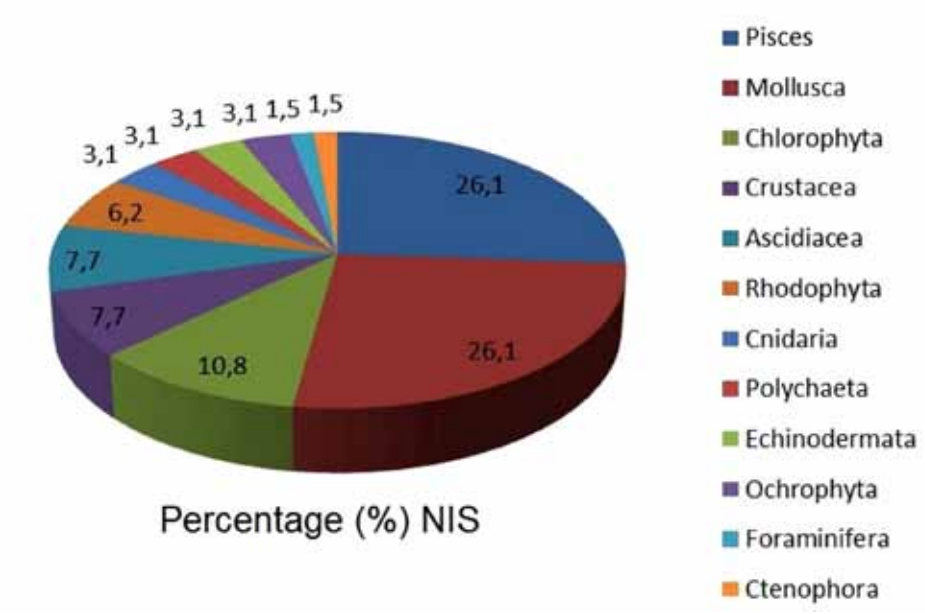

Figure 5.22. Number of NIS by taxa.

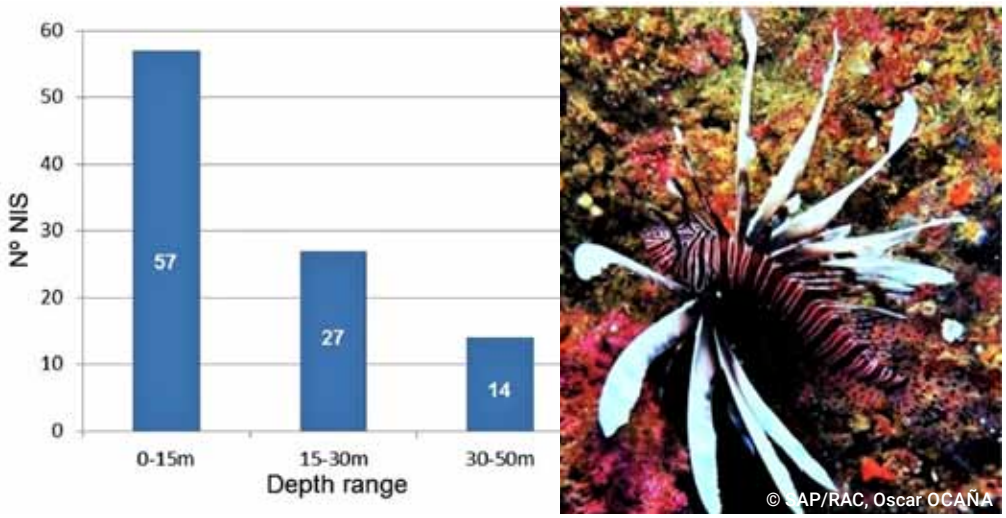

Figure 5.23. Number of NIS by depth range (exact number inside the rectangles). *Pterois miles* (right) front Batroun, 49 m depth.

5.4 NEW RECORDS FOR THE LEBANESE BIODIVERSITY

Probably, thirteen new species records have been observed for the Lebanese marine biodiversity in the 2016 mission. The taxa have been (Fig. 5.24 and 5.25, Annex II):

a) Macroalgae (Fig. 5.24): The *chlorophyta Caulerpa taxifolia* var. *distichophylla,* and the *rhodophyta Hypoglossum hypoglossoides*, *Heterosiphonia crispella* and *Womerleyella setacea*. The NIS species *C. taxifolia* var. *distichophylla* and *W. setacea* have been the subject of a recent publication (Bitar *et al.*, 2016).

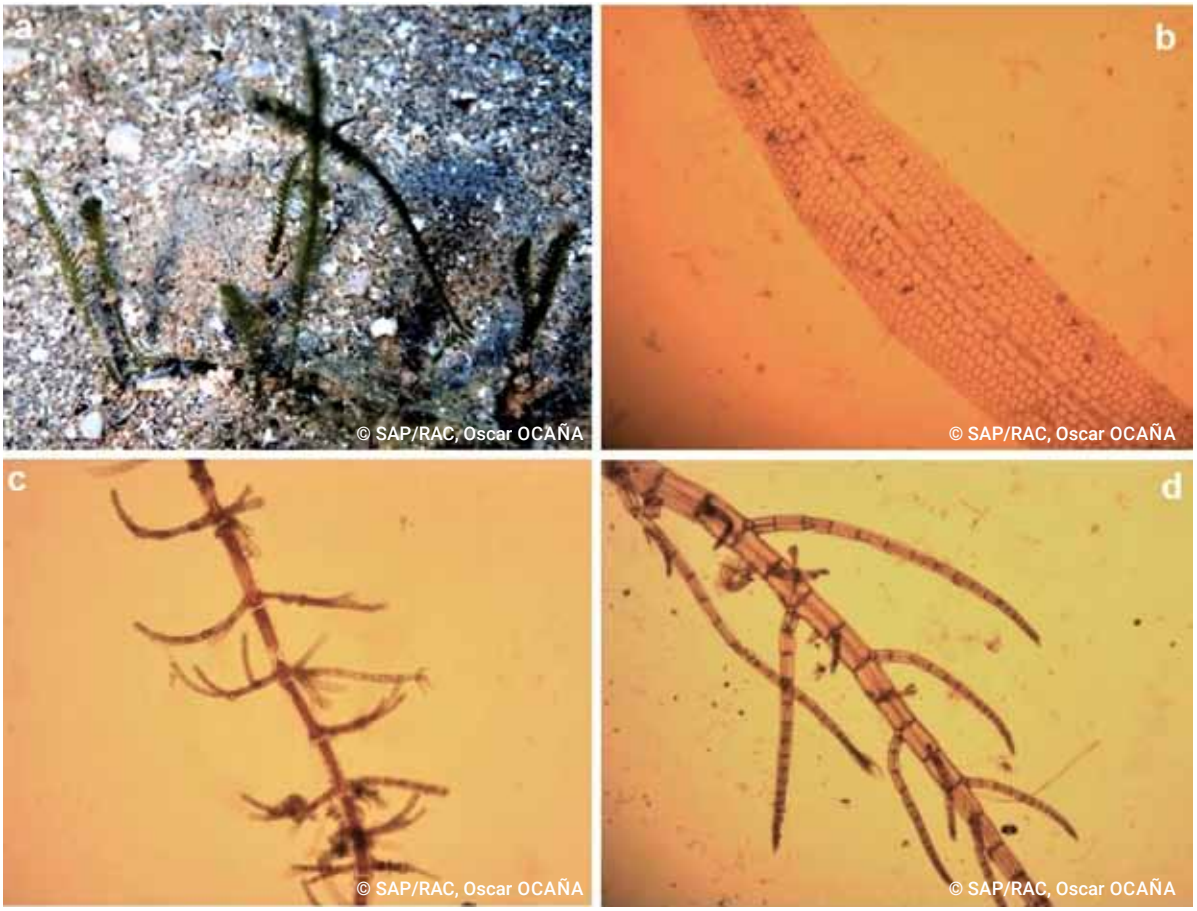

Figure 5.24. Macroalgae first records for Lebanon: (a) *Caulerpa taxifolia* var. *distichophylla*; (b) *Hypoglossum hypoglossides*; (c) *Heterosiphonia crispella*; (d) *Womerleyella setacea*.

b) Invertebrata (Fig. 5.25): The calcareous sponge *Borojevia* cf. *cerebrum* and the demosponge *Poecilloscleridae* sp; the lessepsian polychaeta *Branchiomma bairdi*; the lessepsian decapod *Halimede tyche*; the opithobranchia gastropod *Spurilla* cf. *neapolitana*, and the lessepsian bivalve *Spondylus groschi?*.

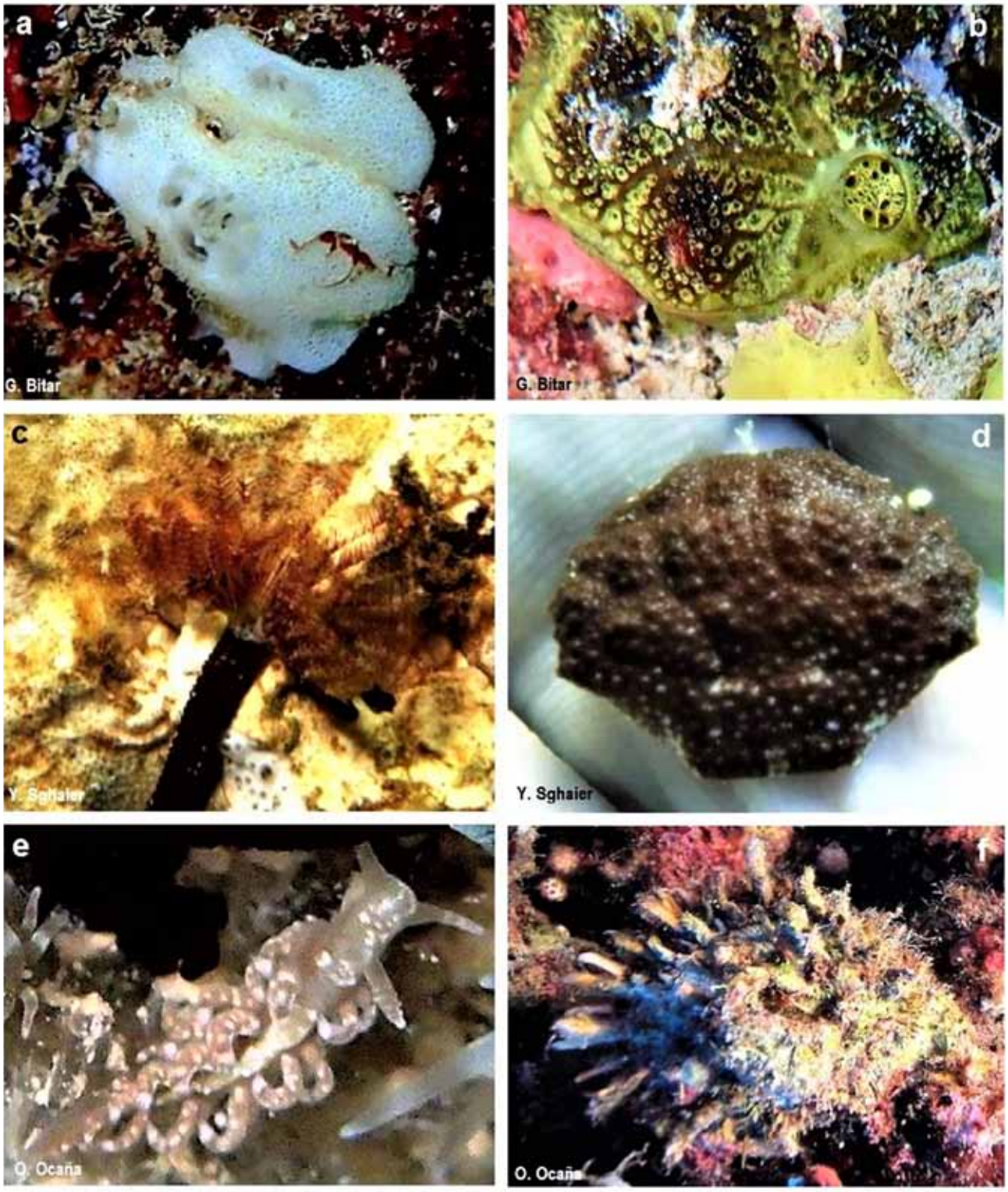

Figure 5.25. Invertebrata, new records for the Lebanese fauna: (a) *Borojevia* cf. *cerebrum*; (b) *Poecilloscleridae* sp: (c) *Branchiomma bairdi*; (d) *Halimede tyche*; (e) *Spurilla* cf. *neapolitana*; (f) *Spondylus groschi?*.

c) Chordata (Fig.5.26): The colonial ascidians of the family Didemnidae: *Didemnum fulgens* and *Lissoclinum perforatum*: and the gobid fish *Gobius paganellus*.

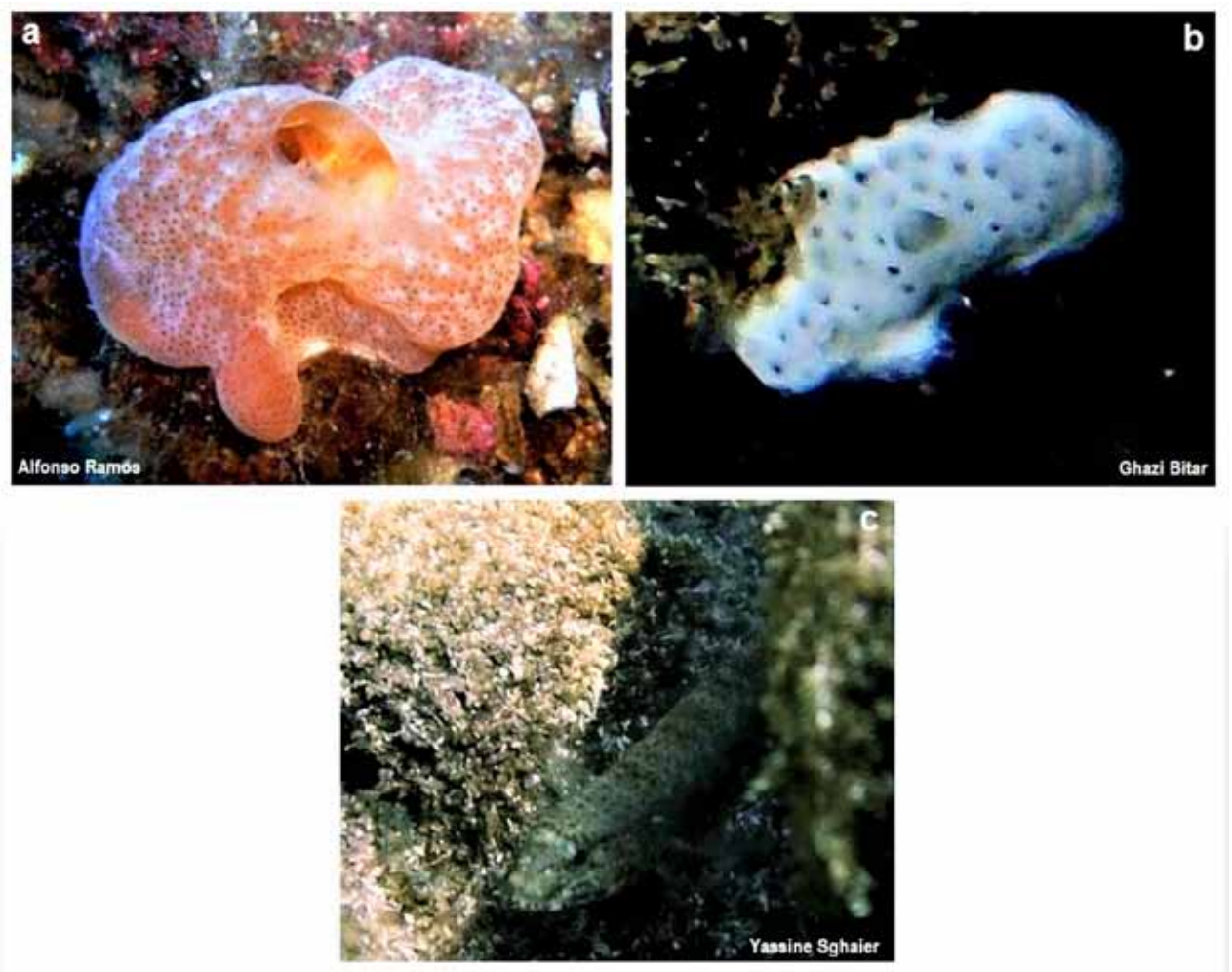

Figure 5.26. Chordata, new records for the Lebanese fauna:
(a) *Didemnum fulgens*; (b) *Lissoclinum perforatum*; (c) *Gobius paganellus*.

5.5 FISH ASSEMBLAGES

The fish assemblage parameters were rather different among the studied stations, and during the study, a total of 33 fish species were observed, of 12 were non-indigenous species (Table 5.4). The mean number of species and abundance were highest in the stations Batroun (Ba-7) and Medfoun (M-5); while the maximum biomass was observed in Batroun (Ba-6, Ba-7) due to the higher size of the population. In the other hand, the lowest value was observed in Byblos (By-6), with only a medium of 1 specie in 125 m^2 (Table 5.4 and Fig. 5.27), due to the homogeneity of the sampled habitat (muddy sand). The spatial distribution of these fish assemblage values are showed in figures 5-28, 5.29 3 and 5.30.

Table 5.4. Fish species

Specie	Native (N) Exotic (E)	SC	TC	Total abundance
Chromis chromis (Linnaeus, 1758)	N	2	MIC	3232
Siganus rivulatus Forsskål & Niebuhr, 1775	E	3	HBV	1885
Diplodus vulgaris (Geoffroy Saint-Hilaire, 1817)	N	3	MEC	1415
Oblada melanura (Linnaeus, 1758)	N	1	MIC	1040
Sargocentron rubrum (Forsskål, 1775)	E	6	MEC	835
Cheilodipterus novemstriatus (Rüppell, 1838)	E	6	MEC	368
Pempheris vanicolensis Cuvier, 1831	E	6	MEC	324
Plotosus lineatus (Thunberg, 1787)	E	4	MEC	219
Thalassoma pavo (Linnaeus, 1758)	N	5	MEC	194
Coris julis (Linnaeus, 1758)	N	5	MEC	132
Siganus luridus (Rüppell, 1829)	E	3	HBV	88
Torquigener flavimaculosus Hardy & Randall, 1983	E	4	MIC	86
Spicara smaris (Linnaeus, 1758)	N	3	MIC	71
Diplodus sargus (Linnaeus, 1758)	N	3	MEC	67
Xyrichtys novacula (Linnaeus, 1758)	N	5	MEC	44
Sparisoma cretense (Linnaeus, 1758)	N	5	MEC	26
Serranus cabrilla (Linnaeus, 1758)	N	5	MAC	20
Caranx crysos (Mitchill, 1815)	E	1	MAC	18
Serranus scriba Linnaeus, 1758	N	5	MAC	13
Pterois miles (Bennett, 1828)	E	6	MAC	9
Fistularia commersonii Rüppell, 1838	E	4	MEC	5
Stephanolepis diaspros Fraser-Brunner, 1940	E	5	MEC	5
Pteragogus pelycus Randall, 1981	N	5	MEC	3
Symphodus ocellatus (Linnaeus, 1758)	N	5	MEC	3
Dasyatis pastinaca (Linnaeus, 1758)	N	6	MAC	2
Epinephelus costae Valenciennes, 1828	N	5	MAC	2
Symphodus tinca (Linnaeus, 1758)	N	5	MEC	2
Apogon imberbis (Linnaeus, 1758)	N	6	MEC	1
Apogonichthyoides nigripinnis (Cuvier, 1828)	E	6	MEC	1
Diplodus cervinus Lowe, 1841	N	3	MEC	1
Gymnothorax unicolor (Delaroche, 1809)	N	6	MAC	1
Mycteroperca rubra (Bloch, 1793)	N	5	MAC	1
Pagrus auriga Valenciennes, *1843*	N	3	MAC	1

Origin: (N) native species; (E) exotic species. Spatial category (SC): (1) highly mobile gregarious, pelagic erratic species; (2) planktophagous and relatively sedentary species, living throughout the water column; (3) demersal mesophagous species, with medium-amplitude vertical movements and relatively broad horizontal movements; (4) demersal species, with slight vertical and high lateral movements; (5) sedentary demersal mesophagous species; (6) highly sedentary cryptic benthic species. Trophic category (TC): (HBV) herbivores; (MIC) microphagic carnivores; (MEC) mesophagic carnivores; (MAC) macrophagic carnivores.

Table 5.5. Mean values (± standard error) of number of species, total abundance and total biomass in the studied stations

	Station						
	Ba-6	Ba-7	By-5	By-6	K-1	M-4	M-5
Number of spp./125 m^2	5.00 ± 0.78	8.75 ± 0.95	4.25 ± 0.63	1.06 ± 0.06	7.88 ± 0.97	3.00 ± 0.71	8.75 ± 0.46
Abund. (ind./125 m^2)	233.50 ± 124.21	543.75 ± 187.30	33.50 ± 7.24	2.81 ± 0.32	275.75 ± 70.76	21.25 ± 9.47	300.08 ± 71.68
Biomass (g/125 m^2)	9 312.84 ± 3 422.22	29 519.45 ± 8 920.41	1 915.55 ± 904.63	52.94 ± 11.04	3 694.54 ± 922.56	299.28 ± 197.79	4 019.38 ± 798.71

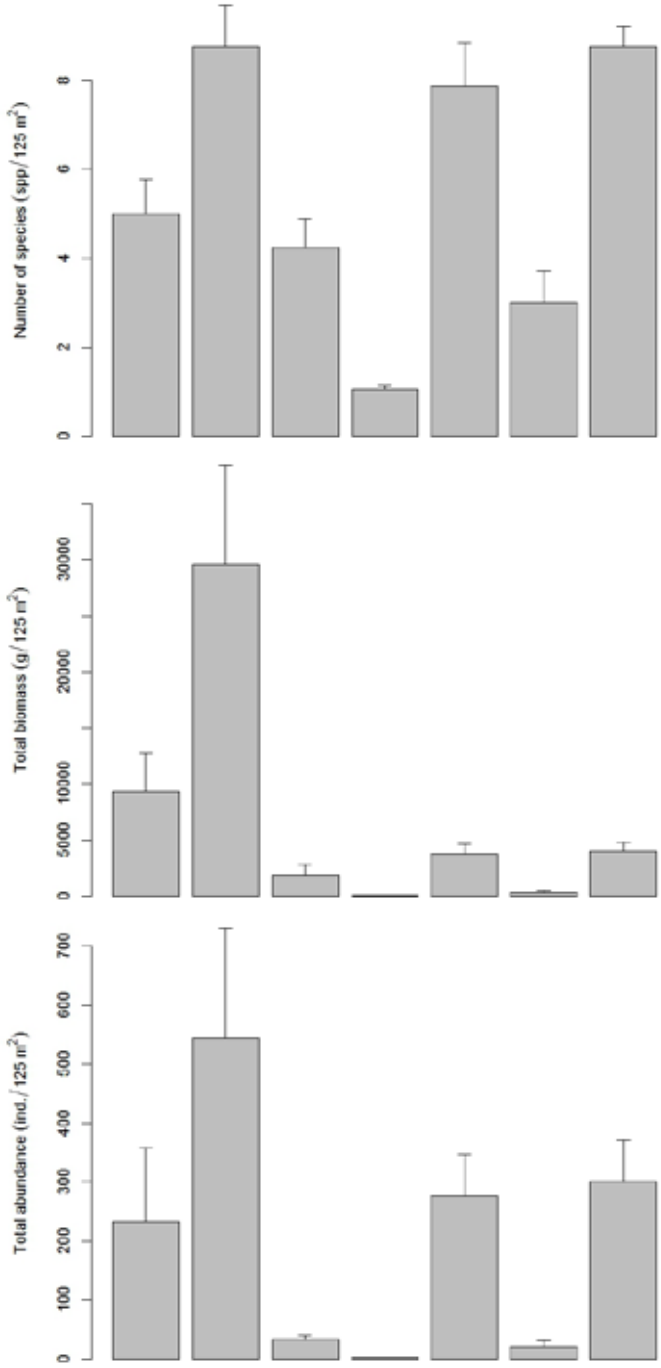

Figure 5.27. Mean values (± standard error) of number of species (nº of spp/125 m^2), total abundance (ind./125 m^2) and total biomass (g/125 m^2) in the studied stations.

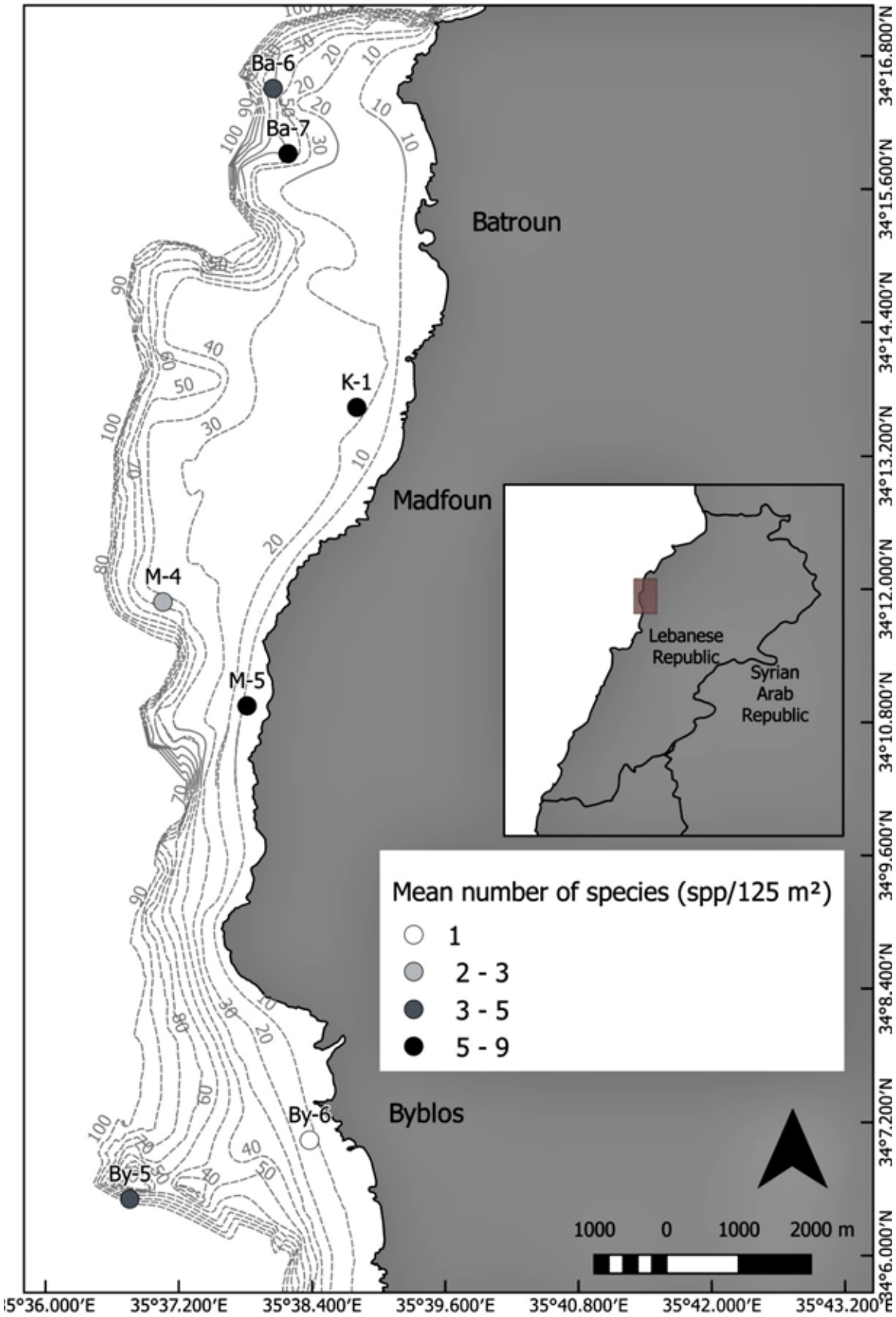

Figure 5.28. Spatial distribution of mean number of species (nº of spp/125 m^2) in the studied area.

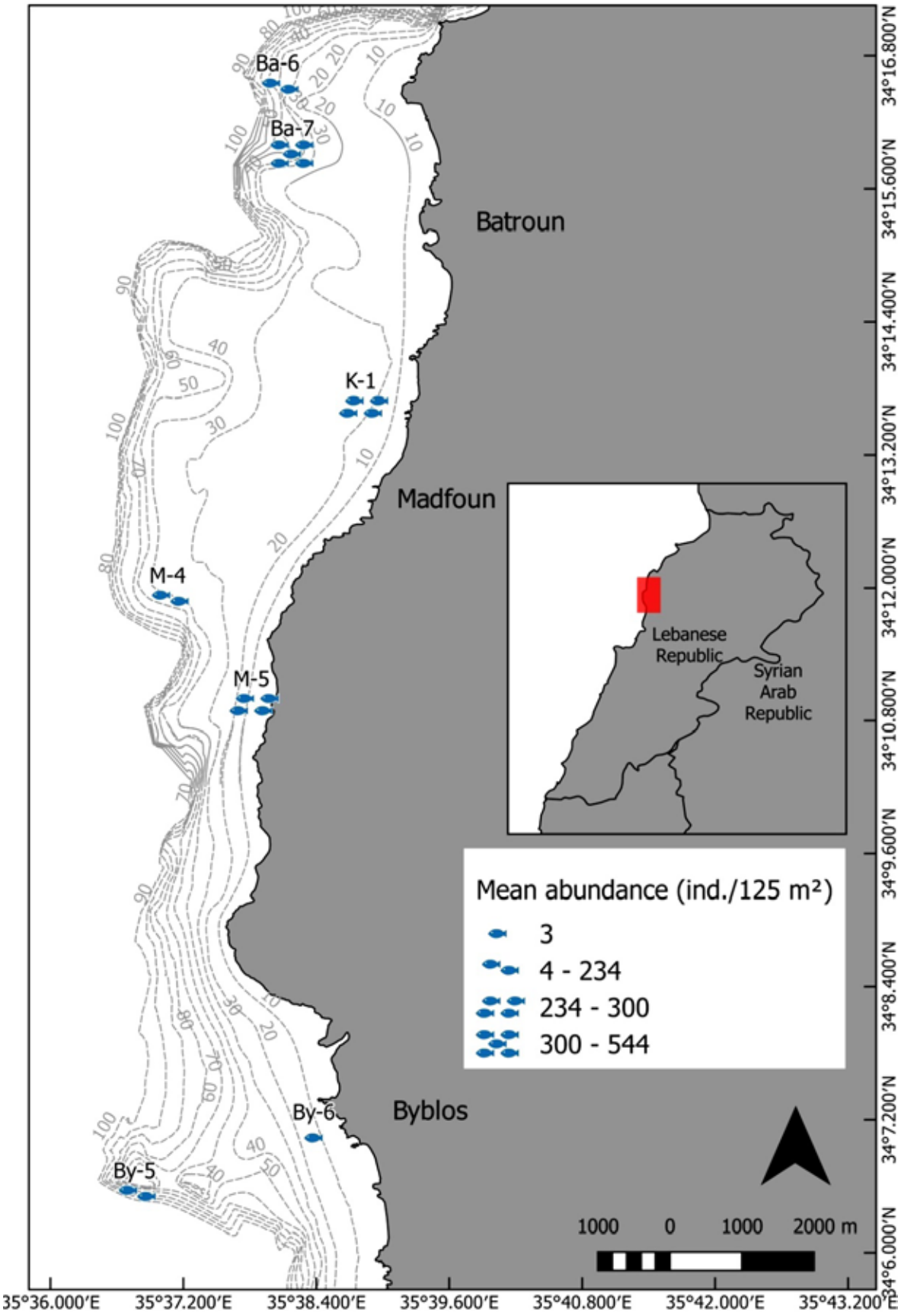

Figure 5.29. Spatial distribution of mean total abundance (ind./125 m^2) in the studied area.

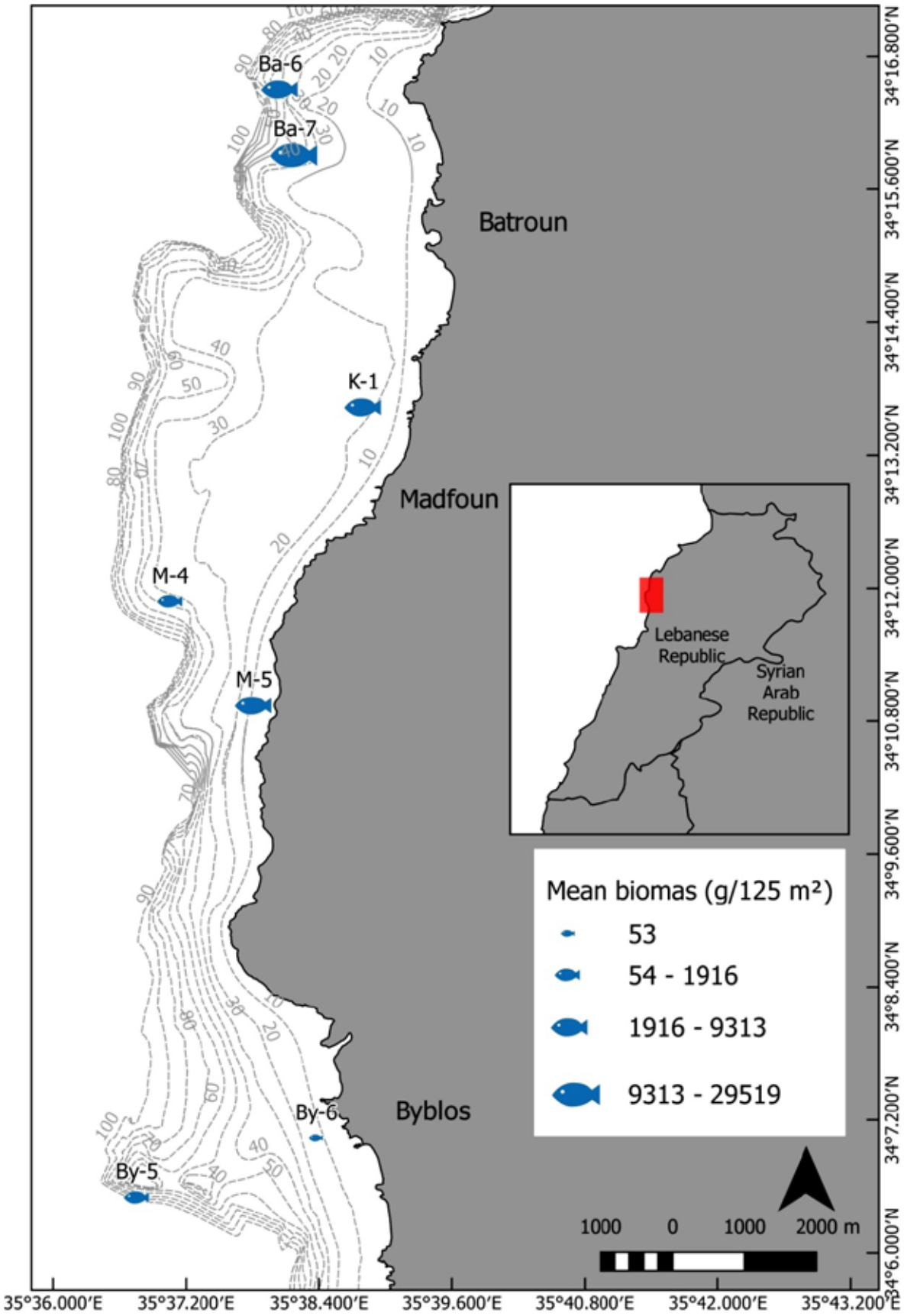

Figure 5.30. Spatial distribution of mean total biomass (g/125 m^2) in the studied area

5.5.1 Abundance and biomass

The mean abundance (Table 5.6) and mean biomass (Table 5.7) were characterized for the high presence of *D. vulgaris* and *O. melanura* in Batroun (Ba-7) and *S. rivulatus* in Medfoun (M-5). Some species were observed only in one station: A. *imberbis, D. pastinaca, D. cervinus, M. rubra, P. auriga* and *P. lineatus* in Ba-6 (Batroun); *A. nigripinnis* and *X. novacula* in Byblos (By-6); *C. crysos, F. commersonii, G. unicolor, P. vanicolensis* and *S. tinca* in Medfoun (M-5); and *E. costae, P. trispilus, S. smaris* and *S. ocellatus* in Kfar Abida (K-1).

Table 5.6. Mean abundance (ind./125 m² ± standard error) of the species sampled in each station

Specie	Station						
	Ba-6	Ba-7	By-5	By-6	K-1	M-4	M-5
Apogonichthyoides nigripinnis	0	0	0	0.06 ± 0.06	0	0	0
Apogon imberbis	0.13 ± 0.13	0	0	0	0	0	0
Caranx crysos	0	0	0	0	0	0	1.50 ± 1.50
Cheilodipterus novemstriatus	0	9.75 ± 9.75	0	0	41.00 ± 28.32	0	0.08 ± 0.08
Chromis chromis	85.13 ± 61.78	79.75 ± 79.75	6.50 ± 4.27	0	77.25 ± 35.75	0	132.33 ± 44.50
Coris julis	0	4.00 ± 1.91	0.25 ± 0.25	0	10.13 ± 1.95	2.50 ± 1.89	2.00 ± 0.62
Dasyatis pastinaca	0.25 ± 0.16	0	0	0	0	0	0
Diplodus cervinus	0.13 ± 0.13	0	0	0	0	0	0
Diplodus sargus	0.50 ± 0.38	6.25 ± 3.92	0	0	2.75 ± 2.34	0	1.33 ± 0.59
Diplodus vulgaris	63.88 ± 46.26	218.00 ± 140.77	0	0	0.13 ± 0.13	0	2.58 ± 0.56
Epinephelus costae	0	0	0	0	0.25 ± 0.16	0	0
Fistularia commersonii	0	0	0	0	0	0	0.42 ± 0.19
Gymnothorax unicolor	0	0	0	0	0	0	0.08 ± 0.08
Mycteroperca rubra	0.13 ± 0.13	0	0	0	0	0	0
Oblada melanura	35.50 ± 23.24	189.00 ± 105.84	0	0	0	0	0
Pagrus auriga	0.13 ± 0.13	0	0	0	0	0	0
Pempheris vanicolensis	0	0	0	0	0	0	27.00 ± 10.24
Plotosus lineatus	27.38 ± 25.54	0	0	0	0	0	0
Pterois miles	0.75 ± 0.37	0.75 ± 0.48	0	0	0	0	0
Pteragogus trispilus	0	0	0	0	0.38 ± 0.18	0	0
Sargocentron rubrum	16.63 ± 8.41	26.00 ± 17.72	11.75 ± 6.49	0	50.25 ± 21.06	0	12.42 ± 4.25
Serranus cabrilla	0.13 ± 0.13	0.50 ± 0.29	1.50 ± 0.50	0	0.13 ± 0.13	2.00 ± 0.71	0.17 ± 0.11
Serranus scriba	0	0	0	0	0.63 ± 0.26	0	0.67 ± 0.22
Siganus luridus	0.38 ± 0.26	2.00 ± 2.00	10.50 ± 9.53	0	1.25 ± 0.56	4.50 ± 4.50	0.58 ± 0.29
Siganus rivulatus	2.25 ± 2.25	3.50 ± 2.06	0	0	70.38 ± 38.64	0	107.50 ± 51.79
Sparisoma cretense	0.13 ± 0.13	0.75 ± 0.75	1.75 ± 1.44	0	0.50 ± 0.33	0.50 ± 0.50	0.75 ± 0.39
Spicara smaris	0	0	0	0	8.88 ± 8.88	0	0
Stephanolepsis diaspros	0.13 ± 0.13	0.50 ± 0.50	0.25 ± 0.25	0	0	0	0.08 ± 0.08
Symphodus ocellatus	0	0	0	0	0.38 ± 0.26	0	0
Symphodus tinca	0	0	0	0	0	0	0.17 ± 0.17
Thalassoma pavo	0	0.25 ± 0.25	0	0	8.63 ± 2.83	0	10.33 ± 2.44
Torquigener flavimaculosus	0	2.75 ± 0.95	1.00 ± 0.71	0	2.88 ± 0.97	11.75 ± 4.55	0.08 ± 0.08
Xyrichthys novacula	0	0	0	2.75 ± 0.30	0	0	0

With reference to species abundance, apart from the pelagic schooling specie *C. chromis*, the more abundant species in the entire studied area were S. rivulatus (33.7 ± 13.4 ind. m^{2}), *D. vulgaris* (25.3 ± 13.3 ind. m^{-2}), *O. melanura* (18.6 ± 9.8 ind. m^{-2}), *S. rubrum* (14.9 ± 4.1 ind. m^{-2}), *C. novemstriatus* (6.6 ± 4.3 ind. m^{-2}) and *P. vanicolensis* (5.8 ± 2.6 ind. m^{-2}). The total abundance of these seven species represented the 90 % of the total estimated individuals. Between the twelve more abundant species, there are 7 non-indigenous species (*S. rivulatus, S. rubrum, C. novemstriatus, P. vanicolensis, P. lineatus, S. luridus* and *T. flavimaculosus*). The total abundance of the non-indigenous species represented the 38 % of the total estimated individuals.

Table 5.7. Mean biomass (g/125 m^{2} ± standard error) of the species sampled in each station.

Specie	Station						
	Ba-6	Ba-7	By-5	By-6	K-1	M-4	M-5
Apogonichthyoides nigripinnis	0	0	0	0.1 ± 0.02	0	0	0
Apogon imberbis	2.0 ± 0.7	0	0	0	0	0	0
Caranx crysos	0	0	0	0	0	0	329.3 ± 95.1
Cheilodipterus novemstriatus	0	20.9 ± 10.5	0	0	88.3 ± 31.2	0	0.4 ± 0.1
Chromis chromis	376.5 ± 133.1	640.8 ± 320.4	32.5 ± 16.3	0	405.8 ± 143.5	0	1039.9 ± 300.2
Coris julis	0	34.4 ± 17.2	0.4 ± 0.2	0	26.9 ± 9.5	9.7 ± 4.9	20.2 ± 5.8
Dasyatis pastinaca	4040 ± 1428.4	0	0	0	0	0	0
Diplodus cervinus	9.4 ± 3.3	0	0	0	0	0	0
Diplodus sargus	37.7 ± 13.3	425.2 ± 212.6	0	0	41.7 ± 14.8	0	34 ± 10.1
Diplodus vulgaris	2246.5 ± 794.3	15886.2 ± 7943	0	0	11.3 ± 4	0	77.6 ± 22.4
Epinephelus costae	0	0	0	0	70.9 ± 25.1	0	0
Fistularia commersonii	0	0	0	0	0	0	108.2 ± 31.2
Gymnothorax unicolor	0	0	0	0	0	0	54.6 ± 15.8
Mycteroperca rubra	232.1 ± 82.1	0	0	0	0	0	0
Oblada melanura	725.7 ± 256.6	10571 ± 5285.5	0	0	0	0	0
Pagrus auriga	14.9 ± 5.28	0	0	0	0	0	0
Pempheris vanicolensis	0	0	0	0	0	0	818.2 ± 236.2
Plotosus lineatus	448.1 ± 158.4	0	0	0	0	0	0
Pterois miles	121.2 ± 42.9	135.8 ± 67.9	0	0	0	0	0
Pteragogus trispilus	0	0	0	0	2.1 ± 0.7	0	0
Sargocentron rubrum	980.2 ± 346.6	1503.4 ± 751.7	1269.3 ± 634.6	0	2395.1 ± 846.8	0	838.3 ± 242.1
Serranus cabrilla	2.3 ± 0.8	7.4 ± 3.7	12.1 ± 6	0	0.7 ± 0.3	10.2 ± 5.1	1 ± 0.3
Serranus scriba	0	0	0	0	21.2 ± 7.5	0	21.0 ± 6.1
Siganus luridus	16.3 ± 5.8	64.1 ± 32.1	392.2 ± 196.1	0	46.8 ± 16.5	144.2 ± 72.1	27.6 ± 8
Siganus rivulatus	48.3 ± 17.1	88.3 ± 44.1	0	0	496.9 ± 175.7	0	573.9 ± 165.7
Sparisoma cretense	2.8 ± 1	41.4 ± 20.7	57.3 ± 28.7	0	12.5 ± 4.4	8.8 ± 4.4	21.9 ± 6.3
Spicara smaris	0	0	0	0	24.4 ± 8.6	0	0
Stephanolepsis diaspros	8.9 ± 3.2	35.7 ± 17.8	132.2 ± 66.1	0	0	0	1.3 ± 0.4
Symphodus ocellatus	0	0	0	0	1 ± 0.4	0	0
Symphodus tinca	0	0	0	0	0	0	17 ± 4.9
Thalassoma pavo	0	0.1 ± 0.1	0	0	14 ± 5	0	32.8 ± 9.5
Torquigener flavimaculosus	0	64.8 ± 32.4	19.7 ± 9.9	0	34.9 ± 12.3	126.6 ± 63.2	1.1 ± 0.3
Xyrichthys novacula	0	0	0	52.9 ± 13.2	0	0	0

5.5.2 Spatial categories

Regarding the spatial categories, fish assemblage was manly dominated by very mobile pelagic species and relatively sedentary species. These results are due to the high abundance of the species *O. melanura* and *C. chromis*, the only species of the COE1 and COE2, respectively (Table 5.8). The main differences for each station are due to the greater abundance of some specie: *S. rubrum* (COE6) and *X. novacula* (COE5) were very abundant in Byblos (By-5 and B-6, respectively); *S. rubrum* and *C. novemstriatus* (COE6) in Kfar Abida (K-1); and T. *flavimaculosus* (COE4), in Medfoun (M-4).

In the other hand, there are some differences when observing the biomass data for the spatial categories (Table 5.9). The main difference is the high value of COE6, the cryptic species, due to the presence of big individuals of *D. pastinaca* in Ba-6 (Batroun), *S. rubrum* in Ba-7 (Batroun) and *G. unicolor* in M-5 (Medfoun).

Table 5.8. Mean abundance (ind./125 m^2 ± standard error) for the spatial categories

	Station						
	Ba-6	Ba-7	By-5	By-6	K-1	M-4	M-5
COE1	35.50 ± 23.24	189.00 ± 105.84	0	0	0	0	1.50 ± 1.50
COE2	85.13 ± 61.78	79.75 ± 79.75	6.50 ± 4.27	0	77.25 ± 35.75	0	132.33 ± 44.50
COE3	67.25 ± 46.37	229.75 ± 139.81	10.50 ± 9.53	0	83.38 ± 39.07	4.50 ± 4.50	112.00 ± 51.86
COE4	27.38 ± 25.54	2.75 ± 0.95	1.00 ± 0.71	0	2.88 ± 0.97	11.75 ± 4.55	0.50 ± 0.19
COE5	0.50 ± 0.19	6.00 ± 2.61	3.75 ± 2.10	2.75 ± 0.30	21.00 ± 4.46	5.00 ± 2.48	14.17 ± 2.42
COE6	17.75 ± 8.51	36.50 ± 18.64	11.75 ± 6.49	0.06 ± 0.06	91.25 ± 45.87	0	39.58 ± 13.91

(1) very mobile pelagic species, (2) moderately sedentary pelagic species,
(3) demersal species moving moderately along vertical axis,
(4) nekto-benthic species, (5) relatively sedentary species, (6) cryptic species.

Table 5.9. Mean biomass (g/125 m^2 ± standard error) for the spatial categories

	Station						
	Ba-6	Ba-7	By-5	By-6	K-1	M-4	M-5
COE1	725.66 ± 497.91	10571.03 ± 4028.50	0	0	0	0	329.28 ± 329.28
COE2	376.48 ± 249.85	640.75 ± 640.75	32.50 ± 18.77	0	405.78 ± 138.51	0	1039.89 ± 369.05
COE3	2373.10 ± 1512.26	16463.78 ± 10919.88	392.18 ± 226.73	0	621.16 ± 215.70	144.20 ± 144.20	714.02 ± 186.35
COE4	448.10 ± 406.43	64.80 ± 24.86	19.70 ± 17.66	0	34.90 ± 13.74	126.48 ± 49.12	109.31 ± 50.82
COE5	246.08 ± 230.22	118.95 ± 89.98	201.93 ± 121.81	52.86 ± 11.02	149.25 ± 59.25	28.63 ± 11.57	115.29 ± 21.74
COE6	5143.43 ± 3220.85	1660.15 ± 819.15	1269.25 ± 734.05	0.08 ± 0.08	2483.46 ± 1027.7	0	1711.57 ± 646.57

(1) very mobile pelagic species, (2) moderately sedentary pelagic species,
(3) demersal species moving moderately along vertical axis,
(4) nekto-benthic species, (5) relatively sedentary species, (6) cryptic species.

5.5.3 Trophic cateories

Concerning the trophic categories (Table 5.10), the microphagus species (*C. chromis* and *O. melanura*) were the most abundant, followed by the mesophagous species (mainly *S. rubrum*). Herbivorous, which were represented only by two species of Siganus, were observed mainly in Kfar Abida (K-1) and Medfoun (M-5). However, the mean biomass for the trophic categories (Table 5.11) is affected for the observed macrophagous specie *D. pastinaca* in Batroun (Ba-6) and for the big size of individuals for the mesophagous species *S. rubrum* and *P. vanicolensis* in Kfar Abida (K-1) and Medfoun (M-5).

Table 5.10. Mean abundance (ind./125 m^2 ± standard error) for the trophic categories in the studied stations

	Station						
	Ba-6	Ba-7	By-5	By-6	K-1	M-4	M-5
CMC	1.25 ± 0.59	1.25 ± 0.25	1.50 ± 0.50	0	1.00 ± 0.42	2.00 ± 0.71	2.42 ± 1.52
CMM	120.75 ± 78.88	271.50 ± 184.97	7.50 ± 4.29	0	89.00 ± 40.07	11.75 ± 4.55	132.42 ± 44.51
CMS	108.88 ± 50.24	265.50 ± 129.45	14.00 ± 6.07	2.81 ± 0.32	114.13 ± 48.08	3.00 ± 1.91	57.17 ± 14.99
HBV	2.63 ± 2.35	5.50 ± 1.89	10.50 ± 9.53	0	71.63 ± 38.71	4.50 ± 4.50	108.08 ± 51.79

CMC: macrophagous; CMM: microphagous; CMS: mesophagous; HBV: herbivorous.

Table 5.11. Mean biomass (g/125 m^2 ± standard error) for the trophic categories in the studied stations

	Station						
	Ba-6	Ba-7	By-5	By-6	K-1	M-4	M-5
CMC	4395.63 ± 3083.49	143.23 ± 82.83	12.05 ± 2.61	0	92.83 ± 55.18	10.18 ± 2.69	405.93 ± 329.76
CMM	1117.06 ± 609.52	11276.58 ± 4576.32	52.18 ± 31.84	0	465.03 ± 157.86	126.48 ± 49.12	1040.99 ± 369.11
CMS	3735.59 ± 1699.41	17947.30 ± 10610.89	1459.10 ± 811.96	52.94 ± 11.04	2593.03 ± 1046.10	18.48 ± 11.30	1970.94 ± 651.70
HBV	64.56 ± 53.92	152.38 ± 69.01	392.18 ± 226.73	0	543.68 ± 230.93	144.20 ± 144.20	601.48 ± 180.27

CMC: macrophagous; CMM: microphagous; CMS: mesophagous; HBV: herbivorous

Fish size structure was similar for all the stations (Fig. 5.31), with small, medium small and medium sizes dominating the fish assemblage. This pattern was different in Medfoun (M-4), where the medium big individuals clearly dominated the community due to the presence of *P. vanicolensis* belonging to this size.

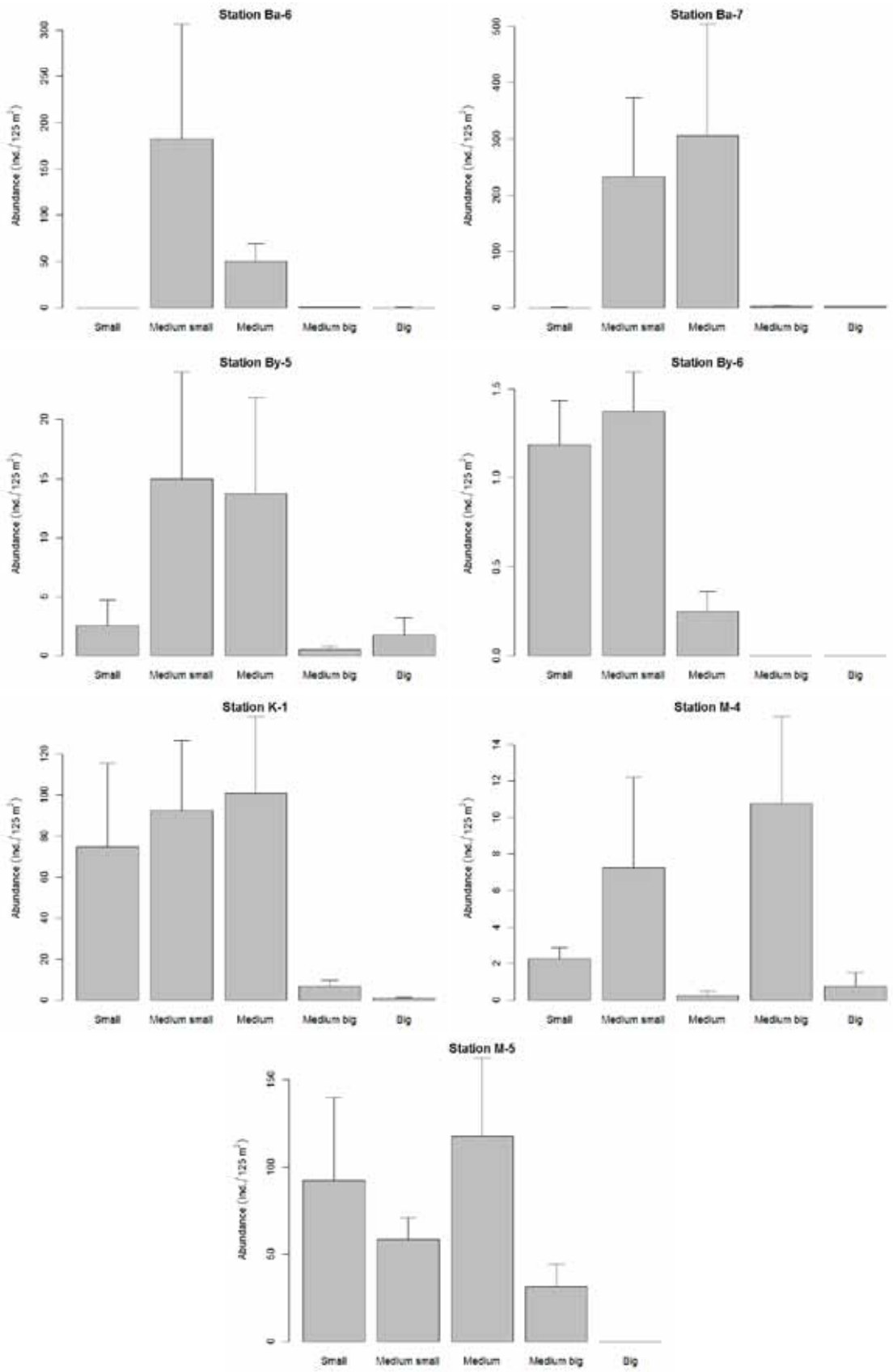

Figure 5.31. Mean abundance (ind./125 m^2 ± standard error) of the fish assemblage size structure in the studied stations.

5.5.4 Differences among stations

Looking for differences among stations, the two dimensional nMDS ordination of abundances showed that the fish assemblages varied mainly among By-6 (Byblos) and the other six stations (Fig. 5.32). This is due to the habitat of this station, with a 100 % muddy sand cover and represented for the dominance of *X. novacula*.

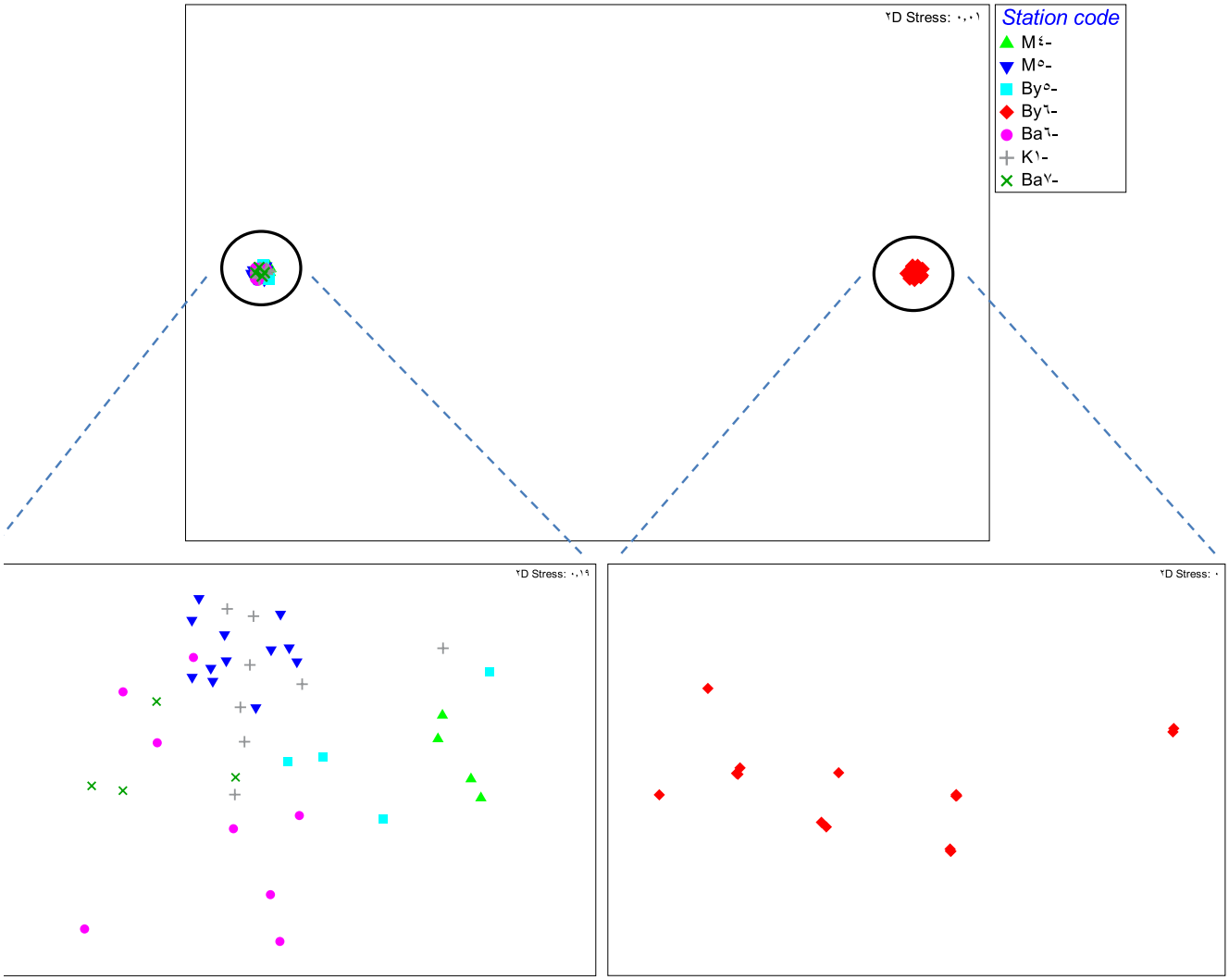

Figure 5.32. Two dimensional nMDS ordination of abundances of the species observed at each underwater visual census.

Regarding these differences in the fish assemblage among stations, the analysis of similarity (SIMPER) (Table 5.12) helped in identifying the most important species in each one. The station with a higher similarity was By-6 (Byblos), with *X. novacula* contributing the 100 %. In the other stations, the mean similarity ranged between 10.77 in Ba-6 (Batroun) and 36.88 in M-5 (Medfoun). These similarities were mainly due to *S. rubrum* in Ba-6 (Batroun) and By-6 (Byblos), *S. rivulatus* in K-1 (Kfar Abida) and M-5 (Medfoun), *O. melanura* in Ba-7 (Batroun) and *T. flavimaculosus* in M-4 (Medfoun).

Table 5.12. Analysis of similarity (SIMPER) of the species abundance sampled in each station. Only species that contribute until 85 % of the dissimilarity are indicated.

	ABU	% sim	% acu
Station Ba-6			
SM=10.77			
S. rubrum	16.63	42.28	42.28
D. vulgaris	63.88	27.49	69.76
C. chromis	85.13	14.39	84.16
O. melanura	35.50	6.74	90.90
Station By-5			
SM=18.57			
S. rubrum	11.75	53.60	53.60
C. chromis	6.50	17.73	71.32
S. cabrilla	1.50	16.87	88.19
Station K-1			
SM=26.38			
S. rivulatus	70.38	27.32	27.32
C. chromis	77.25	26.96	54.28
S. rubrum	50.25	20.81	75.10
C. julis	10.13	11.56	86.66
Station M-5			
SM=36.88			
S. rivulatus	107.50	39.78	39.78
C. chromis	132.33	36.63	76.41
T. pavo	10.33	7.42	83.83
P. vanicolensis	27.00	7.00	90.83
Station Ba-7			
SM=28.28			
O. melanura	189.00	51.40	51.40
D. vulgaris	218.00	39.69	91.09
Station By-6			
SM=73.62			
X. novacula	2.75	100.00	100.00
Station M-4			
SM=35.53			
T. flavimaculosus	11.75	76.22	76.22
S. cabrilla	2.00	21.25	97.46

SM: mean similarity; ABU: Mean abundance (ind./125 m^2); % sim: percentage contribution of each species in the station similarity; % acu: accumulated percentage.

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6. BENTHIC BIONOMY AND HABITATS

The biocenosis, habitats and associations (with facies) have followed the classifications of UNEP/MAP-RAC/SPA (1998, 2002), mainly based on the Pérès & Picard (1964), Péres (1967) and Bellan-Santini *et al* (1994), according to the division in stages: supralittoral, midlittoral, infralittoral and circalittoral; and after by substrata (hard and soft). We have included the more abundant species and/or characteristic of the observed megabenthos (phyto and zoobenthos, fishes; see Annex II (inventory of taxa)).

6.1 HARD SUBSTRATA

The MDS (Fig. 6.1) analysis for stations on hard substrate has discriminated five groups belonging to the stages:

i) littoral (0 m depth);
ii) infralittoral (0-40 m depth); and
iii) circalittoral (40-55 m depth).

Within the infralittoral zone 2 groups are separated by depth: (I-1) stations between 0 and 10 m deep; and (I-2) stations between 10 and 40 m deep. In the same way, within the circalittoral floor have separated by localities: (C-1) Batroun; and (C-2) Medfoun and Byblos.

6.1.1. Biocenosis of the supralittoral rock (RAC/SPA: I.4.1)

The biocenosis is rich in endolithic cyanobacteria. The main zoobenthos are the gastropods *Melarhaphe neritoides* and *Echinolittorina punctata* (Fig. 6.2) and the crustaceans *Ligia italica, Euraphia depressa* and *Pachygrapsus marmoratus*.

Stations: Batroun (Ba-5), Kfar Abida (K-3, K-4), Medfoun (M-7), Byblos (By-4).

6.1.2. Biocenosis of the upper midlittoral rock (RAC/SPA: II.4.1)

a) Facies with *Chthamalus* spp. With epilithic and endolithic cyanobacteria and the sessile fauna is represented by *Chthamalus depressus* and *Ch. montagui*, with the mobile fauna by the gastropods *Melarhaphe neritoides*, *Echinolittorina punctata* and *Patella rustica* (Fig. 6.3) and the crustaceans *Ligia italica* and *Pachygrapsus marmoratus*. The main facies has been the belt with *Chthamalus* spp.

Stations: Batroun (Ba-5), Kfar Abida (K-3, K-4), Medfoun (M-7), Byblos (By-4).

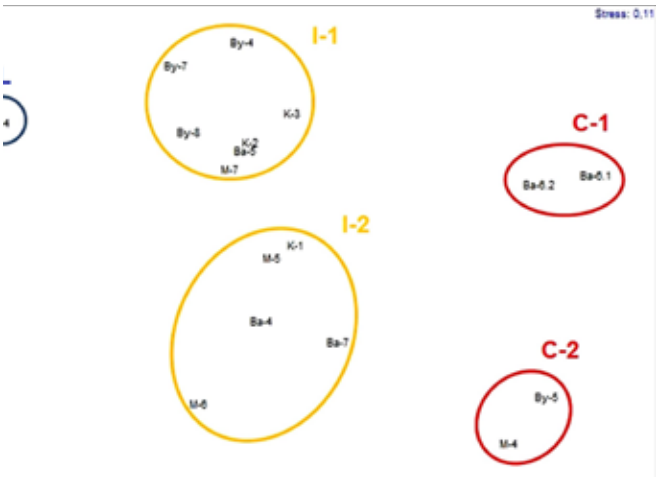

Figure 6.1. MDS analysis discriminating the groups of littoral (L), infralittoral (I) and circalittoral (C) stations (see Annex I).

Figure 6.2. The supralittoral zone with the littorinids *Melarhaphe neritoides* and *Echinolittorina punctata*. Batroun.

Figure 6.3. Biocenosis of the upper midlittoral rock with *Chthamalus* spp, *Patella rustica* and *Echinolittorina* ***punctata***. Kfar Abida (st. k-4).

6.1.3. Biocenosis of the lower midlittoral rock (RAC/SPA: II.4.2)

The biocenosis, in its summer aspect, is characterized by the presence of encrusting corallinalceae *Lithophyllum papillosum* and *Neogoniolithon brassica-florida* with gastropods (*Patella* spp., *Phorcus* spp.). The main facies/associations have been:

a) Association with *Lithophyllum papillosum* (Fig. 6.4). The fauna in the lower mediolittoral rock is represented mainly by the gastropods *Patella ulyssiponensis* and *Porcus turbinatus*, and the crustaceans *Chthamalus* spp. and *Pachygrapsus marmoratus*.

Stations: Kfar Abida (K-4).

b) *Dendropoma* and *Neogoniolithon concretions*. With the vermetid *Dedropoma petraeum* and the calcareous algae *Neogoniolithon brassica-marina*, that forming small cushion and plate structures, and sometimes microatolls (Fig. 6.5a).

The vermetid formations appear developed in all of the area but they are cover by algae, and many of the vermetids bio-concretions are dead.

Stations: Batroun (Ba-5), Kfar Abida (K-4), Medfoun (M-7), Byblos (By-4).

c) Littoral pools sometimes associated with vermetids (infralittoral enclave, Fig. 6.5b): These infralittoral enclaves are frequent in the sandstones and limestones rocks. The macroalgae are abundant: as chlorophytes (*Cladophora, Ulva, Chaetomorpha, Bryopsis* spp.) and rhodophytes (*Jania rubens, Ellisolandia elongata, Chondracanthus acicularis*).

Stations: Kfar Abida (K-4).

Figure 6.4. The encrusting rhodophytes *Lithophyllum papillosum* (whitish) and *Neogoniolithon brassica-florida* (pinkish) with *Patella ulyssiponensis*. Kfar Abida (st. K-4).

Figure 6.5. Vermetid formations: (a) microatoll in the surf zone (Batroun); (b) formations cover by macroalgae in littoral pools (Kfar Abida, st K-4).

6.1.4 Biocenosis of midlittoral caves (RAC/SPA II.4.3)

Very abundant in the area, representing by the association with *Phymatolithon lenormandii* and *Hildenbrandia rubra* (Fig. 6.6). The "sea tomato" (*Actinia schmidti*) is frequent in this enclave.

Stations: Batroun (Ba-5), Kfar Abida (K-2, K-3, K-4), Medfoun (M-7), Byblos (By-4, By-8).

6.1.5. Biocenosis of the infralittoral algae (RAC/SPA: III.6.1)

The infralittoral rock with macroalgae dominance can reach the 42 m depth, and the macroalgae can be subdivided in four groups, according the hydrodynamism (exposed/sheltered) and light intensity (photophilic/sciaphilic):

i) exposed photophilic macroalgae;
ii) exposed sciaphilic;
iii) sheltered photophilic; and
iv) sheltered sciaphilic.

6.1.5.1 Exposed photophilic macroalgae

The width of this horizon depends on the hydrodynamism, and it can reach about 6-7 m depth in very exposed littoral. The light intensity is very high.

a) Association with *Jania rubens* (Fig. 6.7): The rhodophyte *Jania rubens* can dominate the littoral fringe (0-1 m depth). Usually is accompanied by the rhodophytes *Ellisolandia elongata, Palisada perforata, Chondracanthus acicularis* and *Laurencia obtusa*, and the chorophytes *Cladophora and Bryopsis* spp. Also, the lessepsian species *Bryopsis pennata, Acanthophora nayadiformis* and *Brachidontes pharaonis* are present. It is noteworthy the abundance of *Elysia grandiflora* on *Bryopsis*, particularly, in Kfar Abida.

Stations: Batroun (Ba-5), Kfar Abida (K-4), Medfoun (M-7), Byblos (By-4).

6.1.5.2 Exposed sciaphilic macroalgae

a) Association with *Ellisolandia elongata* (Fig. 6.8): On vertical walls, this corallinacea dominate the substrata, between 0 to 5 m depth, with *Lithophyllum incrunstans*. Another rhodophyte should be present, *Schottera nicaeensis*, but rare. The sessile fauna is not abundant with the poriferans (*Chondrosia reniformis, Crambe crambe*); the hydrozoans (*Aglaophenia* spp. *Pennaria disticha, Macrorhynchia philippina*), the anthozoan *Oculina patagonica*, the cirriped *Perforatus perforatus*, the crab *Atergatis roseus*; and the bivalves *Chama pacifica* and *Spondylus spinosus*.

Stations: Batroun (Ba-5), Kfar Abida (K-2, K-3, K-4), Medfoun (M-7), Byblos (By-4, By-7, By-8)..

Figure 6.6. Midlittoral cave with the encrusting rhodophytes *Hildenbrandia rubra* and *Phymatolithon lenormndii*. Kfar Abida (st. K-3).

Figure 6.7. *Jania rubens* with *Palisada perforata* on the littoral fringe. Kfar Abida (st. K-4).

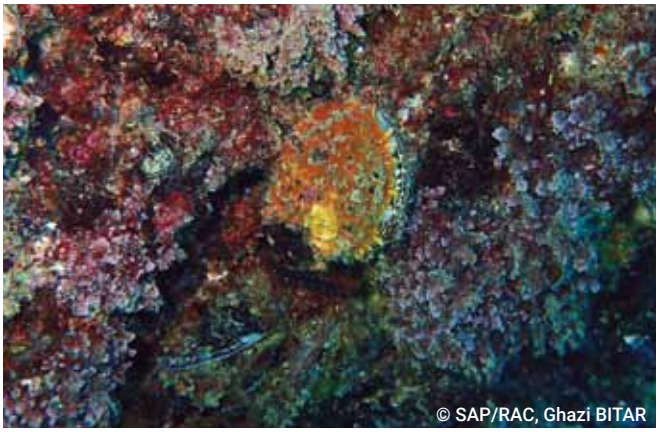

Figure 6.8. Association with *Corallina elongata*; with the bivalves *Spondylus spinosus* and *Chama pacifica*. Kfar Abida, 3 m depth (st. K-3)

6.1.5.3 Sheltered photophilic macroalgae

The width of this horizon depends of the illumination and may reach 40 m depth in horizontal surfaces, with a moderated hydrodynamism.

a) Association with *Spyridia filamentosa* In the littoral platform, behind the break zone, the rodophyte *Spyridia filamentosa* is dominant (Fig. 6.9). Other accompanying macroalgae have been *Jania rubens, Ulva rigida* and *Bryopsis pennata*. In the mobile fauna, the gastropods *Patella* and *Gibula* spp. small paths of Brachidontes pharaonis, the decapods *Clibanarius erythropus* and *Eriphia verrucosa*, and Blennidae fishes.

Stations: Kfar Abida (K-4).

b) Overgrazing facies (Fig. 6.10): In some places the rocky substrata is bare and empty of erected macroalgae, only some encrusting (*Lithophyllum incrustant* and *Neogoniolithon* spp.) and erect corallinales (*Amphiroa, Ellisolandia, Jania*), the ochrphyte *Lobophora variegata* and the chorophyte *Codium taylori* are present.
This overgrazing mainly is due to the herbivorous pressure of the fishes *Siganus rivulatus* and *S. luridus*, because the sea urchins *Arbacia lixula* and *Paracentrotus lividus* are absent in the studied zones. Another reason could be the erosion by the coarse sand of the rock due to the heavy storms. The macrofauna is poorly represented, and some encrusting species, as the poriferans *Crambe crambe* and the boring sponges *Cliona* spp.; the cirripeds *Perforatus perforatus* and *Balanus trigonus*, the ascophoran bryozoan *Schyzoporella errata* and the ascidian *Phallusia nigra*.

Stations: Batroun (Ba-5), Kfar Abida (K-2, K-3, K-4), Medfoun (M-7), Byblos (By-4, By-7, By-8).

c) Association with *Galaxaura rugosa* and Corallinales (Fig. 6.11): Extended in the whole area particularly near the shore, between 1 to 7 m depth. The main species are Galaxaura rugosa with branched (*Amphiroa rigida, Ellisolandia elongata, Jania* spp), and encrusting corallinales (*Neogoniolithon* sp., *Lithophyllum incrustans*), and Codium spp. (*C. taylori, C. parvulum, C. arabicum*).

As sessile fauna, stand out the sponges *Cambe crambe, Chondrilla nucula* and *Ircinia* sp., the hydroids *Macrorynchia philippina* and *Pennaria disticha*; cirripeds (*Perforatus perforatus, Balanus trigonus*), and the bivalves *Chama pacifica, Spondylus spinosus*, *Malleus regulus* and *Dendrostrea frons* are common in this association. The mobile fauna is dominate by gastropods (*Cerithium scabridum, Ergalatax junionae, Conomurex persicus*), the hermit crab *Calcinus tubularis*, and the fishes *Chromis chromis, Thalassoma pavo*, Sparidae (*Diplodus sargus, D. vulgaris*) and Siganidae (*Siganus rivulatus*). This association could be similar to the overgrazing facies with encrusting corallinales, due to the herbivorous pressure on soft algae by the "rabbit fishes" (Siganidae) and *Conomurex persicus*.

Stations: Batroun (Ba-5), Kfar Abida (K-1, K-2, K-3, K-4), Medfoun (M-7), Byblos (By-7, By-8).

Figure 6.9. Brown mats of Spyridia filamentosa on littoral platform with *Jania rubens*. Kfar Abida (st. K-4).

Figure 6.10. Bare rock with corallinales, *Crambe* and *Schizoporella*. Byblos, 5 m depth (st. By-4).

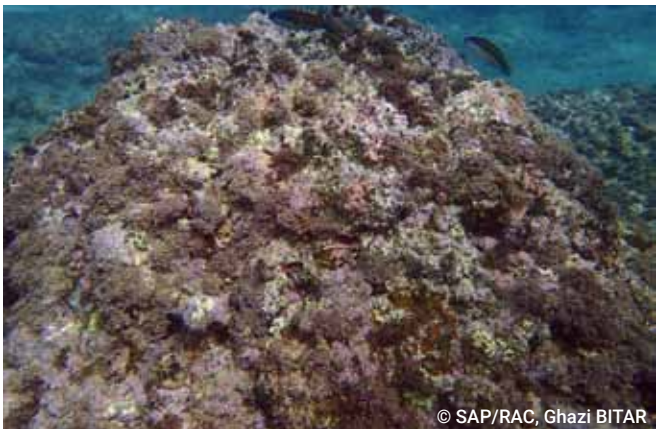

Figure 6.11. Association with corallinales and *Galaxaura rugosa*. Byblos-Amchit, at 7 m depth (st. By-8).

d) Association with *Sargassum vulgare*. (Fig. 6.12): This interesting association has been observed in Byblos, between 2 to 5 m on a rocky outcrop surrounded by fine sand. The thali barely or not has secondary ramifications (herbivorous pressure?); however, some rare leaves appear in the base, and *Padina pavonica* is present, but rare. The concentration of fish has been important (Siganidae, Labridae, Sparidae).

Stations: Byblos (By-4).

Figure 6.12. Association with *Sargassum vulgare* in Byblos, at 2 m depth (st. By-4).

e) Facies with *Chama pacifica* and *Spondylus spinosus* (Fig. 6.13): Although these lessepsian bivalves can be present from 1 to 40 m depth, it between 5 to 30 m depth where they could be dominant, forming an original facies (without comparison with another one in the Mediterranean), with another associated lessepsian bivalve, *Malleus regulus*.

The valves create a heterogeneous substratum where algae (Ceramiales, Corallinales), poriferans (*Crambe crambe, Petrosia ficiformis*), hydrozoans (*Macrorhynchia philippina, Pennaria disticha, Eudendrium* spp.), serpulids, cirripeds (*Balanus* spp.), etc are fixed on the valves. Another common taxa are bryozoans (*Schizoporella, Reptadeonella*) and ascidians (*Didemnidae* spp.).

Stations: Batroun (Ba-1, Ba-4, Ba-5), Kfar Abida (K-1, K-2, K-3), Medfoun (M-5, M-7), Byblos (By-1, By-4, By-7, By-8).

Figure 6.13. Facies with *Chama pacifica* and *Spondylus spinosus*. Batroun, at 21 m depth (Ba-4).

f) Association with *Codium parvulum* (Fig. 6.14): The lessepsian chlorophyte *Codium parvulum* dominate a poor rocky habitat with fine sediment; from 4 to 27 m depth, sometimes associated with *Caulerpa lamourouxi*.

As associated species: *Amphiroa rigida, Crambe crambe, Aplysina aerophoba, Eudendrium* spp., *Schizoporella errata* and *Phallusia nigra*. Among the fish, highlight the abundance of the lessepsian species *Cheilodipterus novemstriatus*.

Stations: Batroun (Ba-1, Ba-4, Ba-5), Kfar Abida (K-1, K-2, K-3, K-4), Medfoun (M-5, M-6, M-7), Byblos By-7, By-8).

Figure 6.14. Association with *Codium parvulum*, with *Serranus scriba* Batroun, at 22 m depth (st. B-4).

g) Association with *Cystoseira* sp. (Fig. 6.15): This interesting association has been observed in Batroun, between 19 to 27 m. Probably the *Cystoseira* sp. may be *C. foeniculacea* (= *C. discors, C. ercegovicii*) cited by Bitar & Kouli-Bitar (2001) and observed in Tyre and Nakoura during the 2013 mission. The thali barely or not has secondary ramifications (herbirous pressure?) and the individuals are more or less isolated.

Stations: Batroun (Ba-1, Ba-4).

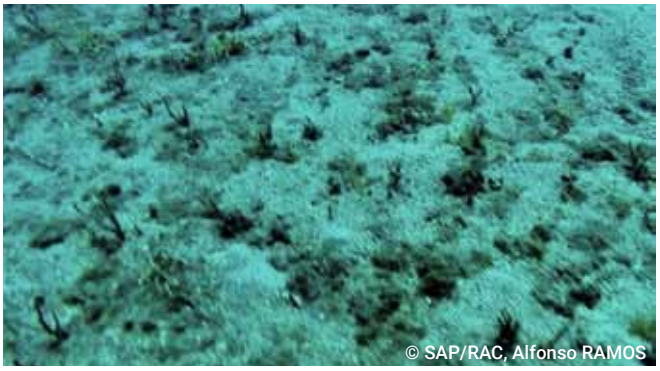

Figure 6.15. Association à *Cystoseira* sp. in front of Batroun, at 29 m depth (st. Ba-1).

6.1.5.4 Sheltered sciaphilic macroalgae

The sheltered sciaphilic algae community is well developed in the area, but with the predominance of the *Peyssonnelia* spp.. It appears in shallow infralittoral enclaves (shadow surfaces: crevices, vertical walls, overhangs) and deep infralittoral rocky surfaces (from 30 m depth).

a) Association with *Lobophora variegata* (Fig. 6.16): This ochrophyta is present on subhorizontal and vertical surfaces, between 1 to 35 m depth, accompanied by encrusting rodophytes (*Lithophyllum, Neogoniolithon, Mesophyllum*) and *Peyssonnelia* spp.

Stations: Batroun (Ba-4, Ba-5, Ba-7), Kfar-Abida (K-1, K-3), Medfoun (M-5, M-7), Byblos (By-4, By-7, By-8).

b) Association with *Peyssonnelia* spp. (Fig. 6.17): Well developed on the sciaphilic rock (until 30 m depth in vertical surfaces). The main algae are the rhodophytes *Peyssonnelia* spp. (between them, *P. rubra* and *P. rosa-marin*a).

With regards to the sessile fauna, the poriferans are frequent as *Crambe crambe, Chondrosia reniformis, Aplysilla sulfurea* and *Ircinia* sp, and the ascidians *Didemnidae* spp., *Herdmania momus* and *Phallusia nigra*. The mobile fauna is represented by the polychaeta *Hermodice carunculata*; the gastropods *Ceritium scabridum* and *Ergalatax junionae*; and the fishes *Sargocentrum rubrum* and *Tripterygion melanurus*.

Stations: Batroun (Ba-4, Ba-5), Kfar Abida (K-1, K-2, K-3), Medfoun (M-5, M-7), Byblos (By-4).

c) Association with encrusting corallinales and sponges (Fig. 6.18): In deeper rocky infralittoral habitats, between 27 to 43 m depth. The corallinales are dominant with encrusting (*Mesophyllum. Neogoniolithon, Peyssonnelia* spp) and geniculate species (*Amphiroa* spp.), the ochrophyte *Lobophora variegata*, and *Caulerpa lamourouxi* can cover flat rock.

The poriferans are abundant, particularly species of the Axinellidae (*Axinella* spp.), *Crambe crambe, Phorbas topsenti, Petrosia ficiformis* and *Aplysina aerophoba*. Also, *Eudendrium* spp. and the bivalves *Chama pacifica, Spondylus spinosus* and *Malleus regulus* are common. The mobile fauna is scarce with *Synaptula reciprocans* and the fishes *Coris julis, Serranus cabrilla, Sargocentrum rubrum* and *Torquigener flavimaculosus*

Stations: Batroun (Ba-4), Kfar Abida (K-2, K-3), Medfoun (M-5, M-6, M-7), Byblos (By-5, By-8).

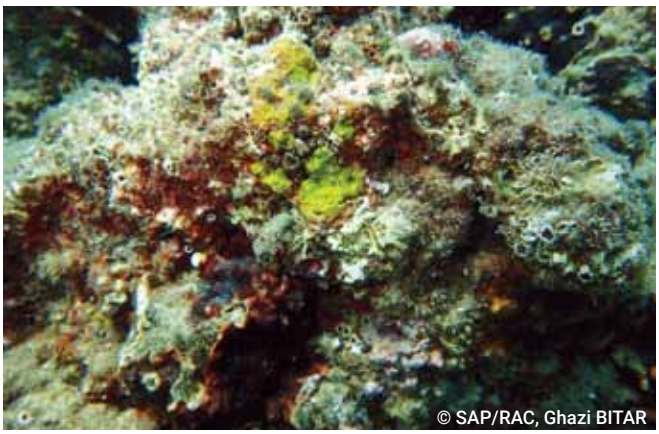

Figure 6.16. *Lobophora variegata* (yellow) with encrusting corallinales. Byblos, at 5 m depth (st. By-4)

Figure 6.17. Sciaphilic macroalgae with *Peyssonnelia* spp. and the sponges *Aplysilla sulfurea* (yellow) and *Poecilloscleridae* sp. (greenish) with *Hermodice carunculata*. Byblos at 5 m depth (st. By-7).

Figure 6.18. Encrusting macroalgae in deep rock (*Mesophyllum, Neogpniolithon* spp.) with th sponges *Aplysina aerophoba* (yellowish), *Phorbas topsenti* (red) and *Crambe crambe* (dark orange). Batroun, at 35 m depth (st. Ba-7).

6.1.6 Biocenosis of the small blocks

This interesting biotope harbours a complex community of both hard (photophilic, sciaphilic) and soft substrates (Fig. 6.19); and nursery area for Sparidae. There is a great contrast between the photophyllous part, very poor (Ceramiales, Corallinales) and the sciaphilic part (sponges, briozoans, ascidians, serpulids, bivalves).

Under stones we have observed encrusting macroalgae (*Lithophyllum, Mesophyllum, Peyssonnelia* spp.), sponges (*Crambe, Phorbas, Haliclona, Terpiops*), turbellaria, polychaeta (Serpulidae and Sabellidae spp.), cirripeds (*Balanus*) gastropods prosobranches (*Gibbula, Jujubinus, Cerithium, Vermetus triquetrus*), opisthobranches (*Berthellina*, ?Philineglossidae), bivalvia (*Anomia ephippium*), bryozoans (*Watersipora. Reptadeonella*) and ascidians (*Cystodytes, Botryllus, Botrylloides, Didemnidae, Rhodosoma, Herdmania*).

Stations: Batroun (Ba-4), Kfar Abida (K-2), Byblos (By-7).

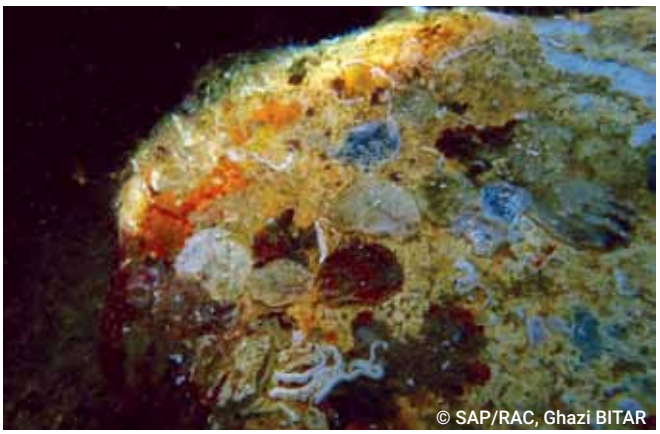

Figure 6.19. Under stone encrusting fauna: *Serpulodae* spp., sponges, the bivalve *Anomia ephippium*, bryozoan (*Watersipora sp.*) and ascidians (*Didemnidae* spp). Byblos, at 4 m depth (st. By-7).

6.1.7 Biocenosis of the 'coralligenous' (RAC/SPA: IV.3.1)

The biocenoses on circalittoral hard substrata are the coralligenous and the semi-dark caves. Both appear in enclaves in shallow waters (overhangs, caves entries, crevices), and the coralligenous community on horizontal surfaces from 42 m depth.

During the 2012 and 2013 missions, the observations were limited as they were achieved at depths up to 43 m. One of the objectives of the present mission has been to extend the characterization of coralligenous in Lebanon, performing dives up to 54 m depth. (max. depth of the present study).

a) Coralligenous in infralittoral enclaves (Fig. 6.20): In the infralittoral enclaves of this community (overhangs, cave entries, crevices) there is the littoral rocky coralligenous community with incrusting calcareous algae (*Lithophyllum stictaeforme, Mesophyllum* spp., *Neogoniolithon mamillosum* and *Peyssonnelia* spp.; also, the chloropyte *Palmophyllum crissum*. The sessile fauna is dominated by the poriferans *Crambe crambe, Chondrosia reniformis, Clathrina* sp.; the hydrozoans *Aglaophenia* spp.; the bryozoans *Schyzoporella* and *Reptadeonella* spp.; and the ascidians Didemnidae spp. and *Herdmania momus*. The mobile fauna is represented by the polychaete *Hermodice carunculata*; the gastropods *Cerithium scabridum* and *Ergalatax junionae*; and fish: *Sargocentrum rubrum, Pempheris vanicolensis* and *Trypterygion melanurum*.

Stations: Batroun (Ba-4, Ba-5), Kfar Abida (K-1, K-2, K-3), Medfoun (M-5, M-7), Byblos (By-4, By-8).

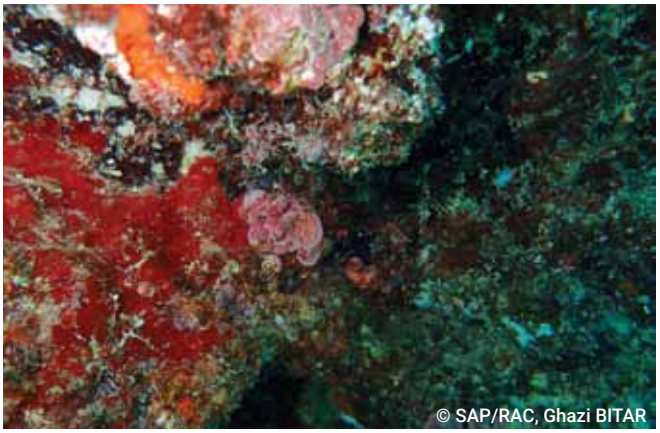

Figure 6.20. Coralligenous enclave in the infralittoral rock, with the encrusting corallinaceae *Lithiophyllum stictiaforme*, and the sponges *Phorbas topsenti* (red), *Crambe crambe* (orange) and *Clathrina coriacea* (white). Kfar Abida, at 4 m depth (st. K-2).

b) Coralligenous biocenosis (in circalittoral bottoms) (Fig. 6.21): The macroalgae form the basal stratum is represented by *Lithophyllum stictaeforme, Mespohyllum* sp. and *Peyssonnelia* spp; with the chlorophyte *Palmophyllum crassum*. *Codium bursa* is common, however the soft rhodophyta (*Botryocladia, Halymenia; Hyppoglossum*) are rare. It is noteworthy the presence of the exotic rhodophyte *Womersleyella setacea* -and the rarity of *Stypopodium schimperi*.

The sessile fauna is abundant with the poriferans *Axinella polyploides, A. damicornis, Agelas oroides, Crambe crambe, Phorbas topsenti, Dysidea avara, Petrosia ficiformis, Corticium candelabrum, Niphates toxifera*, etc.; the polychaete *Serpula vermicularis*; the cnidarians *Aglaophenia kirchempaueri, Madracis phaerensis* and *Phyllangia americana mouchezii*; the bivalves *Spondylus spinosus* and *Malleus regulus* are present; the bryozoans *Frondipora verrrucosa* and *Schizoretepora hassi*; and the ascidians *Cystodytes dellechiajei* and *Didemnidae* spp. In some places, the encrusting corallinaceae (*Mesophyllum, Lithophyllum, Neogoniolithon, Peyssonnelia* spp.) and sponges (*Crambe, Phorbas*) form concretion blocks on the rocks (Fig. 6.22).

The mobile fauna is not abundant, with the hermit crab *Dardanus arrosor*; the echinoderms *Coscinasteria tenuispina* (very rare), *Ophiothrix fragilis* and *Synaptula reciprocans*; and the fishes *Coris julis, Serranus cabrilla, Torquigener flavimaculosum, Sargocentrum rubrum, Plotosus lineatus* and *Pterois miles*.

Stations: Batroun (Ba-6), Medfoun (M-4), Byblos (By-5).

Figure 6.21. Coralligenous community on rocky substratum with the sponges *Axinella polyploides* and *A. damicornis* (yellow), *Niphates toxifera* (brown), *Phorbas topsenti* (red) and *Crambe crambe* (orange); with *Palmophyllum crassum* (green) and *Phyallangia americana mouchezi* (right down). Batroum, at 47 m depth (st. Ba-6.2).

Figure 6.22. Coralligenous concretion blocks with *Mesophyllum* and *Neogoniolithon* spp.; and the poriferan *Crambe crambe*; with remnants of a longline. Medfoun, at 46m depth (st. M-4).

6.1.8 Biocenosis of the semi-dark caves (RAC/SPA: IV.6.2)

The entrance of the caves is colonised by the coralligenous community with incrustant algae *Mesophyllum* sp, *Lithophyllum stictaeforme, Peyssonnelia* spp. In more sciaphilic surfaces the poriferans are abundant (Fig. 6.23) with Demospongiae (*Aplysilla sulfurea, Crambe crambe, Chondrosia reniformis, Haliclona fulva, Terpiops* sp.) and Calcarea (*Borojevia* cf. *cerebrum, Clathrina* spp., *Sycon* spp.); the madreporarians *Phyllangia americana mouchezii* and *Polycyathus muellerae*; the bryozoan *Margaretta cereoides*; and the ascidians Didemnidae spp., *Herdmania momus* and *Cystodytes dellechiajei*.

The mobile fauna is represented by *Hermodice carunculata* and the fishes: *Pempheris vanicolensis* (very common), *Sargocentrum rubrum* and *Tripterygion melanurum*; the Mediterranean fish Apogon imberbis has been very rare.

Stations: Batroun (Ba-4, Ba-5, Ba-6), Kfar Abida (K-1, K-2, K-3), Medfoun (M-4, M-5, M-7), Byblos (By-4, By-5, By-8).

Figure 6.23. Semi-dark cave habitat with the sponges *Haliclona fulva, Crambe crambe* and *Borojevia* cf. *cerebrum*; and the scleractinian *Phyllangia amaricana mouchezii*. Kfar Abida, 3 m dept (st. K-3).

6.1.9 Biocenosis of caves and ducts in total darkness (RAC/SPA: V.3.2)

This bathyal biocenosis is present in enclave in the infralittoral and circalittoral stages, where deep caves and ducts are present. Only it has been observed in the inner part of the Virgin cave front to Batroun at 47 m dept. The substratum is dark brown and cover only by Serpulidae spp. (Fig. 6.24), and some rare sponges (e.g. *Myrmekioderma spelaeum*).

Stations: Batroun (By-6).

Figure 6.24. Dark cave with sepulids and the sponge *Myrmekioderma spelaeum* (left down). Batroun, at 47 m depth (St. Ba-6.2).

6.2 SOFT SUBSTRATA

Although the coast is predominant rocky, and a large part of the infralittoral bottoms front to Batroun is low flat rock, in the all area dominate the soft substrates (cobbles, pebbles, gravel, sand and muddy sand).

6.2.1 Biocenosis of well sorted fine sands (RAC/SPA: III. 2. 2)

The biocenosis is spread in the area, between 0 to 12 m depth, and the deep ripple-marks attest to the strong hydrodynamism of the area (Fig. 6.25).

The fauna is similar to the rest of the Mediterranean with the bivalves: *Acanthocardia tuberculata, Atlantella pulchella, Spisula subtruncata, Mactra stultorum, Donax semisriatus, Loripes orbiculatus, Pitar rudis, Glycymeris* spp.; gastropods: *Nassarius gibbosulus, N. circumcinctus, Tritia mutabilis, Neverita josephina*; the crustaceans *Diogenes pugilator* and *Liocarcinus vernalis*; and the irregular sea urchin *Echinocardium mediterraneum*. Among the fish, highlights *Xyrichtys novacula*, and in lower abundance *Lithognathus mormyrus*.

Stations: Batroun (Ba-4), Medfoun (M-5, M-6), Byblos (By-3, By-4, By-6, By-7).

Figure 6.25. Well sorted fine sands with the hermit crab *Diogenes pugilator* inside shells of *Nassarius circumcinctus*. Byblos, at 7 m depth (st. By-4).

6.2.2 Biocenosis of the muddy sand

a) Association with Caulerpales C*aulerpa prolifera, C. lamourouxi* and *C. taxifolia* var. *distichophylla* form more or less broad turfs between 10 and 43 m depth on muddy sand. (Fig. 6.26a,c), although they can reach 46 m deep. In the same way, from 39 m to 46 m depth, *C. scapelliformis* forms extensive prairies (Fig. 6.26b). The gastropod *Rhinoclavis kochi* is common; and on the leaves of *C. taxifolia* var. *distichophylla* highlight the abundance of the anemone *Buneopsis strumosa*, particularly between 13 to 16 m depth (Fig. 6.26d). The ascidian *Microcosmus exasperatus* forms small biogenic blocks where algae are fixed.

Stations: Batroun (Ba-1, Ba-2, Ba-3), Medfoun (M-5), Byblos (By-2, By-3, By-6).

b) Association with *Cymodocea nodosa* It has been observed front to Byblos, at 27-29 depth (Fig. 6.27), without forming a meadow, only small and isolated plants, probably, come from the germination of seeds. The same was observed in Enfeh during the 2012 mission.

Stations: Byblos (By-3).

Figure 6.26. Caulerpales: (a) *Caulerpa prolifera* (Batroun at 26 m depth, st. Ba-1); (b) *C. scapelliformis* (Batroun, at 46 m depth, st. Ba-2); (c) *C. lamourouxi* (Batroun at 22 m depth, st. Ba-4); (d) *C. taxifolia* var. *distichophylla* with *Bunodeopsis strumosa* (Byblos at 15 m depth, st. By-6).

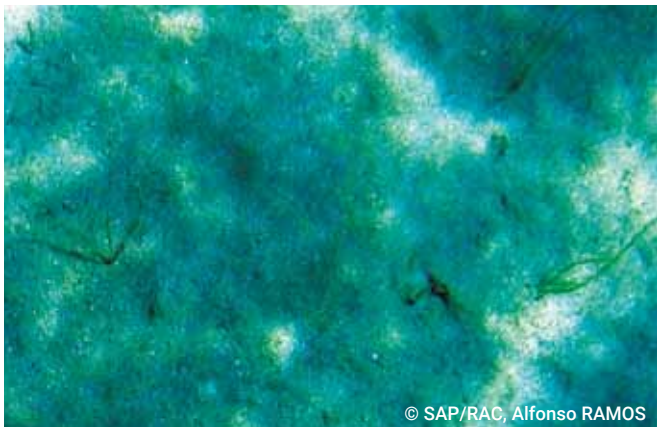

Figure 6.27. Small plants of *Cymodocea nodosa*. Byblos, at 29 m depth (st. By-3).

6.2.3 Biocenosis of coarse sands and gravels (RAC/SPA: III.3.2)

The gravel and coarse sand under the influence of bottom currents are widespread in the area, particularly front to Batroun (between 12 to 46 m depth), sometimes with pebbles and sparse rhodolithes, on flat rocky bottoms, pools and channels between rocks, both in infralittoral and circalittoral stages. In some places, the chlorophyte *Caulerpa lamourouxi* cover the coarse sediment (Fig. 6.28). The fauna is poor in species, with the irregular echinoid *Brissus unicolor*, the holothurian *Synaptula reciprocans*, the bivalve *Venus verrucosa* (shells) and the characteristic fish *Gobius bucchichii*.

Stations: Batroun (Ba-1, Ba-3, Ba-7), Medfoun (M-1, M-6).

Figure 6.28. Gravel and coarse sand with some rhodolithes and *Caulerpa lamourouxi*. Batroun, at 27 m depth (st. Ba-1).

6.2.4 Biocenosis of the muddy detritic bottom (RAC/SPA: IV. 2. 1)

An interesting facies has been observed front to Batroun at 46 m depth, represented by a *Sabella pavonina* aggregation. (Fig. 6.29).

Stations: Batroun (Ba-2).

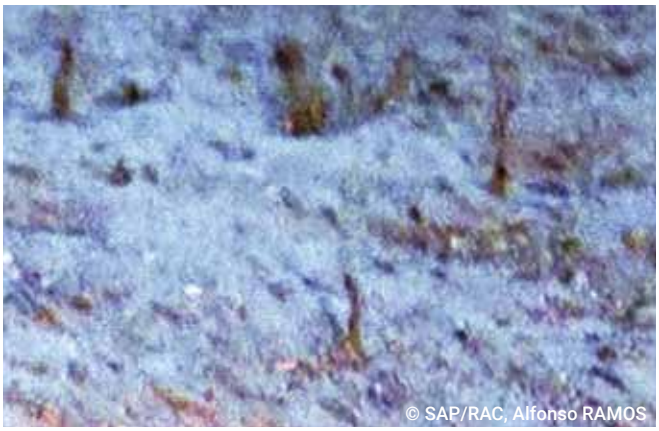

Figure 6.29. Some tubes of the *Sabella pavonina* aggregation. Batroun, at 46 m depth (st. Ba-2).

6.2.5 Biocenosis of the coastal detritic bottom (RAC/SPA: IV. 2. 2)

With the 'maërl facies' (RAC/SPA: IV.2.2.2). The deep maërl beds are present in all the area, between 33-54 m depth. The substratum is formed by shell gravel and coarse sand, with the rhodolithes *Lithothamnion corallioides, Mesophyllum* sp. and *Spongites fruticulosus* (Fig. 6.30) with the chlorophytes *Caulerpa scapelliformis* and *Flabellia petiolate*. The tests of the irregular sea urchin *Echinocyamus pusillus* are frequent, and the epifauna is scarce with the holothurian *Synaptula reciprocans*.

Stations: Batroun (Ba-1, Ba-6), Medfoun (M-1, M-2, M-3, M-4), Byblos (By-1, By-5).

Figure 6.30. Maërl bed with *Lithothamnion corallioides* and *Spongites fruticulosum*. Medfoun, at 50 m depth (st. M-4).

6.3 BIONOMICAL MAPPING

The figures 6.31 to 6.33 show the distribution of the main biocenosis observed in the Batroun-Byblos sector carried out by transects and plot dives, between 0-54 m depth.

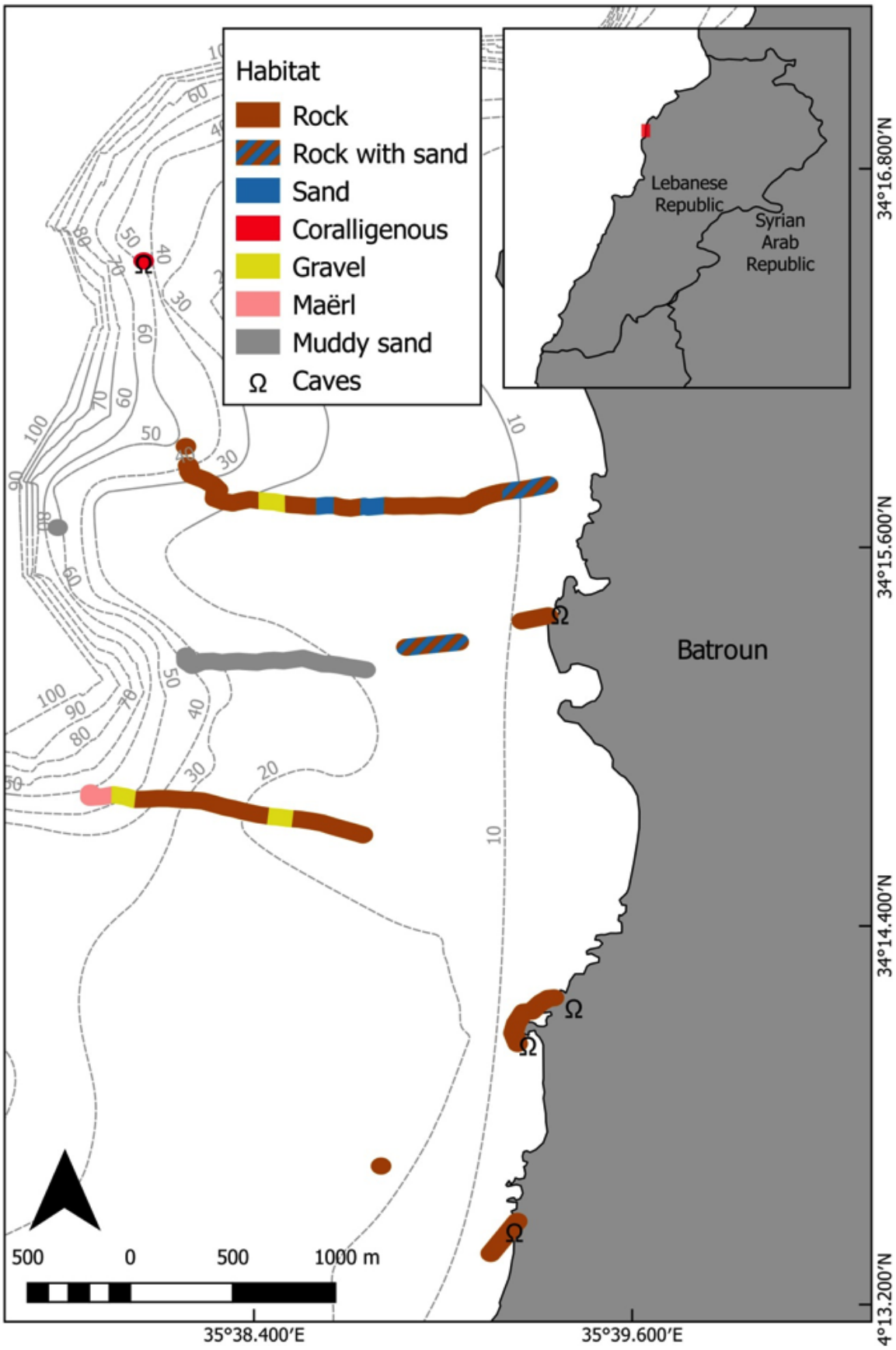

Figure 6.31. Batroun area

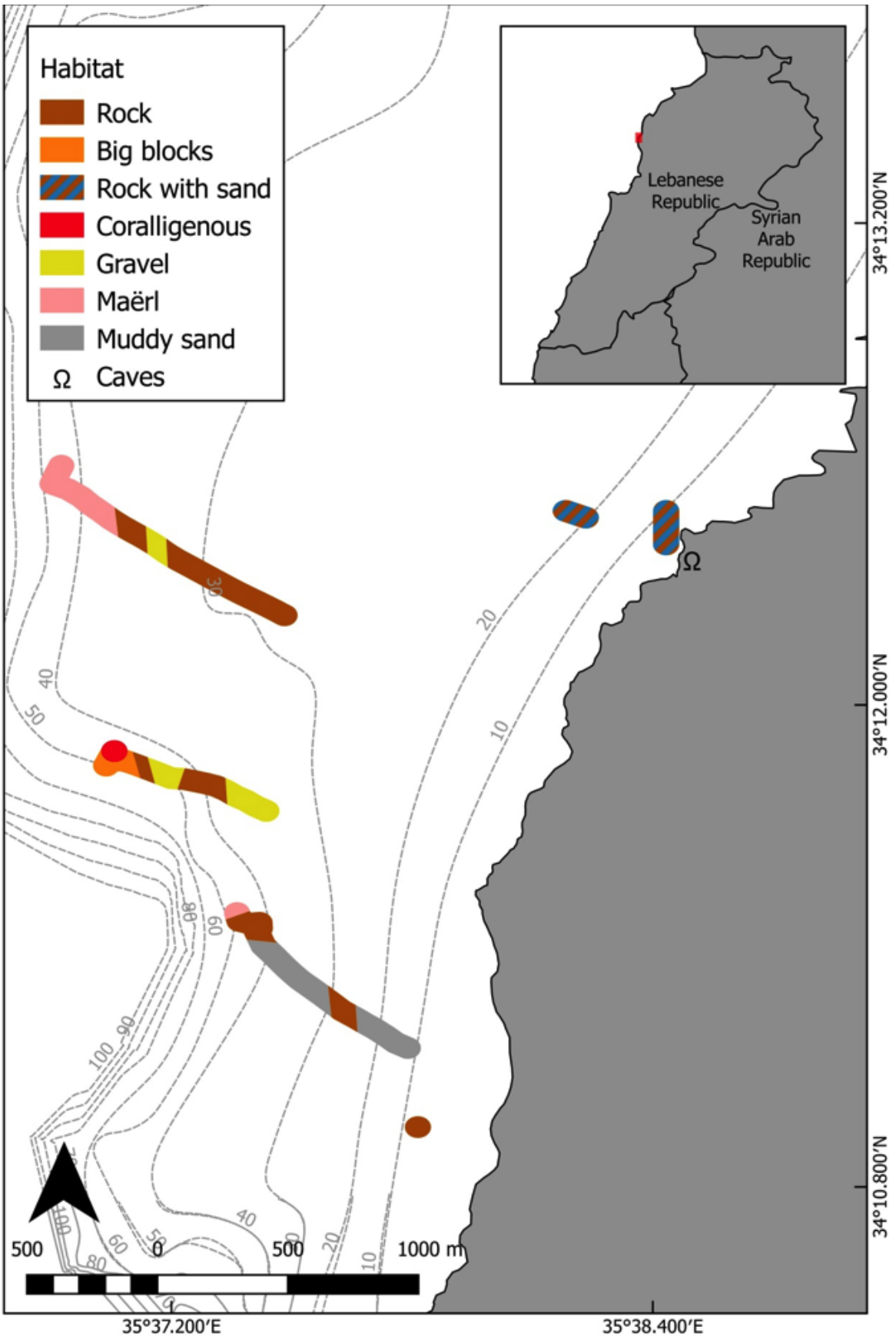

Figure 6.32. Medfoun area

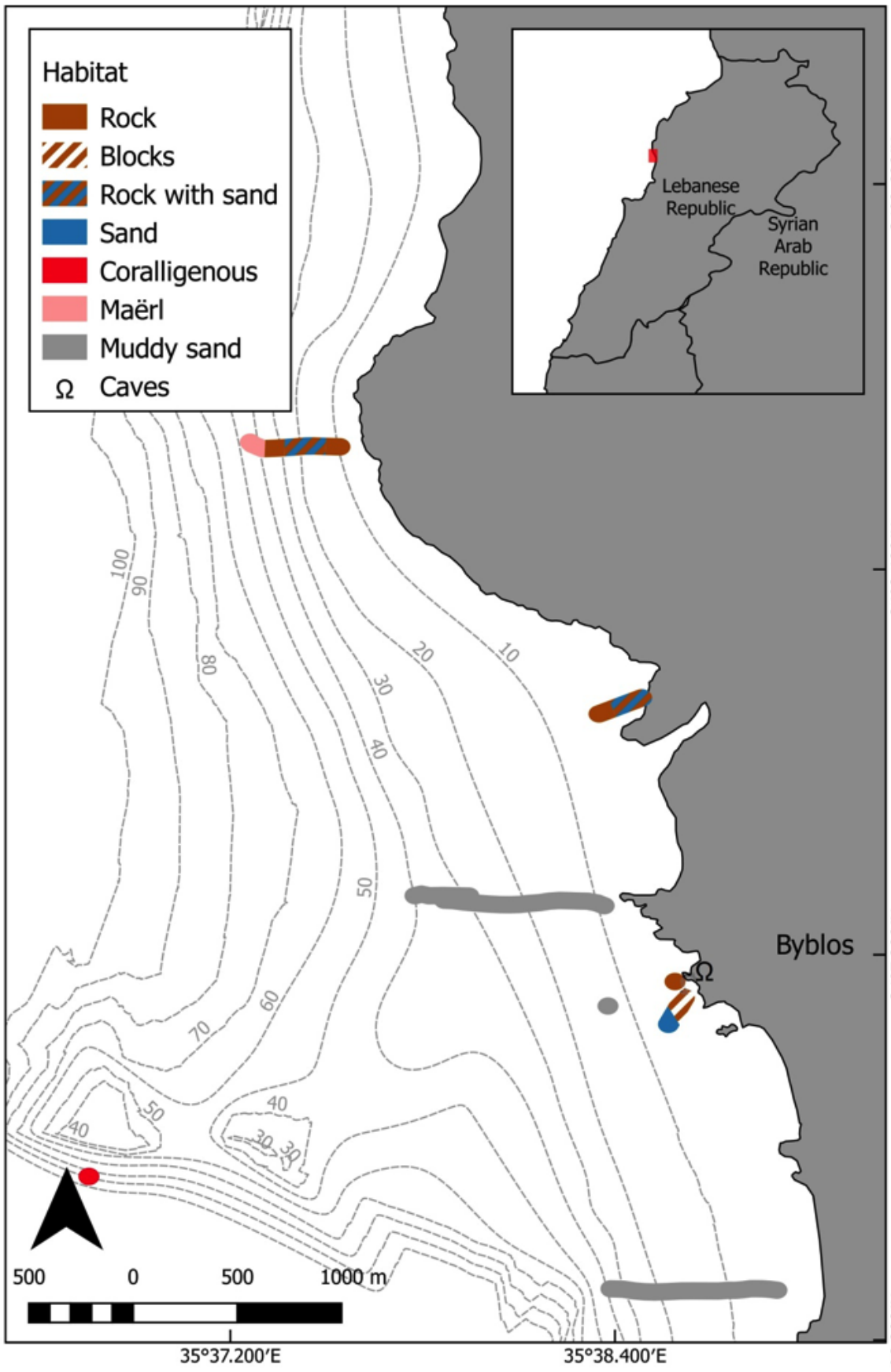

Figure 6.33. Byblos area

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7. EVALUATION OF THE ZONES

To the evaluation of the zones we have considered five parameters (biodiversity, habitats, interesting spp., fish biomass and naturalness of the zones) that can give a comparative and objective assessment of their conservation.

7.1 TAXA BIODIVERSITY

The table 7.1 shows the number of species by zone, the relative abundance and the Margalef's index of species richness.

Table 7.1 Species parameters by zones.

Parameters/zones	Batroun	Kfar Abida	Medfoun	Byblos	Total
Nº plot dives/station	8	4	8	8	28
Depth range (m)	0-50	0-23	0-53	0-54	0-54
Taxa richness	160	170	172	198	334
Relative abundance (RA)	680	641	559	678	2538
Margalef index (M)	24.38	26.15	27.03	30.22	42.48
Nº habitats/zone	23	18	20	22	28
Margalef Index/habitat (M/H)	1.06	1.45	1.35	1.37	1,52
RBI (MH/1.52)	0.7	0.95	0.89	0.9	1

(RBI) Relative Biodiversity Index

a) Taxa richness: Byblos presents the highest values of S (≈ 200 spp.), followed by Medfoun and Kfar Abida (≈170-172); Batroun has presented the lowest value (160 spp.).

b) Relative abundance/station (RA): Batroun and Byblos have presented the highest values (≈ 680) and Medfoun the lowest (≈ 560). However, if we take the average by station (RA/plot dives), Kfar Abida has been the highest (160.25/station).

c) Margalef's index (M): It is a good index of species richness when there is information about the relative abundance of the species. The indices have varied in a narrow margin, being the highest in Byblos (≈ 30) and the lowest in Batroun (≈ 25).

d) Index MH: However, the Margalef index depends of the variety of habitats, which harbor different species. To compare the different zones, it is convenient to know the mean species richness-abundance by habitat with the Margalef index (M/H):

M/H = Margalef's index / number of habitats

Also, it is necessary to adjust these values to the total number of samples (total spp., relative abundance and habitats) where MH = 1.52 (Margalef's index value with the total species and its relative abundance). Table 7.1 presents the number of habitats (biocenosis, associations or facies) observed by zone and the MH value. With this adjustment, Kfar Abida has presented the highest values (0.95), whereas Batroun had the lowest (0.7); Medfoun and Byblos are quite similar (≈ 0.9).

7.2 EVALUATION OF HABITATS

For the evaluation of the habitats (biocenosis, associations or facies), we have followed the UNEP-MAP (1998) valorisation, adapting the criterion values to the different habitats (table 7.2). These habitats – structural and functionally depending on their complexity and heterogeneity, as so as the human impacts - harbour a different diversity of species, some of them with high ecological (key-stone species), patrimonial (vulnerable and endangered species), rarity and/or economical value.

Table 7.2. Evaluation of the habitats

HABITAT	S	V	PV	R	A	E	HV	C
B. supralittoral rock	1	1	1	1	1	1	0.00	N
B. upper mediolittoral rock	-	-	-	-	-	-	-	-
- F. with *Chthamalus* spp.	1	1	1	1	1	1	0.00	N
- A. *Lithophyllum papillosum*	1	1	1	1	1	1	0.00	N
B. lower mediolittoral rock	-	-	-	-	-	-	-	-
- Pools and lagoons associated with vermetids	2	2	3	2	2	1	1.00	P
- A. *Neogoniolithon brassica-florida* with *Dendropoma*	2	3	3	2	2	1	1.20	P
B. midlittoral caves	3	3	3	3	3	2	1.83	P
B. infralittoral algae	-	-	-	-	-	-	-	-
- A. *Callithamnion granulatum*	1	1	1	1	1	1	0.00	N
- F. overgrazing with encrusting algae	1	1	1	1	1	1	0.00	N
- A. *Jania rubens*	2	2	1	1	2	1	0.50	N
- A. *Sargassum vulgare*	3	2	2	1	3	2	1.17	P
- A. *Cystoseira* sp.	2	2	2	3	2	2	1.17	P
- A. *Corallina elongata*	2	1	1	1	2	1	0.33	N
- F. *Chama pacifica* and *Spondylus spinosus*	2	1	1	1	1	2	0.33	N
- A. *Galaxaura rugosa*	2	1	1	1	1	1	0.17	N
- A. *Codium parvulum*	1	1	1	1	1	1	0.00	N
- A. *Lobophora variegata*	2	1	1	1	1	1	0.17	N
- A. *Peyssonnelia* spp.	2	2	2	2	2	1	0.83	P
- A. encrusting Corallinaceae and sponges	2	2	2	1	2	1	0.67	N
B. small blocks	2	3	2	1	2	3	1.17	P
B. coralligenous	-	-	-	-	-	-	-	-
- F. coralligenous (infralittoral enclaves)	3	3	3	3	3	2	1.83	P
- A. coralligenous (circalittoral)	3	3	3	3	3	3	2.00	P
B. semi-dark caves	3	3	3	3	3	3	2.00	P
B. caves and ducts in total darkness	3	3	3	3	3	2	1.83	P
B. fine and muddy sands	-	-	-	-	-	-	-	-
- A. *Cymodocea nodosa*	2	3	3	2	2	3	1.50	P
- A. Caulerpales	1	1	1	2	2	1	0.33	N
B. coarse sands and fine gravels	2	2	1	2	1	1	0.50	N
B. coastal detritic bottom	-	-	-	-	-	-	-	-
- Maerl facies	3	3	3	3	3	2	1.83	P
B. muddy detritic bottom	-	-	-	-	-	-	-	-
- F. *Sabella pavonina*	2	1	2	2	2	1	0.67	N

Criteria: (A) aesthetic value; (E) economic significance; (HV) habitat value; (PV) patrimonial value; (R) rarity; (S) species richness; (V) vulnerability. Classification (C): (P) priority habitat; (N) no important habitat. Evaluation: (3) high value; (2) medium value; (1) low value. (modified of UNEP/MAP, 1998).

Some of them could be considered as priority, i.e. requiring, due to their vulnerability, their natural heritage quality, their rarity of their high aesthetic value, a specific protection whereas the biocenosis itself or the other association/facies are of no specific interest. Moreover, the evaluation levels of each criterion can vary as a function of the local conditions (UNEP-MAP, 1998).

The habitat value (HV) of the habitats represents the sum of the different criterion values (Table 7.2: S, V, P, R, A, E) divided by 6 (number of criterions). The habitats with value 1 (which represents the minimum value) are no considered, that is the reason to subtract 1:

Habitat value (HV) = (Σ S+V+P +R+A+E / 6) -1

The table 7.3 represents the evaluation of the zones in function of the habitat values (see table 7.2). We have calculated a value (relative value of habitats), considering the sum of the values of the habitats in each zone divided by the number of habitats by zone, gives us an average of the value of the habitat / zone (MHVZ: medium habitat value per zone). And in order to homogenize the values, each MHVZ has been divided by the average value of all habitats / zones, obtaining the relative value of the habitats by zone (RVHZ; see table 7.3).

The relative values of the habitats by zone have been similar (0.9-1.0), being Byblos and Medfoun the highest (0.98), and Kfar Abida the lowest (0.89).However, Kfar Abida have not been sampled coralligenous deep bottoms (> 40m depth).

Table 7.3. Relative value of habitats (RVH) by zones

HABITAT /ZONE	HV	Ba	K	M	By
Pools and lagoons associated with vermetids	1	1	1	-	-
B. midlittoral caves	1.83	1.83	1.83	1.83	1.83
A. *Neogoniolithon brassica-florida* with *Dendropoma*	1.2	1.2	1.2	1,2	1.2
A. *Jania rubens*	0.5	0.5	0.5	0.5	0.5
A. *Sargassum vulgare*	1.17	-	-	-	1.17
A. *Cystoseira* sp.	1.17	-	1.16	-	1.17
A. *Corallina elongata*	0.33	0.33	0.33	0.33	0.33
F. *Chama pacifica* and *Spondylus spinosus*	0.33	0.33	0.33	0.33	0.33
A. *Galaxaura rugosa*	0.17	0.17	0.17		0.17
A. *Lobophoravariegata*	0.17	0.17	0.17	0.17	0.17
A. *Peyssonnelia* spp.	0.83	0.83	0.83	0.83	0.83
A. incrusting Corallinaceae and sponges	0.67	0.67	-	0.67	0.67
B. small blocks	1.17	1.17	1.17	1.17	1.17
A. *Cymodocea nodosa*	1.5	-	-	-	1.5
B. coarse sands and fine gravels, bottom currents	0.5	0.5	0.5	0.5	0.5
F. coralligenous (infralittoral enclaves)	1.83	1.83	1.83	1.83	1.83
B. coralligenous	2	2	-	2	2
B. semi-dark caves	2	2	2	2	2
B. caves and ducts in total darkness	1.83	1.83	-	-	-
A. Caulerpales	0.33	0.33	-	0.33	0.33
Maerl facies	1.83	1.83	-	1.83	1.83
F. *Sabella pavonina*	0.67	0.67	-	-	-
Total Value/Zone (ΣHV)	23.03	19.19	13.03	15.52	19.53
Nº Habitats/Zone (HZ)	22	19	14	15	19
Medium Habitat Value/Zone (MVZ = ΣVZ/HZ)	1.05	1.01	0.93	1.03	1.03
Habitat Index (HI = MVZ/1,05)	**1.0**	**0.96**	**0.89**	**0.98**	**0.98**

(Ba) Batroun; (By) Byblos; (K) Kfar Abida; (M) Medfoun. (HV) habitat value: (B) biocenosis; (A) association; (F) facies.

7.3. INTERESTING SPECIES

Another important criterion to establish marine protected areas is the presence of species with patrimonial value (included in the Barcelona Convention, 1995 (Marrakech, 2009: Annexes II and III), Bern Convention 1997-98 (Annexes I-II); EU Habitat Directive 92/43 (Annexes II, IV, V); red book of Mediterranean vegetation (UNEP/IUCN/GIS Posidonie, 1990) and CITES (Annexe II); with large Sparidae and Serranidae of economic interest.

Batroun has presented the highest value (0.37), followed by Medfoun (0.33) and Byblos (0,26); Whereas Kfar Abida the lowest (0,21). However, Kfar Abida have not been sampled coralligenous deep bottoms (> 40 m depth).

Table 7.4. Species with patrimonial value (Barcelona Convention, 1995) and economic interest distributed by zones

Species/Zones	Ba	K	M	By	HV
Cystoseira cf. *foeniculacea*	2	-	-	-	3
Lithothamnion corallioides	1	-	2	1	3
Cymodocea nodosa	-	-	-	1	3
Aplysina aerophoba	3	-	-	2	3
Aplysina spp.	-	-	3	-	3
Axinella polypoides	3	-	2	2	3
Hippospongia communis	-	-	-	1	3
Spongia officinalis	2	2	1	2	3
Cladocora caespitosa	-	-	1	-	3
Phyllnagia americana	3	1	2	-	3
Dendropoma petraeum	1	2	1	1	3
Tonna galea	-	-	1	-	3
Lithophaga lithophaga	1	1	1	1	3
Diplodus cervinus	1	1	2	2	3
Epinephelus costae	1	1	1	-	3
Epinephelus marginatus	1	1	1	-	3
Mycteroperca rubra	1	2	1	1	3
Pagrus auriga	1	-	-	-	3
Chelonia mydas	-	1	-	1	3
Σ spp. values by zone (ΣVZ)	21	12	19	15	57
ISI (ΣVZ/57)	**0.37**	**0.21**	**0.33**	**0.26**	**1**

(Ba) Batroun; (By) Byblos; (HV) highest value (V = 3); (K) Kfar Abida; (M) Medfoun; (ISI) interesting species index.
Relative abundance: (3) abundant; (2) common; (1) scarce.

7.4. FISH BIOMASS OF SPECIES WITH FISHING INTEREST

The study of the commercial fish populations supposes an important criterion to establish marine protected areas because it represents the main resource to the local fishermen, and this resource must be exploited rationally, in order not to collapse it. The fish parameters (mainly species richness, abundance and biomass) by zones have previously been treated in the paragraph 5.4 ('Fish populations'). The table 7.5 summarizes the commercial fish biomass by zones.

The fish biomass index (FBI in the table 7.5) is the result to divide the mean biomass of the zone by 12417.34 gr/125m^2 (max. biomass of species).

Table 7.5. Commercial fish species and its biomass (gr/125 m^2) in function of the zones

Species/Zones	Ba	K	M	By	MV
Caranx chrysos	-	-	164,64	-	164,64
Diplodus cervinus	4,72	-	-	-	4.72
Diplodus sargus	231,43	41,86	17,49	-	231,43
Diplodus vulgaris	9066,37	11,28	38,78	-	9066,37
Epinephelus costae	-	70,91	-	-	70,91
Fistularia commersonii	-	-	54,11	-	54,11
Mycteroperca rubra	116,03	-	-	-	116,03
Pagrus auriga	7,47	-	-	-	7,47
Sargocentron rubrum	1241,82	2395,14	419,17	634,63	2395,14
Serranus cabrilla	4,88	0,74	5,58	6,03	6,03
Serranus scriba	-	21,18	10,52	-	21,18
Siganus luridus	40,19	46,78	85,91	196,09	196,09
Sparisoma cretense	22,09	12,48	15,35	28,67	28,67
Spicara smaris	-	24,35	-	-	24,35
Symphodus tinca	-	-	8,49	-	8,49
Xyrichthys novacula	-	-	-	26,43	26,43
Σ Fish biomass/zones (FBZ)	10735.00	2624,72	820,04	891,85	12417,34
FBI (BZ/20765.34)	**0.86**	**0.21**	**0.07**	**0.07**	**1**

(Ba) Batroun; (K) Kfar Abida; (M) Medfoun; (By) Byblos; (MV) max. value/zone. (FBI) Fish Biomass Index.

7.5 EVALUATION OF USES/IMPACTS AND NATURALNESS

The studied zones are subject to the different uses and human activities (industry, commercial, artisanal and sportive fisheries, tourism, littoral urbanisation, local population; table 7.6), that means a variety of impacts and, subsequently, subject to possible threats.

- Littoral frequentation: urbanisations: domestic sewage discards (values = 0-3), solid wastes (0-2), trampling (0-2).
- Fishing: professional (nets and traps, long-lines), shore angling (0-1), spearfishing (0-3), bait collection (0-3), lost nets (mainly mono-filaments and traps => ghost fishing) (0-3).
- Tourism: marinas (0-3), bathing (0-1), boating/mooring (0-3).
- Industry (ports, sediment/mineral discards, concrete, oil): industrial sewage discards (0-3).

The use/impact index (UI, table 7.6) by zones has been calculated from the sum of the use-impact values/zone and divided by 39 (MVU = 13 uses-impacts x 3). In order to evaluate the zones, from the point of view of conservation, we have calculated the Naturalness Index (NI = 1-UI).

Although the littoral of the zones presents very uses and impacts (industry, littoral urbanization, different fishing activities, sewage discards…), some areas remain little altered, as Kfar Abida and Medfoun. These areas are interesting in order to establishment protection measures with low impact uses.

Table 7.6. Uses and impacts of the zones

Uses-Impacts / Zones	Ba	K	M	By	MVU
Professional fishing	3	2	2	2	3
Shore angling	3	2	2	3	3
Spearfishing	3	3	3	3	3
Lost nets (ghost fishing)	2	1	1	2	3
Trampling	3	2	2	3	3
Bait and shell-fish collecting	3	2	2	3	3
Mooring	2	1	1	3	3
Ports, marinas, cove fishing	2	-	-	3	3
Solid wastes	2	2	2	3	3
Domestic sewage discards	2	1	1	2	3
Industrial sewage discards	1	-	-	1	3
Beaching/bathing	2	2	2	3	3
Urbanisation	3	1	1	3	3
Σ uses-impact values (ΣUV)	31	19	19	34	39
Uses-impacts Index (UI = ΣUV/39)	0.79	0.49	0.49	0.87	1
Naturalness Index (NI=1 – UI)	**0.21**	**0.51**	**0.51**	**0.13**	**0**

(Ba) Batroun; (K) Kfar Abida; (M) Medfoun; (By) Byblos; (MVU) max. value of the uses-impacts.
Relative evaluation of the use/Impact: (3) very important; (2) more or less important; (1) not important;

7.6 EVALUATION OF THE ZONES

For the evaluation of zones, and once the five indices are obtained (biodiversity, habitats, interesting species, commercial fish biomass and naturalness), the conservation value (CV) of each zone is calculated by the sum of these indices.

The conservation index (CI) is the result of dividing the conservation value (CV) by the sum of the maximum value of each index (MV) (Table 7.7). From which, we have established three levels of conservation values (Table 7.7):

i) high (CI >0.67);
ii) medium (CI = 0.67-0.33); and
iii) low (CI <0.33).

According to these levels, Batroun (0.84) and Kfar-Medfound (≈ 0.75) present a high level of conservation. While Byblos has a medium level (0.64).

Table 7.7. Evaluation of the zones

Index	Ba	K	M	By	MV
Biodiversity (B)	0.70	0.95	0.89	0.9	0.95
Habitats (H)	0.96	0.89	0.98	0.98	0.98
Interest spp. (IS)	0.37	0.21	0.33	0.26	0.37
Fish biomass (FB)	0.86	0.21	0.07	0.07	0.86
Naturalness (N)	0.21	0.51	0.51	0.13	0.51
CV = Σ(B+H+IS+F+N)	3.10	2.77	2.78	2.34	3.67
CI (CV/3.67)	**0.84**	**0.75**	**0.76**	**0.64**	**1.00**

(Ba) Batroun; (K) Kfar Abida; (M) Medfoun; (By) Byblos. (MV) max. value zones ;
(EV) environmental value ; (CI) environmental relative index.

7.6.1 Batroun (Fig. 7.1)

Important historical and touristic area with the city of Batroun (45.000 habitants) and a fishery port with small-scale fishery fleet (Fig.7.1a). It is a historic place of interest with the Phoenician wall (Fig.7.1b) and Middle Age city.

a) Geomorphology: The coast is predominantly low rocky with wide littoral platform and small caves and coves. On the seabed also the low rock is dominated by channels of coarse sand and gravel. Some rocky outcrops stand out, between 40 and 50 m deep as the one where the Virgin' cave is present.

b) Taxa biodiversity: The Margalef index was the lowest (24.38), with a taxonomic richness of 160 taxa and a relative biodiversity index of 0.7.

c) Habitats: It has presented, a high habitat index (0.96). Among the habitats of interest are:

i) Cystoseira sp., between 19 and 27 m depth;

ii) small blocks community;

iii) coralligenous and maërl, between 40 and 50 m depth;

iv) semi-obscure and obscure cave communities.

d) Interesting species: Although it has presented the lowest biodiversity index, in terms of species of interest, has been the highest. However, with respect to the species of interest, the index has been the highest (0.37); standing out: *Cystoseira* sp, *Aplysina aerophoba, Axinella polypoides, Spongia officinalis* and *Phyllangia amaericana mouchezii*.

e) Commercial fish biomass: It has been by far the area with the highest biomass of all the studied areas (≈ 18 kg / 125 m^2), emphasizing Diplodus vulgaris (≈ 9 kg / 125 m^2) and Sargocentrum rubrum (1.2 kg / 125 m^2).

f) Uses-impacts: Batroun is a populated village and touristic place (high urbanization) with an important artisanal fishery (lost nets). Therefore, the uses and impacts derived from human frequencies are high (shore angling, spearfishing, trampling, solid wastes, beaching/bathing). Next to the village is the important industrial area of Selaata. The naturalness index is low (0.21).

g) Environmental evaluation: Despite the low environmental assessment, the total assessment of the area has been the higher (0.84), because it has presented the highest indices in species of interest (0.37) and commercial fish biomass (0.86) and a high habitat index (0.96).

h) Other interesting features: The presence of the CNRS Marine Research Center in Batroun (Fig. 7.1c) gives an important scientific, academic and educational aspect. Accessibility to the rocky coastline (wide platforms and littoral pools) and to the community of small blocks (cove next to the CNRS) allows its study and practices in marine ecology. Also, it is to emphasize the presence of circalittoral rocky outcrops (40-50 m of depth) with coralligenous and caves (Fig. 7.1d), one of them has an image of the Virgin Mary; however, due to strong currents, the diving must be done with trained personnel.

Figure 7.1. Batroun area: a) Batroun fishery port; b) low littoral rocky coast with the Phoenician wall to the background of the photograph; (c) the Marine Research Center (CNRS); (d) coralligenous and cave communities, at 47 m depth (st. Ba-6.2).

7.6.2. Kfar Abida - Medfoun (Fig. 7.2)

Interesting area at south of Batroun with relatively low density of constructions (Kfar Abida and Medfoun villages; Fig. 7.2a), a medium tourism with a human frequency relatively low (Fig. 7.2b). The coast is well conserved, without marinas and ports.

a) Geomorphology: The coast is predominantly irregular low rocky with wide littoral platform and small caves and coves (Fig. 7.2c,d); some small beaches in the Medfoun area.

b) Taxa biodiversity: Both areas present a similar Margalef index (MI = 26-27; 170-172 taxa). However, by dividing by the number of habitats, Kfar Abida has presented the highest (RBI = 0.95).

c) Habitats: The habitat index has varied between the highest (0.98) in Medfoun and the lowest (0.89) in Kfar Abida. It deserves special mention the good conservation of shallow habitats (< 25 m depth), particularly, *Dendropoma petraeum* formations, *Cystoseira* sp. association, small blocks and littoral caves with infralittoral enclaves of coralligenous. In Medfoun, the circalittoral bottoms (46-53 m depth): coralligenous community and maërl beds.

d) Interesting species: Regarding the species of interest, the index has varied between 0.33 (Medfoun) and 0.21 (Kfar Abida). These species include: *Lithothamnion corallioides, Aplysina* spp., *Axinella polypoides, Spongia officinalis, Cladocora coespitosa, Phyllangia americana mocheizii, Dendropoma petraeum, Diplodus cervinus* and *Mycteroperca rubra*.

e) Commercial fish biomass: After Batroun, Kfar Abida has been the second area with the highest biomass of commercial fishes (2.6 kg/125 m^2; FBI = 0.21), highlighting Sargocenrum rubrum (≈ 2.4 kg/125 m^2). However, Medfoun has presented, along with Byblos, the lowest index (0.07), highlighting Caranx chrysos as an abundant species (≈ 0.16 kg/125 m^2).

f) Uses-impacts: There are no major urbanizations in the area, Kfar Abida and Medfoun are small villages, with a low-medium tourism. In the absence of significant human concentrations, the contamination by solids and by residual waters is relatively low; and the beaching is localized. However, artisanal and sport fishing (shore angling and spearfishing) are important.

g) Environmental evaluation: The two areas have the same naturalness index (0.51) and similar environmental conservation value (CI ≈ 0.75).

h) Other interesting features: The sandstone rocky littoral of Kfar Abida presents an irregular morphology with wide platforms, littoral pools and midlittoral caves, which (Fig. 7.2c,d) make it particularly interesting in the study of coastal communities (photophilic/sciaphilic and exposed/sheltered enclaves).

Figure 7.2. Kfar Abida and Medfoun areas:
(a) Kfar Abida village; (b) touristic beach in Medfoun;
(c) rock littoral coast in Kfar Abida (st. K-4); littoral cave (st. K-2).

7.6.3. Byblos (Fig. 7.3)

Important historical and touristic zone with a small fishery port (Fig. 7.3a,b); it is very populated (around 100,000 habitants in the area). It presents wide beaches.

a) Geomorphology: The zone presents some long beaches with localized rocky shore. Within the rocky areas with wide coastal pawforms, Fartouch stands out with a medium profile (Fig. 7.3c).

b) Taxa biodiversity: The Margalef index was the highest (30.22), with a taxonomic richness of 198 taxa; although considering the habitats by zone goes to the second place (RBI = 0.90), below Kfar Abida (0.95).

c) Habitats: It has presented, with Byblos, the highest habitat index (0.98). Among the habitats of interest are:

   i) *Cystoseira* sp., between 19 and 27 m depth;
   ii) small blocks community;
   iii) coralligenous and maërl, between 40 and 50 m depth;
   iv) semi-obscure and obscure cave communities.

d) Interesting species: With respect to the species of interest, the index has been one of the lowest (0.26), standing out: *Cymodocea nodosa, Aplysina aerophoba, Axinella polypoides, Spongia officinalis* and *Diplodus cervinus*.

e) Commercial fish biomass: It has presented, together with Medfoun, the lowest value (FIB = 0.07). However, some species has been more abundant in this area (kg/125 m^2): Siganus luridus (≈ 0.2), Sparisoma cretense and Xyrichthys novacula (≈0.03).

f) Uses-impacts: Byblos is a populated and touristic village (high urbanization) with an important artisanal fishery (presence of lost nets) and recreational boats (mooring). Therefore, the uses and impacts derived from human frequencies are high (shore angling, spearfishing, trampling, solid wastes, beaching/bathing), for that reason the naturalness has been very low (0.13). To the north of the village there is an important industrial area close to Hay Al Arab.

g) Environmental evaluation: Despite the low environmental assessment, the total assessment of the area has been 0.64 which represents a medium value. However, Byblos highlights in taxa biodiversity (0.9) and habitat index (0.98).

h) Other interesting features: The littoral platforms around the port are wide (Fig. 7.3a), allowing the observation and study of their associated flora and fauna. On the other hand, the Fartouch represents a small coastal oasis within an overcrowded area (Fig. 7.3c,d).

Figure 7.3. Byblos area: a) general view of the village with the Crusader fortress; (b) Byblos' port with pleasure crafts; (c) Fartouch coast; (d) infralittoral rock in Fartouch (st. By-8).

8. MARINE PROTECTED AREAS, ZONING AND MANAGEMENT

In the previous paragraph, we have evaluated the different zones (taxa biodiversity, habitats, interesting species, fish populations, naturalness) and in this regard, we can establish two management areas (Fig. 8.1):

i) Batroun-Medfoun; and

ii) Byblos

a) Batroun-Medfoun (together with Kfar Abida): Between Ras Selaata (at the north) and Ras Barbara. It presents the highest values (0.84-0.75) with an interesting rocky outcrop (40-50 m depth) with coralligenous, semi-dark cave and dark cave communities front to Batroun. The rocky shore is irregular with wide littoral platforms and pools, and the cove, joint to the CNRS center, harbors an interesting community of small blocks. Although there is a high human pressure concentrated in the Batroun sector, this is not very strong (compared to Byblos), proof of this is the high value of the conservation index (CI > 0.75).

b) Byblos: Between Ras Amchit (at the north) and Fidar (south). It has have presented the lowest CI value (0.64). However, it presents areas of interest, such as the extensive littoral platforms and the Fartouch area. Human pressure is very high.

Due to the high human presence (villages, fishermen, tourism, etc.) cannot apply the strictly protected area figure, at least on the coast. However, three different levels of protection could be applied to the different zones:

i) integral protection (core zone);

ii) partial protection (buffer zone) with prohibition/ regulation of some impact activities; and

iii) resource management area (multiuse zone) with regulation of certain uses. A fourth figure is included (educational zone) of interest in people education.

As in previous work (RAC/SPA-UNEP/MAP, 2014), we have applied zoning based on the philosophy of the biosphere reserves (Price et al., 1993), management in IUCN's marine protected areas (Day *et al*., 2012), and adapting them to the needs of conservation and rational exploitation of marine resources, mainly fishing, leisure and tourism (Ramos-Esplá, 2007).

Figure 8.1: Proposed zones:
(A) Batroun-Medfoun; (B) Byblos. Image from Google Earth.

8.1 ZONING

8.1.1 Batroun-Medfoun Area (Fig. 8.2)

It comprises about 12 km of littoral, between the capes Selaata and Barbara and the isobaths 0-50 m depth (about 2000 m from the coast), covering a surface of about 3000 ha (Figs. 8.2).

a) Core zone (blue): Rocky outcrop front to Selaata Cape, between 40-50 m depth (Fig. 8.2), with the Virgin's cave. In spite of being in front of the industrial complex of Selaata, the strong currents of the zone prevent the arrival of fine sediment. It represents an important enclave of the corallligenous, semi-dark and dark communities. Also, it could be a potential breeding place for large serranids, if fishing (professional and recreational) is prohibited. The protected area has a circle shape, with the top of the outcrop, about 500 m in diameter (≈ 75 ha.). Given the interesting formation at the peak of the rocky outcrop, and the presence of an important cave, it is suggested that the figure of protection for this area is that of Natural Monument (IUCN category: III).

b) Buffer zones (green): Based on its state of conservation, ecological interest (littoral platforms, midlittoral caves, blocks, pools) and relatively low human impact, we can establish 2 buffer zones about 50 ha (rectangle: 1000 x 500 m):

i) Barbara zone (Figs 8.2M and. 8.3M); and

ii) Kfar Abida (Figs. 8.2K and 8.3K). Some soft activities permitted: bathing, snorkeling and scuba-diving. No artisanal and recreational fishing, bait collection, mooring and increase the urbanization of the zone.

c) Educational zone (yellow): Apart from the historical value of the Phoenician Wall, the coast around of the Wall and the cove near the oceanographic center (Figs. 8.2B and 8.3B), of easy accessibility and with interesting communities (wide littoral platforms and pools, small blocks), possesses an educational potential at the levels of graduate and baccalaureate. It will cover an area of 30 ha (1000 x 300 m).

d) Multiuse or peripherical zone (red): Given the good conservation of the coast, it is necessary to implement an integrated plan of coastal zone management with the aim of protecting and preserving this sector of Northern Lebanon. Activities currently carried out in the marine environment (bathing, artisanal fishing, sportive fishing from shore, scuba diving), may continue. Industrial activities and the direct discharge of sewage and/or sediment, and storage of debris or trash on the shore should not be permitted. Also, a plan is needed to avoid pollution and sedimentation produced by the Selaata industrial complex, located north of Batroun.

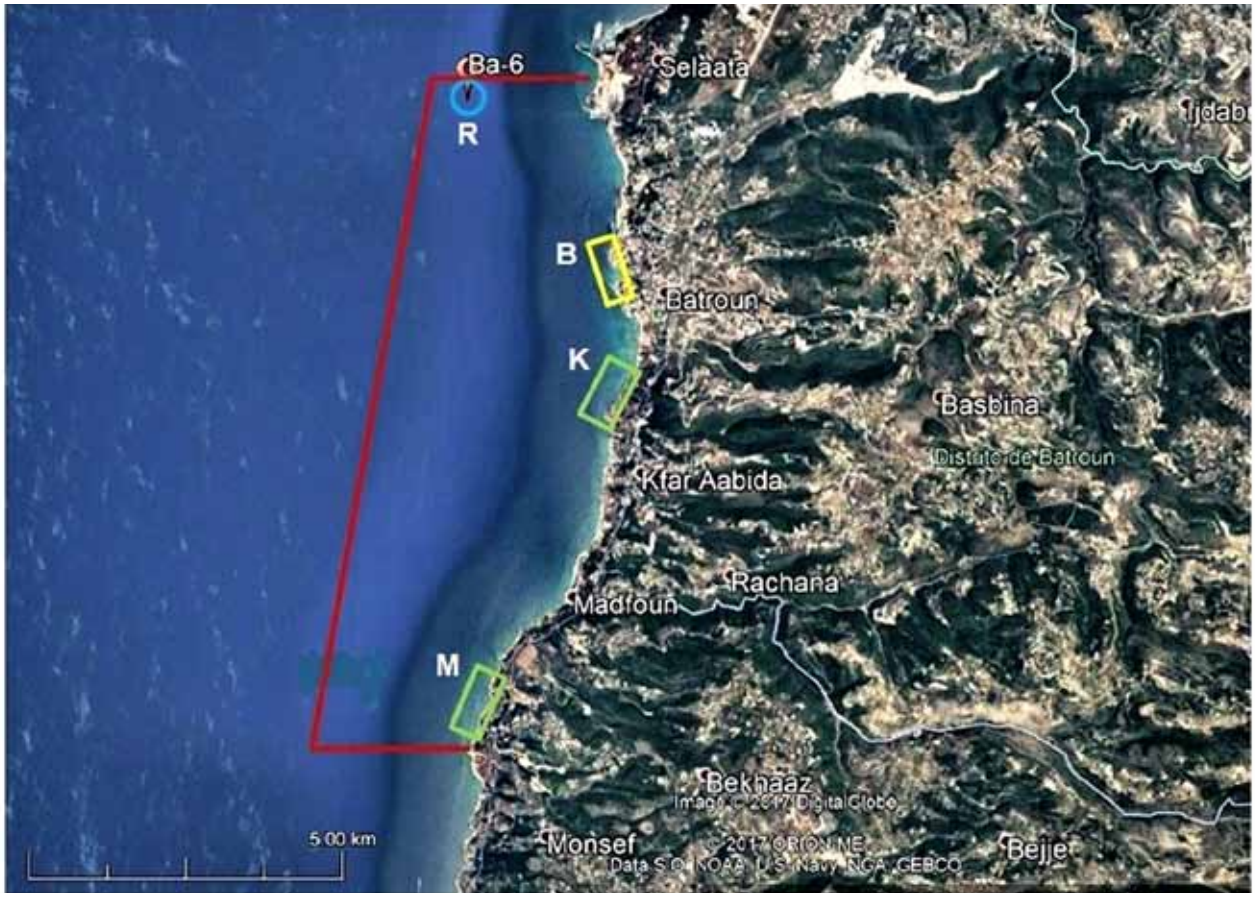

Figure 8.2. Batroun-Medfound marine protected zones: (B) Batroun (educational zone); (K) Kfar Abida (buffer zone); (M) Medfoun (buffer zone); (R) rocky outcrop (core zone). Red lines: delimitation of the proposed managed area. Image from Google Earth.

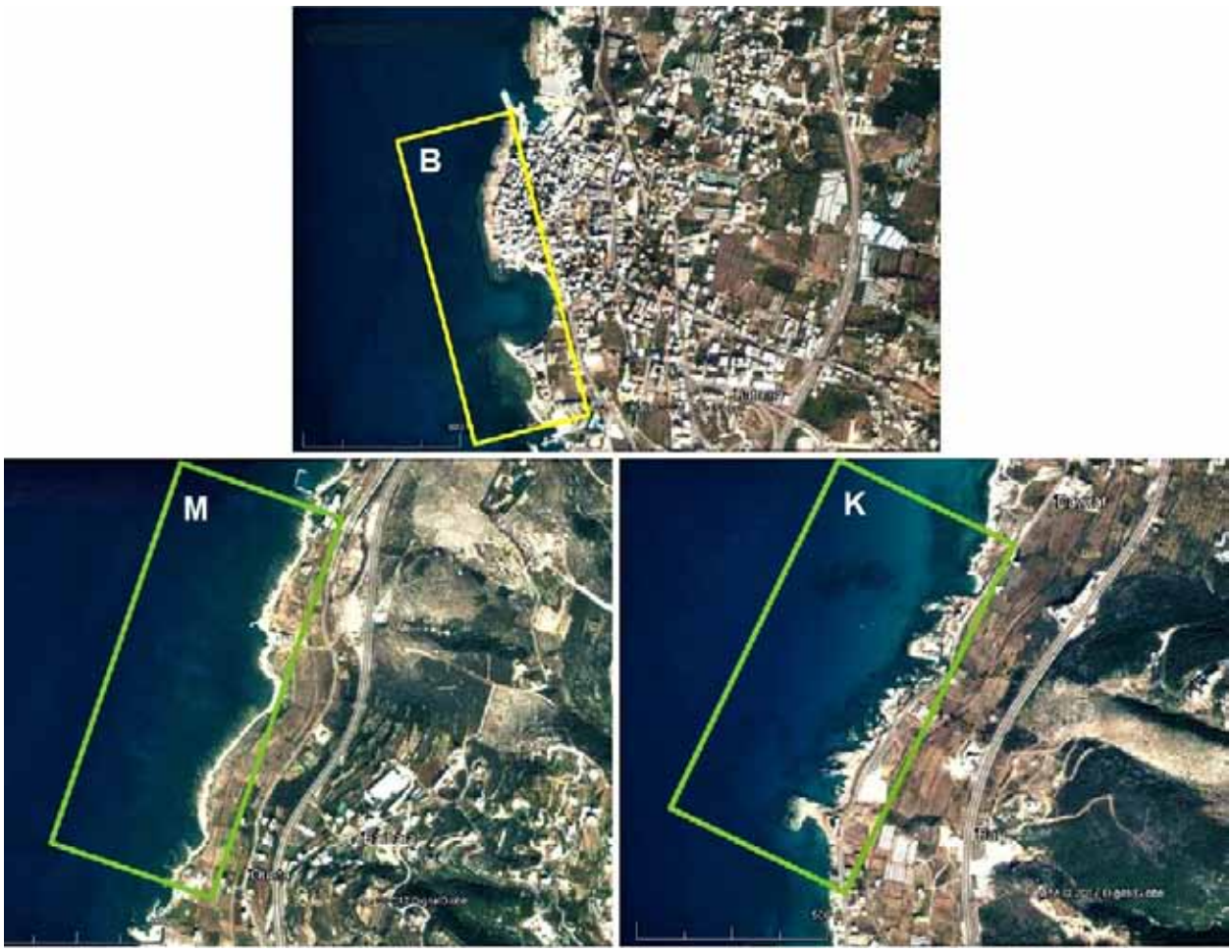

Figure 8.3. Buffer and educational zones in the Batroun-Medfoun area: (M,K) buffer zones of Medfoun and Kfar Abida, respectively; (B) educational zone of Batroun. Images from Google Earth.

8.1.2 Byblos Area

It comprises about 6 km of littoral, between Hay Al Arab (north) and Fidar (south) and the isobaths 0-50 m depth, covering a surface of about 1000 ha (Figs. 8.4).

a) Core zone (blue): Rocky outcrop front to Fidar, between 40-55 m depth (Fig. 8.4R). It represents an enclave of the coralligenous and semi-dark communities. Also, it could be a potential breeding place for large serranids, if fishing (professional and recreational) is prohibited. The protected area has a circle shape, with the top of the outcrop, about 500m in diameter (≈ 75 ha.).

b) Buffer zones (green): Based on its state of conservation, ecological interest (littoral platforms, midlittoral caves, blocks, pools) and relatively low human impact. The Fartouch zone (Figs. 8.4F and 8.5F) meets these requirements, preserving its natural state with little human pressure. The protected area is about 50 ha (500 x 1000 m) and some soft activities can be permitted as bathing, snorkeling and scuba-diving. No artisanal and recreational fishing, bait collection, mooring and increase the urbanization of the zone.

c) Educational zone (yellow): The coast around the small harbor and crusader fortress, apart from its historical interest, presents wide littoral platforms interesting communities (wide littoral platforms and pools, small blocks) (Fig. 8.4B and 8.5B), possesses an educational potential at the levels of graduate and baccalaureate. It will cover an area of 30 ha (1000 x 300 m).

d) Multiuse or peripherical zone (red): Given the high pressure on the coast, it is necessary to implement an integrated plan of coastal zone management with the aim of protecting and preserving this area.

Activities currently carried out in the marine environment (bathing, artisanal fishing, sportive fishing from shore, scuba diving) may continue. However, industrial activities and the discharge of sewage and/or sediment, and storage of debris or trash on the shore should not be permitted. Also, a plan is needed to avoid pollution and sedimentation produced by the Hay Al Arab industrial complex, located north of Byblos.

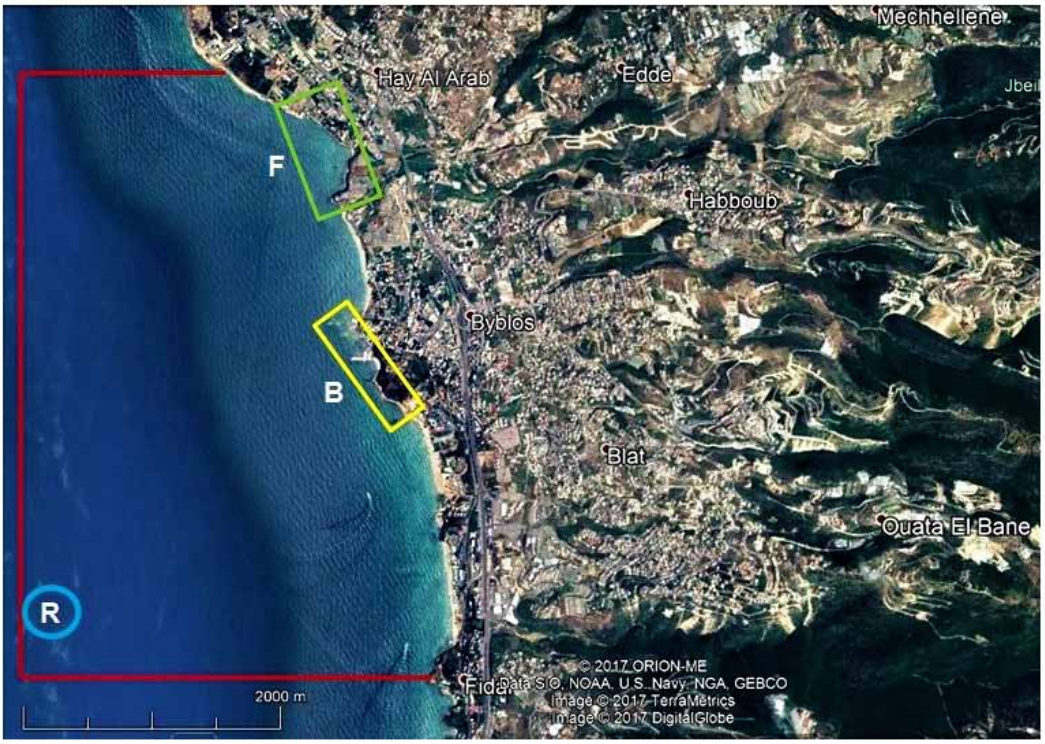

Figure 8.4. Byblos proposed marine managed and protected zones: (B) Byblos (educational zone); (F) Fartouch (buffer zone); (R) rocky outcrop (core zone); Red lines: delimitation of the proposed managed area. Image from Google Earth.

Figure 8.5. Buffer and educational zones in the Byblos area:
(F) buffer zones of Fartouch; (B) educational zone of Byblos. Images from Google Earth.

8.2 MANAGEMENT MEASURES

To avoid as far as possible the human impacts in a MPA, it is necessary to consider management planning through the zoning of the protected area. The management and zoning may resolve some conflicts between users of the coastal zone (industrial / tourism / conservation, selective/ no selective fishing methods, professional/ sportive fishing, scuba diving / spear-fishing) and to make protection compatible with the rational exploitation of the area.

In this sense, the 'Protocol concerning Specially Protected Areas (SPA) and Biological Diversity in the Mediterranean' (Barcelona Convention, 1995) mentions in the article 7-1 that: 'The Parties shall, in accordance with the rules of international law, adopt planning, management, supervision and monitoring measures for the SPAs. Later (art. 7-2), it indicates the measures that should be included for each SPA. The table 8.1 summarises the possible uses and management measures.

Table 8-1. Possible uses and management measures of the different zones in the marine protected/managed areas.

Uses/Zones	CZ	BZ	MZ
Sportive fishing (nets, traps)	N	N	N
Debris, trash storage on shore	N	N	N
Aquaculture (inshore cages)	N	N	Y
Industry	N	N	$Y_{(1)}$
Spearfishing	N	N	$Y_{(2)}$
Dredging	N	N	$Y_{(1)}$
Sewage dumping	N	N	$Y_{(3)}$
Boating	N	Y	Y
Beaching/swimming	N	Y	Y
Snorkelling	N	Y	Y
Littoral urbanisation	N	$Y_{(4)}$	$Y_{(4)}$
Sportive ports	N	$Y_{(5)}$	$Y_{(5)}$
Fishery port	N	$Y_{(5)}$	$Y_{(5)}$
Mooring	N	$Y_{(6)}$	Y
Professional fishing	N	$Y_{(7)}$	$Y_{(7)}$
Shore angling	N	$Y_{(2)}$	Y
Research/education	Y	Y	Y
Scuba diving	$Y_{(2)}$	Y	Y
Tourism, visitors	$Y_{(8)}$	Y	Y

Zones : (CZ) core zone; (BZ) buffer zone; (MZ) multi-use zone. Uses: (Y) permitted; (N) forbidden.
Legend of notes (numbers in brackets): (1) to establish anti-pollution measures and the rigorous control of the discards;
(2) with license/permit; (3) sewage treatment by depuration plant (all of the area); control of the ballast waters;
(4) integrated coastal zone management (more than 100m to shore-line); (5) only in the actual situation;
(6) establishment of mooring zones; (7) permitted with gear restrictions (no monofilament nets); (8) control of visits.

8.3 SURFACE COVER OF MARINE PROTECTED/MANAGED AREAS

The Table 8.2 summarizes the protected surface of the different zones, in function of the protection levels (core, buffer educational and multi-use zones).

The coast line from Lebanon is 225 km, and considering 3 km from the shore to open sea (reaching the isobath 50 m depth), that means 675 km^2. The present proposal of MPA network to Lebanon (Fig. 8.6), as the result of the MedMPAnet project with the 2012, 2013 and 2016 missions, will suppose about the 11.5 % of its marine environment with a measure of protection.

Table 8.2. Surface (in km^2) of the possible MPAs from Batroun-Byblos, according to the different management zones.

Zones	Core Zones	Buffer Zones	Educational zones	Multi-use Zones	Total
Batroun-Medfoun	0.75	1.00	0.30	30.00	32.05
Byblos	0.75	0.50	0.30	10.00	11.55
Total	**1.50**	**1.50**	**0.60**	**40.00**	**43.60**
%	**3.40**	**3.40**	**1.40**	**91.80**	**100**

Figure 8.6. MPA network (MedMPAnet project), north to south: (E-R) Enfeh-Ras Chekaa; (Ba-M) Batroun-Medfoun; (By) Byblos; (R) Raoucheh; (S) Saida; (T) Tyr; (N) Nakoura.

Extrapoling the protection results to the rest of the proposed RAC/SPA-UNEP/MAP AMPs. 2014), the protected and managed areas, according the IUCN categories, would be (Table 8.3):

Table 8.3. Surface (in km^2) of the possible MPAs from Lebanon, according to the different management zones.

Zones	I	III	IV	VI	Total
Enfeh	-	-	4.00	-	4
Enfeh-Ras Chekaa	-	-	-	15.00	15.00
Ras Chekaa	10.00	-	6.00	-	16.00
Batroun-Medfoun	0.75	?	1.00	30.00	31.75
Byblos	0.75	-	0.50	10.00	11.25
Raoucheh	-	1.00	-	-	1.00
Saida	-		1.00	7	8.00
Tyr Springs	1,75	?	3,25	-	5.00
Tyr	-	-	10.00	20.00	30.00
Nakoura	9.00	-	21.00	25.00	55.00
Total	**22.25**	**1.00**	**46.75**	**107.00**	**177.00**
% Lebanon (675 km^2)	**3.30**	**0.15**	**6.93**	**15.85**	**26.23**

a) Strict protected areas or core zones (IUCN category: I): 22.25 km^2 (4.94 %).

b) Natural monument or feature (IUCN category: III): 1 km^2 (0.2 %). This is the case of Raoucheh, but could also be contemplated Tyr Springs and Byblos rocky outcrop.

c) Habitat/species management area or buffer zones (IUCN category IV): 45.75 km^2 (10.37 %).

d) Protected areas with sustainable use of natural resources or multi-use zones (IUCN category VI): 107 km^2 (23.78 %).

If we move to the concept of marine protected areas (IUCN categories I, III and IV) and marine managed areas (category VI), the protected marine areas in Lebanon would reach 70 km^2 (10.38 %) and the marine managed areas 107 km^2 (15.85 %), which supposes 26.23 % of the total Lebanon marine surface between 0-50 m depth.

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ANNEXES

Annex I. Stations of the 2016 mission in Lebanon

Station code	Locality	Date 2016	Depth (m)	Lat 34°N (i)	Long 35°E (i)	Lat 34°N (f)	Long 35°E (f)	Observers	Meth.	Observations
Ba-1	Batroun	30.09	11-28	15' 51.60"	38' 11.45"	15' 47.93"	39' 19.99"	AR	Hy	Low rock with Corallinales and Ceramiales
Ba-2	Batroun	30.09	20-46	15' 15.38"	38' 11.10"	15' 12.56"	38' 45.64"	O	Hy	Muddy sand and gravel with Caulerpa spp.
Ba-3	Batroun	30.09	20-40	14' 49.33"	37' 52.87"	14' 41.34"	38' 44.74"	C	Hy	Low rock and sand, with Axinella sp. and Caulerpales
M-1	Medfoun	30.09	30 -43	12' 35.77"	36' 55.53"	12' 13.40"	37' 28.92"	AF	Hy	Maerl, grabel, blocks
Ba-4	Batroun	30.09	19-22	15' 17.95"	38' 53.55"	15' 18.76"	39' 03.28"	G,Y,Z	Sc	Rock with Codium parvulum, sand
Ba-5	Batroun	30.09	0-15	15' 22.62"	39' 15.68"	15' 23.07"	39' 20.81"	G,Y,Z	Sc	Rock, blocks and sand, cave
H-1	Batroun	30.09	0-391	14' 46.06"	35'41.18"	-	-	M	CTD	Hydrology
By-1	Byblos	01.10	5-45	08' 47.77"	37' 15.74"	08' 46.92"	37' 32.53"	C	Hy	Gravel and rocky outcrops
By-2	Byblos	01.10	9-42	07' 23.04"	37' 46.57"	07' 21.16"	38' 21.99"	O	Hy	Muddy sand
By-3	Byblos	01.10	4-43	06' 09.57"	38' 23.23"	06' 09.31"	38' 54.32"	AR	Hy	Muddy sand, Cymodocea nodosa
M-2	Medfoun	01.10	17-44	11' 53.12"	37' 03.47"	11' 44.17"	37' 26.2"	AF	Hy	Rock, blocks, gravel
By-4	Byblos	01.10	0-7.	07' 06.99"	38' 35.24"	07' 07.03"	38'35.20"	G,AB	Sc	Sand, blocks, rock, Cystoseira, cave
M-3	Medfoun	01.10	15-43	11' 28.93"	37' 21.82"	11' 08.75"	37' 47.36"	C	Hy	maerl, rock, sand, gravel
M-4	Medfoun	02.10	46-53	11' 53.12"	37' 03.47"	-	-	AF,AR,C,O	Sc,f	Rocks with gravel channels ,¬
M-5	Medfoun	02.10	9-14.	10' 56.93"	37' 48.88"	-	-	AF,AR,C,O	Sc,f	Rock with C. parvulum, Chama and Spondylus, cave
M-6	Medfoun	02.10	13-21,5	12' 29.23"	38' 11.12"	12' 28.69"	38' 14.11"	G,Y	Sc	Rocky outcrops, sand
M-7	Medfoun	02.10	0-13	12' 29.87"	38' 26.07"	12' 24.63"	38' 26.65"	G,Y	Sc	Rocks, blocks, sand, caves
By-5	Byblos	03.10	40-54	06' 30.56"	36' 45.54"	-	-	AF,AR,C,O	Sc,f	Rock, coralligene
By-6	Byblos	03.10	15	07' 02.42"	38' 22.69"	-	-	AF,C,O	Sc,f	Muddy sand
By-7	Byblos, South port	03.10	0-15	06' 59.53"	38' 34.28"	07' 04.90"	38' 37.68"	G,Y	Sc	Sand, blocks, infralapidicola
By-8	Byblos (Fartouch)	03.10	0-7	07' 57.11"	38' 21.52"	08' 00.12"	38' 29.06"	G,Y	Sc	Rock with sand channels
H-2	Byblos	03.10	0-338	06' 16.47'	35' 13.96"	-	-	M	CTD	Hydrology
Ba-6.1	Batroun	04.10	40-50	16' 30.48"	38' 03.00"	-	-	AF,C,O	Sc,f	Rock, coralligenous, cave
K-1	Kfar Abida	04.10	21-23	13' 38.35"	38' 48.20"	-	-	AF,AR,C,O	Sc,f	Rock with Chama, coarse sand, gravel and pebbles
K-2	Kfar Abida	04.10	0-7	13' 21.72"	39' 09.10"	13' 29. 89"	39' 12. 55"	G,Y	Sc	Rock, caves
H-3	Kfar Abida	04.10	0-323	13' 33.32"	35' 30.26"	-	-	M	CTD	Hydrology
R-1	Batroun	04.10	70-80	15' 39.78"	37' 46.62"	-	-	M	ROV	Muddy sand
Ba-6.2	Batroun	05.10	40-50	16' 30.48"	38' 03.00"	-	-	AF,C,O	Sc,f	Rock, coralligenous, cave
Ba-7	Batroun-Medfoun	05.10	30-40	15' 55.2"	38' 11.04"	-	-	AF,C,O	Sc,f	wreck, rock, gravel
K-3	Kfar Abida	05.10	0-8	14' 10.35"	39' 21.13"	14' 01. 63"	39' 14. 24"	G,Y	Sc	Rock, caves
K-4	Kfar Abida	05.10	0-3.	14' 09.17"	39' 22.38"	-	-	AR	Sk	Rock, caves

Station code: (Ba) Batroun, (By) Byblos, (K) Kfar Abida, (M) Medfoun. Latitude (Lat), Longitude (Long); (i) initial, (f) final. Observers: (AF) Aitor, (AR) Alfonso, (C) Carlos, (G) Ghazi, (M) Milad, (O) Oscar, (Y) Yassine, (Z) Ziad. Methods (Meth): (CTD) conductivity- temperature-depth probe, (Hy) hydroplane, (f) fish visual census, (ROV) remote operated vehicle, (Sc) scuba diving, (Sk) snorkeling.

Annex II. Inventory of taxa recorded during the 2016 mission.

TAXA	Authors	Common synonymies, spp. interest	RA
CYANOBACTERIA			
Cyanobacteria spp. (spots)			CC
CHLOROPHYTA			
Bryopsis pennata	J.V.Lamouroux, 1809	NIS-L	C
Bryopsis plumosa	(Hudson) C.Agardh, 1823		R
Caulerpa prolifera	(Forsskål) J.V.Lamouroux, 1809		C
Caulerpa lamourouxi	(Turner) C.Agardh, 1817	*C. racemosa* var. *lamourouxi*, NIS-L	CC
Caulerpa scapelliformis	(R.Brown ex Turner) C.Agardh, 1817	NIS-L	CC
Caulerpa taxifolia var. *distichophylla*	(Sonder) Verlaque et al., 2013	NIS-L	CC
Cladophora pellucida	(Hudson) Kützing, 1843		R
Cladophoropsis sp.			R
Codium arabicum	Kützing, 1856	NIS-L	R
Codium bursa	(Olivi) C.Agardh, 1817		R
Codium parvulum	(Bory ex Audouin) P.C.Silva, 2003	NIS-L	CC
Codium taylori	P.C.Silva, 1960	NIS-L	C
Flabellia petiolata	(Turra) Nizamuddin, 1987	*Udotea petiolata*	R
Palmophyllum crassum	(Naccari) Rabenhorst, 1868		R
Ulva rigida	C.Agardh, 1823		C
OCHROPHYTA			
Cystoseira foeniculacea	(Linnaeus) Greville, 1830	BaC (A-II), MRB	R
Dictyopteris polypodioides	(A.P.De Candolle) J.V.Lamouroux, 1809	*D. membranacea*	RR
Dictyota implexa	(Desfontaines) J.V.Lamouroux, 1809	*D. dichotoma* var. *implexa*	R
Lobophora variegata	(J.V.Lamouroux) Womersley ex E.C.Oliveira, 1977		CC
Padina boergesenii	Allender & Kraft, 1983	NIS-L	C
Padina pavonica	(Linnaeus) Thivy, 1960		R
Sargassum vulgare	C.Agardh, 1820		C
Stypopodium schimperi	(Buchinger) Verlaque & Boudouresque, 1991	NIS-L	RR
RHODOPHYTA			
Acanthophora nayadiformis	(Delile) Papenfuss, 1968	NIS-L	C
Hypoglossum hypoglossoides	(Stackhouse) F.S.Collins & Hervey, 1917		R
Amphiroa beauvoisi	Lamouroux (1816)		R
Amphiroa cryptarthrodia	Zanardini, 1844	*A. rubra*	CC
Amphiroa rigida	J.V.Lamouroux, 1816		CC
Botryocladia botryoides	(Wulfen) Feldmann, 1941		R
Callithamnion granulatum	(Ducluzeau) C.Agardh, 1828		CC
Ceramiales spp.			CC
Ceramial sp. (violet)			R
Corallinales spp.			CC
Ellisolandia elongata	(J.Ellis & Solander) K.R.Hind & G.W.Saunders, 2013	*Corallina elongata*	CC
Galaxaura rugosa	(J.Ellis & Solander) J.V.Lamouroux, 1816	NIS-L	C
Gelidium spinosum	(S.G.Gmelin) P.C.Silva, 1996	*G. latifolium*	C
Halymenia latifolia	P. Crouan & H. Crouan ex Kützing 1866		R

TAXA	Authors	Common synonymies, spp. interest	RA
Heterosiphonia crispella	(C.Agardh) M.J.Wynne, 1985	*H. wurdemannii*	C
Hildenbrandia rubra	(Sommerfelt) Meneghini, 1841		C
Irvinea boergesenii	(Feldmann) R.J.Wilkes, L.M.McIvor & Guiry, 2006	*Botryocladia boergesenii*	R
Jania rubens	(Linnaeus) J.V.Lamouroux, 1816		CC
Jania sp.			C
Laurencia obtusa	(Hudson) J.V.Lamouroux, 1813		C
Lithophyllum incrustans	Philippi, 1837		CC
Lithophyllum papillosum	(Zanardini ex Hauck) Foslie 1900		C
Lithophyllum stictaeforme	(J.E. Areschoug) Hauck, 1877		CC
Lithophyllum sp.			CC
Lithothamnion corallioides	P.L.Crouan & H.M.Crouan, 1867	HD (A-V), MRB	R
Lithothamnion sp.			R
Lophocladia lallemandii	(Montagne) F.Schmitz, 1893	NIS-L	C
Mesophyllum alternans	(Foslie) Cabioch & Mendoza, 1998		C
Mesophyllum sp.			CC
Neogoniolithon brassica-florida	(Harvey) Setchell & L.R.Mason, 1943	*N. notarisii*	C
Neogoniolithon mamillosum	(Hauck) Setchell & L.R.Mason, 1943		CC
Palisada perforata	(Bory de Saint-Vincent) K.W.Nam, 2007	*Laurencia papillosa*	C
Peyssonnelia rosa-marina	Boudouresque & Denizot, 1973		CC
Peyssonnelia rubra	(Greville) J.Agardh, 1851		CC
Peyssonnelia spp.			CC
Schottera nicaeensis	(J.V. Lamouroux ex Duby) Guiry & Hollenberg, 1975	*Petroglossum nicaeensis*	R
Tricleocarpa gracilis	(Linnaeus) Huisman & R.A.Townsend, 1993	*Galaxaura oblongata*	C
Womersleyella setacea	(Hollenberg) R.E.Norris, 1992	NIS ?	C
Rhodoliths			CC
MAGNOLIOPHYTA			
Cymodocea nodosa	(Ucria) Ascherson, 1870		RR
FORAMINIFERA			
Amphistegina lobifera	Larsen, 1976	NIS-L	CC
PORIFERA			
Calcarea			
Borojevia cf. cerebrum	(Haeckel, 1872)	*Clathrina cerebrum*	CC
Calcarea spp. (*Vosmaeropsis,Syncetta*)			CC
Clathrina coriacea	(Montagu, 1814)		R
Clathrina sp. (pink)			RR
Paraleucilla magna	Klautau, Monteiro & Borojevic, 2004	NIS-A	R
Sycon spp.			CC
Demospongiae			
Acanthella acuta	Schmidt, 1862		RR
Agelas oroides	(Schmidt, 1864)		C
Aplysina aerophoba	Nardo, 1833	*Verongia aerophoba*, BaC(A-II),BeC(A-II)	CC
Aplysina sp.		BaC (A-II), BeC (A-II)	R
Aplysilla rosea ?	(Barrois, 1876)		RR

TAXA	Authors	Common synonymies, spp. interest	RA
Aplysilla sulfurea	Schulze, 1878		C
Aplysilla sp.			C
Axinella brondstedi ?	Bergquist, 1970	*A. verrucosa*	RR
Axinella damicornis	(Esper, 1794)	*Cymbaxinella damicornis*	C
Axinella polypoides	Schmidt, 1862	BaC (A-II), BeC (A-II)	C
Axinella spp.			CC
Chondrilla nucula	Schmidt, 1862		CC
Chondrosia reniformis	Nardo, 1847		CC
Ciocalypta carballoi	Vacelet et al. 2007		RR
Cliona carteri	(Ridley, 1881)		R
Cliona celata	Grant, 1826		R
Cliona parenzani	Corriero & Scalera-Liaci, 1997		C
Cliona viridis	(Schmidt, 1862)		C
Corticium candelabrum	Schmidt, 1862		R
Crambe crambe	(Schmidt, 1862)		CC
Cymbaxinella sp.			R
Demospongia sp.1 (blue)			R
Demospongia sp.2			R
Demospongia sp.3			R
Demospongia sp.4			R
Diplastrella spp.			CC
Dysidea avara	(Schmidt, 1862)		R
Haliclona fulva	(Topsent, 1893)		CC
Haliclona sp.			R
Hexadella racovitzai	Topsent, 1896		R
Hippospongia communis	(Lamarck, 1814)	BaC (A-III), BeC (A-III)	RR
Ircinia oros	(Schmidt, 1864)		RR
Ircinia cf. retidermata	Pulitzer-Finali & Pronzato, 1981		R
Ircinia sp. (yellow)			CC
Levantiniella levantinensis	(Vacelet, Bitar, Carteron, Zibrowius & Pérez, 2007)	*Cinachyrella levantinensis*	C
Mycale spp.			CC
Myrmekioderma spelaeum	(Pulitzer-Finali, 1983)		R
Myxilla sp. ?			R
Niphates toxifera	Vacelet et al, 2007		C
Oscarella lobularis	(Schmidt, 1862)		R
Petrosia ficiformis	(Poiret, 1789)	*P. dura*	CC
Phorbas fictitius ?	(Bowerbank, 1866)	*Anchinoe fictitius*	R
Phorbas tenacior	(Topsent, 1925)	*Anchinoe tenacior*	C
Phorbas topsenti	Vacelet & Perez, 2008	*part. P. tenacior*	CC
Poecilloscleridae sp.			C
Raspaciona aculeata	(Johnston, 1842)		C
Sarcotragus spinosulus	Schmidt, 1862		C
Spirastrella cunctatrix	Schmidt, 1868		C

TAXA	Authors	Common synonymies, spp. interest	RA
Spongia officinalis	Linnaeus, 1759	*Euspongia officinalis,* BaC(A-III),BeC(AIII)	C
Spongia sp.			R
Terpiops sp.			CC
CNIDARIA			
Hydrozoa			
Aglaophenia kirchenpaueri	(Heller, 1868)		C
Aglaophenia picardi	Svoboda, 1979		C
Aglaophenia spp.			C
Eudendrium merulum	Watson, 1985		C
Eudendrium racemosum	(Cavolini, 1785)		C
Eudendrium spp.			CC
Macrorhynchia philippina	Kirchenpauer, 1872	*Lytocarpus philippinus*, NIS-L	CC
Pennaria disticha	(Goldfuss, 1820)		CC
Sertularia marginata	(Kirchenpauer, 1864)		R
Anthozoa			
Actinia equina	(Linnaeus, 1758)		R
Bunodeopsis strumosa	Andrès, 1881		C
Caryophyllia cf. inornata	(Duncan, 1878)		RR
Cladocora caespitosa	(Linnaeus, 1767)	CBa (A-II), WC (A-II)	RR
Madracis phaerensis	(Heller, 1868)		CC
Oculina patagonica	de Angelis, 1908	NIS-A	C
Phyllangia americana mouchezii	(Lacaze-Duthiers, 1897)	*P. mouchezi, WC (A-II)*	C
Polycyathus muellerae	(Abel, 1959)		C
CTENOPHORA			
Mnemiopsis leidyi	A. Agassiz, 1865	NIS-A	R
POLYCHAETA			
Errantia			
Hermodice carunculata	(Pallas, 1766)		CC
Sedentaria			
Branchiomma bairdi	(McIntosh, 1885)		R
Janua sp.			2
Protula intestinum	(Lamarck, 1818)		RR
Sabella pavonina	Savigny, 1822		R
Sabella spallanzanii	(Gmelin, 1791)	Spirographis spallanzani	RR
Sabellidae spp.			C
Serpulidae spp.			CC
Spirobranchus lamarcki	(Quatrefages, 1866)	NIS-L	R
Spirorbis spp.			C
CRUSTACEA			
Cirripedia			
Balanus trigonus	Darwin, 1854	NIS-L	C
Balanus spp.			CC
Chthamalus montagui	Southward, 1976		CC

TAXA	Authors	Common synonymies, spp. interest	RA
Chthamalus stellatus	(Poli, 1795)		CC
Perphoratus perforatus	(Bruguière, 1789)	*Balanus perforatus*	CC
Isopoda			
Ligia italica	Fabricius, 1798		CC
Decapoda			
Atergatis roseus	(Rüppell, 1830)	NIS-L	C
Calcinus tubularis	(Linnaeus, 1767)	*C. ornatus*	CC
Charybdis hellerii	(A. Milne-Edwards, 1867)	NIS-L	R
Clibanarius erythropus	(Latreille, 1818)	*C. misanthropus*	C
Dardanus arrosor	(Herbst, 1796)		RR
Diogenes pugilator	(Roux, 1829)		CC
Eriphia verrucosa	(Forskål, 1775)	*E. spinifrons*	C
Gebiidea spp.			R
Halimede tyche (tests)	(Herbst, 1801)	NIS-L	R
Liocarcinus vernalis	(Risso, 1827)	*Macropipus vernalis*	R
Pachygrapsus marmoratus	(Fabricius, 1787)		C
Pagurus anachoretus	Risso, 1827	*Eupagurus anachoretes*	C
Percnon gibbesi	(H. Milne Edwards, 1853)	NIS-A	R
MOLLUSCA			
Gasrtropoda Prosobranchia			
Bittium spp.			CC
Cerithium scabridum	Philippi, 1848	NIS-L	CC
Cerithium vulgatum (shells)	Bruguière, 1792		RR
Conomurex persicus	(Swainson, 1821)	NIS-L	CC
Cypaeidae sp.			R
Dendropoma petraeum	(Monterosato, 1884)	BaC (A-II), BeC (A-II)	C
Echinolittorina punctata	(Gmelin, 1791)	*Littorina punctata*	CC
Ergalatax junionae	Houart, 2008	*E. obscura*, NIS-L	CC
Haliotis tuberculata (shells)	Linnaeus, 1758	*H. lamellosa*	RR
Mangelia sp.			R
Melarhaphe neritoides	(Linnaeus, 1758)	*Littorina neritoides*	CC
Nassarius circumcinctus	(A. Adams, 1852)		C
Neverita josephinia (shells)	Risso, 1826		R
Phorcus turbinatus	(Born, 1778)	*Osilinus turbinatus, Monodonta turbinata*	CC
Patella caerulea	Linnaeus, 1758		CC
Patella rustica	Linnaeus, 1758	*P. lusitanica*	CC
Patella ulyssiponensis	Gmelin, 1791		CC
Purpuradusta gracilis	(Gaskoin, 1849) (shell)		R
Rhinoclavis kochi	(Philippi, 1848)		CC
Tonna galea (shell)	(Linnaeus, 1758)	BaC (A-II), BeC (A-II)	RR
Tritia gibbosula	(Linnaeus, 1758)	*Nassarius gibbosulus*	C
Tritia mutabilis	(Linnaeus, 1758)	*Nassarius mutabilis*	C
Trochus erithreus	Brocchi, 1821	*Infundibulum erythraeum*, NIS-L	C

TAXA	Authors	Common synonymies, spp. interest	RA
Thylacodes arenarius	(Linnaeus, 1767)	*Serpulorbis arenarius, Vermetus gigas*	C
Vermetus triquetrus	Bivona-Bernardi, 1832	*V. triqueter*	C
Gastropoda Opisthobranchia			
Berthellina citrina	(Rüppell & Leuckart, 1828)		R
Bulla striata (shells)	Bruguière, 1792		R
Caloria indica	(Bergh, 1896)	NIS-L	R
Elysia grandifolia	Kelaart, 1858	*NIS-L*	CC
Goniobranchus annulatus	(Eliot, 1904)	NIS-L	C
Philineglossidae sp. ?			R
Spurilla cf. *neapolitana*	(Delle Chiaje, 1841)		R
Bivalvia			
Acanthocardia tuberculata (shells)	(Linnaeus, 1758)		CC
Anomia ephippium (shells)	Linnaeus, 1758		C
Arca noae (shells)	Linnaeus, 1758		C
Atlantella pulchella (shells)	(Lamarck, 1818)	*Tellina pulchella*	C
Brachidontes pharaonis	(P. Fischer, 1870)	*NIS-L*	CC
Chama pacifica	Broderip, 1835	*NIS-L*	CC
Dendostrea frons	(Linnaeus, 1758)	NIS-L	CC
Donax semistriatus (shells)	Poli, 1795		C
Flexopecten glaber	(Linnaeus, 1758)	*Chlamys glabra*	R
Gafrarium savignyi (shells)	(Jonas, 1846)	NIS-L	R
Glycymeris bimaculata	(Poli, 1795)		C
Glycymeris glycymeris	(Linnaeus, 1758)		C
Glycymeris sp.			CC
Lioberus agglutinans (shells)	(Cantraine, 1835)	*Amygdalum agglutinans*	C
Lioberus sp.			C
Lithophaga lithophaga	(Linnaeus, 1758)	*BaC (A-II), BeC (A-II)*	R
Loripes orbiculatus (shells)	Poli, 1791		C
Mactra stultorum (shells)	(Linnaeus, 1758)	*M. corallina*	C
Malleus regulus	(Forsskål in Niebuhr, 1775)	*Malvufundus regula, NIS-L*	CC
Polititapes aureus (shells)	(Gmelin, 1791)	*Paphia aurea, Venerupis aurea*	C
Petricola lithophaga	(Retzius, 1788)		C
Pinctada imbricata radiata	(Leach, 1814)	Pinctada radiata, NIS-L	C
Pitar rudis (shells)	(Poli, 1795)		C
Spisula subtruncata (shells)	(da Costa, 1778)		C
Spondylus groschi ?	Lamprell & Kilburn, 1995	NIS-L	R
Spondylus spinosus	Schreibers, 1793	NIS-L	CC
Striarca lactea	(Linnaeus, 1758)	*Arca lactea*	C
Venus verrucosa (shells)	Linnaeus, 1758		R
Venus sp.			C
Cephalopoda			
Loligidae sp.			R

TAXA	Authors	Common synonymies, spp. interest	RA
BRYOZOA			
Calpensia nobilis	(Esper, 1796)		R
Cellepora sp.			R
Cradoscrupocellaria cf. reptans	(Linnaeus, 1758)	*Scrupocellaria reptans*	C
Crisia sp.			C
Entalophoroecia sp.			C
Frondipora verrucosa	(Lamouroux, 1821)		R
Margaretta cereoides	(Ellis & Solander, 1786)		C
Nolella sp.			C
Parasmittina spp.			C
Reptadeonella violacea	(Johnston, 1847)		**C**
Schizoporella errata	(Waters, 1878)		CC
Schizoretepora hassi	Harmelin, Bitar & Zibrowius, 2007		C
ECHINODERMATA			
Asteroidea			
Coscinasterias tenuispina	(Lamarck, 1816)		RR
Echinoidea			
Brissus unicolor (tests)	(Leske, 1778)		C
Echinocardium mediterraneum (tests)	(Forbes, 1844)		C
Echinocyamus pusillus (tests)	(O.F. Müller, 1776)		C
Holothuroida			
Holothuria sanctori	Delle Chiaje, 1823		R
Holothuria tubulosa	Gmelin, 1791		C
Synaptula reciprocans	(Forskal, 1775)	NIS-L	CC
Ophiuroidea			
Ophiocoma scolopendrina	(Lamarck, 1816)	NIS-L	R
Ophiothrix fragilis	(Abildgaard in O.F. Müller, 1789)		R
CHORDATA			
Ascidiacea			
Botrylloides cf. leachii	(Savigny, 1816)		C
Botrylloides sp. 1			C
Botryllus sp.			R
Cystodytes dellechiajei (browm)	(Della Valle, 1877)		R
Cystodytes dellechiajei (greenish)	(Della Valle, 1877)		C
Cystodytes dellechiajei (violet)	(Della Valle, 1877)		CC
Didemnidae sp.1 (orange)			CC
Didemnidae sp.2 (pink)			C
Didemnidae sp.3 (yellow)			CC
Didemnidae sp.4 (white)			CC
Didemnum coriaceum (Drasche, 1883)			R
Didemnum fulgens	(Milne Edwards, 1841)		**C**
Herdmania momus (Savigny, 1816)		*Pyura momus,* NIS-L	CC
Lissoclinum perforatum	(Giard, 1872)	*L. pseudoleptoclinum*	R

TAXA	Authors	Common synonymies, spp. interest	RA
Microcosmus exasperatus	Heller, 1878	NIS-L	CC
Phallusia nigra	Savigny, 1816	NIS-L	CC
Polyclinidae sp.			R
Pyura dura	(Heller, 1877)		C
Rhodosoma turcicum	(Savigny, 1816)	part. R. *verecundum*, NIS-L	R
Stolidobranchia sp. (red)			R
Symplegma brakenhielmi	(Michaelsen, 1904)	NIS-L	C
PISCES			
Elasmobranchii			
Dasyatis pastinaca	(Linnaeus, 1758)		C
Aetomylaeus bovinus	(Geoffroy Saint-Hilaire, 1817)	*Pteromylaeus bovinus*	RR
Taeniura grabata	(E. Geoffroy Saint-Hilaire, 1817)		RR
Actinopterygii			
Alepes sp.		NIS-L	C
Apogon imberbis	(Linnaeus, 1758)		R
Apogonichthyoides nigripinnis	(Cuvier, 1828)	*Apogon nigripinnis*, NIS-L	R
Atherinomorus lacunosus	(Forster, 1801)		CC
Balistes capriscus	Gmelin, 1789	*B. carolinensis*	R
Belone belone (Linnaeus, 1761)			C
Blenniidae sp.			C
Boops boops	(Linnaeus, 1758)		CC
Caranx chrysos	(Mitchill, 1815)		CC
Cheilodipterus novemstriatus	(Rüppell, 1838)	NIS-L	CC
Chomis chromis	(Linnaeus, 1758)		CC
Coris julis	(Linnaeus, 1758)		CC
Diplodus cervinus	(Lowe, 1838)		C
Diplodus puntazzo	(Walbaum, 1792)	*Puntazzo puntazzo*	RR
Diplodus sargus	(Linnaeus, 1758)		CC
Diplodus vulgaris	(Geoffroy Saint-Hilaire, 1817)		CC
Dussumieria elopsoides ?	Bleeker, 1849	NIS-L	C
Echeneis naucrates	Linnaeus, 1758		R
Epinephelus costae	(Steindachner, 1878)	*E. alexandrinus*	C
Epinephelus marginatus	(Lowe, 1834)	*E. guaza*, BaC (A-III), BeC (A-III)	C
Fistularia commersonii	Rüppell, 1835	NIS-L	C
Gobius bucchichii	Steindachner, 1870		CC
Gobius paganellus	Linnaeus, 1758		RR
Gymnothorax unicolor	(Delaroche, 1809)		R
Lithognathus mormyrus	(Linnaeus, 1758)		CC
Mugilidae spp.			CC
Mullus surmuletus	Linnaeus, 1758		C
Muraena helena	Linnaeus, 1758		C
Mycteroperca rubra	(Bloch, 1793)		C
Oblada melanura	(Linnaeus, 1758)		CC

TAXA	Authors	Common synonymies, spp. interest	RA
Pagrus auriga	Valenciennes, 1843	*Sparus auriga*	RR
Parablennius zvonimiri	(Kolombatovic, 1892)	*Blennius zvonimiri*	C
Plotosus lineatus	(Thunberg, 1787)	NIS-L	CC
Pempheris vanicolensis	Cuvier, 1831	NIS-L	CC
Pomadasys incisus	(Bowdich, 1825)	*Pomadasis bennettii*	C
Pteragogus pelycus	Randall, 1981	NIS-L	C
Pteragogus trispilus	Randall, 2013	NIS-L	R
Pterois miles	(Bennett, 1828)	NIS-L	C
Sargocentrum rubrum	(Forsskål, 1775)	NIS-L	CC
Scaridae sp.		NIS-L	RR
Scorpaena maderensis	Valenciennes, 1833		C
Scorpaena porcus	Linnaeus, 1758		R
Seriola dumerili	(Risso, 1810)		R
Serranus cabrilla	(Linnaeus, 1758)		CC
Serranus scriba	(Linnaeus, 1758)		CC
Siganus luridus	(Rüppell, 1829)	NIS-L	CC
Siganus rivulatus	Forsskål, 1775	NIS-L	CC
Sparisoma cretense	(Linnaeus, 1758)	*Scarus cretensis*	CC
Spicara smaris	(Linnaeus, 1758)		C
Stephanolepis diaspros	Fraser-Brunner, 1940	NIS-L	C
Symphodus ocellatus	(Linnaeus, 1758)	*Crenilabrus ocellatus*	RR
Symphodus roissali	(Risso, 1810)	*Crenilabrus quinquemaculatus*	R
Symphodus tinca	(Linnaeus, 1758)	*Crenilabrus tinca*	C
Thalassoma pavo	(Linnaeus, 1758)		CC
Torquigener flavimaculosus	Hardy & Randall, 1983	NIS-L	CC
Tripterygion melanurum	Guichenot, 1850	*T. minor*	C
Tripterygion tripteronotum	(Risso, 1810)		R
Upeneus pori	Ben-Tuvia & Golani, 1989	NIS-L	R
Xyrichtys novacula	(Linnaeus, 1758)		CC
Reptilia			
Chelonia mydas	(Linnaeus, 1758)		R

Annex III. Taxa/station

ANNEX III-1 : BATROUN (STATIONS, SEE ANNEX I).

Locality code (Batroun)	Ba-1	Ba-2	Ba-3	Ba-4	Ba-5	Ba-6.1	Ba-6.2	Ba-7	Ba
Nº Station	1	2	3	5	6	21	24	25	8 st.
Depth (m)	11-28	20-46	20-40	19-22	0-15	40-50	40-50	30-40	0-50
CYANOBACTERIA									
Cyanobacteria spp. (spots)	-	-	-	2	-	-	-	-	2
CHLOROPHYTA									
Bryopsis plumosa	-	-	-	-	1	-	-	-	1
Caulerpa lamourouxi	3	3	3	1	1	-	-	-	11
Caulerpa scapelliformis	3	3	1	-	-	-	-	-	7
Caulerpa taxifolia var. *distichophylla*	-	-	-	-	1	-	-	-	1
Codium arabicum	-	-	-	-	2	-	-	-	2
Codium bursa	-	2	-	-	-	-	-	-	2
Codium parvulum	3	-	-	3	3	-	-	-	9
Flabellia petiolata	-	-	-	-	-	1	-	-	1
Palmophyllum crassum	-	-	-	-	-	2	-	-	2
OCHROPHYTA									
Cystoseira foeniculacea	2	-	-	2	-	-	-	-	4
Lobophora variegata	-	-	-	1	2	-	-	2	5
Padina boergesenii	-	-	-	-	2	-	-	-	2
RHODOPHYTA									
Hypoglossum hypoglossoides	-	-	-	-	-	2	2	-	4
Amphiroa cryptarthrodia	-	-	-	3	3	-	-	-	6
Amphiroa rigida	-	-	-	3	3	-	-	-	6
Ellisolandia elongata	-	-	-	-	3	-	-	-	3
Galaxaura rugosa	-	-	-	-	1	-	-	-	1
Jania rubens	-	-	-	-	3	-	-	-	3
Lithophyllum incrustans	-	-	-	-	3	-	-	-	3
Lithophyllum stictaeforme	-	-	-	-	2	3	2	-	7
Lithophyllum sp.	-	-	-	3	-	-	-	-	3
Mesophyllum sp.	-	-	-	3	-	3	3	-	9
Neogoniolithon mamillosum	-	-	-	3	-	3	2	3	11
Peyssonnelia rosa-marina	-	-	-	-	-	3	1	-	4
Peyssonnelia rubra	-	-	-	-	3	3	-	1	7
Peyssonnelia spp.	-	-	-	2	3	-	-	-	5
Tricleocarpa gracilis	-	-	-	-	1	-	-	-	1
Womersleyella setacea	-	-	-	-	-	3	3	-	6
Rhodoliths	2	-	-	-	-	-	-	1	3
FORAMINIFERA									
Amphistegina lobifera	-	-	-	3	3	-	-	-	6
PORIFERA									
Calcarea									
Borojevia cf. *cerebrum*	-	-	-	-	3	-	-	-	3
Calcarea spp. *(Vosmaeropsis, Syncetta)*	-	-	-	-	3	-	3	-	6
Sycon spp.	-	-	-	2	3	2	2	2	11

Locality code (Batroun)	Ba-1	Ba-2	Ba-3	Ba-4	Ba-5	Ba-6.1	Ba-6.2	Ba-7	Ba
Demospongiae									
Acanthella acuta	-	-	-	-	-	1	-	-	1
Agelas oroides	-	-	-	-	-	1	2	-	3
Aplysina aerophoba	2	-	-	2	2	-	1	3	10
Aplysilla sulfurea	-	-	-	-	-	2	1	-	3
Aplysilla sp.	-	-	-	-	-	-	-	3	3
Axinella damicornis	-	-	-	-	-	2	2	-	4
Axinella polypoides	-	-	-	-	-	3	3	-	6
Axinella spp.	1	-	2	1	-	3	-	2	9
Chondrilla nucula	-	-	-	1	-	-	-	-	1
Chondrosia reniformis	-	-	-	-	2	-	1	-	3
Ciocalypta carballoi	2	-	-	1	-	-	-	-	3
Cliona parenzani	-	-	-	-	2	-	-	-	2
Cliona viridis	-	-	-	-	2	-	-	-	2
Corticium candelabrum	-	-	-	-	-	2	-	-	2
Crambe crambe	3	-	-	3	3	3	2	3	17
Demospongia sp. 2	-	-	-	-	-	-	1	-	1
Diplastrella spp.	-	-	-	-	1	2	2	-	5
Haliclona fulva	-	-	-	-	1	3	2	-	6
Hexadella racovitzai	-	-	-	-	-	1	-	-	1
Ircinia cf. retidermata	-	-	-	1	-	-	-	-	1
Ircinia sp. (yellow)	2	-	-	2	-	1	-	1	6
Levantiniella levantinensis	1	-	-	1	-	-	-	-	2
Mycale spp.	-	-	-	-	2	1	2	-	5
Myrmekioderma spelaeum	-	-	-	-	-	-	1	-	1
Niphates toxifera	-	1	-	2	-	3	2	-	8
Oscarella lobularis	-	-	-	-	-	1	-	-	1
Petrosia ficiformis	-	-	-	1	1	3	2	-	7
Phorbas fictitius ?	-	-	-	-	-	2	-	-	2
Phorbas tenacior	-	-	-	-	-	2	-	-	2
Phorbas topsenti	-	-	-	3	2	2	1	3	11
Raspaciona aculeata	-	-	-	-	-	2	-	-	2
Sarcotragus spinosulus	1	-	-	1	-	-	-	-	2
Spirastrella cunctatrix	-	-	-	-	2	2	1	-	5
Spongia officinalis	-	-	-	-	1	-	2	-	3
Terpiops sp.	-	-	-	-	2	2	-	-	1
CNIDARIA									
Hydrozoa									
Eudendrium spp.	2	-	-	3	2	3	2	3	15
Macrorhynchia philippina	-	-	-	-	3	-	-	-	3
Pennaria disticha	-	-	-	-	3	-	-	2	5
Anthozoa									
Madracis phaerensis	-	-	-	-	2	3	1	-	6
Phyllangia americana mouchezii	-	-	-	-	-	3	-	-	3
Polycyathus muellerae	-	-	-	-	1	1	-	-	2

Locality code (Batroun)	Ba-1	Ba-2	Ba-3	Ba-4	Ba-5	Ba-6.1	Ba-6.2	Ba-7	Ba
POLYCHAETA									
Errantia									
Hermodice carunculata	-	-	-	-	3	2	2	3	10
Sedentaria									
Protula intestinum	-	-	-	-	-	1	-	-	1
Sabella pavonina	-	3	-	-	-	-	-	-	3
Sabella spallanzanii	-	-	-	-	-	-	1	-	1
Sabellidae spp.	-	-	-	1	-	-	-	-	1
Serpulidae spp.	-	-	-	-	3	3	3	-	9
CRUSTACEA									
Cirripedia									
Balanus spp.	-	-	-	3	3	-	-	2	8
Perphoratus perforatus	-	-	-	-	3	-	-	-	3
Decapoda									
Atergatis roseus	-	-	-	-	1	-	-	-	1
Calcinus tubularis	-	-	-	-	1	-	-	-	1
Dardanus arrosor	-	-	-	-	-	-	1	-	1
Halimede tyche (test)	-	-	-	-	1	-	-	-	1
MOLLUSCA									
Gasrtropoda Prosobranchia									
Cerithium scabridum	-	-	-	-	3	-	-	-	3
Conomurex persicus	-	-	-	1	2	-	-	-	3
Ergalatax junionae	-	-	-	-	2	-	-	-	2
Neverita josephinia (shells)	-	-	-	1	-	-	-	-	1
Rhinoclavis kochi	-	-	-	1	-	-	-	-	1
Serpuloides arenarius	-	-	-	-	-	1	2	-	3
Gastropoda Opisthobranchia									
Elysia grandifolia	-	-	-	1	2	-	-	-	3
Bivalvia									
Arca noae (shells)	-	-	-	-	-	-	-	1	1
Chama pacifica	3	-	-	3	3	1	1	2	13
Dendostrea frons	2	-	-	2	2	-	-	-	6
Glycymeris bimaculata	-	-	-	1	-	-	-	-	1
Glycymeris glycymeris	-	-	-	1	-	-	-	-	1
Lioberus sp.	-	-	-	1	-	-	-	-	1
Lithophaga lithophaga (shells)	-	-	-	-	1	-	-	-	1
Malleus regulus	-	-	-	3	3	3	-	2	11
Polititapes aureus (shell)	-	-	-	1	-	-	-	-	1
Pinctada imbricata radiata	-	-	-	1	1	-	-	-	2
Spondylus groschi ?	-	-	-	-	1	1	-	-	2
Spondylus spinosus	2	-	-	1	3	2	-	2	10
Venus verrucosa (shells)	-	-	-	1	-	-	-	-	1
Cephalopoda									
Loligidae sp.	-	-	-	-	1	-	-	-	1

Locality code (Batroun)	Ba-1	Ba-2	Ba-3	Ba-4	Ba-5	Ba-6.1	Ba-6.2	Ba-7	Ba
BRYOZOA									
Crisia sp.	-	-	-	-	3	-	-	-	3
Entalophoroecia sp.	-	-	-	-	2	-	-	-	2
Nolella sp.	-	-	-	-	3	-	-	-	3
Schizoretepora hassi	-	-	-	-	-	3	2	-	5
ECHINODERMATA									
Holothuroida									
Synaptula reciprocans	3	-	1	-	-	1	-	1	6
CHORDATA									
Ascidiacea									
Cystodytes dellechiajei (violet)	-	-	-	-	2	-	-	-	2
Didemnidae sp.1 (orange)	-	-	-	-	3	-	-	-	3
Didemnidae sp.3 (yellow)	-	-	-	-	1	-	-	-	1
Didemnidae sp.4 (white)	-	-	-	1	1	3	-	1	6
Didemnum fulgens	-	-	-	-	-	2	-	-	2
Herdmania momus	-	-	-	-	1	1	1	2	5
Phallusia nigra	-	-	-	1	1	-	-	-	2
Symplegma brakenhielmi	-	-	-	-	1	-	-	-	1
PISCES									
Elasmobranchii									
Dasyatis pastinaca	1	1	-	-	-	-	1		3
Actinopterygii									
Alepes sp.	-	-	-	-	-	-	-	1	1
Apogon imberbis	-	-	-	-	-	1	-	-	1
Balistes capriscus	1	-	-	-	-	-	-	-	1
Cheilodipterus novemstriatus	-	-	-	3	-	2	-	2	7
Chomis chromis	-	-	3	2	3	-	3	3	14
Coris julis	-	-	2	3	2	-	1	3	11
Diplodus cervinus	-	-	-	-	1	-	1	-	2
Diplodus sargus	-	-	-	3	2	2	3	3	13
Diplodus vulgaris	-	-	-	3	2	3	3	3	14
Epinephelus costae	-	-	-	1	-	-	-	-	1
Epinephelus marginatus	-	-	-	1	-	-	-	-	1
Fistularia commersonii	-	-	-	1	-	-	-	-	1
Gobius bucchichii	-	-	-	-	1	-	-	-	1
Lithognathus mormyrus	-	-	-	-	2	-	-	-	2
Mugilidae spp.	-	-	-	2	2	-	-	-	4
Mycteroperca rubra	-	-	-	1	1	-	1	-	3
Oblada melanura	-	-	-	-	3	-	3	2	8
Pagrus auriga	-	-	-	-	-	-	1	-	1
Plotosus lineatus	-	-	-	3	-	-	3	-	6
Pempheris vanicolensis	-	-	-	3	3	-	-	-	6
Pterois miles	-	-	-	-	-	1	1	2	4
Sargocentrum rubrum	-	-	2	2	2	2	3	3	14
Scorpaena maderensis	-	-	-	-	1	1	-	1	3

Locality code (Batroun)	Ba-1	Ba-2	Ba-3	Ba-4	Ba-5	Ba-6.1	Ba-6.2	Ba-7	Ba
Serranus cabrilla	1	-	-	1	1	-	1	2	6
Serranus scriba	-	-	-	2	2	-	-	-	4
Siganus luridus	-	-	1	-	-	-	2	3	6
Siganus rivulatus	2	-	-	3	3	-	2	3	13
Sparisoma cretense	-	-	1	-	-	-	1	3	5
Stephanolepis diaspros	-	-	-	2	1	1	1	-	5
Symphodus tinca	-	-	-	-	1	-	-	-	1
Thalassoma pavo	-	-	-	-	3	-	-	1	4
Torquigener flavimaculosus	3	3	3	3	2	1	-	3	18
Xyrichtys novacula	-	-	1	1	-	-	-	-	2
Species richness (S)	22	7	11	63	88	58	52	38	155
Relative abundance (A)	45	16	20	118	178	117	93	83	667
Margalef' index (MI)	5,52	2,16	3,34	13	16,79	11,97	11,25	8,37	23,68

ANNEX III-2. KFAR ABIDA (STATIONS, SEE ANNEX I)

Locality code (Kfar Abida)	K-1	K-2	K-3	K-4	K
Nº Station	24	25	30	31	4 st.
Depth (m)	21-23	0-7	0-8	0-3	0-23
CYANOBACTERIA					
Cyanobacteria spp. (spots)	-	3	-	3	6
CHLOROPHYTA					
Bryopsis pennata	-	-	-	3	3
Cladophora pellucida	-	1	-	-	1
Cladophoropsis sp.	-	-	-	2	2
Codium parvulum	3	3	3	3	12
Ulva rigida	-	-	-	3	3
OCHROPHYTA					
Lobophora variegata	2	-	2	-	4
Padina boergesenii	-	-	-	1	1
RHODOPHYTA					
Amphiroa cryptarthrodia	2	2	2	2	8
Amphiroa rigida	1	2	-	2	5
Callithamnion granulatum	-	-	-	3	3
Ceramiales spp.	3	3	3	-	9
Ceramial sp. (violet)	2	-	-	-	2
Corallinales spp.	3	-	3	-	6
Ellisolandia elongata	-	3	3	3	9
Galaxaura rugosa	2	2	3	1	8
Jania rubens	-	1	-	3	4
Jania sp.	3	-	-	-	3
Laurencia obtusa	-	-	-	2	2
Lithophyllum incrustans	3	3	3	3	12
Lithophyllum papillosum	-	-	-	3	3
Lithophyllum stictaeforme	-	2	2	3	7
Lithothamnion sp.	-	-	2	-	2
Lophocladia lallemandii	-	-	1	-	1
Mesophyllum sp.	3	2	2	-	7
Neogoniolithon brassica-florida	-	-	-	2	2
Neogoniolithon mamillosum	2	-	2	-	4
Palisada perforata	-	-	-	3	3
Peyssonnelia rubra	-	2	3	3	8
Peyssonnelia spp.	3	3	3	-	9
Tricleocarpa gracilis	-	1	-	-	1
FORAMINIFERA					
Amphistegina lobifera	3	-	-	-	3
PORIFERA					
Calcarea					
Borojevia cf. *cerebrum*	1	2	3	-	6
Calcarea spp. *(Vosmaeropsis, Syncetta)*	2	3	3	3	11

Locality code (Kfar Abida)	K-1	K-2	K-3	K-4	K
Clathrina coriacea	-	1	2	-	3
Clathrina sp. (pink)	-	-	1	-	1
Sycon spp.	2	3	3	-	8
Demospongiae					
Aplysilla rosea ?	-	-	1	-	1
Aplysilla sulfurea	-	-	3	-	3
Aplysilla sp.	2	-	2	-	4
Axinella brondstedi ?	-	-	1	-	1
Axinella damicornis	-	-	1	-	1
Axinella spp.	2	1	2	-	5
Chondrilla nucula	-	3	3	2	8
Chondrosia reniformis	1	3	3	2	9
Cliona celata	-	-	2	-	2
Cliona viridis	-	2	-	-	2
Crambe crambe	3	3	3	3	12
Cymbaxinella sp.	-	-	2	-	2
Demospongia sp. 3	-	-	1	-	1
Diplastrella spp.	-	2	3	-	5
Haliclona fulva	2	2	-	-	4
Haliclona sp.	-	2	-	-	2
Hexadella racovitzai	-	-	1	-	1
Ircinia sp. (yellow)	-	1	2	-	3
Levantiniella levantinensis	-	1	1	-	2
Mycale spp.	-	-	3	2	5
Myrmekioderma spelaeum	-	-	2	-	2
Myxilla sp. ?	-	-	2	-	2
Petrosia ficiformis	3	-	-	-	3
Phorbas tenacior	-	-	1	-	1
Phorbas topsenti	2	2	-	1	5
Raspaciona aculeata	-	1	2	-	3
Sarcotragus spinosulus	-	1	-	-	1
Spirastrella cunctatrix	-	-	1	-	1
Spongia officinalis	-	2	1	-	3
Spongia sp.	-	-	1	-	1
Terpiops sp.	-	2	2	-	4
CNIDARIA					
Hydrozoa					
Aglaophenia picardi	-	-	3	-	3
Eudendrium spp.	2	2	2	-	6
Macrorhynchia philippina	-	3	2	-	5
Pennaria disticha	-	3	2	-	5
Anthozoa					
Actinia equina	-	-	-	1	1
Madracis phaerensis	-	-	2	-	2
Oculina patagonica	-	1	1	2	4

Locality code (Kfar Abida)	K-1	K-2	K-3	K-4	K
Phyllangia americana mouchezii	-	-	1	-	1
Polycyathus muellerae	-	-	3	-	3
POLYCHAETA					
Errantia					
Hermodice carunculata	-	2	3	2	7
Sedentaria					
Janua sp.	-	2	-	-	2
Serpulidae spp.	3	3	3	-	9
Spirobranchus lamarcki	-	2	-	-	2
CRUSTACEA					
Cirripedia					
Balanus spp.	3	3	3	3	12
Chthamalus montagui	-	-	3	3	6
Chthamalus stellatus	-	-	3	3	6
Isopoda					
Ligia italica	-	-	-	3	3
Decapoda					
Atergatis roseus	-	1	-	2	3
Calcinus tubularis	-	-	-	2	2
Charybdis hellerii	-	1	-	-	1
Clibanarius erythropus	-	-	-	3	3
Eriphia verrucosa	-	1	-	2	3
Halimede tyche (tests)	-	1	-	-	1
Pachygrapsus marmoratus	-	-	-	2	2
MOLLUSCA					
Gasrtropoda Prosobranchia					
Cerithium scabridum	1	-	3	-	4
Conomurex persicus	-	-	2	-	2
Dendropoma petraeum	-	-	-	1	1
Echinolittorina punctata	-	-	-	3	3
Ergalatax junionae	1	2	2	2	7
Melarhaphe neritoides	-	-	-	3	3
Phorcus turbinatus	-	-	-	3	3
Patella caerulea	-	-	-	1	1
Patella rustica	-	-	-	2	2
Patella ulyssiponensis	-	-	-	3	3
Vermetus triquetrus	-	2	-	-	2
Gastropoda Opisthobranchia					
Elysia grandifolia	-	1	-	3	4
Bivalvia					
Brachidontes pharaonis	-	-	-	2	2
Chama pacifica	3	2	2	2	9
Dendostrea frons	2	2	-	-	4
Flexopecten glaber	-	-	1	-	1
Lioberus sp.	-	-	2	-	2

Locality code (Kfar Abida)	K-1	K-2	K-3	K-4	K
Malleus regulus	2	-	2	-	4
Spondylus spinosus	3	2	2	2	9
BRYOZOA					
Cellepora sp.	-	-	2	-	2
Margaretta cereoides	-	1	2	-	3
Parasmittina spp.	-	-	2	-	2
Reptadeonella violacea	1	-	-	-	1
Schizoporella errata	-	2	-	-	2
Schizoretepora hassi	-	-	2	-	2
ECHINODERMATA					
Holothuroida					
Holothuria tubulosa	-	-	1	-	1
Ophiuroidea					
Ophiocoma scolopendrina	1	-	-	-	1
CHORDATA					
Ascidiacea					
Botrylloides cf. *leachii*	-	1	-	-	1
Botrylloides sp. 1	-	1	-	-	1
Cystodytes dellechiajei (violet)	-	2	3	2	7
Didemnidae sp.1 (orange)	3	3	2	-	8
Didemnidae sp.3 (yellow)	-	-	1	1	2
Didemnidae sp.4 (white)	3	3	3	-	9
Didemnum coriaceum	-	-	2	-	2
Herdmania momus	1	2	1	-	4
Lissoclinum perforatum	-	-	2	-	2
Phallusia nigra	-	2	2	-	4
Rhodosoma turcicum	-	1	-	-	1
PISCES					
Actinopterygii					
Alepes sp.	-	-	-	1	1
Apogon imberbis	-	-	1	-	1
Atherinomorus lacunosus	-	3	3	-	6
Boops boops	-	-	3	-	3
Caranx chrysos	-	-	3	3	6
Cheilodipterus novemstriatus	3	-	-	-	3
Chomis chromis	1	3	2	-	6
Coris julis	2	1	2	2	7
Diplodus cervinus	-	1	1	-	2
Diplodus sargus	-	2	3	-	5
Diplodus vulgaris	1	2	2	-	5
Dussumieria elopsoides ?	-	3	-	-	3
Epinephelus marginatus	-	1	-	-	1
Fistularia commersonii	-	-	-	1	1
Gymnothorax unicolor	-	1	-	-	1
Lithognathus mormyrus	-	-	-	2	2

Locality code (Kfar Abida)	K-1	K-2	K-3	K-4	K
Mugilidae spp.	-	3	2	-	5
Muraena helena	-	-	1	1	2
Mycteroperca rubra	-	-	-	2	2
Oblada melanura	-	-	2	2	4
Pempheris vanicolensis	-	3	3	3	9
Pteragogus pelycus	1	-	-	-	1
Sargocentrum rubrum	2	3	1	2	8
Scaridae sp.	-	-	1	-	1
Scorpaena maderensis	-	-	1	1	2
Scorpaena porcus	-	1	1	-	2
Serranus scriba	1	2	1	1	5
Siganus luridus	-	2	2	2	6
Siganus rivulatus	-	2	3	3	8
Sparisoma cretense	-	1	1	3	5
Stephanolepis diaspros	-	1	1	-	2
Symphodus tinca	-	1	1	-	2
Thalassoma pavo	3	3	3	3	12
Torquigener flavimaculosus	3	-	-	-	3
Tripterygion melanurum	-	1	-	-	1
Reptilia					
Chelonia mydas (Linnaeus, 1758)	-	-	1	-	1
Species richness (S)	47	84	104	67	166
Relative abundance (RA)	101	164	212	149	628
Margalef' Index (M)	9,97	16,27	19,23	13,15	25,61

ANNEX III-3. MEDFOUN (STATIONS, SEE ANNEX I)

Locality code (Medfoun)	M-1	M-2	M-3	M-4	M-5	M-6	M-7	M
Nº Station	4	11	13	14	15	16	17	7 st.
Depth (m)	30-43	37-44	15-43	46-53	9-14.	13-22	0-13	0-53
CYANOBACTERIA								
Cyanobacteria spp. (spots)	-	-	-	-	-	3	-	3
CHLOROPHYTA								
Caulerpa lamourouxi	-	-	-	-	3	-	-	3
Caulerpa taxifolia var. *distichophylla*	1	-	-	-	-	1	-	2
Cladophora pellucida	-	-	-	-	1	-	-	1
Codium arabicum	-	-	-	-	1	-	-	1
Codium bursa	-	-	-	2	-	-	-	2
Codium parvulum	-	-	-	-	3	3	3	9
Codium taylori	-	-	-	-	-	-	2	2
Flabellia petiolata	-	-	-	2	-	-	-	2
OCHROPHYTA								
Dictyota implexa	-	-	-	-	-	2	-	2
Lobophora variegata	1	-	-	-	1	-	1	3
RHODOPHYTA								
Acanthophora nayadiformis	-	-	-	-	-	-	3	3
Amphiroa beauvoisi	-	-	-	-	-	-	3	3
Amphiroa cryptarthrodia	-	-	-	3	3	-	-	6
Amphiroa rigida	-	-	-	-	3	-	3	6
Botryocladia botryoides	-	-	-	2	-	-	-	2
Ceramiales spp.	-	-	-	-	-	3	-	3
Ellisolandia elongata	-	-	-	-	-	-	3	3
Galaxaura rugosa	-	-	-	-	-	-	1	1
Gelidium spinosum	-	-	-	-	3	-	-	3
Heterosiphonia crispella	-	-	-	-	-	-	2	2
Hildenbrandia rubra	-	-	-	-	-	-	3	3
Irvinea boergesenii	-	-	-	2	-	-	-	2
Jania rubens (Linnaeus)	-	-	-	-	-	-	3	3
Lithophyllum incrustans	-	-	-	-	-	-	3	3
Lithophyllum papillosum	-	-	-	-	-	-	-	-
Lithophyllum stictaeforme	-	-	-	-	-	-	2	2
Lithophyllum sp.	-	-	-	-	2	-	-	2
Lithothamnion corallioides	-	-	-	2	-	-	-	2
Mesophyllum alternans	-	-	-	3	-	-	-	3
Mesophyllum sp.	-	-	-	3	3	3	2	11
Neogoniolithon mamillosum	-	-	-	2	3	3	3	11
Palisada perforata	-	-	-	-	-	-	2	2
Peyssonnelia rosa-marina	-	-	-	2	-	-	2	4
Peyssonnelia rubra	-	-	-	3	-	-	-	3
Peyssonnelia spp.	-	-	-	-	3	-	3	6
Schottera nicaeensis	-	-	-	-	-	-	2	2

Locality code (Medfoun)	M-1	M-2	M-3	M-4	M-5	M-6	M-7	M
Tricleocarpa gracilis	-	-	-	-	-	1	2	3
Rhodoliths	-	3	-	3	-	-	-	6
FORAMINIFERA								
Amphistegina lobifera	-	-	-	-	3	-	-	3
PORIFERA								
Calcarea								
Borojevia cf. cerebrum	-	-	-	-	1	-	3	4
Calcarea spp. (Vosmaeropsis, Syncetta)	-	-	-	-	3	-	3	6
Sycon spp.	-	-	-	1	3	-	2	6
Demospongiae								
Agelas oroides	-	-	-	2	-	-	-	2
Aplysina sp.	-	-	-	-	-	-	3	3
Aplysilla sulfurea	-	-	-	-	-	-	3	3
Aplysilla sp.	-	-	-	-	-	-	3	3
Axinella damicornis	-	-	-	2	-	-	-	2
Axinella polypoides	-	-	-	2	-	-	-	2
Axinella spp.	-	-	1	-	2	-	-	3
Chondrilla nucula	-	-	-	-	-	-	2	2
Chondrosia reniformis	-	-	-	-	-	-	3	3
Cliona parenzani	-	-	-	-	-	-	2	2
Crambe crambe	-	-	-	3	3	3	3	12
Demospongia sp.1	-	-	-	-	-	-	2	2
Haliclona fulva	-	-	-	1	1	-	1	3
Ircinia sp. (yellow)	-	-	-	1	-	-	-	1
Levantiniella levantinensis	-	-	-	-	-	-	1	1
Mycale spp.	-	-	-	-	-	-	1	1
Phorbas fictitius ?	-	-	-	1	-	-	-	1
Phorbas topsenti	-	-	-	1	-	-	1	2
Sarcotragus spinosulus	-	-	-	-	-	-	2	2
Spongia officinalis	-	-	-	-	-	-	1	1
Spongia sp.	-	-	-	-	-	-	1	1
Terpiops sp.	-	-	-	-	2	-	2	4
CNIDARIA								
Hydrozoa								
Aglaophenia kirchenpaueri	-	-	-	3	-	-	-	3
Aglaophenia spp.	-	-	-	2	-	-	-	2
Eudendrium merulum	-	-	-	3	-	-	-	3
Eudendrium spp.	-	-	-	2	3	3	2	10
Macrorhynchia philippina	-	-	-	-	-	1	2	3
Pennaria disticha	-	-	-	-	2	2	3	7
Anthozoa								
Caryophyllia cf. inornata	-	-	-	-	1	-	-	1
Cladocora caespitosa	-	-	-	-	-	-	1	1
Madracis phaerensis	-	-	-	3	-	-	-	3
Oculina patagonica	-	-	-	-	-	-	1	1
Phyllangia americana mouchezii	-	-	-	2	-	-	-	2
Polycyathus muellerae	-	-	-	-	2	-	-	2

Locality code (Medfoun)	M-1	M-2	M-3	M-4	M-5	M-6	M-7	M
POLYCHAETA								
Errantia								
Hermodice carunculata	1	-	-	-	2	-	2	5
CRUSTACEA								
Cirripedia								
Balanus spp.	-	-	-	3	3	2	3	11
Decapoda								
Calcinus tubularis	-	-	-	-	3	-	-	3
Eriphia verrucosa	-	-	-	-	-	-	1	1
Pagurus anachoretus	-	-	-	-	2	-	-	2
Percnon gibbesi	-	-	-	-	-	-	1	1
MOLLUSCA								
Gasrtropoda Prosobranchia								
Bittium spp.	-	-	-	3	-	-	-	3
Cerithium scabridum	-	-	-	-	-	3	-	3
Cerithium vulgatum (shells)	-	-	-	-	-	1	-	1
Conomurex persicus	-	-	-	-	1	2	2	5
Ergalatax junionae	-	-	-	-	2	-	2	4
Haliotis tuberculata (shell)	-	-	-	-	-	1	-	1
Mangelia sp.	-	-	-	-	-	1	-	1
Neverita josephinia (shells)	-	-	-	-	-	1	-	1
Purpuradusta gracilis (shell)	-	-	-	-	1	-	-	1
Rhinoclavis kochi	-	-	-	-	-	3	-	3
Tonna galea (shell)	-	-	-	-	-	1	-	1
Gastropoda Opisthobranchia								
Bulla striata (shells)	-	-	-	-	1	-	-	1
Goniobranchus annulatus	-	-	-	-	1	-	-	1
Bivalvia								
Chama pacifica	-	-	-	1	3	1	3	8
Dendostrea frons	-	-	-	-	1	-	-	1
Glycymeris glycymeris	-	-	-	-	-	1	-	1
Lioberus agglutinans (shells)	-	-	-	-	-	2	-	2
Loripes orbiculatus (shells)	-	-	-	-	-	1	-	1
Malleus regulus	-	-	-	1	3	-	-	4
Polititapes aureus (shell)	-	-	-	-	-	2	-	2
Pinctada imbricata radiata		-	-	-	-	-	1	1
Pitar rudis (shells)	-	-	-	-	-	2	-	2
Spondylus spinosus	-	-	-	1	2	1	2	6
Striarca lactea (shells)	-	-	-	-	-	1	-	1
Venus sp.	-	-	-	-	-	-	1	1
BRYOZOA								
Cradoscrupocellaria cf. *reptans*	-	-	-	2	1	-	-	3
Entalophoroecia sp.	-	-	-	-	2	-	1	3
ECHINODERMATA								
Asteroidea								
Coscinasterias tenuispina	-	-	-	1	-	-	-	1

Locality code (Medfoun)	M-1	M-2	M-3	M-4	M-5	M-6	M-7	M
Echinoidea								
Brissus unicolor (test)	-	-	-	-	-	1	-	1
Echinocyamus pusillus (tests)	-	-	-	1	-	-	-	1
Holothuroida								
Holothuria sanctori	-	-	-	-	-	-	2	2
Ophiuroidea								
Ophiothrix fragilis	-	-	-	2	-	-	-	2
CHORDATA								
Ascidiacea								
Cystodytes dellechiajei (violet)	-	-	-	2	-	-	1	3
Didemnidae sp.1 (orange)	-	-	-	-	1	-	2	3
Didemnidae sp.2 (pink)	-	-	-	2	-	-	2	4
Didemnidae sp.3 (yellow)	-	-	-	-	3	-	-	3
Didemnidae sp.4 (white)	-	-	-	2	2	-	2	6
Didemnum fulgens	-	-	-	3	-	-	-	3
Herdmania momus	-	-	-	1	2	-	1	4
Phallusia nigra	-	-	-	-	-	-	1	1
Polyclinidae sp.	-	-	-	1	-	-	-	1
Stolidobranchia sp. (red)	-	-	-	-	-	-	1	1
PISCES								
Elasmobranchii								
Dasyatis pastinaca	-	-	1	-	-	-	-	1
Taeniura grabata	-	-	1	-	-	-	-	1
Actinopterygii								
Alepes sp.	-	-	-	1	-	-	-	1
Apogon imberbis	-	-	-	1	-	-	1	2
Belone belone	-	-	-	-	-	-	3	3
Caranx chrysos	-	-	-	-	-	-	2	2
Cheilodipterus novemstriatus	-	-	2	-	-	3	-	5
Chomis chromis	-	2	3	-	3	-	3	11
Coris julis	-	2	-	2	2	2	2	10
Diplodus cervinus	-	-	-	-	-	-	2	2
Diplodus sargus	-	1	-	-	1	3	3	8
Diplodus vulgaris	-	-	2	-	1	3	3	9
Epinephelus costae	-	-	-	-	-	1	1	2
Epinephelus marginatus	-	-	-	-	-	-	1	1
Gobius bucchichii	-	-	-	-	2	-	1	3
Gobius paganellus	-	-	-	-	-	-	2	2
Lithognathus mormyrus	-	-	-	-	-	-	2	2
Mugilidae spp.	-	-	-	-	-	-	2	2
Mullus surmuletus	-	-	-	-	-	-	2	2
Mycteroperca rubra	-	-	-	-	-	-	1	1
Oblada melanura	-	-	-	-	-	3	3	6
Pempheris vanicolensis	-	-	-	-	3	2	3	8
Pomadasys incisus	-	-	-	-	-	-	2	2
Pteragogus pelycus	-	-	-	-	-	1	-	1

Locality code (Medfoun)	M-1	M-2	M-3	M-4	M-5	M-6	M-7	M
Sargocentrum rubrum	-	2	-	-	2	3	3	10
Scorpaena maderensis	-	-	-	-	-	-	1	1
Seriola dumerili	-	-	-	1	-	-	-	1
Serranus cabrilla	-	1	-	1	1	2	1	6
Serranus scriba	-	-	-	-	1	3	1	5
Siganus luridus	-	-	1	2	-	-	3	6
Siganus rivulatus	-	2	-	-	3	3	3	11
Sparisoma cretense	-	-	1	1	-	1	2	5
Spicara smaris	-	-	-	-	-	3	-	3
Stephanolepis diaspros	-	-	-	-	-	1	1	2
Symphodus roissali	-	-	-	-	-	-	1	1
Symphodus tinca	-	-	-	-	-	1	-	1
Thalassoma pavo	-	-	-	-	2	3	3	8
Torquigener flavimaculosus	-	3	3	2	-	3	3	14
Tripterygion melanurum	-	-	-	-	3	-	1	4
Upeneus pori	-	-	-	-	-	-	1	1
Xyrichtys novacula	-	-	-	-	-	3	-	3
Species richness (S)	3	8	9	50	55	49	95	165
Relative abundance (A)	3	16	15	95	115	99	190	533
Margalef' index (M)	1,82	1,82	2,95	10,76	11,38	10,45	17,91	26,12

ANNEX III-4. BYBLOS (STATIONS, SEE ANNEX I)

Locality code (Byblos)	By-1	By-2	By-3	By-4	By-5	By-6	By-7	By-8	By
Station	7	8	9	11	17	18	19	20	8 st.
Depth (m)	5-45	9-42	4-43	0-7	40-54	15	0-15	0-7m	0-54
CYANOBACTERIA									
Cyanobacteria spp. (spots)	-	-	-	-	-	3	3	3	9
CHLOROPHYTA									
Caulerpa prolifera	-	2	2	-	-	2	-	-	6
Caulerpa taxifolia var. *distichophylla*	-	1	2	1	-	2	2	-	8
Cladophoropsis sp.	-	-	-	-	-	-	1	-	1
Codium bursa	-	-	-	-	1	-	-	-	1
Codium parvulum	-	-	-	-	1	-	2	2	5
Codium taylori	-	-	-	-	-	-	2	2	4
Palmophyllum crassum	-	-	-	-	1	-	-	-	1
OCHROPHYTA									
Dictyopteris polypodioides	-	-	-	1	-	-	-	-	1
Lobophora variegata	-	-	-	2	-	-	3	1	6
Padina boergesenii	-	-	-	1	-	-	-	-	1
Padina pavonica	-	-	-	1	-	-	-	-	1
Sargassum vulgare	-	-	-	3	-	-	-	-	3
Stypopodium schimperi	-	-	-	-	1	-	-	-	1
RHODOPHYTA									
Acanthophora nayadiformis	-	-	-	2	-	-	-	-	2
Amphiroa cryptarthrodia	-	-	-	-	2	-	-	3	5
Amphiroa rigida	-	-	-	-	-	-	3	2	5
Ceramiales spp.	-	-	-	-	3	-	3	-	6
Corallinales spp.	-	-	-	-	-	-	3	-	3
Ellisolandia elongata	-	-	-	3	-	-	3	3	9
Galaxaura rugosa	-	-	-	-	-	-	1	3	4
Halymenia latifolia	-	-	-	-	1	-	-	-	1
Jania rubens	-	-	-	3	-	-	3	3	9
Lithophyllum incrustans	-	-	-	-	-	-	3	3	6
Lithophyllum stictaeforme	-	-	-	-	2	-	-	-	2
Lophocladia lallemandii	-	-	-	-	-	-	-	3	3
Mesophyllum sp.	-	-	-	-	3	-	-	2	5
Neogoniolithon mamillosum	-	-	-	-	3	-	-	-	3
Palisada perforata	-	-	-	2	-	-	-	-	2
Peyssonnelia rosa-marina	-	-	-	-	2	-	-	-	2
Peyssonnelia rubra	-	-	-	2	2	-	2	2	8
Peyssonnelia spp.	-	-	-	2	3	-	-	-	5
Rhodoliths	-	-	-	-	1	-	-	-	1
MAGNOLIOPHYTA									
Cymodocea nodosa	-	-	1	-	-	-	-	-	1
FORAMINIFERA									
Amphistegina lobifera	-	-	-	-	3	-	3	3	9

Locality code (Byblos)	By-1	By-2	By-3	By-4	By-5	By-6	By-7	By-8	By
PORIFERA									
Calcarea									
Borojevia cf. *cerebrum*	-	-	-	2	-	-	2	-	4
Calcarea spp. *(Vosmaeropsis, Syncetta)*	-	-	-	-	-	-	2	-	2
Paraleucilla magna	-	-	-	3	-	-	-	-	3
Sycon spp.	-	-	-	-	-	-	2	2	4
Demospongiae									
Agelas oroides	-	-	-	-	2	-	-	-	2
Aplysina aerophoba	-	-	-	2	-	-	-	-	2
Aplysilla sulfurea	-	-	-	1	-	-	1	1	3
Aplysilla sp.	-	-	-	-	-	-	2	2	4
Axinella damicornis	-	-	-	-	2	-	-	-	2
Axinella polypoides	-	-	-	-	2	-	-	-	2
Axinella spp.	1	-	-	-	2	-	-	-	3
Chondrilla nucula	-	-	-	-	-	-	-	2	2
Chondrosia reniformis	-	-	-	3	-	-	2	2	7
Cliona carteri	-	-	-	1	-	-	-	-	1
Crambe crambe	3	-	-	3	3	-	3	3	15
Demospongia sp. 4	-	-	-	1	-	-	-	-	1
Diplastrella spp.	-	-	-	-	-	-	1	-	1
Dysidea avara	-	-	-	-	3	-	-	-	3
Haliclona fulva	-	-	-	-	-	-	2	2	4
Haliclona sp.	-	-	-	-	-	-	1	-	1
Hippospongia communis	-	-	-	-	1	-	-	-	1
Ircinia oros	-	-	-	-	1	-	-	-	1
Ircinia cf. *retidermata*	-	-	-	1	-	-	-	-	1
Ircinia sp. (yellow)	-	-	-	2	-	-	-	-	2
Levantiniella levantinensis	-	-	-	-	-	-	-	1	1
Niphates toxifera	-	1	-	-	-	-	-	-	1
Oscarella lobularis	-	-	-	-	-	-	1	-	1
Phorbas tenacior	-	-	-	-	2	-	-	-	2
Phorbas topsenti	-	-	-	2	-	-	-	1	3
Poecilloscleridae sp.	-	-	-	3	-	-	3	1	7
Sarcotragus spinosulus	-	-	-	-	1	-	1	2	4
Spirastrella cunctatrix	-	-	-	-	1	-	-	-	1
Spongia officinalis	-	-	-	2	-	-	-	1	3
Terpiops sp.	-	-	-	-	-	-	1	-	1
CNIDARIA									
Hydrozoa									
Aglaophenia spp.	-	-	-	-	2	-	-	-	2
Eudendrium racemosum	-	-	-	-	-	3	-	-	3
Eudendrium spp.	2	-	-	1	3	-	2	2	10
Macrorhynchia philippina	-	-	-	3	-	-	2	3	8
Pennaria disticha	-	-	-	3	-	3	3	3	12
Sertularia marginata	-	-	-	2	-	-	-	-	2

Locality code (Byblos)	By-1	By-2	By-3	By-4	By-5	By-6	By-7	By-8	By
Anthozoa									
Bunodeopsis strumosa	-	2	-	-	-	3	2	-	7
Madracis phaerensis	-	-	-	-	2	-	-	-	2
Oculina patagonica	-	-	-	2	-	-	-	2	4
CTENOPHORA									
Mnemiopsis leidyi	-	-	-	-	-	1	-	-	1
POLYCHAETA									
Errantia									
Hermodice carunculata	1	-	-	2	1	-	3	1	8
Sedentaria									
Branchiomma bairdi	-	-	-	-	-	-	1	-	1
Sabellidae spp.	-	-	-	-	-	-	3	-	3
Serpulidae spp.	-	-	-	3	-	-	3	-	6
Spirobranchus lamarcki	-	-	-	-	-	-	2	-	2
Spirorbis spp.	-	-	-	-	-	-	3	-	3
CRUSTACEA									
Cirripedia									
Balanus trigonus	-	-	-	-	-	-	2	-	2
Balanus spp.	-	-	-	3	-	-	-	3	6
Perphoratus perforatus	-	-	-	-	-	-	3	3	6
Decapoda									
Atergatis roseus	-	-	-	1	-	-	-	-	1
Calcinus tubularis	-	-	-	-	-	-	-	1	1
Diogenes pugilator	-	-	-	3	-	-	3	-	6
Eriphia verrucosa	-	-	-	-	-	-	-	1	1
Gebiidea spp.	-	-	-	-	-	-	2	-	2
Liocarcinus vernalis	-	-	1	-	-	-	-	-	1
MOLLUSCA									
Gasrtropoda Prosobranchia									
Cerithium scabridum	-	-	-	-	-	-	3	3	6
Conomurex persicus	-	-	-	1	-	-	3	1	5
Cypaeidae sp.	-	-	-	-	-	-	-	1	1
Ergalatax junionae	-	-	-	3	-	-	2	2	7
Nassarius circumcinctus	-	-	-	3	-	-	1	-	4
Nassarius gibbosulus	-	-	-	-	-	-	2	-	2
Rhinoclavis kochi	-	-	-	-	-	-	3	-	3
Serpuloides arenarius	-	-	-	1	-	-	-	-	1
Tritia mutabilis	-	-	-	2	-	-	2	-	4
Trochus erithreus	-	-	-	-	-	-	1	3	4
Gastropoda Opisthobranchia									
Berthellina cf. *edwardsii*	-	-	-	-	-	-	1	-	1
Caloria indica	-	-	-	-	-	1	-	-	1
Elysia grandifolia	-	-	-	-	-	-	-	2	2
Goniobranchus annulatus	-	-	-	-	-	-	1	-	1
Philineglossidae sp. ?	-	-	-	-	-	-	1	-	1
Spurilla cf. *neapolitana*	-	-	-	-	-	1	-	-	1

Locality code (Byblos)	By-1	By-2	By-3	By-4	By-5	By-6	By-7	By-8	By
Bivalvia									
Acanthocardia tuberculata (shells)	-	-	3	1	-	-	3	-	7
Anomia ephippium (shells)	-	-	-	-	-	-	2	-	2
Arca noae (shells)	-	-	-	-	-	-	-	1	1
Atlantella pulchella (shells)	-	-	-	-	-	-	2	-	2
Brachidontes pharaonis	-	-	-	-	-	-	3	-	3
Chama pacifica	3	-	-	3	-	-	3	2	11
Dendostrea frons	-	-	-	3	-	-	3	2	8
Donax semistriatus (shells)	-	-	-	1	-	-	2	-	3
Gafrarium savignyi (Jonas, 1846) (shell)	-	-	-	-	-	-	-	1	1
Glycymeris sp.	-	-	-	1	-	-	-	-	1
Lithophaga lithophaga (shells)	-	-	-	1	-	-	-	-	1
Mactra stultorum	-	-	-	1	-	-	-	-	1
Malleus regulus	-	-	-	3	-	-	2	2	7
Petricola lithophaga	-	-	-	-	-	-	1	-	1
Pinctada imbricata radiata	-	-	-	2	-	-	-	2	4
Spisula subtruncata (shells)	-	-	3	-	-	-	-	-	3
Spondylus groschi ?	-	-	-	-	-	-	1	-	1
Spondylus spinosus	-	-	-	3	-	-	2	1	6
Venus verrucosa (shells)	-	-	-	1	-	-	-	1	2
BRYOZOA									
Calpensia nobilis	-	-	-	-	-	-	1	1	2
Cradoscrupocellaria cf. reptans	-	-	-	-	-	-	3	-	3
Parasmittina spp.	-	-	-	-	-	-	2	-	2
Reptadeonella violacea	-	-	-	-	-	-	1	-	1
Schizoporella errata	-	-	-	3	-	-	2	2	7
ECHINODERMATA									
Echinoidea									
Echinocardium mediterraneum	-	-	1	-	-	-	-	-	1
Echinocyamus pusillus	-	-	-	-	1	-	-	-	1
Holothuroida									
Synaptula reciprocans	1	-	-	-	-	1	-	-	2
CHORDATA									
Ascidiacea									
Botrylloides cf. *leachii*	-	-	-	-	-	-	1	1	2
Botrylloides sp. 1	-	-	-	-	-	-	3	-	3
Botryllus sp.	-	-	-	-	-	-	1	-	1
Cystodytes dellechiajei	-	-	-	3	-	-	2	3	8
Didemnidae sp.4 (white)	-	-	-	2	-	-	2	3	7
Didemnum coriaceum	-	-	-	-	-	-	1	-	1
Herdmania momus	-	-	-	1	-	-	2	-	3
Microcosmus exasperatus	-	-	2	2	-	2	-	-	6
Phallusia nigra	-	-	-	3	-	-	3	3	9
Pyura dura	-	-	-	1	-	-	-	1	2
Rhodosoma turcicum	-	-	-	-	-	-	1	-	1
Stolidobranchia sp. (red)	-	-	-	3	-	-	-	-	3
Symplegma brakenhielmi	-	-	-	2	-	-	-	-	2

Locality code (Byblos)	By-1	By-2	By-3	By-4	By-5	By-6	By-7	By-8	By
PISCES									
Elasmobranchii									
Dasyatis pastinaca	1	1	-	-	-	-	-	-	2
Aetomylaeus bovinus	1	-	-	-	-	-	-	-	1
Actinopterygii									
Alepes sp.	-	-	-	-	-	-	2	-	2
Apogon imberbis	-	-	-	1	-	-	-	-	1
Apogonichthyoides nigripinnis	-	-	-	-	-	1	-	-	1
Blenniidae sp.	-	-	-	-	-	-	1	1	2
Boops boops	-	-	-	-	-	-	3	-	3
Caranx chrysos	-	-	-	-	-	-	2	-	2
Cheilodipterus novemstriatus	-	-	-	-	-	-	2	1	3
Chomis chromis	2	-	-	3	-	-	-	3	8
Coris julis	2	-	-	2	-	-	2	2	8
Diplodus cervinus	-	-	-	-	-	-	2	2	4
Diplodus puntazzo	-	-	-	1	-	-	-	-	1
Diplodus sargus	1	-	-	2	-	-	2	2	7
Diplodus vulgaris	2	-	-	2	-	-	2	2	8
Echeneis naucrates	1	-	-	-	-	-	-	-	1
Gobius bucchichii	-	-	-	-	-	-	-	2	2
Lithognathus mormyrus	-	-	-	-	-	-	2	-	2
Mugilidae spp.	-	-	-	-	-	-	3	-	3
Muraena helena	-	-	-	-	-	-	-	1	1
Mycteroperca rubra	-	-	-	1	-	-	1	-	2
Oblada melanura	-	-	-	3	-	-	3	-	6
Parablennius zvonimiri	-	-	-	-	-	-	1	1	2
Pempheris vanicolensis	-	-	-	2	-	-	1	-	3
Pomadasys incisus	-	-	-	-	-	-	2	-	2
Sargocentrum rubrum	2	-	-	2	-	-	1	1	6
Scorpaena maderensis	-	-	-	1	-	-	2	1	4
Scorpaena porcus	-	-	-	-	-	-	-	1	1
Seriola dumerili	-	-	-	-	-	-	1	1	2
Serranus cabrilla	1	1	-	-	2	-	-	-	4
Serranus scriba	-	-	-	1	-	-	-	-	1
Siganus luridus	-	-	-	2	-	-	3	3	8
Siganus rivulatus	-	-	-	3	-	-	3	3	9
Stephanolepis diaspros	-	-	-	-	-	-	-	1	1
Symphodus tinca (Linnaeus, 1758)	-	-	-	2	-	-	-	-	2
Thalassoma pavo	3	-	-	3	-	-	3	3	12
Torquigener flavimaculosus	2	-	-	1	1	-	-	-	4
Tripterygion melanurum	-	-	-	-	-	-	1	-	1
Tripterygion tripteronotum	-	-	-	-	-	-	-	1	1
Xyrichtys novacula	-	-	2	2	-	2	2	-	8
Reptilia									
Chelonia mydas (Linnaeus, 1758)	-	-	1	-	-	-	-	-	1
Species richness (S)	17	6	10	78	33	13	103	66	191
Relative abundance (RA)	29	8	18	156	61	25	211	144	653
Margalef' index (M)	4,72	2,4	3,06	15,25	7,78	3,73	19,06	13,08	29,31

UN environment
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Environment Programme

MAP
Mediterranean Action Plan
Barcelona Convention

SPA / RAC
The Mediterranean Biodiversity Centre

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