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The Mediterranean Biodiversity Centre
SPA / RAC

ECOLOGICAL CHARACTERIZATION OF POTENTIAL NEW MARINE PROTECTED AREAS IN LEBANON:

Batroun, Medfoun and Byblos

MedMPA Network Project

With the financial support of

With the partnership of

IUCN

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MedMPA Network Project

Study required and financed by:

MedMPA Network Project

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MINISTERIAL FOREWORD

تعتبر المناطق البحرية الساحلية من أكثر النظم البيئية إنتاجية في العالم. إلا ان هذه النظم الإيكولوجية - في الوقت نفسه - تعاني بشكل متزايد من ضغط الزيادة السكانية المستمر. في العديد من الأماكن، يتم استغلال هذه النظم الإيكولوجية الهامة بشكل مفرط وتلويثها وتدهورها. كما أن تدابير الحماية الحالية المتخذة ليست كافية لمعالجة هذه المشاكل الملحة والمتزايدة. ومن هنا، تظهر أهمية إنشاء محميات بحرية وتفعيل تنفيذ تدابير أفضل للحماية.

وانطلاقاً من إيمان الحكومة اللبنانية بأهمية اتخاذ قرارات فعالة لصون بيئتها البحرية، فقد وضعت وزارة البيئة ضمن أولوياتها إنشاء عدد من المحميات الطبيعية البحرية الوطنية، حيث تم في عام ٢٠١٢ وضع استراتيجية وطنية للمحميات البحرية بهدف إنشاء شبكة من المحميات الطبيعية البحرية التي تساهم في ضمان صحة البيئة البحرية في لبنان.

وفي هذا الإطار، فإن وزارة البيئة اللبنانية تقوم بالتنسيق مع مركز الأنشطة الإقليمية للمناطق المتمتعة بحماية خاصة (SPA/RAC) بتنفيذ أنشطة مشروع«نحو إنشاء شبكة محميات بحرية ممثلة إيكولوجيا ومدارة بكفاءة وفعالية في منطقة البحر المتوسط» الممول من الاتحاد الأوروبي والمعروف باسم (MedMPA Network Project). ساهم المشروع في تطبيق عدد من أنشطة الاستراتيجية الوطنية للمحميات البحرية في لبنان من خلال إجراء في العام ٢٠١٦ توصيف بيئي للمواقع البحرية ذات الأولوية، وهي البترون وجبيل ومدفون. يساهم هذا التوصيف البيئي في دعم الاسباب الموجبة لإنشاء في المستقبل محميات طبيعية بحرية في هذه المناطق.

Marine coastal areas are among the world's most productive ecosystems. At the same time, however, coastal ecosystems are increasingly suffering under the pressure of a constantly growing population. In many places, these important ecosystems are being overexploited, polluted and degraded. Existing conservation measures are not sufficient to address the increasingly urgent problems. It is therefore necessary to establish marine protected areas and to promote better conservation measures.

The Lebanese Government understands the importance of effective decision-making for its marine environment. Accordingly, the Ministry of Environment, within its mandate to establish protected areas, has elaborated in 2012 a Marine Protected Areas Strategy with the aim of creating a network of marine protected areas that contributes to the health of Lebanon's sea and marine environment.

Accordingly, the Ministry of Environment (MoE) and the Specially Protected Areas Regional Activity Centre (SPA/RAC) are implementing the European Union financially supported project "Towards an ecologically representative and efficiently managed network of Mediterranean Marine Protected Areas (MedMPA Network Project)". The project contributed to the implementation of the Marine Protected Areas Strategy in Lebanon by carrying out in 2016 an ecological characterization of marine sites of conservation interest, namely Batroun, Byblos and Medfoun. This ecological characterization would serve to reinforce the rationale and justification for their future establishment as Marine Protected Areas.

Fadi Jreissati
Minister of Environment

SPA/RAC FOREWORD

The Mediterranean is one of the richest biodiverse seas in the world, it is a jewel that must be preserved for the well-being of present and future generations. The Mediterranean countries having recognised its value and the need to preserve this common space, they adopted the Mediterranean Action Plan (MAP) framework since 1975, and the Barcelona Convention on 1976.

At a time when the loss of biodiversity is becoming a global issue under the mankind different activities, exacerbated by climate change impacts, the importance of marine protected areas (MPAs) for the conservation of marine and coastal biodiversity and its resilience is clearly established. On a Mediterranean level, since 1995, the Parties to the Barcelona Convention have committed to a collective approach and adopted "*The Protocol concerning Specially Protected Areas and Biological Diversity (SPA/BD Protocol)*" which constitutes the overarching regional instrument for implementing the 1992 United Nations Convention on Biological Diversity (UNCBD) in relation with the conservation and sustainable management of the coastal and marine biodiversity.

Hence, being committed under the Convention on Biological Diversity (CBD) to achieve the Aichi Targets, the Contracting Parties to the Barcelona Convention requested SPA/RAC to prepare a "*Roadmap for a Comprehensive Coherent Network of Well-Managed MPAs to Achieve Aichi Target 11 in the Mediterranean*". This roadmap aims at guiding and harmonizing the Mediterranean efforts towards achieving the Aichi Target 11 by 2020. It builds on the progress made so far in the Mediterranean to develop marine and coastal protected areas in view to ensure the long-term conservation and sustainable use of the components of the marine and coastal biodiversity.

SPA/RAC is consequently involved in several pragmatic initiatives and focussed projects to preserve and sustainably manage marine and coastal biodiversity, and to improve the governance of the Mediterranean Sea in partnership with national authorities and involving the relevant regional actors with a longstanding experience in this field. In this context, SPA/RAC and the Ministry of Environment of the Government of Lebanon have committed to work together and build on the National MPA's Strategy with the aim of creating a network of marine protected areas. This fruitful collaboration, reinforced through the European Union financially supported project "*Towards an ecologically representative and efficiently managed network of Mediterranean Marine Protected Areas (MedMPA Network Project)*" has led to carrying out an ecological characterization of marine sites of conservation interest, namely Batroun, Byblos and Medfoun towards declaring them as new MPAs in Lebanon, thus contributing to a healthy and productive Lebanese sea and marine environment.

Khalil Attia
SPA/RAC Director

EXECUTIVE SUMMARY

The present study has been undertaken within the framework of the MedMPA Network project, a regional project financially supported by the European Union, with the purpose to contribute to achieving a connected, ecologically representative, effectively managed and monitored 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, the project activities were outlined in close consultation with the Ministry of Environment (MoE) in order to implement the Marine Protected Areas Strategy, whose overall objective is to develop an effective MPAs network contributing to sustainable development by enhancing natural and cultural diversity. Hence, an ecological characterization of the coastal and marine environment of three areas, namely Batroun, Kfar Abida-Medfoun and Byblos, has been undertaken. Those three areas were already listed among the nine sites that could be declared as future marine protected areas according to the above-mentioned MPAs Strategy in Lebanon.

To overcome challenges and for smooth implementation of the project activities, especially the field ones, a multilateral collaboration has been set up between the Ministry of Environment of Lebanon, SPA/RAC, the University of Alicante and the Museo del Mar of Ceuta in Spain, the Lebanese University, the Lebanese National Centre for Marine Research (CNRS-L) and the IUCN Regional Office for West Asia (IUCN-ROWA). All technical partners worked together and formed a multidisciplinary team to carry out the current study.

The study has shown the main following results:

- About three hundred twenty-nine taxa (320 at lower level (family, genus, species) and 9 at higher level (class, order)), belonging to twenty-six higher taxa (phyla, classes), were observed. The main group was the Mollusca, with 62 taxa (18.8 %), followed by Pisces (59 taxa, 17.9 %) and Porifera (57 taxa, 17.3 %). Worth noting is the low representation of Echinodermata with only 9 taxa (2.7 %);

- With regard to macroalgae, Rhodophyta were observed with 39 taxa (11.8 %), followed by Chlorophyta (15 taxa, 4.5 %). The Ochrophyta were lowly presentd with 8 taxa (2.4 %);

- Concerning the exotic species, a total of 66 species were recorded, from which 62 species are Lessepsian and 4 species from Atlantic origin (Paraleucilla magna, Oculina patagonica, Mnemiopsis leidyi and Percnon gibbesi), representing about the 20.2 % of the taxa observed;

- Thirteen new species were observed for the Lebanese marine biodiversity. They were represented by (i) the Macroalgae, especially with the presence of the chlorophyta Caulerpa taxifolia var. distichophylla, and the rhodophyta Hypoglossum hypoglossoides, Heterosiphonia crispella and Womerleyella setacea, (ii) the calcareous sponge Borojevia cf. cerebrum, (iii) the demosponge Poecilloscleridae sp; (iv) the Lessepsian polychaeta Branchiomma bairdi; (v) the Lessepsian decapod Halimede tyche; (vi) the opithobranchia gastropod Spurilla cf. neapolitana, (vii) the Lessepsian bivalve Spondylus groschi, (viii) the Chordata, with the colonial ascidians of the family Didemnidae Didemnum fulgens and Lissoclinum perforatum, and (ix) the gobid fish Gobius paganellus;

- 33 fish species were observed, of 12 were non-indigenous species. The mean number of species and abundance were highest in the stations Batroun and Medfoun, while the maximum biomass was observed in Batroun due to the greater size of the population. On the other hand, the lowest value was observed in Byblos, with only a mean of 1 species in 125 m2, due to the homogeneity of the sampled habitat (muddy sand);

- In terms of taxa richness, Byblos presented the highest values of species (≈ 200 spp.), followed by Medfoun and Kfar Abida (≈170-172); Batroun presented the lowest value (160 spp.);

- In terms of species with heritage value, Batroun presented the highest value of (0.37), followed by Medfoun (0.33) and Byblos (0.26); while Kfar Abida had the lowest (0.21). However, Kfar Abida was not sampled for coralligenous deep bottoms (> 40m down);

- Although the littoral of the zones presented many uses and impacts (industry, littoral urbanization, different fishing activities, sewage discard…), some areas remain little altered, like Kfar Abida and Medfoun. These areas are interesting for establishing protection measures with low impact uses.

According to the assessment made over the study (taxa biodiversity, habitats, interesting species, fish populations, naturalness, etc.), it seems that two management areas could be established respectively, at (i) Batroun-Medfoun and (ii) Byblos, as follows:

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

- **Byblos**: Between Ras Amchit (in the north) and Fidar (in the south). It presented the lowest CI value (0.64). However, it presented areas of interest, such as the extensive littoral platforms and the Fartouch area. However, human pressure is very high.

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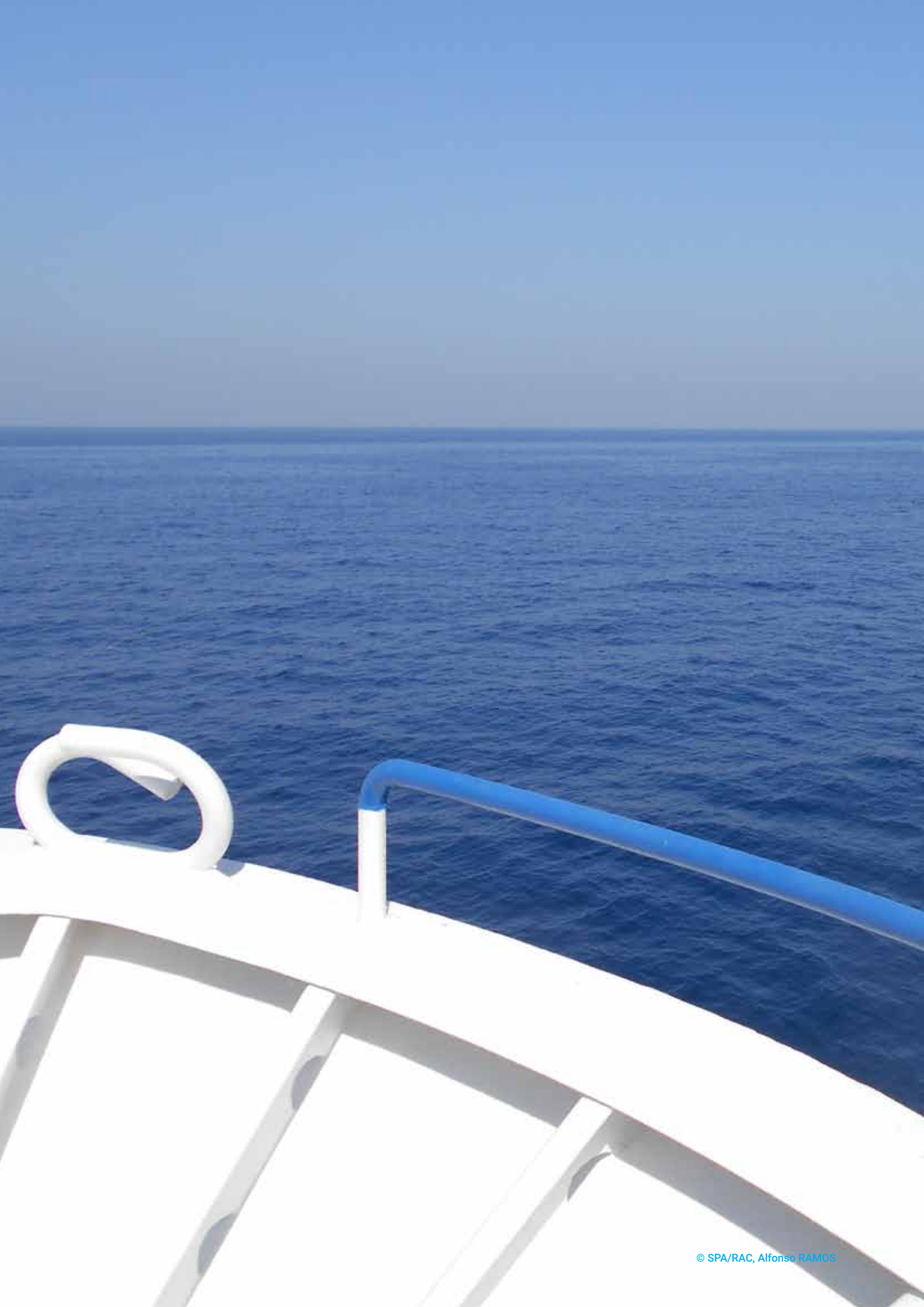

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1. INTRODUCTION

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 *inter alia*, 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 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 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 was organized in a way that would:

- 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 done 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 these.

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 regard to the exotic species that have successfully established themeselves in the area, for the inventorying of the biodiversity of this very special part of the Mediterranean.

Also, we made a sequence of the specific nature of the associations and facies that are a feature of this sector to show how they differ from other parts of the Mediterranean. This obviously requires drawing attention to 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 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).

Awareness of the particular forms of harm caused to the coastal environment by human activities (industry, fishing, sewers, human frequentation, etc.) could help reflection on how to protect and conserve those areas of interest and maintain them in a natural state.

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2. REPORT OF THE ASSIGNMENT

The present document was 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 assignment to be carried out in Lebanon in September-October 2016". This report represents the synthetized information about the assignment carried out in Lebanon from 29 September to 5 October 2016 on the littoral and sublittoral surveys (0-54m down) of Batroun, Medfoun and Byblos as potential future Marine Protected Areas. The expected outputs of the assignment were:

- Rapid natural habitat assessment (phytobenthos, zoobenthos and fishes) along all the coastal and marine parts of the concerned areas, for their better assessment.
- Inventorying of species (mainly, of heritage and fisheries interest), and mapping of benthic habitats.
- Ecological characterization, human impacts and previous evaluation of the zones, with recommendations for 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 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.) all lie around (from north to south): Batroun (between 0 and 54 m down); Medfoun (between 0 and 50 m down); and the Byblos area (0-40 m down), all in central Lebanon.

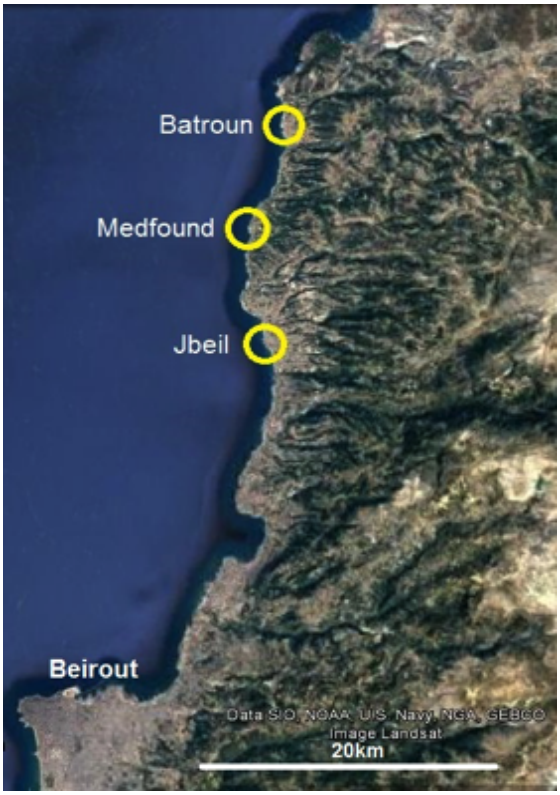

Figure 2.1. Location of prospected areas.

2.2 CHRONOGRAM

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

Wednesday 28/9/2016

- Arrival of the Spanish team.

Thursday 29/9/2016

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

Friday 30/9/2016

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

Saturday 1/10/2016

- 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 2/10/2016

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

Monday 3/10/2016

- Scuba diving plots: 7 dives (1-2 divers x 4 sites) in Byblos
- Visual fish census: 4 dives (2 divers x 2 sites) in Byblos
- Hydrological station off Byblos
- Work progress meeting

Tuesday 4/10/2016

- Scuba diving plots: 4 dives (1-2 divers x 3 sites) in Batroun and Kfar Abida
- Visual fish census: 4 dives (2 divers x 2 sites) in Batroun and Kfar Abida
- ROV station off Batroun
- Hydrological station off Kfar Abida
- Work progress meeting

Wednesday 5/10/2016

- 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
- Visual fish census: 4 dives (2 divers x 2 sites) in Batroun
- Work progress meeting

Thursday 6/10/2016

- Meeting at the end of the assignment
- Exchange of data and visual material

Friday 7/10/2016

- Departure of a part of the Spanish team (Oscar, Carlos and Aitor)
- Meeting of 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 assignment

Saturday 8/10/2016

- Departure of the head 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 *Cana* oceanographic vessel (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 assignment.

a. The *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 down) and deep water habitats (0-50 m down).

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 the University of Lebanon; and, the efficient help of the fisherman Toufik Assal with the fishing boat support.

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

Name	Affiliation	Tasks
Ghazi Bitar	Lebanese University	Benthos, habitats
Yassine R. Sghaier	SPA/RAC	Benthos, habitats
Gaby Khalaf	CNRS	CNRS coordinator
Milad Fakhri	CNRS	Hydrology, ROV
Aitor Forcada	University of Alicante	Fish, cartography
Oscar L. Ocaña	Museum Mer Ceuta	Benthos, habitats
Alfonso A. Ramos	University of Alicante	Benthos, habitats
Carlos Valle	University of Alicante	Fish, cartography
Ziad Samaha	IUCN	Diving support

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3. MATERIAL AND METHODS

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

In order to accomplish the study with rational planning, and according to topographic and human pressure features, the prospected areas (Batroun, Kfar Abida, Medfoun and Byblos) were divided into 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

There were thirty-one stations (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 snorkelling and pedestrian sampling 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.

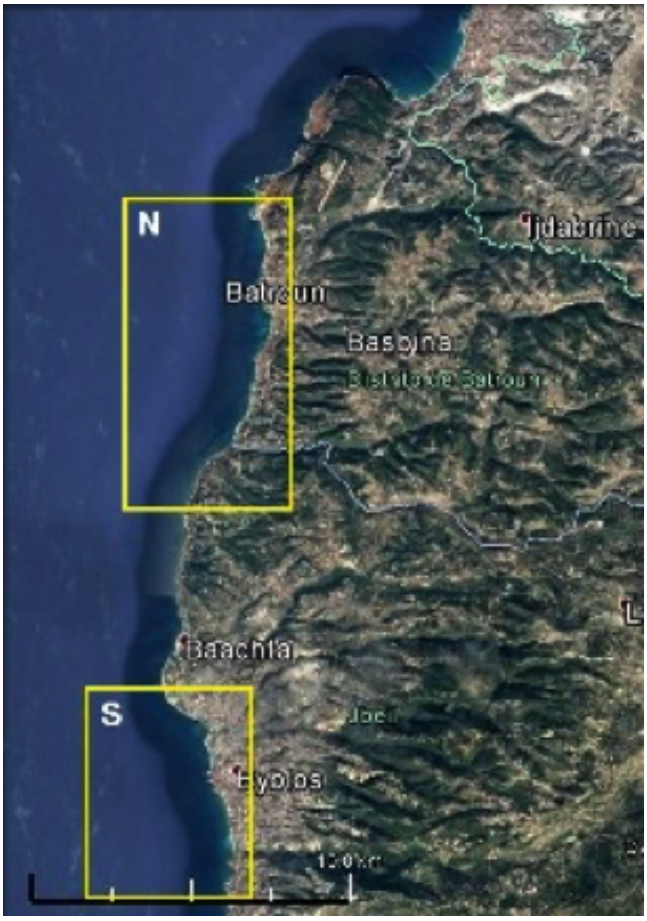


Figure 3.1. Studied areas: Batroun-Medfoun (north square); Byblos (south square) (image from Google Earth).

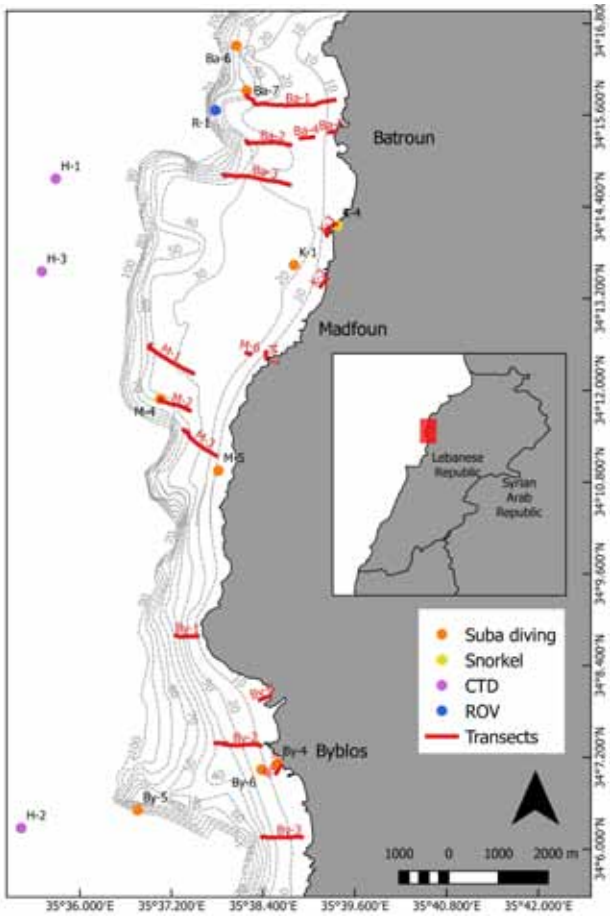


Figure 3.2. Distribution of the stations in Batroun-Byblos by different methods.

Table 3.1. Research activities by site and depth range. Number of dives (in brackets).

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)
Visual fish census	3 (6)	1 (2)	2 (4)	2 (4)	8 (16)
Snorkelling	-	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 were used during the 2016 mission in Lebanon. In addition to the hydroplane based transects, one of the main objectives of the assignment was to study the coralligenous community, so other methods were 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 permitted 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 was on the bottom, he recorded on a plastic plate his observations as to the habitats encountered; and took a transect record with a GoPro video-camera located on his head. Aboard the inflatable dinghy, one person sailed the boat while two others noted the position (using GPS), depth (a hand-held echo sounder), time check and the diver's safety. The GPS data were to be downloaded later on a computer.

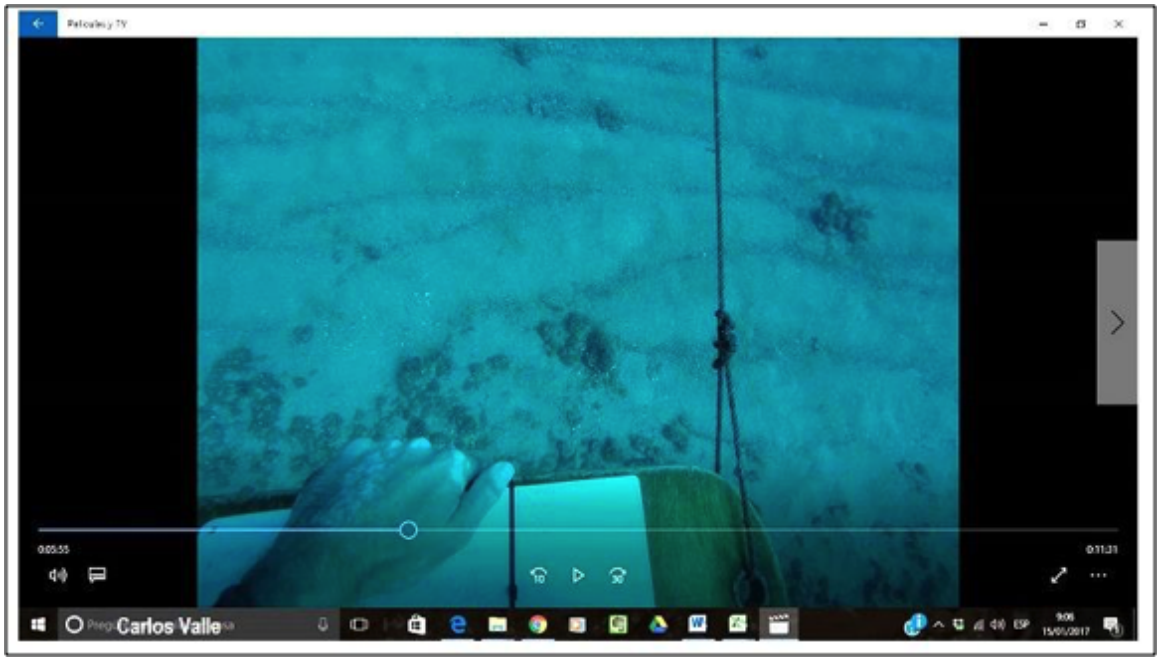


Figure 3.3. Image captured during a hydroplane transect, using a GoPro.

b) Echo sounder: As we said, one of the objectives of the 2016 mission was to observe and characterize the coralligenous biocenosis (between 42 and 54 m down). 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 to study this community by diving.

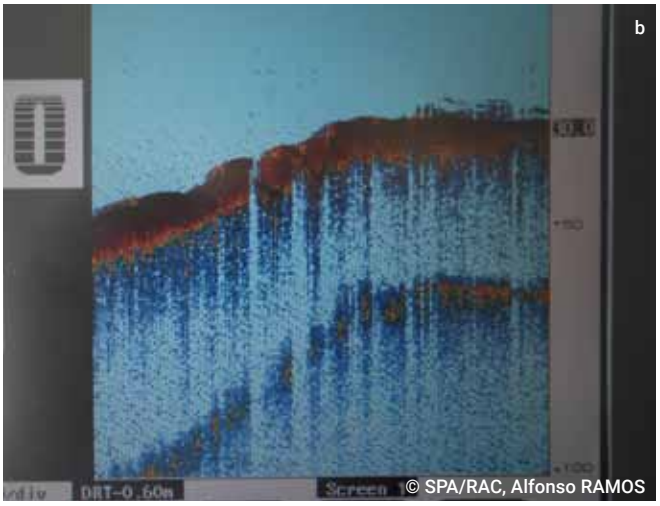


Figure 3.4. Bridge of the O/V '*Cana*' with GPS-plotter (a) and echosounder (b) to locate the coralligenous (rocky outcrops, between 45-55 m down).

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

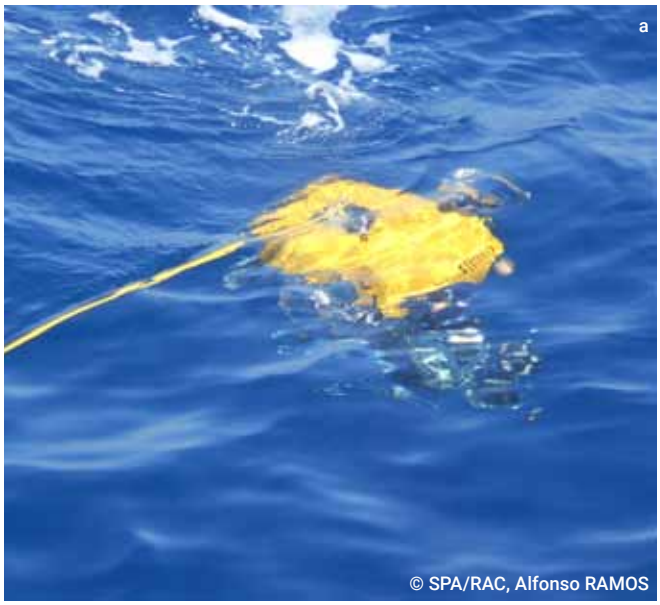


Figure 3.5. ROV '*Prometeo*':
a) On the surface of the water before sinking;
b) display on deck showing the seafloor (73 m down).

3.3 CHARACTERIZATION OF HABITATS AND SPECIES

A direct, non-destructive and semiquantitative methodology was 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 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). For the species, only the fraction of the mega-organisms (ø > 10 mm) was considered (visual observation); and three levels of a semi-quantitative value were 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 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 off Batroun, Kfar Abida and Byblos, between 1 and 100 m down.

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 which there were taxonomical doubts or which were not identified, were collected to be identified on board the *Cana* (Fig. 3.9 right) or taken to laboratories to be classified. 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 subsequent transport to the laboratories.

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

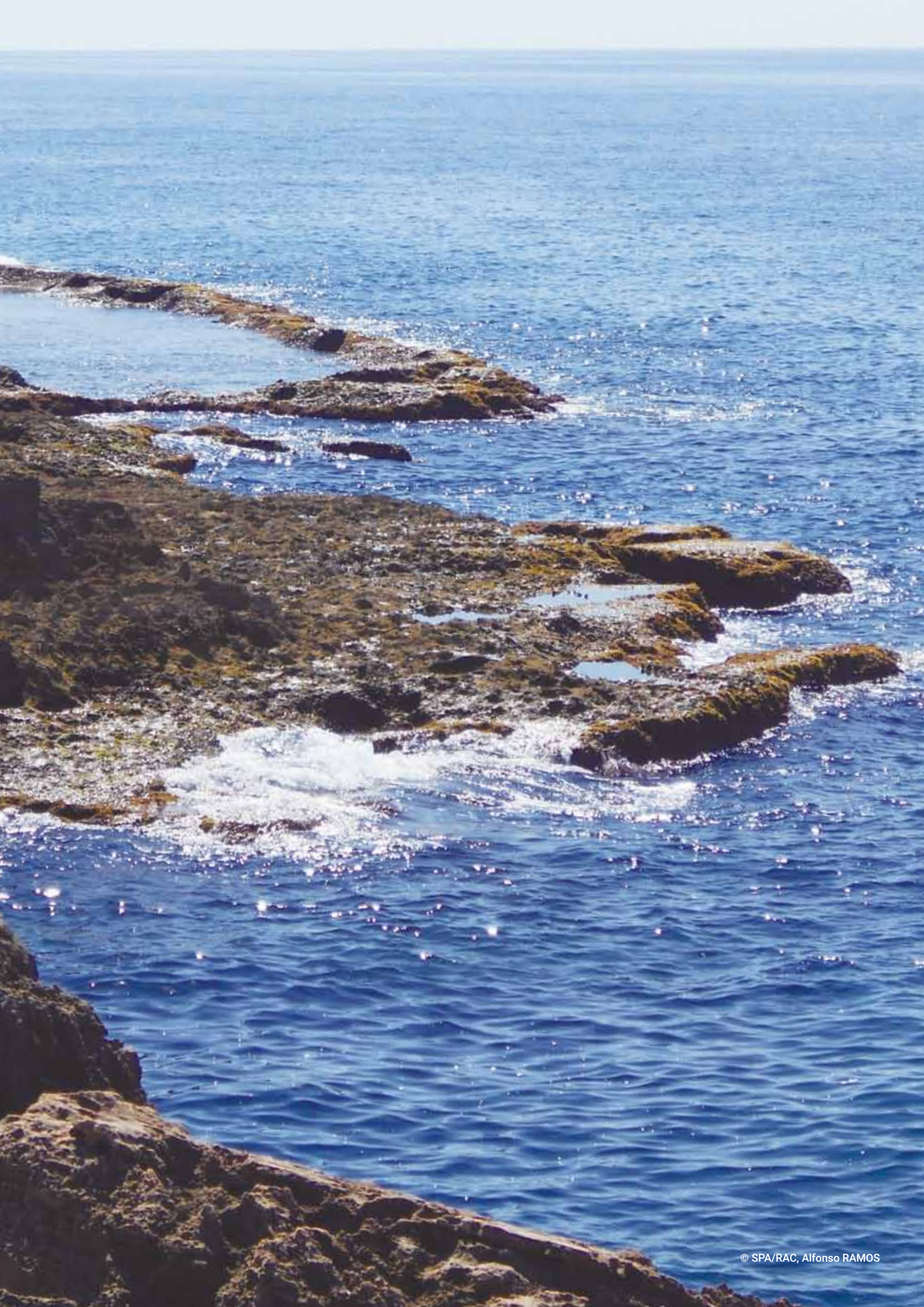
With regard to the bibliography, aside from the Mediterranean bibliography, some papers from Lebanon were consulted:

- 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 World Register of Marine Species (www.marinespecies.org) was consulted for the most recent scientific name of the species.

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

Rocks predominating in the shores of the studied areas, with rare sandy beaches (e.g. Byblos) are mainly sandstone with some limestone sectors. This type of rock allows the profile of the low irregular rocky shore (Fig. 4.1) with a wide variety of biotopes (wide littoral platforms, littoral caves, small coves ...).

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

The continental shelf is narrow, varying between 1500m off Ras Amchit and 4000m off 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 canyons off Selaata and Byblos, rocky escarpments and numerous outcrops (Fig. 4.3), some of them with submarine caves.

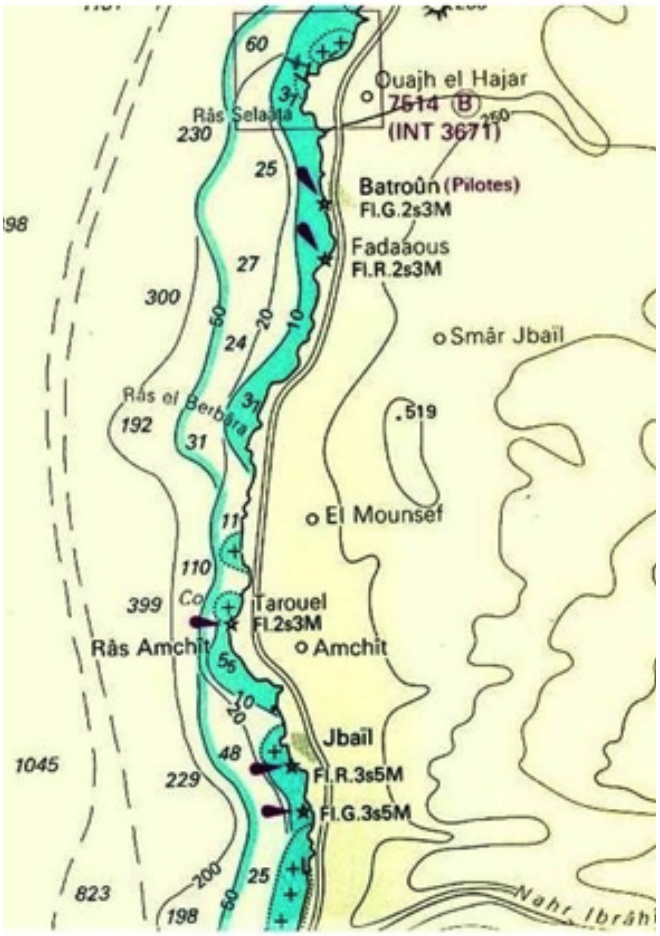

Figure 4.2. Studied areas: Batroun-Medfoun (north square); Byblos (south square) (images from Google-Earth and maritime chart INT 3606, 7255)..

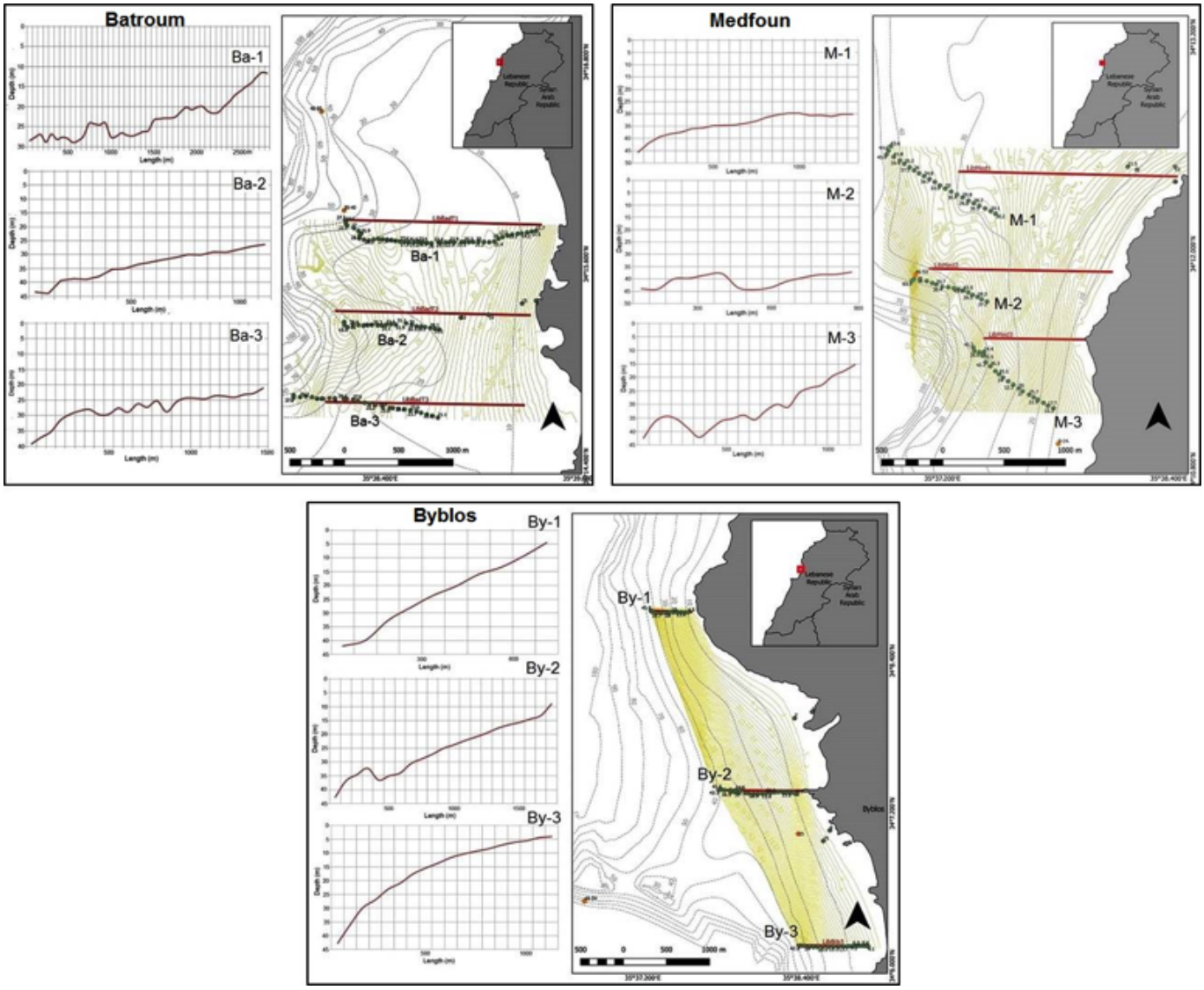

Figure 4.3. Bathymetry of the Batroun, Medfoun and Byblos areas with the profiles of hydroplane transects.

4.2 TYPES OF SUBSTRATA

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

a) Littoral rock (0-2 m depth)

As mentioned above, the sandstone and limestone rocks undergo 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 their associated flora and fauna.

b) Sublittoral seafloor (0-50 m down)

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

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

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

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 (off Batroun and Medfoun), with predominating low rock, and high rocky outcrops (Fig. 4.5a,b). Calcareous algal concretions (*Mesophyllum, Neogoniolithon, Lithophyllum*) are frequent from 40 m down (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).

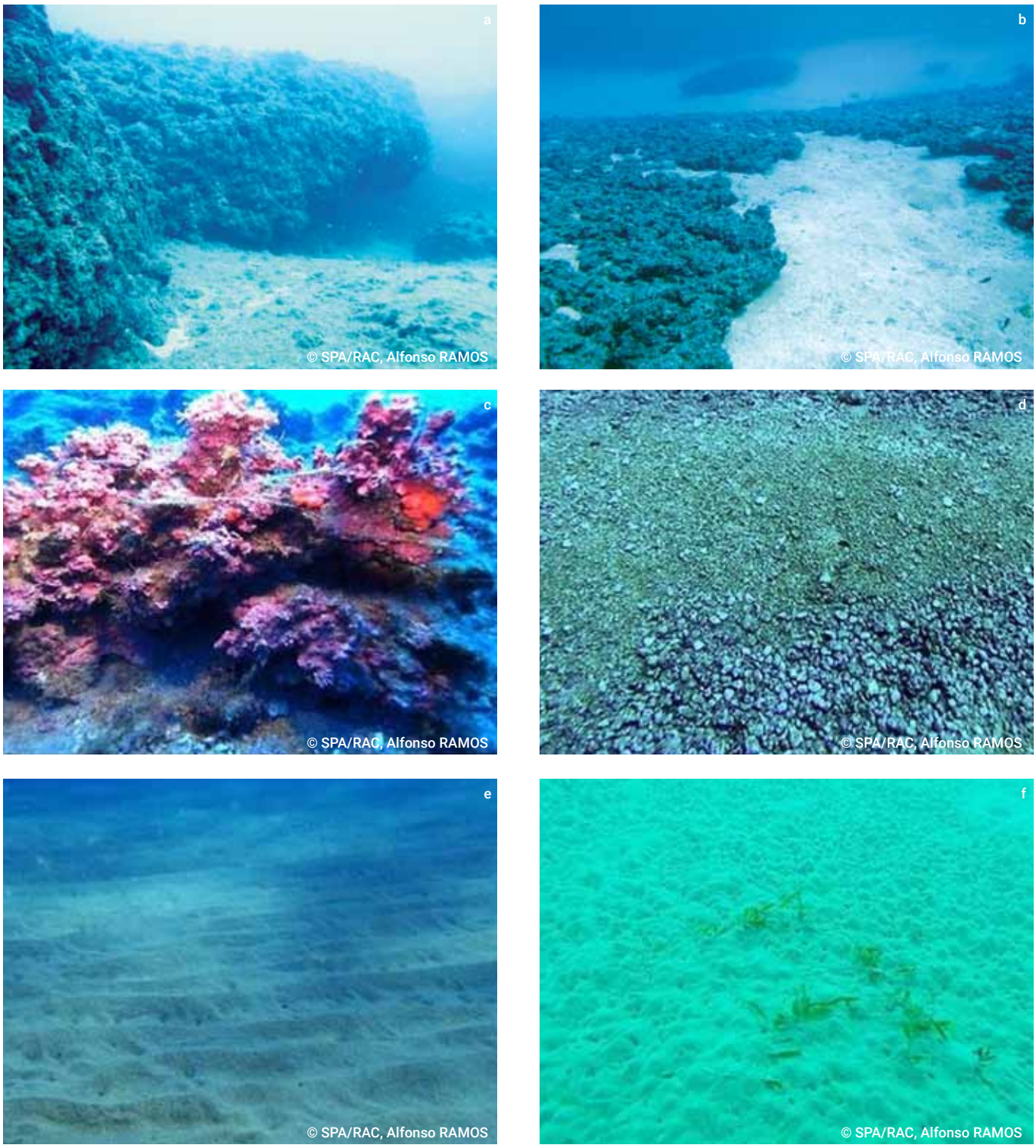

Figure 4.5. Morphological features and substrate types:
(a) rocky outcrops; (b) low rock (<1m) with gravel channels;
(c) biogenic concretion (>40 m down); (d) gravel and coarse sand; (e) fine sand; (f) muddy sand.

4.3 HYDROLOGY

The temperature and salinity profiles in early autumn (30/9 - 4/10/2017) show a relative hydrological homogeneity (25-27°C, 39.2-39.4 psu) in the first 35m down (Fig. 4.6).

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

The vertical distribution of the temperature is an important factor for understanding the bathymetric spread of the Lessepsian species. Based on the profile of the thermocline which descends, between 40 and 60 m down, from 25 to 21 °C, we can assume that from 60m down, the fauna is typically Mediterranean, this has been corroborated by the MedKeyHabitats project campaign on Lebanon's deep-sea communities.

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

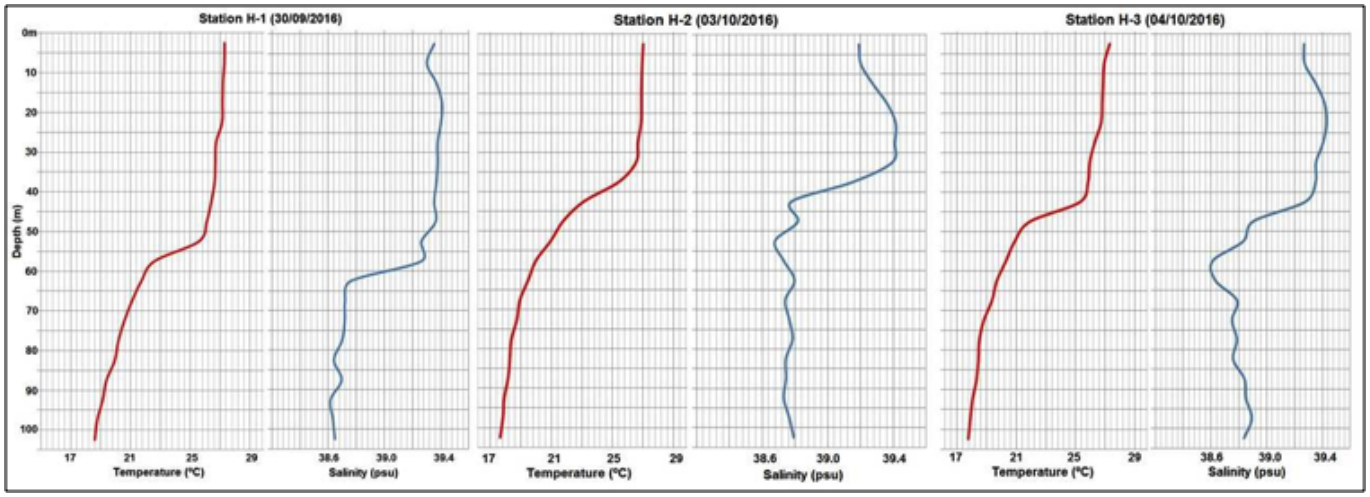

Figure 4.6. Temperature (T°C) and salinity (psu) profiles off Batroun (H-1), Byblos (H-2) and Kfar Abida (H-3).


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5. MARINE BIODIVERSITY

5.1 TAXA

About three hundred and thirty-nine taxa (320 at lower level: family, genus, species; and 9: at higher level: class, order), belonging to twenty six higher taxa (phyla, classes), were observed (see Annex II; Fig. 5.1). The main group was the Mollusca, with 62 taxa (18.8 %), followed by Pisces (59 taxa, 17.9 %) and Porifera (57 taxa, 17.3 %). Worth noting is the low representation of Echinodermata with only 9 taxa (2.7 %). Unlike other campaigns in Lebanon (RAC/SPA-UNEP/MAP, 2014), and despite extensive exploration (0-54 m down), the species *Echinaster sepositus, Paracentrotus lividus* and *Arbacia lixula* were not observed.

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

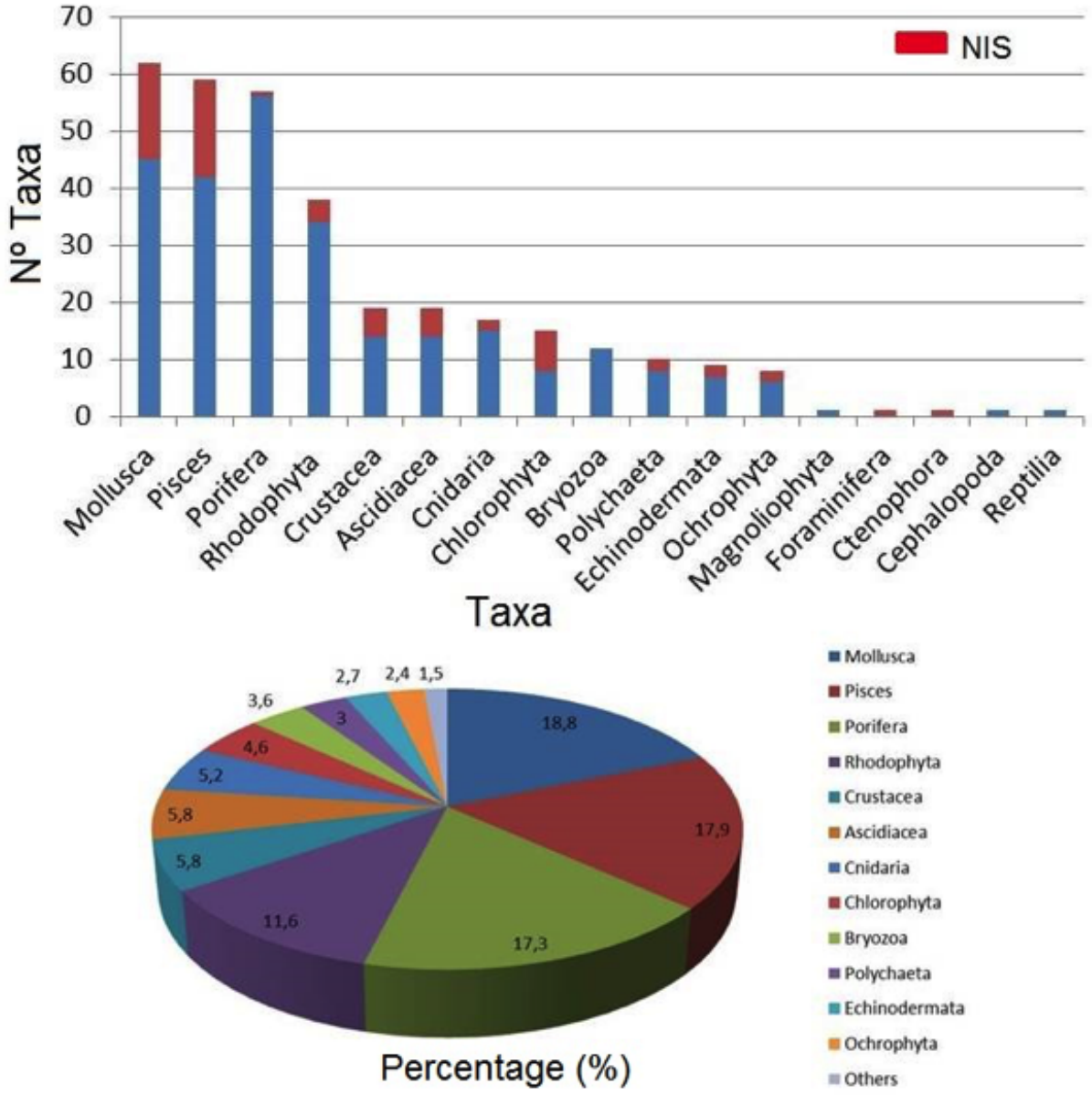

Figure 5.1 Number of species/taxa (in red NIS species) and percentage (%) of the main taxa.

5.2 SPECIES WITH HERITAGE AND INTEREST VALUE

In this paragraph we include the protected species that were observed during the 2016 assignment (see Annex II). Each species is presented with the common synonymies, protection status, geographical distribution, habitats, threats and distribution in Lebanon with some observations. The protection status 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 Special Areas of Conservation designation.
  - Annex II. Species requiring Special Areas of Conservation designation.
  - Annex IV. Species in need of strict protection.
  - Annex V. Species whose removal 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 assignments (2012, 2013).

5.2.1 Macrophyta

The main marine macrophytes important for the protection, and observed in the 2016 assignment in Lebanon appear in the Table 5.1.

Table 5.1. Marine Macrophyta of special interest observed in the Lebanon 2016 assignment.

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

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

a) Ochrophyta

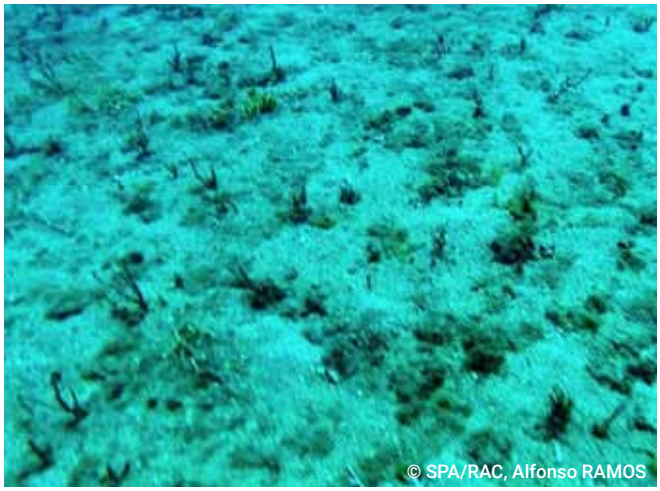

Figure 5.2. *Cystoseira* cf. *foeniculacea* thalli sparse on rocky bottom covered by coarse sand, -27 m down (st. Ba-1).

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 down (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 down (st. B-1). Attached to the flat rock and cobbles; covered by coarse sand and gravel (intense bottom current) where it forms sparse 'forests'.

b) Rhodophyta

Figure 5.3. *Lithothamnion corallioides* rhodolith (Nakoura, st. 15, 43 m down).

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

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

Protection status: Maerl beds (including *L. corallioides*) are included in the Mediterranean Action Plan for the Conservation of the Coralligenous and Other Calcareous Bio-concretions. Species whose removal 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 a 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, being pulled up by fixed bottom nets, trawling.

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

c) Magnoliophyta

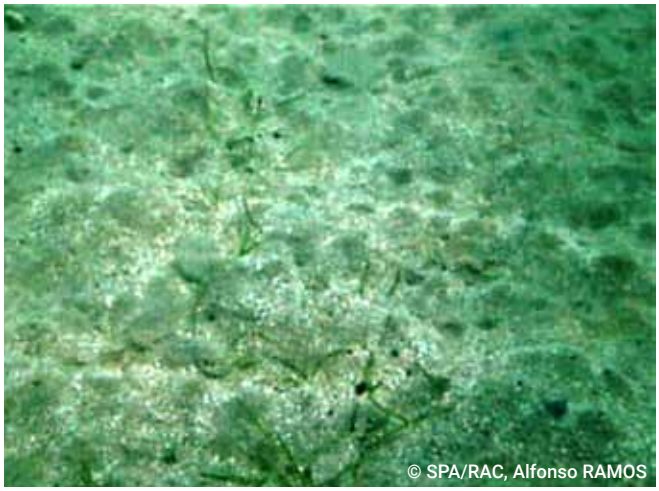

Figure 5.4. Sparse plants of a *Cymodocea nodosa* meadow in Byblos, -27 m down (st. B-3).

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 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 down; and coastal lagoons (Pergent, 2009; Rodriguez-Prieto *et al*., 2013).

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

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

5.2.2 Invertebrata

Marine invertebrates important for protection, observed in the 2016 assignment in Lebanon, are indicated in Table 5.2.

Table 5.2. Marine invertebrata of special interest observed in the 2016 assignment 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 anguliferum	II	II	-	-
Tonna galea	II	II	-	-
Lithophaga lithophaga	II	II	IV	II

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

a) Porifera

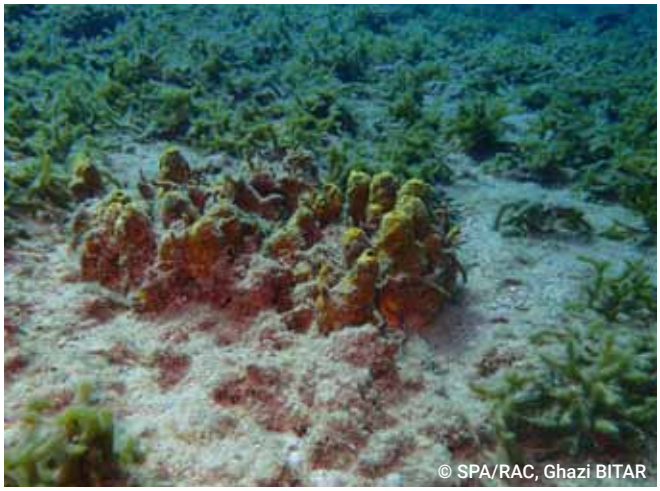

Figure 5.5. *Aplysina aerophoba* on rocky substratum in Batroun, -15 m (st. Ba-4).

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 *Aplysina* spp. plur in the list of endangered or threatened species.

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 down. (Moreno *et al*., 2008).

Threats: Sediment dumping, anchoring, collection by divers.

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

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 *Aplysina* spp. plur in the list of endangered or threatened species.

Geographical distribution: At present, only observed in Lebanon.

Habitat: This species was only sampled in shallow caves.

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

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

Figure 5.7. *Axinella polypoides* on a rocky outcrop off Batroun, at 51 m down (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 crevices and overhangs. The bathymetric range is from 15 to >300 m down (Moreno *et al*., 2008), although it is more abundant in the upper circalittoral horizon (40-50 m down).

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

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

Figure 5.8. *Hippospongia communis* off Byblos, at 40 m down (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 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 down in Libya (Vacelet, 1987).

Threats: Siltation, hyper-sedimentation, being pulled up by fixed nets, trawling, unregulated collection.

Observations: The species seemed very rare in the Lebanon. During the assignment, only one specimen was observed off Byblos at 40 m down (st. By-5).

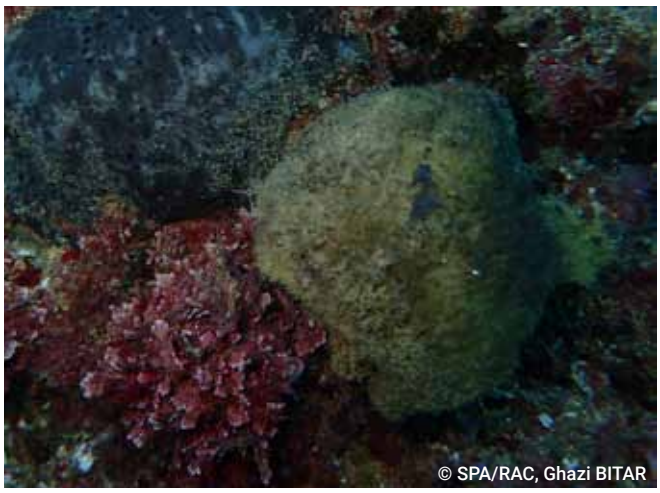

Figure 5.9. *Spongia officinalis*, dead specimen from south of Byblos, 5 m down (st. By-4)

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 it in Annex V (species whose exploitation must be regulated).

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

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

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

Observations: *S. officinalis* was not a common species, but was spreading 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 was observed in shallow and deep waters (3-40 m down) and, usually on overhangs and rocky crevices.

b) Cnidaria: Anthozoa

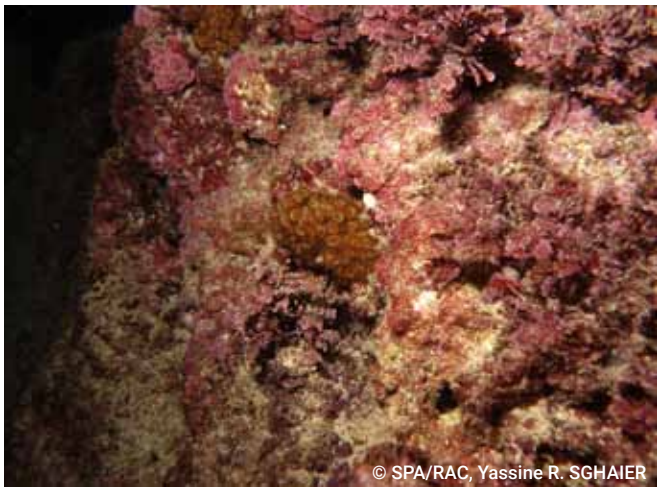

Figure 5.10. The hermatypic coral *Cladocora caespitosa* in Medfoun at 3m down (st. M-7).

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 the Mediterranean Sea. The species has also signaled in the NE Atlantic from southern Portugal to Agadir (Morocco) (Zibrowius, 1980).

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

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

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

Figure 5.11. *Phyllangia americana mouchezii* off Batroun at 50 m down (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 lives in sciaphilic infralittoral and circalittoral bottoms (0-70 m down) (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 down, mainly on coralligenous and cave habitats in Batroun (st. Ba-6), Kfar Abida (st. K-3) and Medfoun (st. M-4)

c) Mollusca

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

Dendropoma anguliferum (Monterosato, 1878)

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 the Mediterranean Sea, from Gibraltar Strait to Lebanon; also, in the near Atlantic coasts from Spain to Morocco (Templado *et al*., 2004).

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

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

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

Maintenant l'espèce *Dendropoma petraeum* est divisée en trois espèces *D. lebeche, D. cristatum* et *D. anguliferum* (Templado et al. 2016). Pour la Méditerranée orientale, c'est *D. anguliferum* qui est présente.

Figure 5.13. Piece of *Tonna galea* shell collected off 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 to Brazil), Mediterranean Sea (Templado *et al*., 2004).

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

Threats: Trawling, collection by divers.

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

Figure 5.14. The sea date *Lithophaga lithophaga* off 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 signaled in the Red Sea (Templado *et al.*, 2004).

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

Threats: Highly appreciated resource whose collection implies the destruction of the rocky substratum by divers.

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

5.2.3 Vertebrata

Marine vertebrata important for protection and observed in the Batroun-Byblos area are indicated in Table 5.3.

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

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

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

a) Actinopterygii

Figure 5.15. A juvenile dusky grouper *Epinephelus marginatus* from Ras-Chekaa at 12 m down.

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 list of endangered or threatened species whose removal from the wild can be restricted. Endangered species (IUCN Red List, 2004).

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

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

Threats: Over-exploitation by spear-fishing of big individuals (male populations).

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

b) Reptilia

Figure 5.16. The green turtle *Chelonia mydas* at 26 m down (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; it lays eggs on beaches (Marquez, 1990).

Threats: Destruction of habitats critical to its life cycle (nesting beaches, feeding areas, shallow seagrass meadows), bycatch from trawling, egg collection, collision with vessels.

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

5.2.4 Other fish species of interest

Then we considered other target fish species without any protection status but of economic value that it would be interesting to monitor in and around Marine Protected Areas.

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* off 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 at minimum size for catching 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 down (Tortonese, 1986b).

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

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

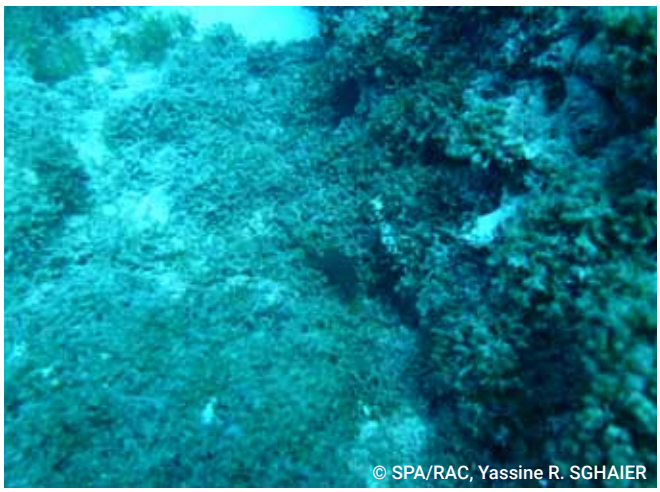

Figure 5.18. Juvenile comb grouper *Mycteroperca rubra* off Batroun (st. Ba-5).

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 at minimum size for catching 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 down (Tortonese, 1986); juveniles in shallow waters.

Threats: Over-exploitation by spear-fishing of big individuals (selective hermaphrodite fishing of male populations).

Observations: *M. rubra* was the most frequent large serranidae species 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 was observed; all the individuals were juveniles (size < 25 cm).

b) Large Sparidae

During the diving observations, *Diplodus cervinus* and *D. sargus* were common, whereas *D. puntazzo* and *Pagrus auriga* are 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 zebra sea bream *Diplodus cervinus* juveniles off Byblos (st. By-7).

Diplodus cervinus (Lowe, 1838)

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

Protection status: None.

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

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

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

Observations: *D. cervinus* was 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 was observed; all the individuals were juveniles (size < 25 cm).

Figure 5.20. *Diplodus puntazzo* on a rocky outcrop off Bylos, at 5m down (st. By-4).

Diplodus puntazzo (Cetti, 1777)

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

Protection status: None.

Geographical distribution: Atlanto-Mediterranean species. Eastern 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 down (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* was very rare in the area: Only one individual was observed in Byblos, at 6m down (By-4).

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

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 down; juveniles in shallow waters (Bauchot & Hureau, 1986).

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

Observations: The species seemed rare, only one juvenile individual was observed in deep waters, 40-50m down off Batroun (st. Ba-6.1). Probably, like other large sparids, the species is subject to high fishing pressure.

5.3 NON-INDIGENOUS SPECIES (NIS)

For exotic species, a total 66 spp. were recorded, 62 spp. Lessepsian and 4 spp. of Atlantic origin (*Paraleucilla magna, Oculina patagonica, Mnemiopsis leidyi and Percnon gibbesi*), representing about 20.2 % of the taxa observed. Figures 5.22 and 5.23 show the number and percentage of species by taxa, respectively: molluscs 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 approximately half the species decreased per depth range (Fig. 5.23 left). It should be noted that the Lessepsian fish *Pterois miles* was only observed from 35 m down (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. Absence of *Laurencia* cf. *chondroides* and *Lagocephalus sceleratus*, very common in the Saida-Nakoura area in 2013 (RAC/SPA - UNEP/MAP, 2013).

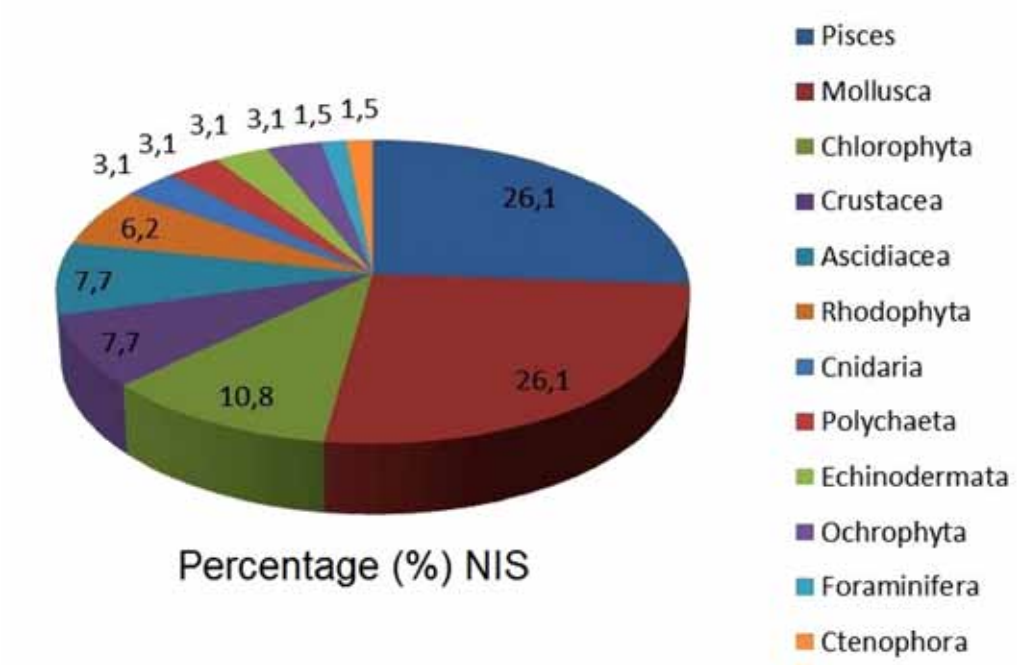

Figure 5.22. Number of NIS by taxa.

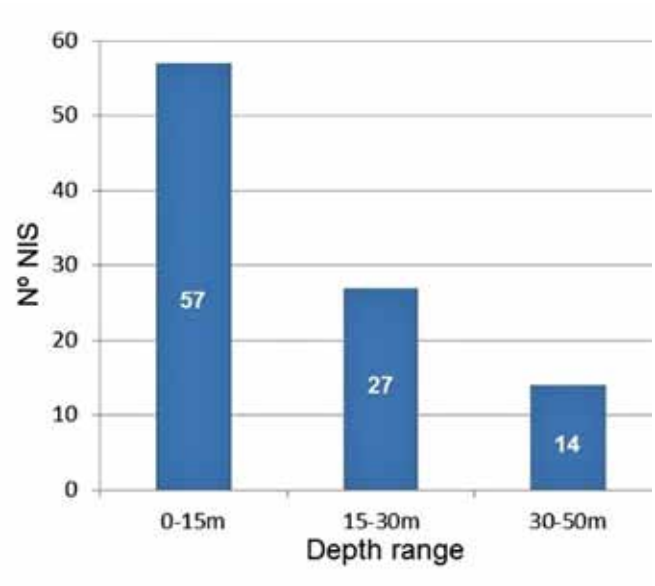

Figure 5.23. Number of NIS by depth range (exact number inside the rectangles).
Pterois miles (right) off Batroun, 49 m down.

5.4 NEW RECORDS FOR LEBANESE BIODIVERSITY

Probably thirteen new species were observed for Lebanese marine biodiversity in the 2016 assignment. The taxa were (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* were the subject of a recent publication (Bitar *et al.*, 2016).

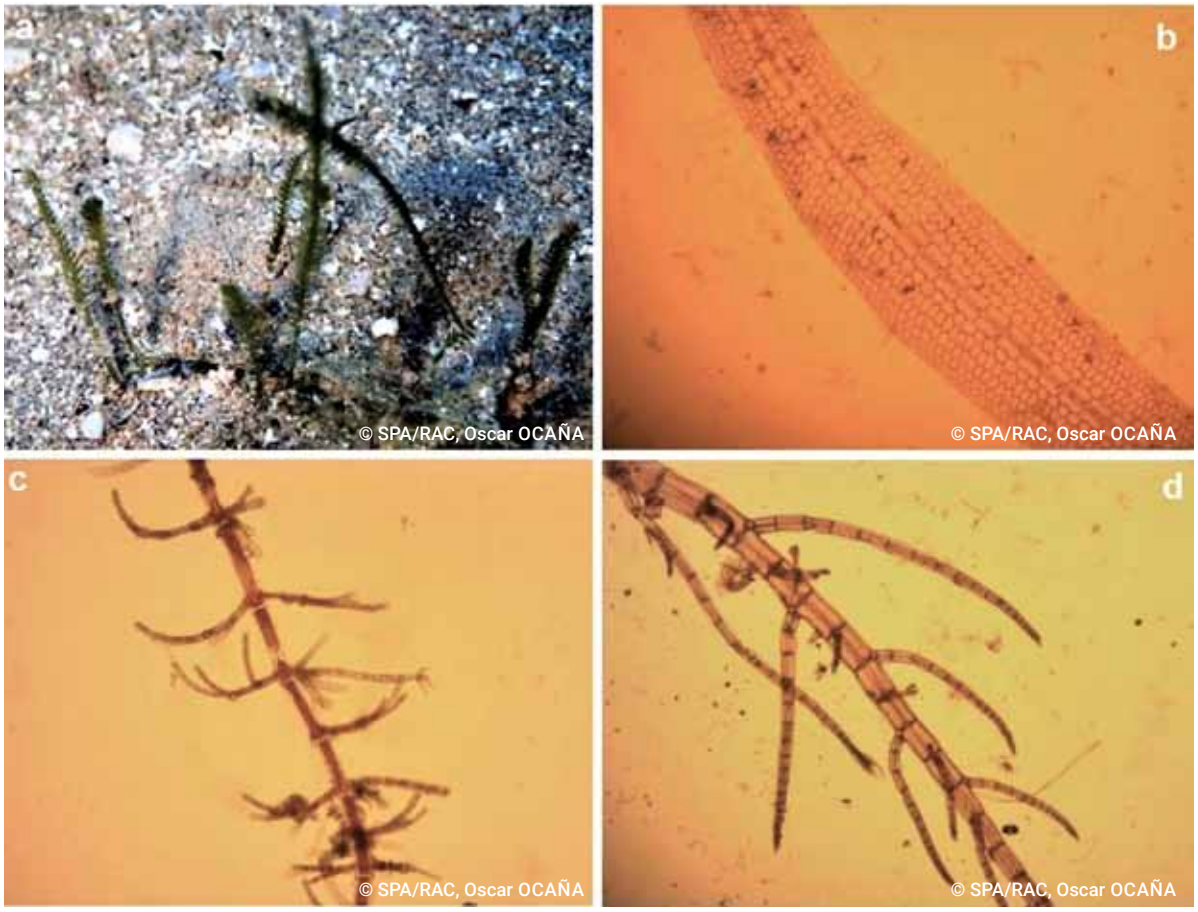

Figure 5.24. first macroalgae recorded for Lebanon: (a) *Caulerpa taxifolia* var. *distichophylla*; (b) *Hypoglossum hypoglossides*; (c) *Heterosiphonia crispella*; (d) *Womerleyella setacea*.

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

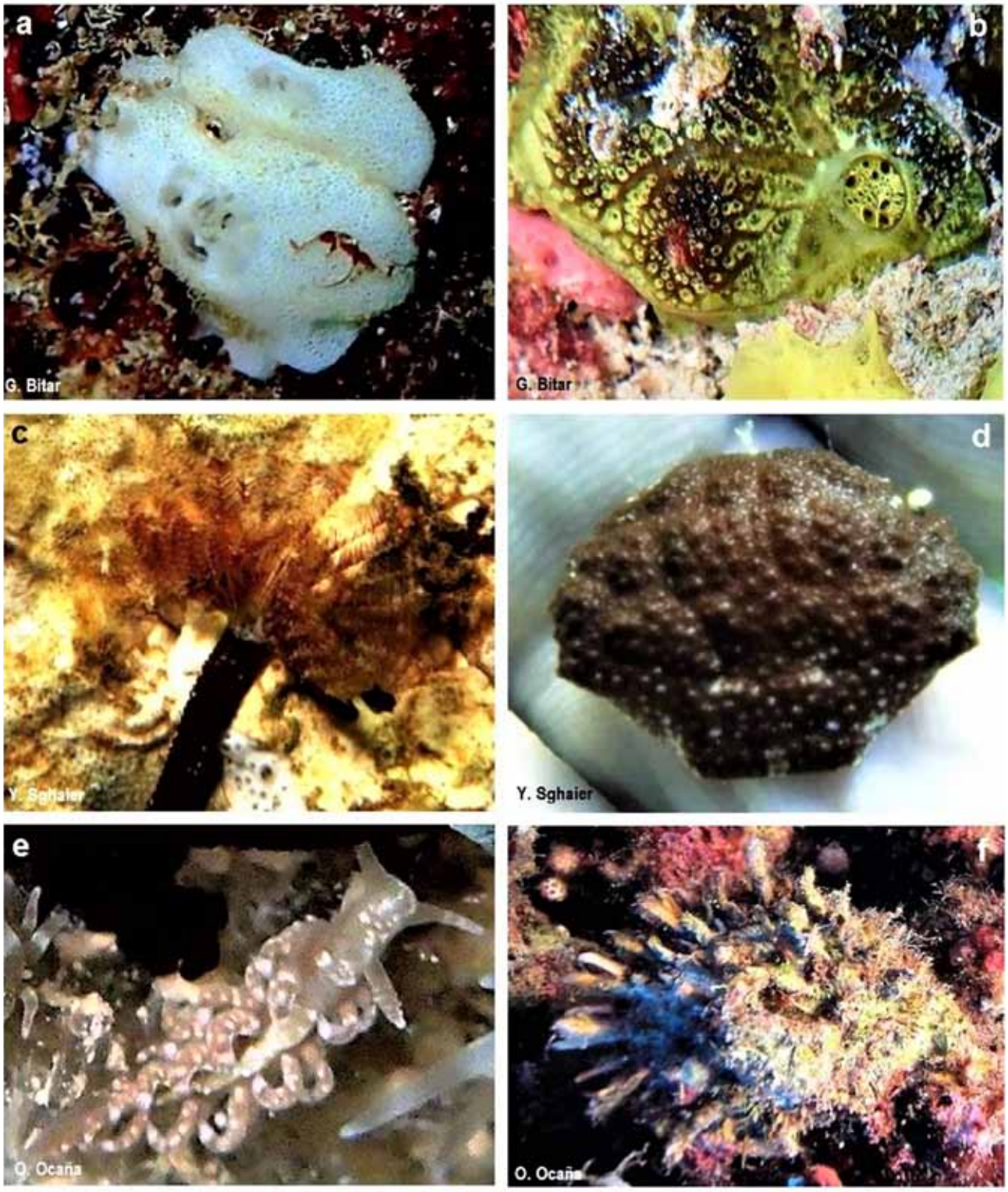

Figure 5.25. New invertebrata recorded for Lebanese fauna: (a) *Borojevia* cf. *cerebrum*; (b) *Poecillosclaridae* sp: (c) *Branchiomma bairdi*; (d) *Halimede tyche*; (e) *Spurilla* cf. *neapolitana*; (f) *Spondylus groschii?*.

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

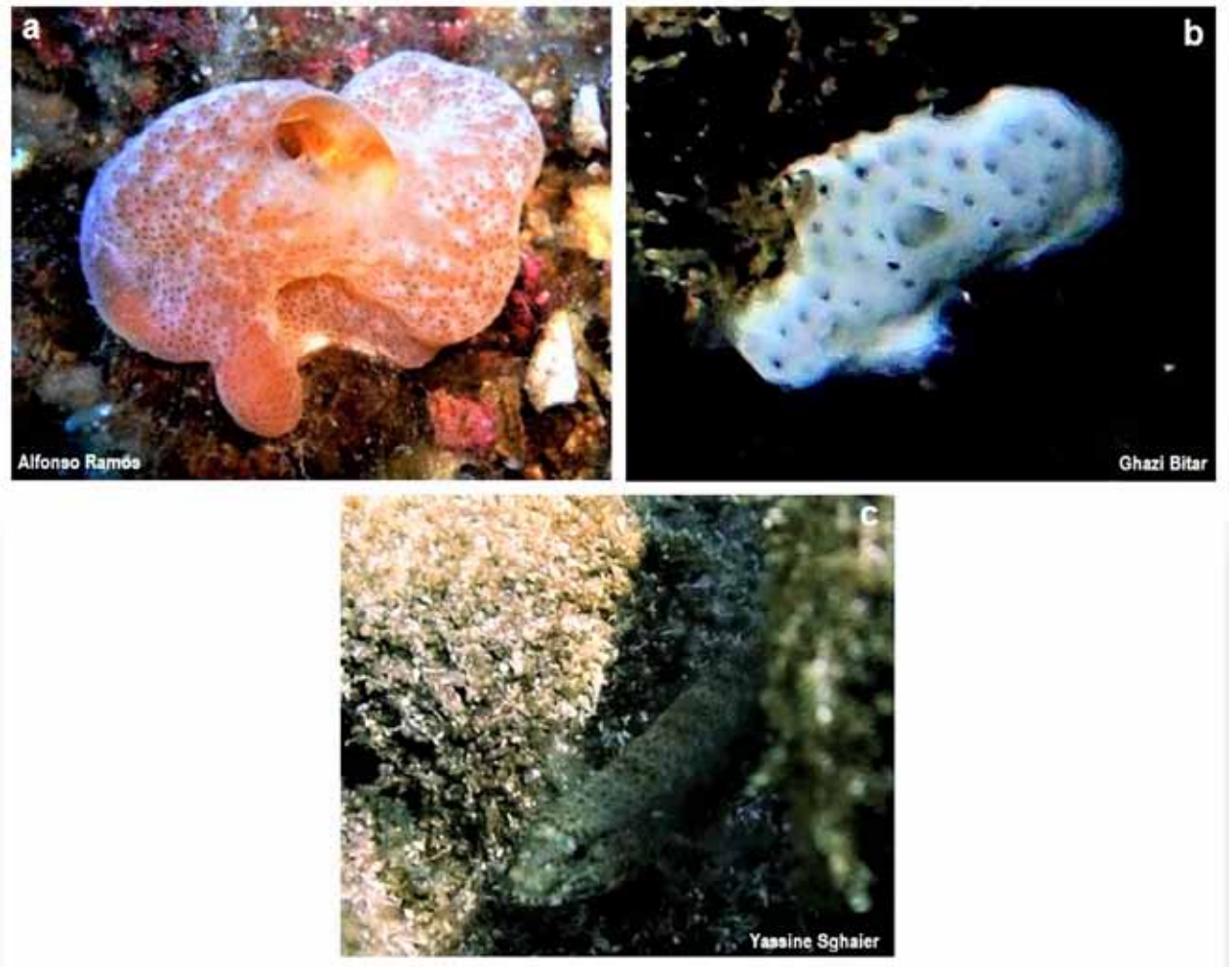

Figure 5.26. New Chordata recorded for Lebanese fauna:
(a) *Didemnum fulgens*; (b) *Lissoclinum perforatum*; (c) *Gobius paganellus*.

5.5 FISH ASSEMBLAGES

The fish assemblage parameters were rather different between the studied stations, and during the study, 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 greater size of the population. On the other hand, the lowest value was observed in Byblos (By-6), with only a mean of 1 species 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 movement; (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

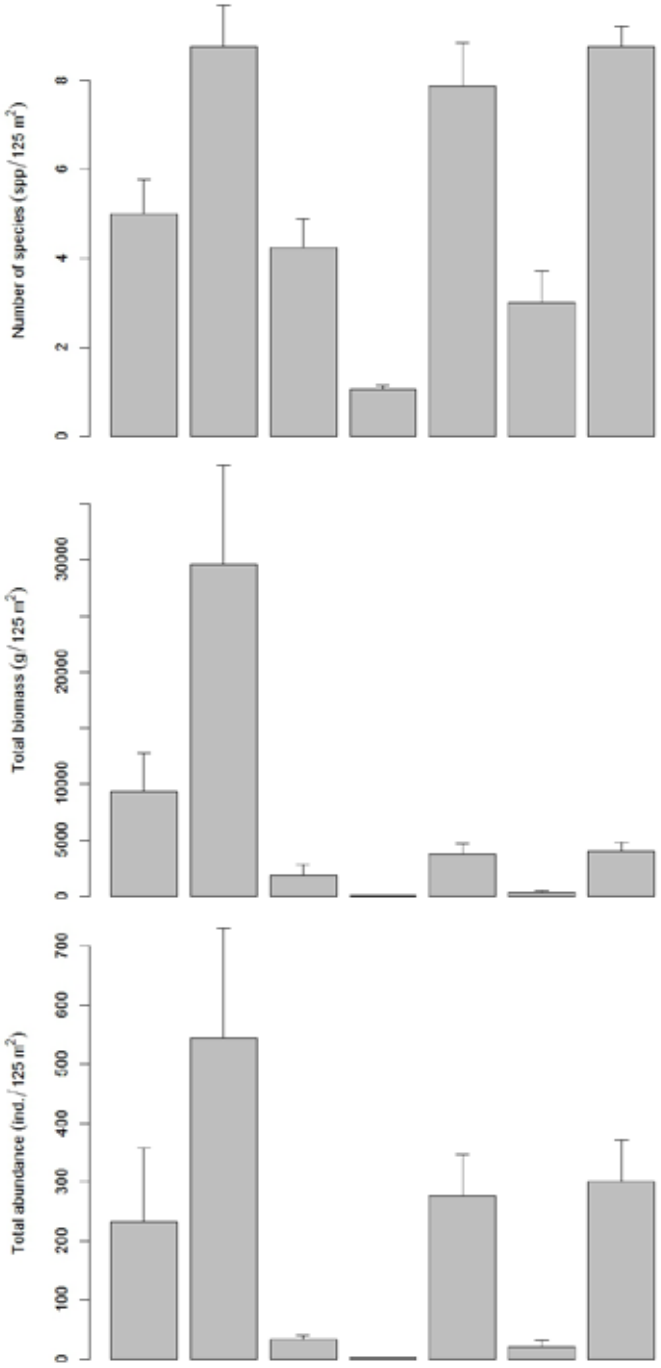

Figure 5.27. Mean values (± standard error) of number of species (nº of spp/125 m^2), total abundance (ind./125 m^2) and total biomass (g/125 m^2) in the studied stations.

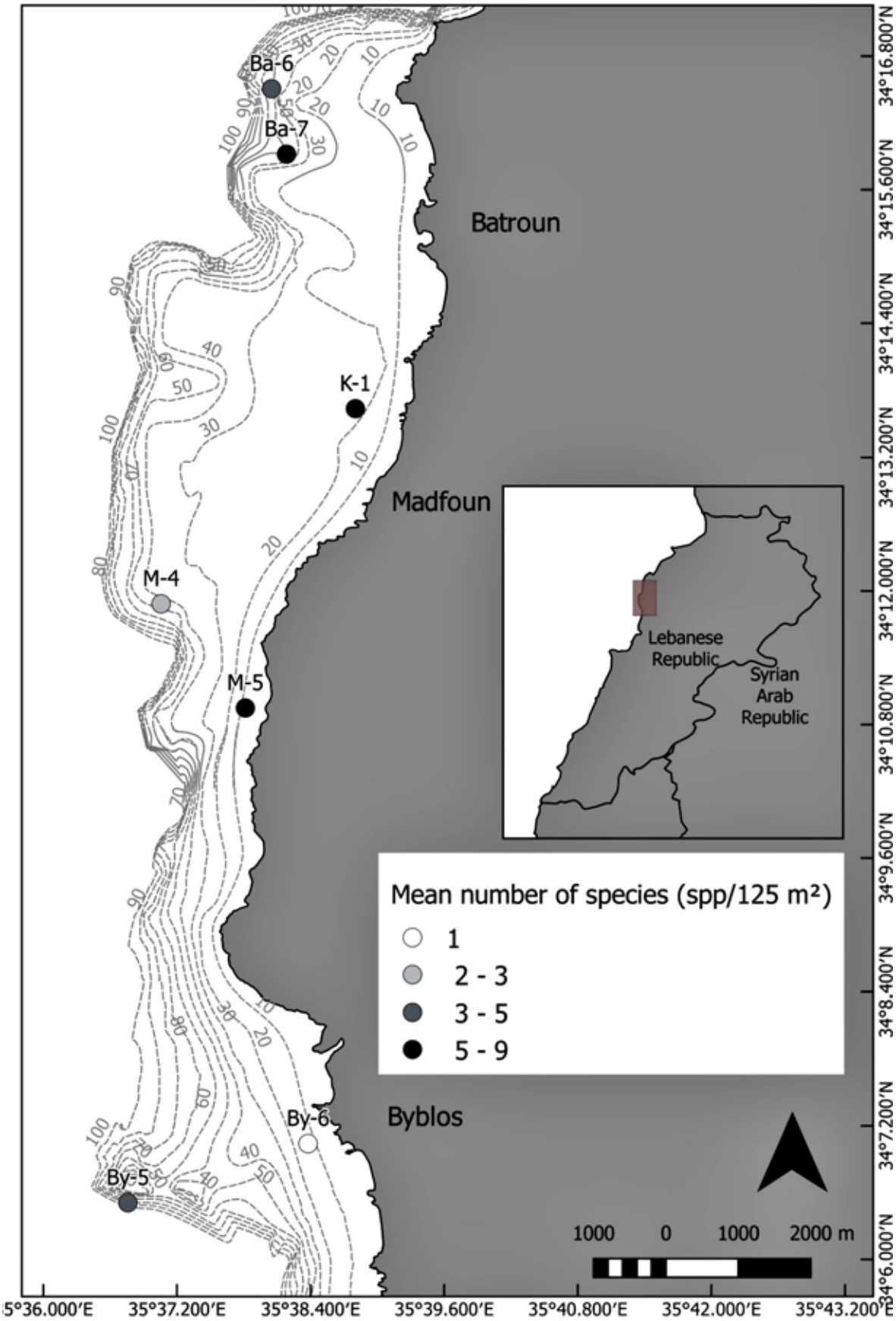

Figure 5.28. Spatial distribution of mean number of species (nº of spp/125 m^2) in the studied area.

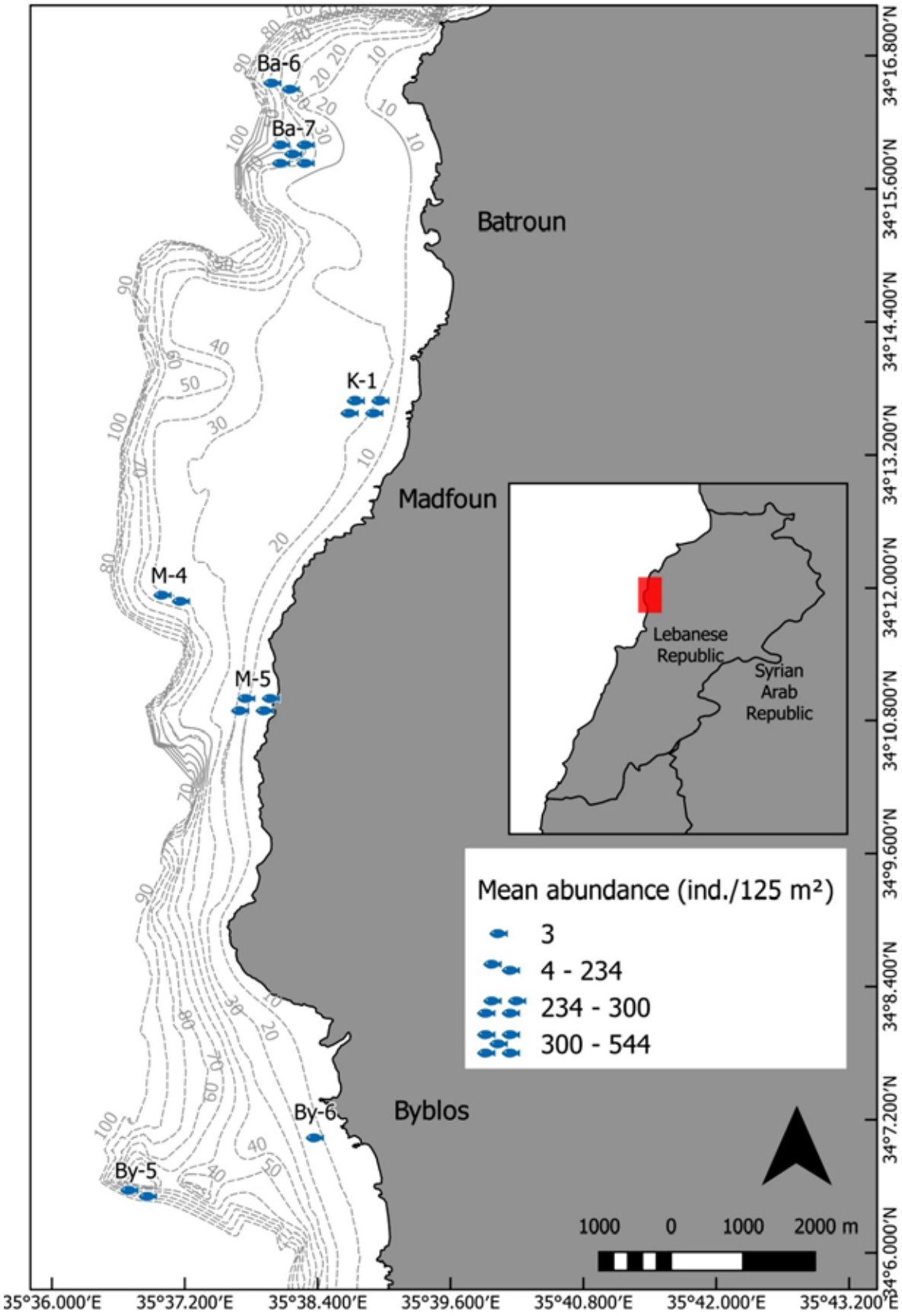

Figure 5.29. Spatial distribution of mean total abundance (ind./125 m^2) in the studied area.

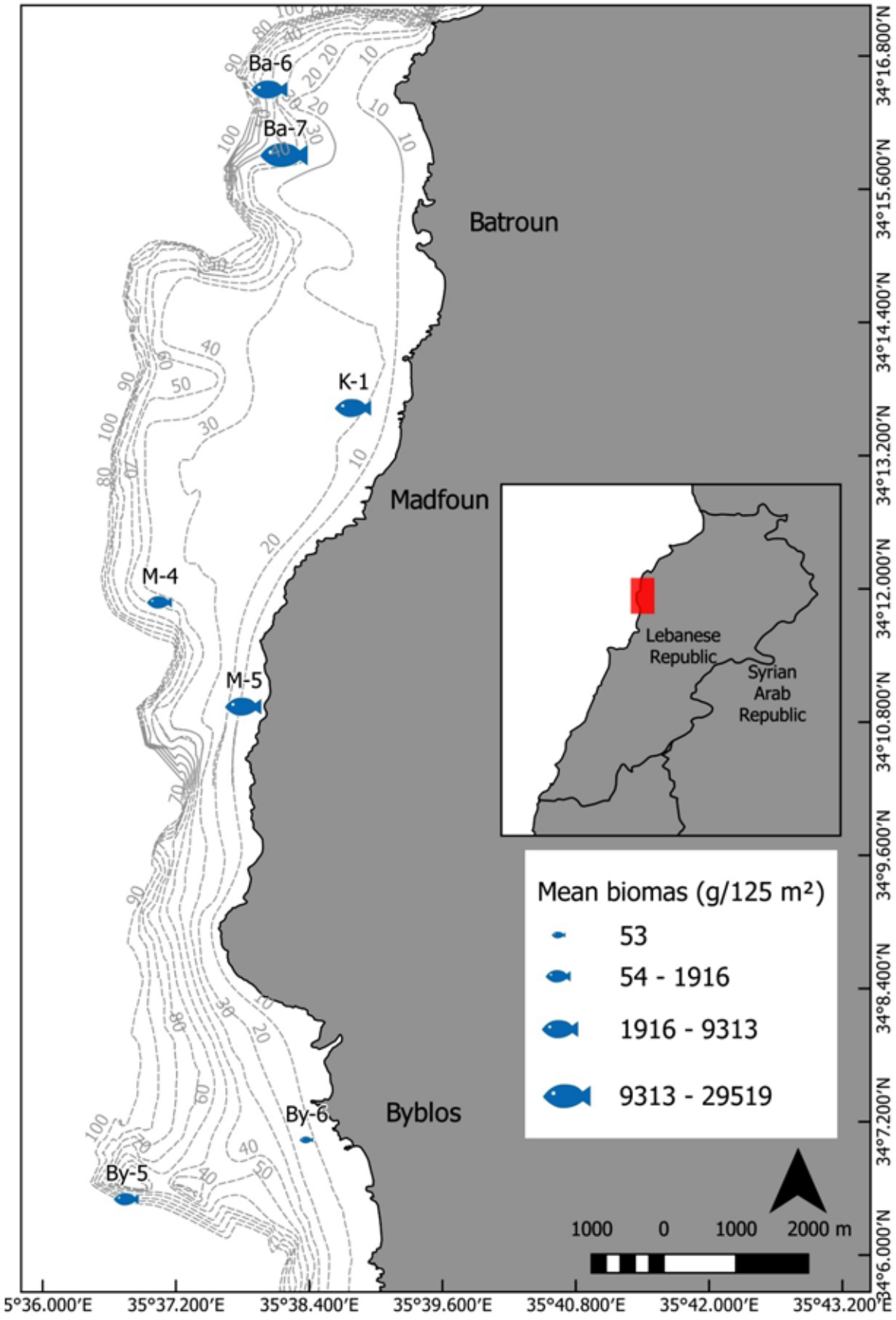

Figure 5.30. Spatial distribution of mean total biomass (g/125 m^2) in the studied area.

5.5.1 Abundance and biomass

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 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	0.06 ± 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 species *C. chromis*, the most 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. varicolensis* (5.8 ± 2.6 ind. m^{-2}). The total abundance of these seven species represented 90 % of total estimated individuals. Between the twelve most abundant species, there were 7 non-indigenous species (*S. rivulatus, S. rubrum, C. novemstriatus, P. varicolensis, P. lineatus, S. luridus* and *T. flavimaculosus*). The total abundance of the non-indigenous species represented 38 % of total estimated individuals.

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

Species	Station						
	Ba-6	Ba-7	By-5	By-6	K-1	M-4	M-5
Apogonichthyoides nigripinniss	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

For spatial categories, the 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 COE1 and COE2 species, respectively (Table 5.8). The main differences for each station were due to the greater abundance of some species: *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).

On the other hand, there were some differences when observing biomass data for spatial categories (Table 5.9). The main difference was 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 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 a 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 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 a vertical axis, (4) nekto-benthic species, (5) relatively sedentary species, (6) cryptic species.

5.5.3 Trophic categories

For 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*. The herbivorous, represented by only two species of Siganus, were observed mainly in Kfar Abida (K-1) and Medfoun (M-5). However, mean biomass for trophic categories (Table 5.11) was affected for the observed macrophagous species *D. pastinaca* in Batroun (Ba-6) and for big individuals of the mesophagous species *S. rubrum* and *P. varicolensis* in Kfar Abida (K-1) and Medfoun (M-5).

Table 5.10. Mean abundance (ind./125 m^2 ± standard error) for 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 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. varicolensis* belonging to this size.

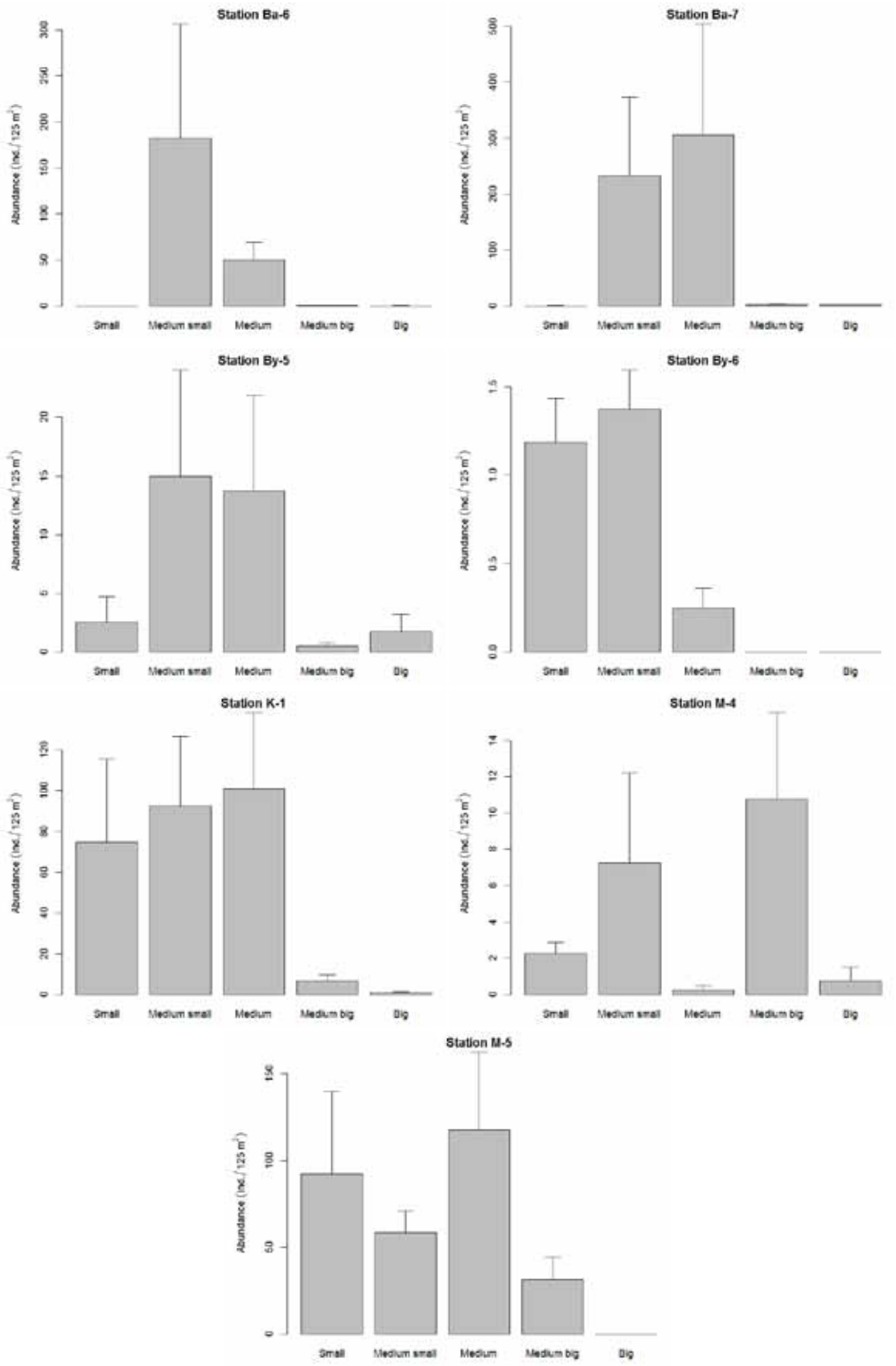

Figure 5.31. Mean abundance (ind./125 m^2 ± standard error) of fish assemblage size structure in the studied stations.

5.5.4 Differences between stations

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

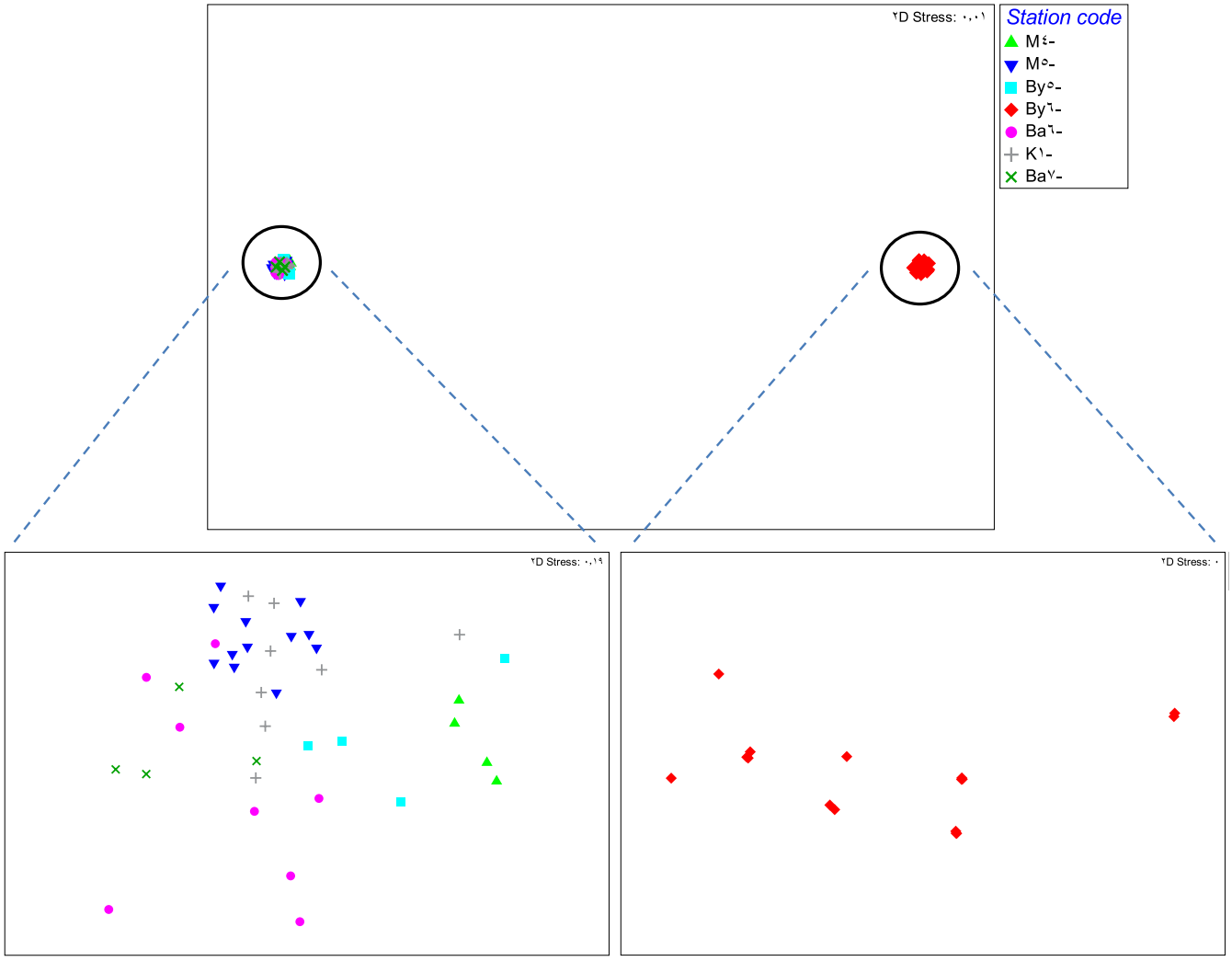

Figure 5.32. Two-dimensional nMDS ordination of abundance of species observed at each underwater visual census.

Regarding these differences in the fish assemblage between stations, an analysis of similarity (SIMPER) (Table 5.12) helped identify the most important species in each one. The station with highest similarity was By-6 (Byblos), with *X. novacula* contributing 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 abundance of species sampled in each station. Only species that contribute up to 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) followed the classifications of UNEP/MAP-RAC/SPA (1998, 2002), mainly based on Pérès & Picard (1964), Péres (1967) and Bellan-Santini *et al* (1994), according to division by stages: supralittoral, midlittoral, infralittoral and circalittoral; and after by substrata (hard and soft). We included species that are most abundant 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 distinguished five groups belonging to stage:

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

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

6.1.1. Biocenosis of 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; sessile fauna is represented by *Chthamalus depressus* and *Ch. montagui*, and 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 was the belt with *Chthamalus* spp.

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

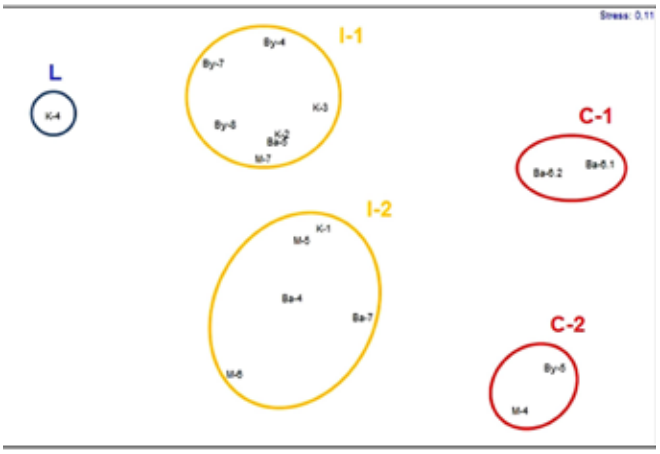

Figure 6.1. MDS analysis distinguishing groups of littoral (L), infralittoral (I) and circalittoral (C) stations (see Annex I).

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

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

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

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

a) Association with *Lithophyllum papillosum* (Fig. 6.4). Fauna in the lower mediolittoral rock was 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 *Dendropoma anguliferum* and the calcareous algae *Neogoniolithon brassica-marina*, forming small cushion and plate structures, and sometimes microatolls (Fig. 6.5a).

Vermetid formations appeared developed throughout the area but were covered by algae, and many of the vermetid bio-concretions were 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 sandstone and limestone rocks. Macroalgae were abundant: 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, represented by the association with *Phymatolithon lenormandii* and *Hildenbrandia rubra* (Fig. 6.6). The sea tomato *Actinia schmidti* was frequent in this enclave.

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

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

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

The infralittoral rock with macroalgae dominance can reach 42 m down, and the macroalgae can be subdivided into four groups, according to 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 hydrodynamism, and can reach about 6-7 m down in a very exposed littoral. Light intensity is very high.

a) Association with *Jania rubens* (Fig. 6.7): The rhodophyte *Jania rubens* dominated the littoral fringe (0-1 m down). Usually it was 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* were present. The abundance of *Elysia grandiflora* on *Bryopsis*, particularly, in Kfar Abida was noted.

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

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

6.1.5.2 Exposed sciaphilic macroalgae

a) Association with *Ellisolandia elongata* (Fig. 6.8): On vertical walls, this corallinacea dominated the substrata, between 0 to 5 m down, with *Lithophyllum incrustans*. Another rhodophyte was present, *Schottera nicaeensis*, but rare. Sessile fauna was 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).

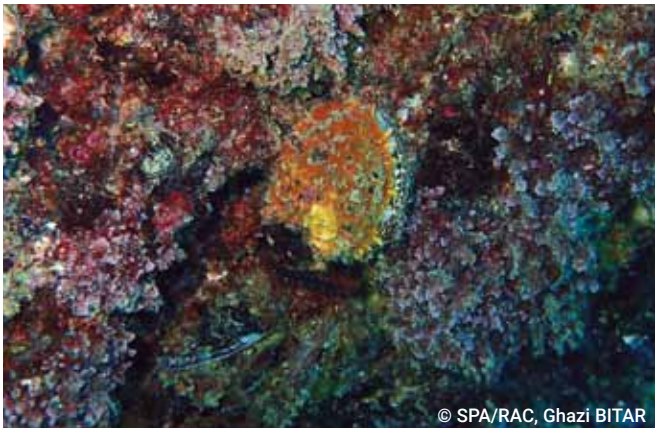

Figure 6.8. Association with *Corallina elongata*; with the bivalves *Spondylus spinosus* and *Chama pacifica*. Kfar Abida, 3 m down (st. K-3).

6.1.5.3 Sheltered photophilic macroalgae

The width of this horizon depends on the light and may reach 40 m down in horizontal surfaces, with moderate hydrodynamism.

a) Association with *Spyridia filamentosa* (Fig. 6.9): In the littoral platform, behind the break zone, the rhodophyte *Spyridia filamentosa* was dominant (Fig. 6.9). Other accompanying macroalgae were *Jania rubens, Ulva rigida* and *Bryopsis pennata*. For mobile fauna, there were 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).

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

b) Overgrazing facies (Fig. 6.10): In some places the rocky substrata was bare and empty of erect macroalgae; only some encrusting (*Lithophyllum incrustant* and *Neogoniolithon* spp.) and erect corallinales (*Amphiroa, Ellisolandia, Jania*), the ochrophyte *Lobophora variegata* and the chorophyte *Codium taylori* were present.

This overgrazing was mainly due to the herbivorous pressure of the fishes *Siganus rivulatus* and *S. luridus*, because the sea urchins *Arbacia lixula* and *Paracentrotus lividus* were absent from the studied zones. Another reason could be the erosion by coarse sand of the rock in heavy storms. Macrofauna was poorly represented, with some encrusting species, such 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).

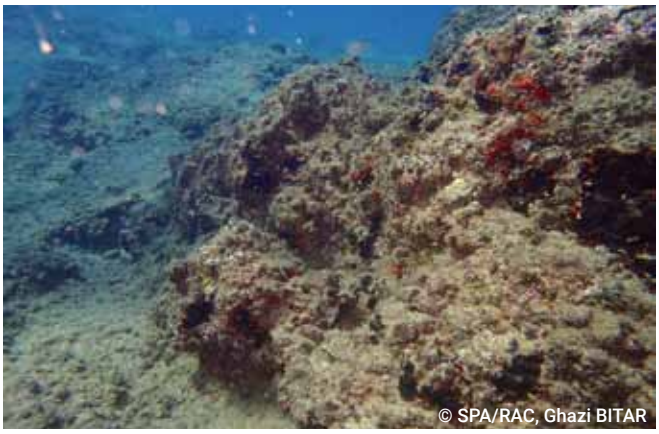

Figure 6.10. Bare rock with corallinales, *Crambe* and *Schizoporella*. Byblos, 5 m down (st. By-4).

c) Association with *Galaxaura rugosa* and Corallinales (Fig. 6.11): Extensive in the whole area particularly near the shore, between 1 to 7 m down. The main species were *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*).

For sessile fauna, the sponges *Cambe crambe, Chondrilla nucula* and *Ircinia* sp., the hydroids *Macrorynchia philippina* and *Pennaria disticha*, the cirripeds (*Perforatus perforatus, Balanus trigonus*), and the bivalves *Chama pacifica, Spondylus spinosus*, *Malleus regulus* and *Dendrostrea frons* were common in this association. The mobile fauna was dominate by the 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).

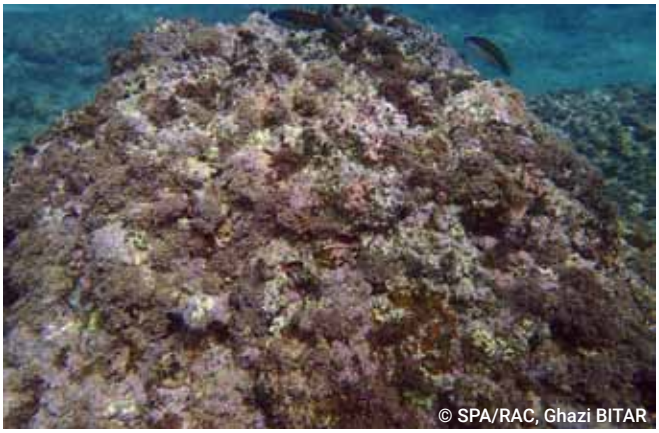

Figure 6.11. Association with corallinales and *Galaxaura rugosa*. Byblos-Amchit, at 7 m down (st. By-8).

d) Association with *Sargassum vulgare* (Fig. 6.12): This interesting association was observed in Byblos, between 2 to 5 m down on a rocky outcrop surrounded by fine sand. The thalli had hardly any secondary ramifications (herbivorous pressure?); however, some rare leaves appeared at the base, and *Padina pavonica* was present, but rare. The concentration of fish was important (Siganidae, Labridae, Sparidae).

Stations: Byblos (By-4).

Figure 6.12. Association with *Sargassum vulgare* in Byblos, at 2 m down (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 down, it between 5 to 30 m down that they were dominant, forming an original facies (no comparable to another one in the Mediterranean), with another associated Lessepsian bivalve, *Malleus regulus*.
The valves created a heterogeneous substratum where algae (Ceramiales, Corallinales), poriferans (*Crambe crambe, Petrosia ficiformis*), hydrozoans (*Macrorhynchia philippina, Pennaria disticha, Eudendrium* spp.), serpulids, cirripeds (*Balanus* spp.), etc. were fixed on the valves. Other common taxa were 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).

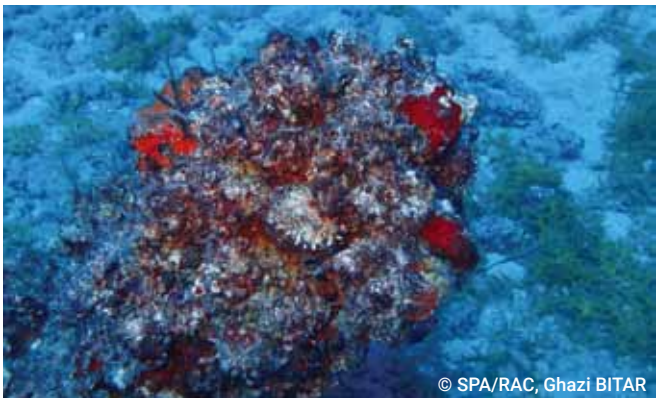

Figure 6.13. Facies with *Chama pacifica* and *Spondylus spinosus*. Batroun, at 21 m down (Ba-4).

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

Associated species were: *Amphiroa rigida, Crambe crambe, Aplysina aerophoba, Eudendrium* spp., *Schizoporella errata* and *Phallusia nigra*. Among the fish, the Lessepsian species *Cheilodipterus novemstriatus* was abundant.

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 down (st. B-4).

g) Association with *Cystoseira* sp. (Fig. 6.15): This interesting association was observed in Batroun, between 19 to 27 m down. Probably the *Cystoseira* sp. was *C. foeniculacea* (= *C. discors, C. ercegovicii*) signaled by Bitar & Kouli-Bitar (2001) and observed in Tyre and Nakoura during the 2013 assignment. The thalli had hardly any secondary ramifications (herbivorous pressure?) and the individuals were more or less isolated.

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

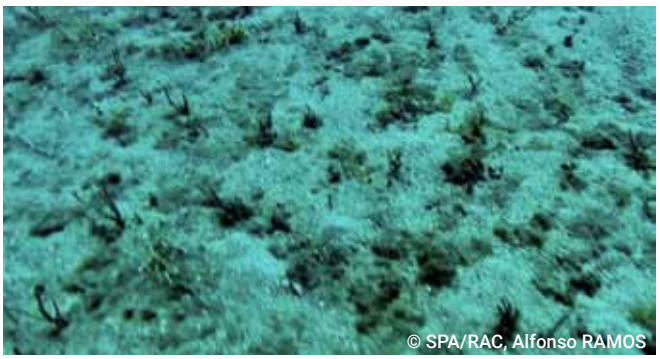

Figure 6.15. Association with *Cystoseira* sp. off Batroun, at 29 m down (st. Ba-1).

6.1.5.4 Sheltered sciaphilic macroalgae

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

a) Association with *Lobophora variegata* (Fig. 6.16): This ochrophyta was present on subhorizontal and vertical surfaces, between 1 to 35 m down, accompanied by the encrusting rhodophytes *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).

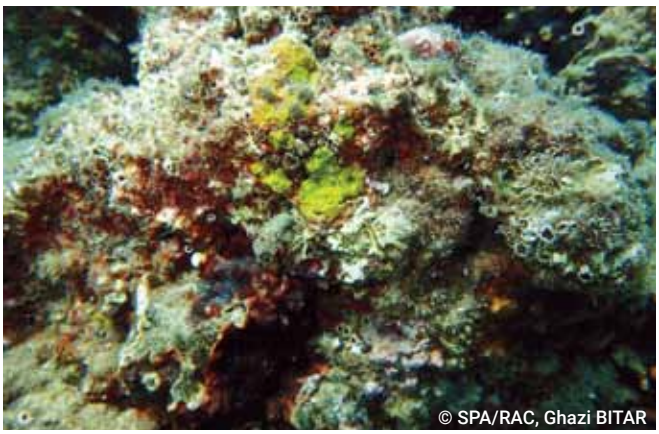

Figure 6.16. *Lobophora variegata* (yellow) with encrusting corallinales. Byblos, at 5 m down (st. By-4).

b) Association with *Peyssonnelia* spp. (Fig. 6.17): Well developed on the sciaphilic rock (down to 30 m down on vertical surfaces). The main algae were the rhodophytes *Peyssonnelia* spp. (inclusing, *P. rubra* and *P. rosa-marina*).
For sessile fauna, poriferans such as *Crambe crambe, Chondrosia reniformis, Aplysilla sulfurea* and *Ircinia* sp were frequent, and the ascidians *Didemnidae* spp., *Herdmania momus* and *Phallusia nigra*. 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).

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

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

Poriferans were 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* were common. Mobile fauna was 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 6.18. Encrusting macroalgae on deep rock (*Mesophyllum, Neogpniolithon* spp.) with the sponges *Aplysina aerophoba* (yellowish), *Phorbas topsenti* (red) and *Crambe crambe* (dark orange). Batroun, at 35 m down (st. Ba-7).

6.1.6 Biocenosis of small blocks

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

Under stones we 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).

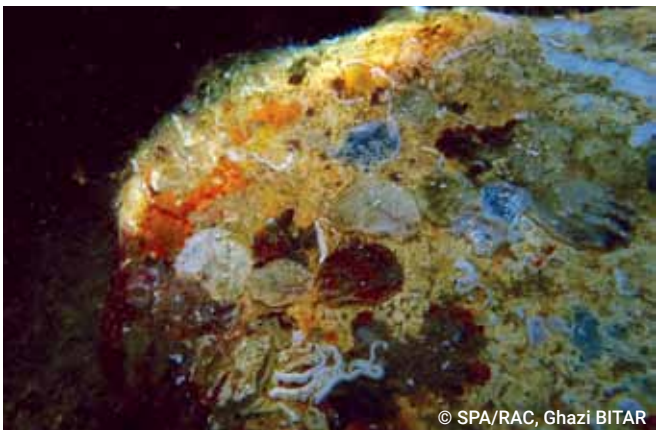

Figure 6.19. Under stone encrusting fauna: *Serpulodae* spp., sponges, the bivalve *Anomia ephippium*, bryozoan (*Watersipora sp.*) and ascidians (*Didemnidae* spp). Byblos, at 4 m down (st. By-7).

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 appeared in enclaves in shallow waters (overhangs, caves entrancies, crevices), and the coralligenous community on horizontal surfaces from 42 m down.

During the 2012 and 2013 assignments, the observations were limited, being done at depths of down to 43 m. One of the objectives of the present assignment was to extend the characterization of the coralligenous in Lebanon, performing dives down to 54 m (max. depth of the present study).

a) Coralligenous in infralittoral enclaves (Fig. 6.20): In the infralittoral enclaves of this community (overhangs, cave entrancies, crevices) there was the littoral rocky coralligenous community with the encrusting calcareous algae *Lithophyllum strictiaforme, Mesophyllum* spp., *Neogoniolithon mamillosum* and *Peyssonnelia* spp.; also, the chlorophyte *Palmophyllum crissum*. Sessile fauna was 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*. Mobile fauna was represented by the polychaete *Hermodice carunculata*; the gastropods *Cerithium scabridum* and *Ergalatax junionae*; and the 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).

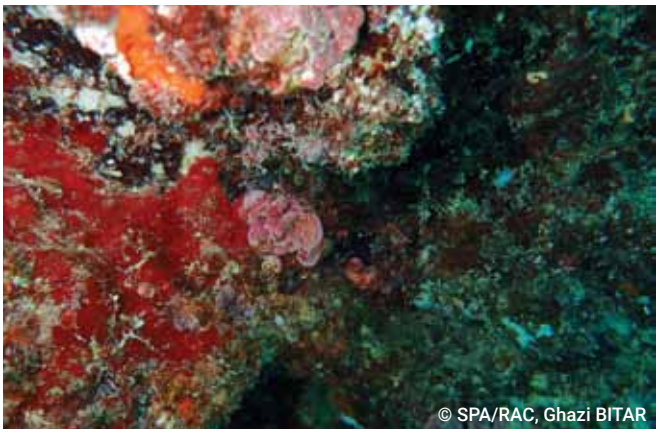

Figure 6.20. Coralligenous enclave on the infralittoral rock, with the encrusting corallinaceae *Lithiophyllum strictiaforme*, and the sponges *Phorbas topsenti* (red), *Crambe crambe* (orange) and *Clathrina coriacea* (white). Kfar Abida, at 4 m down (st. K-2).

b) Coralligenous biocenosis (on circalittoral bottoms) (Fig. 6.21): Macroalgae formed the basal stratum represented by *Lithophyllum strictiaforme, Mespohyllum* sp. and *Peyssonnelia* spp; with the chlorophyte *Palmophyllum crassum*. *Codium bursa* was common, but the soft rhodophyta (*Botryocladia, Halymenia; Hyppoglossum*) were rare. The presence of the exotic rhodophyte *Womersleyella setacea* and the rarity of *Stypopodium schimperi* were clear.

Sessile fauna was 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* were 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* formed concretions on the rocks (Fig. 6.22).

Mobile fauna was 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 mouchezii* (bottom right). Batroum, at 47 m down (st. Ba-6.2).

Figure 6.22. Coralligenous concretions with *Mesophyllum* and *Neogoniolithon* spp., and the poriferans *Crambe crambe*, with remnants of a longline.
Medfoun, at 46m down (st. M-4).

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

The entrance to the caves was colonised by the coralligenous community with the encrustant algae *Mesophyllum* sp, *Lithophyllum strictiaforme, Peyssonnelia* spp. On more sciaphilic surfaces poriferans were 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*.

Mobile fauna is represented by *Hermodice carunculata* and the fishes *Pempheris varicolensis* (very common), *Sargocentrum rubrum* and *Tripterygion melanurum*; the Mediterranean fish Apogon imberbis was 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 americana mouchezii*.
Kfar Abida, 3 m down (st. K-3).

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

This bathyal biocenosis was present in enclaves in the infralittoral and circalittoral stages, where deep caves and ducts are present. It was only observed in the inner part of the Virgin's Cave off Batroun at 47 m down. The substratum was dark brown and covered 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* (bottom left). Batroun, at 47 m down (St. Ba-6.2).

6.2 SOFT SUBSTRATA

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

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

The biocenosis spreads throughout 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 semistriatus, Loripes orbiculatus, Pitar rudis, Glycymeris* spp.; the 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, were many *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 *Nassarius circumcinctus* shells. Byblos, at 7 m down (st. By-4).

6.2.2 Biocenosis of muddy sand

a) Association with Caulerpales *Caulerpa prolifera, C. lamourouxi* and *C. taxifolia* var. *distichophylla* formed fairly broad turfs between 10 and 43 m down on muddy sand. (Fig. 6.26a,c), although they can reach 46 m down. In the same way, from 39 m to 46 m down, *C. scapelliformis* formed extensive prairies (Fig. 6.26b). The gastropod *Rhinoclavis kochi* was common; and on the leaves of *C. taxifolia* var. *distichophylla* the anemone *Buneopsis strumosa*, particularly between 13 to 16 m down (Fig. 6.26d). The ascidian *Microcosmus exasperatus* formed small biogenic blocks where algae were fixed.

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

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

b) Association with *Cymodocea nodosa* It was observed off Byblos, at 27-29 down (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 assignment.

Stations: Byblos (By-3).

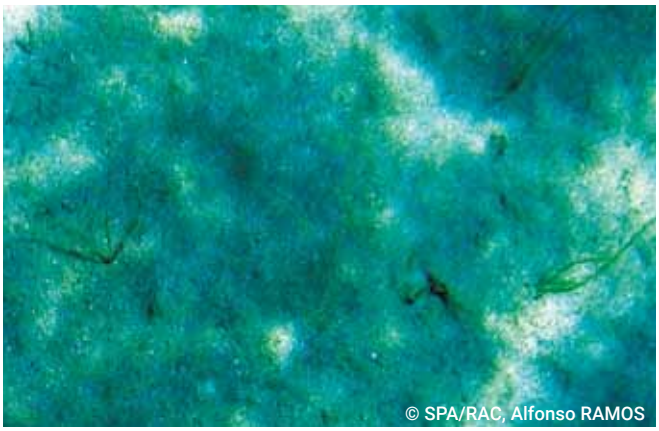

Figure 6.27. Small plants of *Cymodocea nodosa*. Byblos, at 29 m down (st. By-3).

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

Gravel and coarse sand under the influence of bottom currents were widespread in the area, particularly off Batroun (between 12 to 46 m down), sometimes with pebbles and sparse rhodolithes, on flat rocky bottoms, pools and channels between rocks, both in the infralittoral and circalittoral stages. In some places, the chlorophyte *Caulerpa lamourouxi* covered the coarse sediment (Fig. 6.28). Fauna was 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 down (st. Ba-1).

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

An interesting facies was observed off Batroun at 46 m down, represented by a *Sabella pavonina* aggregation. (Fig. 6.29).

Stations: Batroun (Ba-2).

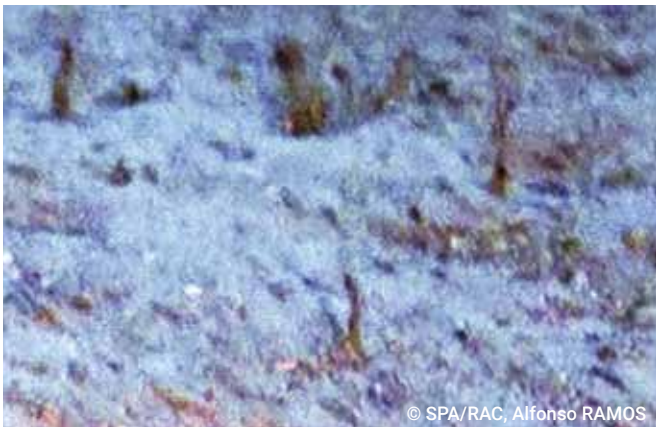

Figure 6.29. Some tubes of the *Sabella pavonina* aggregation. Batroun, at 46 m down (st. Ba-2).

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

With the 'maërl facies' (RAC/SPA: IV.2.2.2), deep maërl beds were present throughout the area, between 33-54 m down. The substratum was formed of 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* were frequent, and the epifauna was 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 fruticulosus*. Medfoun, at 50 m down (st. M-4).

6.3 BIONOMICAL MAPPING

Figures 6.31 to 6.33 show the distribution of the main biocenoses observed in the Batroun-Byblos sector carried out by transects and plot dives, between 0-54 m down.

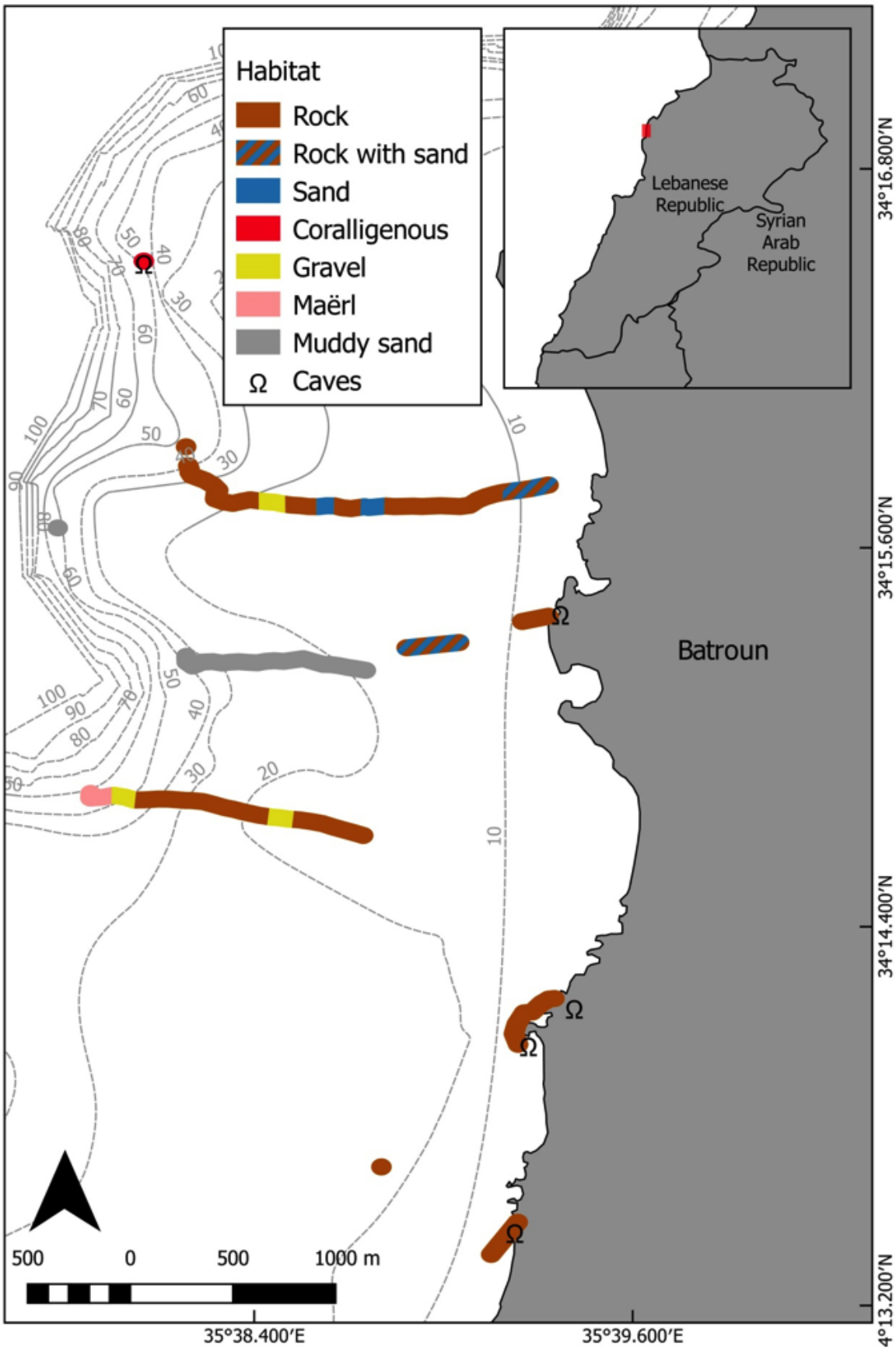

Figure 6.31. Batroun area.

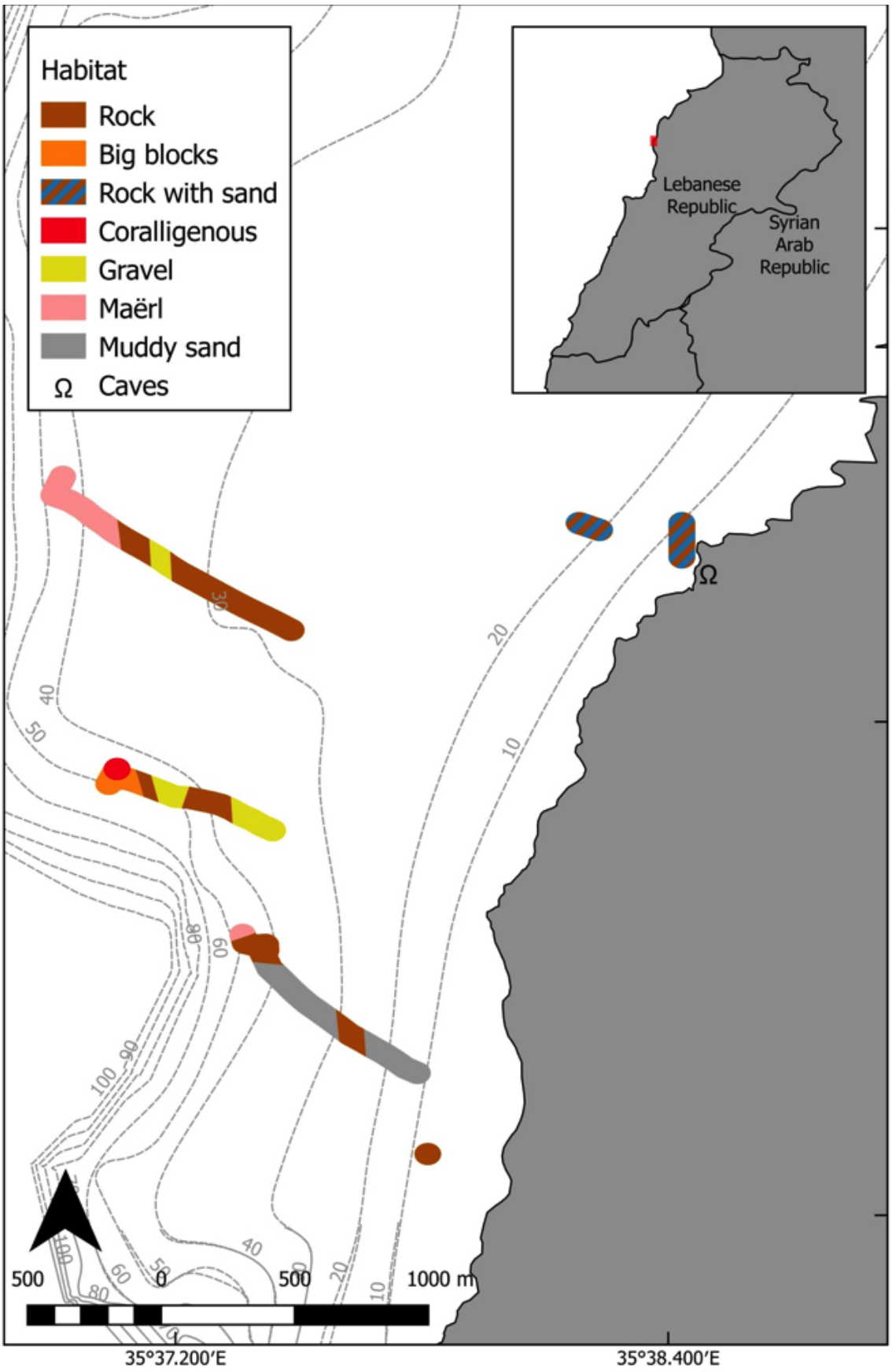

Figure 6.32. Medfoun area.

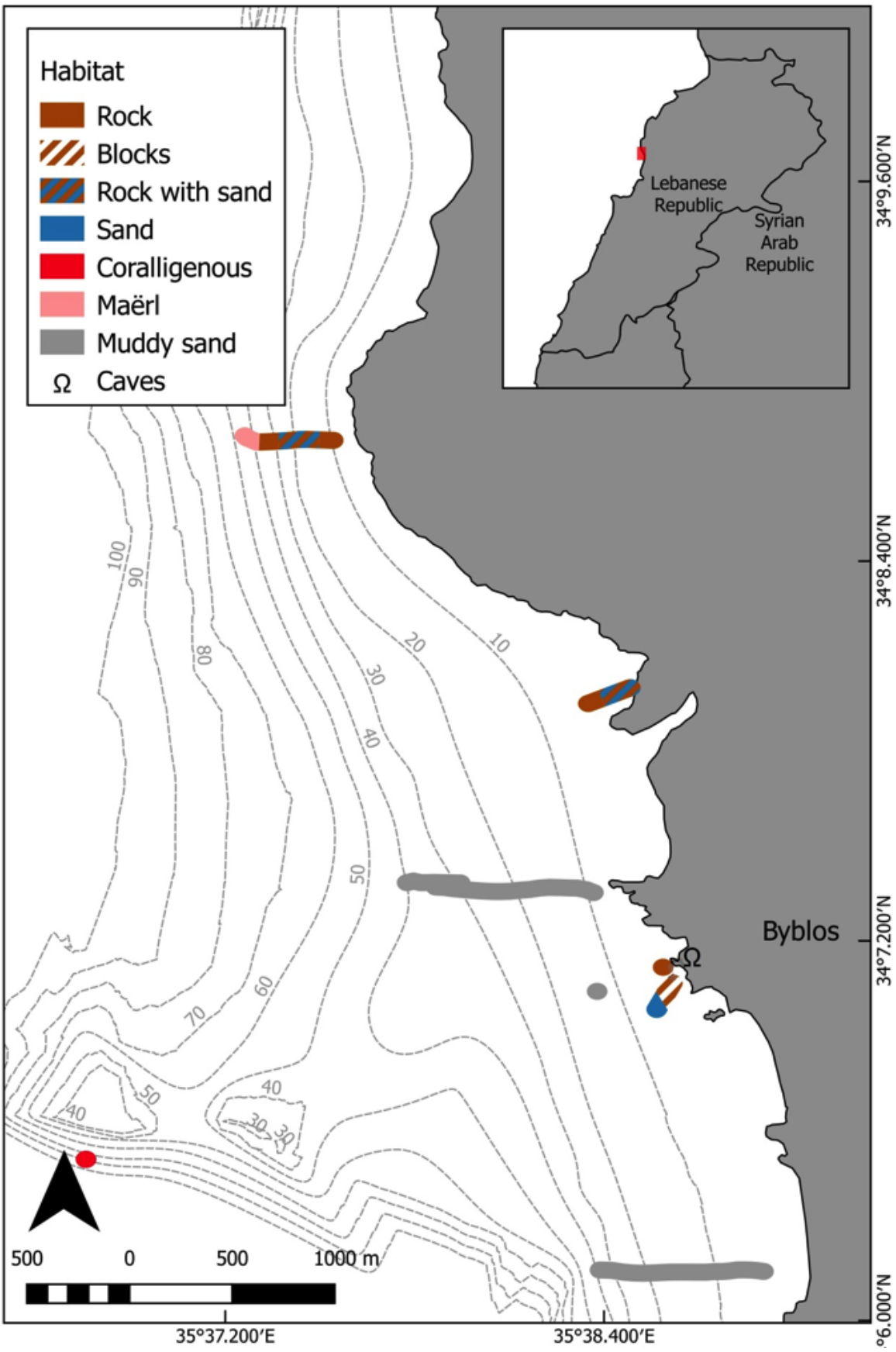

Figure 6.33. Byblos area.

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7. EVALUATION OF THE ZONES

To assess the zones we 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

Table 7.1 shows number of species by zone, relative abundance and the Margalef Index of species richness.

Table 7.1 Species parameters by zone.

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 presented the highest values of S (≈ 200 spp.), followed by Medfoun and Kfar Abida (≈170-172); Batroun presented the lowest value (160 spp.).

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

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

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

M/H = Margalef 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 (the Margalef 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 presented the highest values (0.95), whereas Batroun had the lowest (0.7); Medfoun and Byblos were quite similar (≈ 0.9).

7.2 EVALUATION OF HABITATS

To assess the habitats (biocenosis, associations or facies), we followed the UNEP/MAP (1998) valorisation, adapting the criterion values to the different habitats (Table 7.2). These habitats, structurally and functionally dependent on their complexity and heterogeneity and, as so as the human impacts, harbour a different diversity of species, some of them of great ecological (key-stone species), heritage (vulnerable and endangered species), rarity and/or economic 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) Heritage 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 from UNEP/MAP, 1998).

Some of these could be considered as priority, i.e. requiring, due to their vulnerability, their natural heritage quality, their rarity or their high aesthetic value, specific protection whereas the biocenosis itself or the other associations/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 criteria). Habitats with value 1 (which represents the minimum value) are not considered, that is the reason for subtracting 1:

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

Table 7.3 represents the evaluation of the zones according to 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, which 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 was 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 down).

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

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. Encrusting 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 heritage 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 presented the highest value (0.37), followed by Medfoun (0.33) and Byblos (0,26); Kfar Abida had the lowest (0,21). However, Kfar Abida was not sampled for coralligenous deep bottoms (> 40 m down).

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

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 anguliferum	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 OF FISHING INTEREST

The study of the commercial fish populations offers an important criterion for establishing Marine Protected Areas because it represents the local fishermen's main resource, and this resource must be exploited rationally, in order not to exhaust it. The fish parameters (mainly species richness, abundance and biomass) by zone are previously treated in Paragraph 5.4 (Fish populations). Table 7.5 summarizes the commercial fish biomass by zone.

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

Table 7.5. Commercial fish species and its biomass (gr/125 m^2) accordingt to the zone.

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 different uses and human activities (industry, commercial, traditional and creational fisheries, tourism, littoral urbanisation, local population; Table 7.6), i.e. a variety of impacts and, subsequently, possible threats.

- Littoral frequentation: urbanisation: domestic sewage discards (values = 0-3), solid waste (0-2), trampling (0-2).
- Fishing: commercial (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 discard, concrete, oil): industrial sewage discard (0-3).

The use/impact index (UI, Table 7.6) by zone was calculated from the sum of the use-impact values/zone divided by 39 (MVU = 13 uses-impacts x 3). To assess the zones, from the point of view of conservation, we calculated the Naturalness Index (NI = 1-UI).

Although the littoral of the zones presented many uses and impacts (industry, littoral urbanization, different fishing activities, sewage discard...), some areas remain little altered, like Kfar Abida and Medfoun. These areas are interesting for establishing protection measures with low impact uses.

Table 7.6. Uses and impacts of the zones.

Uses-Impacts / Zones	Ba	K	M	By	MVU
Commercial 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 waste	2	2	2	3	3
Domestic sewage discard	2	1	1	2	3
Industrial sewage discard	1	-	-	1	3
Beach/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 ZONES

To assess the zones, once the five indices are obtained (biodiversity, habitats, interesting species, commercial fish biomass and naturalness), the conservation value (CV) of each zone is calculated from 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:

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 Abida-Medfound (≈ 0.75) present a high level of conservation. While Byblos has a medium level (0.64).

Table 7.7. Evaluation of 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)

An important historical and tourist area with the city of Batroun (45,000 residents) and a fishery port with small-scale fishery fleet (Fig.7.1a). Place of historical interest with the Phoenician wall (Fig.7.1b) and medieval city.

a) Geomorphology: The coast is predominantly low rocky with wide littoral platform and small caves and coves. On the seabed the low rock is dominated by channels of coarse sand and gravel. Some rocky outcrops appear between 40 and 50 m down, like the one where the Virgin's 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 presented, a high habitat index (0.96). Among the habitats of interest are:

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

ii) small blocks community;

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

iv) semi-dark and dark cave communities.

d) Interesting species: Although it presented the lowest biodiversity index, in terms of species of interest, the index was the highest (0.37); outstanding were: *Cystoseira* sp, *Aplysina aerophoba, Axinella polypoides, Spongia officinalis* and *Phyllangia americana mouchezii*.

e) Commercial fish biomass: It was the area with by far 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 tourist place (high urbanization) with a big traditional fishery (lost nets). Therefore, the uses and impacts from human frequency are high (shore angling, spearfishing, trampling, solid waste, beach/bathing). Next to the village is the big industrial area of Selaata. The naturalness index was low (0.21).

g) Environmental evaluation: Despite the low environmental assessment, the total assessment of the area was the highest (0.84), because it presented the highest indices in species of interest (0.37), 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. Access to the rocky coastline (wide platforms and littoral pools) and to the community of small blocks (cove near the CNRS) allows the study and practice of marine ecology. Also, we should emphasize the presence of circalittoral rocky outcrops (40-50 m down) with coralligenous and caves (Fig. 7.1d), one of them having an image of the Virgin Mary; however, due to strong currents, diving must only be done with trained personnel.

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

7.6.2. Kfar Abida - Medfoun (Fig. 7.2)

An interesting area south of Batroun with a relatively low density of construction (Kfar Abida and Medfoun villages; Fig. 7.2a), some tourism with relatively low human frequentation (Fig. 7.2b). The coast is well conserved, without marinas or 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 presented a similar Margalef Index (MI = 26-27; 170-172 taxa). However, when divided by the number of habitats, Kfar Abida presented the highest (RBI = 0.95).

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

d) Interesting species: For species of interest, the index varied between 0.33 (Medfoun) and 0.21 (Kfar Abida). These species included: *Lithothamnion corallioides, Aplysina* spp., *Axinella polypoides, Spongia officinalis, Cladocora caespitosa, Phyllangia americana mouchezii, Dendropoma anguliferum , Diplodus cervinus* and *Mycteroperca rubra*.

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

f) Uses-impacts: There is no major urbanization in the area, Kfar Abida and Medfoun are small villages, with low-medium tourism. In the absence of significant human concentrations, contamination by solid waste and by residual water is relatively low; and beach activities are localized. However, traditional and recreational fishing (shore angling and spearfishing) are important.

g) Environmental evaluation: The two areas hadthe 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 for the study of coastal communities (photophilic/ sciaphilic and exposed/sheltered enclaves).

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

7.6.3. Byblos (Fig. 7.3)

An important historical and tourist zone with a small fishery port (Fig. 7.3a,b); it is highly populated (around 100,000 residents in the area), with wide beaches.

a) Geomorphology: The zone presents some long beaches with localized rocky shore. Within the rocky areas with wide coastal platforms is Fartouch 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 habitats by zone it held second place (RBI = 0.90), below Kfar Abida (0.95).

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

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

ii) small blocks community;

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

iv) semi-dark and dark cave communities.

d) Interesting species: For species of interest, the index was one of the lowest (0.26), outstanding were: *Cymodocea nodosa, Aplysina aerophoba, Axinella polypoides, Spongia officinalis* and *Diplodus cervinus*.

e) Commercial fish biomass: It presented, together with Medfoun, the lowest value (FIB = 0.07). However, some species were 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 populous tourist village (high urbanization) with a big traditional fishery (presence of lost nets) and recreational boats (mooring). Therefore, the uses and impacts caused by human frequentation are high (shore angling, spearfishing, trampling, solid waste, beach/bathing), and thus naturalness was 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 was 0.64, which represents a medium value. However, Byblos had high 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, 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 craft; (c) Fartouch coast; (d) infralittoral rock in Fartouch (st. By-8).

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8. MARINE PROTECTED AREAS, ZONING AND MANAGEMENT

In the previous paragraph, we have assessed the different zones (taxa biodiversity, habitats, interesting species, fish populations, naturalness) and thus 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 (in the north) and Ras Barbara. It presented the highest values (0.84-0.75) with an interesting rocky outcrop (40-50 m down) with coralligenous, semi-dark cave and dark cave communities off Batroun. The rocky shore is irregular with wide littoral platforms and pools, and the cove near the CNRS center harbors an interesting community of small blocks. Although there is high human pressure concentrated in the Batroun sector, this is not very strong (compared to Byblos), proof of this being the high value of the conservation index (CI > 0.75).

b) Byblos: Between Ras Amchit (in the north) and Fidar (south). It presented the lowest CI value (0.64). However, it presented 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.) strictly protected area status connot apply, 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 status is included (educational zone) of interest for popular education.

As in our previous work (RAC/SPA-UNEP/MAP, 2014), we applied zoning based on the biosphere reserves idea (Price *et al*., 1993), managing IUCN's Marine Protected Areas (Day *et al*., 2012), and adapting them to the needs of the 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 Capes Selaata and Barbara and the isobaths 0-50 m down (about 2000 m from the coast), covering a surface of about 3000 ha (Figs. 8.2).

a) Core zone (blue): Rocky outcrop off Selaata Cape, between 40-50 m down (Fig. 8.2), with the Virgin's cave. In spite of being in front of the industrial complex of Selaata, the strong currents in 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 (commercial and recreational) is prohibited. The protected area is circular, 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 a big cave, it is suggested that the protection status for this area be 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 of 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, snorkelling and scuba-diving. No traditional or recreational fishing, bait collection, mooring, or increased urbanization of the zone.

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

d) Multi-use or peripheral 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 part of northern Lebanon. Activities currently carried on in the marine environment (bathing, traditional fishing, recreational fishing from the shore, scuba diving), may continue. Industrial activities and the direct discharge of sewage and/or sediment, and the leaving of debris or trash on the shore should not be permitted. Also, a plan is needed to avoid the pollution and sedimentation produced by the Selaata industrial complex, located north of Batroun.

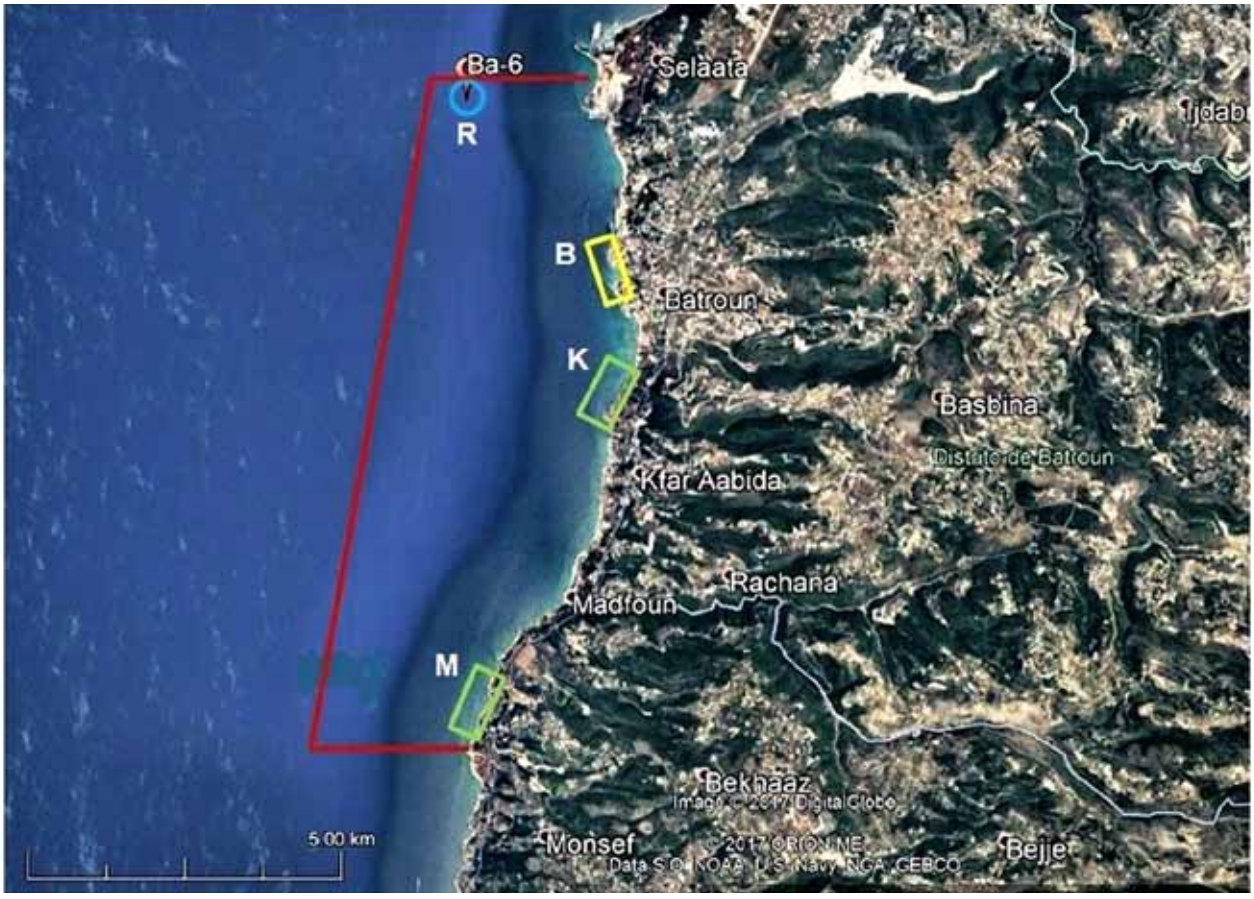

Figure 8.2. Batroun-Medfoun marine protected zones: (B) Batroun (educational zone); (K) Kfar Abida (buffer zone); (M) Medfoun (buffer zone); (R) rocky outcrop (core zone). Red lines: defining the proposed managed area. Image from Google Earth.

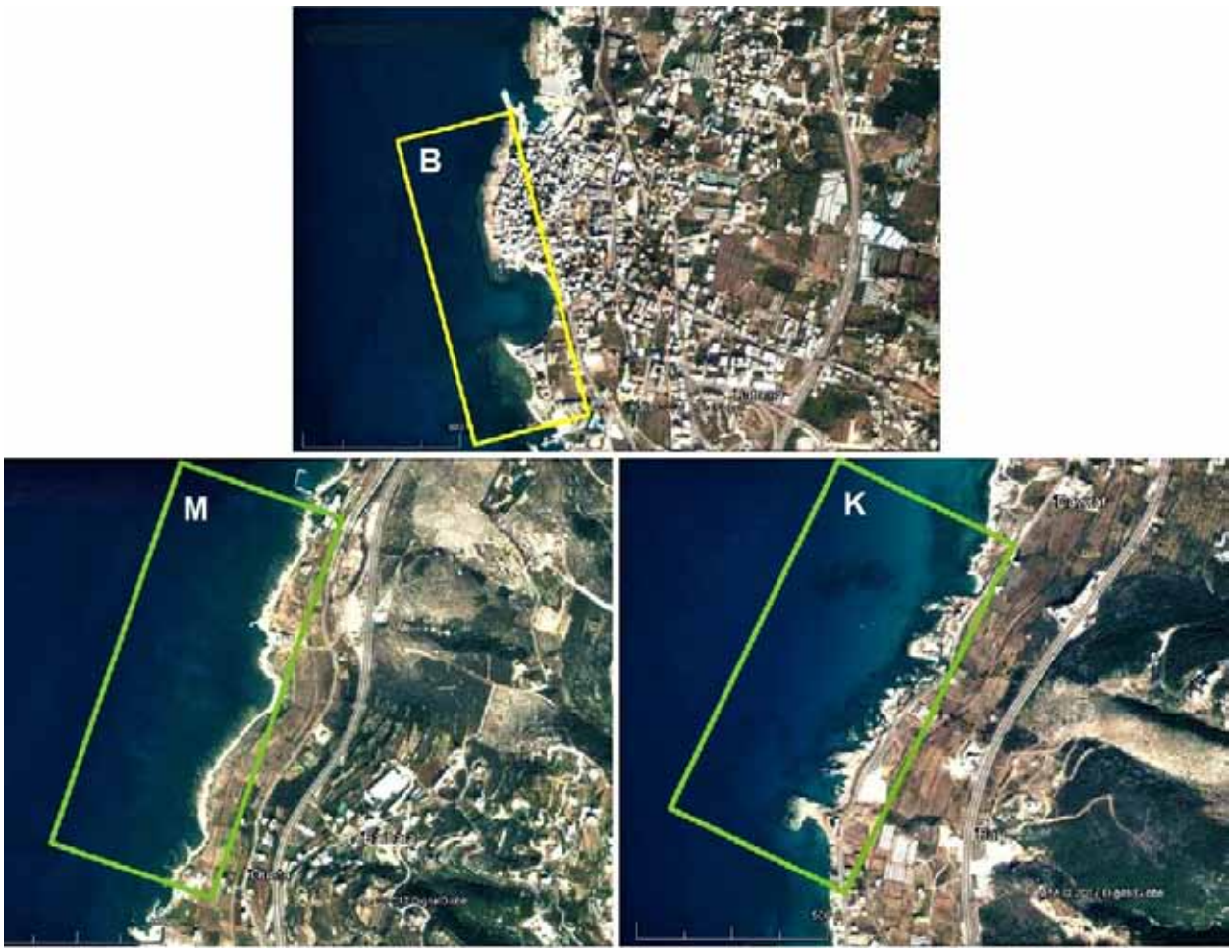

Figure 8.3. Buffer and educational zones in the Batroun-Medfoun area: (M,K) buffer zones of Medfoun and Kfar Abida, respectively; (B) educational zone of Batroun. Images from Google Earth.

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 down, covering a surface of about 1000 ha (Figs. 8.4).

a) Core zone (blue): Rocky outcrop off Fidar, between 40-55 m down (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 (commercial and recreational) is prohibited. The protected area is circular, 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 such as bathing, snorkelling and scuba-diving. No traditional or recreational fishing, bait collection, mooring or increased 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), and possesses educational potential at graduate and baccalaureate level. It will cover an area of 30 ha (1000 x 300 m).

d) Multi-use or peripheral 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 on in the marine environment (bathing, traditional fishing, recreational fishing from the shore, scuba diving) may continue. However, industrial activities and the discharge of sewage and/or sediment, and leaving of debris or trash on the shore should not be permitted. Also, a plan is needed to avoid the pollution and sedimentation produced by the Hay Al Arab industrial complex, located north of Byblos.

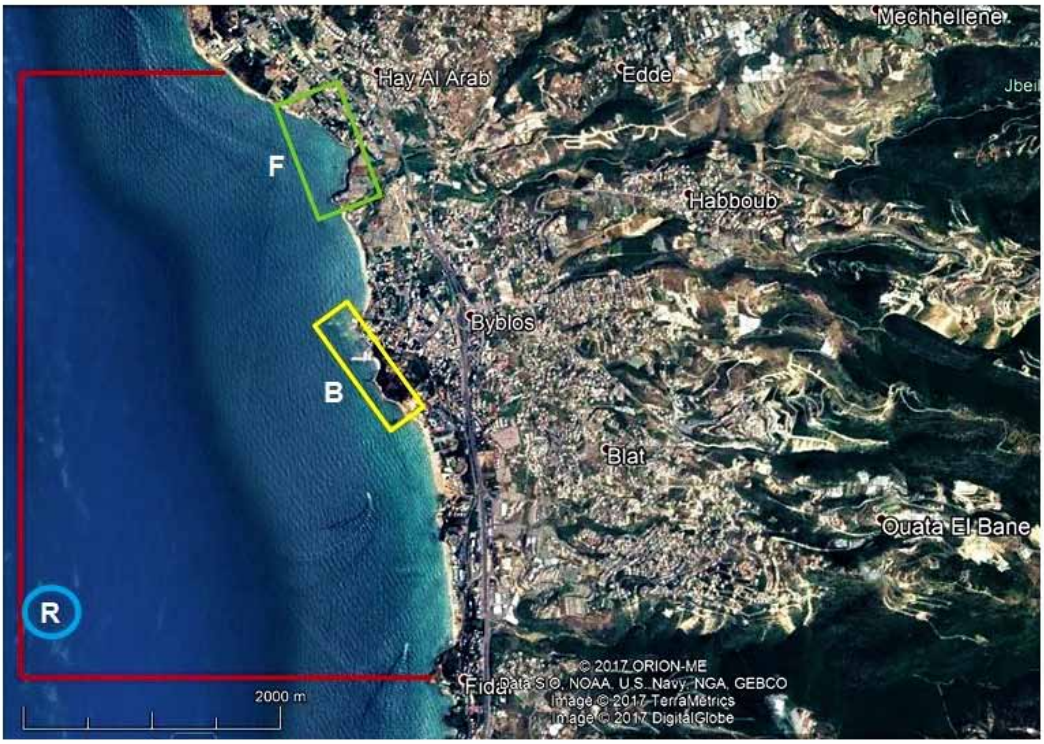

Figure 8.4. Byblos proposed marine managed and protected zones: (B) Byblos (educational zone); (F) Fartouch (buffer zone); (R) rocky outcrop (core zone). Red lines: delimitation of the proposed managed area. Image from Google Earth.

Figure 8.5. Buffer and educational zone 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 human impacts on a MPA, it is necessary to consider management planning through the zoning of the protected area. Management and zoning may resolve some conflicts between users of the coastal zone (industrial/tourism/conservation, selective/no selective fishing methods, commercial/creational fishing, scuba diving/spear-fishing) and make protection compatible with the rational exploitation of the area.

To this effect, the Protocol concerning Specially Protected Areas (SPA) and Biological Diversity in the Mediterranean (Barcelona Convention, 1995) states in Article 7-1: '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. Table 8.1 summarises the possible uses and management measures.

Table 8.1. Possible uses and management measures in the different zones in the marine protected/managed areas.

Uses/Zones	CZ	BZ	MZ
Recreational 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
Beach/swimming	N	Y	Y
Snorkelling	N	Y	Y
Littoral urbanisation	N	$Y_{(4)}$	$Y_{(4)}$
Recreational ports	N	$Y_{(5)}$	$Y_{(5)}$
Fishery port	N	$Y_{(5)}$	$Y_{(5)}$
Mooring	N	$Y_{(6)}$	Y
Commercial 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.
Key to notes (numbers in brackets): (1) to establish anti-pollution measures and the rigorous control of discard; (2) with license/permit; (3) sewage treatment by water treatment plant (the whole area); control of ballast water; (4) integrated coastal zone management (more than 100m to shore-line); (5) only in the current situation; (6) establishment of mooring zones; (7) permitted with restrictions on gear (no monofilament nets); (8) control of visiting.

8.3 SURFACE COVER OF MARINE PROTECTED/MANAGED AREAS

Table 8.2 summarizes the protected surface of the different zones, according to protection level (core, buffer, educational and multi-use zones).

The Lebanese coast line is 225 km long, and extending 3 km from the shore to the open sea (reaching the isobath 50 m down), i.e. 675 km^2. The present proposal of a MPA network for Lebanon (Fig. 8.6), as the result of the MedMPAnet Project and the 2012, 2013 and 2016 assignments, will provide about 11.5 % of its marine environment with a protection mesure.

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.

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

Table 8.3. Surface (in km^2) of possible Lebanese MPAs, 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) Strictly 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 for Tyr Springs and the Byblos rocky outcrop.

c) Habitat/species management area or buffer zone (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 Marine Protected Areas in Lebanon would cover 70 km^2 (10.38 %) and the Marine Managed Areas 107 km^2 (15.85 %), i.e. 26.23 % of the total Lebanese marine surface between 0-50 m down.

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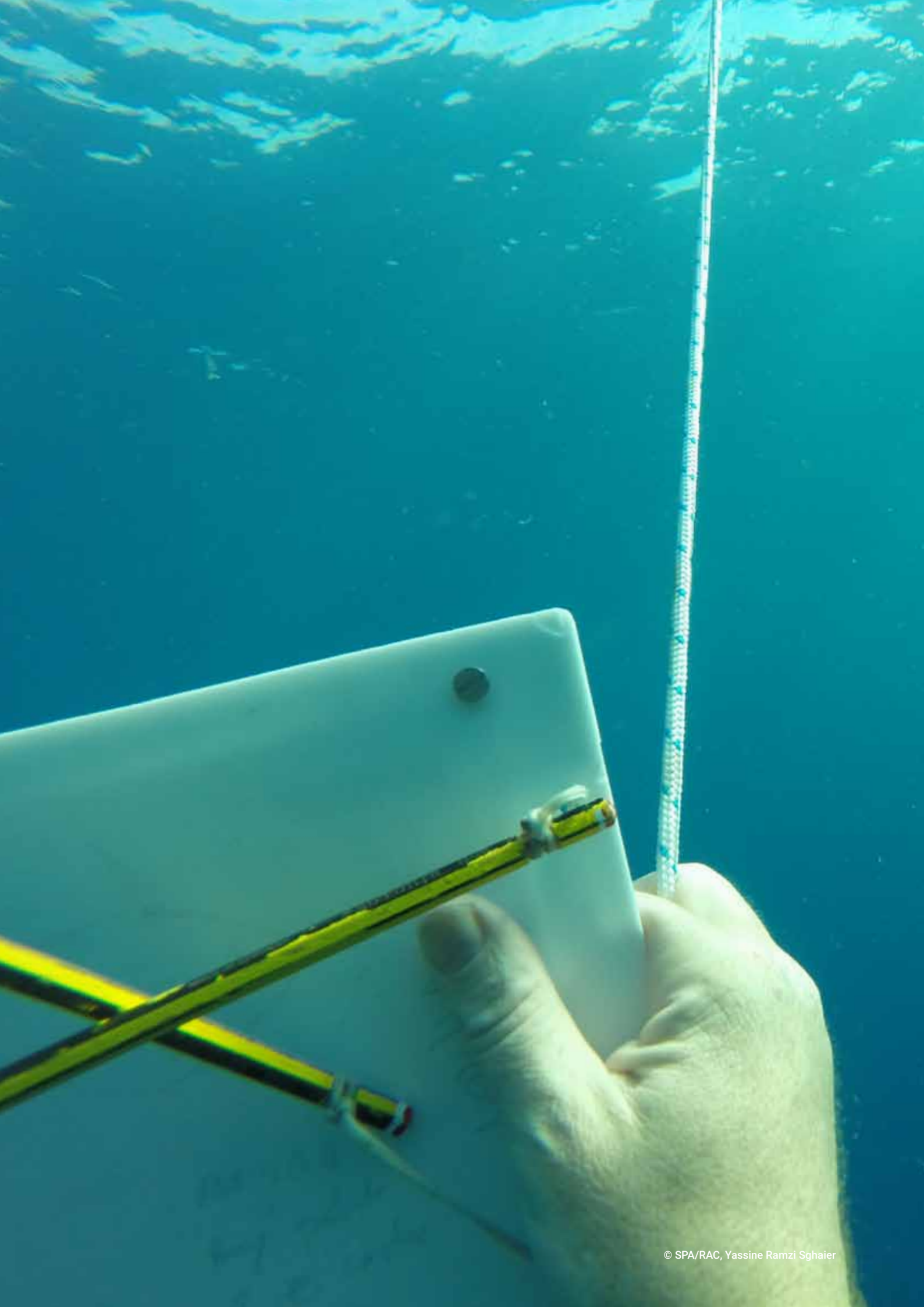

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ANNEXES

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 anguliferum	(Monterosato, 1878)	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 anguliferum	-	-	-	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

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MAP
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The Mediterranean
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