MedMPAnet project

ECOLOGICAL CHARACTERIZATION OF SITES OF INTEREST FOR CONSERVATION IN LEBANON:

Enfeh Peninsula, Ras Chekaa cliffs, Raoucheh, Saida, Tyre and Nakoura

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This document has been elaborated within the framework of the Regional Project for the Development of a Mediterranean Marine and Coastal Protected Areas (MPAs) Network through the boosting of Mediterranean MPAs Creation and Management (MedMPAnet Project). For Lebanon, the project activities were outlined in close consultation with the Ministry of Environment (MoE)"

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Strategic Partnership for the Mediterranean Sea Large Marine Ecosystem
MedPartnership
Together for the Mediterranean Sea
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ECOLOGICAL CHARACTERIZATION OF SITES OF INTEREST FOR CONSERVATION IN LEBANON:

ENFEH, RAS CHEKAA, RAOUCHEH, SAIDA, TYRE AND NAKOURA

MedMPAnet project

Regional Project for the Development of a Mediterranean Marine and Coastal Protected Areas (MPAs) Network through the boosting of MPA creation and management

Study required and financed by:

MedMPAnet project

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CONTENT

FOREWORD

The present document has been prepared within the framework of the "Regional Project for the Development of a Mediterranean Marine and Coastal Protected Areas (MPAs) Network through the boosting of Mediterranean MPAs creation and management (MedMPAnet Project)", whose general objective is to enhance the effective conservation of regionally important coastal and marine biodiversity features, through the creation of an ecologically coherent MPA network in the Mediterranean region', as required by the Barcelona Convention's Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (SPA/BD Protocol).

The project activities aim at assisting the participating countries to implement the prioritized elements of the Strategic Action Programme for The Conservation of Biological Diversity (SAP BIO) in The Mediterranean Region through the provision of a series of enabling activities at national, sub-regional and regional levels. The following twelve Mediterranean riparian countries are beneficiaries of this Project: Albania, Algeria, Bosnia and Herzegovina, Croatia, Egypt, Lebanon, Libya, Morocco, Montenegro, Lebanon, Tunisia and Turkey

For Lebanon, the project activities were outlined in close consultation with the Ministry of Environment (MoE) following coordination missions undertaken which led to (i) prepare a rapid review of what has been undertaken in relation to marine protected areas, and (ii) to identify the potential site(s) to be surveyed with clear rationale and justifications for their future establishment as Marine Protected Areas.

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

To overcome challenging issues and to help a smooth implementation of the project activities, especially the field ones, a multilateral collaboration has been set up between the representatives of the Ministry of Environment of Lebanon, RAC/SPA, the University of Alicante and the Museo del Mar - Ceuta (Spain), the Lebanese University, the Lebanese National Centre for Marine Research (CNRS) and the IUCN Centre for Mediterranean Cooperation (IUCN-Med). They have joint their efforts and formed a multidisciplinary team that took part to the field surveys at Enfeh Peninsula, Ras Chekaa cliffs, Raoucheh, Saida,Tyre and Nakoura sites during 2012 and 2013.

1. INTRODUCTION

The Barcelona Convention and its Protocol on Specially Protected Areas and Biodiversity (SPA/BD Protocol) in the Mediterranean recommends giving highest priority to promoting the management of the marine areas to be protected and to identify the 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 a restricted area itself;
- 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 MedMPAnet research project, which is part of the greater Med-GEF 'Strategic Partnership for the Greater Marine Ecosystem of the Mediterranean Sea' Partnership, commissioned by UNEP and carried out by the Regional Activity Centre for Specially Protected Areas with the financial support of the European Commission (EC), the Spanish Agency for International Development Cooperation (AECID), and the French Global Environment Facility (FFEM).

The overall aim of the project is to protect important biodiversity at national, Mediterranean and international level and to promote economic development based on the sustainable management of marine and coastal natural resources.

For Lebanon and following consultations with the Ministry of the Environment through three visits to Lebanon (February and June 2011 and May 2013), field surveys were suggested, with the following purposes:

- Rapid assessment of the marine natural habitats along the coast of six suggested areas (Enfeh Peninsula, Ras Chekaa cliffs, Raoucheh, Saida,Tyre and Nakoura), in order to have a better assessment
- Characterization of the ecology of threatened habitats with recommendations for conservation measures.

In order to complement and enrich the knowledge of this important Mediterranean Lebanese areas, the project's aims to discover the distribution of the main marine habitats and set up tools for monitoring the state of heritage species, enabling the effects of those protection and management strategies adopted to be appraised.

Thus the assignment's objectives were:

- to explore the suggested areas (between 0 and 50 meters down), locating and generally mapping the habitats;
- to elaborate an updated inventory of the biodiversity of species and habitats, mainly targeting species with heritage value;
- to characterize the habitats, mainly those that are to be protected, and define their conservation status.

This information will help to the elaboration of relevant actions for Enfeh Peninsula, Ras Chekaa cliffs, Raoucheh, Saida,Tyre and Nakoura areas. This 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 an awareness and educational strategy for users of the marine and coastal area.

The field surveys in the above-mentioned areas were undertaken during June 2012 and August-September 2013. The present report brings together data from the field surveys with a first ecological characterization of the areas, and makes recommendations for the possible development of the studied sites.

Another aim is to collect as much information as possible on the marine fauna and flora of these interesting parts of Lebanon's coast, especially about the exotic species that have successfully established themselves, and to continue with the inventorying of the biodiversity of this very special part of the Mediterranean. Also, the aim is to determine the specific nature of the associations and facies that are a feature of this sector and to show how they differ from other parts of the Mediterranean.

In summary, the aims of the present investigation have been:

- The study of the composition of the Lebanon inshore megabenthos;
- The characterization of the seascapes and habitats;
- A hierarchical ecological approach for marine biodiversity conservation;
- Use of focal species in marine conservation and management;
- Properties of focal species under various ecological and anthropogenic conditions: Implications for marine conservation and management.

2. REPORT OF THE MISSIONS (2012, 2013)

The present document has been prepared following the schedule implementation that signals the output of a draft synthetic report of ecological characterization along with recommendations on the management outlines of the studied areas, in the "Technical fiche of the mission to be carried out in Lebanon in June 2012 and August-September 2013". This report represents the information about the missions carried out in Lebanon (during 2012 and 2013) about the littoral and sublittoral surveys (0-47 m depth) in Enfeh, Ras Chekaa, Raoucheh, Saida, Tyre and Nakoura sites.

The expected outputs of the mission have been:

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

2.1. Prospected areas

The prospected areas in the 2012 mission (Fig. 1 left) lie all around the Enfeh peninsula (between 0 and 47 meters down); along the Ras Chekaa coast up to the port of Selaata (between 0 and 46 meters down); and the Raoucheh cave (0-4 meters down). In the 2013 mission, the prospected areas (Fig. 1 right) lie all around the Nakoura area (between 0 and 44 m depth); along the Tyre coast (between 0 and 4 m depth); and the Saida area (0-39 m depth), all at the Southern coastal area of Lebanon.

Figure 1. Location of the prospected areas

2.2. Chronogram

a) 2012 Mission: The survey and assessment lasted eleven days (18 to 28 June 2012) as is shown in Table 1. The work duration was a 9- to 10-hour per day, from 6.30 to 7 a.m. (leaving the hotel) until 5 to 6 p.m. (return to the hotel).

Every day was a working day.

Table 1. Distribution of activities/day during the 2012 mission

Activities/day (June 2012)	18	19	20	21	22	23	24	25	26	27	28
Work Meeting	X										X
Enfeh		X	X			X					
Chekaa			X	X	X		X	X	X		
Raoucheh										X	

b) 2013 Mission: The survey and assessment lasted twelve days (27/08-07/09/2013) as is shown in Table 2. The work duration was a 9- to 10- hour day, from 6.30 to 7 a.m. (leaving the hotel) until 5 to 6 p.m. (return to the hotel). Every day was a working day.

Table 2. Distribution of activities/day during the 2013 mission

Activities/day	27	28	29	30	31	01/09	02	03	04	05	06	07
Work Meeting	X										X	X
Nakoura	X	X	X		X			X				
Tyre			X	X			X	X	X	X		
Saida						X						

2.3 Staff

Table 3 shows the participants of the two missions from UNEP/MAP - RAC/SPA, IUCN, Lebanese University, Museo del Mar and the University of Alicante (Spain).

Table 3. Participants of the 2012 and 2013 Lebanon missions

Name	Affiliation	Tasks
BITAR, Ghazi	Lebanese University	Benthos, habitats
EL SHAER, Hany	IUCN	GIS, benthos
FORCADA, Aitor	University of Alicante	Ichthyofauna, GIS
OCAÑA, Oscar L.	Museo del Mar, Ceuta	Benthos, habitats
RAMOS, Alfonso A.	University of Alicante	Benthos, habitats
SGHAIER, Yassine R.	RAC/SPA	Benthos, habitats
VALLE, Carlos	University of Alicante	Ichthyofauna, cartography

We should mention the excellent collaboration of both the staff from the Lebanese National Centre for Marine Research (CNRS) (Gaby KALAF, Milad FAKHRI and Elie TAREK); the crew of the Lebanese CNRS oceanographic vessel 'CANA' (Michel YOUSSEF, Georges NOCHAL and Georges TOUMA); the efficient help of the sailors, Toufik ASSAL and Bilal ISTAMBOULI with their fishing boat support, and Ziad SAMAHA of the Purple Reef Association for the diving support.

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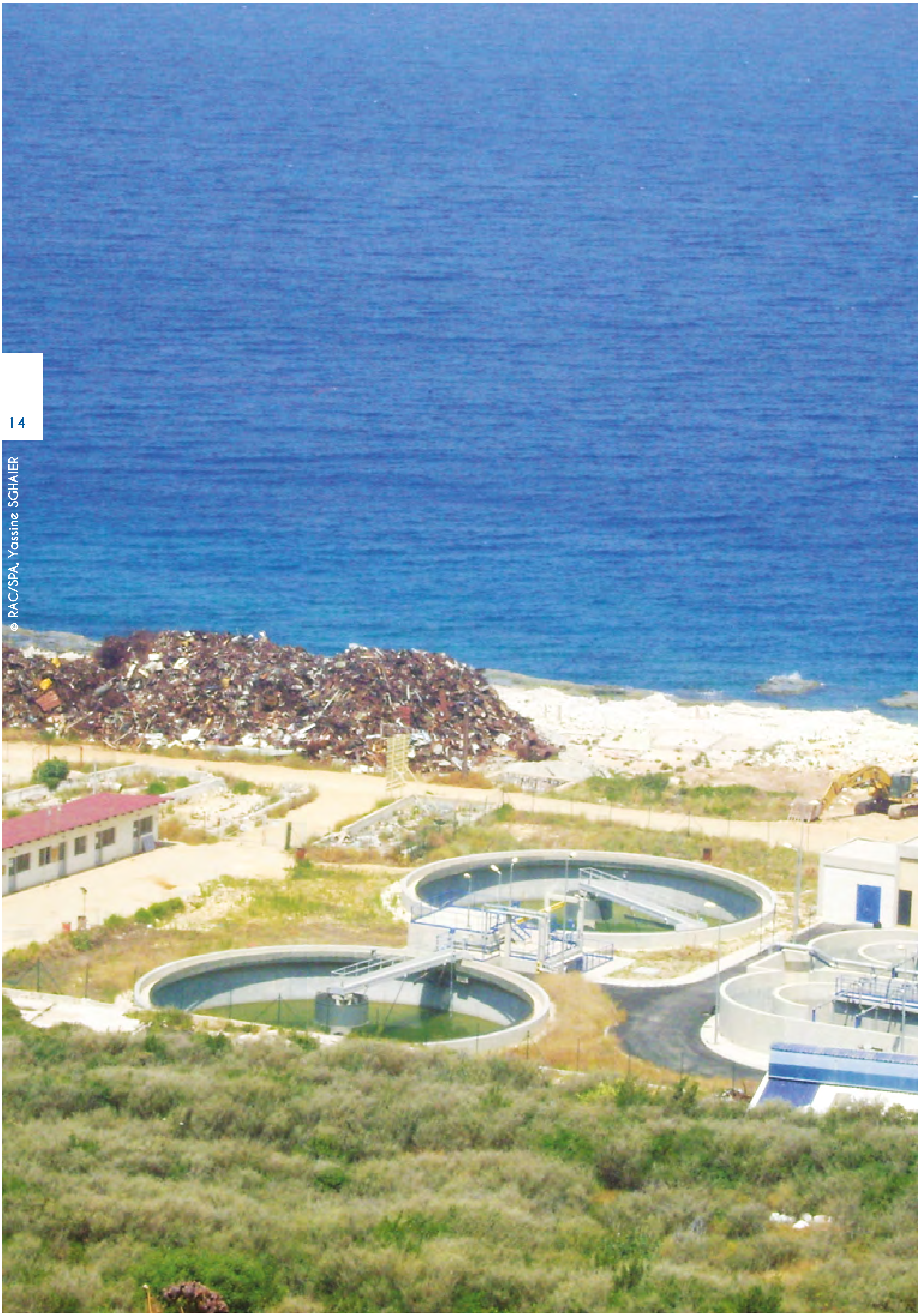

3. MATERIAL AND METHODS

The material and methods of observation used differ according to the type of dive (hydroplane transects, plot dives) and objective (mapping, characterization of habitats, fish counts). A total of 181 dives have been realized, representing about 120 hours of underwater work.

3.1 Stations

a) Northern sector: Fifty stations were prospected (See Annex I, Fig. 2): 18 in Enfeh, 29 in Ras Chekaa and 3 in Raoucheh. Depending on the sector, the depths were between 0 and 47 meters (Table 4).

b) Southern sector: Fifty-six stations were prospected (See Annex I, Fig. 3): 21 in the Nakoura-El Bayada area, 28 around Tyre and 7 in front of the Saida area. Depending on the sector, the depths were between 0 and 47 meters (table 4).

All the stations were surveyed by scuba diving, except five stations where snorkeling and sampling by foot were used. In total, 102 dives were made, 4 of these without tanks, which represents about 85 hours of underwater **work.**

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

The workplace was reached on board of the oceanographic vessel 'Cana' (Fig. 4-1). Once in the area, the researchers moved to the diving site using the inflatable dinghy of the oceanographic vessel and two traditional fishing boats belonging to the fishermen Toufic Assal and Bilal Istambouli from Batroun and Tyr, respectively (Fig. 4-3).

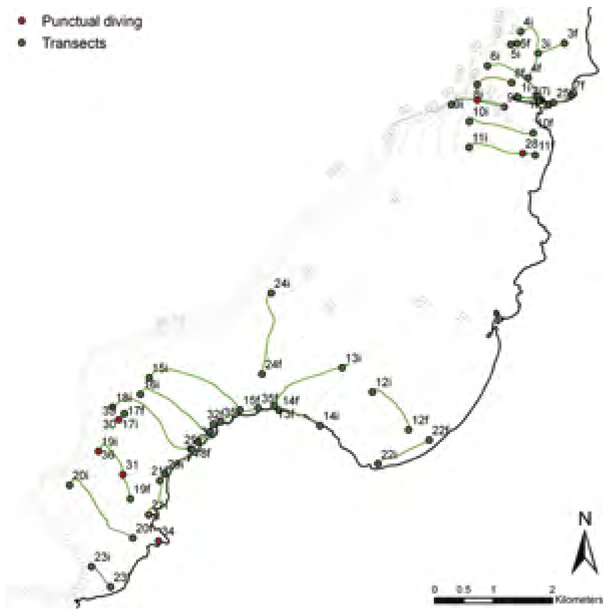

Figure 2. Distribution of the stations in the Enfeh and Ras Chekaa areas (2012 and 2013 missions)

Table 4. Research activities by site and depth ranges. Number of dives (in brackets).

Locality	Enfeh	R. Chekaa	Raoucheh	Nakoura	Tyre	Saida	Total
Depth range (m)	0-47m	0-46m	0-6m	0-44m	0-47m	0-39m	0-47m
Hydroplane trans.	8 (8)	10 (10)	-	5 (5)	9 (9)	4 (4)	36 (36)
Scuba diving plots	4 (10)	10 (23)	1 (3)	10 (20)	13 (38)	2 (6)	40 (64)
Fish visual census	2 (4)	4 (4)	1 (2)	4 (5)	4 (2)	-	6 (17)
Snorkeling	2 (5)	3 (9)	-	-	3 (10)	1 (3)	9 (13)
Littoral	1	1	-	1	1	-	4
CTD Profiles	1	1	1	1	1	-	4
Total stations (dives)	**18 (28)**	**29 (46)**	**3 (5)**	**21 (30)**	**28 (59)**	**7 (13)**	**106 (181)**

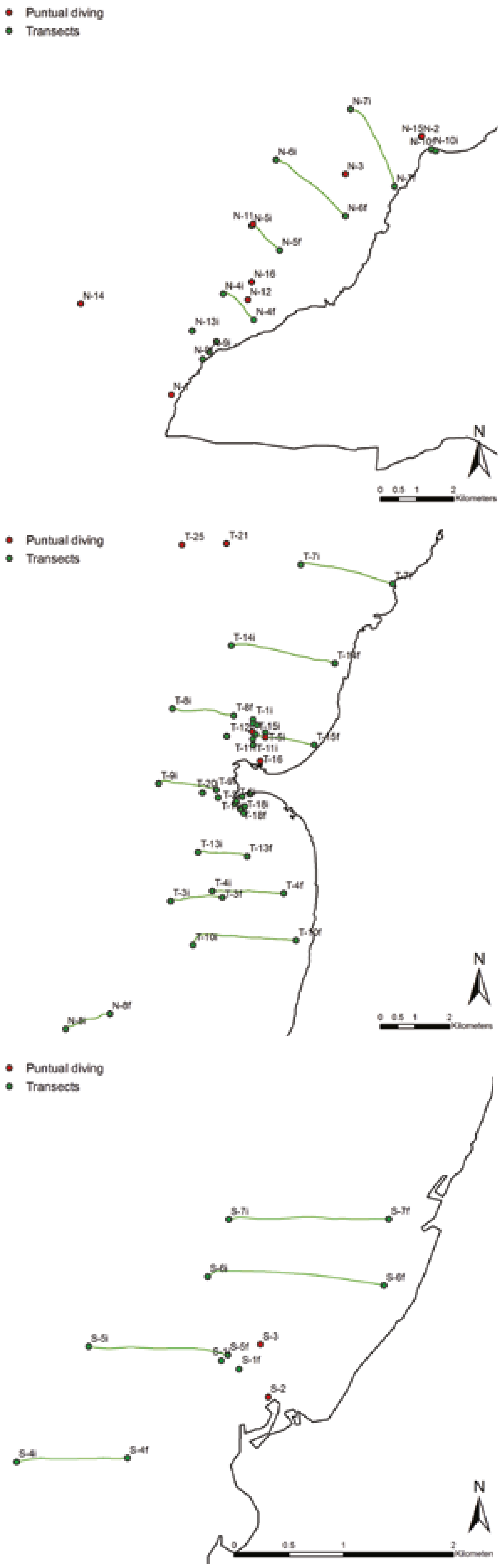

Figure 3. Distribution of the stations in the Nakoura, Tyre and Saida areas (2013 mission)

3.2 Methods

The megabenthos (size > 10 mm) and nekton have been studied in selected areas of the Lebanon coast, between 0-50 m depth, with the purpose of establishing marine protected areas (MPA). Data were collected with a visual, non-destructive, and semi- quantitative method in selected points. Previous observations were realized by hydroplane profiles with three aims:

i) to know the depth distribution of the flora/fauna and biocenosis;

Figure 4. Oceanographic vessel 'CANA' with its inflatable dinghy (1), and two traditional fishing boats from Batroun (2) and Tyre (3)

ii) locate the plot diving stations;

iii) bionomical cartography of the area.

3.2.1 Mapping

The seabed was mapped using a hydroplane (Fig. 5 -1) that allowed extensive exploration of the concerned area (Ramos-Esplá, 1984). At the same time, the hydroplane observations provided information about the bathymetric range of the target species.

With a 100-meter rope and a 3-meter chain, the diver was pulled by the inflatable dinghy. Once the diver was on the bottom, he recorded his observations on the encountered habitat on a plastic plate; and took a transect record with a video-camera (GoPro-Hero3+) that was attached at the top of his head (Fig. 5 -2). Aboard the inflatable, one person sailed the boat while two others noted the position (using a GPS), depth (a hand-held echo sounder), check time and the diver's safety. The GPS data was downloaded later on to a computer.

3.2.2 Observations and characterization of habitats

Using one-off dives, and taking underwater photographs and noting down the depth, type of seabed, fauna and flora species on a plastic plate with polyester paper, and some species were sampled for taxonomical determination (Fig. 6). Each station was located using GPS.

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

3.2.3 Visual fish census

Using dives to count fish is an excellent bioindicator to assess and make best use of the protection/exploitation effect (Bayle & Ramos, 1993). The methodology adopted is standardized (Harmelin-Vivien *et al., 1985*). Indeed, the dives are made at a given depth between 0 and 45 meters (transects with measuring tape).

The method (Fig. 7), with a measuring tape, was used to cover a distance of 3-5 m wide (according to visibility) in trajectories lying parallel to the coast, and noting the species of fish encountered, the number of individuals of each species, roughly their size and the type/complexity of the seabed. Usually, the transects were of 125 m^2 (25 m x 5 m) and with 4-10 replicates per station, depending on the depth.

Figure 5. Diver with hydroplane at the start of a transect (1). Video-camera at the top of the diver head (2)

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Figure 6. Observation, photography (1) sampling (2) and during the diving plots

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Figure 7. Fish visual census by scuba diving. Cape Greco in Cyprus

3.2.4 *Cymodocea nodosa* meadows

Two Lebanese coastal areas were investigated by scuba diving and snorkeling (Fig. 8):

i) the northern and eastern coast of peninsula the Enfeh over a distance of 1.5 km from 0 to 11 m depth (Fig. 1) ;

ii) the north and east coast of Ras Chekaa with a distance of five kilometers of coast from 0 to 15 m depth (Fig. 2).

Sampling for shoot morphology, density and biomass (above- and belowground biomass) of *C. nodosa* was conducted in the Enfeh peninsula. The *C. nodosa* was very sparse at Ras Chekaa, only the shoot density was assessed. The shoot density was assessed. Shoot density of *C. nodosa* was measured 20 x 20 cm plots (10 replicates) and cover by 40 x 40 cm frame (Fig. 9).

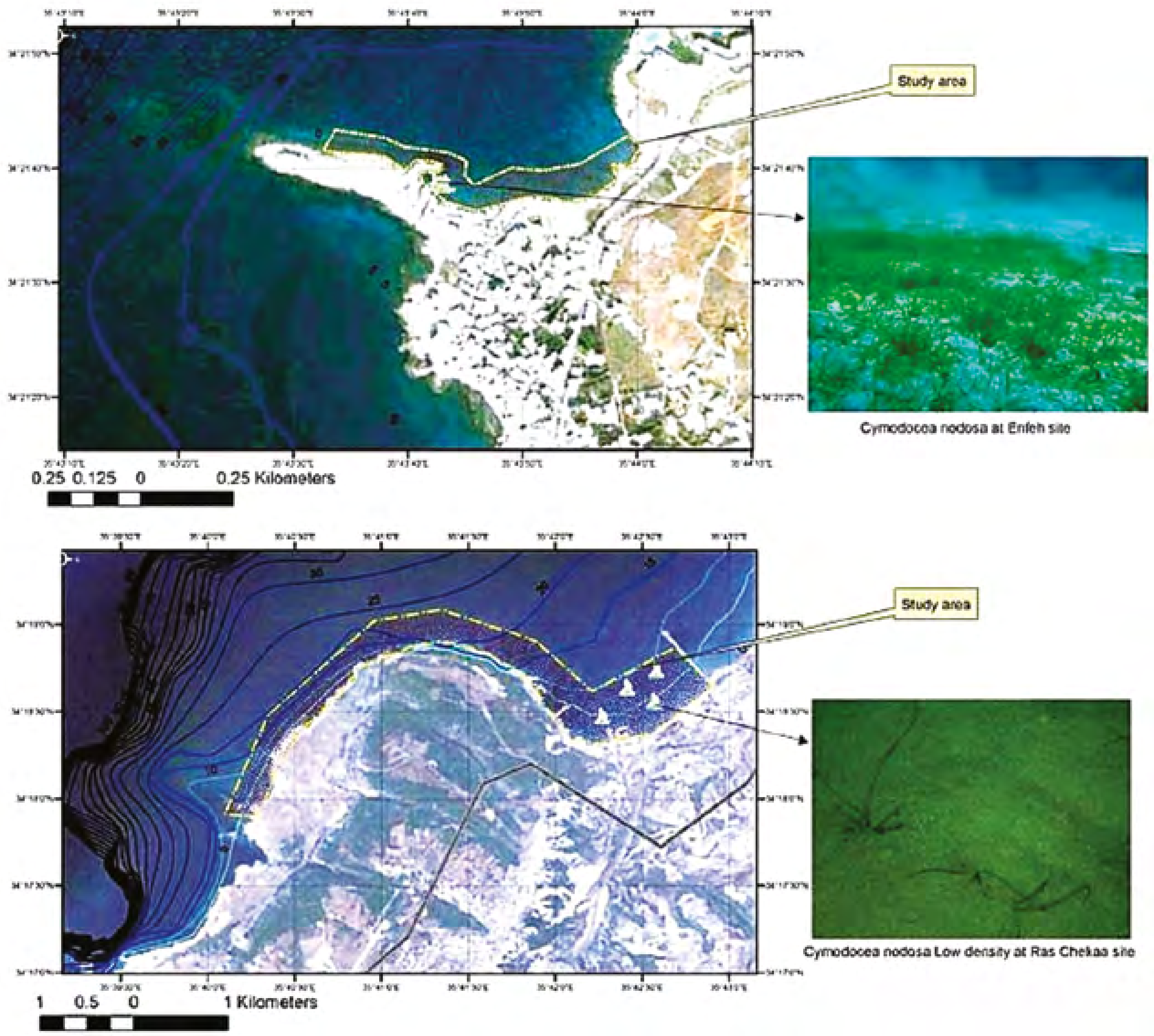

Figure 8. The prospected coast zone along the Enfeh peninsula (above) and Ras Chekaa (down), by diving and snorkeling

The plant biomass (above and below ground) was collected using a 20 x 20 cm plots (5 random replicates). Replicates were taken about 1m apart. Twenty shoots were collected randomly at the sampling station to measure plant morphometrics. All plant material was washed with seawater to remove sediments and temporarily stored in labeled plastic bags in a refrigerator (< 6 °C) until processing.

In the laboratory, the number of leaves from the 20 collected shoots was counted and separated into differentiated leaves (with sheath) and undifferentiated leaves (without sheath). Leaf length (from the meristem to the tip of the leaf), and leaf width were measured.

For biomass determination, leaves, rhizomes and roots were separated and rinsed with tap water to remove salts. Live roots and rhizomes were separated from dead macro-organic matter, which was excluded from all measurements. The leaves had attached epiphytes which were easily removed by scraping (Kemp *et al.* 1987). The material was dried at 75°C to constant weight to determine the dry weight of each fraction.

Figure 9. Cover measures of *Cymodocea nodosa*, Enfeh, 3m depth (st. E-7)

3.2.5 Hydrology

To round off the information on the marine ecosystem, hydrological profiles were made on board the oceanographic boat 'Cana' using a TCD (Fig. 10) and the water transparency was noted using a Secchi disk.

Two stations (Table 5) were carried out in front of Nakoura and Kasmiyeh, between 0 and 160-200 m depth.

Figure 10. Launching the TCD off the stern of the oceanographic boat 'CANA'

Table 5. Hydrological stations

Locality	Date	Latitude N	Longitude E	Depth (m)
Nakoura	03.09.13	33° 08,440'	35° 01,762'	0-160
Kasmiyeh	04.09.13	33° 20,349'	35° 08,888'	0-200

3.2.6 Processing the samples and data

Specimens not identified or with taxonomical uncertainties were collected to be identified on board the 'Cana' (Fig. 11, 1). On board, the specimens collected were placed in bowls filled with seawater to be defined, observed using a low power stereo microscope, photographed (Fig. 11, 2) and/or anaesthetized and set in 10 % formalin in seawater for later studies. At the same time, the underwater observations recorded on the plastic plates were transferred to the note-book, and latterly to the Excel files.

The World Register of Marine Species (WoRMS: www.marinespecies.org) has been consulted for an up-to-date scientific names of the species.

Data treatment: When the study doesn't have a determined surface/volume of samples (case of our underwater surveys), the best index to apply is the Margalef's index (R) where the species richness (S) is independent from the sample size. It is founded in the relation among S and the total number of individuals observed (N), in our case a semi quantitative value (1 = less common; 2 = common; 3 = very common).

The formula is: $R = S-1/\ln N$

(S = species richness; N = total number of individuals of the sample). For the analysis of data (species number, relative abundance, Margalef's index…) we have applied the PAST software program (http://folk.uio.no/ohammer/past/).

Figure 11. Work on board (1). Observation and classification of some species (2)

4. PHYSICAL ENVIRONMENT

4.1 Geomorphological features

4.1.1. Enfeh-Selaata

The continental shelf at a 100 m depth in the Enfeh-Selaata area, with the Ras Chekaa zone, is steep with unevenness values from 2,5 % (front El Hari) to 7,6 % (front Enfeh) and 6,3 % (front Ras Chekaa). In fact, there are two submarine canyons from Enfeh and Selaata (Fig. 12)

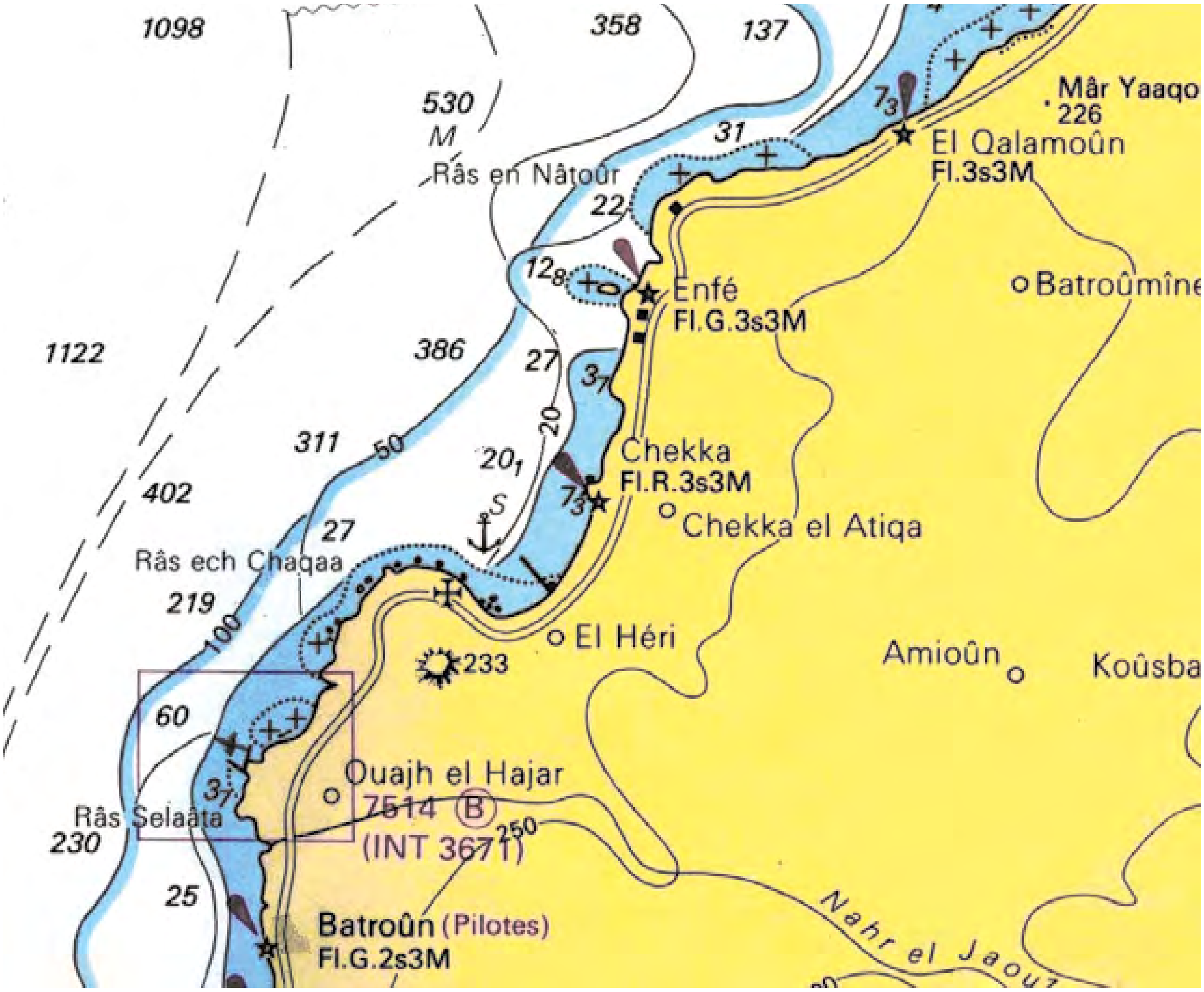

Figure 12. Maritime chart of the Enfeh-Selaata area.(INT 3606, 7255).

The Enfeh peninsula and the Ras Chekaa are limestone headland surrounded by muddy-sand bottoms. The coastline of the area presents a more or less wide abrasion platform (2-10 m width) with rocky pools and, in some places there are small littoral caves (Fig. 13). The shallower rocky seabed is formed by submarine vertical surfaces (1-6 m high) with big blocks at the base.

The submarine topography of both seabeds (> 50 m depth) shows some differences between the north and south sectors. Whereas in the north the slope is more gentle, from the east to the south, the topography of the seabed changes markedly from 40 m depth (Fig. 14, transect E-9) with a big narrow rocky reef, and an irregular topography at the southern part of Enfeh (transect E-11) with rocks and blocks. The massif limestone rock can reach 30 m high and it presents an irregular surface cover with *Chama* and *Spondylus* bivalves.

The same as Enfeh, the north of the Ras Chekaa area is surrounded by muddy-sand bottoms. However, there is a higher seabed heterogeneity (Fig. 14), with rocky outcrops between 25-50 m depth and heterogeneous sediment (pebbles, gravel and coarse sand) cover the flat rock, which demonstrates the high hydrodynamism of the area.

The hydroplane profiles show this heterogeneity, in the form of rocky outcrops (profiles C-4 and C-13) and elevation of the seabed due to the rock massifs (e.g. profiles C-7, C-8, C-9). The profile C-12 has been realized in the upper part of the Selaata canyon, with muddy-sand bottoms. Between 25-45 m depth there is an irregular flat rock cover with small boulders, cobbles, pebbles, gavel and coarse sand. From 25-30 m depth the seabed turns into a high massif rock bottom reaching the littoral. The canyon heads of Enfeh and Selaata were observed (transects C-9 and C-12, respectively), the seabed is composed of muddy-sand.

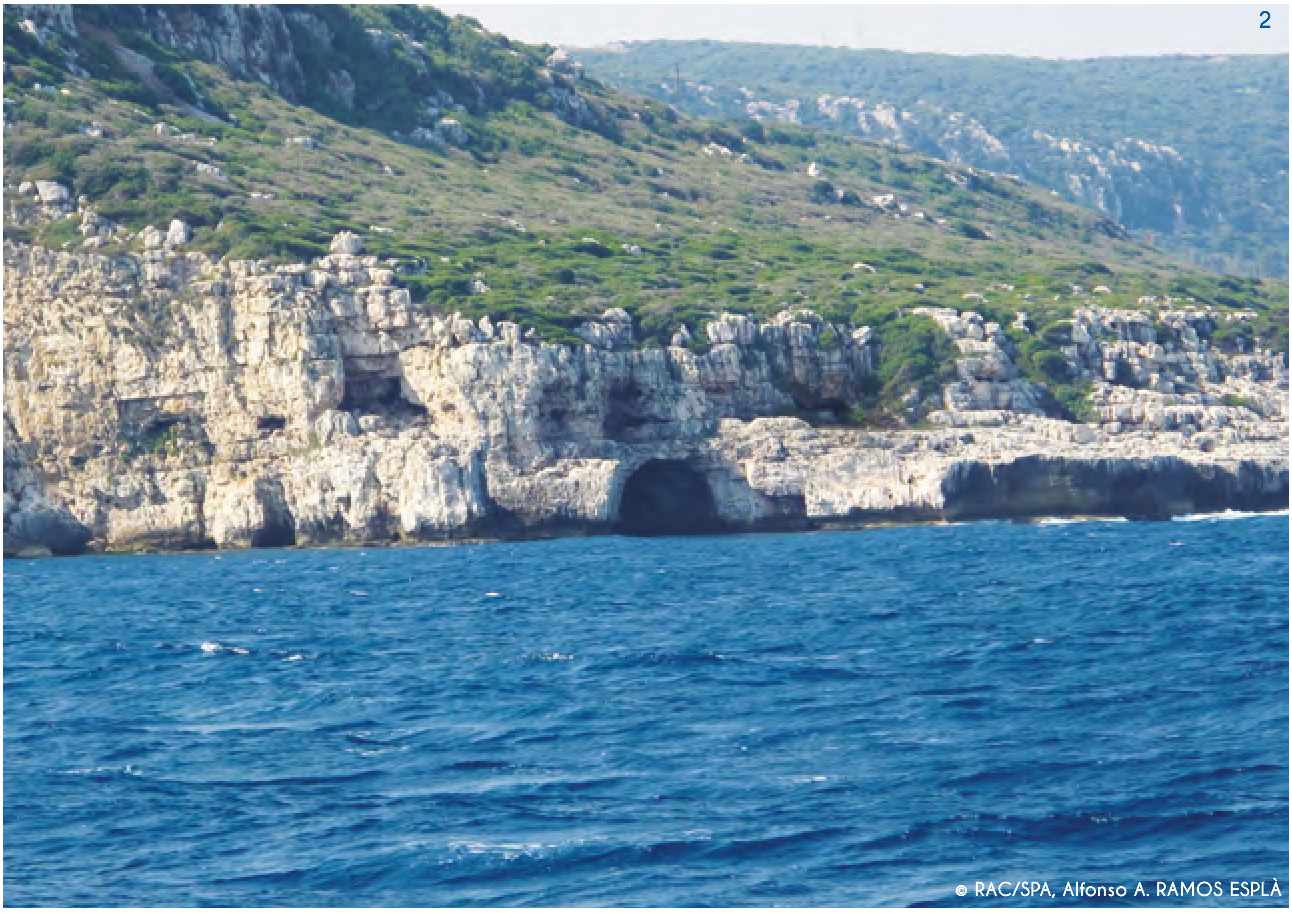

Figure 13. Abrasion platform in Enfeh peninsula (1). Littoral caves in the limestone rocks of the north of Ras Chekaa (2)

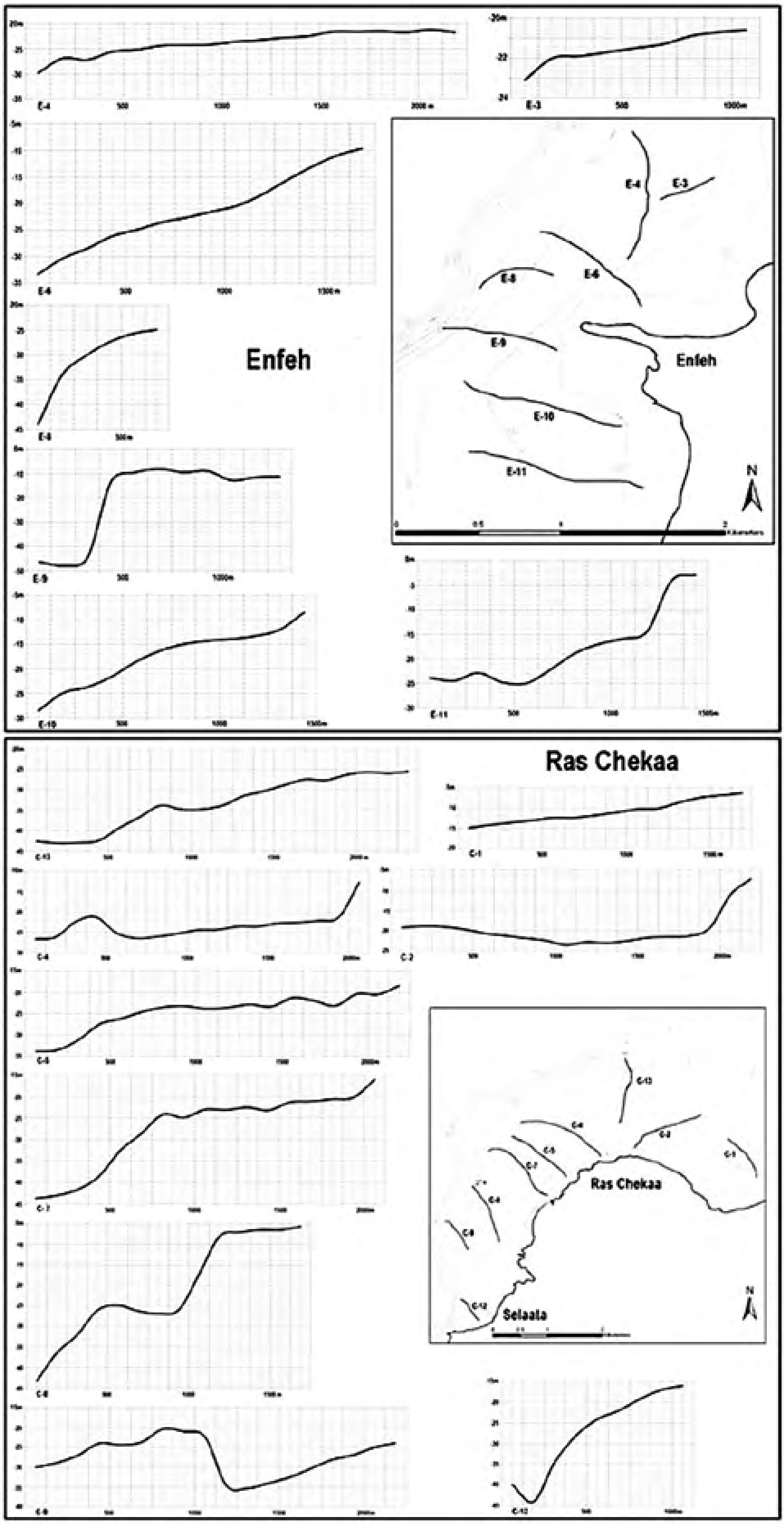

Figure 14. Topography profiles (Enfeh and Ras Chekaa areas) made by hydroplane

4.1.2 Raoucheh

The Raoucheh area represents an impressive limestone rocky massif (about 50 m high) with very interesting littoral caves and tunnels (Fig. 15).

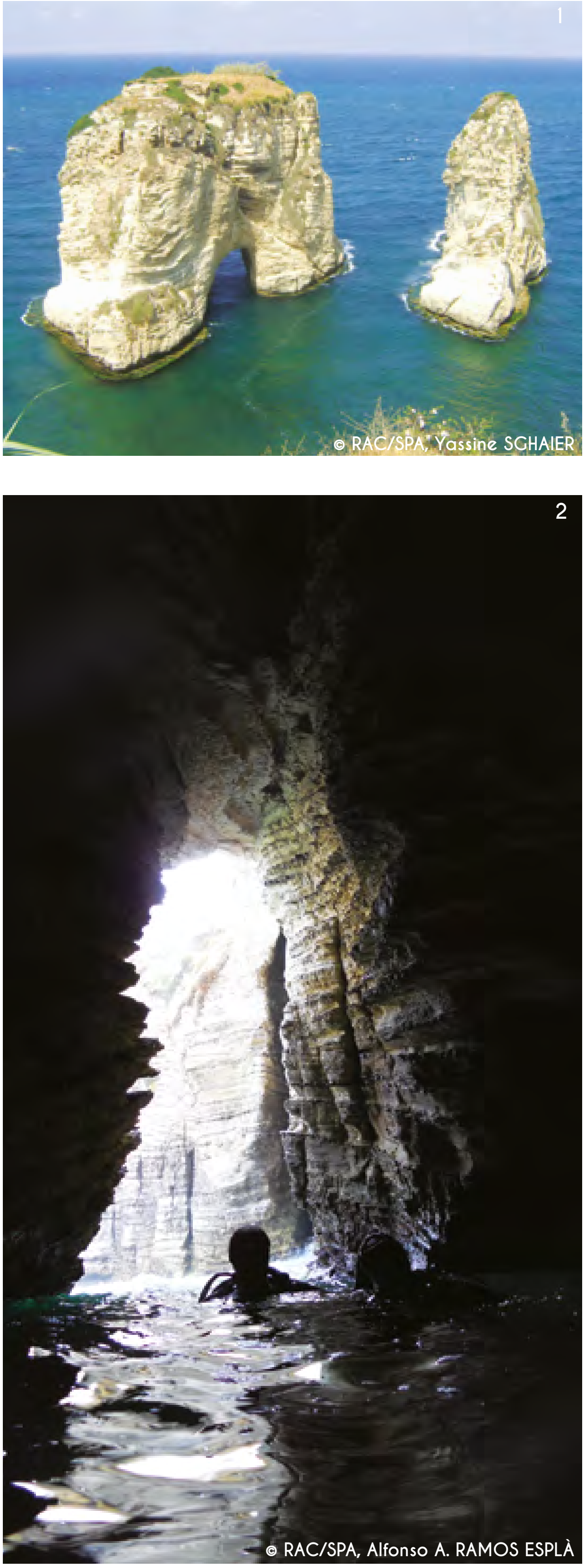

Figure 15. The Raoucheh limestone massifs (1). Inside of the Raoucheh tunnel (2)

4.1.3 Saida-Nakoura

The continental shelf at a 100 m depth in the Saida-Nakoura area, with the Tyre zone, is lesser steep than Enfeh-Selaata, unevenness values vary from 1,5 % (front Tyre) to 2,9 % (front Saida). Nevertheless there are also two submarine canyons front Saida and Tyre (Fig. 16).

One of the most interesting topography features is the presence in Saida and Tyre of littoral sandstone reefs with a wide abrasion platform (Fig. 17). Noteworthy is the presence of littoral caves in the shore of Ras El Bayada.

The Saida inshore topography (Fig. 18) is gentle with low flat rocky bottoms with shell gravel and coarse sand spots, cobbles and pebbles. In some places there are small blocks (Ø < 1 m), and low rocky outcrops.

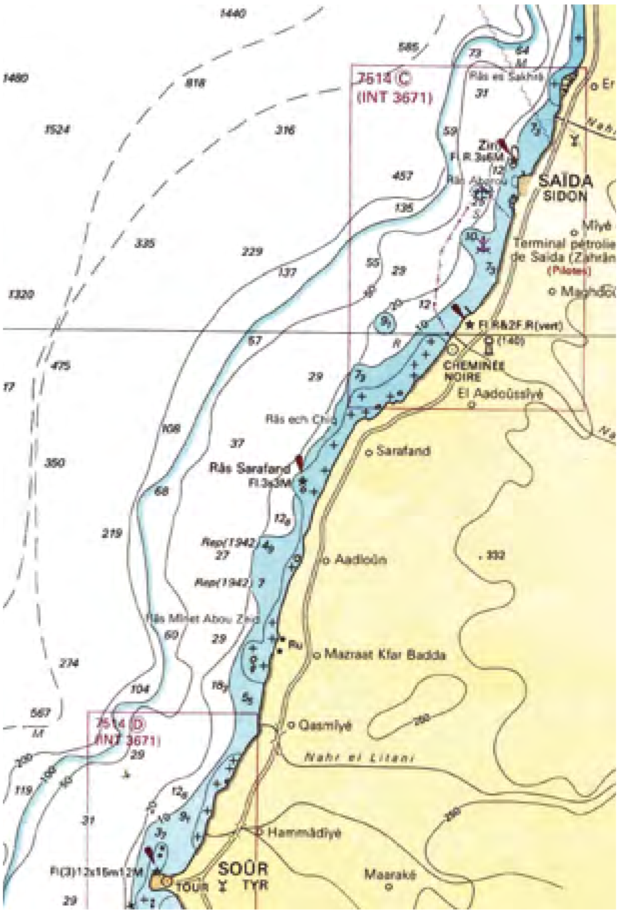

Figure 16. Maritime chart of the Saida - Nakoura area (INT 3606, 7255)

The inshore seabed on the northern sector of Tyre (Fig. 18) is more irregular than Saida, with smooth and irregular flat rock, presence of wide detritic channels, high rocky massifs and big blocks (Ø > 1 m) from 20 m depth to shallow waters. The seabed of the 'lagoon' between the rocky reefs and the northern Tyre beach (transect T-15, fig. 19) is predominately sandy, with fine and coarse sand ; in some places (between 9-10 m depth) the cobbles are abundant with some rhodoliths.

The presence of high rocky massifs is continued in the southern sector of Tyre (Fig. 19), also with smooth and irregular flat rock. However, in some zones, the muddy sand bottoms are predominant from a 27 m depth, and fine sand between 0-16 m depth front Rachidiye (transect T-4, Fig. 19).


1
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2
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Figure 17. Littoral sandstone rocky reef from Tyre (1). Littoral cave in Ras El Bayada (2)

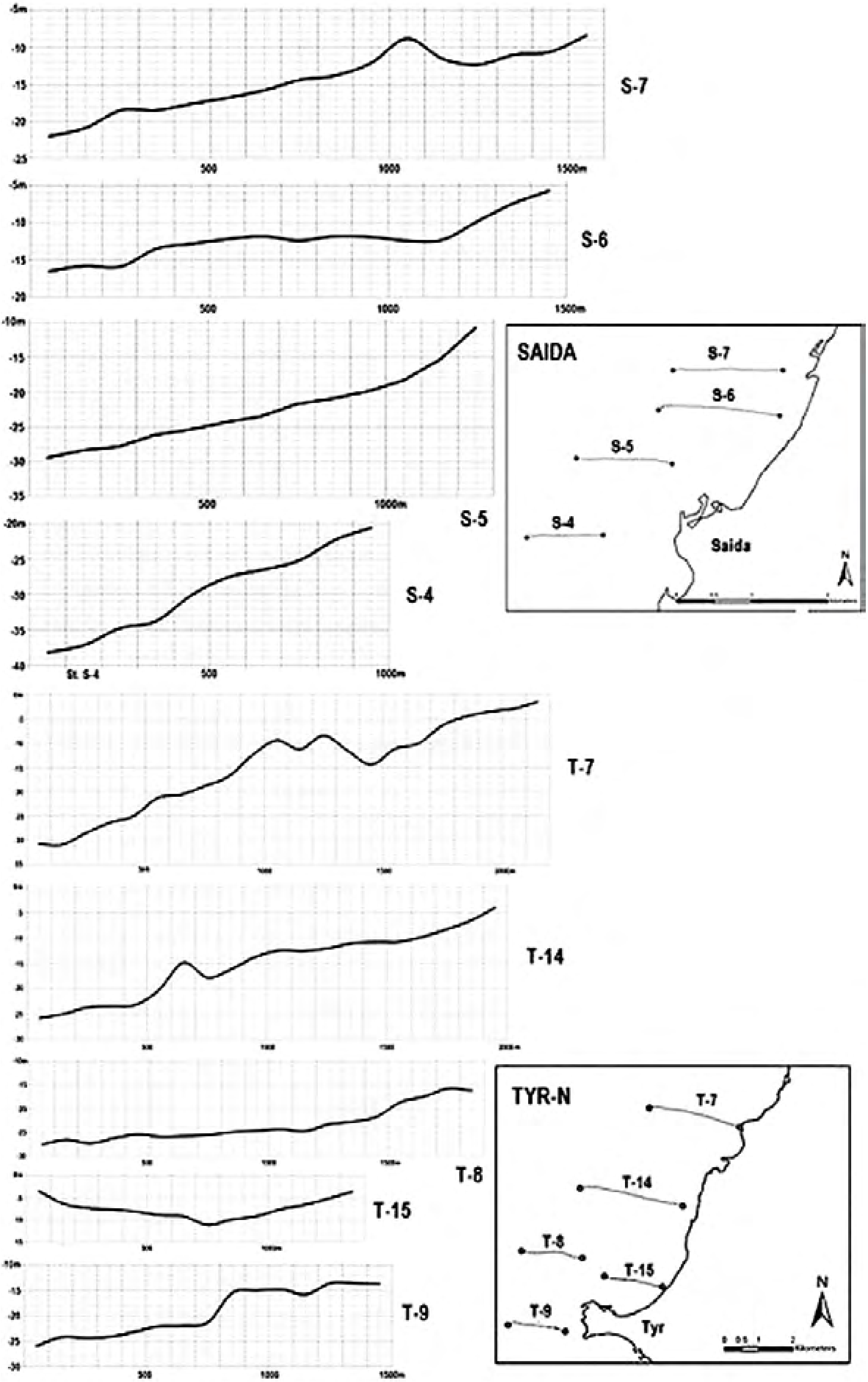


Figure 18. Topography profiles (Saida and Northern Tyre areas) made by hydroplane

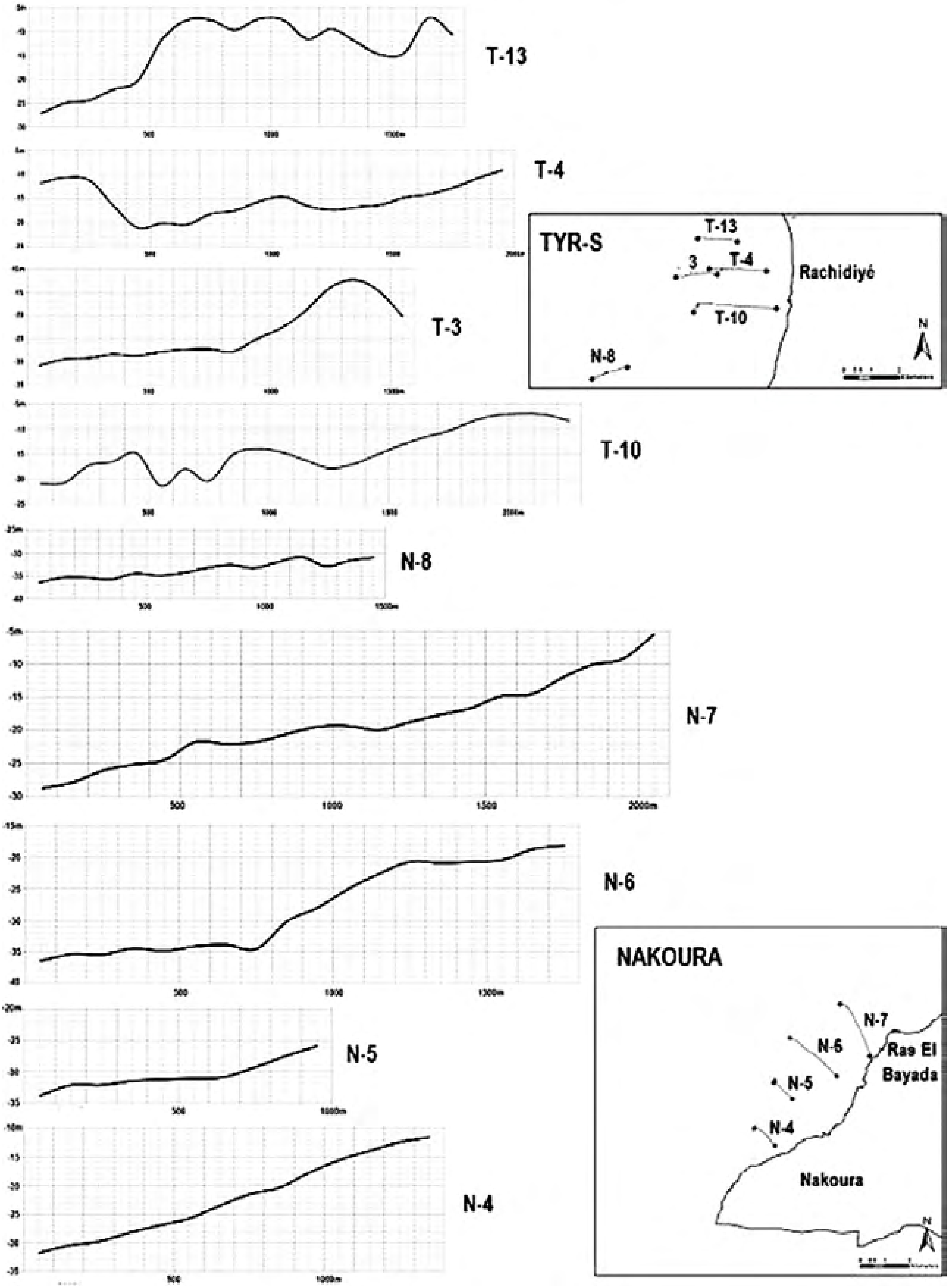


Figure 19. Topography profiles (Southern Tyre and Nakoura) made by hydroplane

The Nakoura area presents two different geo-morphological sectors:

i) the limestone cliff from Ras El Bayada;

ii) the sandstone coast from Nakoura. Although the El Bayada abrasion platform is shorter (1-2 m width) than Nakoura (many meters width), the type of substrata is similar.

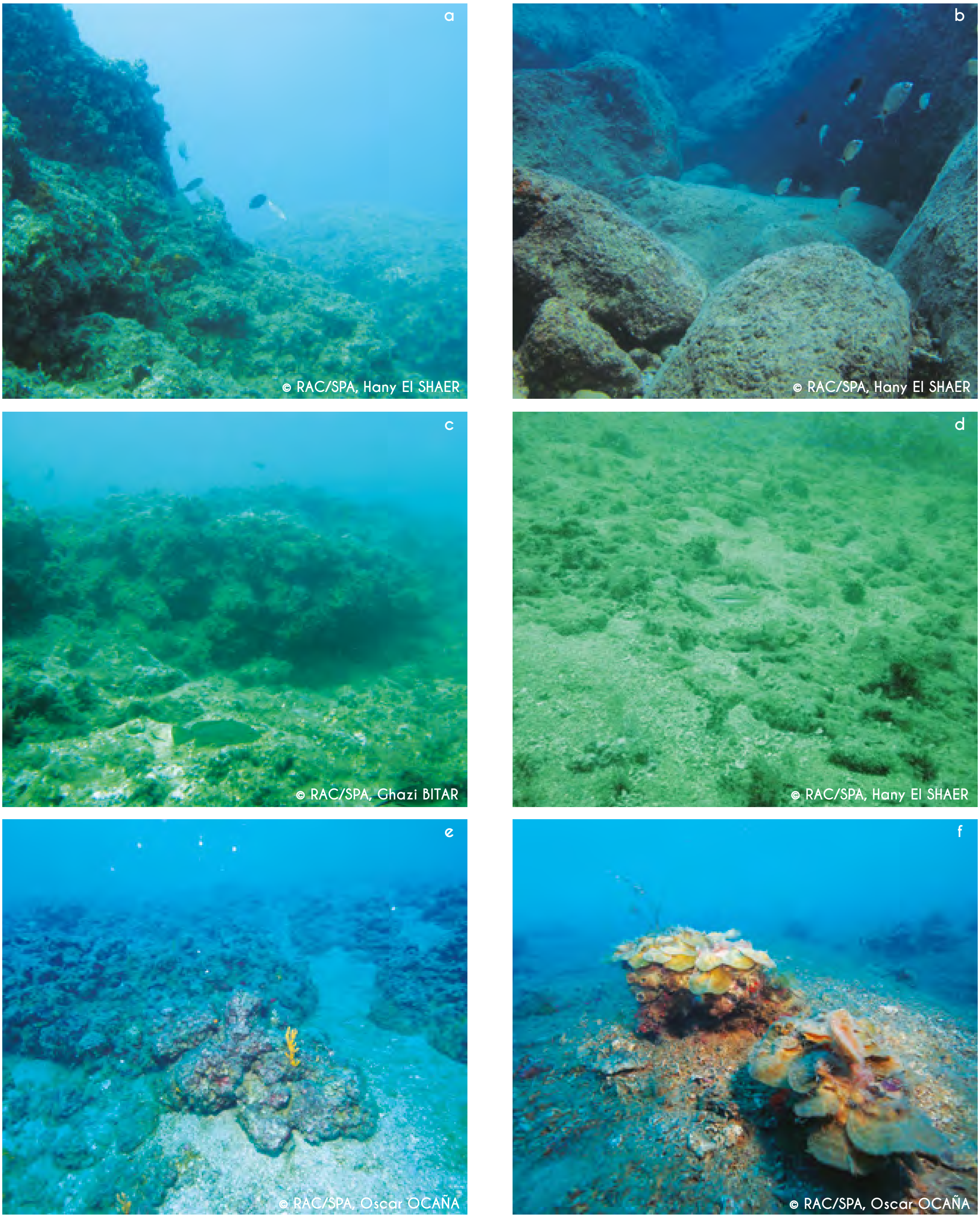


Figure 20. Types of the seabed:
a) littoral vertical rock (Ras Chekaa, st.C-14, -10 m); b) big blocks (Ras Chekaa, st.C-20, -7 m);
c) high irregular rock (El Bayada, st.N-3, -6 m); d) low rock without channels (El Bayada, st.N-2, -12 m);
e) low irregular rock with gravel-coarse sand channels (Nakoura, st.N-11, -35 m);
f) small blocks on detritic seabed (Nakoura, st.N-14, -44 m).

The great rocky massifs from Enfeh and Ras Chekaa are not present in this area, where the rocky seabed presents different typologies, from the shore to a 50 m depth (Fig. 20):

- **Littoral rock** (Fig. 20a): With a more or less wide abrasion platform followed by a vertical rock profile with big blocks at the base (0-8 m depth).
- **Big blocks** (Fig. 20b): With a diameter > 1 m, and located at the base of the shallow vertical rock.
- **High irregular rock** (Fig. 20c): The rock forms great massifs, normally, near to the coast, between 0-20 m depth.
- **Low and smooth flat rock** (Fig. 20d): The rocky seabed is more or less continuous without crevices or canals, only some small boulders, cobbles or pebbles are present. Normally, this type of rocky substratum is cover with shell gravel and coarse sand. It is widespread in the zone, mainly between 8 to 43 m depth.
- **Low and irregular flat rock with channels** (Fig. 20e). The rock is 0,5-1 m high, with irregular shell gravel-coarse sand channels. This is a dominant seabed in the Nakoura area, between 12 and 40 m depth.
- **Dispersed blocks** (fig. 20f): In the Nakoura area, many small blocks (Ø < 1 m) are disseminated on the detritic bottom between 39-45 m depth.

Normally, the transition between the different types of rocky bottoms is gradual. However, in some places this change is marked, as Ras el Bayada with smooth flat rock to an irregular high one (Figs. 21-22).

Figure 21. Two types of hard bottom: smooth flat and irregular high rocks in Ras El Bayada (st. N-10, -8 m)

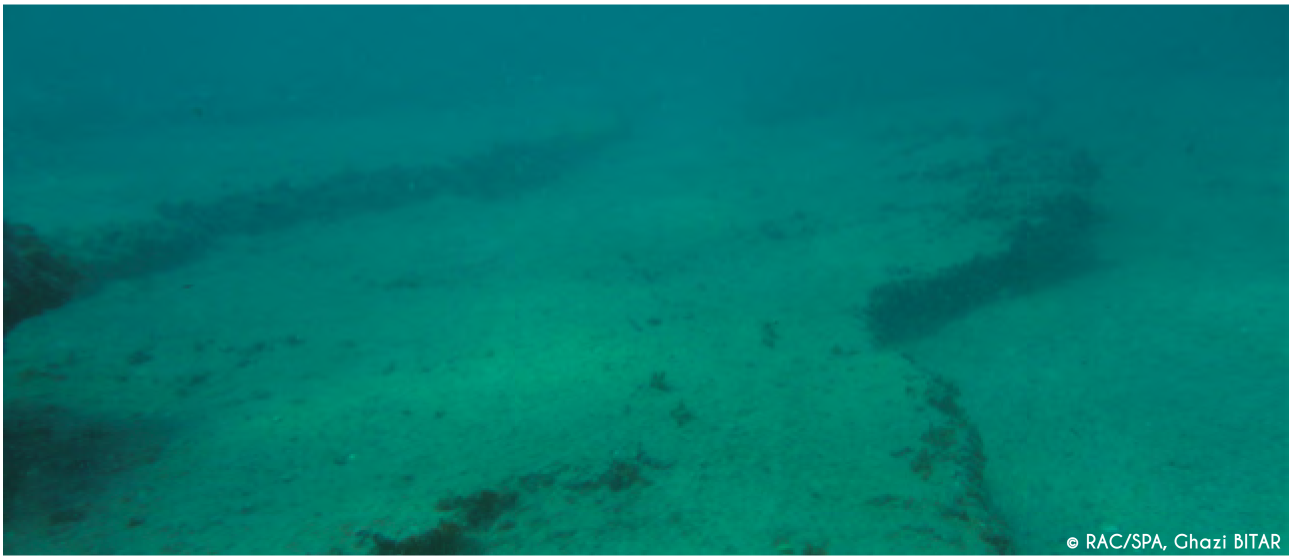


Figure 22. Bare rocks in Ras El Bayada (st. N-10, 8m depth)

4.2 Hydrology features

a) Temperature: The temperature profiles in June 2012 (Fig. 23) show a relative homogeneity (26-27 °C) in the first 23 m depth, deeper than Beirut (32 m depth). In September 2013, the thermocline has been more pronounced (20-28 °C) and it went down the 40 m depth, with 28-29 °C in the shallows. With regard to June (2012), where the thermocline was located at 25 m depth, a significant drop was observed during the summer of 2013 (40-50 m depth, about 15-25 m deeper, Fig. 23).

The thermocline depth is interesting with regards to the bathymetric distribution of species, because its first depth (-40 m) determines a change in the dominance of lessepsian ones.

b) Salinity: The salinity varied between 38.41 - 39.15 psu, although the normal range of the salinity has been between 38.80 - 39.10 psu.

c) Hydrodynamism: The Lebanese coast is prone to big swells, since the western fetch is located in eastern Tunisia, about 2400 km from Lebanon. The maximum wave height recorded during the period 2000-2003 was 9 m and occured in the south of Beirut (Kabbara, 2005), that means a wave length of about 140m.

The bottom influence of these waves (1/4 λ) is at 35 m depth. In fact, our observations by hydroplane transects confirm this, with marked ripple-marks on gravel-coarse sand at a 40 m depth.

That means considerable erosion by sediment scour on rocky substrata. This sediment abrasion could explain the presence of bare rocks in littoral areas (Fig. 23), apart from the grazing pressure.

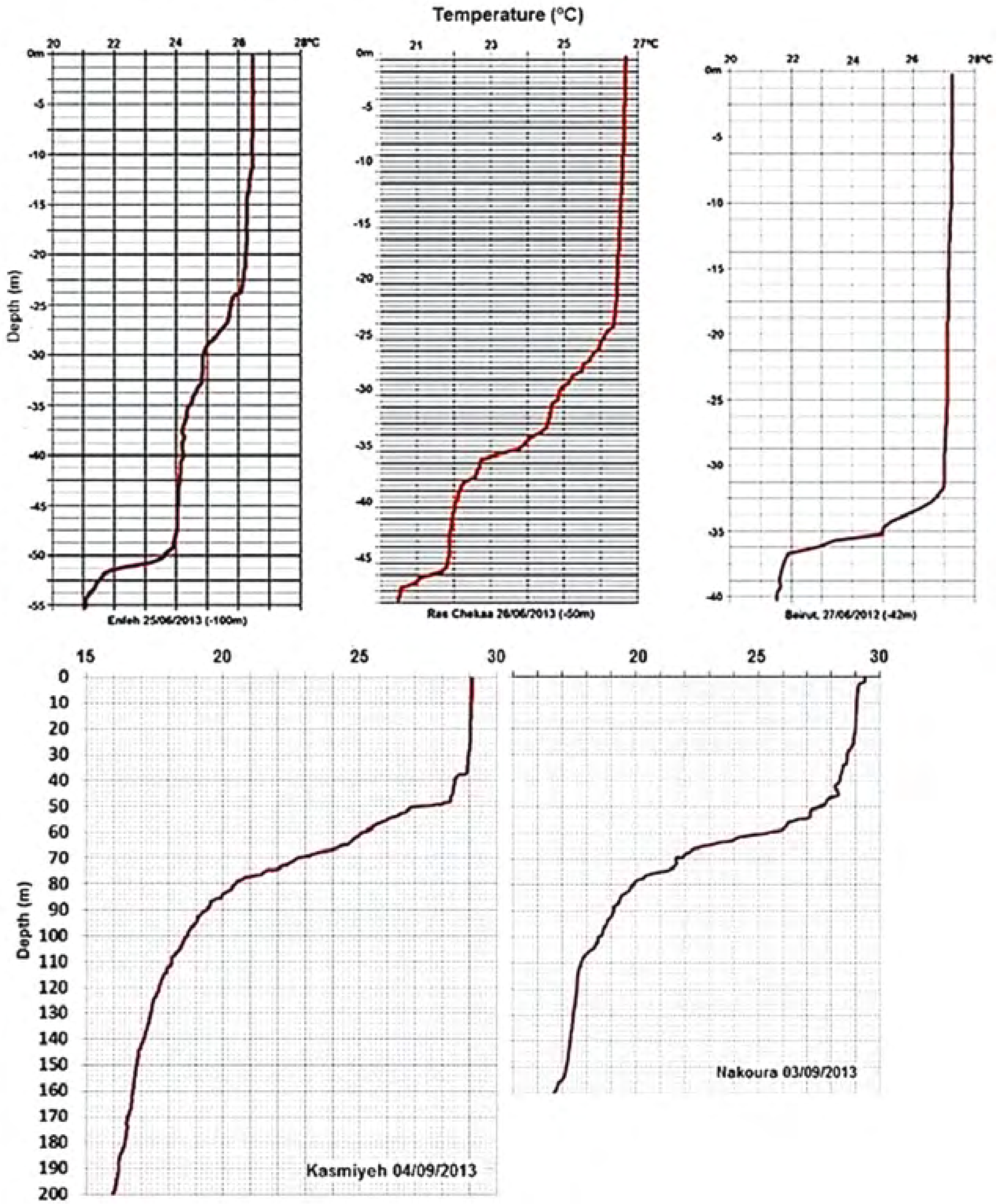


Figure 23. Temperature profiles in 2012 (late June) and 2013 (early September) missions

5. LEBANON'S MARINE BIODIVERSITY

During the 2012 and 2013 missions, about four hundred thirty six low taxa (at the level of species, genus or family) of megabenthic organisms and nekton, belonging to twenty one high taxa (phyla, classes) have been observed (see Annex 10-2).

5.1 Flora and fauna inventory

a) **Taxa:** The main group has been (Figs. 24, 25): Mollusca, with 78 species (17,8 %), followed by Actinopterygii (77 spp., 17,6 %), Rhodophyta (64 spp., 14, 7 %) and Porifera (56 spp., 12,8 %).

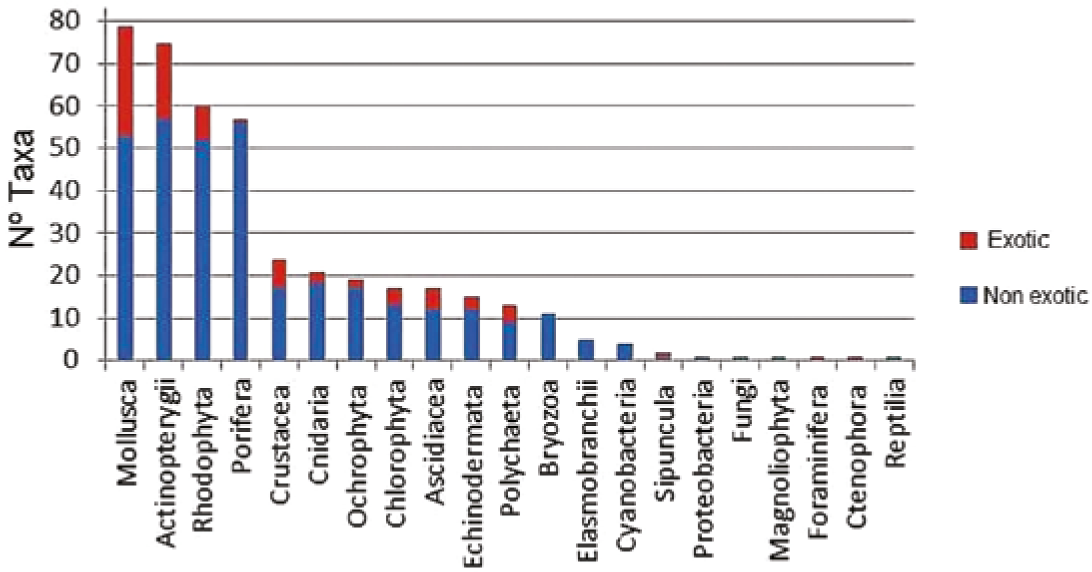


Figure 24. Number of species/taxon observed in the two Lebanon missions (06/2012, 08-09/2013). Exotic species are in red

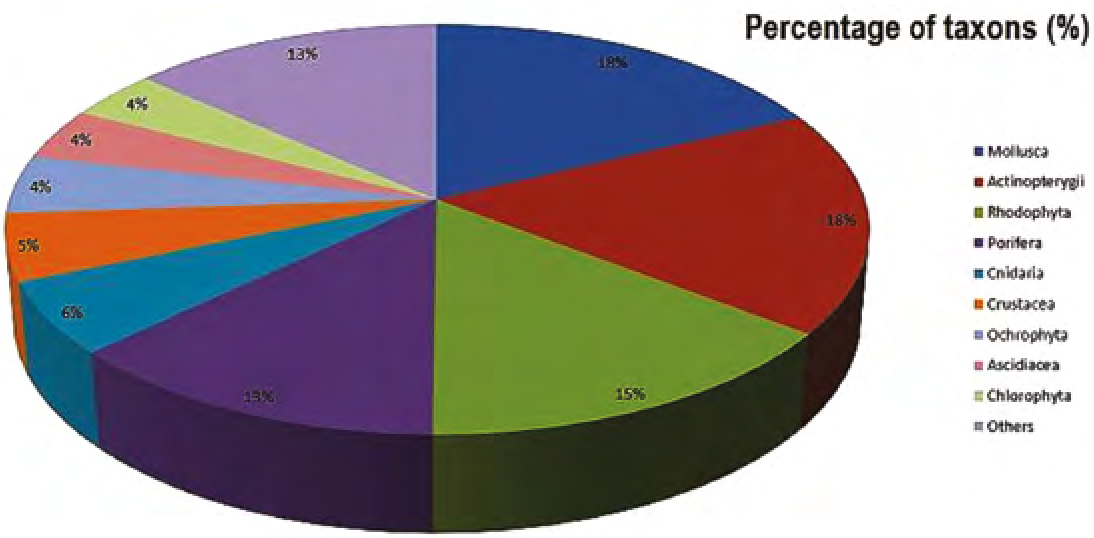


Figure 25. Percentage of the different high taxa observed in the two Lebanon missions (06/2012, 08-09/2013)

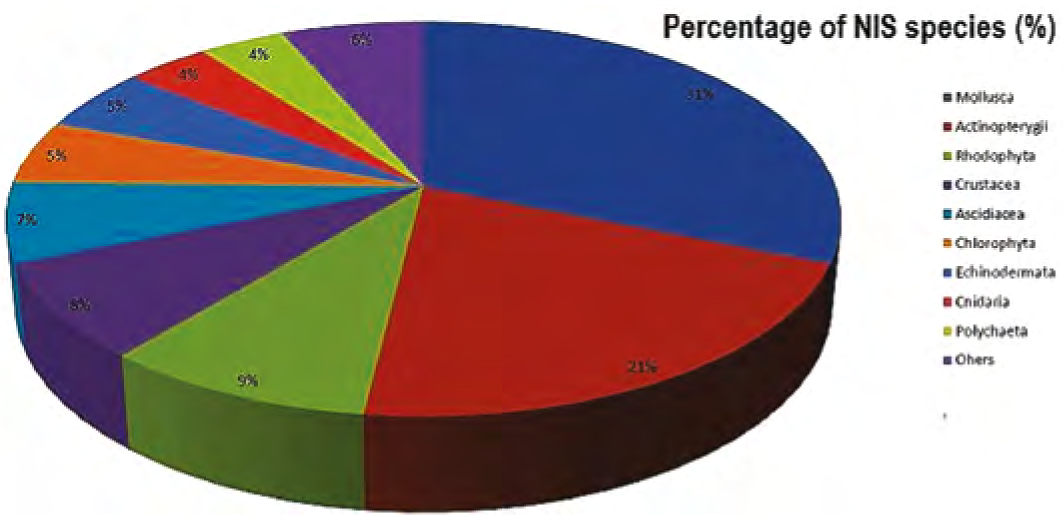


Figure 26. Percentage (%) of Non-Indigenous Species (NIS) by taxons/groups observed in the Lebanon missions 2012 and 2013.

b) Alien species: As for the exotic species, 77 spp. are considered non indigenous (about 17,6 %). Among them, 75 spp. are lessepsian and 2 spp. are from Atlantic origin (*Oculina patagonica* and *Percnon gibbesi*). The Figure 26 shows the percentange of the species by groups, with the mollusks standing out (24 spp. 31,2 %) and actinopterygii fishes (16 spp, 20,8 %).

5.2 New records for the Lebanes marine biodiversity:

With regard to the Lebanon marine biodiversity, aside from the Mediterranean bibliography, fauna and flora papers from Lebanon have been consulted:

- Benthos: Bitar & Kouli-Bitar (1995a, 1995b, 1998, 2001), Bitar *et al.* (2007), Bitar (2010).
- Macrophyta: Lakkis & Novel-Lakkis (2000, 2007), Bitar *et al.* (2000).
- Invertebrata: Zibrowius & Bitar (2003),
- Poriferans: Perez *et al* (2005), Vacelet *et al.* (2007, 2008), Vacelet & Perez (2008).
- Cnidaria. Hydrozoa: Morri *et al.* (2009) ; Anthozoa: Zibrowius & Bitar (1997).
- Polychaeta: Lakkis & Novel-Lakkis (2005), Aguado & San Martin (2007).
- Crustacea. Cirripedia: Young *et al.* (2003) ; Isopoda: Bariche & Trilles (2005), Castelló (2010) ; Decapoda: Galil *et al.* (2002), Katsanevakis *et al.* (2011).
- Mollusca: Zenetos *et al.* (2003), Crocetta *et al.* (2013a, 2013b), Bitar (2014).
- Bryozoa: Harmelin *et al.* (2007, 2009, 2011).
- Brachiopoda: Logan *et al.* (2002).
- Ophiuroidea: Stöhr *et al.* (2009).
- Ascidiacea: Izquierdo *et al.* (2009), Ramos-Esplá *et al.* (2013).
- Fishes: Mouneimne (1978, 2002), Golani *et al.*(2002), Harmelin-Vivien *et al.* (2005). Bariche (2012), Bariche & Azzurro (2012).

Probably, eighteen new records for the Lebanese marine biodiversity have been observed during the two missions (2012-2013) (Fig. 27)

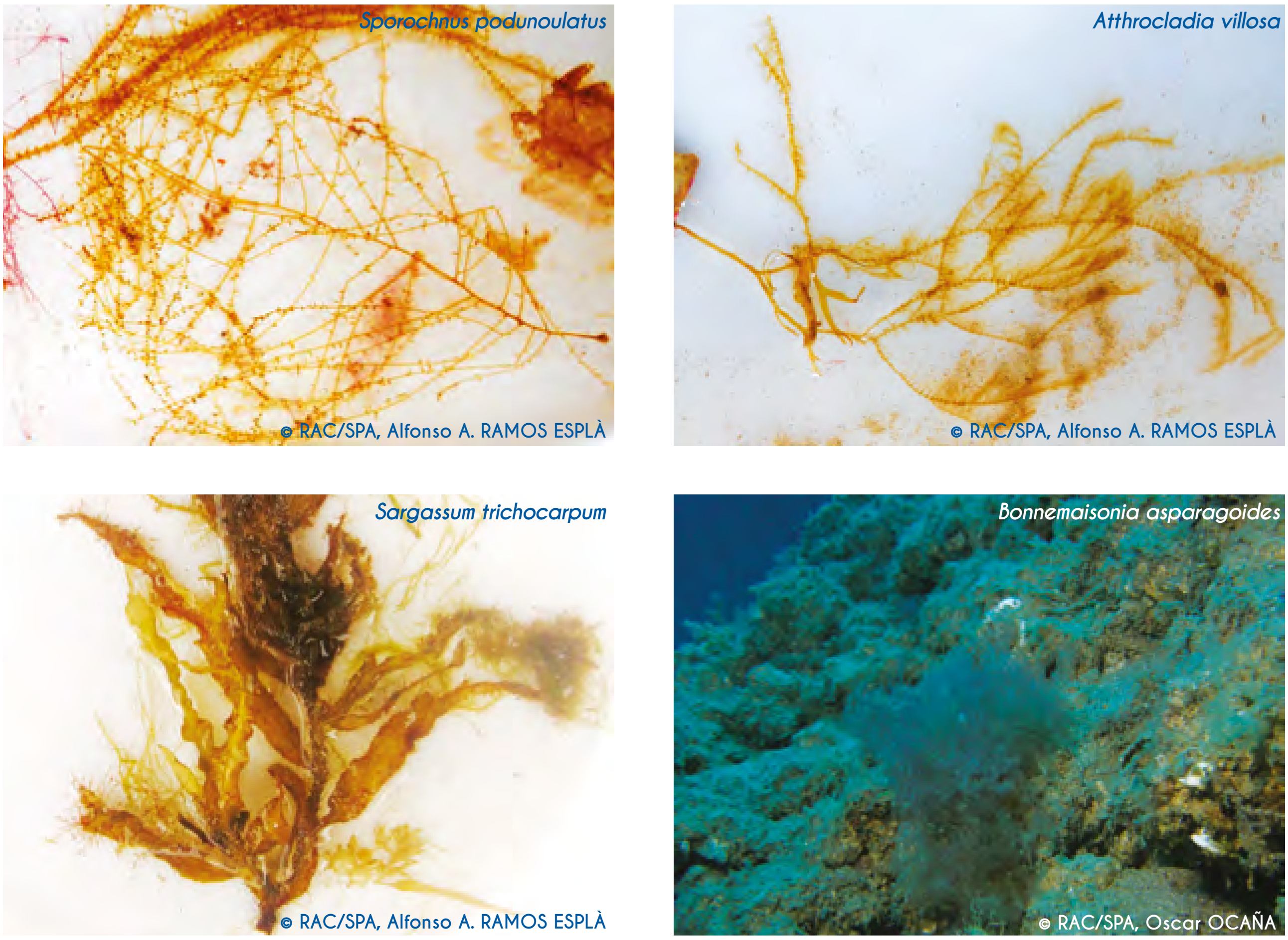


Figure 27. New records for the Lebanese marine biodiversity. Macroalgae: *Ochrophyta* and *Rhodophyta*

a) Macroalgae

- ***Ochrophyta:*** *Arthrocladia villosa* (Hudson) Duby, 1830 (st. E-5, E-14, C-4, C-5, C-6, C-7, C-8, C-15, C-18, C-21) ; *Sargassum trichocarpum* J.Agardh, 1848 (st. E-4, C-4) ; *Sporochnus pedunculatus* (Hudson) C.Agardh, 1820 (st. C-18).
- ***Rhodophyta:*** *Bonnemaisonia asparagoides* (Woodward) C.Agardh, 1822 (st. E-14).

b) Invertebrata

- ***Porifera:*** *Paraleucilla magna* Klautau, Monteiro & Borojevic, 2004. (st. R-1).
- ***Anthozoa:*** *Asterosmilia* sp. (st. T-16).
- ***Polychaeta:*** cf. *Ditrupa arietina* (O. F. Müller, 1776) (E-6).
- ***Gastropoda:*** cf. *Cellana rota* (Gmelin, 1791) (st. S-3) ; *Elysia timida* (Risso, 1818) (st. T-5).
- ***Bivalvia:*** *Venus casina* Linnaeus, 1758 (st. T-19).
- ***Holothuroidea:*** *Holothuria impatiens* (Forskål, 1775) (st. E-1, C-3, T-6).
- ***Ascidiacea:*** *Didemnum coriaceum* (Drasche, 1883) (st. N-14); *Polysyncraton bilobatum* Lafargue, 1968 (st. R-1) ; *Pseudodistoma cyrnusense* Pérès, 1952 (st. R-1).

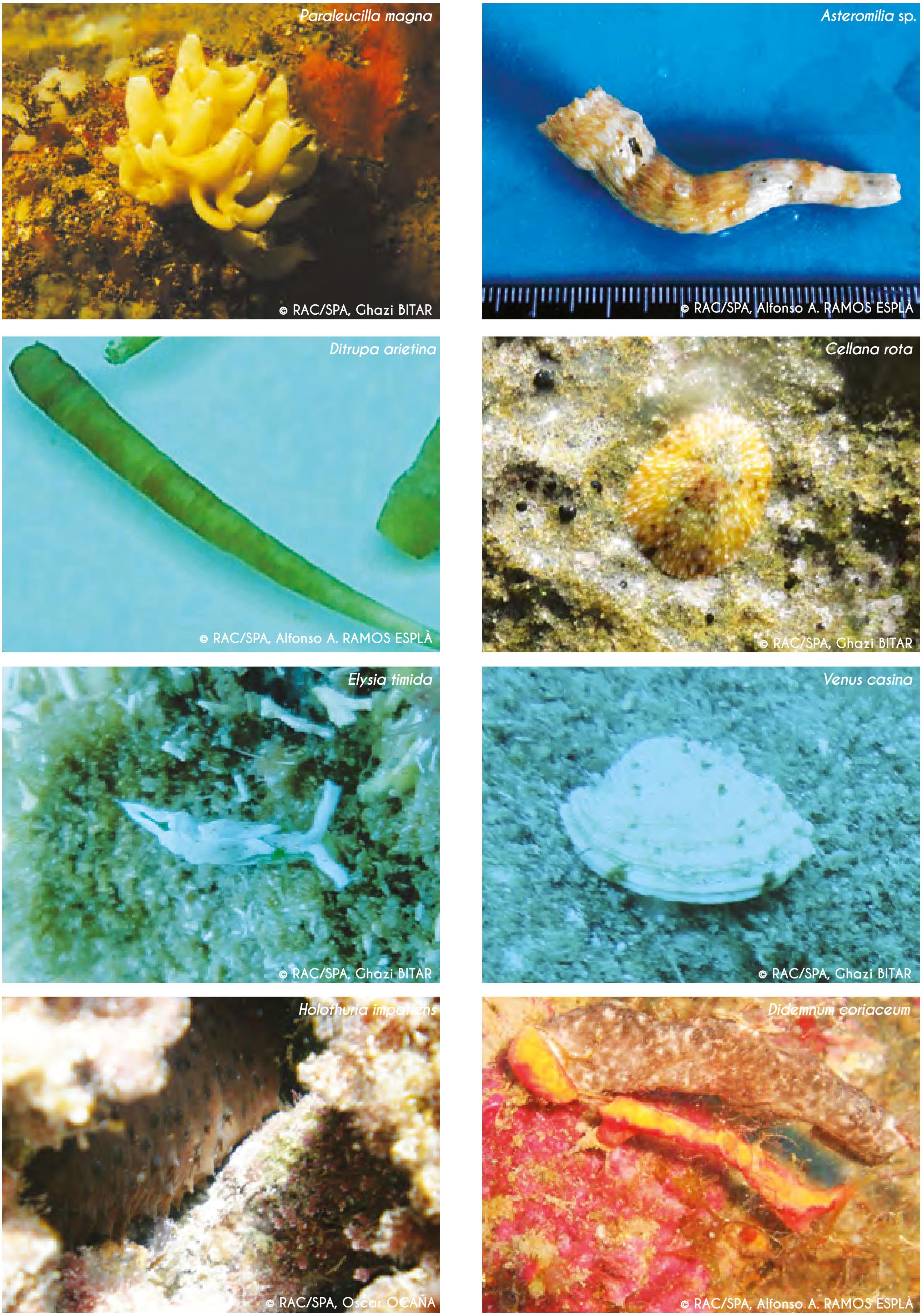
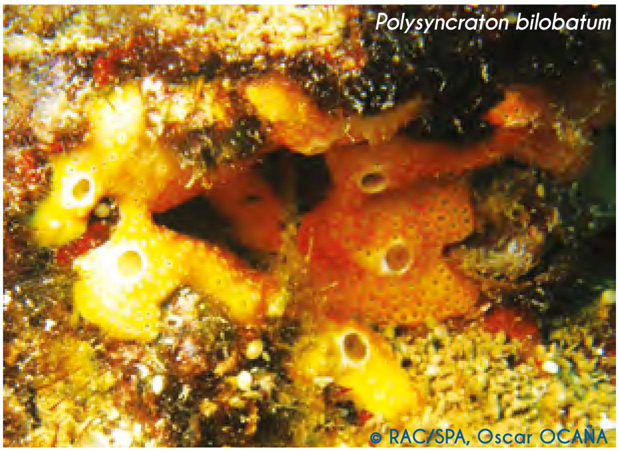
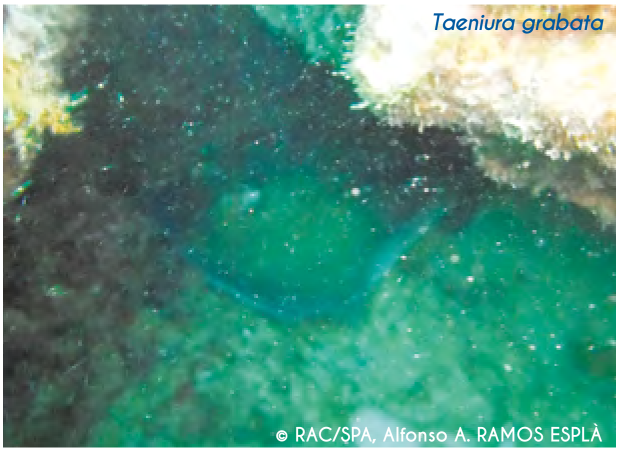


Figure 27 (cont). New records for the Lebanese marine biodiversity.
Invertebrata: Porifera, Anthozoa, Polychaeta, Mollusca, Ascidiacea

c) Pisces:

- ***Elasmobranchii:*** *Taeniura grabata* (E. Geoffroy Saint-Hilaire, 1817) (st. N-15).
- ***Actinopterygii:*** *Gobius geniporus* Valenciennes, 1837 (St. E-8, C-18, C-21, N- 11, N-13); *G. kolombatovici* Kovacic & Miller, 2000 (st. C-15); *G. vittatus Vinciguerra*, 1883 (st. C-18, C-21, T-25).





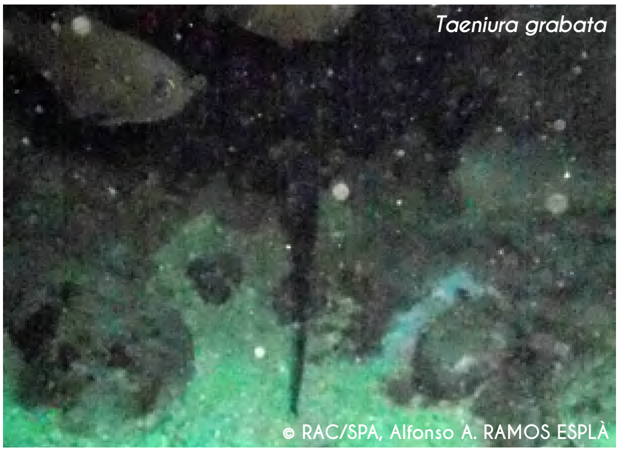


Figure 27 (cont). New records for the lebanese marine biodiversity. Ascidacea and Pisces

5.3 Fish populations

5.3.1 Enfeh – Ras Chekaa (2012 Survey)

During the study conducted in 2012, a total of 32 fish species were observed (Table 6), 6 spp. of which were lessepsian species: *Pempheris vanicolensis*, *Stephanolepis diaspros*, *Siganus luridus*, *Siganus rivulatus*, *Sargocentron rubrum* and *Torquigener flavimaculosus*. The fish assemblage parameters were rather different among the studied stations.

Table 6. Sampled species and its spatial* and trophic** categories in 2012 survey.

Species	COE	Trophic cat.	Station						
			E-14	E-15	C-15	C-21	C-16	C-19	R-1
Atherina hepsetus	1	CMM	0	0	100.0 ± 66.7	80.3 ± 80.3	0	100.0 ± 66.7	55.6 ± 55.6
Apogon imberbis	6	CMS	0.3 ± 0.1	0.1 ± 0.1	0	0	0	0	0.3 ± 0.3
Boops boops	1	CMM	0	0	0	17.8 ± 17.8	0	0.8 ± 0.8	0
Bothus podas	6	CMS	0	0	0	0	0	0	0.1 ± 0.1
Chromis chromis	2	CMM	26.8 ± 7.3	50.7 ± 10.0	0	0.1 ± 0.1	15.7 ± 10.9	38.6 ± 28.0	1.0 ± 1.0
Coris julis	5	CMS	35.2 ± 12.5	11.2 ± 4.5	9.6 ± 2.3	0.8 ± 0.5	48.6 ± 8.4	14.5 ± 5.5	2.2 ± 1.5
Diplodus cervinus	3	CMS	0	0	0	0	0	0.1 ± 0.1	0
Diplodus sargus	3	CMS	0	0.8 ± 0.5	0	0	2.3 ± 0.9	36.9 ± 14.3	38.0 ± 19.3
Epinephelus costae	5	CMC	0.5 ± 0.3	0.5 ± 0.4	0	0.5 ± 0.5	0	0.1 ± 0.1	0
Epinephelus marginatus	5	CMC	0.1 ± 0.1	0.1 ± 0.1	0	0.1 ± 0.1	0	0.3 ± 0.2	0
Gobius geniporus	6	CMS	0	0	0.1 ± 0.1	2.8 ± 1.9	0	0	0
Muraena helena	6	CMC	0.3 ± 0.1	0	0	0	0.2 ± 0.1	0	0
Mycteroperca rubra	5	CMC	0.1 ± 0.1	0.3 ± 0.2	0	0.3 ± 0.3	0	0	0.4 ± 0.2
Mullus surmuletus	4	CMS	0	0.1 ± 0.1	0	0	0	0.2 ± 0.2	0
Oblada melanura	1	CMM	0	6.7 ± 4.2	0	0	1.8 ± 1.8	7.3 ± 2.6	0.9 ± 0.9
Pseudocaranx dentex	1	CMC	0	0	0	0	0	0.8 ± 0.8	0
Pomadasys incisus	4	CMS	0	0.4 ± 0.3	0	0	0	0.3 ± 0.3	0
Pempheris vanicolensis	6	CMS	0	0	0	0	0	0.8 ± 0.8	7.9 ± 7.9
Serranus cabrilla	5	CMC	0.8 ± 0.3	0.7 ± 0.4	3.0 ± 0.9	1.9 ± 0.8	0.4 ± 0.2	0.1 ± 0.1	0
Sparisoma cretense	5	CMS	0.6 ± 0.5	2.4 ± 1.8	2.4 ± 1.0	0.3 ± 0.3	2.5 ± 1.6	7.9 ± 2.4	4.9 ± 2.0
Stephanolepis diaspros	5	CMS	0.1 ± 0.1	0	0	0	0.1 ± 0.1	0	0
Serranus hepatus	5	CMC	0	0	0.1 ± .1	1.5 ± 0.9	0	0	0
Siganus luridus	3	HBV	0.2 ± 0.2	0	0	0	0	0.5 ± 0.3	0
Scorpaena maderensis	6	CMC	0.1 ± 0.1	0.1 ± 0.1	0	0	0	0.2 ± 0.1	0
Symphodus ocellatus	5	CMS	0.3 ± 0.2	0.8 ± 0.8	0	0	0.2 ± 0.1	0	0.1 ± 0.1
Siganus rivulatus	3	HBV	1.7 ± 1.4	0.8 ± 0.6	0	0	0	18.5 ± 9.7	36.6 ± 17.7
Symphodus roissali	5	CMS	0	0	0	0	0.1 ± 0.1	0	0
Sargocentron rubrum	6	CMS	0.7 ± 0.6	5.3 ± 2.8	0	8.9 ± 8.9	11.9 ± 5.5	10.7 ± 8.2	0.2 ± 0.1
Serranus scriba	5	CMC	0.3 ± 0.2	0.5 ± 0.3	0	0	0	0.3 ± 0.2	0.2 ± 0.1
Sciaena umbra	5	CMC	0	0.1 ± 0.1	0	0	0	0	0
Torquigener flavimaculosus	4	CMM	1.3 ± 0.6	0.2 ± 0.2	1.5 ± 0.5	0	0	0	0.1 ± 0.1
Thalassoma pavo	5	CMS	0.7 ± 0.3	3.7 ± 0.7	0.2 ± 0.2	0	23.0 ± 9.0	24.8 ± 14.9	1.2 ± 0.5

*COE; 1: very mobile pelagic species, 2: moderately sedentary pelagic species, 3: demersal species moving moderately along vertical axis, 4: nekto-benthic species, 5: relatively sedentary species, 6: cryptic species.
**Trophic. cat.; CMM: microphagous, CMS: mesophagous, CMC: macrophagous, HBV: herbivorous.
Mean abundance (ind/125 m^2 ± standard error) of the species sampled in each station.
Stations: (E) Enfeh, (C) Ras Chekaa, (R) Raoucheh.

a) Fish assemblage parameters

The fish assemblage parameters (mean number of species, total abundance and total biomass) were maximum in the station C-15 of Ras Chekaa, while the minimum values were observed in station C-21 for the number of species, E-14 for total abundance and C- 15 for total biomass (Table 7, Fig. 28-31).

Table 7. Mean values (± standard error) of number of species, total abundance and total biomass in the study stations of the 2012 survey

Variable	Station						
	E-14	E-15	C-15	C-21	C-16	C-19	R-1
Number of species /125 m²	4.6 ± 0.5	6.7 ± 0.9	3.3 ± 0.5	2.6 ± 0.5	5.0 ± 0.8	7.7 ± 0.6	4.8 ± 0.8
Abundance (ind./125 m²)	69.8 ± 16.3	85.5 ± 13.1	116.9 ± 68.3	115.0 ± 77.4	106.8 ± 20.1	263.7 ± 63.3	149.8 ± 53.5
Biomass (kg/125 m²)	0.59 ± 0.15	1.00 ± 0.30	0.24 ± 0.09	2.66 ± 2.5	1.19 ± 0.43	3.66 ± 1.07	2.39 ± 0.79

Stations: (E) Enfeh, (C) Ras Chekaa, (R) Raoucheh.

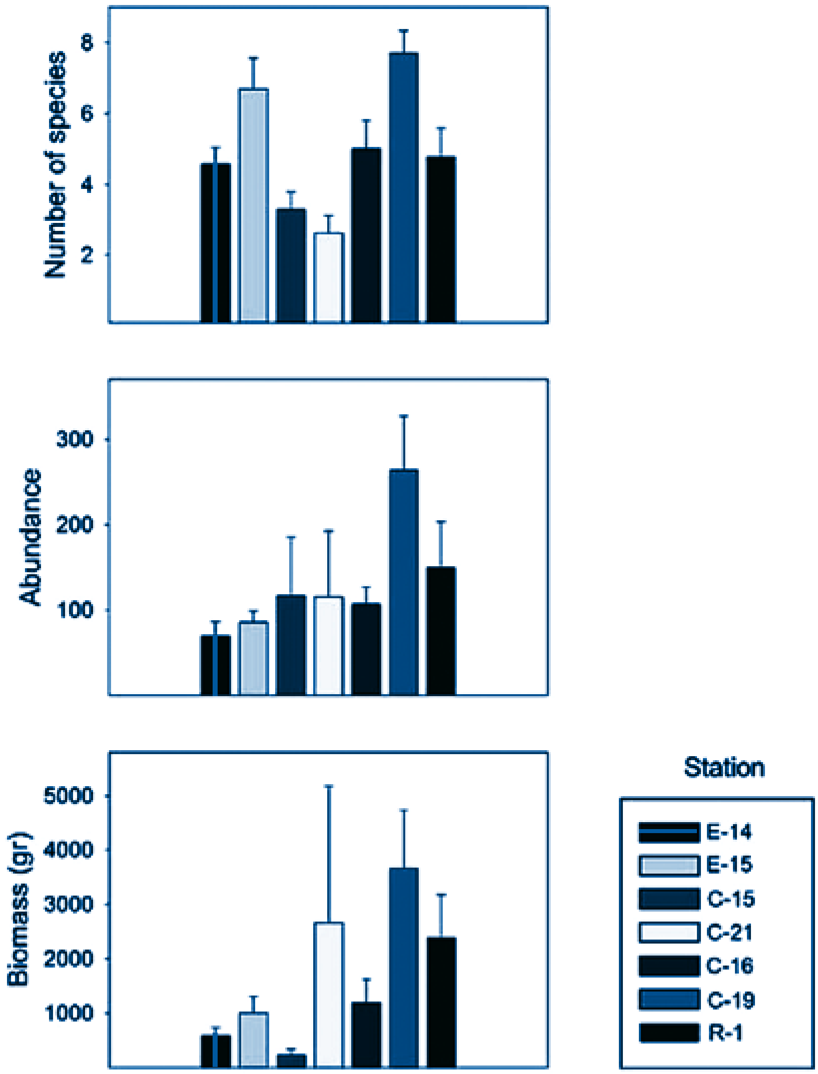


Figure 28. Mean values (± standard error) of number of species (n° of spp/125 m²), total abundance (ind./125 m²) and total biomass (g/125 m²) in the study stations of the 2012 survey. Stations: (E) Enfeh, (C) Ras Chekaa, (R) Raoucheh

b) Spatial categories

Regarding the spatial categories, the fish assemblage was manly dominated by very mobile pelagic species and relatively sedentary species (Table 8). The former presented the greater abundances in the stations C-15, C-19 and C-21, and the latter in stations E-14 and C-16.

Other spatial categories were less important, although some of them were moderately sedentary pelagic species and demersal species moving moderately along vertical axis were the most abundant in the station E-15 and R-1 respectively.

Table 8. Mean abundance (ind./125 m² ± standard error) for the spatial categories in the study stations of the 2012 survey

	Station						
	E-14	E-15	C-15	C-21	C-16	C-19	R-1
COE1	0	6.7 ± 4.2	100.0 ± 66.7	98.0 ± 79.7	1.8 ± 1.8	108.9 ± 65.9	56.4 ± 55.5
COE2	26.7 ± 7.6	50.7 ± 9.9	0	0.1 ± 0.1	15.7 ± 10.9	38.6 ± 28.0	1.0 ± 1.0
COE3	1.8 ± 1.5	1.6 ± 0.8	0	0	2.3 ± 0.9	56.0 ± 21.9	74.6 ± 30.4
COE4	1.3 ± 0.6	0.7 ± 0.4	1.5 ± 0.5	0	0	0.5 ± 0.3	0.1 ± 0.1
COE5	38.7 ± 12.8	20.3 ± 4.7	15.3 ± 3.1	5.3 ± 1.2	74.9 ± 10.1	48.0 ± 16.6	9.1 ± 3.2
COE6	1.3 ± 0.8	5.5 ± 2.8	0.1 ± 0.1	11.6 ± 8.7	12.1 ± 5.5	11.7 ± 8.4	8.6 ± 8.3

1: very mobile pelagic species, 2: moderately sedentary pelagic species,3: demersal species moving moderately along vertical axis, 4: nekto-benthic species, 5: relatively sedentary species, 6: cryptic species.
Stations: (E) Enfeh, (C) Ras Chekaa, (R) Raoucheh

c) Trophic categories

Concerning the trophic categories, the microphagous species were the most abundant followed by the mesophagous species (Table 9). Microphagous predominated in stations E-15, C-15, C-19, C-21 and R-1, meanwhile mesophagous prevail in the station E-14 and C-16. Herbivorous, which were represented only by two species of *Siganus*, were observed only in the shallower stations (E-14, E-15, C-19 and R-1).

Table 9. Mean abundance (ind./125 m² ± standard error) for the trophic categories in the study stations of the 2012 survey

	Station						
	E-14	E-15	C-15	C-21	C-16	C-19	R-1
CMC	2.2 ± 0.5	2.3 ± 0.7	3.1 ± 1.0	4.3 ± 0.8	0.6 ± 0.2	1.8 ± 1.1	0.7 ± 0.2
CMM	28.1 ± 7.6	57.6 ± 11.5	101.5 ± 66.6	98.1 ± 79.7	17.5 ± 10.8	146.7 ± 68.4	57.6 ± 55.3
CMS	37.8 ± 12.8	24.8 ± 6.0	12.3 ± 2.9	12.6 ± 8.7	88.7 ± 12.2	96.2 ± 23.8	55.0 ± 19.5
HBV	1.8 ± 1.5	0.8 ± 0.6	0	0	0	19.0 ± 9.8	36.6 ± 17.8

CMC: macrophagous; CMM: microphagous; CMS: mesophagous; HBV: herbivorous.
Stations: (E) Enfeh, (C) Ras Chekaa, (R) Raoucheh.

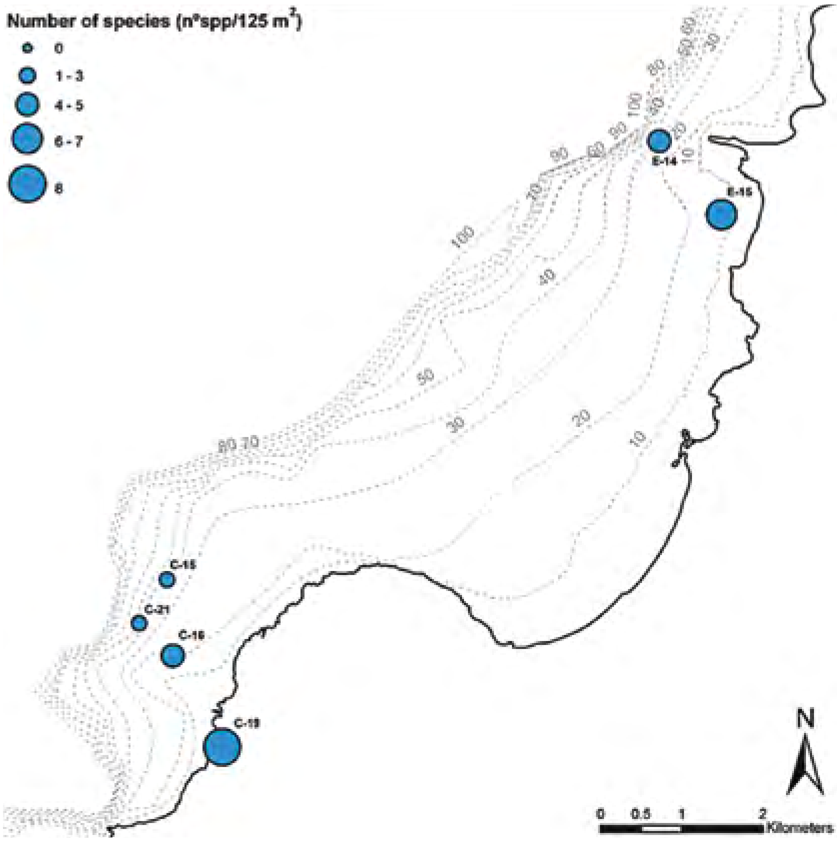


Figure 29. Spatial distribution of mean number of species (nº of spp/125 m²) in the study area of the 2012 survey. Stations: (E) Enfeh, (C) Ras Chekaa

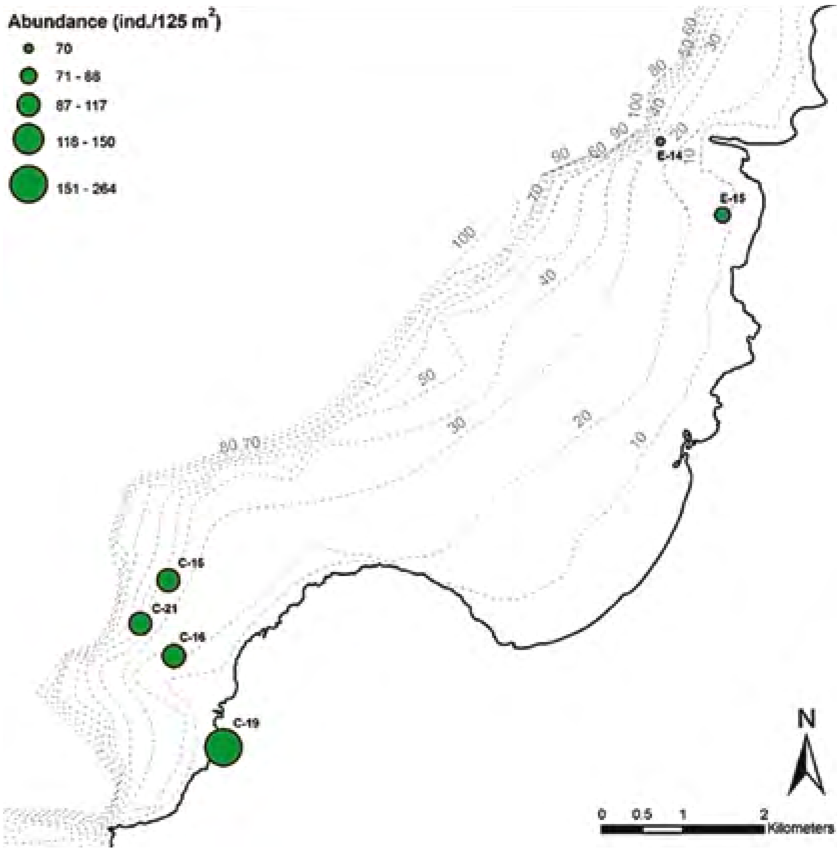


Figure 30. Spatial distribution of mean total abundance (ind./125 m²) in the study area of the 2012 survey. Stations: (E) Enfeh, (C) Ras Chekaa

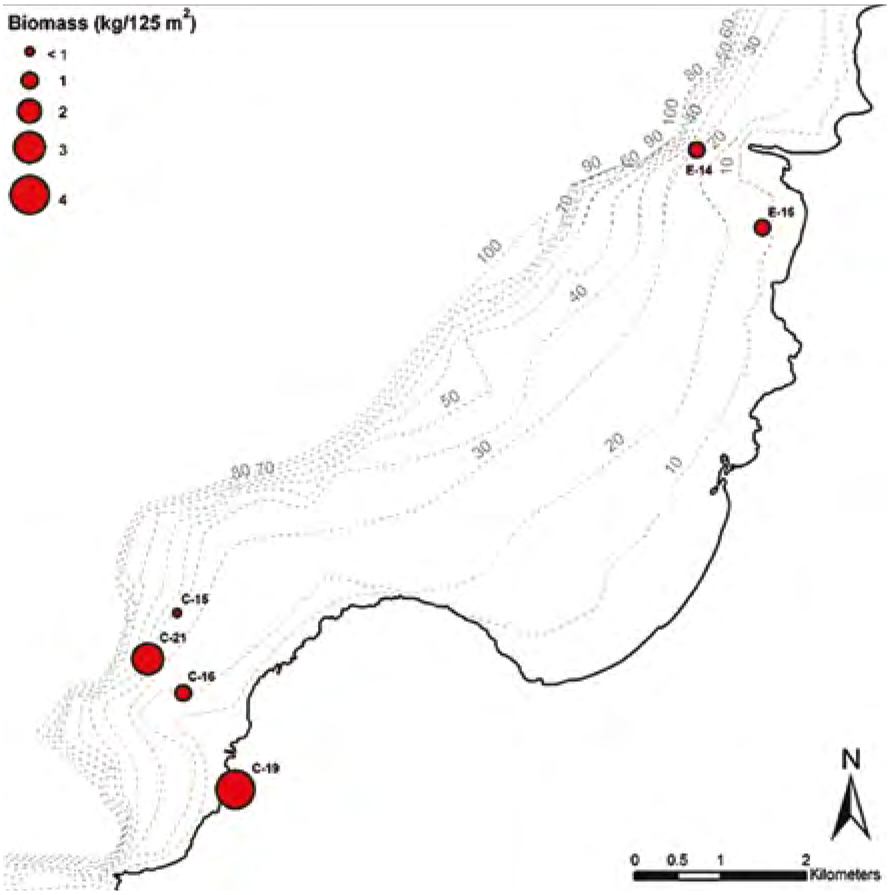


Figure 31. Spatial distribution of mean total biomass (kg/125 m²) in the study area of the 2012 survey. Stations: (E) Enfeh, (C) Ras Chekaa

d) Fish size structure

Fish size structure was also different among the stations (Fig. 32). Small individuals clearly dominated in stations E-14, E-15, C-16 and C-21, representing around 40-50 % of all the individuals observed. However, in stations C-19 and R-1 the most abundant size class was the medium small individuals. And finally, in station C-15 the individuals observed were mainly medium sized.

With reference to species abundance, apart from the pelagic schooling species *Atherina hepsetus*, *Chromis chormis* and *Boops boops*, the more abundant species in the entire studied area were *Coris julis* (18.7 ± 3.3 ind. 125 m^{-2}), *Diplodus sargus* (10.8 ± 3.7 ind. 125 m^{-2}), *Siganus rivulatus* (7.9 ± 3.0 ind. 125 m^{-2}), *Thalassoma pavo* (7.8 ± 2.7 ind. 125 m^{-2}) and Sargocentron rubrum (5.2 ± 1.8 ind. 125 m^{-2}). Even, though *C. julis* was very abundant in five of the seven studied stations (table 6), the two dimensional nMDS ordination of abundances showed that the fish assemblages varied among stations (figure 33). The stations that differed more were the deepest ones of Ras Chekaa (C-15 and C-21).

Regarding these differences in the fish assemblage among stations, the analysis of similarity (SIMPER) (table 10) helped to identify the most important species in each one. *C. chromis* and *C. julis* contributed over 70 % to the similarity of the Enfeh stations (E- 14 and E-15). However, in the deepest stations of Ras Chekaa (C-15 and C-21), the species that highly contributed to the similarity was *S. cabrilla*. In the stations C-16 and R-1, only three species contribute up to 90 % to the similarity, in the former *C. julis*, *S. rubrum* and *T. pavo*, and in the latter *S. rivulatus*, *D. sargus* and *S. cretense*. On the other hand, six species participated in the similarity of the station C-19, being the most important *D. sargus*, *C. julis* and *S. cretense*.

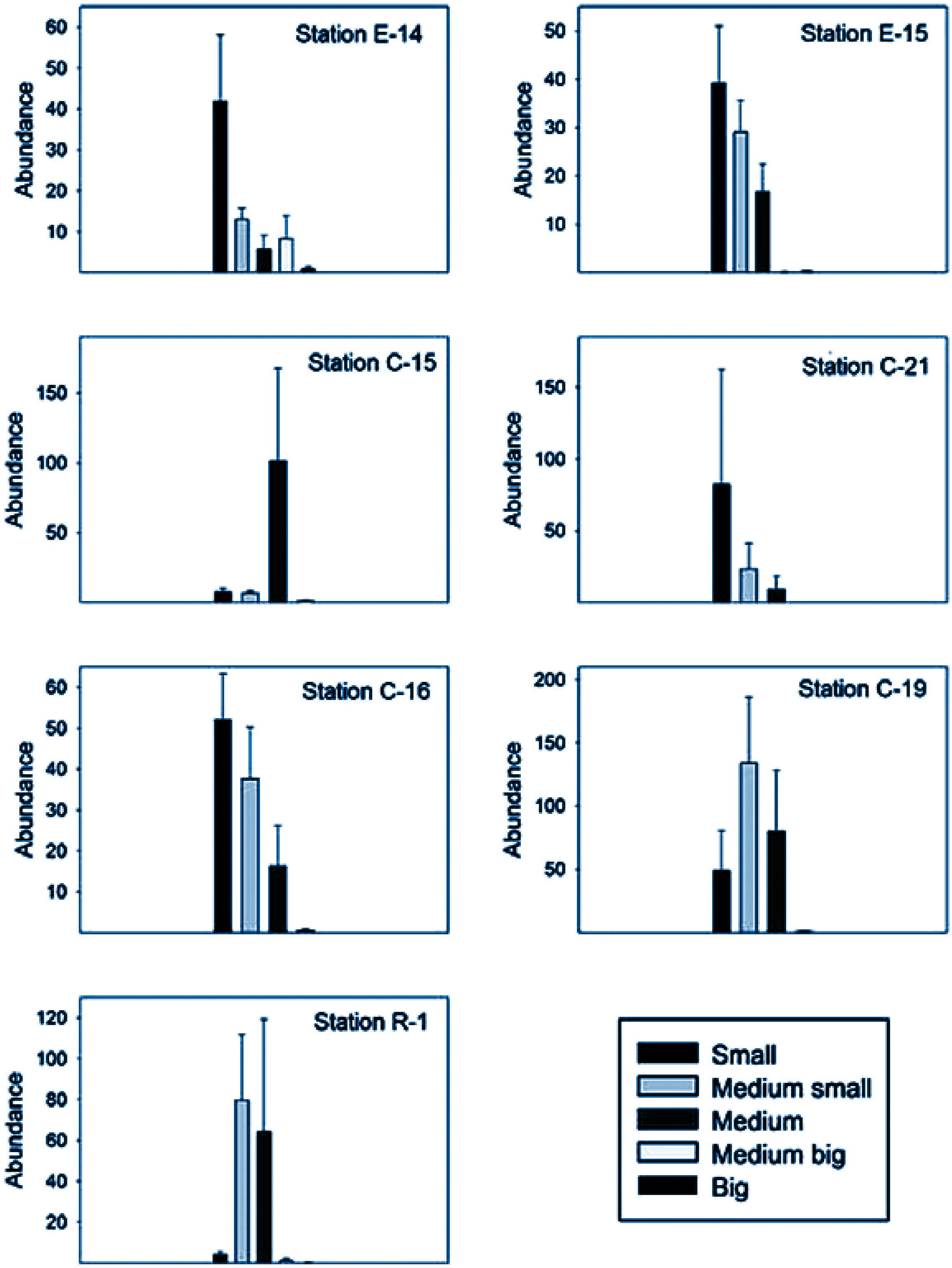


Figure 32. Mean abundance (ind./125 m² ± standard error) of the fish assemblage size structure in the study stations of the 2012 survey. Stations: (E) Enfeh, (C) Ras Chekaa, (R) Raoucheh.

Table 10. Analysis of similarity (SIMPER) of the species abundance sampled in each station of the 2012 survey. Only the species that contribute up to 85 % of the dissimilarity are indicated.

	ABU	% sim	% acu
Station E-14: SM=36.80			
C. chromis	4.2	44.0	44.0
C. julis	4.6	41.7	85.7
Station E-15: SM=54.21			
C. chromis	6.8	55.7	55.7
C. julis	2.8	16.8	72.5
T. pavo	1.8	14.4	86.8
Station C-15: SM=37.20			
C. julis	2.7	42.0	42.0
S. cabrilla	1.5	31.2	73.2
T. flavimaculosus	0.9	13.7	86.9
Station C-21: SM=14.59			
S. cabrilla	0.9	54.4	54.4
G. geniporus	1.0	28.9	83.3
S. hepatus	0.7	11.8	95.1
Station C-16: SM=53.51			
C. julis	6.7	62.4	62.4
S. rubrum	2.8	16.7	79.0
T. pavo	3.4	11.1	90.1
Station C-19: SM=36.70			
D. sargus	4.8	21.3	21.3
C. julis	3.1	17.1	38.4
S. cretense	2.5	15.0	53.5
T. pavo	3.6	13.8	67.3
S. rivulatus	2.9	9.3	76.6
O. melanura	2.0	8.7	85.3
Station R-1: SM=25.88			
S. rivulatus	4.5	36.9	36.9
D. sargus	4.4	35.1	72.1
S. cretense	1.6	13.4	85.5

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

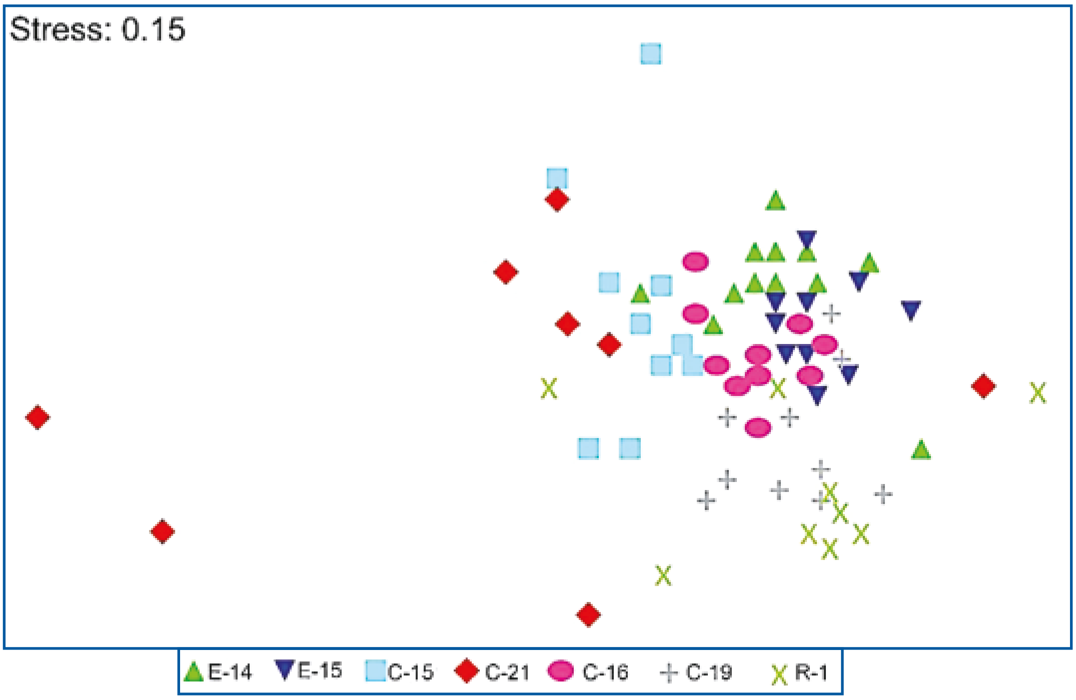


Figure 33. Two dimensional nMDS ordination of abundances of the species observed at each underwater visual census of the 2012 survey. Stations: (E) Enfeh, (C) Ras Chekaa, (R) Raoucheh.

5.3.2. Saida-Tyre-Nakoura (2013 Survey)

On the other hand, during the 2013 survey, a total of 28 fish species were observed (table 5-6), 7 of which were lessepsian species: *Cheilodipterus novemstriatus, Plotosus lineatus, Pempheris vanicolensis, Siganus luridus, Siganus rivulatus, Sargocentron rubrum* and *Torquigener flavimaculosus*. Two of these lessepsian species were not recorded in the 2012 survey: *C.novemstriatus* and *P. lineatus*. On the contrary, *Stephanolepis diaspros*, was not censused during 2013.

a) Fish assemblage parameters

The fish assemblage parameters were, in general, lower in 2013 than in the 2012. (Table 11). Also these parameters were rather different among the studied stations in the 2013 survey. The mean number of species was maximum in the station N-12, while total abundance peaked in N-15. However, the maximum values of total biomass were observed in two stations: N-15 and T-21. The minimum values were observed in station T-22 for the number of species, and in N-14 for total abundance and total biomass (Table 12, Figs. 34-37).

Table 11. Sampled species and its spatial* and trophic** categories in the 2013 survey

Species	COE	Trophic cat.	Station N-						
			N-11	N-12	N-14	15	T-21	T-22	T-25
Apogon imberbis	6	CMS	0	0.1 ± 0.1	0	0	0	0	0
Chromis chromis	2	CMM	13.9 ± 13.9	38.3 ± 14.9	0	17.9 ± 6.7	9.0 ± 9.0	0	26.0 ± 13.0
Coris julis	5	CMS	5.8 ± 1.6	10.0 ± 2.2	2.8 ± 0.8	8.4 ± 1.6	2.5 ± 0.5	9.6 ± 3.0	6.7 ± 0.3
Cheilodipterus novemstriatus	6	CMS	0.3 ± 0.3	1.3 ± 1.3	0	1.4 ± 1.0	0	0	0
Diplodus sargus	3	CMS	0.6 ± 0.5	0.4 ± 0.2	0	0	0	0	0
Diplodus vulgaris	3	CMS	0	0	0	2.3 ± 2.3	0	0	0
Epinephelus costae	5	CMC	0.3 ± 0.2	0	0	0.1 ± 0.1	0	0	0
Gobius bucchichi	6	CMS	0.6 ± 0.3	1.3 ± 0.6	0	0.6 ± 0.3	0	0.1 ± 0.1	0
Muraena helena	6	CMC	0.3 ± 0.2	0	0	0	0	0	0
Mycteroperca rubra	5	CMC	0	0.5 ± 0.3	0	0	0	0	0
Pagellus erythrinus	3	CMS	0.1 ± 0.1	0	0	0	0	0	0
Plotosus lineatus	4	CMS	0	0	0	12.5 ± 12.5	0	0	0
Pempheris vanicolensis	6	CMS	0	0	0	44.5 ± 44.5	0	0	0
Serranus cabrilla	5	CMC	0.3 ± 0.2	0.3 ± 0.2	0.8 ± 0.3	0	0	0	0.7 ± 0.7
Sparisoma cretense	5	CMS	2.0 ± 0.9	8.0 ± 3.7	0	0.5 ± 0.5	3.0 ± 1.0	0	6.7 ± 2.3
Serranus hepatus	5	CMC	0	0	0.3 ± 0.3	0	0	0	0
Siganus luridus	3	HBV	0.1 ± 0.1	0	0	1.6 ± 1.0	9.0 ± 9.0	0	26.0 ± 24.5
Symphodus mediterraneus	5	CMS	0	0	0	0.3 ± 0.2	0	0	0
Symphodus ocellatus	5	CMS	0.1 ± 0.1	0	0	0	0	0	0
Siganus rivulatus	3	HBV	0	0	0	10.6 ± 5.8	36.0 ± 0.0	2.0 ± 0.9	0
Symphodus roissali	5	CMS	0	0	0	0	0	0.8 ± 0.5	0.3 ± 0.3
Sargocentron rubrum	6	CMS	5.0 ± 2.9	3.4 ± 2.6	0	3.6 ± 3.0	1.5 ± 1.5	0	0
Serranus scriba	5	CMC	0.1 ± 0.1	0.5 ± 0.2	0	0	0	0	0
Spicara smaris	3	CMM	0	0	0.3 ± 0.3	0	0	0	0
Symphodus tinca	5	CMS	0	0.3 ± 0.2	0	0	0	0	0
Torquigener flavimaculosus	4	CMM	0	0	0	0	0.5 ± 0.5	0	0
Thalassoma pavo	5	CMS	0.3 ± 0.3	1.9 ± 0.5	0	11.5 ± 5.2	0.5 ± 0.5	0.3 ± 0.3	2.7 ± 2.2
Xyrichthys novacula	5	CMS	0	0	0	0	0	0.1 ± 0.1	0

*COE ; 1: very mobile pelagic species, 2: moderately sedentary pelagic species, 3: demersal species moving moderately along vertical axis, 4: nekto-benthic species, 5: relatively sedentary species, 6: cryptic species)
**Trophic cat.; CMM: microphagous, CMS: mesophagous, CMC: macrophagous, HBV: herbivorous.
Mean abundance (ind./125 m^2 ± standard error) of the species sampled in each station.
Stations: (N) Nakoura, (T) Tyre.

Table 12. Mean values (± standard error) of number of species, total abundance and total biomass in the study stations of the 2013 survey

Variable	Station						
	N-11	N-12	N-14	N-15	T-21	T-22	T-25
Number of species /125 m^2	4.1 ± 0.5	6.4 ± 0.6	2.3 ± 0.5	5.6 ± 0.8	5.5 ± 0.5	2.3 ± 0.4	4.7 ± 0.9
Abundance (ind./125 m^2)	29.6 ± 13.0	66.0 ± 16.2	4.0 ± 0.4	115.8 ± 41.9	62.0 ± 0.0	12.9 ± 4.3	69.0 ± 34.7
Biomass (kg/125 m^2)	0.6 ± 0.2	0.7 ± 0.2	0.02 ± 0.005	1.8 ± 1.0	1.8 ± 0.6	0.06 ± 0.02	1.0 ± 0.8

Stations: (N) Nakoura, (T) Tyre.

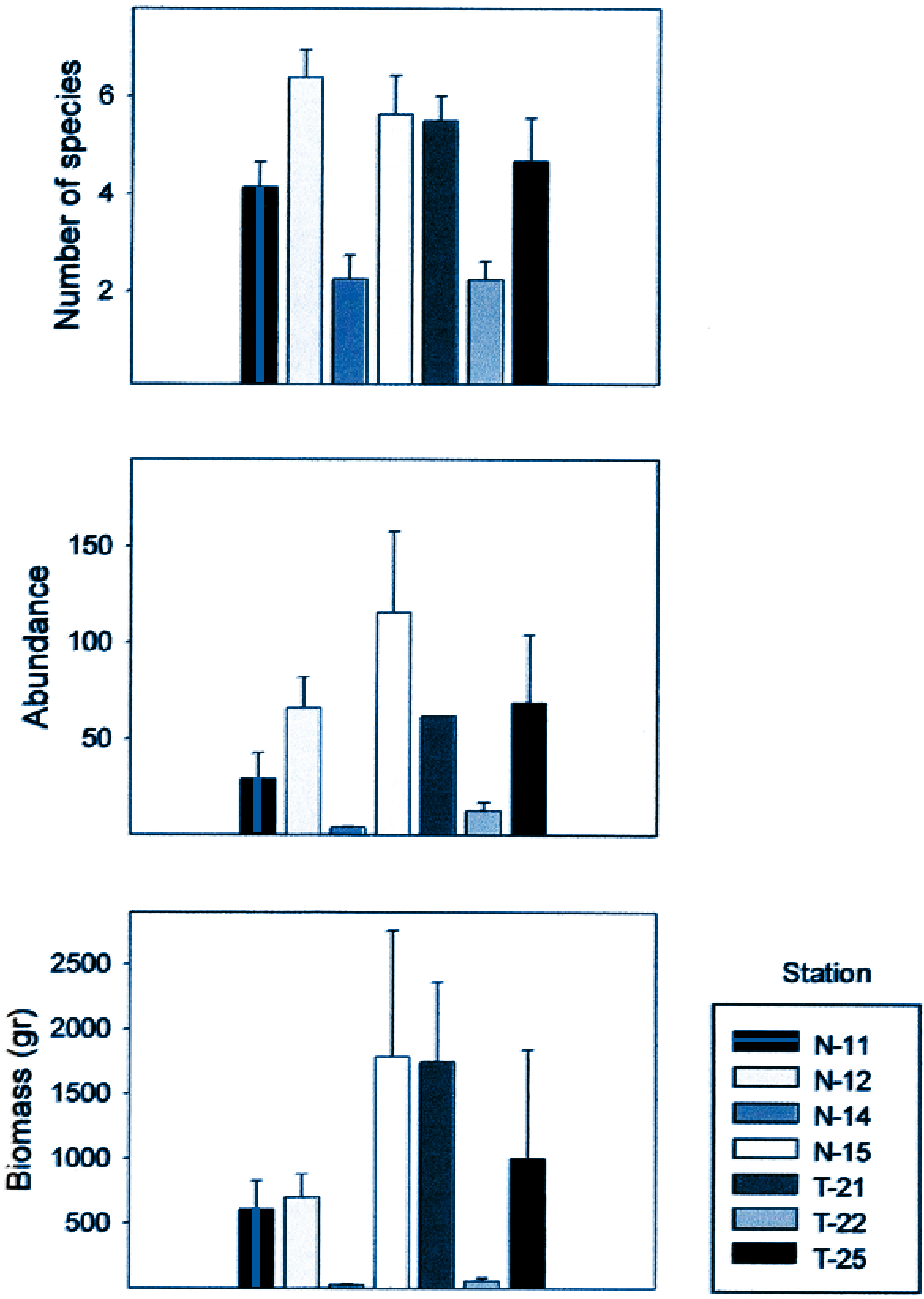


Figure 34. Mean values (± standard error) of number of species (nº of spp/125 m²),
total abundance (ind./125 m²) and total biomass (g/125 m²) in the study stations of the 2013 survey.
Stations: (N) Nakoura, (T) Tyre

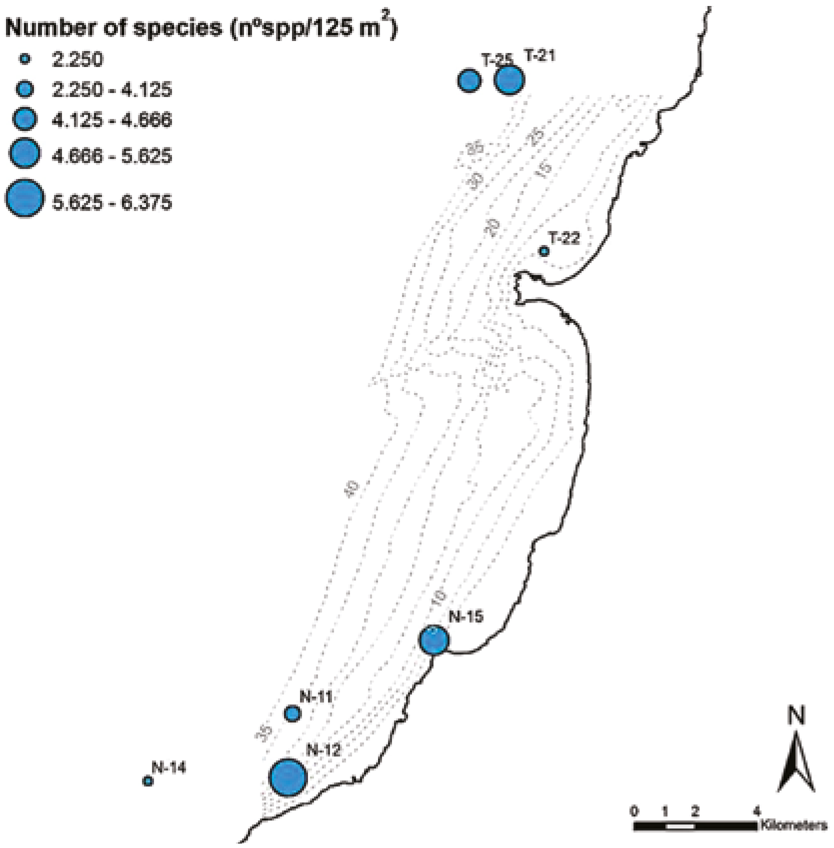


Figure 35. Spatial distribution of mean number of species (nº of spp/125 m^2) in the study area of the 2013 survey. Stations: (N) Nakoura, (T) Tyre

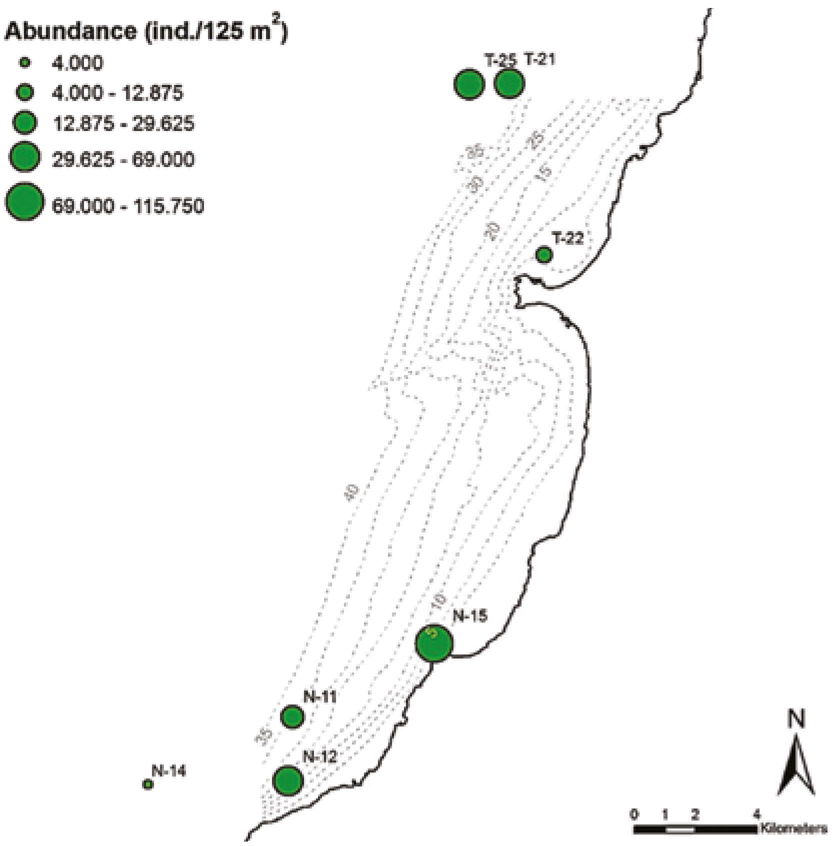


Figure 36. Spatial distribution of mean total abundance (ind./125 m^2) in the study area of the 2013 survey. Stations: (N) Nakoura, (T) Tyre

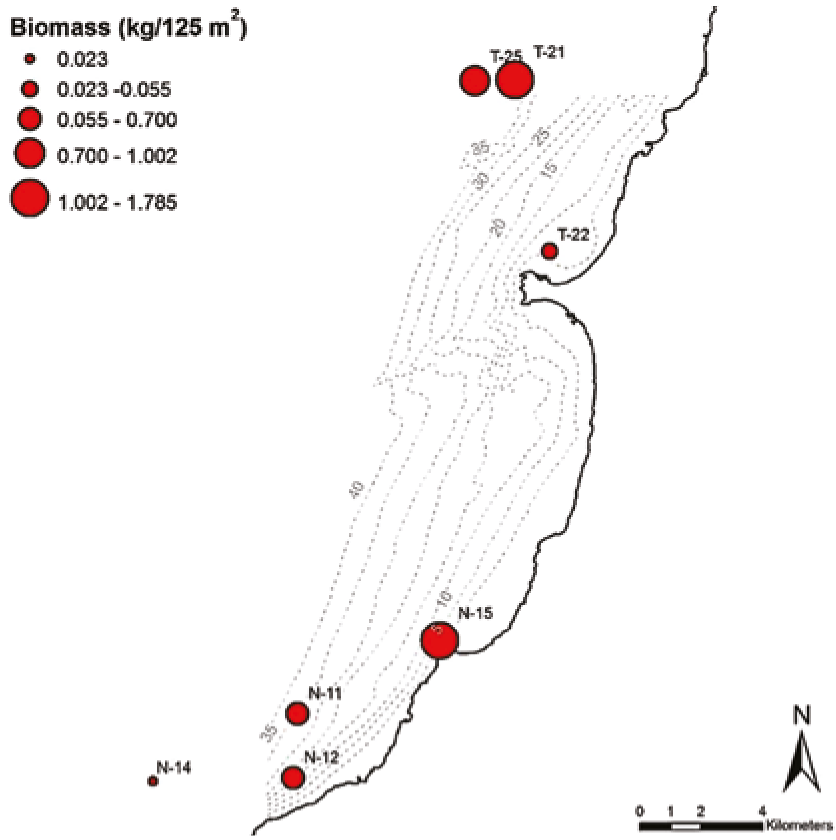


Figure 37. Spatial distribution of mean total biomass (kg/125 m²) in the study area of the 2013 survey. Stations: (N) Nakoura, (T) Tyre

b) Spatial categories

Regarding the spatial categories, although very mobile pelagic species were dominant in 2012, during 2013 none of the species of these categories were censed. In the 2013 survey, the fish assemblage was mainly dominated by moderately sedentary pelagic species and demersal species moving moderately along the vertical axis (Table 13). The former presented the greater abundances in the stations N-11, N-12 and T-25, and the latter in stations T-21 and also in T-25. Other spatial categories were less important, although some of them, as relatively sedentary species were the most abundant in stations N14 and T-22.

Table 13. Mean abundance (ind./125 m² ± standard error) for the spatial categories in the study stations of the 2013 survey

	Station						
	N-11	N-12	N-14	N-15	T-21	T-22	T-25
COE1	0	0	0	0	0	0	0
COE2	13.9 ± 13.9	38.3 ± 14.9	0	17.9 ± 6.7	9.0 ± 9.0	0	26.0 ± 13.0
COE3	0.9 ± 0.6	0.4 ± 0.2	0.3 ± 0.3	14.5 ± 8.7	45.0 ± 9.0	2.0 ± 0.9	26.0 ± 24.5
COE4	0	0	0	12.5 ± 12.5	0.5 ± 0.5	0	0
COE5	8.8 ± 1.5	21.4 ± 5.3	3.8 ± 0.6	20.8 ± 5.5	6.0 ± 2.0	10.8 ± 3.6	17.0 ± 4.6
COE6	6.1 ± 2.7	6.0 ± 4.3	0	50.1 ± 45.5	1.5 ± 1.5	0.1 ± 0.1	0

1: very mobile pelagic species, 2: moderately sedentary pelagic species, 3: demersal species moving moderately along the vertical axis, 4: nekto-benthic species, 5: relatively sedentary species, 6: cryptic species. Stations: (N) Nakoura, (T) Tyre.

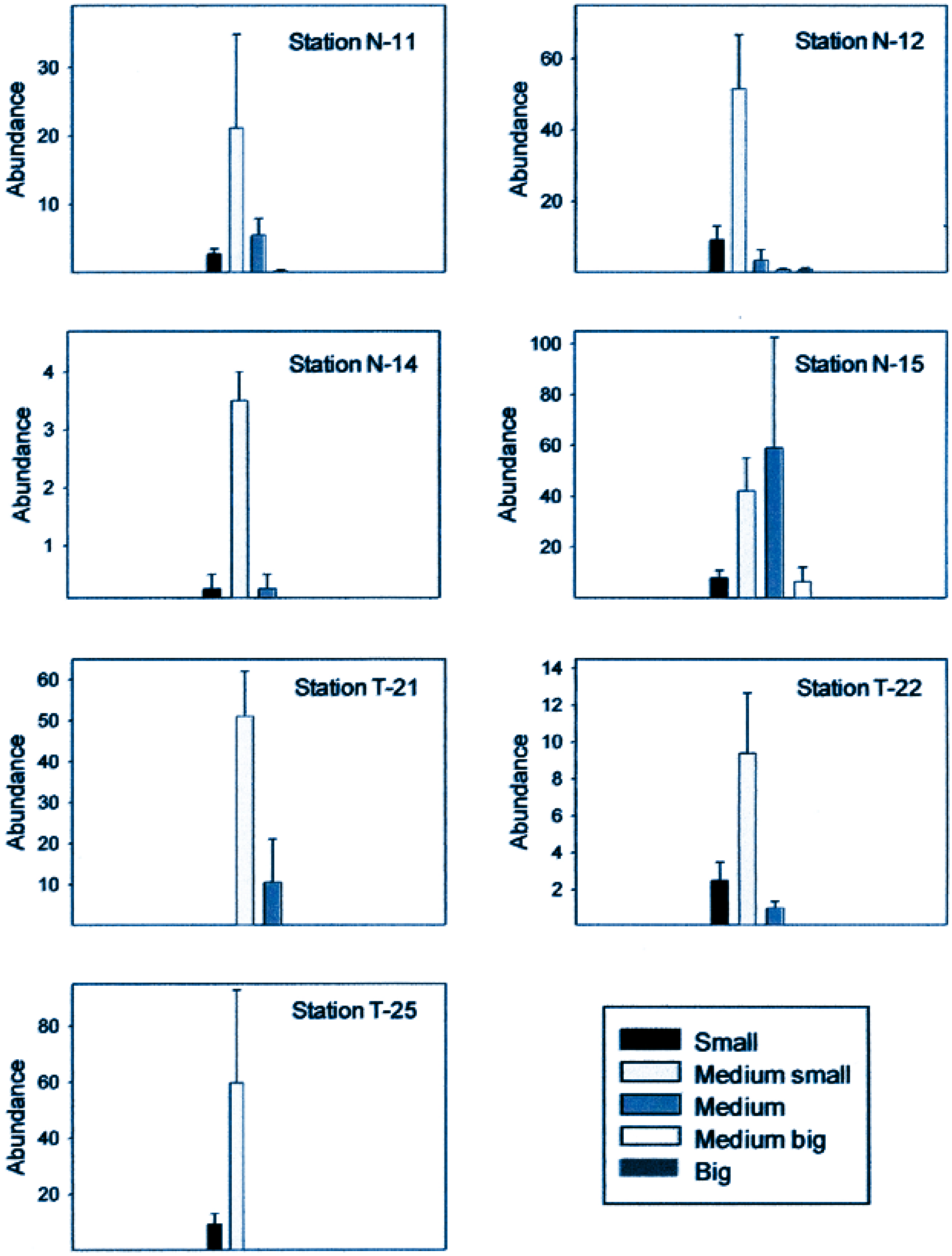


Figure 38. Mean abundance (ind./125 m² ± standard error) of the fish assemblage size structure in the study stations of the 2013 survey. Stations: (N) Nakoura, (T) Tyre

c) Trophic categories

Concerning the trophic categories, similarly to the 2012 survey, the mesophagous species were the most abundant followed by the microphagous and herbivorous species (Table 14). Mesophagous predominated in stations N-11, N-14, N-15 and T-22, meanwhile microphagous prevail in the station N-12 and herbivorous in T-21. In the station T-25, microphagous and herbivorous both co-dominated.

Table 14. Mean abundance (ind./125 m^2 ± standard error)
for the trophic categories in the study stations of the 2013 survey

	Station						
	N-11	N-12	N-14	N-15	T-21	T-22	T-25
CMC	0.9 ± 0.3	1.3 ± 0.4	1.0 ± 0.4	0.1 ± 0.1	0	0	0.7 ± 0.7
CMM	13.9 ± 13.9	38.3 ± 14.9	0.3 ± 0.3	17.9 ± 6.7	9.5 ± 9.5	0	26.0 ± 13.0
CMS	14.8 ± 2.8	26.5 ± 6.0	2.8 ± 0.8	85.5 ± 43.7	7.5 ± 0.5	10.9 ± 3.6	16.3 ± 4.4
HBV	0.1 ± 0.1	0	0	12.3 ± 6.7	45.0 ± 9.0	2.0 ± 0.9	26.0 ± 24.5

CMC: macrophagous; CMM: microphagous; CMS: mesophagous; HBV: herbivorous.
Stations: (N) Nakoura, (T) Tyre.

d) Fish size structure

Contrary to the 2012 survey, in 2013 the fish size structure was quite similar among the stations (Fig. 38). Medium small individuals clearly dominated in all stations (representing more than 60 % of all individuals) except in N-15, where the most abundant size class was the medium individuals.

With reference to species abundance, apart from the pelagic schooling species *Chromis chormis*, the more abundant species in the entire studied area were *Pempheris vanicolensis* (8.7 ± 8.7 ind. 125 m^{-2}), *Coris julis* (7.5 ± 0.9 ind. 125 m^{-2}) and *Siganus rivulatus* (4.2 ± 1.7 ind. 125 m^{-2}). It must be pointed out that the most abundant species differed between the 2012 and 2013 surveys. Even though *C. julis* was very abundant in four of the seven stations studied in 2013 (Table 15), the two dimensional nMDS ordination of abundances showed that the fish assemblages varied among thestations (Fig. 39).

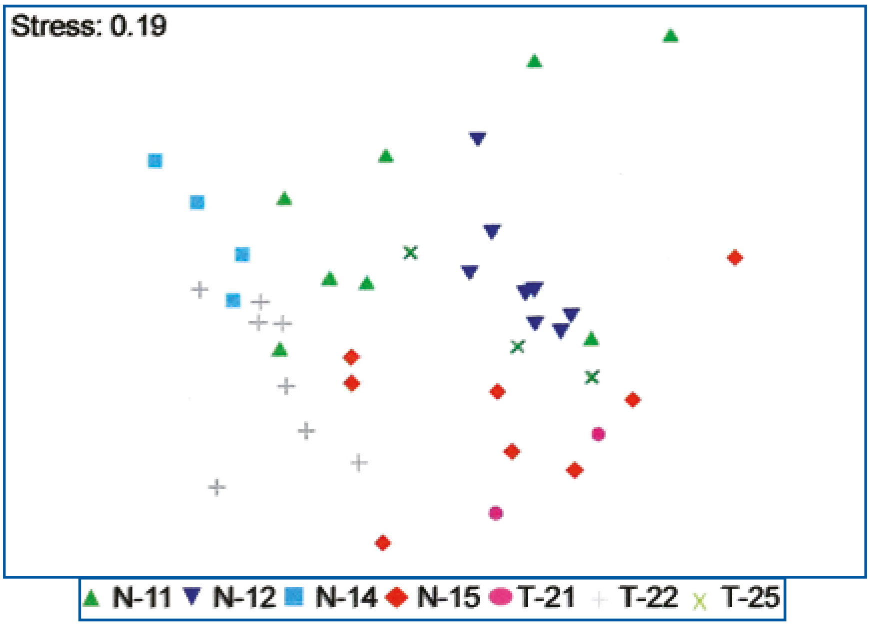


Figure 39. Two dimensional nMDS ordination of abundances of the species observed at each underwater visual census of the 2013 survey. Stations: (N) Nakoura, (T) Tyre.

Table 15. Analysis of similarity (SIMPER) of the species abundance sampled in each station of the 2013 survey. Only species that contribute up to 85 % of the dissimilarity are indicated

	ABU	% sim	% acu
Station N-11: SM=31.90			
C. julis	2.13	61.88	61.88
S. cretense	1.04	17.54	79.41
s. rubrum	1.31	9.52	88.94
Station N-12: SM=53.33			
C. chromis	5.07	32.45	32.45
C. julis	3.04	29.86	62.31
S. cretense	2.36	17.23	79.53
T. pavo	1.16	8.66	88.20
Station N-14: SM=62.76			
C. julis	1.60	74.59	74.59
S. cabrilla	0.75	25.41	100.0
Station N-15: SM=39.83			
C. julis	2.77	35.88	35.88
T. pavo	2.97	30.36	66.24
C. chromis	3.22	16.92	83.16
S. rivulatus	2.27	9.97	93.13
Station T-21: SM=57.37			
S. rivulatus	6.00	67.96	67.96
C. julis	1.57	16.02	83.98
S. cretense	1.71	16.02	100.0
Station T-22: SM=54.63			
C. julis	2.85	86.71	86.71
S. rivulatus	0.98	10.42	97.13
Station T-25: SM=48.99			
C. julis	2.58	36.55	36.55
S. cretense	2.47	27.00	63.55
C. chromis	4.16	25.52	89.06

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

5.3.3 Discussion

The observed fish assemblage showed the typical characteristics of an exploited assemblage in both surveys, 2012 and 2013, even though the abundances and biomasses censused in the 2013 areas (Nakoura and Tyre) were lower than in the areas studied in 2012 (Enfeh, Ras Chekaa and Raoucheh). The very low presence of big sizes and the low mean abundance of commercial target species indicate the overexploited situation. However, the high heterogeneity of habitats that occurs in the study area makes it possible to host a high diversity of fishes. For example, the very high habitat complexity observed in the deeper freshwater springs stations in Tyre (T-21 and T-25), could provide this place with a high capacity to become a hot spot of fish biodiversity in a non-overexploited situation. The fish assemblage observed along the studied stations varies a lot, showing the high capability of the area. The establishment of marine protected areas which will regulate the activities in the study area, will help in the natural restoration of fish assemblages, and will ensure a sustainable development of the artisanal fisheries that operates in the area.

5.4 Species with patrimonial and interest value

In this paragraph, are included the actually protected species that have been observed during the missions (2012, 2013), together with other ones that deserve to be protected. Each species is presented by the common synonymies, status of protection, geographical distribution, habitats, threats and the Lebanon distribution with some observations about them. The protection degree of the different Conventions and Directives:

- Barcelona Convention (1995, with the Marrakech -2009 and Istambul -2013 amendments): annex II, endangered or threatened species; annex III, species whose exploitation must be regulated.
- Bern Convention (1996, 1998): annex I, strictly protected flora species; annex II, strictly protected fauna species; annex III, protected fauna species.
- Directive 92/43 CE on the conservation of natural habitats and of wild fauna and flora, European Commission: annex I, natural habitat types whose conservation requires the designation of special areas of conservation; annex II, species requiring designation of Special Areas of Conservation; annex IV, species in need of strict protection; annex V, species whose taking from the wild can be restricted.
- Washington Convention. Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES): appendix I, species that are the most endangered and threatened 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).

Together with these species, we have included others of economic interest (large Sparidae and Serranidae) that were observed in the two Lebanon missions (2012, 2013).

5.4.1 Macrophyta

Table 16 shows a list of the macrophytes that are under Mediterranean protection and have been observed in Lebanon.

Table 16. Marine Macrophyta of special interest, observed in Lebanon

MACROPHYTA	MRB	EU	BaC	BeC
Ochrophyta				
Cystoseira dubia	-	-	II	-
Cystoseira foeniculacea	+	-	II	-
Sargassum trichocarpum	-	-	II	-
Rhodophyta				
Lithothamnion corallioides	+	V	-	-
Phymatolithon calcareum	+	V	-	-
Magnoliophyta				
Cymodocea nodosa	+	-	II	I

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

a) Ochrophyta

Figure 40. Talus of *Cystoseira dubia* fixed on a rhodolith. Ras Chekaa (st. C-15, 42 m depth)

Cystoseira dubia Valiante, 1883 (Fig. 40)

Common synonymies: *Cystoseira fucoides* Ercegovic, 1952.

Status of protection: 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.

Geographical distribution: Endemic species of the Mediterranean sea. SW-Italy, Sicily, Adriatic Sea and Mediterranean Eastern basin (Ribera et *al.,* 1992).

Habitat: Infralittoral and upper circalittoral rock, and coastal detritic bottoms, between 25 and 170 m depth (Giaccone & Verlaque, 2009).

Threats: Hyper-sedimentation, sediment dumping, turbidity, trawling, pull up by trammel nets.

Lebanon missions: Lower infralittoral from Ras Chekaa, (st. C-15, C-18, C-21); 33 to 42 m depth.

Observations: Uncommon on rocky substratum and rhodoliths.

Figure 41. *Cystoseira foeniculacea* attached on a cobble and epiphyted by *Dictyota fasciola.* Lagoon of northern Tyre (st. T-22, 9 m depth)

Cystoseira foeniculacea (Linnaeus) Greville, 1830 (Fig. 41)

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

Status of protection: 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 Spatin to Canary islands) and Mediterranean Sea (*Cabioch et al.*, 1995; *Ribera et al.*, 1992).

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

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

Lebanon missions: Relatively common in Nakoura (N-4, N-5, N-9), Ras El Bayada (N- 2) and Tyre (T-2, T-5, T-6, T-14, T-15, T-22, T-24); rare in Ras Chekaa (C-11) and Saida (st. S-2, S-6, S-7); 5 to 15 m depth.

Observations: Attached on the flat rock and cobbles; where it forms sparse 'forests'. *C. foeniculacea* is abundant in the lagoon created between the northern beach and the inlets, on cobbles which are moved by the swell.

Figure 42. Talus of *Sargassum trichocarpus* sampled in Enfeh area (st. E-4, 31m depth)

Sargassum trichocarpum
J.Agardh, 1848 (Fig. 42)

Common synonymies: *Sargassum vulgare* var. *trichocarpum* J. Agardh, 1848; *S. boryanum* Montagne, 1846.

Status of protection: 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.

Geographical distribution: Endemic species of the Mediterranean sea. From the Iberian Peninsula to the Eastern Mediterranean basin (Ribera *et al.*, 1992).

Habitat: Infralittoral on rocky substratum, down to 30 m depth (Gómez-Garreta *et al.*, 2001).

Threats: Hyper-sedimentation, turbidity, sediment dumping, land reclamation, and pull up by trammel nets.

Lebanon missions: It has only been observed in Enfeth (st. E-4) and Ras Chekaa (C- 4); 28-30 m depth.

Observations: Rare species, on rocky substratum in the lower infralittoral.

b) Rhodophyta

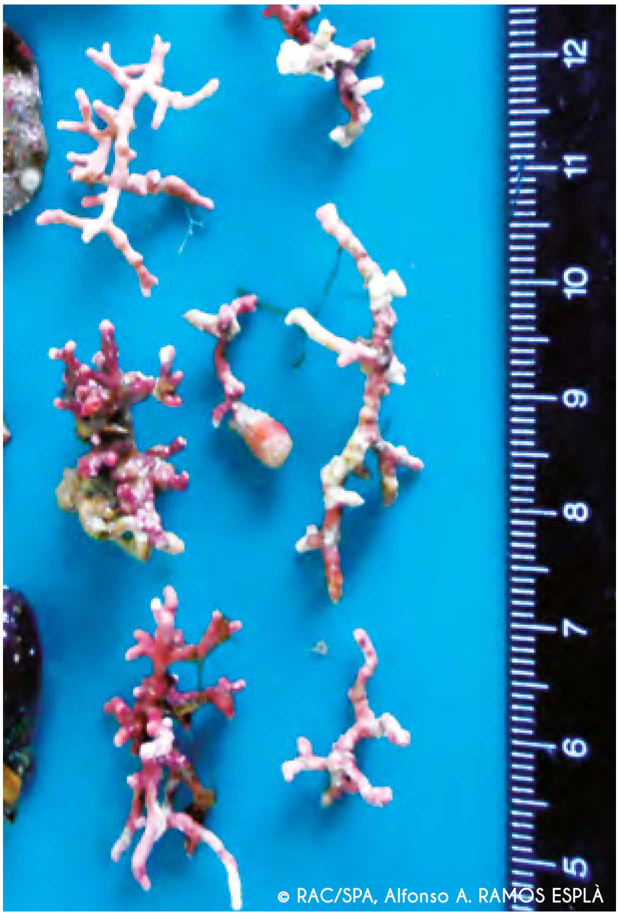


Figure 43. Some branched rhodoliths of *Lithothamnion corallioides*. Nakoura (st. 15, 43 m depth)

Lithothamnion corallioides
(P.L.Crouan & H.M.Crouan, 1867) (Fig. 43)

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

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

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

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

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

Lebanon missions: Common in Ras Chekaa (st. C-15, C-18), Tyre (T-25) and Nakoura (N-11, N-14); 35 to 47 m depth.

Observations: Normally with *Spongites fruticulosum* (c) and *Phymatolithon cf. calcareum* (r),

Figure 44. Some rhodoliths of *Phymatolithon* cf. *calcareum* from Ras Chekaa (st. C-15, 4 4m depth)

Phymatolithon cf. *calcareum* (Pallas) (Adey & McKibbin, 1970) (Fig. 44)

Common synonymies: *Lithophyllum calcareum* (Pallas) Foslie, 1898; *Millepora polymorpha* Linnaeus, 1767.

Status of protection: The maerl beds (including *P. calcareum*) have been included in the Mediterranean Action Plan for the Conservation of the Coralligenous and Other Calcareous Bio-concretions. Species whose taking from the wild can be restricted (Annex V, EU Habitats Directive 92/43). Mediterranean Flora 'Red Book' (UNEP/IUCN/GIS-Posidonia, 1990) as maerl habitat.

Geographical distribution: Wide range of geographical distribution in the Atlantic, Pacific, Antarctic, 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, with Lithothamnion coralliodes and Spongites fruticulosum; also on lower infralittoral horizon (Bressan & Babbini, 2003).

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

Lebanon missions: Only observed in Ras Chekaa (st. C-15, C-18); > 42 m depth.

Observations: Rare in the Eastern Mediterranean basin. In Lebanon, it has only been observed on the deeper maerl beds.

c) Magnoliophyta

Figure 45. *Cymodocea nodosa* meadow in Enfeh (st. E-12, 3 m depth)

Cymodocea nodosa (Ucria) (Ascherson, 1870) (Figs. 45)

Common synonymies: None.

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

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

Habitat: Infralittoral species on sand and muddy sand bottoms, from shallow waters to a 50 m depth; and coastal lagoons (Pergent, 2009).

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

Figure 46. *Cymodocea nodosa* germinated seeds collected at 31 m depth in Enfeh (st. E-5)

Lebanon missions: Common around the Enfeh area (st. E-1, E-2, E-3, E-5, E-6, E-7, E-8, E-9) and less common in Ras Chekaa (C-22). On the other hand, it has been rare in the southern sector of Lebanon, where it has only been observed at the front of the south beach of Tyre (st. T-3, T-4); 1 to 31 m depth.

Observations: *Cymodocea nodosa* colonizes the sandy and muddy sand bottoms. The meadows are developed in shallow waters (1-4 m depth). Noteworthy is the abundance of germinated seeds (Fig. 46) in June of 2012 (19-26/06/2012), that colonised the deeper sediments (as far as 31 m depth).

d) Other protected Macrophyta

Other protected Macrophyta spp. (Annex II, Barcelona Convention) have been observed from Lebanon (G. Bitar, pers. obs.):

- *Cystoseira amentacea* (C.Agardh) Bory de Saint-Vincent, 1832.
- *Titanoderma trochanter* (Bory) (= *T. undulosa*) Benhissoune, Boudouresque, Perret-Boudouresque & Verlaque, 2002.
- *Zostera noltii* Hornemann, 1832.

Despite the intense observations, we couldn't spot them during the 2012 and 2013 missions. Noteworthy is the presence of *T. trochanter* in the Ramkime island, now practically absent from the Lebanese coast.

5.4.2 Invertebrata

The important marine invertebrates observed in the Lebanon missions that are under protection are indicated in the table 17.

Table 17. Marine invertebrata of special interest in 2012 and 2013 Lebanon missions

Species	BaC	BeC	EU	WC
Porifera				
Aplysina aerophoba	II	II	-	-
Aplysina sp.	II	II	-	-
Axinella polypoides	II	II	-	-
Sarcotragus foetidus	II	II	-	-
Spongia officinalis	III	III	-	-
Cnidaria				
Cladocora caespitosa	II	-	-	II
Phyllangia mouchezii	-	-	-	II
Mollusca				
Dendropoma petraeum	II	II	-	-
Erosaria spurca	II	II	-	-
Luria lurida	II	II	-	-
Tonna galea	II	II	-	-
Pinna nobilis	II		IV	-
Lithophaga lithophaga	II	II	IV	II
Echinodermata				
Paracentrotus lividus	III	III	-	-

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

a) Porifera

Figure 47. *Aplysina aerophoba* on rocky substratum in Ras Chekaa (st. C-20, 7 m depth)

Aplysina aerophoba (Nardo, 1833) (Fig. 47)

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

Status of protection: 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 be included in the list of endangered or threatened species *Aplysina* spp. plur.

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

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

Threats: Sediment dumping, anchoring, collection by divers.

Lebanon missions: Very common in the Northern Lebanon, particularly in the Enfeh area (E-1, E-5, E-8, E-9, E-14, E-15) and less common in Ras Chekaa (C-8, C-16, C- 20). Very rare in the Southern sector, only observed in Nakoura (N-10) and Tyre (T-6); in shallow waters (0-8 m depth).

Observations: The species has been observed on photophilic/hemi-sciaphilic rocky substrata, between 0 to 30 m depth, mainly in shallow waters (< 15 m depth).

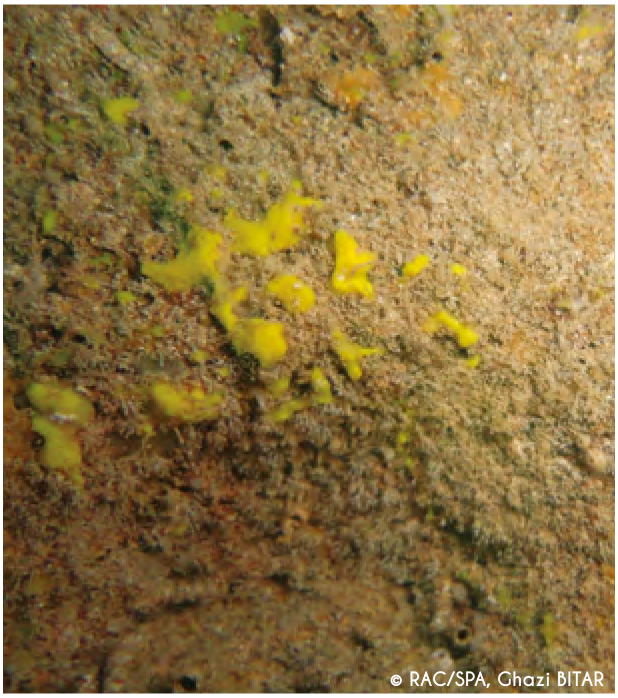


Figure 48. *Aplysina* sp. inside the cave at Ras El Bayada (st. N-10, 3 m depth)

Aplysina sp. (Fig. 48)

Status of protection: 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 on the list of endangered or threatened species *Aplysina* spp. plur.

Geographical distribution: At present, only observed in Lebanon.

Habitat: This species has only been sampled in shallow caves.

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

Lebanon missions: Common in Raoucheh (st. R-1) and Ras El Bayada (st. N-3, N-10); in shallow waters caves (1-5 m depth).

Observations: The species has only been observed in very located caves (Raoucheh and Ras El Bayada), where it has been abundant. This species, together with *Cymbaxinella* sp., were first found by one of us (GB) and *H. Zibrowius* in the Raoucheh tunnel and the Bouknai cave, respectively, under the CEDRE project (1999-2002) and latterly studied under the ECIMAR project (2007-2011).

Figure 49. *Axinella polypoides* on vertical surface of the rocky outcrop front Tyre (st. T-21, 42 m depth)

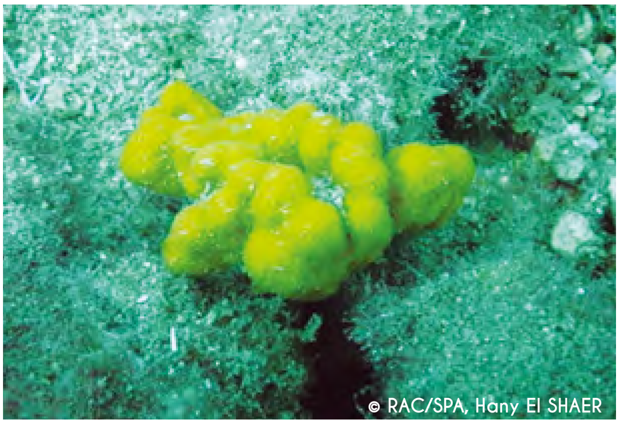


Figure 50. Axinellidae species:
a) *Cymbaxinella* sp. at the entrance of the Chack El Hatab cave (Ras Chekaa, st. C-19, 5 m depth);
b) *Axinella* sp. (perhaps *A. dissimilis*) in Ras El Bayada (st. N-2, -14 m depth)

Axinella polypoides Schmidt, 1862 (Fig. 49)

Common synonymies: None.

Status of protection: 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 the 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. It has a bathymetric range from 15 to > 300 m depth (Moreno *et al.*, 2008), although it is more abundant in the upper circalittoral horizon (40-50 m depth).

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

Lebanon missions: Rare in the Ras Chekaa area (C-21) and common in the Nakura (st. N-4, N-5, N-6, N-8, n-11) and Tyre areas (st. T-72, t-21, T-25); very rare in Saida (S-5); 25 to 47 m depth.

Observations: *A. polypoides* is present in a coralligenous community, overhangs, vertical surfaces and crevices in the infralittoral lower horizon. The family of Axinellidae is well represented in the Lebanon area, where another species, *Cymbaxinella* sp. , is located in the entrance of littoral caves (Fig. 50a). Small *Axinellida*e specimens are present in rocky crevices, between 13 to 25 m depth (perhaps belonging to the *Axinella dissimilis*, Fig. 50b).

Figure 51. *Sarcotragus foetidus* in Ras Chekaa, 8 m depth (St. C-11)

Sarcotragus cf. foetidus Schmidt, 1862 (Fig. 51)

Common synonymies: *Hircinia foetida* (Schmidt, 1862), *Ircinia muscarum* (Schmidt, 1864), *Sarcotragus muscarum* Schmidt, 1984.

Status of protection: Endangered or threatened species (Barcelona Convention, Annex II); strictly protected fauna species (Annex II, Bern Convention 1996-98).

Geographical distribution: Endemic species of the Mediterranean Sea, with the distribution extending to Portugal and Galicia (NW Spain).

Habitat: Typical infalittoral species on rocky substrata, between 1 to 31 m depth.

Threats: Sediment dumping, littoral reclamation, littoral works (marinas, ports), domestic sewage.

Lebanon missions: Present in Tyre (T-1, T-11, T- 12, T-19), Ras El Bayada (N-10) and Ras Chekaa area (C-11); 2-18 m depth.

Observations: The species seems rare in Lebanon.

Figure 52. *Spongia officinalis*, entrance of the Chack El Hatab cave (st. C-19, 5 m depth)

Spongia officinalis Linnaeus, 1759 (Fig. 52)

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

Status of protection: Species whose exploitation must be regulated (Annex III, Barcelona Convention, 1995); protected fauna species (annex III, Bern Convention, 1996).

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

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

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

Lebanon missions: Rare species, only very few individuals have been observed in Enfeh (st. E-12), Ras Chekaa (C-19), Raoucheh (R-1), Tyre (T-10) and Ras El Bayada (N-10); 3-20 m depth.

Observations: All of the individuals have been observed in shallow waters (< 10 m depth) and, normally, in overhangs and rocky crevices.

b) Cnidaria: Anthozoa

Figure 53. The Mediterranean hermatypic coral *Cladocora coespitosa* in Tyre (st. T-2, 2 m depth)

Cladocora caespitosa
(Linnaeus, 1767) (Fig. 53)

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

Status of protection : 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 been signaled in the NE Atlantic from southern Portugal to Agadir (Morocco) (Zibrowius, 1980).

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

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

Lebanon missions: Only one colony has been observed in Tyre (st. T-2, 0-5 m depth).

Observations: Very rare species in Lebanon. Competition with *Oculina patagonica* that can overgrow on *Cladocora*.

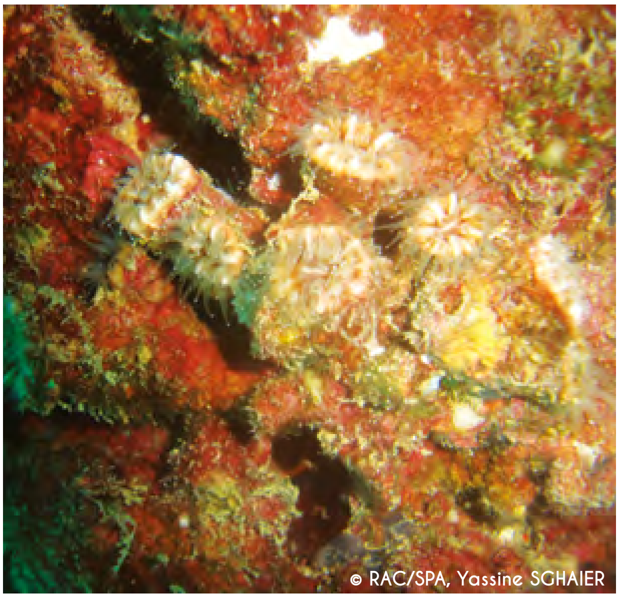


Figure 54. The ahermatypic coral *Phyllangia americana mouchezii* in Ras Chekaa (st. C-17, 5 m depth)

Phyllangia americana mouchezii
(Lacaze-Duthiers, 1897) (Fig. 54)

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

Status of protection : Appendix II CITES (Washington Convention, 2013).

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

Habitat: Ahermatypic coral that live in sciaphilic infralittoral and circalittoral bottoms (0- 47 m depth).

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

Lebanon missions: Ras Chekaa (C-17, C-19, C-20), Raoucheh (R-1) and Tyre (T-21).

Observations: Not rare species on coralligenous and caves habitats in Lebanon, between 2 to 47 m depth.

c) Mollusca Gastropoda

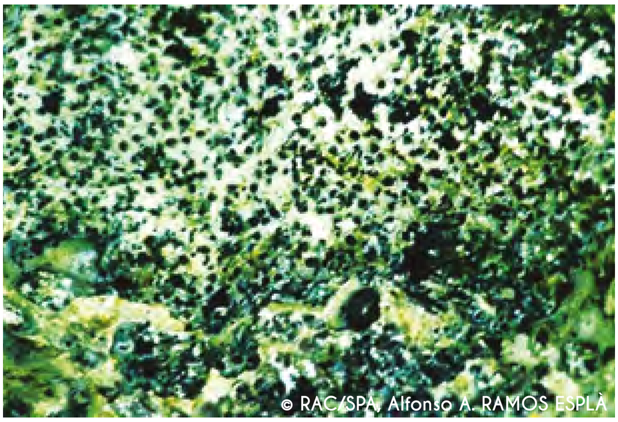


Figure 55. *Dendropoma petraeum* from Tabarca Island (Alicante, Spain)

Figure 56. Dead vermetid platforms in the littoral fringe in front of Tyre

Dendropoma petraeum (Monterosato, 1884) (Figs. 55, 56)

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

Status of protection: 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, Atlantic coasts from Spain and Morocco (Templado *et al.,* 2004).

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

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

Lebanon missions: Present in Enfeh (st. E-1, E-12), Ras Chekaa (st. C-3, C-23), Tyre (T-2) and Ras El Bayada (st. N-1, N-2), at 0 m depth.

Observations: The species is more common in the Enfeh-Ras Chekaa sector, whereas it seems to be rare in the Saida-Nakoura sector; only some small living colonies have been observed in Ras El Bayada, particularly in the rocky reefs around Tyre (Fig. 56).

Figure 57. The 'cowrie' *Erosaria spurca*, eroded specimen from Ras Chekaa, 11 m depth (st. C-17)

Erosaria spurca (Linnaeus, 1758) (Fig. 57)

Common synonymies: *Cypraea spurca* (Linnaeus, 1758); *Cypraea lunata* (Fisher von Waldheim, 1807); *Cypraea elliptica* (Gray, 1825); *Cypraea verdensia* (Melvill, 1888); *Cypraea minima* (Monterosato, 1897).

Status of protection: 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: Eastern Atlantic from Gibraltar Strait to Angola (also, Canary, Madeira, Cape Verde, Ascension and Saint Helene Islands, Mediterranean Sea (Templado *et al.,* 2004).

Habitat: On rocky infralittoral bottoms, under stones, and *Posidonia oceanica* meadows, between 0 to 20 m depth (Templado *et al.*, 2004), deeper (30 m depth) in Levantine basin (UNEP/MAP-RAC/SPA, 2007).

Threats: Impacts associated with the infralittoral habitat loss (hyper-sedimentation, sediment dumping, littoral works, organic pollution); collection by divers; competition with lessepsian Cypraeidae (e.g. *Purpuradusta gracilis, Erosaria turdus*).

Lebanon missions: Observed in Ras Chekaa (st. C-16, C-17); 12-25 m depth.

Observations: Very rare species in Lebanon, only two empty shells have been collected.

Figure 58. The 'crowrie' *Lurida lurida* from Ras Chekaa, 11 m depth (st. C-17)

Luria lurida
(Linnaeus, 1758) (Fig. 58)

Common synonymies: *Cypraea lurida* (Linnaeus, 1758); *Cypraea leucogaster* (Gmelin, 1791); *Cypraea kunthii* (Audouin, 1826); *Cypraea aurora* (Monterosato, 1897).

Status of protection: 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: Eastern Atlantic from southern Portugal to Angola (also, Canary, Madeira, Cape Verde, Ascension and Saint Helene Islands, Mediterranean Sea (Templado *et al.*, 2004).

Habitat: On rocky bottoms (overhangs, crevices) and under stones, between 0 to 50 m depth (Barea-Azcón *et al.*, 2008).

Threats: Impacts associated with the infralittoral habitat loss (hyper-sedimentation, sediment dumping, littoral works, organic pollution); collection by divers; competition with lessepsian Cypraeidae (e.g. *Purpuradusta gracilis, Erosaria turdus*).

Lebanon missions: Observed in Ras Chekaa (st. C-16, C-17); 12-25 m depth.

Observations: Very rare species in Lebanon, only two empty shells have been collected.

Figure 59. Small empty shell of the 'giant tun' (*Tonna galea*) from Tyre, 7 m depth (st. T-11)

Tonna galea
Linnaeus, 1758 (Fig. 59)

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

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

Threats: Trawling, collection by divers.

Lebanon missions: Observed in Tyre (st. T-11), 7 m depth.

Observations: Very rare, only one empty shell has been sampled.

d) Mollusca Bivalvia

Figure 60. The 'sea date' (*Lithophaga lithophaga*) from Ras El Bayada, 15 m depth (st. N-15)

Lithophaga lithophaga
(Linnaeus, 1758) (Fig. 60)

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

Status of protection: 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 in the future, 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 reported in the Red Sea (Templado *et al.*, 2004).

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

Threats: Very appreciated resource whose collection might imply the destruction of the rocky substratum by divers.

Lebanon missions: Observed in Ras El Bayada, 15 m depth (st. N-15).

Observations: Although, only one specimen has been observed in Ras El Bayada, the species seems common in the Lebanon coast (G. Bitar, *pers. obs.*).

Figure 61. Fragments of the 'fan mussel' (*Pinna nobilis*) in Ras Chekaa, 42 m depth (st. C-15)

Pinna nobilis (Linnaeus, 1758) (Fig. 61)

Common synonymies: *Pinna incurvata* (Von Born, 1780); *Pinna squamosa* (Gmelin, 1791); *Pinna angustana* (Lamarck, 1819); *Pinna cornuformis* (Brusina, 1870); *Pinna ensiformis* (Monterosato, 1884); *Pinna nigella* (de Gregorio, 1885).

Status of protection: 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).

Geographical distribution: Endemic species of the Mediterranean Sea (Moreno & Barrajón, 2008).

Habitat: Characteristic species on soft substrata, mainly in Posidonia and Cymodocea meadows; also, in coarse sand and muddy sand bottoms (Moreno & Barrajón, 2008). From shallow waters to 40 m depth.

Threats: Impacts associated with the seagrass habitat loss (hyper-sedimentation, sediment dumping, littoral works, organic pollution, trawling); collection by divers; pull up by fixed nets.

Lebanon missions: Observed in Enfeh (st. E-1), Ras Chekaa (st. C-15, C-21) and Ras El Bayada (st. N-7), from 7 to 42 m depth. Some fragments of shells have been observed in the northern lagoon of Tyre (st. T- 16), but probably are debris from trammel nets.

Observations: At present, the species seems to be rare in Lebanon waters. Only two alive specimens were observed (Enfeh and Ras El Bayada).

e) Echinodermata

Figure 62. The 'rock sea urchin' (*Paracentrotus lividus*) from Enfeh, 2 m dept (st. E-1)

Paracentrotus lividus
(Lamarck, 1816) (Fig. 62)

Common synonymies: *Echinus saxatilis* (Tiedemann, 1816); *Echinus vulgaris* (Blainville, 1825); *Echinus purpureus* (Risso, 1826).

Status of protection: Species whose exploitation must be regulated (Annex III, Barcelona Convention); protected fauna species (annex III, Bern Convention, 1996).

Geographical Distribution: Atlanto-Mediterranean species. Eastern Atlantic, from Brittany islands to Mauritania (incl. Azores, Madeira and Canary islands), and Mediterranean Sea (Templado *et al.*, 2004).

Habitat: On rocky substrata and Posidonia meadows, from 0 to 80 m depth, normally in shallow waters (< 20 m depth).

Threats: Hyper-sedimentation, collection by divers.

Lebanon missions: Observed in Enfeh (st. E-1, E-7, E-12), Ras Chekaa (st. C-10, C- 14, C-17, C-19, C-20, C-23) and Ras El Bayada (st. N-3, N-10); 0 m to 5 m depth.

Observations: The species has not been abundant, particularly in the Saida-Nakoura sector. In this sector, *Paracentrotus* is heavily collected for food, and it has only been observed in Ras El Bayada.

f) Other protected invertebrates

Other protected invertebrate species reported from Lebanon waters (Barcelona Convention) have not been observed during the 2012 and 2013 missions.

It is the case of:

- Annex II: 'honey comb sponge' (*Hippospongia communis*), the 'trumpet shells' (*Charonia lampas* and *Ch. tritonis*), and the 'hatpin sea urchin' (*Centrostephanus longispinus*).
- Annex III: 'slipper lobster' (*Scyllarides latus*).

5.4.3 Vertebrata

The important marine fishes to be protected and observed in Lebanon are indicated in the table 18.

Table 18. Marine fishes of special interest and observed in Lebanon during the 2012 and 2013 missions

MARINE VERTEBRATA	BaC	BeC	EU
Gymnura altavela	II	-	-
Rhinobatos cemiculus	III	-	-
Epinephelus marginatus	III	III	-
Chelonia mydas	II	II	IV

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

a) Elasmobranchii

Figure 63. The 'spiny butterfly ray' (*Gymnura altavela*)

Gymnura altavela (Lamarck, 1816) (Fig. 63)

Common synonymies: *Pteroplatea altavela* (Linnaeus, 1758); *Raja maclura* (Lesueur, 1817); *Dasyatis canariensis* (Valenciennes, 1843); *Pteroplatea binotata* (Lunel, 1879); *Pteroplatea vaillantii* (Rochebrune, 1880); *Pteroplatea valenciennii* (Duméril, 1865).

Status of protection: Endangered or threatened species (Barcelona Convention, Annex II, Marrakech 2009); strictly protected fauna species (Annex II, Bern Convention 1996-98); critically endangered species (IUCN Red List).

Geographical Distribution: Amphi-Atlantic species (from Bay of Biscay to Angola ; from Massachusetts to La Plata estuary); Mediterranean and Black Seas (Bauchot, 1987).

Habitat: Benthic species on coastal sandy and muddy bottoms, near to estuaries: Normally, from shallow waters up to 80 m depth. (Bauchot, 1987).

Threats: Gill nets, trawling, estuary degradation.

Lebanon missions: One exemplar observed in Enfeh, at 31 m depth (st. E-4).

Observations: Rare species in Lebanon.

Figure 64. The 'blackchin guitarfish (*Rhinobathos cemiculus*) from the Gulf of Gabès (Tunisia). South-eastern of Kerkennah, between 29-30 m depth (rule = 40 cm)

Rhinobatos cemiculus (E. Geoffroy Saint-Hilaire, 1817) (Fig. 64)

Common synonymies: *Glaucostegus cemiculus* (Geoffroy Saint-Hilaire, 1817); *Rhinobatos congolensis* (Giltay, 1928); *Rhinobatos rasus* (Garman, 1908).

Status of protection: Endangered or threatened species (Barcelona Convention, Annex II, Marrakech 2009); strictly protected fauna species (Annex II, Bern Convention 1996-98); critic endangered species (IUCN Red List).

Geographical distribution: Species of warm affinities. Eastern Atlantic from Bay of Biscay to Angola, Mediterranean Sea (McEachram & Capapé, 1984).

Habitat: Benthic species on sandy or muddy bottoms of the continental shelf, from shallow waters to 100 m depth (McEachram & Capapé, 1984; Bauchot, 1987b).

Threats: Bottom trawling on the coastal areas where the juveniles are present.

Lebanon missions: Observed in Tyre (T-8) and Saida (S-5), between 25 to 30 m depth.

Observations: Rare species, only two specimens have been observed in Tyre and Saida.

b) Actinopterygii

Figure 65. One juvenile of 'dusky grouper' (*Epinephelus marginatus*) from Enfeh, 4 m depth (st. E-12)

Epinephelus marginatus (Linnaeus, 1758) (Fig. 65)

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

Status of protection: Species whose exploitation must be regulated (Annex III, Barcelona Convention, 1995); protected fauna species (annex III, Bern Convention, 1996). European Union proposal (COM (2009) 585) to include it in the Annex V, whose capture 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 (Bermuda's Islands to Brazil), Mediterranean Sea (Tortonese, 1986).

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

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

Lebanon missions: More or less common in Enfeh (st. E-1, E-9, E-12, E-14), Ras Chekaa (st. C-14, C-17, C-19, C-20, C-23), Tyre (st. T-2, T-19, T-20) and Ras El Bayada (st. N-7, N-10), from 1 m to 8 m depth.

Observations: *E. marginatus* seems to be more or less common in the Lebanon coast. Nevertheless, the population observed corresponds to juvenile specimens (size < 20 cm). This means a possible recovery of the size classes, when the marine protected areas would become operative.

Figure 66. The 'brown meagre' (*Sciaena umbra*). National Park of Zembra (Tunisia), 24 m depth

Sciaena umbra (Linnaeus, 1758) (Fig. 66)

Common synonymies: *Johnius umbra* (Linnaeus, 1758), *Corvina nigra* (Bloch, 1791).

Status of protection: Species whose exploitation must be regulated (Annex III, Barcelona Convention, 1995); protected fauna species (annex III, Bern Convention, 1996). European Union proposal (COM (2009) 585) to include it in the Annex V whose capture from the wild can be on the restricted list of endangered or threatened species.

Geographical distribution: Atlanto-Mediteranean species. Eastern Atlantic (from English Channel to Senegal, Canary islands), Mediterranean and Black Seas (Bauchot, 1987).

Habitat: Demersal species in coastal waters, on seagrass, rocky and sandy bottoms, from shallow waters up to 180 m depth (Bauchot, 1987).

Threats: Spear-fishing; alteration or destruction of the seagrass meadows (juvenile areas).

Lebanon missions: Only one specimen was observed in Enfeh, at 18 m depth (st. E-15).

Observations: Very rare, this species seems to be in regression (heavy spear-fishing, competition with lessepsian species).

c) Reptilia

Figure 67. The green turtle (*Chelonia mydas*) in Tyre, 3 m depth (st. T-20)

Chelonia mydas
(Linnaeus, 1758) (Fig. 67)

Common synonymies: *Testudo viridis* (Schneider, 1783).

Status of protection: 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 co-operation (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 seagrasses meadows; and it lay eggs on beaches (Marquez, 1990).

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

Lebanon missions: Observed around the inlets of Tyre (st. T-18, T-20), 0-3 m depth. Another individual was observed in the Raoucheh area (may-2012 by H. El Shaer).

Observations: Of interest is the observation of *Chelonia mydas* around Tyre inlets quite near to the Tyre Coast Nature Reserve that represents an important nesting area for this endangered species.

d) Other protected vertebrata

Other protected vertebrates reported from Lebanon waters (Barcelona Convention) have not been observed during the missions of 2012 and 2013. It is the case of:

- Annex II: 'loggerhead turtle' (*Caretta caretta*), 'bottlenose dolphin' (*Tursiops truncatus*).
- Annex III: 'shi drum corb' (*Umbrina cirrosa*).

5.4.4 Other species of interest

Then we have considered other target species which have no protection status but are of economic value and so, it will be interesting to monitor them in marine protected areas and surroundings.

a) Crustacea Decapoda

Figure 68. The 'spiny spider crab' (*Maja goltziana*) front of Enfeh.

Maja goltziana
d'Oliveira, 1888 (Fig. 68)

Common synonymies: None.

Geographical Distribution: Eastern Atlantic (from Portugal to Guinean Gulf), rare in Western Mediterranean (Langeneck & Di Franco, 2013) and more common in the Eastern Mediterranean (Holtuis, 1987).

Habitat: Benthic species on soft substrata (muddy sand with stones), from the infralittoral to upper bathyal (15-300 m depth) (Holtuis, 1987; González-Pérez, 1995).

Threats: The species is caught accidentally by gillnets, and is of no economic interest. .

Observations: One specimen was caught in a gillnet during the 2012 mission (20.06.2012) at 110 m depth in front of Enfeh.

b) Mollusca Cephalopoda

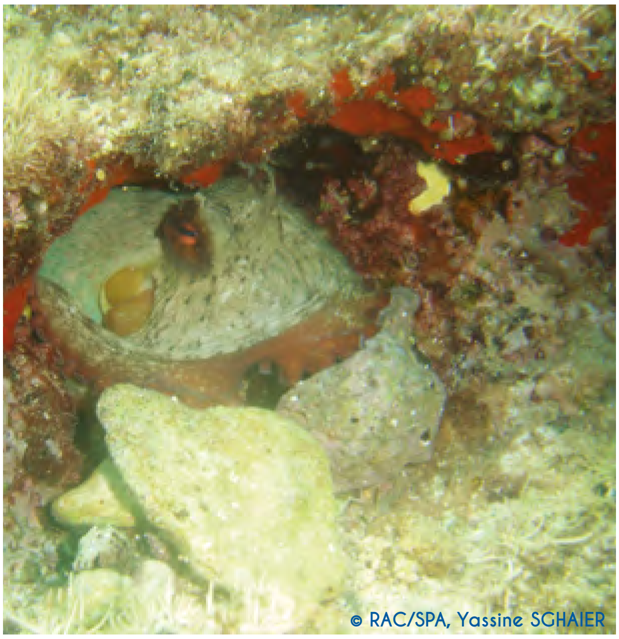


Figure 69. Octopus vulgaris in Ras Chekaa, 5 m depth (st. C-3)

Octopus vulgaris
Cuvier, 1797 (Fig. 69)

Common synonymies: *Octopus bitentaculatus* (Risso, 1854); *Octopus niger* (Risso, 1854).

Status of protection: None. With regard to the conservation of fishery resources through technical measures for the protection of juveniles of marine organisms (Council Regulation EC No. 850/98), the European Union establishes 750 g. as the minimum total weight to commercialize the species.

Geographical Distribution: Cosmopolitan species, in tropical, subtropical and temperate waters (Guerra, 1992).

Habitat: Benthic species living in different habitats (rocks, seagrass meadows, coastal detritic, muddy detritic) on the continental shelf, between 0 m to 200 m depth (Guerra, 1992).

Threats: The species do not seem threated, except by the possible degradation of the littoral spawning sites (siltation, organic pollution).

Lebanon missions: Observed (June 2012) in Enfeh (st. E-1, E-12) and Ras Chekaa (C-3, C-14, C-16, C-17, C-22); 0-21 m depth.

Observations: Relatively frequent in the Enfeh-Ras Chekaa sector. Nevertheless, it has not been observed in the Saida-Nakoura sector (28/08-05/09/2013).

c) Large Serraridae

During the diving observations some juveniles of large Serranidae, apart from *Epinephelus marginatus*, have been reported: *E. costae* (c) and *Mycteroperca rubra* (c); whereas another, *E. aeneus*, has been observed in fishing markets. This shows the importance of the Lebanon shore as a nursery area of these species, particularly the Northern sector.

Figure 70. A 'white grouper' (*Epinephelus aeneus*) caught in the Gulf of Gabes (Tunisia) by trawling, 35-38 m depth

Epinephelus aeneus
(Geoffroy Saint-Hilaire, 1817) (Fig. 70)

Common synonymies: *Cherna aenea* (Geoffroy Saint-Hilaire, 1817), *Perca robusta* (Couch, 1832).

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

Geographical Distribution: Eastern Atlantic (from northern Portugal to Angola), Mediterranean Sea (North Africa and Eastern basin, exc. Aegean Sea) (Tortonese, 1973; 1986b).

Habitat: Sandy and muddy bottoms, between 20 to 200 m depth (Tortonese, 1986b)

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

Observations: The species has not been observed underwater during the missions, but it is present in the fish-markets (Tyre, Batroum) and captured by spearfishing. However, *E. aeneus* does not seems to be frequent in Lebanon waters.

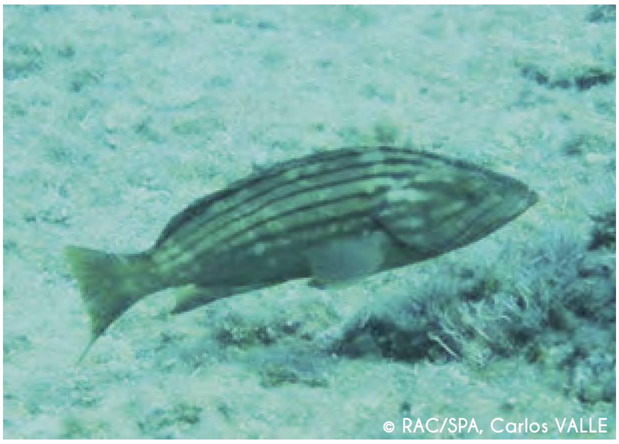


Figure 71. A juvenile of the 'golden grouper' (*Epinephelus costae*) in Enfeh, -14 m (st. E-14)

Epinephelus costae
(Steindachner, 1878) (Fig. 71)

Common synonymies: *Plectropoma fasciatus* (Costa, 1844); *Cerna chrysotaenia* (Döderlein, 1882); *no Epinephelus alexandrinus* (Valenciennes, 1828), *synonymy of E. fasciatus* (Forsskål, 1775).

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

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

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

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

Lebanon missions: Enfeh (E-9, E-11, E-14, E-15), Ras Chekaa (C-7, C-19, C-21), Nakoura (N-6, N-7, N-11, N-13), El Bayada (N-15), Tyre (T-1, T-12, T-14, T-19), Saida (S-5); 5-30 m depth.

Observations: Relatively frequent species in all of the prospected areas, on but only represented by juveniles specimens (size < 25 cm). The presence of a suitable habitat (mainly, heterogeneous rock) and juveniles would make possible the recovery of the population with protection measures.

Figure 72. Juvenile of 'comb grouper' (*Mycteroperca rubra*) in Enfeh, at 18 m depth (st. E-14)

Mycteroperca rubra (Bloch, 1793) (Fig. 72)

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

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

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

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

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

Lebanon missions: Enfeh (E-1, E-7, E-12, E-14, E-15), Ras Chekaa (C-1, C-3, C-10, C- 11, C-14, C-17, C-19, C-21), Raoucheh (R-1), Saida (S-1), Tyre (T-1, T-2, T-5, T-6, T-11, T-12, T-18, T-19, T-20, T-23, T-24), Ras El Bayada (N-2, N-3, N-15), Nakoura (N-7, N-9, N-10, N-12, N-13); 1-23 m depth.

Observations: *M. rubra* has been the most frequent serranid species in the underwater studies. Nevertheless, no adult has been observed; all the individuals were juveniles (size < 25 cm). The presence of a suitable habitat (mainly, heterogeneous rock) and juveniles would make possible the recovery of the population with protection measures.

d) Large Sparidae

During the diving observations, *Diplodus* cervinus and *D. sardus* have been common, whereas *D. puntazzo* and *Pagrus auriga* were rare.

However, others large sparids such as *Dentex dentex* and *Sparus aurata* have not been observed during the missions.

Figure 73. One individual of the 'zebra sea bream' (*Diplodus cervinus*) (st. E-12, 4 m depth)

Diplodus cervinus
(Lowe, 1838) (Fig. 73)

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

Status of protection: None.

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

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

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

Lebanon missions: Enfeh (E-9), Ras Chekaa (C-3, C-17, C-19, C-22), Tyre (T-12), Ras El Bayada (N-3, N-10); 1-13 m depth.

Observations: The species is not abundant, but it has been present in all of the sectors. All of the observed individuals had presented a size < 25 cm.

Figure 74. One individual of the 'redbanded sea bream' (*Pagrus auriga*) (st. R-1, 3 m depth)

Pagrus auriga
(Valenciennes, 1843) (Fig. 74)

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

Status of protection: None.

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

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

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

Lebanon missions: Rare, only observed in Raoucheh (R-1) and Nakoura (N-2), 0-10 m depth.

Observations: The species seems rare, only two juvenile individuals have been observed in shallow waters, 0-10 m depth. Probably, like other large sparids, the species is subject to high fishing pressure.

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6. BENTHIC BIONOMY AND MARINE HABITATS

6.1 Introduction

Identification and typification of the marine habitats, and their benthic assemblages is a consistent tool to explain the delimitation of the marine protected areas and located anthropogenic impacts (Roff *et al.,* 2003). Thus, the development of a standard habitat classification is required for evaluating of the nature conservation and a long term monitoring of the sites (Costello & Emblow, 2005).

Two studies of the Lebanon marine habitats have been intended to cover all inshore marine habitats from the supralittoral up to 50 m depth (upper circalittoral). They have also been used in mapping and inventorying areas of possible conservation measures. Nevertheless, some characteristics of the Lebanon's benthic habitats are peculiar and difficult for the application of the usual Mediterranean habitat/biocenosis classifications (Pérès & Picard, 1964; Bellan-Santini *et al.*, 1994, 2002; UNEP/MAP, 1998; Davis & Moss, 2004). Among these limitations are:

i) Scarcity of studies about Lebanon's marine habitats;

ii) many habitats are quite different from to the rest of Mediterranean sectors (Western Mediterranean Sea, Aegean Sea, Adriatic Sea, Ionian Sea);

iii) high variability of the infralittoral rock assemblages;

iv) relative homogeneity of the infralittoral fauna and flora (late summer thermocline at 40-50 m depth);

v) influence of some lessepsians species (as Siganidae, *Chama-Spondylus* bioconstructions) on the habitat; and the seasonal changes are very pronounced in the flora composition.

Therefore, the comparisons with equivalent habitats from other Mediterranean sectors represent some difficulties, on spatial and temporal scales. To solve this problem, we have done an approximation of the seascape ecology (Pittman *et al.*, 2011; Fuller, 2013), since it seems fundamental to understand how abiotic patterns influence species distribution, mainly, throughout the rocky bottoms. One pragmatic approximation has been to consider the seascapes as geo-morphological units with the associated communities, based in the sessile epibenthic assemblages. A seascape represents the combination of the physical habitat (mainly geo-morphological features) and the more conspicuous or dominant flora/fauna.

The main benefit of using habitat classification based on geo-morphological features makes possible to compare the results from surveys of one or more sites with other studies, independently of the season (with the variation of the megabenthic species). This classification aims to provide a standard nomenclature for describing and mapping marine habitats, mainly in areas where very little is known about the benthic environment.

Each biocenosis and association/facies have been assigned a code (UNEP/MAP-RAC/SPA, 2006; as UMR in the text); but to some of them, it has not been possible to give them this code. We have included the more abundant species and characteristic of the observed megabenthos (phyto and zoobenthos, fishes) with a subjective appreciation of the abundance: (cc) very common, (c) common, and (r) rare. The species observed in the different communities are included in the Annex II (inventory of species).

6.2 Hard substrata

We have applied the seascape/biocenosis concepts to hard substrata, classifiying them as: littoral rock (supra and midlittoral), infralittoral rock (upper, middle and lower horizons) and circalittoral rocky bottoms.

6.2.1 Littoral rock

The littoral rock embraces the supralittoral and midlittoral stages, with the littoral fringe (> 0 m in calm waters and high barometric pressure).

Biotope: The nature of substrata has been limestone (Enfeh, Ras Chekaa, Raoucheh, Ras El Bayada, Fig. 75) and sandstone rocks (Saida, Tyre, Nakoura, Fig. 76). The hydrodynamism (by waves) has varied from moderate to high. The abrasion platform is more or less wide, although there are variations among the zones (between 1 to 20 m width).

Figure 75. Littoral rock of Enfeh (st. E-1)

Conservation interest: The vermetid bio-builder (*Dendropoma petraeum* with *Neogoniolithon brassica-florida*) develops intertidal plateaus on the abrasion platform. Although the association of *Cystoseira amentacea* has not been observed; other species, important for conservation purposes, are *Sargassum vulgare, Cystoseira compressa* and *Palisada perforata*.

Potential threats: Due to human activities, the littoral rock is the most threatened marine habitat. The main anthropogenic impacts are tramplig, shell-fish and algae collection (normally for baits), hydrocarbon and sewage pollution, littoral disturbance (building, ports, sediment filling). Vermetid platforms are the main threatened habitat.

Associated biocenosis:

- Supralittoral rock (UMR: I.4.1)
- Upper midlittoral rock (UMR: II.4.1)
- Lower midlittoral rock (UMR: II.4.2)
- Midlittoral caves (UMR: II.4.3)
- Littoral fringe (abrasion platform with littoral pools)

6.2.1.1 Biocenosis of the supralittoral rock (Fig. 77)

Structure of the community: Only the lower stratum is present, with the lichen *Verrucaria amphibian* (r), the gastropods *Melarhaphe* (= *Littorina*) *neritoides* (cc) and *Echinolittorina* (= *Littorina*) *punctata* (cc), and the *crustaceans Ligia italica* (cc), *Euraphia depressa* (r) and *Pachygrapsus marmoratus* (r).

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Figure 77. The supralittoral zone with the littorinids *Melarhaphe neritoides* and *Echinolittorina punctata.* Inlets of northern Tyre (station T-5)

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Figure 76. Littoral rock in Nakoura (st. N-1)

Facies and associations: Association with *Enthophysalis deusta* and *Verrucaria* spp. (UMR: I.4.1.2).

Stations: Enfeh (E-1, E-7, E-12), Ras Chekaa (C-3, C-10, C-14, C-17, C-19, C-20, C- 23), Saida (S-2, S-3), Tyre (T-2, T-5, T-6, T-17, T-18, T-20), Nakoura (N-1, N-3, N-10).

6.2.1.2 Biocenosis of the upper midlittoral rock

Structure of the community: It is exclusively recognized in the lower stratum. In the summer season, it can only be observed in this lower strata with endolitic *Cyanophyta* (cc) and white patches of *Lithophyllum papillosum*; as sessile epifauna, the cirripeds *Chthamalus stellatus* (cc) and Ch. *montagui* (cc). In winter and spring periods, the ephemeral rhodophytes *Bangia atropurpurea*, *Porphyra leucosticta* and *Nemalion helmintoides* are present.

Mobile fauna: The gastropods *Echinolittorina punctata* (cc) and *Patella rustica* (cc); the isopod *Ligia italica* (c) and the crab *Pachygrapsus marmoratus* (c).

Facies and associations:

- Association with *Lithophyllum papillosum* and *Polysiphonia* spp. (UMR: II.4.1.4).
- Facies with *Chthamalus* spp.

During winter and spring periods, it is possible to observe seasonal assemblages at the upper midlittoral as associations with the rhodophyta *Bangia atropurpurea* (UMR II.4.1.1), *Porphyra leucosticta* (UMR II.4.1.2) and *Nemalion helmintoides* (UMR II.4.1.3).

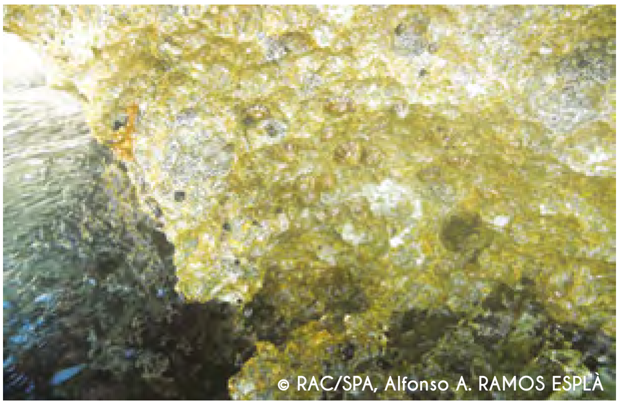


Figure 78. Biocenosis of the upper midlittoral rock with *Lithophyllum papillosum* (white patches), *Echinolittorina punctata, Chthamalus stellatus, Patella rustica* (Ras Chekaa, st. C-23)

Association with *Lithophyllum papillosum* and *Polysiphonia* spp. (Fig. 78)

In the summer period (from late June to early September), this association dominate the rocky substratum. In some places (e.g. Saida), the rhodophyte *Polysiphonia* sp. is also present (Fig. 79).

Stations: Enfeh (E-1, E-7, E-12), Ras Chekaa (C-3, C-10, C-14, C-17, C-19, C-20, C- 23), Saida (S-2, S-3), Tyre (T-2, T-5, T-6, T-17, T-18, T-20), Nakoura (N-1, N-3, N-10).

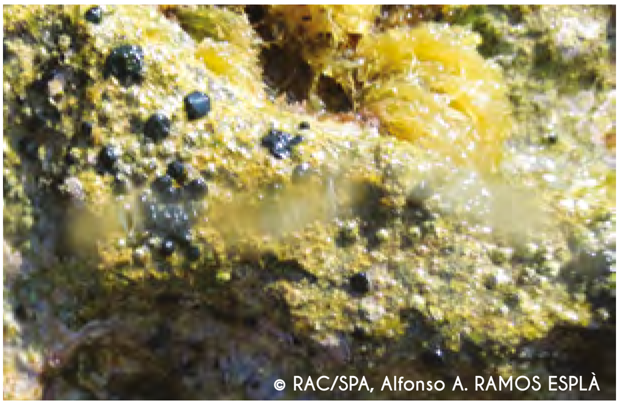


Figure 79. Upper midlittoral rock with *Chthamalus* spp. (*Ch. stellatus, Ch. montagui*), behind *Polysiphonia* sp. (yellow turfs). Saida (st. S-3)

Facies with *Chthamalus* spp. (Fig. 79)

This facies occurs in exposed environments, with the species *Chthamalus stellatus* (cc) and *Ch. montagui* (c). The limpet *Patella rustica* is also common.

Stations: Enfeh: (E-1, E-12), Ras Chekaa (C-3, C-23), Saida (S-3), Tyre (T-5, T-6) and Nakoura (N-1).

6.2.1.3 Biocenosis of the lower midlittoral rock (Fig. 80)

Structure of the community: It occurs in the middle and the lower strata. In the summer season, it only appears on the lower strata with endolitic *Cyanophyta* (cc) and the epilithic *Rivularia atra* (c), the encrusting *Ralfsia verrucosa* (r) and *Neogoniolithon brassica-florida* (c), and the turf of gelidiales *Gelidium cf. pusillum* and *Parviphycus pannosus* (c).

The soft macroalgae *Ulva compressa* (cc) is a characteristic species. The cirripeds *Chthamalus stellatus*, and *Ch. montagui* are present, mainly in exposed shores.

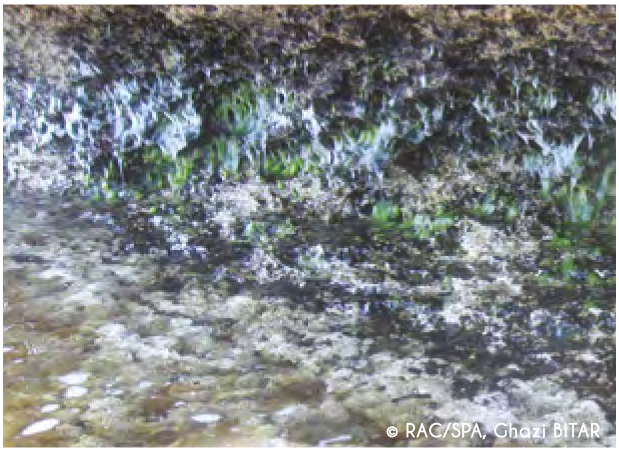


Figure 80. Lower midlittoral rock with *Ralfsia verrucosa* and *Ulva compressa*. Enfeh (st. E-1)

Figure 81. Vermetid platforms in the Fanar zone. Tyre (st. T-18)

Mobile fauna: The gastropods *Echinolittorina punctata* (cc), *Patella ulyssiponensis* (cc), *P. caerulea* (c), *Phorcus turbinatus* (r); the polyplacophore *Acanthochitona fascicularis* (r); the crustaceans *Ligia italica* (c) and *Pachygrapsus marmoratus* (c). Also, the blennidae *Coryphoblennius galerita* has been observed.

Facies and associations: During the study period (late June), the associations are:

- Association with Ulva compressa (UMR: II.4.2.6)
- Association with Gelidiales spp. (UMR: II.4.2.9)
- Pools and lagoons associated with vermetids (UMR: II.4.2.10)

Association with *Ulva compressa* (Fig. 80)

The species distribution has been very localized, in natural conditions, and during the period of sampling (early summer). Apparently, this seasonal species may be suffering a regressive process; it has not been observed in the second mission (late summer). Although, *U. compressa* may develop populations in spring which then disappear during the summer period.

Stations: Only observed in Enfeh (E-1) and Ras Chekaa (C-23).

Association with Gelidiales

Although, the characteristic species is *Gelidium* cf. *pusillum*, in the Levantine rocky shores *Parviphycus pannosus* is another gelidial observed.

Stations: Only observed in Enfeh: (E-1) and Ras Chekaa (C-23).

Pools and lagoons associated with vermetids (Fig. 81)

The vermetid *Dendropoma petraeum* and the corallinale *Neogoniolithon brassica-florida* from small plates in the lower midlittoral.

Stations: Enfeh (E-1), Ras Chekaa (C-23), Saida (S-3), Tyre (T-18), Nakoura (N-1).

6.2.1.4 Biocenosis of midlittoral caves (Fig. 82)

Structure of the community: Only the lower stratum with the encrusting rhodophytes *Hidenbrandia rubra* and *Phymatolithon lenormandii*. Some exemplaries of *Actinia schmidti* have been observed.

Association and facies: Association with *Phymatolithon lenormandii* and *Hildenbrandia rubra* (UMR: II. 4.3.1).

Stations: Enfeh (E-12), Raoucheh (R-1). The littoral of the northern Ras Chekaa presents some interesting midlittoral caves (Fig. 83).

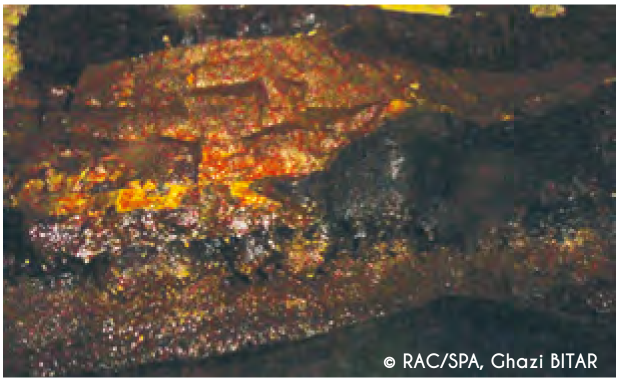


Figure 82. Association with *Hildenbrandia rubra* in Raoucheh tunnel (st. R-1)

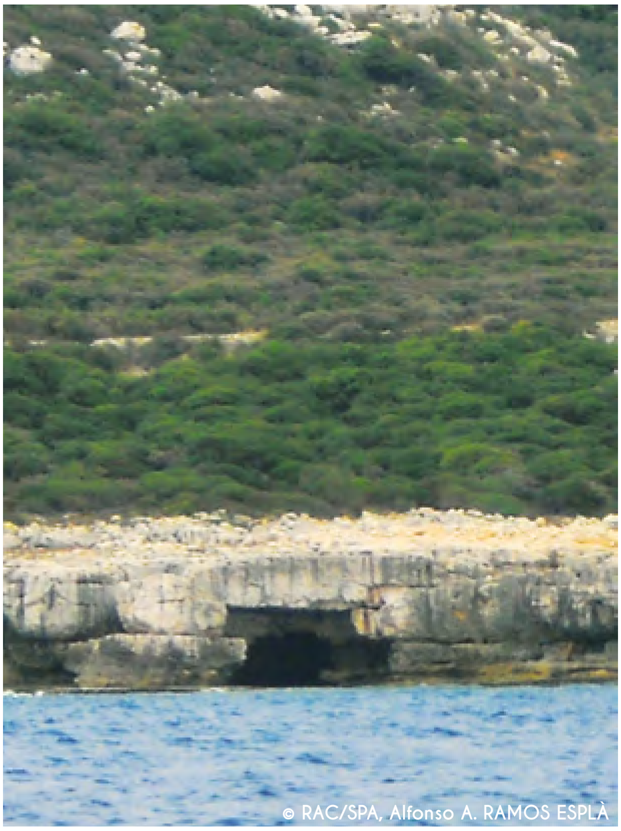


Figure 83. Littoral cave in the northern of Ras Chekaa

6.2.1.5 Littoral fringe

The littoral fringe is the uppermost horizon of the infralittoral algae. It can be identified by the abrasion platform, the shallow littoral pools and surf zone. Under high barometric pressures, this zone can remain above the sea level for some days.

Structure of the community: The abrasion platform presents a middle and lower strata, dominated by chlorophytes, rhodophytes and Mytilidae.

- **Upper stratum:** In the surf zone, some ramified macroalgae (*Sargassum, Cystoseira, Palisada, Laurencia, Acanthophora*) can develop a complex habitat.

- **Middle stratum:** The abrasion platform is dominated by chlorophytes (*Ulva compressa, U. rigida, Cladophora and Chaetomorpha* spp.) and the rhodophyte *Hypnea musciformis* (June in Enfeh and Ras Chekaa). In the littoral pools, the ochrophytes *Dictyota fasciola* (cc) and *Padina boergenseni* (cc) are frequent, particularly in the Nakoura area (Fig. 84).

- **Lower stratum:** The surf zone is mainly colonized by *Jania rubens* and *Valonia utricularis* (r) The sessile fauna is dominated by the mytilid *Brachidontes pharaonis* and *Vermetus triquetrus*.

- **Mobile fauna:** With *Patella caerulea* (c) and *Eriphia verrucosa* (c). In the littoral pools the decapod crustaceans *Palaemon serratus* and the Blenniidae fishes are common.

Facies and associations: They are concentrated in the uppermost part of the infralittoral rock (0-0,5 m depth) with the associations/facies:

- Vermetids with *Dendropoma* and *Neogoniolithon* (UMR III.6.1.3)
- Littoral pools sometimes associated with vermetids (infralittoral enclave)
- Association with Ulvales
- *Sargassum vulgare* (UMR III. 20) and *Cystoseira compressa* (UMR III.6.1.25)
- *Jania rubens*
- Mytilids with *Brachidontes pharaonis* (UMC III.6.1.4)

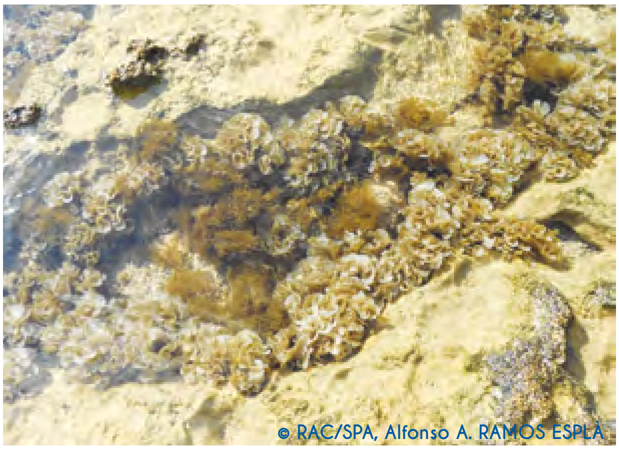


Figure 84. Littoral pool with the algae *Dictyota fasciola* and *Padina boergesenii*. Nakoura, st. N-1).

Dendropoma and Neogoniolithon concretions

The vermetid *Dendropoma petraeum* (c) and the calcareous algae *Neogoniolithon brassica-marina* (= *Spongites notarisii*) (cc), form a small cushion and plate structures (Fig. 81). *Vermetus triquetrus* is another frequent vermetid. The vermetid formations appear developed in all of the area but they are covered by algae, and many of the vermetids bio-concretions are dead.

Stations: Enfeh (E-1), Ras Chekaa (C-23), Saida (S-3), Tyre (T-18), Nakoura (N-1).

Littoral pools sometimes associated with vermetids (infralittoral enclave)

These infralittoral enclaves are frequent in the sandstones and limestones rocks (Fig. 84). The macroalgae are abundant,: as chlorophytes (*Cladophora* spp., *Ulva* spp. *Chaetomorpha* spp.), ochrophytes (*Dictyota fasciola, Padina boergesenii*) and rhodophytes (*Jania rubens, Hypnea musciformis, H. spinella*). The decapode *Palaemon serratus* is frequent.

Stations: Enfeh (E-1), Ras Chekaa (C-23), Saida (S-3), Tyre (T-18).

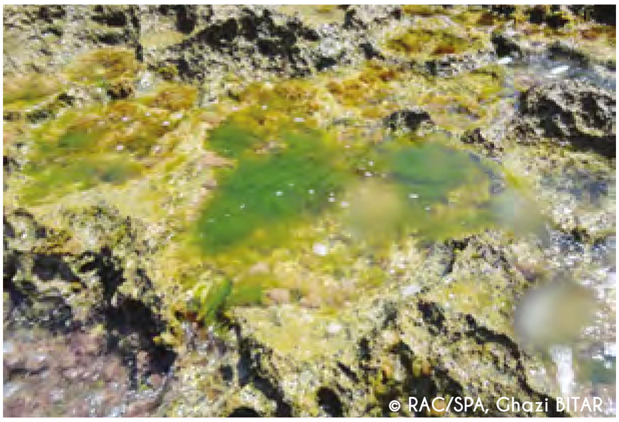


Figure 85. *Ulva* spp. on the lower midlittoral rock (Saida, station S-3)

Association with Ulvales (Fig. 85)

In some places, normally subject to some organic pollution, the chlorophytes are dominant with Ulvales, Bryopsidales and Cladophorales (*Ulva intestinalis, U. compressa, U. rigida, Chaetomorpha* spp., *Bryopsis* spp.). This association has been observed on the Saida inlets.

Stations: Enfeh (E-12), Saida (S-3).

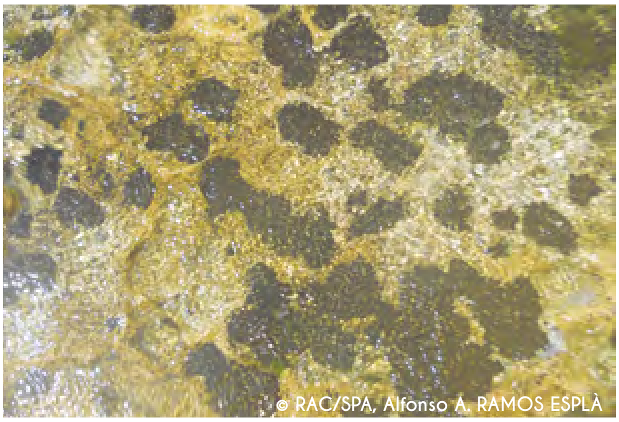


Figure 86. Facies with *Brachidontes pharaonis* on the abrasion platform in Ras Chekaa (st. C-23)

Facies with *Brachidontes pharaonis* (Fig. 86).

This lessepsian mussel dominates the abrasion platform and it forms a marked belt in the lower part of the midlittoral, with Ulvales (*Ulva* spp.) and *Chaetomorpha* spp. It is frequent in many places, in the Northern part of Ras Chekaa, in Raoucheh, Tyre and Saida.

Stations: Enfeh (E-1, E-12), Ras Chekaa (C-3, C-10, C-11, C-14, C-19, C-22, C-23), Raoucheh (R-1), Saida (S-3), Tyre (T-2, T-5, T-6, T-17, T-18, T-20) and Nakoura (N-1, N-3, N-10).

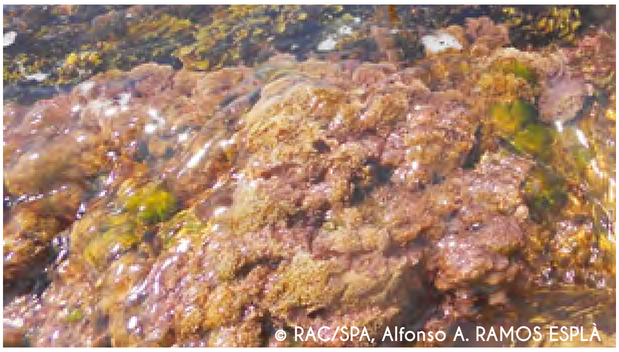


Figure 87. *Jania rubens* on the littoral fringe, with *Cladophora sp.* Tyre (northern inlets, st T-17)

Association with *Jania rubens* (Fig. 87)

The rhodophyte *Jania rubens* can dominate the littoral fringe (0-1 m depth) in the surf zone. Usually it is accompanied by the rhodophytes *Corallina elongata* (c), *Palisada perforata* (c) and *Laurencia obtusa* (r), and the chorophytes *Cladophora* spp. (c).

Stations: Enfeh (E-1, E-7, E-12, E-14), Ras Chekaa (C-3, C-10, C-11, C-14, C-17, C- 19, C-23), Saida (S-2, S-3), Tyre (T-1, T-2, T-17, T-18, T-20, T-22), Nakoura (N-2, N-3, N-10) .

Associacion with *Sargassum vulgare* and *Cystoseira compressa* (Fig. 88)

In calm and unpolluted shallow waters (0-2 m depth), the ocrophytes *Sargassum vulgare* and *Cystoseira compressa* can be dominant, together with *Jania rubens* (Nakoura and northern Tyre); also, the ceramiale *Palisada perforata* can be present.

Stations: Enfeh (E-1, E-7, E-12, E-15), Ras Chekaa (C-11, C-23), Tyre (T-5, T-6, T-17).

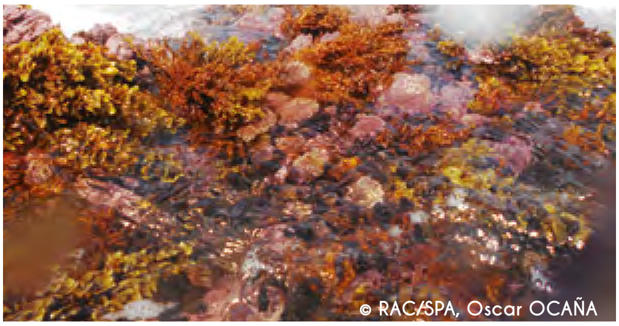


Figure 88. Association with *Sargassum vulgare* and *Cystoseira compressa*, together with *Jania rubens* (inlets of northern Tyre, station T-17)

6.2.2 Infralittoral rock

The infralittoral rock represents a complex of habitats depending on the nature and topography of the substratum, surface slope, wave exposure, illumination, sediment cover and scour, seasonal temperature changes, thermocline depth, etc. That means a zonation of the communities, with a unique biocenosis: the infralittoral algae (UMR: III.6.1).

According to wave exposure and light extinction, we have considered three horizons in the infralittoral rock: upper, middle and lower (Riedl, 1971).

- **Upper horizon:** From the mean sea level up to 8 m depth. Here the intense wave action prevents the sedimentation ;
- **Middle horizon:** From 8 m to 29 m depth, with the dominance of the photophilic algae on horizontal surfaces ;
- **Lower horizon:** From 29 to 42 m depth, with the dominance of sciaphilic algae on horizontal surfaces.

The topography of the rocky bottoms changes with the depths. So in shallow depths (0-8 m), normally, the rocky profile is vertical (Fig. 89) with big boulders on the base. In the middle horizon, the topography of the rock varies from sloping to horizontal with/without sandy channels, according to the zones. Therefore, in the Enfeh-Ras Chekaa what prevails is the slopping and high rock; whereas, in the Saida-Nakoura one, it is and horizontal and lower with coarse sediment patches.

According with this zonation, the biocenosis of the infralittoral algae dominates the three horizons, with four groups (depending on the hydrodynamism (exposed/sheltered) and light intensities: (photophilic/sciaphilic):

i) exposed photophilic macroalgae ;

ii) exposed sciaphilic macroalgae ;

iii) sheltered photophilic macroalgae ;

iv) sheltered sciaphilic macroalgae.

6.2.2.1 Upper horizon of the infralittoral rock

Biotope: Following the abrasion platform, the rock profile falls vertically to 2-8 m depth (Fig. 89), depending of the zones (shallower in Enfeh, deeper in Nakoura), normally, with big boulders on the bottom. The wave exposure is high and the presence of vertical surfaces and overhangs favours the sciaphilic communities.

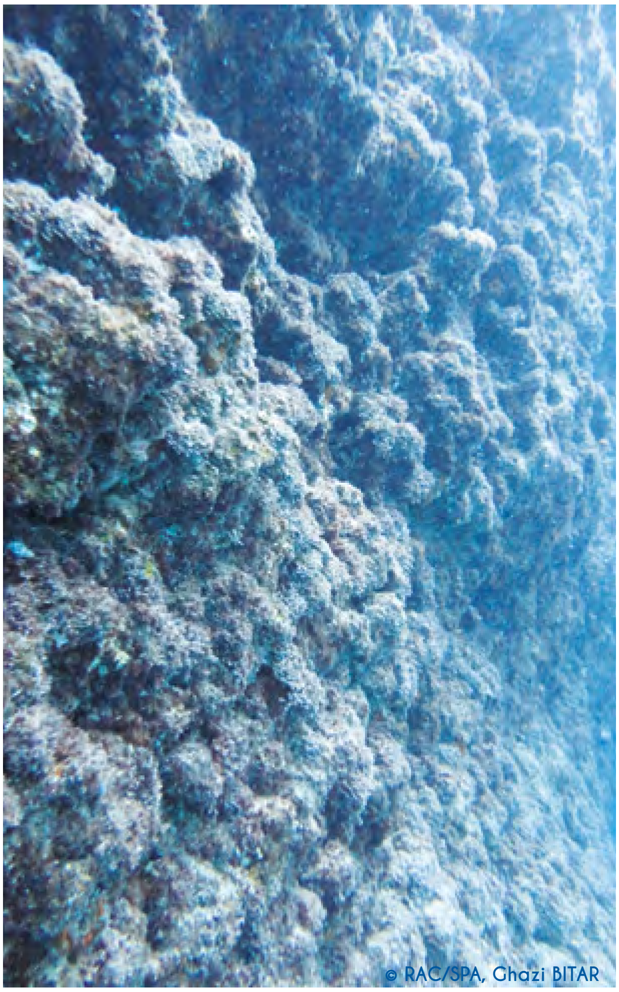


Figure 89. Rocky vertical profile with *Corallina elongata* association, Ras Chekaa, 5 m depth (st. C- 20)

Conservation interest: There are some species of conservation interest. The erect ochrophyte *Sargassum* and *Cystoseira* (we've seen it previously) create a photophilic complex habitat. The sciaphilic assemblage with *Schottera* and *Plocamium* is diverse, harbouring many species. Also, the impact of lessepsian species is low (*Brachidontes pharaonis* are dominant in some places).

Potential threats: The upper infralittoral rock is threated by many anthropogenic impacts, such as sewage pollution (industrial and domestic), littoral development (building, ports), sediment filling and land reclamation. Also, it must be considered the serious impact of dynamite on the living resources must be taken into consideration, as well as on the harvest of *Lithophaga lithophaga*, and the spearfishing of some targed species (such as the large Serranidae).

Associated biocenosis:

- Part of the biocenosis of infralittoral algae (UMC III.6.1), corresponding to wave exposed habitats (photophilic and sciaphilic algae) ;
- Coralligenous infralittoral enclaves (UMR: IV.3.1).

6.2.2.1.1 Exposed photophilic algae

The width of this horizon depends on the hydrodynamism, and it can reach about 6-8 m depth in a very exposed littoral. The light intensity is very high.

Structure of the community: The middle and lower stratum predominate in the community, although some ochrophytes (*Sargassum vulgare, Cystoseira compressa*) and large hydrozoans (*Pennaria, Macrorhynchia*) can create an upper stratum.

- **Middle-lower stratum:** With the algal turfs of geniculate Corallinales (*Jania rubens, Corallina elongata*). In some places, the mytilid *Barchidontes pharaonis* and/or hydroids are dominant. In Enfeh, some *Sagassum vulgare* and *Cystoseira compressa* patches have been observed (Fig. 89). Among the sessile fauna, the poriferans (*Chondrilla nucula, Chondrosia reniformis, Crambe crambe, Cliona parenzani, Phorbas topsenti*), the hydrozoan (*Pennaria disticha, Macrorhynchia philippina*) and the cirripeds (*Balanus trigonus and Perforatus perforatus*) have been frequent. Another common sessile fauna has been the anthozoan *Oculina patagonica*, bryozoan *Schizoporella sanguinea* and ascidian *Phallusia nigra*. Noteworthy is the rarity of sea urchins (*Paracentrotus, Arbacia*) in some locations (as in Saida, Tyre and Nakoura) due to the surcollection by divers.

The presence of bare rock is very frequent, with *Lithophyllum incrustans* and small Ceramiales (Fig. 90), accompanied by *Cliona parenzani* and *Balanus* spp. In some altered sites with organic pollution (some places located in Enfeh and Raouched), the chloropyta (*Ulva* spp., *Codium taylori*) and rhodophyta (*Pterocladiella capillacea*) dominate the rocky substratum.

- **Mobile fauna:** As for the mobile fauna, the decapods *Eriphia verrucosa* (c) and the pagures *Clibanarius erythropus* (cc) and *Calcinus tubularis* (c), with the lessepsian gastropoda *Cerithium scabridum* (cc) and *Conomurex persicus* (c) are frequent; the sea urchins *Arbacia lixula* and *Paracentrotus lividus* are relatively rare (mainly in the Saida-Nakoura sector). Among the fishes are *Diplodus* spp. (*D. sargus, D. vulgaris*) (cc), *Thalassoma pavo* (cc), *Siganus rivulatus* (cc), *Sparisoma creense* (cc), *Coris julis* (c), *Symphodus roissali* (r), *Serranus scriba* (r) and *Blennidae* (cc).

Facies and associations

- Overgrazed facies with encrusting algae (UMR: III.6.1.1)
- Association with *Sargassum vulgare* (UMR: III.6.1.20);
- Association with *Cystoseira compressa* (UMR: III.6.1.25);
- Association with *Pterocladiella capillacea* and *Ulva* spp. (UMR: III.6.1.26);
- Facies with Mytylidae (*Brachidontes pharaonis*) (UMR: III.6.1.4);
- Facies with large hydrozoans (UMR: III.1.27);
- Facies with *Balanidae* spp.

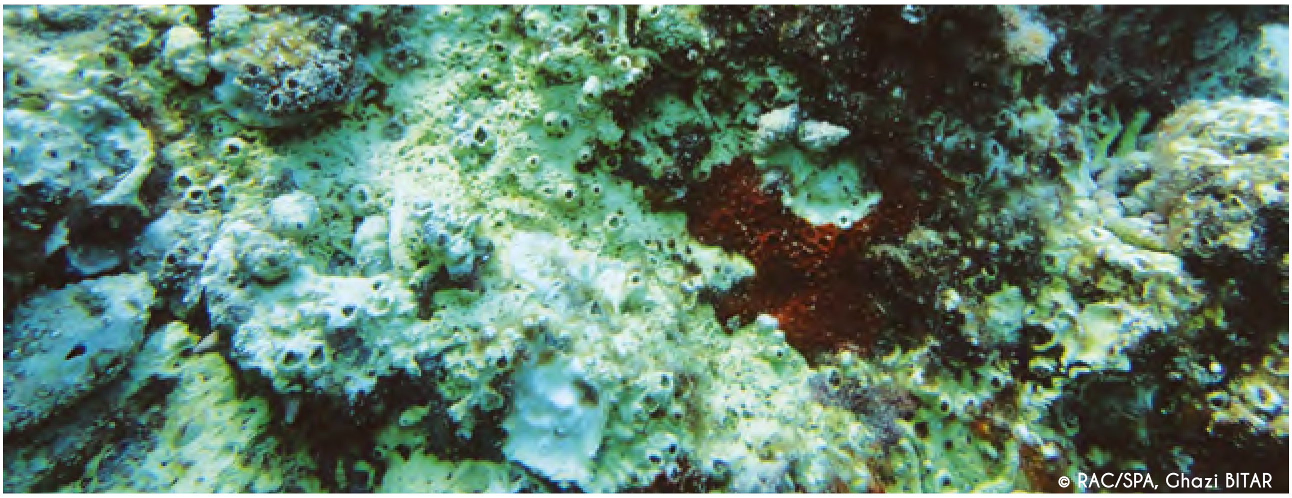


Figure 90. Exposed photophilic algae with *Lithophyllum incrustans*, cirripeds (*Balanus, Perforatus*), gastropods (*Ergalatax junionae*) and the red sponge *Phorbas topsenti*. Enfeh, 3 m depth (st. E-12)

Figure 91. Overgrazing facies with *Lithophyllum incrustans* and *Arbacia lixula*. Enfeh, 2 m depth (st. E-12)

Overgrazing facies (Fig. 91)

In some places, the rocky substrata is bare and empty of erected soft macroalgae, only some encrusting corallinales are present (*Lithophyllum incrustant* and *Neogoniolithon* spp.) with some *Amphiroa rigida* talus.

Although the typical facies with *Lithophyllum incrustans* and *Arbacia lixula* (Fig. 91) is present, normally this overgrazing is due to the herbivorous pressure of the fishes *Siganus rivulatus* (cc) and *S. luridus* (c), whereas the sea urchins (*Arbacia lixula* and *Paracentrotus lividus*) are very scarce in the studied zones. Another reason could be the erosion by the coarse sand of the rock due to the heavy storms (Fig. 92). The bare rock can appears up to a depth of 8 m.

The macrofauna is poorly represented, and some encrusted and well anchored animals are present. Like the poriferans *Crambe crambe* (c) and the boring sponges *Cliona* spp. (c); the cirripeds *Perforatus perforatus* (r) and *Balanus trigonus* (r), the ascophoran bryozoan *Schyzoporella errata* (c); and the ascidian *Phallusia nigra* (r).

Stations: This overgrazing facies is extensively spread in all of the areas. Enfeh (E-1, E-7, E-12, E-15), Ras Chekaa (C-3, C-14, C-17, C-20, C-23), Raoucheh (R-1), Tyre (T-1, T-2, T-5, T-6, T-11, T-18, T-24, T-24), Saida (S-1, S-2) and Nakoura (N-3, N-3,).

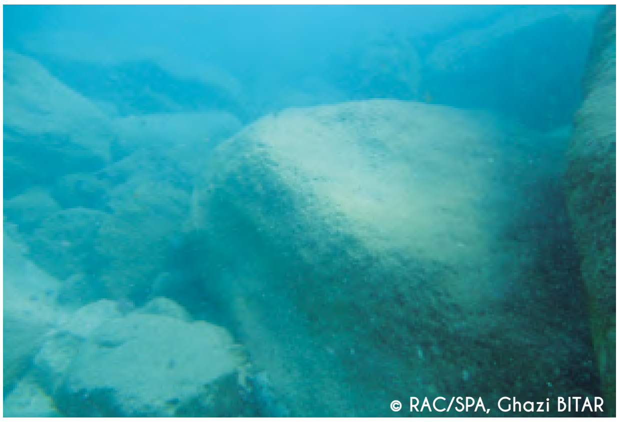


Figure 92. Bare rock in the Ras El Bayada, 6 m depth (station N-10)

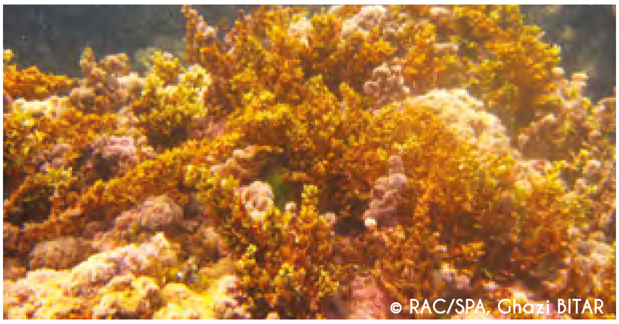


Figure 93. The association with *Sargassum vulgare*, accompanied by *Jania rubens*. Enfeh, 1 m depth (St. E-1)

Association with *Sargassum vulgare* (Fig. 93)

The association has been more frequent in the northern sector than the southern one, perhaps due to seasonal changes.

Stations: Enfeh (E-1, E-7, E-12, E-15), Ras Chekaa (C-11, C-23), Tyre (T-5, T-6, T-17), Common in Enfeh and Tyre, between 0-1 m depth; the association seems rare or it has not been observed in Saida and Nakoura.

Figure 94. Associaion with *Cystoseira compressa* in Enfeh, 1 m depth (st. E-1)

Association with *Cystoseira compressa* (Fig. 94)

Although it is present in the same sites of *S. vulgare*, *C. compressa* has been less frequent than *Sargassum*.

Stations: Enfeh (E-1, E-7, E-12, E-15), Ras Chekaa (C-23), Tyre (T-5, T-6, T-17). Common in Enfeh and Tyre, between 0-1 m depth; the association seems rare in Ras Saida and Nakoura, where it has not been observed.

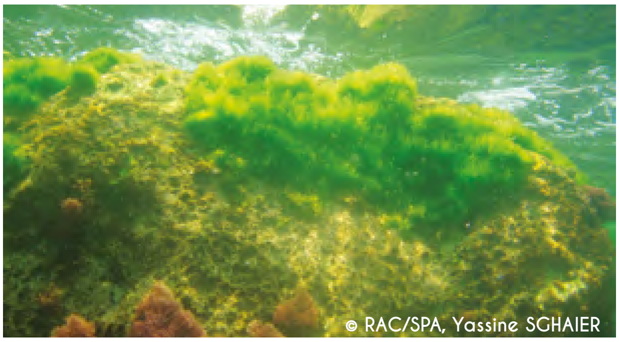


Figure 95. Association with *Ulva* spp. and *Pterocladiella capillacea*. Enfeh, 0.5 m depth (st. E-1)

Association with *Pterocladiella capillacea* and *Ulva* spp. (Fig. 95)

This association is located in some stations with organic pollution. The rhodophyte *Pterocladiella capillacea* and the chlorophites *Ulva intestinalis* and *U. lactuca* are dominant in shallow waters (0-4 m depth). Also, the lessepsian chorophyte *Codium taylori* is present.

Stations: Enfeh (E-1, E-7, E-12), Ras Chekaa (C-3) and Raoucheh (R-1).

Figure 96. Upper infralittoral facies with *Brachidontes pharaonis*. Saida (st. S-3).

Facies with the Mytilidae *Brahidontes pharaonis* (Fig. 96)

It is a very common facies, particularly in the southern sector (Saida, Tyre and Nakoura), between 0 to 8 m depth. In some places, the lessepsian mytilid *Brachidontes pharaonis* can completely cover the rocky surfaces.

Stations: Enfeh (E-1, E-12), Ras Chekaa (C-3, C-10, C-11, C-14, C-17, C-19, C-23), Raoucheh (R-1), Saida (S-1, S-2, S-3), Tyre (T-1, T-2, T-5, T-6, T-7, T-11, T-17, T-18, T- 20) and Nakoura (N-2, N-3, N-9, N-10).

Figure 97. Facies with the hydroid *Pennaria disticha*, Ras El Bayada, 2 m depth (st. N-10).

Facies with large hydrozoans (Fig. 97)

In some exposed surfaces the hydroids *Pennaria disticha* (cc) and *Macrorynchia philippina* (c) are present, particularly, in the Nakoura area (Ras El Bayada).

Stations: Enfeh (E-1,), Ras Chekaa (C-3, C-10, C-14, C-17, C-19, C-22, C-23), Raoucheh (R-1), Saida (S-1, S-2), Tyre (T-1, T-2, T-4, T-5, T-5, T-6, T-10, T-11, T-20), Nakoura (N-2, N-3, N-10). The facies is distributed in all of the observed areas, between 0-7 m depths. However, it has been more frequent in Ras Chekaa and Tyre.

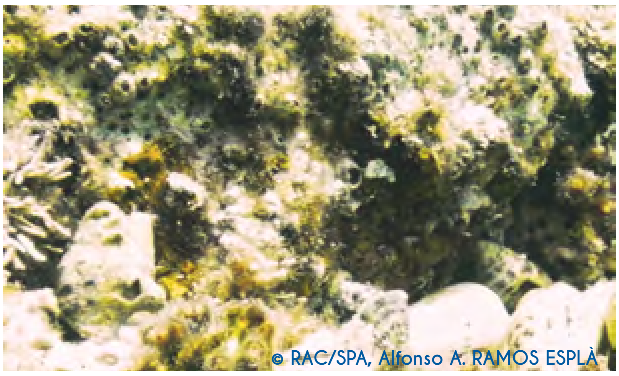


Figure 98. Facies with *Perforatus perforatus* and *Balanus trigonus*, and some gastropods *Ergalatax junionae*. Enfeh, 4 m depth (st. E-1).

Facies with Balanidae spp. (Fig. 98)

This facies is dominated by *Perforatus perforatus* and *Balanus trigonus* is common in the northern and southern areas on horizontal and subhorizontal surfaces, between 1 to 15 m depth. Noteworthy is the high frequency of empty tests.

Stations: Enfeh (E-1, E-12), Ras Chekaa (C-10, C-11, C-14, C-17, C-19, C-20, C-23), Saida (S-1, S-2), Tyre (T-2, T-5, T-19) and Nakoura (N-2, N-3, N-10, N-16).

6.2.2.1.2 Exposed sciaphilic algae (Fig. 99)

Structure of the commnity: It predominates on the vertical rock between 0-6 m depth, with the middle and lower strata.

- **Middle stratum:** With the dominance of rhodophytes *Corallina elongata* and *Plocamium cartilagineum*. The sessile fauna is abundant, with the poriferans (*Chondrosia reniformis, Clathrina cf. coriacea, Niphates toxifera*), hydrozoans (*Pennaria disticha, Aglaophenia* spp.), some lessepsian bivalves (*Chama pacifica, Malleus regula, Spondylus spinosus*) and ascidians (*Herdmania momus, Phallusia nigra*).

- **Lower stratum:** With the rhodophytes *Schottera nicaeensis* and *Lithophyllum incrustans*); the ochrphyte *Lobophora variegata* (c) is present in some places. Also, the sessile fauna is abundant, with encrusting poriferans (*Crambe crambe, Phorbas topsenti*), cirripeds (*Perforatus perforatus, Balanus trigonus*), bivalves (*Brachidontes pharaonis*) and ascidians (Didemnidae spp.).

- **Mobile fauna:** As for the mobile fauna, the polychaete *Hermodice carunculata* is very frequent, particularly, in the northern area (Enfeh, Ras Chekaa). Also, the decapods (*Charybdis helleri, Atergatis roseus, Calcinus tubularis*), gastropodes (*Ergalatax junionae*) and fishes (Blennidae, *Pempheris vanicolensis, Scorpaena maderensis, Tripterygion minor*) are common in this habitat.

Figure 100. Association with *Corallina elongata*; on the left, the poriferan *Niphates toxifera*. In front of El Fanar, 4 m depth (st. T-11).

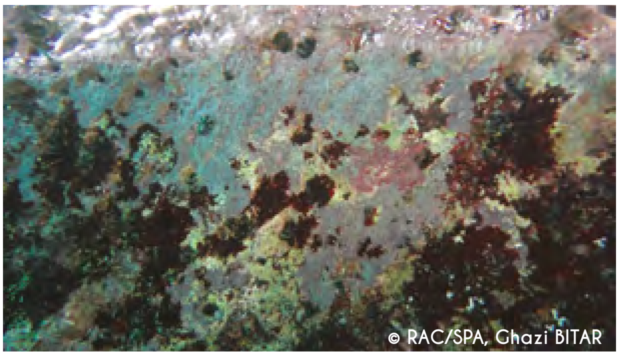


Figure 101. Exposed sciaphilic rock with *Schottera nicaeensis* and *Didemnidae sp.* in Enfeh, 1 m depth (st. E-12).

Associations (UMR: code UNEP/MAP - RAC/SPA, 1998)

- *Corallina elongata* (UMR: III.6.1.5);
- *Shottera nicaeensis* (UMR: III.6.1.29).

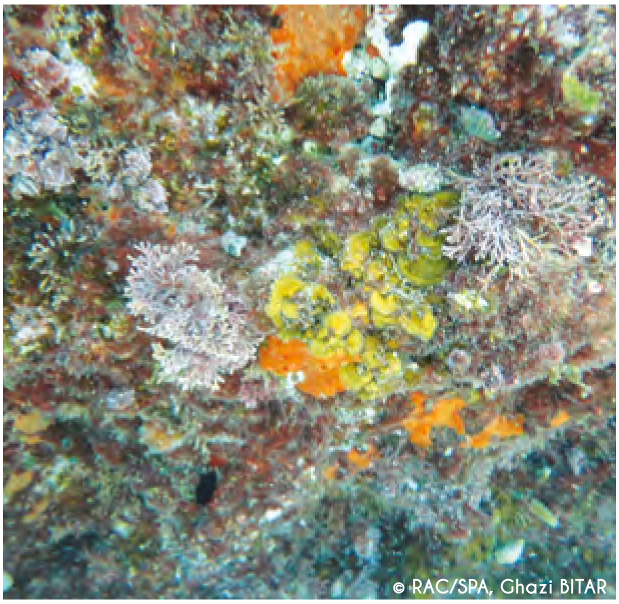


Figure 99. Exposed sciaphilic algae (*Corallina elongata, Plocamium cartilagineum, Lobophora variegata*) with poriferans (*Crambe crambe*) ascidians (*Didemnidae sp.*) and gastropods. Enfeh, 2 m depth (st. E-12).

Association with *Corallina elongata* (Fig. 100)

On vertical walls, this corallinacea dominate the substrata, between 0 to 6 m depth. Another rhodophyte should be present, *Plocamium cartilagineum* (c). The sessile fauna is not abundant with the poriferans *Chondrilla nucula* (c), *Chondrosia reniformis* (c), *Crambe crambe* (c) and *Niphates toxifera* (r); the hydrozoans *Aglaophenia* spp. and *Pennaria disticha* (c); the cirriped *Perforatus perforatus*; the bryozoan *Schichoporella errata* (c); and the ascidians *Didemnidae* spp. (c) and *Phallusia nigra* (c).

Stations: Enfeh (E-1, E-7, E-12); Ras Chekaa (C-3, C-10, C-11, C-14, C-17, C-19, C- 20, C-23), Raoucheh (R-1); Tyre (T-1, T-2, T-5, T-6, T-10, T-11, T-18, T-20); and Nakoura (N-2, N-3, N-10).

Association with *Schottera nicaeensis* (Fig. 101)

This association is located on more sciaphilic surfaces of the upper infralittoral horizon, in shallow water (0-2 m depth), with the rhodophytes *Schottera nicaeensis* (c), *Plocamium cartilagineum* (c), *Corallina elongata* (c), *Lithophyllum incrustans* (cc) and *Mesophyllum* sp. (r). The poriferans *Chondrosia reniformis* (c), *Crambe crambe* (cc) and *Clathrina* cf. *coriacea* (r) are present.

Stations: Enfeh (E-12), Rash Chekaa (C-19) and Raoucheh (R-1).

6.2.2.2 Middle horizon of the infralittoral rock (Figs. 102, 103)

Biotope: The rock profile changes with the studied zones. It is steep in the Enfeh-Ras Chekaa sector (Fig. 102) and gentler in the Saida-Nakoura sector (Fig. 103), normally flat rock with coarse sand patches and channels. Nevertheless, in some areas such as Ras El Bayada, the rock profile is more irregular and higher than the rest of the southern coast.

The wave exposure is moderate and the presence of vertical surfaces and overhangs favours the sciaphilic communities. The bathymetric range varies from 2 m depth (in sheltered places) to 28 m depth on horizontal surfaces.

Conservation interest: There are some species of conservation interest. The erect ochrophyte *Cystoseira foeniculacea* create a photophilic complex habitat. The sciaphilic assemblage with *Peyssonnelia* spp. and *Lobophora variegata* is diverse, together with poriferans (*Axinella* sp., *Chondrosia reniformis, Aplysina aerophoba, Petrosia ficiformis,* etc.), and can harbour many species. Even, the *Chama-Spondylus* reefs create a complex habitat where many invertebrates find shelter (gastropods, crustaceans, polychaetes, and ophiurids). Furthermore, the presence of juveniles of some target species (*Diplodus cervinus, Epinephelus costae, E. marginatus and Mycteroperca rubra*) proves the potential of this biotope to recover these overfished species.

Potential threats: The infralittoral rock is threated by many anthropogenic impacts, such as sewage pollution (industrial and domestic), littoral development (building, ports), sediment filling and land reclamation. The impact of dynamite on the living resources must be taken into consideration, as well as the spearfishing of the target species (such as big Serranidae) and the loss of monofilament nets and traps ('ghost fishing').

Figure 102. Rocky massifs with the photophilic algae (*Padina, Amphiroa, Galaxaura*) and *Aplysina aerophoba*; foreground, the fish *Mycteroperca rubra*. Enfeh, 23 m depth (st. E-14)

Associated biocenosis:

- Part of the biocenosis of infralittoral algae (UMR III.6.1), corresponding to sheltered sciaphilic macroalgae.
- Coralligenous enclaves (UMR: IV.3.1).
- Interesting is the presence of submarine freshwater springs in the Ras El Bayada area.

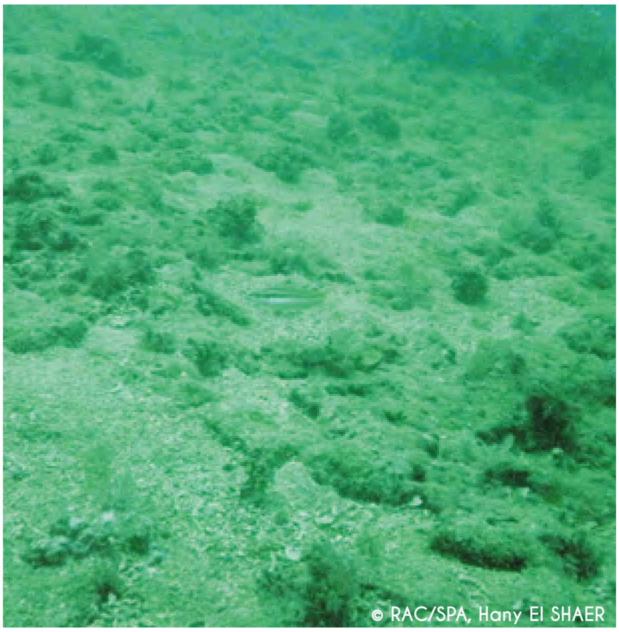


Figure 103. Middle infralittoral rock with *Galaxaura rugosa*, with coarse sand and shell gravel. Ras El Bayada, 12 m depth (st. N-2)

6.2.2.2.1 Sheltered photophilic algae (Fig. 104)

In the Lebanon area, it is difficult to establish associations and/or facies due to the important seasonal changes in the macroalgae assemblages, together with the deeper thermocline (48 m depth) and the herbivorous pressure (Siganidae, *Conomurex*). The width of this horizon depends of the hydrodynamism and illumination reaching a 28 m depth in the Ras Chekaa, Nakoura and Tyre areas. The macroalgae are dominant, but this is not always the rule.

Structure of the communities: The major part of the communities presents a middle and lower stratum. Whereas, the upper one has been very rare, only represented by *Cystoseira foeniculacea* in shallow biotopes (5-17 m depth) and *Axinella* sp. in deeper ones (18-29 m depth).

- **Middle stratum:** Mainly, with erect rhodophytes (*Jania longifurca, Amphiroa beauvoissi, Galaxaura rugosa*), ochrophytes (*Stypocaulon scoparium, Padina* spp. *Colpomenia sinuosa, Dictyota dichotoma*) and the chlorophyte *Codium parvulum*. Also, the sessile epifauna forms part of this middle stratum, such as the poriferans (*Aplysina aerophoba, Niphates toxifera, Petrosia ficiformis, Ircinia and Sarcotragus* spp.), polychaetes (*Sabellida* spp.), actiniarians (*Anemonia viridis,* *Aiptasia mutabilis*); bivalves (*Chama pacifica, Conomurex persicus, Pinctada imbricata, Malleus regulus*) and ascidians (*Phallusia nigra, Herdmania momus*).

- **Lower stratum:** With the encrusting corallinales (*Lithophyllum incrustans, Neogonioliton mamillosum*), the poriferans (*Crambe crambe, Phorbas topsenti, P. tenacior, Cliona* spp.), cirripeds (*Balanus trigonus, Perforatus perforatus*), bryozoans (*Schizoporella errata*) and ascidians (*Didemnidae* spp.) bryozoans.

- **Mobile fauna:** With the polychaete *Hermodice carunculata* (mainly in the Enfeh-Ras Chekaa area), the gastropods *Cerithium scabridum* (cc), *Conomurex persicus* (cc), *Ergalatax junionae* (c) *Fusinus verrucosus*, and fishes (*Chromis chromis, Diplodus* spp., *Thalassoma pavo, Sparisoma cretense, Siganus* spp., *Serranus scriba, S. cabrilla, Scorpaena maderensis, Torquigener flavimaculosus,* Blenniidae spp., *Gobiidae* spp, etc). The echinoderms are relatively rare (mainly in the Saida-Tyre- Nakoura area), such as the echinoids *Arbacia lixula* and *Paracentrotus lividus*; and the holothurians (*Holothuria tubulosa, H. forskali, H. impatiens*), only the lessepsian *Synaptula reciprocans* has been more frequent.

Facies and associations: Due to the complexity of the rocky substrata, the differences between zones (Enfeh-Ras Chekaa and Saida-Nakoura) and the sampling periods (late June, early September), it has been very difficult to establish the different associations (some of them as seasonal aspects). Nevertheless, some assemblages can be distinguished and others are probably new and specific to the Levantine infralittoral.

- Association with *Colpomenia sinuosa* (UMR: III.1.1.22), seasonal aspect;
- Association with *Stypocaulon scoparium* (UMR: III.6.1.23);
- Association with *Ganonema farinosum*, seasonal aspect;
- Association with *Cystoseira foeniculacea*;
- Association with erect Corallinales;
- Association with *Padina* spp., seasonal aspect;
- Association with *Galaxaura rugosa* and *Laurencia* sp.;
- Association with *Codium parvulum*;
- Facies with *Chama pacifica* and *Spondylus spinosus*.

The association with *Dictyopteris polyploides* (UMR: III.6.1.21) has not been observed, because it is present during late winter to spring.

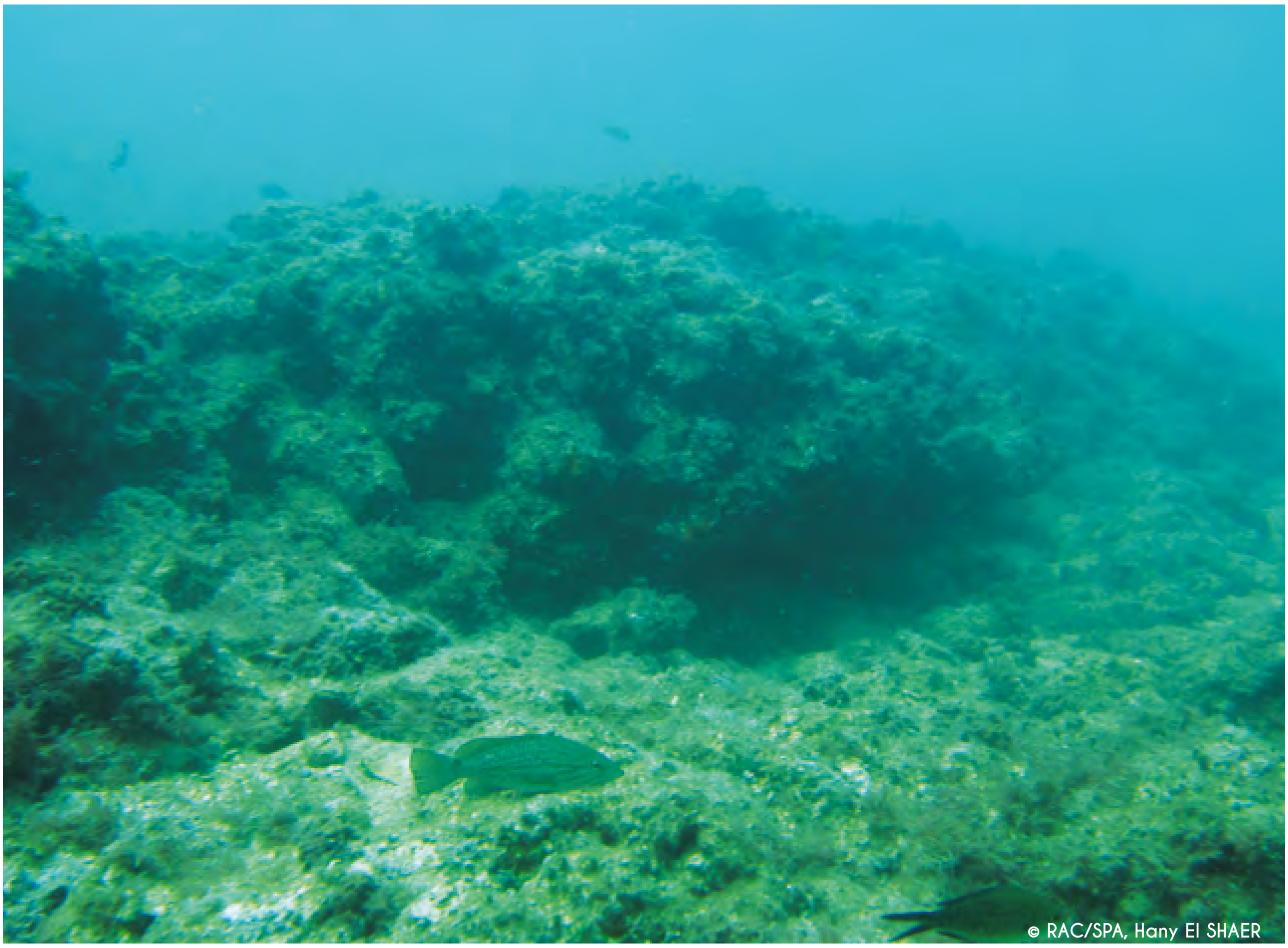


Figure 104. Middle infralittoral rock with the biocenosis of photophilic algae (*Galaxaura rugosa and Laurencia sp.*) with a juvenile of *Mycteroperca rubra*. Ras El Bayada, 14 m depth (st. N-2)

Figure 105. Association with *Colpomenia sunuosa*. Enfeh, 3 m depth (st. E-12)

Association with *Colpomenia sinuosa* (Fig. 105)

It represents a seasonal aspect of the infralittoral algae biocenosis in cold months (December to June), between 1 to 14 m depth.

Stations: Only observed in the northern sector in late June. Enfeh (E-1, E-6, E-11, E- 12, E-15) and Ras Chekaa (C-3).

Figure 106. Patches of *Stypocaulon scoparium* with *Lithophyllum incrustans* (Tyre northern inlets, station T-17)

Association with *Stypocaulon scoparium* (Fig. 106)

This ochrophyte seems to be common on the littoral rocks of the Enfeh and Ras Chekaa; but rare in the southern area, it has only been observed in the Saida and Tyre inlets. This association presents a patchy distribution in shallow waters (0-3 m depth); and it has not been frequent in the observed areas, particularly in the southern sector.

Stations: Enfeh (E-1, E-7, E-12, Ras Chekaa (C-3, C-10, C-11, C-23), Saida (S-1) and Tyre (T-17).

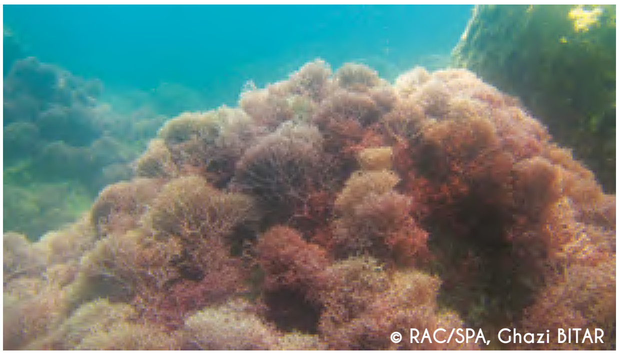


Figure 107. Association with *Ganonema farinosum*, Enfeh, 3 m depth (st. E-12)

Association with *Ganonema farinosum* (Fig. 107)

This species appears in warm months (June to September), forming gaudy masses between 1 to 3 m depth.

Stations: Only observed in the northern sector in late June. Enfeh (E-1, E-7, E-12, E- 12) and Ras Chekaa (C-3, C-11, C-23).

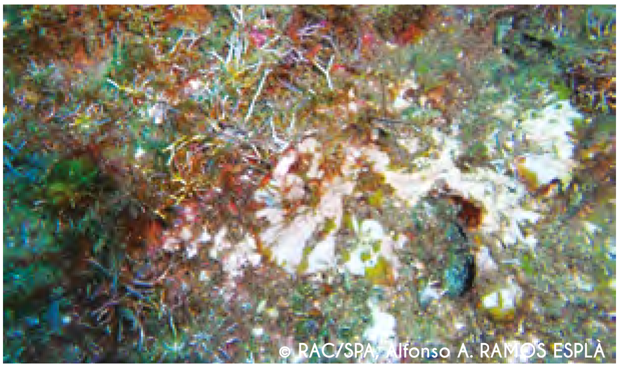


Figure 108. Association with corallinales: *Amphiroa* spp., *Jania* spp., and *Lithophyllum incrustans*. Ras El Bayada, 14 m depth (st. N-15)

Association with erect Corallinales (Fig. 108)

This association is spread along the whole area, although much more concentrated around the inlets, between 3 to 25 m depth. The main species are the ramified corallinales *Amphiroa rigida* (cc) and *Jania rubens* (cc), both replaced by *A. beauvoisii* and *J. longifurca* in deeper waters (from 15 m depth). Also, the encrusting Corallinales *Lithophyllum incrustans* (in shallow waters) and *Neogoniolithon mamillosum* (in deeper ones) are very common. In the Enfeh area, *Jania longifurca* develop dense grasses on rock, between 10-15 m depth (Fig. 109).

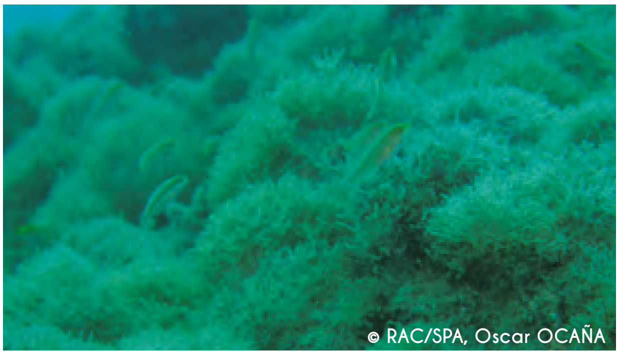


Figure 109. Dense mats of *Jania longifurca* with juveniles of *Sparisoma cretense*. Enfeh, 14 m depth (st. E-15)

Figure 110. Association with *Padina* spp. (mainly, *Padina boergenseni*), and the lessepsian fish *Torquigener flavimaculatum*. Enfeh, 24 m depth (st. E-14)

Figure 111. An empty shell near to an alive individual (down left) of *Chama pacifica*.
Ras el Bayada, 14 m depth (st. N-15)

The sponges *Crambe crambe*, *Aplysina aerophoba*, *Niphates toxifera* and *Ircinia* sp., and the bivalve *Spondylus spinosus* were the more common sessile fauna in this association. This association could be similar to the overgrazing facies with encrusting corallinales, due to the herbivorous pressure on soft algae by the siganids fishes and *Conomurex persicus*.

Stations: Enfeh (E-1, E-14, E-15), Ras Chekaa (C-3, C-10, C-11, C-14, C-16, C-17, C- 20), Saida (S-1, S-2), Tyre (T-1, T-2, T-5, T-6, T-12, T-15, T-19, T-22, T-23, T-24) and Nakoura (N-2, N-12, N-13, N-15, N-16).

Association with *Padina* spp. (Fig. 110)

This association has been observed in Enfeh and Ras Chekaa, between 21 to 28 m depth. The lessepsian *Padina boergenseni* is the prevailing species, although *P. pavonica* is also present. Other accompanied macroalgae have been the ochrophyte *Dictyota dichotoma* (c), and the corallinales *Jania corniculata* (r) and *Amphiroa beauvoissi* (r).

The poriferans (*Aplysina aerophoba, Petrosia ficiformis, Crambe crambe*) and the ascidians (*Didemnidae* spp.*, Herdmania momus*) are common.

Stations: Enfeh (E-9, E-11, E-14, E-15), Ras Chekaa (C-4, C-5, C-7, C-9), Saida (S-1, S-7), Tyre (T-4) and Nakoura (N-2, N-13, N-15). Although this association has been present in all of the areas, important populations of *Padina* spp. have been observed only in Enfeh.

Facies with *Chama pacifica* and *Spondylus spinosus* (Fig. 111)

Although these lessepsian bivalves can be present from 1 to 31 m depth, it is between 5 to 26 m depth where they could be prevailing on the bottoms. Those develop original facies, without comparison along the whole Mediterranean, with another lessepsian bivalve *Malleus regulus* (cc).

The heterogeneous substrata of the valves allow the growing of a high number of sessile organisms such as the algae (Ceramiales, Corallinales *as Amphiroa beauvoisii*), poriferans (*Crambe crambe, Phorbas tenacior, Petrosia ficiformis, Haliclona fulva, Sycon* sp.*, Niphates toxifera, Aplysina aerophoba, Ircina* sp.), hydrozoans (*Aglaophenia* spp.*, Eudendrium* spp.*, Macrorhynchia philippina, Pennaria disticha*), serpulids, cirripeds, etc. are fixed. Another common species are the encrusting bryozoans (*Schizoporella, Reptadeonella*) and ascidians (Didemnidae spp.).

Figure 112. The candlestick sponge (*Axinella sp.*) in the association *Chama-Spondylus*. Ras Chekaa, 25 m depth (st. C-16)

The facies is common on the sloping surfaces of the limestone massifs, between 8 to 27 m depth (as in Ras Chekaa and Enfeh). Also, it is common in the southern sector (Saida-Nakoura), forming small blocks attached on the flat rock (Nakoura and Saida). The erected sponge Axinella sp. is common (Fig. 112), especially in Ras Chekaa, between 23 to 27 m depth.

Stations: Enfeh (E-14, E-15), Ras Chekaa (st. C-10, C-14, C-16), Saida (S-1), Tyre (T- 1, T-10, T-12, T-15, T-19) and Nakoura (N-9, N-12, N-13, N-15, N-16).

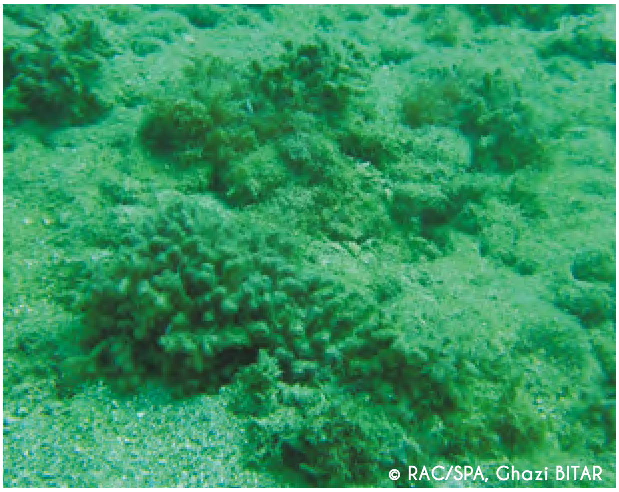


Figure 113. Association with *Glaxaura rugosa* and *Laurencia* sp. (Nakoura, station N-13)

Association with *Galaxaura rugosa* and *Laurencia* sp. (Fig. 113)

It is accompanied by the corallinales *Amphiroa* spp. and *Neogoniolithon sp.*; the poriferans *Axinella* sp. (c), *Crambe crambe* (cc) and *Ircinia* sp. (c); the hydroids *Macrorynchia philippina* (c), *Pennaria disticha* (c) and *Eudendrium* sp. (c); and the ascidian *Phallusia nigra*. As for the mobile fauna, the gastropod *Conomurex persicus* and the gobid fish *Gobius buchichii* are common.

Stations: Saida (S-1), Tyre (T-1, T-6, T-8, T-9, T-12, T-14, T-19, T-23) and Nakoura (N- 2, N-4, N-9, N-10, N-12, N-13, N-15, N-16). It has been very abundant in the Nakoura area, between 7-23m depth. Although, *G. rugosa* has been observed in Enfeh (E-1, E- 7, E-12, E-15) and Ras Chekaa (C-3, C-16, C-20), it does not form an association.

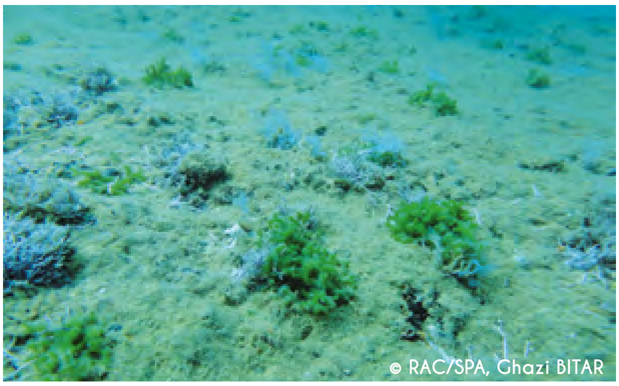


Figure 114. Association with *Codium parvulum* and *Amphiroa rigida*. Saida, 13 m depth (S-1)

Association with *Codium parvulum* (Fig. 114)

The lessepsian chlorophyte *Codium parvulum* colonizes stressed rocky habitats with a low number of sessile species and the presence of fine sediments. *Amphiroa rigida* (cc), *Schizoporella errata* (c) and *Phallusia nigra* (c) are escort species: This association is characteristic of the rocky bottoms around the Saida area, between 5-15 m depth.

Stations: Saida (S-1, S-2, S-6, S-7), Tyre (T-9, T-19) and Nakoura (N-4, N-12, N-13, N- 16). It has not been observed in the northern sector (Enfeh-Ras Chekaa).

Association with *Cystoseira* sp. (Fig. 115)

This interesting association was observed in some localities such as Nakoura (9-11 m depth) and the lagoon located behind the Tyre's northern inlets (7-9 m depth). Probably the *Cystoseira* sp. may be *C. foeniculacea* (= *C. discors*) cited by Bitar & Kouli-Bitar (2001). Rarely, the thali present secondary branches (herbivorous pressure) and the individuals are more or less isolated. Curiously, it was observed the fixation of the Cystoseira was observed fixed on cobbles in the lagoon, where they were moving due to the action of the waves. The epiphytes *Dictyota fasciola* and the hydroid *Pennaria disticha* were observed tangled on the thali.

Stations: Ras Chekaa (C-3, C-14), Saida (S-2, S-6, S-7), Tyre (T-2, T-5, T-9, T-14, T- 15, T-22, T-24) and Nakoura (N-4, N-9)

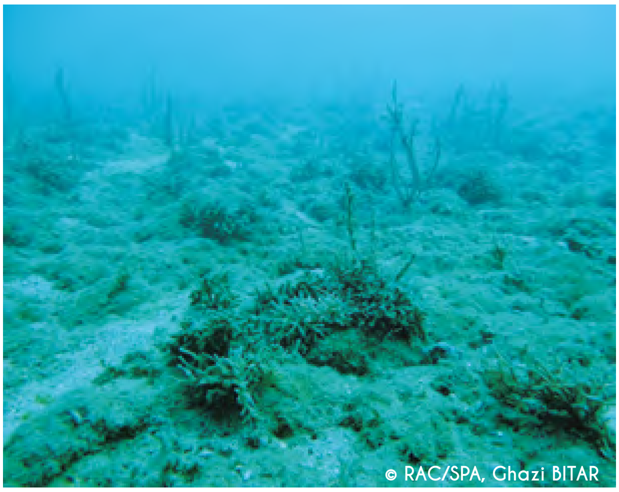


Figure 115. Association with *Cystoseira* cf. *foeniculacea*. in Nakoura, 11 m depth (st. N-9, left); and Tyre lagoon, 7 m depth (st. T-22, right)

6.2.2.2.2 Sheltered sciaphilic algae

The sheltered sciaphilic algae community is well developed in the area, but with the predominance of the *Peyssonnelia* spp. and *Lobophora variegata*. *Flabellia petiolata* is very rare and located in deep bottoms, and we have not observed *Halimeda tuna*. It appears in shallow infralittoral enclaves (shadow surfaces: crevices, vertical walls, overhangs) and deep infralitoral rocky surfaces (from 26 m depth).

Structure of the community:

- **Medium stratum:** Some geniculated corallinales such as *Amphiroa beauvoisii* (cc) and *Jania longifurca* (c) dominate this stratum, with the gelidial *Gelidium bipectinatum* (c), the ochrophyte *Stypopodium schimperi* (c) and the chlorophyte *Cladophora pellucida* (r). The massive poriferans are not abundant, with *Petrosia ficiformis* (c), *Ircinia variabilis* (c) and *Spongia officinalis* (r); on the other hand, the lessepsian bivalve *Malleus regula* and the solitary ascidian *Herdmania momus* are frequent.

- **Lower stratum:** It is dominated by the encrusting corallinales *Mesophyllum* sp. (c) and *Neogoniolithon mamillosum* (c), and *Peyssonnelia* spp. (cc); with the ochrophyte *Lobophora variegata* (c). The encrusting poriferans (*Crambe crambe, Phorbas topsenti, Cliona parenzani, Lyosina blastifera*) and ascidians (Didemnidae spp.) are frequent.

- **Mobile fauna:** The polychaete *Hermodice carunculata* is common (particularly, in the northern sector, however it is rare in the southern one); some crustacean decapods such as *Charybdis helleri* (c), *Atergatis roseus* (c) and *Calcinus ornatus* (c); the holothurian *Holothuria sanctori* (r). The fishes *Pempheris vanicolensis* (cc), *Sargocentron rubrum* (cc), *Scorpaena maderensis* (c) and *Tripterygion minor* (c).

Facies and associations

- Association with *Lobophora variegata* (UMR: III.6.1.12)
- Association with *Peyssonnelia* spp. (UMR: III.6.1.34)

Association with *Lobophora variegata* (Fig. 116)

The ochrophyta *Lobophora variegata* dominate some hemi-photophilic and sciaphilic rocky surfaces, between 2 to 18 m depth, with the corallinales *Jania longifurca* (c) and *Amphiroa beauvoisii* (c), and gelidial *Gelidium bipectinatum* (c).

Stations: Enfeh (E-1, E-14, E-15), Ras Chekaa (C-10, C-16), Tyre (T-1, T-5, T-6, T-15, T-22, T-23) and Nakoura (N-2, N-3, N-10, N-15, N-16).

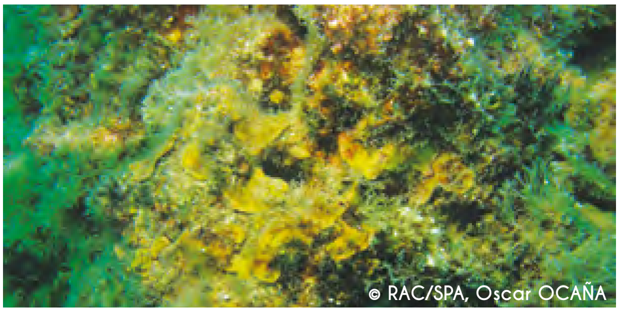


Figure 116. Association with *Lobophora variegata* accompanied by *Jania longifurca*. Enfeh, 14 m depth (st. E-15).

Association with *Peyssonnelia* spp. (Fig. 117)

This association is well developed on sciaphilic rock (as far as 35 m depth in horizontal surfaces). The main algae are the rhodophytes *Peyssonnelia* spp. (cc) (*P. squamaria* and *P. rubra*). As for to the sessile fauna, the poriferans are frequent such as *Crambe crambe* (cc), *Chondrosia reniformis* (c), *Petrosia ficiformis* (cc), *Ircinia* sp. (c), and the ascidians Didemnidae spp. (c) and *Phallusia nigra* (c).

Stations: Enfeh (E-1, E-7, E-14, E-15), Ras Chekaa (C-14, C-15, C-16, C-17, C-20, C- 21), Raoucheh (R-1), Tyre (T-1, T-4, T-5, T-11, T-19, T-22, T-24), Nakoura (N-2, N-4, N-9, N-10, N-12, N-16).

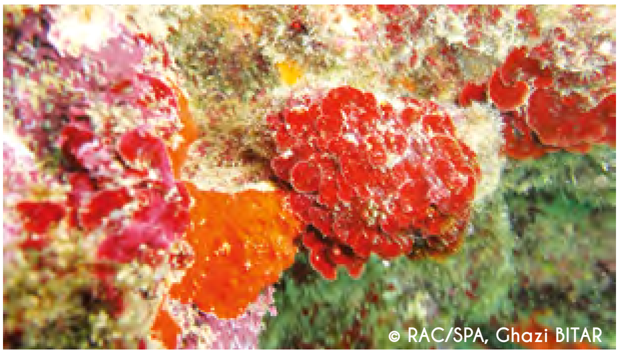


Figure 117. Sciaphilic community with *Peyssonnelia* spp. and the sponge *Crambe crambe*. Northern inlets of Tyre, 3 m depth (st. T-20)

6.2.2.3 Lower horizon of the infralittoral rock

Biotope: The dominant rock profile in all studied zones has been flat, with coarse sand and gravel patches and channels. The sciaphilic species dominate on horizontal surfaces due to the light absorption (Fig. 118); and the bottom current is moderate. The presence of vertical surfaces and overhangs favours the coralligenous community. The bathymetric range varies from 28 to 44 m depth.

Conservation interest: There are some species of conservation interest, mainly the ochrophytes *Cystoseira dubia* and *Sargassum trichocarpum* (protected by the Barcelona Convention) in the Ras Chekaa area; with the candlestick sponge *Axinella* sp. Moreover, the presence of small adults of some target species (*Epinephelus costae, E. marginatus* and *Mycteroperca rubra*) proves the potential of this biotope to help with the recovery of these overfished species.

Potential threats: The lower infralittoral rock is threated by sediment filling. The high impact of dynamite on the living resources must also be considered; the spearfishing on some target species (such as the big Serranidae); and the loss of monofilament nets and traps ('ghost fishing').

Figure 118. Lower infralittoral rock with *Axinella polypoides*. Nakoura, 35 m depth (st. N-11)

Associated biocenosis:

- Part of the biocenosis of infralittoral algae (UMC III.6.1), corresponding to shelter photophilic and sciaphilic macroalgae;
- Coralligenous infralittoral enclaves (UMR: IV.3.1).

6.2.2.3.1 Biocenosis of sheltered sciaphilic algae

This assemblage appears on horizontal surfaces at 28 m depth, and it reaches the circalittoral communities at a depth of about 44 m (Fig. 119). The profile of the rock is flat with gravel channels/patches and/or small boulders, cobbles and pebbles. In these gravel patches, the rhodolites are present from a depth of 32 m depth.

Structure of the communities: There are some differences between the northern and southern sectors, maybe to the seasonal period of sampling (early vs. late summer). In Ras Chekaa, the sciaphilic deep community is dominated by ochrophytes (*Arthrocladia villosa, Cystoseira dubia, Sargassum trichocarpum, Sporochnus pedundulatus*) and rhodophytes (Halymeniales, Rhodymeniales Gelidiales spp.). Whereas, in the southern sector, the encrusting rhodophytes (*Neogoniolithon, Mesophyllum, Peyssonnelia* spp.) with *Axinella* sp. are dominant. Perhaps, *A. villosa* represents a seasonal aspect, which disappears during the summer period.

- **Upper stratum:** In the northern sector (Enfeh-Ras Chekaa), the ochrophyte *Arthrocladia villosa* (cc), with *Cystoseira dubia* (r), *Sargassum trichocarpum* (r) and *Sporochnus pedunculatum* (r), forms an upper stratum. Whereas this one does not appear on the southern sector, where *Axinella* sp. and *Eudendrium* sp. are the mainly erect species, but they are very sparse and does form a typical facies.

- **Middle stratum:** Formed by ochrophytes *Dictyota dichotoma* (c), *Padina pavonica* (cc), *Stypopodium schimperi* (r); rhodophytes *Amphiroa* spp. (*A. beauvoisii, A, cryptarthrodia*) (c), *Rhodymenia ardissonei* (c), *Galaxaura rugosa* (r), *halimeniales* (c) (*Halymenia floresia, H. latifolia*), *Scinaia furcellata* (r); and the chlorophyte *Codium parvulum* (r). The massive poriferans are rare, such as *Haliclona mediterranea* (r), *Petrosia ficiformis* (r), *Agelas oroides* (r) and *Niphates toxifera* (r); on the contrary, the hydrozoans (*Aglaophenia* sp.) and the ascidia *Hermania momus* are common.

- **Lower stratum:** With the rhodophytes *Peyssonnelia* spp. (cc), *Neogoniolithon mamillosum* (c), *Mesophyllum alternans* (c), *Gelidium bipectinatum* (c) and *Botryocladia botryoides* (r); and the ochrophyte *Lobophora variegata*. The poriferans *Crambe crambe*, *Sycon* sp., *Phorbas topsenti*, *Haliclona fulva* and *Cliona viridis*, also, the Didemnidae spp. are the more common species. Some shallower species are present in this association, such as *Spirobranchus lamarcki* (c), *Balanus trigonus* (c), *Malleus regula* (c) and *Chama pacifica* (r).

- **Mobile fauna:** The gastropods prosobranchia, as *Goniobranchus annulatus*, and the decapod crustaceans (*Pilumnus hirtellus*) are rare; as well as, the echinoderms *Echinaster sepositus* and *Synaptula recoprocans*. Within the fishes, *Boops boops* (cc), *Chromis chromis* (c), *Coris julis* (c), *Sargocentron rubrum* (cc), *Serranus cabrilla* (c), *Sparisoma cretense* (c) and *Torquigener flavimaculosus* (c). Some more littoral species such as *Diplodus sargus* (r), *Serranus scriba* (r), *Siganus luridus* (r) and *Thalassoma pavo* (c) can reach these depths.

Facies and associations

- Association with *Arthrocladia villosa* (UMR: IV.2.2.4);
- Association with encrusting corallinales.

Figure 119. Sciaphilic algae (*Mesophyllum alternans* and *Peyssonnelia* spp.), with poriferans (*Crambe crambe*), hydrozoans (*Eudendrium* sp.) and ascidians (*Herdmania momus*). Nakoura, 35 m depth (st. N-11)

Association with *Arthrocladia villosa* (Fig. 120)

This association is included in the circalittoral stage on coastal detritic communities (UMR: IV.2.2.4) under relatively high bottom currents. Nevertheless, in the Ras Chekaa area, apart from the gravel and pebbles, it also develops on flat rocky substrata, accompanied by another erected ochropytes, such as *Cystoseira dubia* (r), *Sargassum trichocarpum* (r) and *Sporochnus pedunculatus* (r); in the middle stratum, *Dictyota dichotoma* (c), *Padina pavonica* (r) and *Stypopodium schimperi* (r) are frequent in the Ras Chekaa sector, between 27 to 42 m depth.

Stations: Enfeh (E-5) and Ras Chekaa (C-4, C-5, C-6, C-7, C-8, C-21).

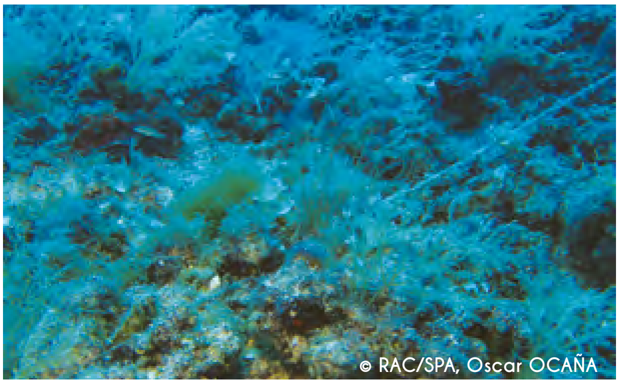


Figure 120. Association with *Arthrocladia villosa*. Ras Chekaa, 33 m depth (st. C-21)

Association with encrusting corallinales (Fig. 121)

In deeper rocky infralittoral habitats (26 to 35 m depth) the encrusting rhodophyte are dominant with the species *Mesophyllum* spp. *Neogoniolithon* spp., and *Peyssonnelia* spp.; and the erect *Amphiroa cryptarthrodia* and the ochrophyta *Stipopodium schimperi*. The poriferans are abundant, particularly the species of the Axinellidae family (*Axinella polyploides, Axinella* sp., *Crambe crambe*). Interesting is the presence of more littoral species such as *Pennaria disticha*, *Macrorhynchia philippina* and *Phallusia nigra* in the proximity of the cold water springs (station T-21, at 38 m depth).

Stations: Ras Chekaa (C-19), Raoucheh (R-1), Saida (S-5), Tyre (T-7, T-8, T-21, T-25) and Nakoura (N-4, N-5, N-6, N-8).

Figure 121. Macroalgae on deep rock, such as *Mesophyllum alternans* (rose patches) and *Codium parvulum* (green) with the poriferan *Axinella polyploides*. Nakoura, 35 m depth st. N-11)

6.2.3 Upper circalittoral rock

Biotope: Apart from the coralligenous infralittoral enclaves (overhangs, caves entrances) and caves, the circalitoral rocky bottoms have been rare between 44 to 47 m depth (maximum depth in the present study) on vertical surfaces in the Tyre area (Fig. 122). The dominant rock profile in all studied zones has been flat, with coarse sand and gravel patches and channels. The sciaphilic species dominate on horizontal surfaces due to the light absorption; and the bottom current is moderate. The presence of vertical surfaces and overhangs favours the coralligenous community. The bathymetric range varies from 28 to 42 m depth.

Conservation interest: The coralligenous and cave communities are considered as priority habitats under protection (Barcelona Convention, European Union Habitat Directive), due to the high fragility because of the human impacts.

Potential threats: The coralligenous and caves communities are very fragile to human impacts, mainly the mechanical impacts by non-trained scuba divers (erosion by flippers, rubbing), and boat anchoring on the rock. Also, the erosion produced by the fixed nets that pull up the candle sponges and madreporarians; the spearfishing with tanks on some target species (such as big Serranidae); and the collection of some vulnerable species (sponges, anthozoans) as 'souvenirs'.

Associated biocenosis:

- Coralligenous (UMR: IV.3.1)
- Semi-dark cave (UMR: IV.3.2).

Figure 122. Coralligenous community with *Axinella polypoides*. Tyre, 43 m depth (st. T-21)

6.2.3.1 Biocenosis of the 'coralligenous'

The biocenoses on circalittoral hard substrata are the coralligenous and the semi-dark caves. Both appear in high sciaphilic enclaves in shallow waters (overhangs, caves entrances, crevices), on vertical surfaces at 32 m depth and horizontal ones from 43 m depth (Fig. 123).

Structure of the community: The coralligenous represent the most complex community on the Mediterranean. There are various strata (upper, middle, lower, epibiosis) with a diverse biota. Nevertheless, typical associations and facies described for the Mediterranean are not present in Lebanon, except the association with *Cystoseira dubia*.

- **Upper stratum:** The more apparent species in the coralligenous community from Lebanon is the candlestick sponges *Axinella polyploides*, *Axinella dissimilis* and *Axinella* sp. The ochrophyte *C. dubia* is very sparse to form small 'forests'; also, *Arthrocladia villosa* and *Sporochnus pedunculatus*, from the lower infralittoral rock, are present in the coralligenous.

- **Middle stratum:** Many erect rhodophytes form the middle stratum with massive poriferans, large hydrozoans, anthozoans, erect bryozoans and solitary ascidians. Within the rhodophyta, there are some Ceramiales (*Acrosorium* sp.), Rhodymeniales (*Rodymenia ardissonei*), Gelidiales (*Gigartina bipictinatum*) and Halymeniales (*Halymenia floresia, H. latifolia, Cryptonemia cf. lomation*); and the ochrophyta *Dictyota dichotoma* and *Stypopodium schimperi*.

With regard to the epifauna, the massive poriferans are rare with *Agelas oroides*, *Acanthella acuta*, *Corticium candelabrum*, *Cymbaxinella damicornis*, *Dysidea avara Haliclona mediterranea* and *Petrosia ficiformis*. In the same way, the erect bryozoans *Adeonella pallasii*, *Caberea boryi* and *Reteporella* sp. have been rare. However, the large hydrozoans *Aglaophenia* and *Eudendrium* spp., the anthozoans *Madracis phaerensis* and *Phyllangia americana mouchezii*, the polychaete *Filograna* sp. and the solitary ascidian *Hermania momus* are common. The lessepsian bivalves *Chama pacifica*, *Malleus regula* and *Spondylus spinosus* are present, but they are rare.

- **Lower stratum:** With the rhodophytes *Lithophyllum stictaeforme* (cc), *Mespohyllum alternans* (c), *Peyssonnelia* spp. (cc) and *Botryocladia botryoides*. The encrusting poriferans *Crambe crambe* (cc), *Haliclona fulva* (c), *Spirastrella cunctatrix* (r) and *Phorbas tenacior* (r); bryozoans (*Schizomavella* spp.) and the ascidians Didemnidae spp. (cc) and *Cystodytes dellechiajei* (cc).

- **Mobile fauna:** Within the polychaete *Hermodice carunculata* (r), the gastropod *Conomurex persicus* (r), the decapod crustacean *Pilumnus hirtellus* (c), and the asteroids *Echinaster sepositus* (r) and *Coscinasterias tenuispina* (r). The fishes are more abundant, with *Coris julis* (cc), *Sargocentron rubrum* (cc), *Serranus cabrilla* (c), *Gobius vittatus* (c) and *Scorpaena maderensis* (c). Some infralittoral species are present, such as *Chromis chromis* (c), *Sparisoma cretense* (c), *Siganus luridus* (c), *Torquigener flavimaculosus* (c) and *Thalassoma pavo* (r).

Facies and associations :

- Coralligenous in infralittoral enclaves (UMR: III. 6. 1. 35).
- Association with *Cystoseira dubia* (UMR: IV. 3. 1. 3).
- Facies with *Axinella* spp.
- Coralligenous on blocks (platforms) (UMR: IV.1.15)

Figure 123. The anthozoan *Phyllangia americana mouchezii*, with poriferans (*Axinella, Crambe*) and hydrozoans. Tyre, 44 m depth (st. T-21)

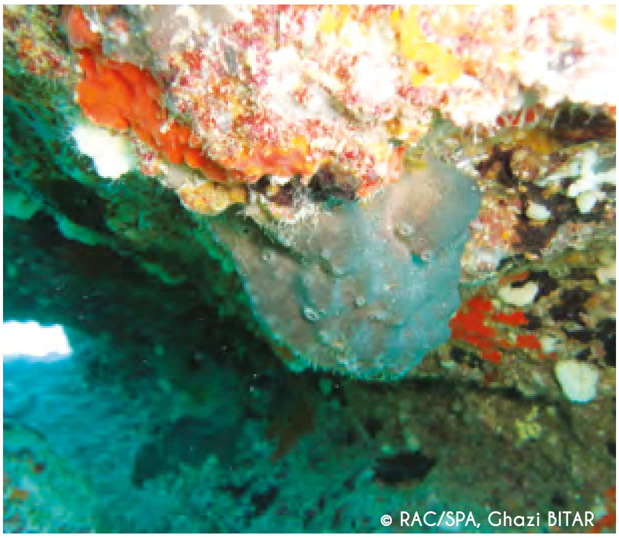


Figure 124. Coralligenous enclave in the infralittoral rock, with the poriferans *Spongia* sp., *Crambe crambe* and *Clathrina* spp. Tyre, 3 m depth (st. T-2)

Coralligenous in infralittoral enclaves (Fig. 124)

In the infralittoral enclaves of this community (overhangs, cave entrances, crevices), there is the littoral rocky coralligenous community with encrusting calcareous algae (*Lithophyllum stictaeforme* (r), *Mesophyllum alternans* (c), *Neogoniolithon mamillosum* (c)) and *Peyssonnelia* spp. (cc); also, the chlorophyte *Palmophyllum crassum* (r).

The sessile fauna is dominated by the poriferans *Crambe crambe*, *Chondrosia reniformis* and *Clathrina* sp.; the hydrozoan *Aglaophenia* spp.; the bryozoans *Schyzoporella* and *Reptadeonella* spp.; the ascidians Didemnidae spp. and *Herdmania momus*. The mobile fauna is represented by the fish: *Sargocentrum rubrum* (cc), *Pempheris vanicolensis* (cc) and *Trypterygion minor* (r).

Stations: Enfeh (E-1, E-12), Ras Chekaa (C-10, C-14, C-19, C-20), Raoucheh (R-1), Tyre (T-2) and Nakoura (N-3, N-10).

Figure 125. *Cystoseira dubia* and *Sporochnus pedunculatus* with the goby *Gobius kolonvatovici*. Ras Chekaa, 44 m depth (st. C-18)

Association with *Cystoseira dubia* (Fig. 125)

This association has been observed in Ras Chekaa on some flat rocky outcrops surrounded by coastal detritic bottoms with rhodoliths (maerl facies), between 43-44 m depth. Other accompanying ochrophyta species have been observed *Arthrocladia villosa* and *Sporochnus pedunculatus*, normally on pebbles.

Stations: Ras Chekaa, between 43-44m depth (C-15, C-18).

Figure 126. Coralligenous community on rocky substratum with the sponges *Axinella polyploides* (yellow) and *Crambe crambe* (red); a colony of *Phyllangia americana mouchezii* (white polyps). Tyre, 43 m depth (st. T-21)

Facies with *Axinellidae* spp. (Figs. 126, 127)

This association is present in the high rocky outcrops from northern Tyre, quite near of the cold water springs, where the candlestick *Axinella polypoides* is common between 40-42 m depth.

The sessile fauna is abundant with the other poriferans *Crambe crambe* (cc), *Dysidea avara* (r), *Oscarella lobularis* (r) and *Haliclona fulva* (c); the hydrozoan *Eudendrium glomeratum*; the sclerantinians *Phyllangia americana mouchezii* (cc) and *Madracis phaerensis* (c); and the ascidians *Cystodytes dellechiajei* (cc), Didemnidae spp. (cc) and *Herdmania momus* (c).

Station: Tyre, between 41-47 m on vertical surfaces (T-25).

Another interesting facies with *Axinellidae* spp. is located at the entrance of the Chack El Hatab cave. Here there is a *Cymbaxinella* sp. (Fig. 127).

Station: Ras Chekaa (C-19).

Coralligenous on blocks (platforms) (Fig. 127).

On the flat rock from Nakoura, between 44-45 m, there are small boulders (ø = 30-50 cm) covered by encrusting calcareous rhodophytes (*Lithophyllum stictaeforme, Mesophyllum alternans, Neogoniolithon* sp.), poriferans *(Crambe crambe, Phorbas tenacior, Spirastrella cunctatrix*); bryozoans (*Frondipora verrucosa, Schizomavella* spp.) and ascidians (Didemnidae spp., *Cystodytes dellechiajei*).

These blocks are surrounded by gravel and coarse sand with rhodoliths (maerl facies). Noteworthy is the abundance of an ochrophyte *Lobophora* sp. (M. Verlaque's *pers. com.*) on the top of these blocks.

We do not think that these blocks must be coralligenous platforms, due to the depth (the coralligenous on subhorizontal surfaces appears from 43 m depth in the prospected areas), but rather, rocky boulders cover by encrusting organisms.

Station: Nakoura, between 43-44 m depth (N-14).

Figure 127. Population of *Cymbaxinella* sp. in the entrance of the Chack El Hatab cave, 4 m depth (st. C-19)

6.2.3.2 Biocenosis of the semi-dark caves (Figs. 129, 130, 131)

This biocenosis has been observed between 0 to 5 m depth in Enfeh, Ras Chekaa, the Raoucheh tunnel and Ras El Bayada. The entrance of the caves is colonized by an impoverished coralligenous community (except in the Chack El Hatab cave) the encrusting algae *Mesophyllum* sp. (c), *Lithophyllum stictaeforme* (c), *Peyssonnelia* spp (cc) and *Palmophyllum crassum* (r).

Structure of the community:

- **Medium stratum:** With the massive sponges *Chondrosia reniformis* (cc), *Petrosia ficiformis* (c), *Myrmekioderma spelaeum* (c), *Euryspongia raouchensis* (c) and *Clathrina* spp.; (*C. coriacea, C. cf. clathrus, C.* cf. *lacunosa*); the scleractinian *Phyllangia americana mouchezii* (c) and the actinian *Telmatactis cricoides* (r); some specimens of *Chama pacifica* (r); the bryozoan *Margaretta cereoides* (cc); and the ascidians *Herdmania momus* (c), *Phallusia nigra* (c) and *Pyura dura* (r).

Figure 128. Coralligenous concretion blocks with poriferans (*Crambe, Mycale*) and ascidians (*Cystodytes, Didemnum*) (Nakoura, station N-14)

- **Lower stratum:** With the encrusting species *Aplysina* sp. (cc), *Crambe crambe* (c), *Haliclona fulva* (c), *Sycon* sp. (c), *Diplastrella* spp. (r), *Hexadella racovitzai* (r); the madreporarian *Phyllangia mouchezii* (cc); the bryozoans *Schizoretepora hassi* (c), *Cellaria, Crisia* and *Scrupocellaria* spp. (c), and the ascidians Didemnidae spp., *Symplegma brakenhielmi* (r) and *Cystodytes dellechiajei* (cc).

- **Mobile fauna:** With the polychaete *Hermodice carunculata* (c); the decapodes *Charybdis helleri* (c) and Galatheidae sp. (r), The observed fishes have been: *Pempheris vanicolensis* (cc), *Sargocentrum rubrum* (cc), *Apogon imberbis* (r) and *Tripterygion minor* (r).

Noteworthy is the original and rich sessile fauna of Lebanon's caves, particularly in the Chack El Hatab and

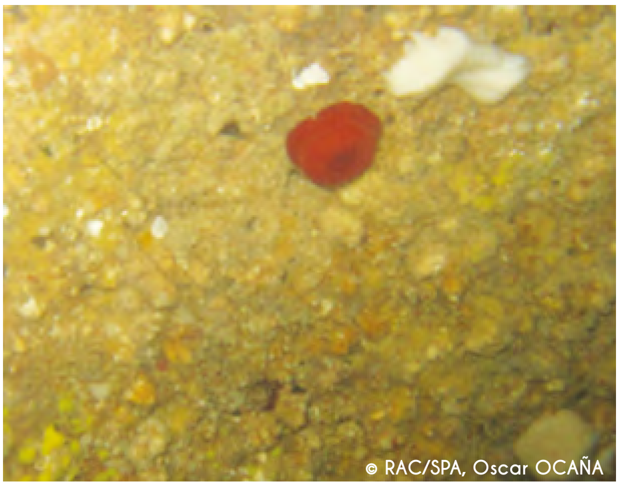


Figure 129. Semi-dark cave habitat with *Actinia schmidti* (red), *Chondrosia reniformis* (white) and *Aplysina* sp. (yellow). Ras El Bayada, 2 m depth (st. N- 10)

Raoucheh. The first one presents some interesting endemics sponges, such as the lithistid *Microscleroderma lamina* and *Gastrophanella phoeniciensis* (Fig. 130).

Figure 130. The endemic sponge from Lebanon *Microcleroderma lamina* in the inner of the Chack El Hatab cave. Ras Chekaa, 2 m depth (st. C-19)

As for Raoucheh's tunnel (fig. 131), the diversity of poriferans (*Aplysina, Chondrosia, Cliona, Crambe, Clathrina, Diplastella, Disporella, Euryspongia, Gastrophanella, Haliclona, Hexadella, Ircinia, paraleucilla, Petrosia, Phorbas, Spongia, Sycon* spp.) and ascidians (*Aplidium, Botrylloides, Cystodytes, Didemnum, Diplosoma, Hedmania, Phallusia, Polysyncraton, Pseudodistoma, Pyura, Symplegma*) is very high.

This cave perhaps represents one of the richest filter-feeding communities in the Levantine coast, due to the strong currents and high abundance of organic matter.

Stations: Enfeh (E-1, E-12), Ras Chekaa (C-10, C-14, C-19, C-20), Raoucheh (R-1), Tyre (T-2) and Nakoura (N-3, N-10).

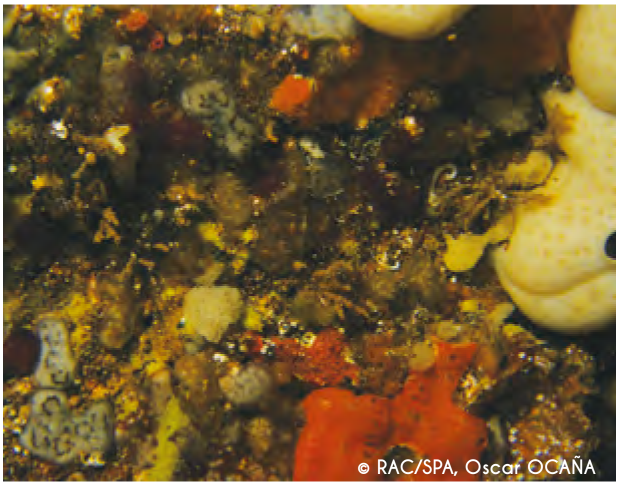


Figure 131. Ascidian community (*Pseudodistoma, Cystodytes, Didemnum, Pyura, Symplegma* spp.) in the Raoucheh tunnel, -2 m depth (st. R-1)

6.2.3.3 Biocenosis of the caves and ducts in total darkness (in enclave in the upper stages) (Fig. 132)

Only observed in the inner part of the Chack El Hatab cave, where the illumination is absent and freshwater springs are present.

Structure of the community: It is Only present on the lower stratum with *Serpulidae* spp. (cc) and *Madracis phaerensis* (c).

Facies and associations: None

Station: Ras Chekaa (C-19).

Figure 132. Inside of the Chack El Hatab cave in the total darkness with *Serpulidae* spp. and *Madracis phaerensis* (st. C-19)

6.2.4 Submarine cold and hot freshwater springs

The submarine cold and hot fresh water springs are very interesting due to their rarity and organisms adaptations around them. We have had the opportunity to dive in these underwater features in Ras El Bayada and Tyre.

Cold freshwater springs (Fig. 133, 134):

They have been located in front of the Ras El Bayada (12 to 15 m depth) and Tyre (32-40 m depth). Around the cold water springs, one deep red Cyanobacteria dominates (*Oscillatoria* sp.) and cover some organisms such as the poriferan *Phorbas topsenti*.

In Ras El Bayada (Fig. 133), some encrusting species such as rhodophytes (*Peyssonnelia spp.* and *Lithophyllum* spp.) and the poriferan *Crambe crambe* and *Chondrilla nucula* are abundant. Also, the hydroids *Macrorynchia philippina* (cc) and *Pennaria disticha* (cc) with the ascidian *Phallusia fumigata* (c).

Figure 133. Cold freshwater spring in Ras El Bayada (14 m depth, st N-15) with Cyanobacteria, encrusting rhodophytes, poriferans (*Crambe*), and some colonies of hydroids (*Pennaria*).

In Tyre, a deeper station (Fig. 134), it is noteworthy the abundance of the shallower species around the springs, such as the hydrozoan *Pennaria disticha* and the ascidian *Phallusia nigra*. Other common species were *Crambe crambe*, *Eudendrium* spp., *Chama pacifica* and *Spondylus spinosus*.

Stations: Ras El Bayada (N-15) and Tyre (T-21).

Figure 134. Cold freshwater spring in Tyre (40 m depth, st. T-21) with *Pennaria disticha, Crambe crambe, Chama pacifica* and *Plallusia nigra*

Hot-water springs (Fig. 135)

Located in the north of Tyre, between 38-42 m depth. The colonies of the bacteria Beggiatoa are characteristic and they growth quite near to the hot spring hole. The biodiversity around the hot springs is poorer than that of the cold water ones, dominating the encrusting rhodophytes.

Around the spring an impoverished community of sciaphilic algae is present with rhodophytes (*Ceramiales, Peyssonnelia* spp., *Amphiroa beauvoisii*), ochrophytes (*Stypopodium schimperi*), poriferans (*Petrosia ficiformis*), hydrozoans (*Aglaophenia* and *Eudendrium* spp.) and ascidians (*Cystodytes dellechiajei*).

Station: Tyre (T-25).

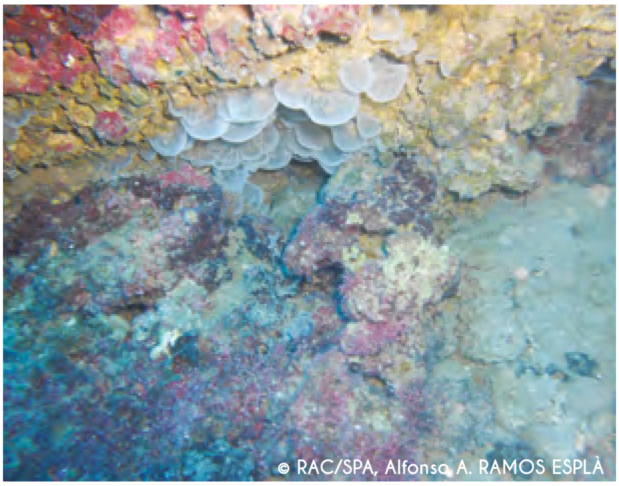


Figure 135. Hot water spring with *Beggiatoa* bacterial colonies (white semicircles). Around some encrusting rhodophytes (Tyre, station T-25)

6.3 Soft substrata

The soft substrata are the dominant around the areas, from 0 m in the littoral sand beaches to deeper muddy sand bottoms (at 50 m depth). The granulometry has been very varied: cobbles, pebbles, gravel, sand (coarse, fine) and mud. The more predominant sediments have been: well sorted sand in shallow waters (0-15 m depth); coarse and shell gravel (8-32 m depth); maerl beds (32-47 m depth); and muddy sand (15-50 m deph).

6.3.1 Infralittoral soft bottoms

Biotope: In shallow waters (< 15 m) the well sorted sand is frequent, particularly from the littoral beaches (Chekaa, north and south of Tyre). The wave action procures clean sandy bottoms without mud, from 0 to 15 m depth; then, the mud fraction increases to 50 m depth (maximum isobath reached in the present study). In rocky shore areas, the coarse sand and fine shell gravel bottoms are the dominant, normally forming patches and channels in the rocky substratum. Although the separation in the infralittoral and circalittoral soft substrata communities is not clear, we have considered the presence of deep maerl beds (from 32-33 m depth) as the limit of these stages.

Conservation interest: From the conservation point of view, there is one community of special interest, the *Cymodocea* *nodosa* meadows (Barcelona Convention, Fig. 136). At present,this community is becoming rare in Lebanon. The causes are not elucidated, but the competition with another magnoliophyte *Halophila stipulacea* (lessepsian species), together with the increasing temperature and anthropic impacts may be some possible causes of this rarefaction.

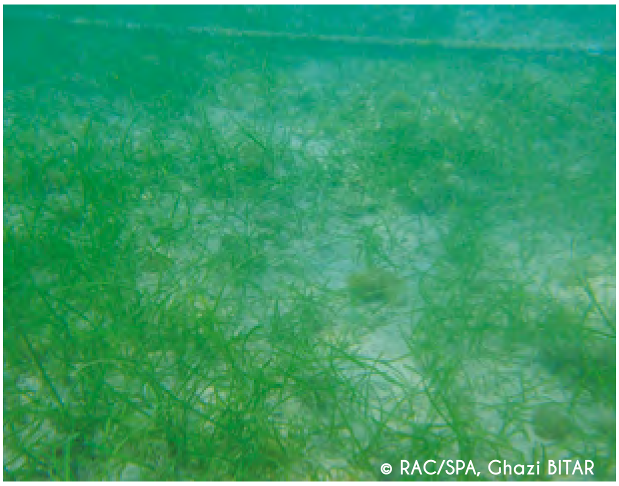


Figure 136. *Cymodocea nodosa* meadow establishes on fine sand. Enfeh, 2 m depth (st. E-2)

Nevertheless, *Halophila stipulacea* has been absent in the 2012 and 2013 missions, and only was observed in Selaata (in 2004 at 30 m depth).

Potential threats: The *Cymodocea* meadows are subject to various threats. One of the more important ones is the hyper-sedimentation from sediment discharge (e.g. Selaata harbour; concrete factories). Other impacts could be related to untreated domestic waters and littoral constructions (such as marinas, ports, beach replenishment, littoral gains).

Associated biocenosis:

- Biocenosis of well sorted sand (UMR: III.2.2).
- Biocenosis of muddy sand (UMR: III.3.).
- Coarse sands and gravels, under the influence of bottom currents (UMR: III.3.2).

6.3.1.1 Biocenosis of well sorted fine sands (Fig. 137)

The biocenosis of well sorted fine sand is developed from the open beaches, mainly in Enfeh-Chekaa and Tyre, between 0 to 15 m depth.

Structure of the community: The upper stratum with *Cymodocea nodosa* in some shallow locations, 1-3 m depth. As for the middle and lower strata, it is only represented by Cerianthidae sp. (r).

- **Infauna:** Mainly with the bivalves *Acanthocardia tuberculata* (cc), *Glycymeris* spp. (cc), *Mactra stultorum* (c), *Gafrarium savignyi* (c); and the echinoidea, *Echinocardium mediterraneum* (c).

- **Mobile fauna:** With the decapod *Diogenes pugilator* (cc); the gastropodes *Rhinoclavis kochi* (c), *Conomurex persicus* (c), *Nassarius reticulatus* (c) and *N. mutabilis* (c); the holothurian *Holothuria tubulosa* (r); and the fishes *Lithognathus mormyrus* (c), *Mullus surmuletus* (r), *Bothus podas, Xyrichthys novacula, Pomatoschistus* sp. (c).

facies and association:

- Association with *Cymodocea nodosa* on well sorted fine sands (UMR: III.2.2.1).

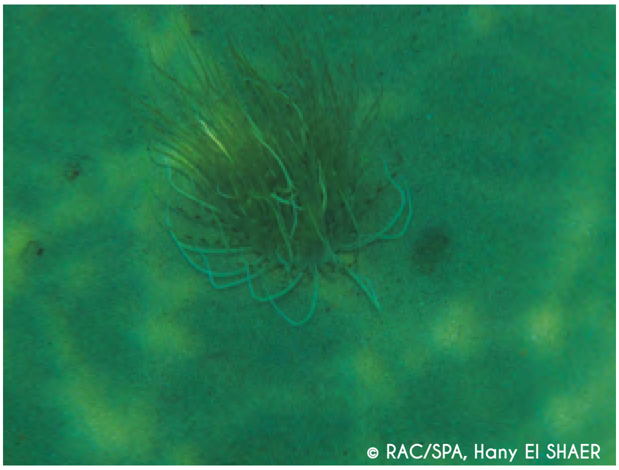


Figure 137. Cerianthidae sp. in well sorted fine sand. Chekaa, 3 m depth (st. C-22)

Association with *Cymodocea nodosa* in fine sand

a) Distribution: In the prospected coast, *Cymodocea nodosa* was only observed three times: in front of Beny beach and the Florida hotel in the Ras Chekaa area and in the small port in the Enfeh Peninsula (Table 19; Fig. 138-1). Furthermore, a sparse shoots of *Cymodocea* were also observed at a depth of 11 m between the Enfeh Peninsula and Ras Chekaa (Fig. 138-2).

Despite the intensity of our surveys (more than 6.5 km of coastline), we detected only four new occurrences of *Cymodocea nodosa* (Enfeh Peninsula, Beny beach and Florida hotel in Ras Chekaa). However, the presence of germinated seeds (Fig. 139) has been frequent around the Enfeh and Chekaa beach from 8 to 29m depth.

In Rachidiye (southern Tyre), *C. nodosa* small isolated plants have been observed between 28-31 m depth (st. T-3). In shallower water, some dispersed meadows on fine sand have been present between 9-14 m depth (st. T-4).

b) Meadow parameters (characteristics, plant density, biomass and morphological features): Biometric data for the prospected meadows in the Enfeh Peninsula and Ras Chekaa were provided in the table 19.

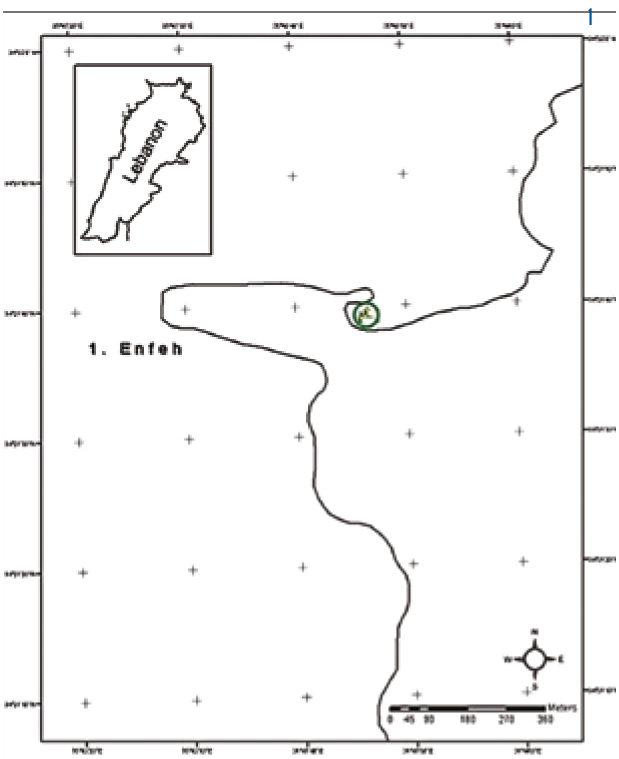
The total surface of seagrass meadows is very small (less than 8 m^{-2}). At the Enfeh Peninsula, the area colonized by *C. nodosa* was very small of 5 m^{-2} (3×5 m) and 2.25 m^{-2} (1.5 x 1.5 m). At Ras Chekaa (Beny beach and Florida hotel), the *C. nodosa* was more present with a very low density less than 5 shoot m^{-2}.

The shoot density values were slightly lower than those recorded across the range of *C. nodosa* (2060 shoots m^{-2}, Caye & Meinesz 1985; 2000 $sh.m^{-2}$, Pérez 1989; 1925 $sh.m^{-2}$, Cancemi *et al.* 2002; 1900 $sh.m^{-2}$, Terrados & Ros 1992; 1900 $sh.m^{-2}$, Cunha & Duarte 2007; 1928 $sh.m^{-2}$, Reyes 1993; 2302 $sh.m^{-2}$, Rismondo *et al.* 1997), except *C. nodosa* growing in the Canary islands-Spain (710 $sh.m^{-2}$, Barberá *et al.* 2005), Montazah Bay-Egypt (404 $sh.m^{-2}$, Mostafa 1996) and Banc d'Arguin-Mauritania (576 $sh.m^{-2}$, Van Lent *et al.* 1991).

The shoot biomass are lower than those recorded in Ischia (101.4 g DW m^{-2}, Cancemi *et al.* 2002), Ebro Delta (215 g DW m^{-2}, Pérez 1989), in the Canary Islands (245 g DW m^{-2}, Reyes *et al.* 1995) and in the Montazah Bay-Egypt (287 g DW m^{-2}, Mostafa 1996).

C. nodosa at the present study site exhibited a lower value in morphology, shoot density, and biomass during the summer period. This could be related to the extreme environmental conditions, which are the limit of the distribution of the *C. nodosa* in this sector for the Mediterranean Sea.

Stations: Enfeh (E-1, E-2, E-7, E-15), Ras Chekaa (C-1, C-10, C-22) and Tyre (T-4).



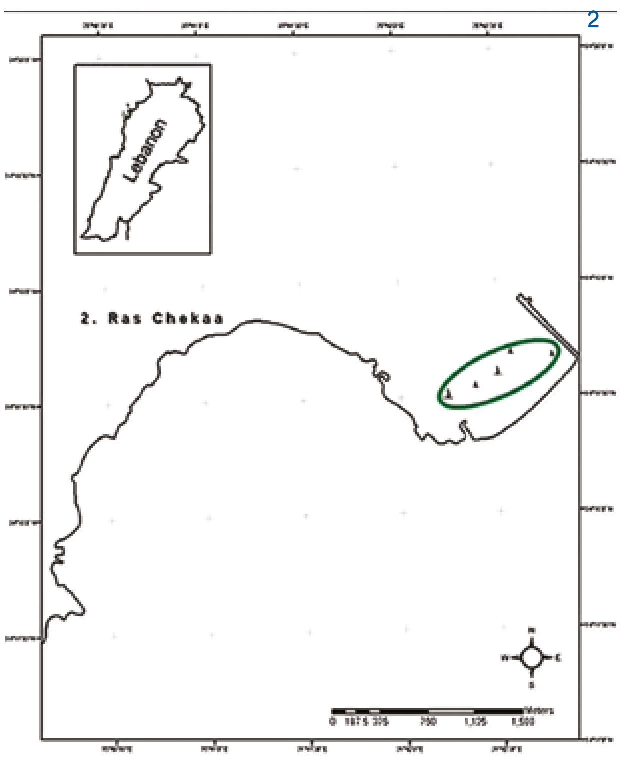


Figure 138. Distribution of the *C. nodosa* (green circles) in the Enfeh peninsula (1) and Ras Chekaa (2)

Table 19. *Cymodocea nodosa*: biometric data (± SD) for Enfeh and Ras Chekaa

Cymodocea parameters	Enfeh Peninsula	Ras Chekaa	
		Beny beach	Florida hotel
Density (Shoot m^{-2})	1567±80	5	1
Number of leaves per shoot	4,25±0,35	-	-
Number of adult leaves per shoot	2,35±0,20	-	-
Number of Intermediate leaves per shoot	1,9±0,2	-	-
Mean adult leaf length (mm)	57,05±12,95	-	-
Mean adult leaf wide (mm)	1,2+0,15	-	-
Mean intermediate leaf length (mm)	44,8±14,35	-	-
Leaf area index (m^2 m^{-2})	0,15±0,01	-	-
Shoot biomass (g DW m^{-2})	41,6±14,4	-	-
Below-ground biomass (g DW m^{-2})	74,86±3,74	-	-

6.3.1.2 Biocenosis of muddy sands

This community is spread in all the areas, between 8 to 47 m depth, particularly around Enfeh and Selaata with *Cymodocea nodosa* and *Caulerpa prolifera* patches.

Structure of the community

- **Middle and lower strata:** With the chlorophytes *Caulerpa prolifera* (c), *C. scapelliformis* (r) and *Flabellia petiolata* (r); isolated mats of *Cymodocea nodosa* have been observed in this community. *Caulerpa racemosa* and the magnoliophyte *Halophila stipulacea* have not been observed during the missions. Some isolated individuals from Cerianthidae spp. have been observed .

- **Infauna:** With the polychaete *Ditrupa arietina* (cc); the bivalves *Acanthocardia tuberculata* (c), *Ctena decusata* (c), *Lucinella divaricata* (c) and *Fulvia fragilis* (c); the echinoida *Echinocardium mediterraneum* (r).

- **Mobile fauna:** With the crustacean decapods *Diogenes pugilator* (cc) and *Myra fugax* (r); the gastropoda *Rhinoclavis kochi* (cc), *Conomurex persicus* (c), *Murex forskoehlii forskoehlii* (c), *Nassarius mutabilis* (c) and *Semicassis granulata* (c); the holothuroids *Holothuria tubulosa* (r) and *Synaptula reciprocans* (r); the fishes *Dasyatis pastinaca* (c), *Pagellus acarne* (c), *Serranus hepatus* (cc), *Bothus podas* (r), *Xyrichthys novacula* (c) and *Spicara smaris* (c).

Facies and association:

- Association with *Cymodocea nodosa* on muddy sands (UMR: III.2.3.4).
- Association with *Caulerpa prolifera* (UMR: III.2.3.6)
- Association with *Flabellia petiolata* and *Caulerpa scapelliformis*.

Association of *Cymodocea nodosa* on muddy sands (Fig. 139)

Cymodocea nodosa on muddy sand has been frequently observed in the Enfeh-Ras Chekaa sector in sites deeper than 14m, but it does not form meadows only dispersed mats, resulting from seed recruitment (Fig. 139).

During the 2012 mission in June many germinated seeds have been observed, between 14 to 44 m depth (Fig. 140), it means that the fructification period occurs in later spring. In the Saida-Nakoura sector, *C. nodosa* has been observed (Fig. 139) on one site (in front

Figure 139. A small plant of *Cymodocea nodosa*, Rachidiye, 31 m depth (st. T-3)

of Rachidiye, southern Tyre) forming a small patch with isolated plants at 30-31 m depth.

Stations: Enfeh (E-3, E-5, E-6, E-8, E-9, E-10, E-11), Ras Chekaa (C-1), Tyre (T-3).

Figure 140. Some germinated seeds from *Cymodocea nodosa*. Enfeh, 40 m depth (st. E-8)

Association with *Caulerpa prolifera* (Fig. 141)

The Caulerpa prolifera meadows have only been observed in the Enfeh – Ras Chekaa sector, between 17 to 44 m depth. *C. prolifera* meadows are dispersed and dense from 20 to 27 m depth.

Stations: Enfeh (E-8, E-10), Ras Chekaa (C-12).

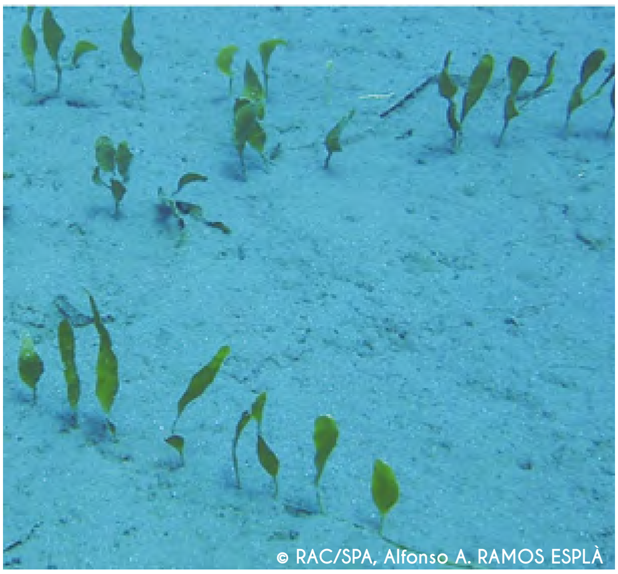


Figure 141. Dispersed *Caulerpa prolifera* mats in Enfeh, -44 m depth (st. E-8)

6.3.1.3 Biocenosis of coarse sands and gravels (under the influence of bottom currents) (Fig. 142)

The biocenosis of coarse sand and gravels under the influence of bottom currents is widespread in the Ras Chekaa, Nakura and Tyre zones. Both on infralittoral and circalittoral bottoms (mainly, between 7 to 44 m depth),it appears in rocky channels and pools, between blocks, around maerl beds and rock ridges.

Structure of the community: The upper and middle strata are absent. In the lower stratum appear some rhodoliths and Ceramiales (cc) with the poriferans *Ciocalypta carballoi* (c) and *Cinachyrella levantinensis* (r);

The invertebrate mobile fauna has been poor, with the polychaete: *Hermodice carunculata*; the gastropods *Bittium* sp. (c) and *Conomurex persicus* (r); the bivalves *Venus verrucosa* (c) and *Mimachlamys varia* (r); and the holothurian *Synaptula reciprocans* (r). Noteworthy is the frequency of empty shells of *Brissus unicolor* (Fig. 142) on this bottom.

Figure 142. Shell gravel and coarse sand with a test of the echinoid *Brissus unicolor*. Nakoura, 13 m depth (st. N-9)

Nevertheless, and due to the proximity of rocky and sandy bottoms, the fishes have been common, such as *Dasyatis pastinca* (c), *Boops boops* (c), *Coris julis* (cc), *Plotosus lineatus* (c), *Thalassoma pavo* (c), *Diplodus vulgaris* (c), *Serranus cabrilla* (cc), *Sargocentron rubrum* (c), *Spicara smaris* (c), *Torquigener flavimaculosus* (r) and *Gobius geniporus* (r), The more characteristic fish has been *Gobius bucchichi* (cc).

Stations: Enfeh (E-14), Ras Chekaa (C-16), Saida (S-1), Tyre (T-5, T-15, T-16, T-22, T- 24, T-23), Nakoura (N-9, N-12, N-13, N-16).

Facies and Associations:

- Association with rhodoliths (UMR: III. 3. 2. 2).

Association with rhodoliths (Fig. 143)

Although this community is enclosed in the biocenosis of coarse sands and gravels under the influence of bottom currents, this original and rare habitat in the Mediterranean deserves to be considered separately. The substratum is formed by free living rhodoliths (some of them ∅ = 7 cm) of the Corallinacea (Melobesiae), mainly the species *Neogoniolithon brassica-florida* and *Lithophyllum incrustans*, with small cobbles, shell gravel and coarse sand.

This maerl bed has been located in northern Tyre, where the inlets and beach form a lagoon. A complex community is associated with this habitat, between 6 to 9 m depth (Fig. 143), mainly sessile fauna are bivalves (*Chama, Spondylus, Malleus, Pictada*), hydroids (*Macrorynchia, Pennaria*), sponges (Crambe), ascidians (*Phallusia, Rhodosoma, Styelidae*) and macroalgae (*Cystoseira, Dictyota, Amphiroa, Lobophora, Lithophyllum…*). Noteworthy is the the presence of juvenile fishes (*p.e. Mycteroperca rubra*), as a nursery area.

Stations: Tyre (T-5, T-15, T-16, T-22, T-24).

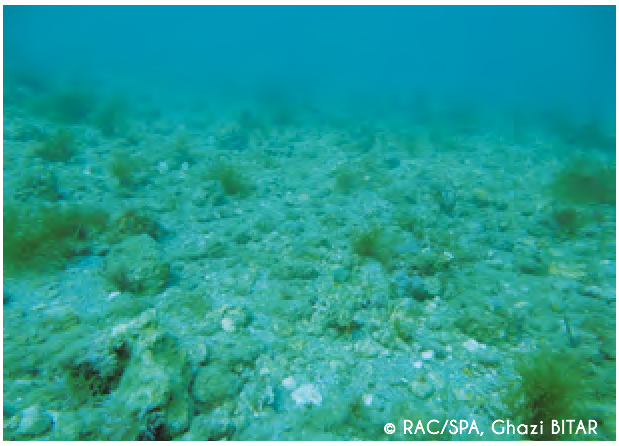


Figure 143. Shallow rhodoliths between cobbles and shell gravel. Tyre lagoon, 7 m depth (st. T- 5)

6.3.2 Upper circalittoral soft bottoms

It has been difficult to establish the separation between infra and circalittoral soft bottom communities. The criterion has been pragmatic, when the rhodolith cover in the coarse sand and gravel exceeded the 10 %, it was considered maerl bed (according with Steller *et al.* 2003). This occurs at a depth of about 32-3 3m depth.

Biotope: The coarse sand and gravel are very spread around the areas where the intensity of the bottom currents, preventing the presence of mud (Fig. 144). Nevertheless, from 40 m the muddy sediment becomes frequent on gravel bottoms, revealing the muddy detritic bottoms. In the summer time (mission 2013) the thermocline (28 °C) has reached 42 m depth.

Conservation interest: The maerl facies represents the most important communities on soft bottoms from the conservation point of view. It is protected by the Barcelona Convention and the European Union habitat Directive (annex V).

Potential threats: The maerl beds are subject to various threats. One of the most important threats is the hyper-sedimentation from sediment discharge (e.g. *Selaata harbour; concrete factories*). Another impact is related to fixed nets that pull up the rhodoliths and associated species (e.g. *Cystoseira dubia*).

Associated biocenosis:

- Biocenosis of the muddy detritic bottom (UMR: IV.2.1).
- Biocenosis of the coastal detritic bottom (UMR: IV.2.2).
- Also, the muddy sands are present at this stage with the *Caulerpa prolifera* facies.

Figure 144. Maerl bed with the holothurian *Synaptula reciprocans*. Nakoura, 34 m depth (st. N-11)

6.3.2.1. Biocenosis of the muddy detritic bottom

The biocenosis of the muddy detritic bottom has been present in patches on the maerl bed, between 35-47 m depth. The most characteristic association has been *Flabellia petiolata* and *Caulerpa scapelliformis*; this later species is also present on muddy bottoms.

Structure of the community

- **Upper and lower strata:** The *Flabellia petiolata* and *Caulerpa scapelliformis thali* form an upper stratum, although very dispersed; some *Arthrocladia villosa* and *Halymenia floresia* individuals are present.

- **Lower stratum:** Some living rhodoliths (*Lithothamnion corallioides*) with small *Ceramiales* spp. are present.

- **Mobile fauna:** The mobile fauna has been rare, only the fish Serranus hepatus is common. Also, the polychaete *Hermodice carunculata* (r), the lessepsian holothurian *Synaptula reciprocans* (r) and the fishes *Serranus cabrilla* (c) and *Coris julis* (r) have been observed.

Facies and associations: Association with *Flabellia petiolata* and *Caulerpa scapelliformis*

Association with *Flabellia petiolata* and *Caulerpa scapelliformis* (Fig. 145)

This interesting association has been only observed in Ras Chekaa, between 42-44 m on maerl bed degraded by the mud.

Stations: Ras Chekaa (C-15, C-18).

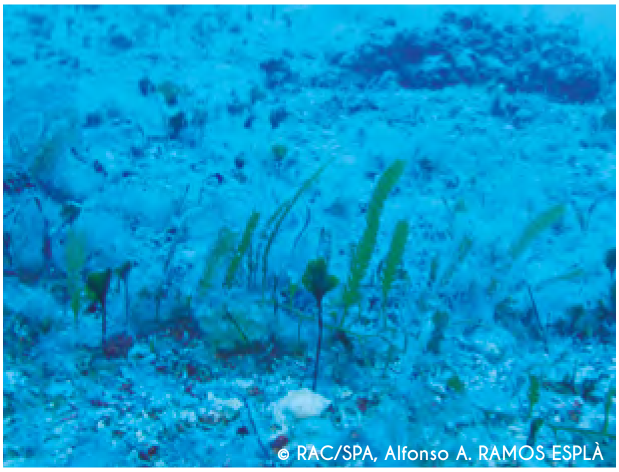


Figure 145. Association with *Flabellia petiolata* and *Caulerpa scapelliformis*. Rash Chekaa, 43 m depth (st. C-15).

6.3.2.2 Biocenosis of the coastal detritic bottom

The coastal detritic bottoms appear at 32 m depth, where the coarse sand and fine gravel sediment are dominated by the rhodoliths (cover > 10 % of the bottom surface).

Structure of the community

- **Upper stratum:** With *Arthrocladia villosa* (cc) and *Sporochnus pedunculatus* (c); some thalli of *Cystoseira dubia* are present and fixed on rhodoliths (Fig. 146).

- **Middle stratum:** Mainly, with soft rhodophytes such as *Halymenia floresia* (c) and *Rhodymenia ardissonei* (c); the ochrophytes *Dictyota dichotoma* (c) and *Stypopodium schimperi* (r). The ascidian *Herdmania momus* (c) can agglomerate with some rhodolites.

- **Lower stratum:** With the corallinales *Lithothamnion corallioides* (cc), *Spongites fruticulosa* (c), *Mesophyllum* sp. (c) and *Phymatolithon calcareum* (r); the soft rhodophytes *Cryptonemia lomation* (c), *Botryocladia botryoides* (c), *Peyssonnelia* spp. (cc) and Ceramiales (cc), the sponge *Crambe crambe* (c); the madreporarian *Madracis phaerensis* (r); and the bivalve *Striarca lactea* (c).

- **Mobile fauna:** With the polychaete *Hermodice carunculata* (r); the gastropods *Bittium* sp. (cc) and *Conomurex persicus* (r); the brachyuran *Pilumnus hirtellus* (r); the echinoderms *Echinaster sepositus* (r) and *Synaptula reciprocans* (r). The most abundant fishes have been *Coris julis* (c), *Sparisoma cretense* (r), *Serranus cabrilla* (c), *Pagellus erythrinus* (r), *Torquigener flavimaculosus* (c) and Gobiidae [with *Gobius geniporus* (c), *G. kolombatovici* (r) and *G. vittatus* (c)].

Associations and facies

- Maerl facies (*Lithothamnion corallioides* and *Phymatoliton calcareum*) (UMR: IV.2.2.2)
- Association with *Arthrocladia villosa* (UMR: IV.2.2.4)

Figure 146. *Cystoseira dubia* on a rhodolith. Ras Chekaa, 44 m depth (st. C-15)

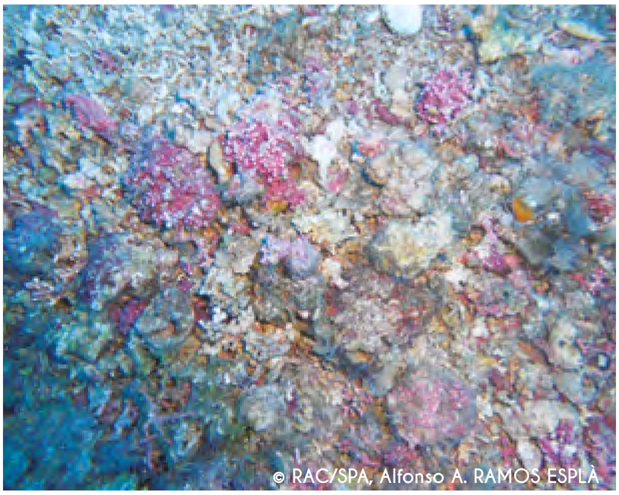


Figure 147. Deep rhodolith bed with *Lithothamnion corallioides* and *Spongites fruticulosa*. Tyre, 38 m depth (st. T-25)

Maerl facies (Fig. 147)

The deep maerl beds have appeared in Nakoura and Tyre, between 32-45 m depth. The substratum is formed by shell gravel and coarse sand, with the rhodoliths *Lithothamnion corallioides* (c), *Mesophyllum* sp. (c) and *Spongites fruticulosus* (c). The lessepsian chlorophyte *Caulerpa scapelliformis* is present.

The epifauna has been scarce with the gastropod *Conomurex persicus* (c), and the holothurian *Synaptula reciprocans* (r).

Stations: Ras Chekaa (C-15, C-18, C-19), Tyre (T-21, T-25), Nakoura (N-11).

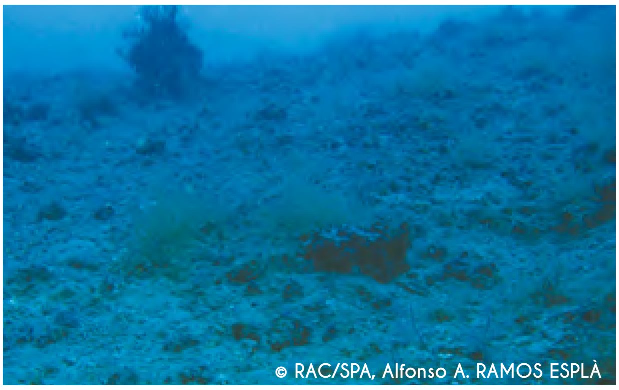


Figure 148. Detritic bottom with *Arthrocladia villosa*. Ras Chekaa, 42 m depth (St. C-18)

Association with *Arthrocladia villosa* (Fig. 148)

Only this association has been present in the Ras Chekaa area, between 32-42 m depth. The upper stratum is formed by *Arthrocladia villosa* (cc) and *Sporochnus pedunculatus* (c). Other ochrophytes are present, *Dictyota linearis* (c) and *D. dichotoma* (c).

Stations: Ras Chekaa (C-15, C-18, C-21).

6.4 Bionomical mapping

6.4.1 Northern sector

The figures 149 and 150 show the distribution of the main biocenoses observed in the Enfeh-Ras Chekaa sector, between 0-50 m depth.

Noteworthy is the prolongation of the rocky areas towards the sea in the eastern part of Enfeh and Ras Chekaa, with some extensive rocky outcrops. Near to the shore, the boulders are common forming interesting photophilic and sciaphilic enclaves. The presence of littoral caves around this area is frequent.

a) Enfeh area (Fig. 149)

The shallow bottoms (< 10 m depth) around the Enfeh area are predominately hard, with some sector with fine sand. Noteworthy is the underwater prolongation of the Enfeh peninsula as far as 40 m depth, forming a massive rock reef. Of interest is also the rocky outcrop (19-27 m depth) in the southern part of Enfeh.

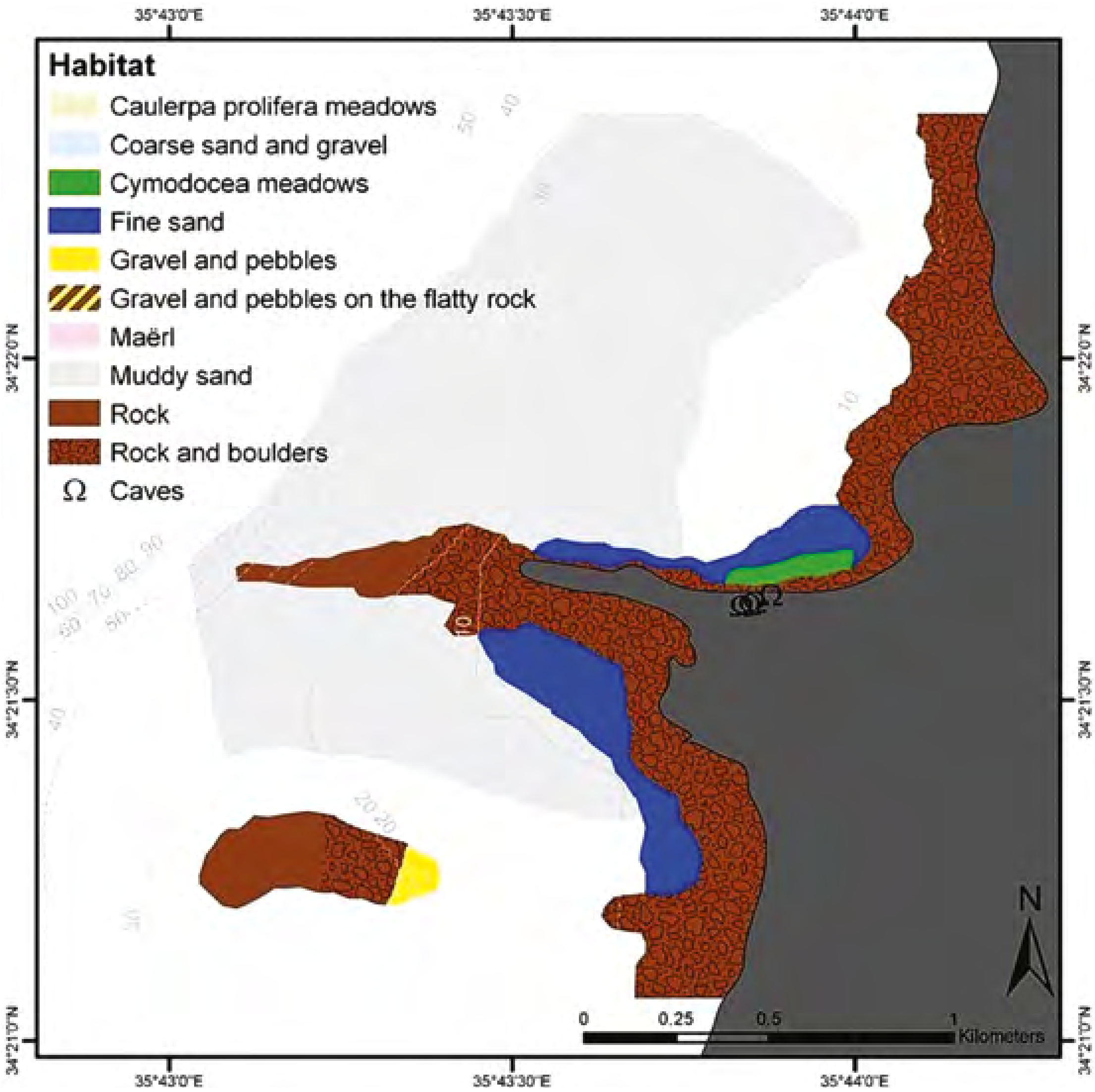


Figure 149. Bionomical mapping of the Enfeh area

b) Ras Chekaa area (Fig. 150)

The Ras Chekaa geomorphology follows the Enfeh area, with the extension of the shore rocky substratum as far as 40 m depth. However, in the Ras Chekaa area, the rocky bottoms are surrounded by gravel-coarse sand, with maerl patches; whereas, in the Enfeh area, they are surrounded by muddy sand bottoms.

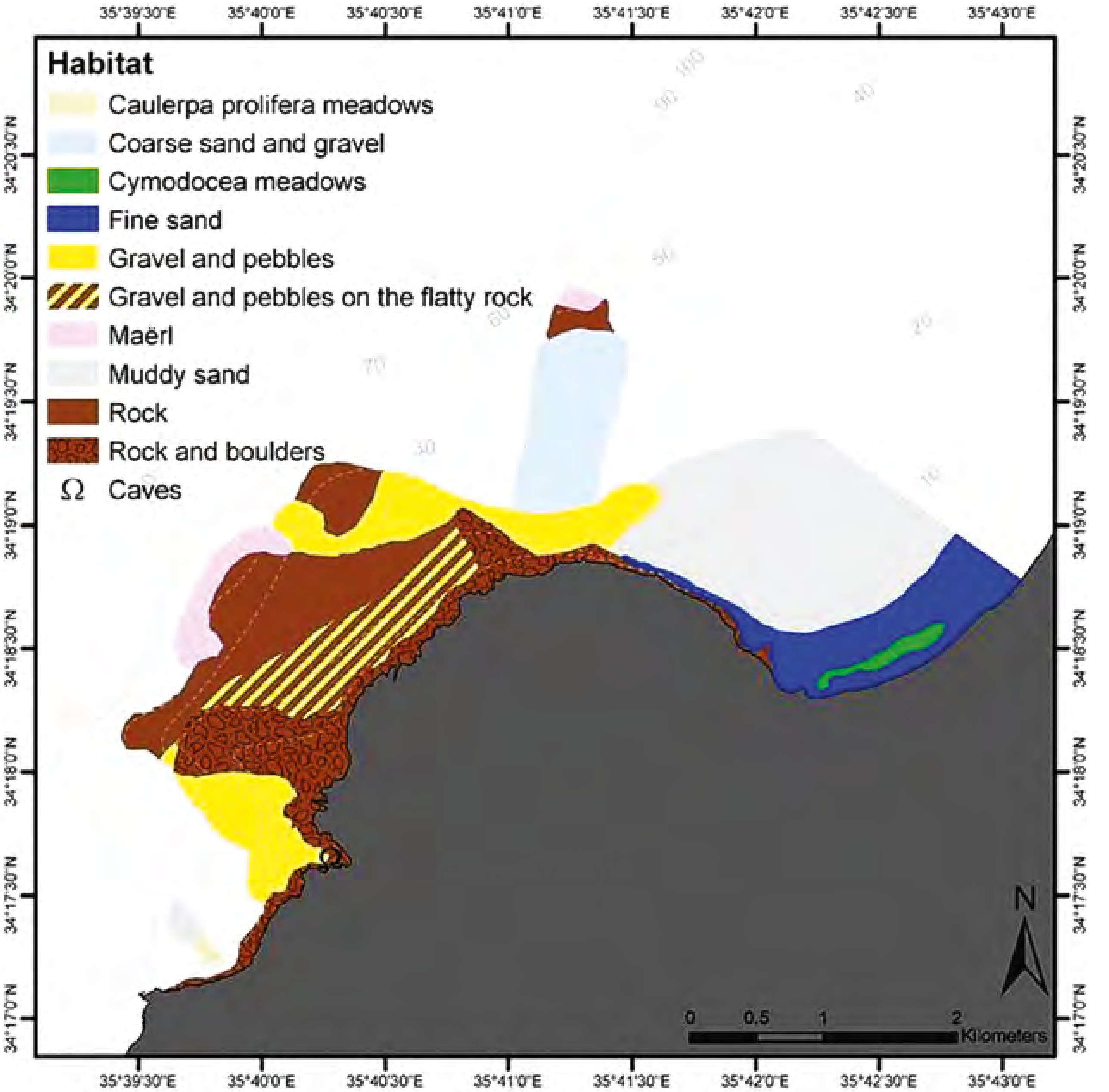


Figure 150. Bionomical cartography of the Ras Chekaa area

6.4.2 Southern sector (Saida-Nakoura)

The bionomical mapping of the southern sector (Saida-Nakoura) has been more difficult than the Enfeh-Ras Chekaa sector due to the variety of the hard substratum complexity.

Whereas in the northern sector the massive rock has been predominant, in the southern one a heterogeneous flat rock (with channels, different sediment patches…) has been the rule.

This is the reason, other than the major distances between transects, that explains why the hydroplane profiles cannot be adequately extrapolated to benthic mapping of the whole areas.

a) Saida area (Fig. 151)

The major surface of the Saida area corresponds to the flat rocky substrata with small boulders and cobbles; between 6 to 39 m depth. In the northern part, the fine sand is present from 12 m to the shore.

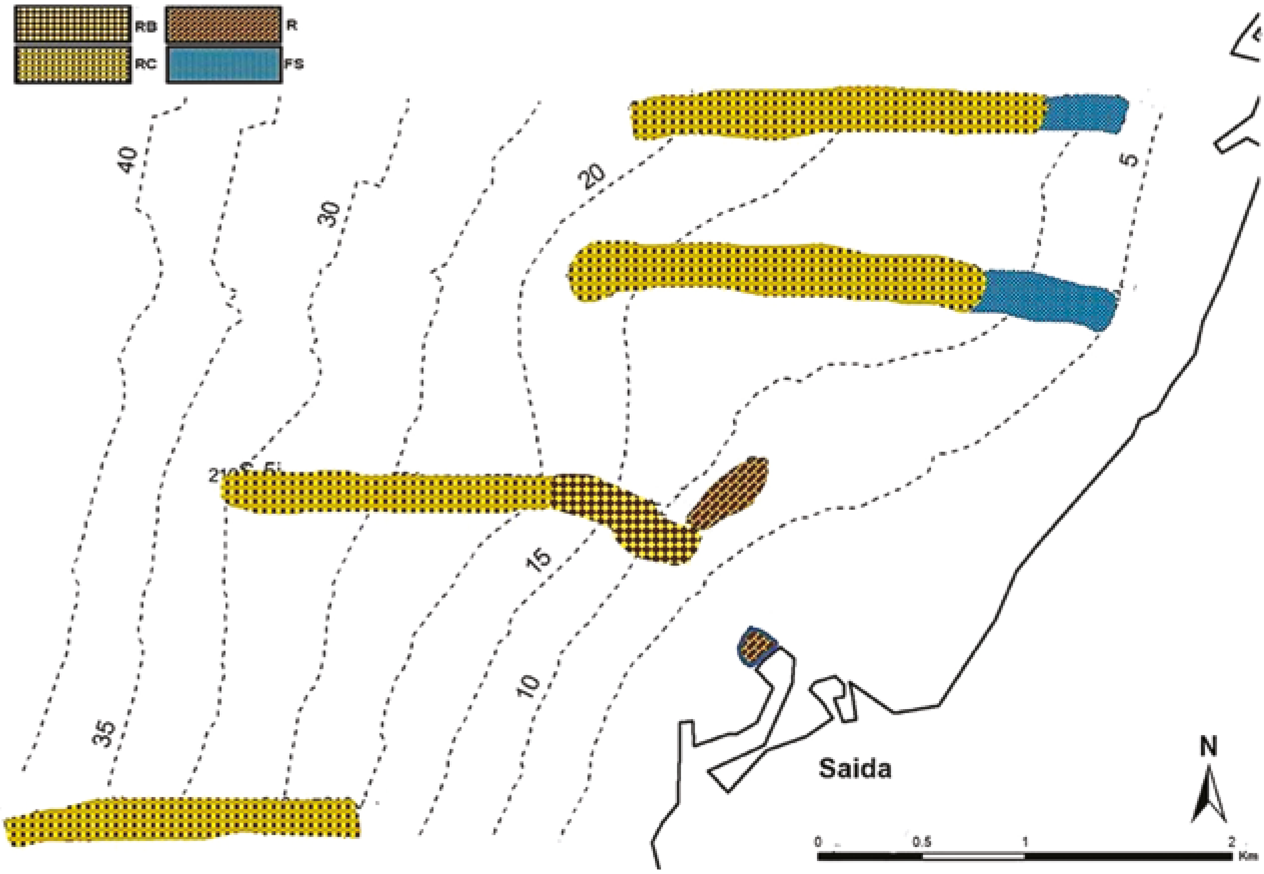


Figure 151. Bionomical mapping of the Saida area (hydroplane transects and plot dives)

Legend: (R) rock; (RB) rock and boulders;
(RC) rock and coarse sand-gravel channels; (FS) fine sand.

b) Tyre area

Northern sector (Fig. 152)**:** The rocky substrata are predominant with flat rocky bottoms covered by boulders, cobbles and pebbles (5-30m depth); in the north-western part, some high rock outcrops with cold and hot freshwater springs are present (35-45 m depth). In the lagoon, due to the action of the northern rocky reefs and beach, the dominant bottom is soft with fine and coarse sand, and some cobble sectors.

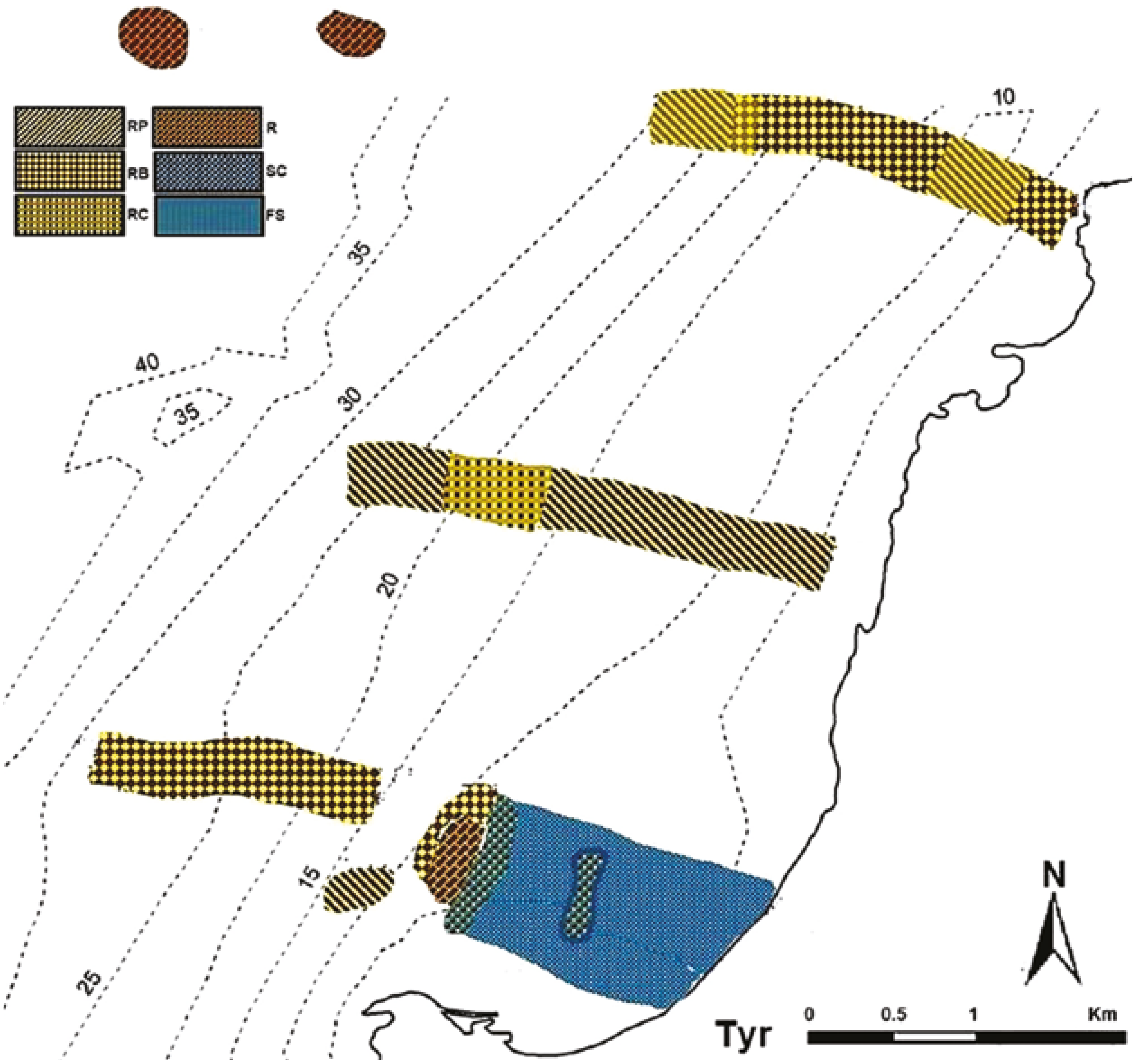


Figure 152. Bionomical mapping of the Northern Tyre area (hydroplane transects and plot dives)

Legend: (FS) fine sand; (R) rock; (RB) rock and boulders; (RC) rock and coarse sand-gravel channels; (RP) rock and pebbles; (SC) sand and cobbles.

Southern sector (Fig. 153)**:** Noteworthy in this area is the variety of different substrata (hard and soft bottoms) with different typologies (10-22 m depth). The rocky substrata are dominant with high and flat rock, covered by boulders, cobbles, pebbles and gravel- coarse sand; particularly, between 10-22 m depth with small high rock hummocks; from 22 m depth, the substratum changes to muddy sand bottom. The sector sector in front of the Rachidiye presents a *Cymodocea nodosa* meadow, between 9-12 m depth in fine sand bottoms.

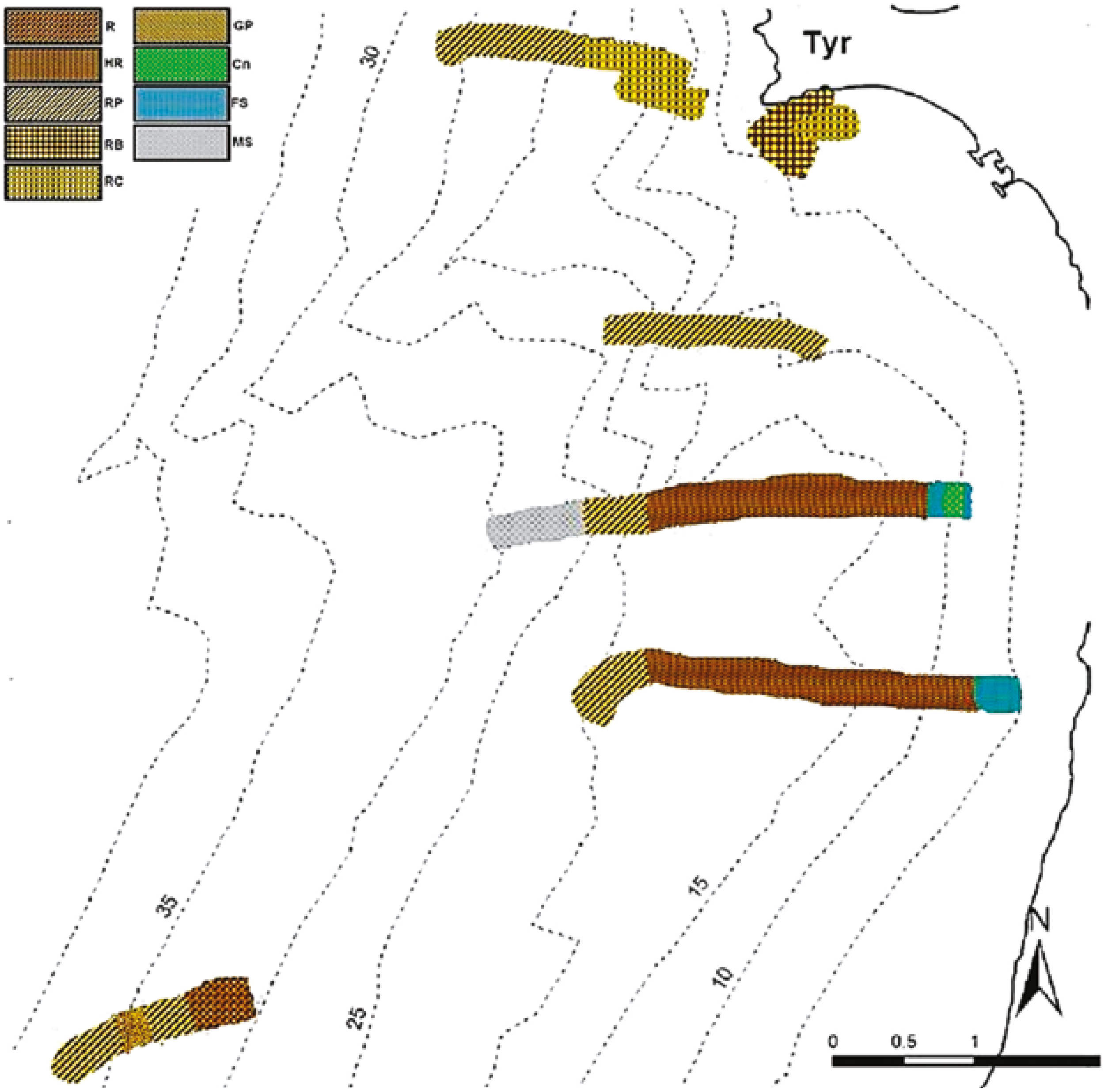


Figure 153. Bionomical mapping of the Southern Tyre area (hydroplane transects and plot dives)

Legend: (Cn) *Cymodocea nodosa* meadow; (FS) fine sand; (GP) gravel and pebbles; (HR) high rocky outcrops; (MS) muddy sand; (R) rock; (RB) rock and boulders; (RC) rock and coarse sand-gravel channels; (RP) rock and pebbles

c) Nakoura area (Fig. 154)

Like the other areas, the predominant substratum is the flat rock with coarse sand-gravel channel and patches (0-37 m depth). From 37-44 m depth, the rocky bottom is covered by gravel-coarse sand, with small boulders (ø < 50 cm).

In front of Ras El Bayada, some high rock outcrops are present, some of them with cold freshwater springs, between 12-15 m depth.

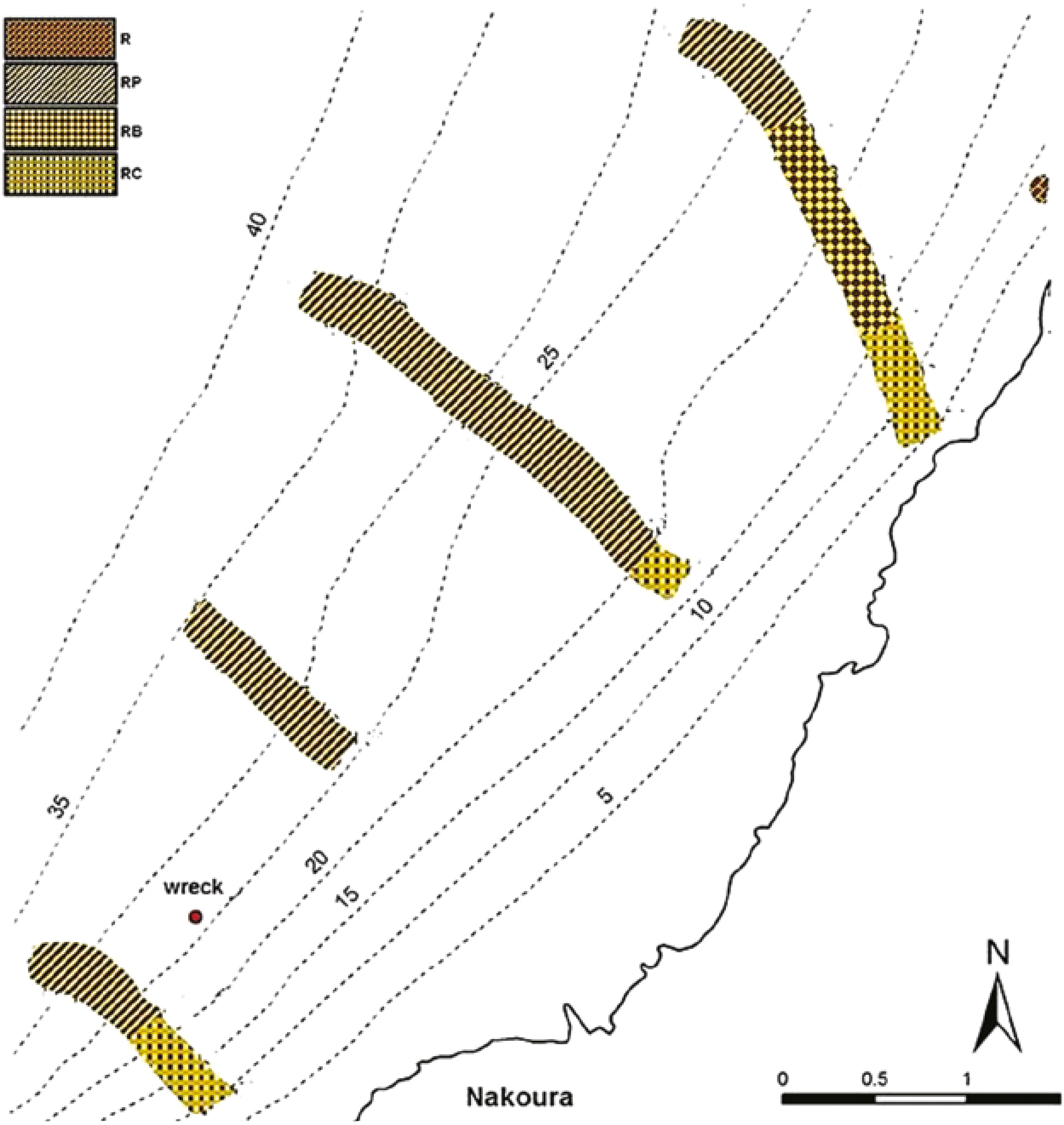
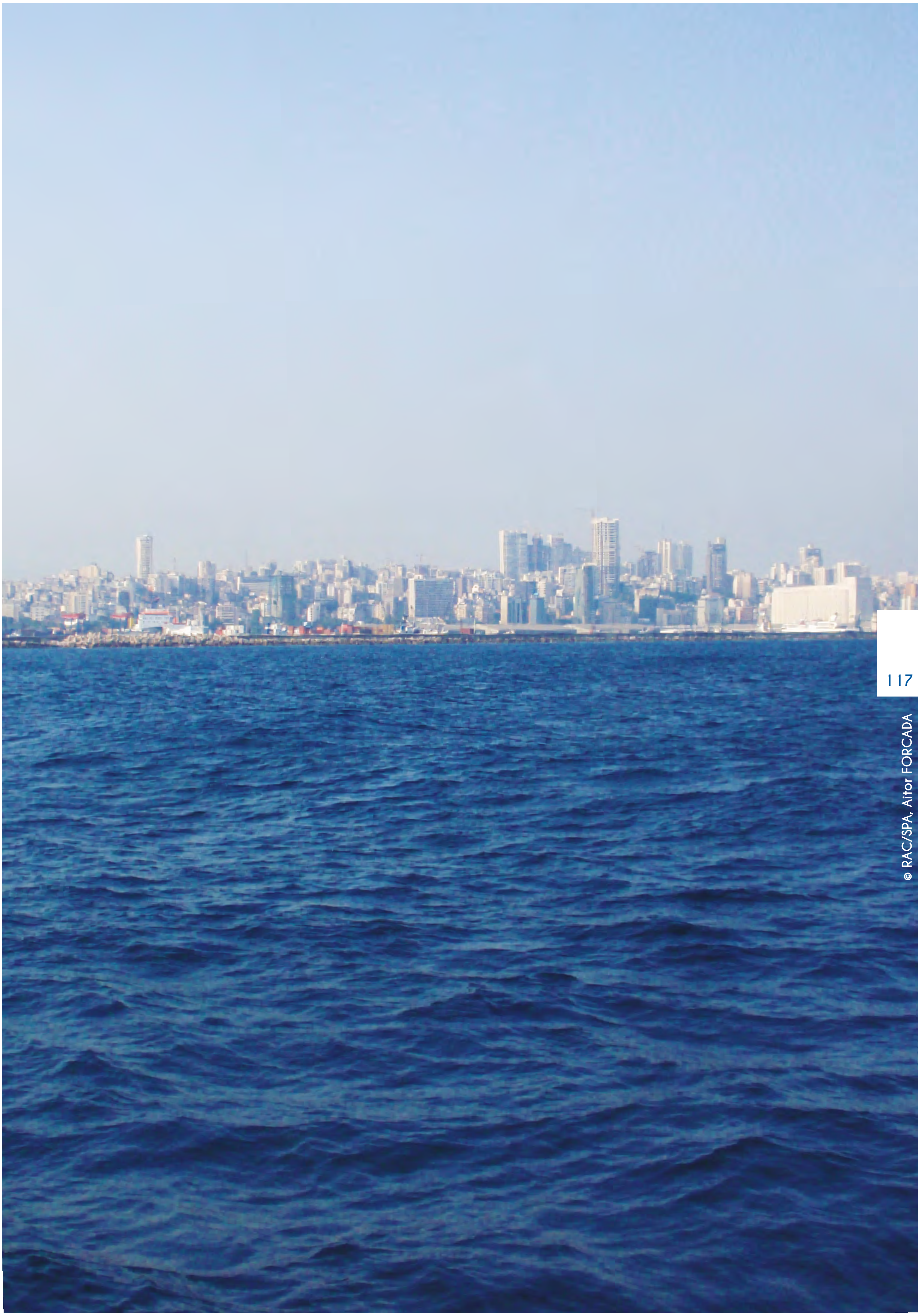


Figure 154. Bionomical mapping of the Saida area (hydroplane transects)

Legend: (R) rock; (RB) rock and boulders;
(RC) rock and coarse sand-gravel channels; (RP) rock and pebbles



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7. EVALUATION OF THE ZONES

For the evaluation of the zones, we have considered some objective parameters (relative species richness, habitat index, patrimonial species and fish populations).

7.1 Species richness

The table 20 shows the number of species by zone, the relative abundance and the Margalef's index of species richness.

Species richness (S): Ras Chekaa, Tyre and Enfeh present the highest values of S (> 200 spp.), followed by Nakoura (192 spp.), Saida (107 spp.), Raoucheh and Tyre springs (S < 100 spp.).

Appreciative abundance (A): Also Ras Chekaa, Nakoura and Tyre present the highest values (RA > 1000). The lowest values correspond to Saida (359), Raoucheh (179) and the Tyre springs (160).

Margalef's index (MI): It is a good index of species richness when there is information about the relative abundance of the species. The MI is elevated (≥ 30) in Ras Chekaa (37.66); followed by Enfeh (30.78). Whereas, Saida, Raoucheh and Tyre springs have got a lower value (< 20).

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

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

Also, it is necessary to adjust these values to the total number of samples (total spp., relative abundance and habitats) where MH = 1.29 (Margalef' index value with the maximum number of species and the total of relative abundance). Table 20 present the number of habitats (biocenosis, associations or facies) observed by zone and the MH value. With this adjustment, the Tyre springs (1.76) and Raoucheh (1.09) have presented the highest values (> 1.0), whereas Saida (0.82) had the lowest one.

Table 20. Species parameters by zones

Parameters/Zones	E	C	R	S	T	TS	N	Tot.
N dive stations	6	13	1	3	14	2	11	50
Depth range	0-28 m	0-44 m	0-6 m	0-14 m	0-18 m	32-45 m	0-44 m	0-45 m
Species richness (S)	209	284	81	107	212	70	192	436
Relative abundance (RA)	861	1835	179	359	1173	160	1195	5794
Margalef' index (M)	30.78	37.66	15.42	18.02	29.86	13.6	27.10	50.20
Nº Habitats/Zone (H)	27	33	11	17	26	6	25	39
Index MH (M/H)	1.14	1.15	1.40	1,06	1.15	2.27	1.08	1.29
Adjustment (MH/1.29)	0.88	0.89	1.09	0.82	0,89	1.76	0.84	1.0

(E) Enfeh; (C) Ras Chekaa; (R) Raoucheh; (S) Saida; (T) Tyre; and (N) Nakoura.

7.2 Habitats

For the evaluation of the habitats (biocenosis, associations or facies), we have followed the UNEP/MAP (1998) valorization, adapting the criterion values to the different habitats (table 21).

These habitats - structurally and functionally depending on their complexity and heterogeneity, as well as sensitivity to human impacts - harbour a different diversity of species, some of them with high ecological (key-stone species), patrimonial (vulnerable and endangered species), rarity and/or economical value.

Table 21. Evaluation and classification of the habitats

HABITAT	S	V	PV	R	A	E	HV	C
B. supralittoral rock	1	1	1	1	1	1	0	N
B. upper mediolittoral rock	-	-	-	-	-	-	-	-
- F. with *Chthamalus* spp.	1	1	1	1	1	1	0	N
- A. *Nemalion helminthoides*	1	1	1	1	1	1	0	N
- A. *Lithophyllum papillosum*	1	1	1	1	1	1	0	N
B. lower mediolittoral rock								
- A. *Ulva compressa*	1	1	1	1	1	1	0	N
- Pools and lagoons associated with vermetids	2	2	3	2	2	1	1	P
- A. with Gelidiales	1	1	1	1	1	1	0	N
B. mediolittoral caves	3	3	3	3	3	2	1.83	P
B. infralittoral algae								
- F. overgrazing with encrusting algae	1	1	1	1	1	1	0	N
- A. *Neogoniolithon brassica-florida* with *Dendropoma*	2	3	3	2	2	1	1.2	P
- A. *Jania rubens*	2	2	1	1	2	1	0.5	N
- F. *Brachidontes pharaonis*	1	1	1	1	1	1	0	N
- A. *Sargassum vulgare* and *Cystoseira compressa*	3	2	2	1	3	2	1.16	P
- F. large hydrozoans	1	1	1	1	1	1	0	N
- F. Balanidae spp.	1	1	1	1	1	1	0	N
- A. *Colpomenia sinuosa*	2	1	1	1	2	1	0.33	N
- A. *Stypocaulon scoparium*	2	1	1	1	2	1	0.33	N
- A. *Cystoseira* cf. *foeniculacea*	2	2	2	3	2	2	1.16	P
- A. *Ganonema farinosum*	1	1	1	1	1	1	0	N
- A. *Pterocladiella capillacea* and *Ulva* spp.	1	1	1	1	1	1	0	N
- A. *Corallina elongata*	2	1	1	1	2	1	0.33	
- A. erect Corallinales *(Amphiroa, Jania)*	2	1	1	1	1	1	0.16	N
- A. *Padina* spp.	2	1	1	1	1	1	0.16	N
- F. *Chama pacifica* and *Spondylus spinosus*	2	1	1	1	1	2	0.33	N
- A. *Galaxaura rugosa* and *Laurencia* sp.	2	1	1	1	1	1	0.16	N
- A. *Codium parvulum*	1	1	1	1	1	1	0	N
- A. *Schottera nicaeensis*	2	2	2	2	2	1	0.83	P
- A. *Lobophora variegata*	2	1	1	1	1	1	0.16	N
- A. *Peyssonnelia* spp.	2	2	2	2	2	1	0.83	P
- A. encrusting Corallinaceae	2	2	2	1	1	1	0.33	N
B. fine and muddy sands								
- A. *Cymodocea nodosa*	2	3	3	2	2	3	1.50	P
- A. *Caulerpa prolifera*	1	1	1	2	2	1	0.33	N
B. coarse sands and fine gravels, bottom currents	2	2	1	2	1	1	0.5	N
- Association with rhodoliths	2	2	3	3	2	2	1.33	P
B. muddy detritic bottom								
- A. *Flabellia petiolata* and *Caulerpa scapelliformis*	2	1	2	2	2	1	0.67	P
B. coastal detritic bottom	-	-	-	-	-	-	-	-
- Maerl facies	3	3	3	3	3	2	1.83	P
- A. *Arthrocladia villosa*	3	2	2	2	2	2	1.16	P
B. coralligenous								
- F. coralligenous (infralittoral enclaves)	3	3	3	3	3	2	1.83	P
- A. *Cystoseira dubia*	3	3	3	3	3	3	2.00	P
- F. Axinellidae spp.	3	3	3	3	3	3	2.00	P
- Coralligenous on blocks (platforms')	3	3	3	3	3	2	1.83	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
Submarine cold freshwater springs	2	3	3	2	3	3	1.67	P
Submarine hot freshwater springs	2	3	3	3	3	3	1.83	P

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

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

The relative habitat value (HV) of the habitats represents the sum of the different criteria values (Table 21: S, V, P, R, A, E) divided by 6 (number of criteria). The habitats with value 1 are not considered (that is the reason less 1):

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

The table 22 represents the evaluation of the zones in function of the habitat values. We can compare the different zones and obtain a medium value by habitat/zone.

Table 22. Relative habitat value (HV) by zones

HABITAT / ZONE	E	C	R	S	T	TS	N	HV
Pools and lagoons associated with vermetids	1	1	-	1	1	-	1	1
B. mediolittoral caves	1.83	1.83	1.83	-	-	-	-	1.83
A. *Neogoniolithon brassica-florida* with *Dendropoma*	1.2	1.2	-	1.2	1.2	-	1.2	1.2
A. *Jania rubens*	0.5	0.5	-	0.5	0.5	-	0.5	0.5
A. *Sargassum vulgare* and *Cystoseira compressa*	1.16	1.16	-	-	1.16	-	-	1.16
A. *Colpomenia sinuosa*	0.33	0.33	-	-	-	-	-	0.33
A. *Stypocaulon scoparium*	0.33	0.33	-	0.33	0.33	-	-	0.33
A. *Cystoseira* cf. *foeniculacea*	-	1.16	-	1.16	1.16	-	1.16	1.16
A. *Corallina elongata*	0.33	0.33	0.33	-	0.33	-	0.33	0.33
A. erect Corallinales *(Amphiroa, Jania)*	0.16	0.16	-	0.16	0.16	-	0.16	0.16
A. *Padina* spp.	0.16	0.16	-	0.16	0.16	-	0.16	0.16
F. *Chama pacifica* and *Spondylus spinosus*	0.33	0.33	-	-	0.33	-	0.33	0.33
A. *Galaxaura rugosa* and *Laurencia* sp.	-	-	-	0.16	0.16	-	0.16	0.16
A. *Schottera nicaeensis*	0.83	0.83	0.83	-	-	-	-	0.83
A. *Lobophora variegata*	0.16	0.16	-	-	0.16	-	0.16	0.16
A. *Peyssonnelia* spp.	0.83	0.83	0.83	-	0.83	-	0.83	0.83
A. incrusting Corallinaceae	-	0.33	0.33	0.33	0.33	0.33	0.33	0.33
A. *Cymodocea nodosa*	1.5	1.5	-	-	1.5	-	-	1.5
B. coarse sands and fine gravels, bottom currents	0.5	0.5	-	0.5	0.5	0.5	0.5	0.5
Association with rhodoliths	-	-	-	-	1.33	-	-	1.33
F. coralligenous (infralittoral enclaves)	1.83	1.83	1.83	-	1.83	-	1.83	1.83
B. semi-dark caves	2	2	2	-	2	-	2	2
A. *Cystoseira dubia*	-	2	-	-	-	-	-	2
F. Axinellidae spp.	-	2	-	-	-	2	-	2
Coralligenous on blocks (platforms')	-	-	-	-	-	-	1.83	1.83
B. caves and ducts in total darkness	-	2	-	-	-	-	-	1.83
Submarine cold freshwater springs	-	-	-	-	-	1.67	1.67	1.67
Submarine hot freshwater springs	-	-	-	-	-	1.83	-	1.83
A. *Caulerpa prolifera*	0.33	0.33	-	-	-	-	-	0.33
A. *Flabellia petiolata* and *Caulerpa scapelliformis*	-	0.67	-	-	-	-	-	0.67
Maerl facies	-	1.83	-	-	-	1.83	1.83	1.83
A. Arthrocladia villosa	-	1.16	-	-	-	-	-	1.16
Total Value/Zone (TVZ = Σ HV)	15.31	26.46	7.98	5.5	14.97	8.16	15.98	33.11
Nº Habitats/Zone (HZ)	19	27	7	10	19	6	18	32
Medium Value Habitat/Zone (MVZ = TVZ/HZ)	0.81	0.98	1.14	0.55	0.79	1.36	0.89	1.03
Adjustment (MVZ/1,03)	0.79	0.95	1.11	0.53	0.76	1.32	0.86	1.0

(E) Enfeh; (C) Ras Chekaa; (R) Raoucheh; (S) Saida; (T) Tyre; and (N) Nakoura.
Habitats: (B) biocenosis; (A) association; (F) facies. (HV) habitat value.

Although the highest value by zone has been Ras Chekaa (TVZ = 26.46), when this value referres to the number of habitats by zone (HZ), Raoucheh is bigger than Ras Chekaa (1.14 and 0.98, respectively).

7.3 Interesting species

Another criterion to establish marine protected areas is the presence of species with patrimonial value (included in the Annexes II and III, Barcelona Convention, 1995, Marrakech, 2009; Bern Convention 1997-98; EU Habitat Directive 92/43).

Ras Chekaa has presented the highest value (1,0), followed by Tyre and Nakoura (0,96). Whereas Raoucheh and Saida have the lowest one (0,19).

Table 23. Species with patrimonial value (Barcelona Convention, 1995) distributed by zones

Species/Zones	E	C	R	S	T	TS	N
Cystoseira dubia	-	2	-	-	-	-	-
Cystoseira cf. *foeniculacea*	-	1	-	1	3	-	2
Sargassum trichocarpum	1	2	-	-	-	-	-
Lithothamnion corallioides	-	2	-	-	-	3	3
Phymatolithon cf. *calcareum*	-	2	-	-	-	-	-
Cymodocea nodosa	3	2	-	-	1	-	-
Aplysina aerophoba	3	2	-	-	1	-	1
Aplysina sp.	-	-	3	-	-	-	3
Axinella polypoides	-	1	-	1	-	3	3
Sarcotragus cf. *phoetidus*	-	1	-	-	1	-	1
Spongia officinalis	1	1	1	-	1	-	1
Cladocora caespitosa	-	-	-	-	1	-	-
Dendropoma petraeum	2	2	-	1	1	-	2
Erosaria spurca	-	1	-	1	1	-	1
Luria lurida	-	1	-	-	-	-	-
Tonna galea	-	-	-	-	1	-	-
Lithophaga lithophaga	-	-	-	-	-	-	2
Pinna nobilis	1	1	-	-	1	-	1
Paracentrotus lividus	1	2	-	-	-	-	1
Gymnura altavella	1	-	-	-	-	-	-
Rhinobatos cemiculus	-	-	-	1	1	-	-
Epinephelus costae	1	1	-	-	2	-	1
Epinephelus marginatus	1	1	-	-	1	-	1
Mycteroperca rubra	2	1	1	1	2	-	2
Sciaena umbra	1	-	-	-	-	-	-
Chelonia mydas	-	-	-	-	1	-	-
Σ spp. values by zone (SVZ)	18	26	5	6	19	6	25
SVZ/26	0.69	1.0	0.19	0.23	0.73	0.23	0.96

(E) Enfeh; (C) Ras Chekaa; (R) Raoucheh; (S) Saida; (T) Tyre; and (N) Nakoura. Relative abundance: (3) abundant; (2) common; (1) scarce.

7.4 Fish populations

The study of the fish populations is an important criterion to establish marine protected areas because it represents the main resource for the local fishermen. The fish parameters (mainly species richness, abundance and biomass) by zones have previously been treated in the paragraph 5.2. The table 24 summarizes these parameters by zones.

The relative biomass index (Table 24) is the result of the division of the mean biomass of the zone by 29.28 (max. mean biomass from Ras Chekaa).

Table 24. Fish parameters as a function of the zones

Fish parameters	E	C	R	S	T	TS	N
FVC	2	4	1	1	1	2	4
Abundance (ind./m²)	0.68	2.11	1.20	0.1	0.1	0.55	0.92
Biomass (gr/m²)	8.0	29.28	19.12	0.48	0.48	14.28	14.4
Relative biomass index	0.27	1.0	0.65	0.02	0.02	0.49	0.49

(E) Enfeh; (C) Ras Chekaa; (R) Raoucheh; (S) Saida; (T) Tyre; (TS) Tyre springs and (N) Nakoura. Abundance = ind./m^2; biomass = gr/m^2.

7.5 Uses/impacts and Naturalness

The studied zones are subject to the different uses and human activities (industry, commercial, artisanal and sportive fisheries, tourism, littoral urbanization, local population; table 25), this means a variety of impacts and, subsequently, it is exposed to possible threats:

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

The use / impact index (UI, table 25) by zones has been calculated from the sum of the relative values of uses-impacts and divided by 39 (13 uses-impacts x3).

Although the littoral of the Lebanon relative to the study undergoes many uses and impacts (industry, littoral urbanization, different fishing activities, sewage discharge…), some areas (Table 25) are more or less pristine, such as Ras Chekaa (central sector) and Ras El Bayada. These areas are important in order to establishment the core zones of MPAs, due to the relative low impact and frequentation.

In order to evaluate the zones, we have calculated the Naturalness Index (NI = 1-UI), to be considered in the evaluation of the zones.

Table 25. Uses and impacts of the zones

Uses-Impacts / Zones	NE	SE	EC	NC	CC	SC	R	S	NT	ST	TS	B	N	MV
Professional fishing	3	3	3	3	2	2	3	3	3	3	3	3	3	3
Shore angling	1	1	1	1	1	1	1	1	1	1	-	1	1	1
Spearfishing	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Lost nets (ghost fishing)	2	2	2	2	3	3	1	2	2	2	3	2	2	3
Trampling	2	2	2	2	1	1	1	2	2	2	-	2	2	2
Bait and shell-fish collecting	3	3	3	3	2	1	3	3	3	3	-	2	2	3
Mooring	1	2	3	3	1	3	1	3	3	3	2	2	2	3
Ports, marinas, cove fishing	1	1	3	2	-	3	-	3	3	2	-	-	1	3
Solid wastes	3	3	3	2	1	3	3	3	2	2	-	2	2	3
Domestic sewage discharge	2	3	3	2	-	3	3	3	3	2	-	1	2	3
Industrial sewage discharge	-	-	3	-	-	3	1	2	-	-	-	-	-	3
Hyper-sedimentation	2	3	3	2	2	3	1	2	1	1	-	1	1	3
Beaching/bathing	1	1	1	2	-	1	1	2	2	2	-	1	1	2
Σ uses-impact values (TUV)	30	34	38	33	18	27	29	38	36	33	11	24	28	35
TUV/39 (UI)	0.69	0.77	0.94	0.77	0.46	0.86	0.60	0.94	0.80	0.74	0.31	0.57	0.63	1
Naturalness Index (NI=1 – UI)	0.31	0.27	0.06	0.23	0.54	0.14	0.40	0.06	0.20	0.26	0.69	0.43	0.37	

(NE) N-Enfeh; (SE) S-Enfeh; (EC) Enfeh-Chekaa; (NC) N-Ras Chekaa; (CC) Centre Ras Chekaa;
(SC) S-Ras Chekaa; (R) Raoucheh; (S) Saida; (NT) N-Tyre; (ST) S-Tyre; (TS) Tyre springs; (B) Ras El Bayada; (N) Nakoura.
Relative evaluation of the use/Impact: (3) very important; (2) more or less important; (1) not important;

7.6 Evaluation of the zones

With the sum of the different indices (species richness, habitats, patrimonial species, fish populations and naturalness), we have calculated the relative value of the zones (environmental value) (Table 26). The environmental value (EV) could be: very high (≥ 4); high (3-4); medium (2-3); and low (<2).

Table 26. Evaluation of the zones (environmental value) according to the different criteria

Zone	Species richness	Habitats	Patrimonial species	Fish populations	Naturalness*	Environmental value
Enfeh	0.88	0.79	0.69	0.27	0.31	**2.94**
Ras Chekaa	0.89	0.95	1.00	1.00	0.54	**4.38**
Raoucheh	1.09	1.11	0.19	0.65	0.40	**3.44**
Saida	0.82	0.53	0.23	0.02	0.06	**1.66**
Tyre	0.89	0.91	0.96	0.02	0.26	**3.04**
Tyre springs	1.76	1.32	0.23	0.49	0.69	**4.49**
Nakoura	0.84	0.86	0.96	0.49	0.43	**3.58**

(*) Max. value of the Naturalness in the zone.

7.6.1 Enfeh (Fig. 155)

Species richness: It is relatively high, due to the depth range (0-28 m depth) with 209 spp. (48 % of the total) and a moderate abundance (14.7 % of the total). Also, the Margalef's index is high (30.78).

Habitats: A total of 27 habitats (biocenosis, associations, facies) have been observed, standing out: pools and lagoons associated with vermetids, Biocenosis (B) of midlittoral caves, Association (A) with *Neogoniolithon brassica-florida* with *Dendropoma,* A. *Sargassum vulgare* and *Cystoseira compressa*, A. *Schottera nicaeensis*, Facies (F) coralligenous in infralitoral enclaves, B. semi-dark caves, and *Cymodocea nodosa* meadows.

Interesting species: Twelve spp. have been observed:

- Macrophyta: *Sargassum trichocarpum* (r), *Cymodocea nodosa* (cc).
- Invertebrata: *Aplysina aerophoba* (cc), *Spongia officinalis* (r), *Dendropoma petraeum* (c), *Pinna nobilis* (r), *Paracentrotus lividus* (r).
- Vertebrata: *Gymnura altavella* (1), *Epinephelus costae* (r), *E. marginatus* (1), *Mycteroperca rubra* (r), *Sciaena umbra* (r).

Fish populations: The fish biomass has been low (8 gr/m^2), which means a high fishing pressure.

Naturalness: Low, due to the domestic sewage, solid wastes, littoral urbanization, over-frequentation, over-fishing.

Patrimonial value: The *Cymodocea* meadows are in good conservation status; as well as the littoral fringe (*Dendropoma, Palisada, Sargassum, Cystoseira*) and the midlittoral caves. It is noteworthy the presence of a Phoenician settlement (Fig. 155).

Environmental value: Although Enfeh has got a mean value (2.94), the marine patrimonial environment needs to be protected through a MPA without core zone (urbanized site).

Figure 155. Littoral of the Enfeh northern part, with the Phoenician settlement

7.6.2 Chekaa (Fig. 156)

Species richness: Although the number of species (65.1 % of the total), relative abundance (31,7 % of the total) and Margalef index have been the highest compared to the other zones (37.66), when the number of habitats (33) and the adjustment are applied the species richness value descends (0,89), occupying the 4th place.

Habitats: A total of 33 habitats (biocenosis, associations, facies) have been observed, standing out: pools and lagoons associated with vemetids, Biocenosis (B) of midlittoral caves, Association (A) with *Neogoniolithon brassica-florida* with *Dendropoma*, A. *Sargassum vulgare* and *Cystoseira compressa*, A. *Schottera nicaeensis*, Facies (F) coralligenous in infralitoral enclaves, B. semi-dark caves, caves in total darkness, coralligenous with Axinellidae spp., A. *Cystoseira dubia*, maerl beds and *Cymodocea nodosa* meadows.

Figure 156. Ras Chekaa cliffs and rocky coast

Interesting species: It has presented the highest value (= 1,0), with 17 spp.:

- Macrophyta: *Cystoseira* cf. *foeniculacea* (r), *Cystoseira dubia* (c), *Sargassum trichocarpum* (c), *Lithothamnion corallioides* (c) *Phymatolithon calcareum* (c), *Cymodocea nodosa* (c).
- Invertebrata: *Aplysina aerophoba* (c), *Sarcotragus phoetidus* (1), *Spongia officinalis* (r), *Dendropoma petraeum* (c), *Erosaria spurca* (r), *Luria lurida* (r), *Pinna nobilis* (r), *Paracentrotus lividus* (c).
- Vertebrata: *Epinephelus costae* (r), *E. marginatus* (r), *Mycteroperca rubra* (r).

Fish populations: Ras Chekaa has presented the highest value from fish biomass (29,28 gr/m^2).

Naturalness: The northern sector is impacted by tourism (littoral urbanization, port/marina, beaching, boating, mooring), and professional and sportive fishing (shore angling, spearfishing, bait and shell collecting, lost traps and nets). Whereas the southern sector is impacted by industrial activities (commercial port, hyper- sedimentation, industrial sewage, chemical fertilizer plant), mainly from the Selaata harbour. Nevertheless, the central part presents a pristine environment, only affected by professional and sportive fishing and hyper-sedimentation from the Selaata area.

Patrimonial value: The landscape is impressive (high coast, cliffs) with cultural value (Maronite's churches). Noteworthy is also the presence of midlittoral and underwater caves with a very interesting and endemic fauna.

Environmental value: The EV has been very high (4.38). The Ras Chekaa area represents an excellent example of a pristine Mediterranean coast (rare in the Lebanon), and the marine environment is a candidate to be protected through an MPA with a core zone (central Ras Chekaa) .

7.6.3 Raoucheh (Fig. 157)

Species richness: Although the number of species, relative abundance and Margalef' index have been relatively low (81, 179 and 15.42, respectively): However, with the adjustment (MH/1,29) this value has been very high (1,09).

Figure 157. Inside of the Raoucheh tunnel

Habitats: A total of 11 habitats (biocenosis, associations, facies) have been observed, standing out: B. midlittoral caves, A. *Schottera nicaeensis*, F. *coralligenous* in infralittoral enclaves and B. semi-dark caves.

Interesting species: It has presented a low value (= 0,19), with only 3 spp.:

- Invertebrata: *Aplysina* sp. (cc), *Spongia officinalis* (r).
- Vertebrata: *Mycteroperca rubra* (r).

Fish populations: Despite the proximity to the city of Beirut and fishing pressure, the fish biomass has been relatively high (19,12 gr/m^2).

Naturalness: The Raoucheh' massive rocks are surrounded by a very crowded city, where the human pressure is high. Mainly, solid wastes, domestic sewage and sportive fishing (shore angling, spearfishing).

Patrimonial value: The landscape is impressive with submarine caves and tunnels. In these caves and tunnels, the presence of bats (order Chiroptera) has been detected; and, probably, the monk seal (*Monachus monachus*) carry out sporadic visits. It represents the Beirut's emblem.

Environmental value: The EV is medium-high (3,44), which entails the protection of this small area as Natural Monument.

7.6.4 Saida (Fig. 158)

Species richness: The number of species, relative abundance and Margalef's index have been relatively low (107, 359 and 18.2, respectively), with 17 observed habitats. This supposes the lowest relative species richness value (0,82) of the whole prospected zones.

Habitats: A total of 17 habitats (biocenosis, associations, facies) have been observed, standing out: pools and lagoons associated with vermetids, A. *Neogonioliton* and *Dendropoma*, A. *Cystoseira* cf. *foeniculacea*.

Interesting species: It has presented a low value (= 0,23), with 6 spp.:

- Macrophyta: *Cystoseira* cf. *foeniculacea* (r)
- Invertebrata: *Axinella polypoies* (r), *Dendropoma petraeum* (r), *Erosaria spurca* (r).
- Vertebrata: *Rhinobatos cemiculus* (r), *Mycteroperca rubra* (r).

Fish populations: Very low biomass (< 1gr/m^2), which means a high fishing pressure in the zone.

Naturalness: The zone of Saida is subject to many human impacts (over-fishing, domestic and industrial sewage discharge, sediment dumping, high presence of solid wastes underwater…). The Naturalness index, together with the urbanized Chekaa sector (Table 25) has been the lowest (0,06).

Figure 158. Northern inlet of Saida, an interesting place to be protected

Patrimonial value: The northern inlets with *Dendropoma* formations, together with the area around the Crusader fortress at the entrance of the harbor, represent the two places to apply protection measures.

Environmental value: The EV value is low (1,66). The whole coastal and marine areas from Saida need urgent measures for integrated coastal zone management, particularly the southern sector (rubbish accumulation on the shore, oil industry, sewage discharge…). However, the sector between Crusader fortress and northern inlets could be the object of some measures of protection.

7.6.5 Tyre (Fig. 159)

Species richness: Although the number of species, relative abundance and Margalef' index have been relatively high (212, 1173 and 29,86, respectively), the adjustment (MH/1,22) presents a relative high value (0,89).

Habitats: A total of 26 habitats (biocenosis, associations, facies) have been observed, standing out: pools and lagoons associated with vermetids, A. *Neogoniolithon* and *Dendropoma*, A. *Sargassum vulgare* and *Cystoseira compressa*, A. *Cystoseira* cf. *foeniculacea*, F. coralligenous (infralittoral enclaves), semi-dark caves, A. *Cymodocea nodosa* and A. *rhodolithes*.

Interesting species: It has presented a high value (= 0,73), with 15 spp.:

- Macrophyta: *Cystoseira* cf. *foeniculacea* (cc), *Cymodocea nodosa* (r).
- Invertebrata: *Aplysina aerophoba* (c), *Sarcothagus* cf. *foetidus* (r), *Spongia officinalis* (r), *Cladocora coespitosa* (r), *Dendropoma petraeum* (r), *Erosaria spurca* (r), *Tonna galea* (r), *Pinna nobilis* (r).
- Vertebrata: *Rhinobatos cemiculus* (r), *Epinephelus costae* (c), *E. marginatus* (r), *Mycteroperca rubra* (c), *Chelonia mydas* (r).

Fish populations: Very low biomass (< 1gr/m^2), that means a high fishing pressure in the zone.

Naturalness: It shows a low value (mean = 0,23) due to the city of Tyre (over- frequentation, trampling, bathing, boating, professional and sportive fishing, domestic sewage discharge, solid wastes…). Industries and commercial harbors are not present on this area, which mean a relatively good environment.

Patrimonial value: The southern beaches of Tyre represents a nesting point for the marine turtles (*Chelonia mydas* and *Caretta caretta*), this area is the object of protection (Tyre Coast Nature Reserve). Around the Tyre peninsula, there are many small inlets and rocky reefs with *Dendropoma* formations. The lagoon formed by the northern inlets and beach harbours is an interesting habitat with rhodoliths.

Environmental value: Although the EV is medium-high (3,04), the Tyre zone represents an excellent area (easily accessible) to environmental education (fishing, habitats, marine conservation…) and monitoring research. Some protection measures would be necessary, particularly to avoid sewage discharge, solid wastes and dynamite fishing.

Figure 159. El Jamal area (Tyre) presents a variety of habitats (rocky reefs and sandy creeks)

7.6.6 Tyre springs (Fig. 160)

Species richness: It has shown the highest value (1,76), with 70 spp. and a relative abundance of 160. Although the Margalef index is relatively low (13,6), only 6 habitats have been observed, which signifies the high value of this parameter.

Habitats: Also the value of habitats has been the highest (1,32), due to the presence of cold and hot freshwater springs, coralligenous biocenosis with Axinella polyploides and maerl beds.

Interesting species: Not abundant, only *Axinella polypoides* and *Lithothamnion corallioides*, both very common.

Fish populations: The biomass index has a mean value of 0,49 (14,28 gr/m^2). Although many lost nets and long-lines appear around the area.

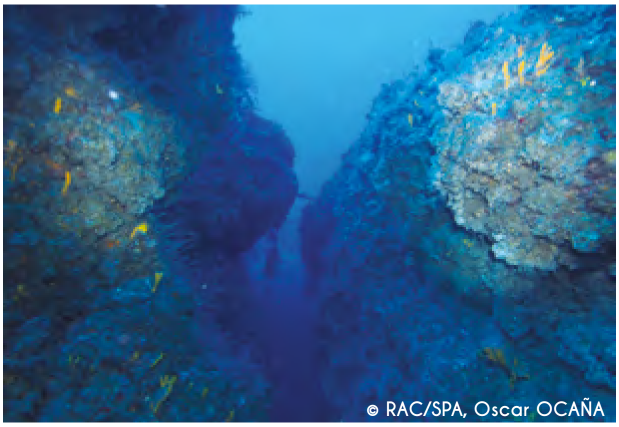

Figure 160. Rocky outcrops in the northern Tyre with lost long-lines, -43 m (st. T-21).

Naturalness: It has the highest value of the zones (0,69), due to the restricted human impacts, with only including professional and sportive fishing (spearfishing, lost nets, mooring), and scuba diving.

Patrimonial value: The presence of freshwater springs, particularly the very rare hot springs, shows the necessity to protect this area. Also, the coralligenous and maerl communities are well represented; as well as the rocky outcrops, which could be a spawning area for groupers.

Environmental value: The EV of the Tyre springs has been the highest (4.49) of the studied zones. The area needs protection measures due to the fishing impacts.

7.6.7 Ras El Bayada (Fig. 161)

Species richness: The number of species, relative abundance and Margalef' index have been relatively high (192, 1195 and 27.1, respectively). However, the adjustment (MH/1,22) presents a low value (0.84).

Habitats: A total of 18 habitats (biocenosis, associations, facies) have been observed, standing out: pools and lagoons associated with vermetids, A. *Neogoniolithon* and *Dendropoma*, A. *Cystoseira* cf. *foeniculacea*, F. coralligenous (infralittoral enclaves), coralligenous on blocks, semi-dark caves, cold freshwater springs and maerl facies.

Species with patrimonial value: It has a high value (= 0,96), with 15 spp.:

- Macrophyta: *Cystoseira* cf. *foeniculacea* (c), *Lithothamnion corallioides* (cc).
- Invertebrata: *Aplysina aerophoba* (r), *Aplysina* sp. (cc), *Axinella polypoides* (cc), *Sarcothagus* cf. *foetidus* (r), *Spongia officinalis* (r), *Dendropoma petraeum* (c), *Erosaria spurca* (r), *Lithophaga lithophaga* (c), *Pinna nobilis* (r), *Paracentrotus lividus* (r).
- Vertebrata: *Epinephelus costae* (c), *E. marginatus* (r), *Mycteroperca rubra* (c).

Fish populations: The biomass index has a mean value of 0,49 (14,28 gr/m^2).

Naturalness: Although the environmental value is medium-high (mean = 3,64), the impacts are mainly due to fishing pressure, particularly the use of dynamite. Ras El Bayada presents a good naturalness index (0,43).

Patrimonial value: Noteworthy are the wide abrasion platforms with littoral pools, where *Dedropoma* is frequent; the littoral caves from Ras El Bayada; and the coralligenous infralittoral enclaves. Also, the cold freshwater springs in front of Ras El Bayada.

Environmental value: The EV is medium high (3.58), but the zone presents important characteristics for a marine protected area with a core zone (Ras El Bayada):

i) low littoral urbanization;

ii) absence of an industrial zone;

iii) relatively good conservation of the coast and marine environment.

Dynamite fishing causes a huge impact and must be completely eliminated.

Figure 161. Ras El Bayada in the Nakoura zone

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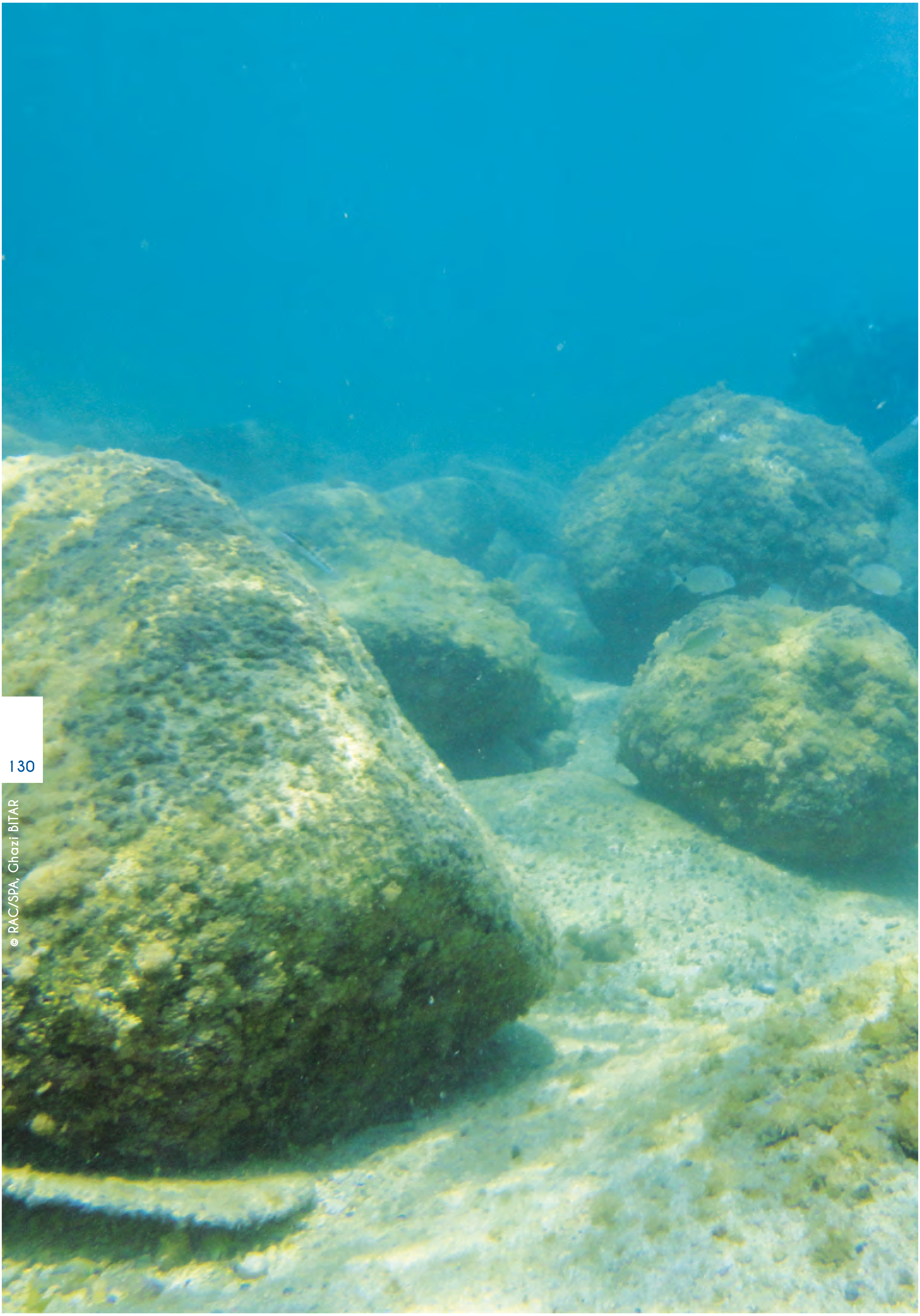

8. MARINE PROTECTED AREAS, ZONING AND MANAGEMENT

To establish the zoning and management of the future marine protected areas (MPA), it is necessary to evaluate the present uses of the zones, including the human impacts and possible threats. This is fundamental, as the success or failure of the MPA depends on the control of the different human pressures, mainly fishing and tourism (Ramos- Esplá, 2009; IUCN, 2012).

8.1 Types and figures of MPAs.

There is no standard model of marine protection; most of the existing models have been taken from regulations based on protected land areas. It is necessary to know what is the main aim when establishing each MPA (species and/or community protection ?, to promote fishing development ?, educational or cultural purposes ?, ..) and what mediums and infrastructure are needed to attain the objectives of each area. MPAs have been established under different legislation and with diverse objectives/criteria:

A variety of nomenclature has been used, and established under different national and regional legislation (fisheries, hunting, environment…): fishery preserved zone, prolongation of terrestrial parks, hunting refuges, marine reserves, marine-terrestrial parks. The objectives are diverse:

- Restricting fishery activity (number of boats, methods, periods, species);
- Marine protection of terrestrial parks (marine buffer zone);
- Preservation of flag species (sanctuaries for monk seal, marine turtles, cetaceans);
- Restocking areas (marine reserves, 'no take zones', 'cantonnements de pêche', 'aree di tutela biologica');
- Preservation of marine and/or coastal environment (e.g. maritime national parks, natural marine reserves).

The IUCN (Day *et al.*, 2012) establishes six management categories (one with a sub-division), summarized below.

Category I:

Strict nature reserve (Ia) and wilderness Area (Ib)

<u>Strict nature reserve</u>: Strictly protected for biodiversity and also possibly for geological/geomorphological features, where human visitation, use and impacts are controlled and limited to ensure protection of the conservation values.

<u>Wilderness area</u>: Usually large unmodified or slightly modified areas, retaining their natural character and influence, without permanent or significant human habitation, protected and managed to preserve their natural condition.

Category II:

<u>National park</u>: Large natural or near-natural areas protecting large-scale ecological processes with characteristic species and ecosystems, which also have environmentally and culturally compatible spiritual, scientific, educational, recreational and visitor opportunities.

Category III:

<u>Natural monument or feature</u>: Areas set aside to protect a specific natural monument, which can be a landform, sea mount, marine cavern, geological feature such as a cave, or a living feature such as an ancient grove.

Category IV:

<u>Habitat/species management area</u>: Areas to protect particular species or habitats, where management reflects this priority. Many will need regular, active interventions to meet the needs of particular species or habitats, but this is not a requirement of the category.

Category V:

<u>Protected landscape or seascape</u>: Where the interaction of people and nature over time has produced a distinct character with significant ecological, biological, cultural and scenic value: and where safeguarding the integrity of this interaction is vital to protect and sustain the area and its associated nature conservation and other values.

Category VI:

<u>Protected areas with sustainable use of natural resources</u>: Areas which conserve ecosystems, together with associated cultural values and traditional natural resource management systems. Generally large, mainly in a natural condition, with a proportion under sustainable natural resource management and where low-level non-industrial natural resource use compatible with nature conservation is seen as one of the main aims.

8.2 Zoning and management

Generally, conflicting interests, such as those between conservation and exploitation, represent a major issue in resource-allocation exercises. There are many different approaches to marine protected area planning, management and zoning. The choice of approach should be influenced by the prevailing resources as well as the environmental, social, political and economic parameters (Salm & Dobbin, 1993).

Thus, we should consider in MPAs:

- the ecological component: linked environments and component species (scientific support);
- the socio-economic component: pressures on the ecological component from human activities and needs (socio-economic support);
- the political component: the administrative and institutional influences and constraints (legal support).

To avoid human impacts as far as possible, it is necessary to consider the zoning of the MPA planning. Moreover, the zoning may resolve some conflicts between users of the coastal zone (selective/non selective fishing methods, professional/sports fishing, scuba diving/spearfishing). The principle objectives of zoning reflect the objectives for the management of the MPA and are usually (Kelleher & Kenchington, 1992; Laffoley, 1995):

- To provide protection for critical or representative habitats, ecosystems and ecological processes;
- To preserve some areas of the MPA in their natural state undisturbed by humans except for the purposes of scientific research or education;
- To separate conflicting human activities;
- To protect the natural and/or cultural qualities of the MPA whilst allowing a spectrum of reasonable human uses;
- Traditional users of the managed area should be consulted and involved in the development and implementation of management plans;
- To reserve suitable areas for particular human uses, whilst minimizing the effects of those uses on the MPA.

An MPA refers to a management area in which the use is regulated by zoning for different activities. It includes marine reserves, which are strictly no-take areas. In this sense, the philosophy and zoning (Fig. 162) of the Biosphere Reserves (Man and Biosphere Program, UNESCO, 1976) may be useful for integrating the conservation and exploitation in MPAs, according to three basic functions of the Biosphere Reserves:

- **Conservation function:** preservation of the different levels of biological biodiversity (genetic, taxonomic, habitats, ecosystems).
- **Logistic function:** focused on research and monitoring from inside and outside the MPAs, as well as supplying services for education and information.
- **Development function:** to allow traditional uses (artisanal fishing) and low impact activities ('soft-tourism') that sustain a rational and continuous exploitation of natural resources and cooperation with local populations.

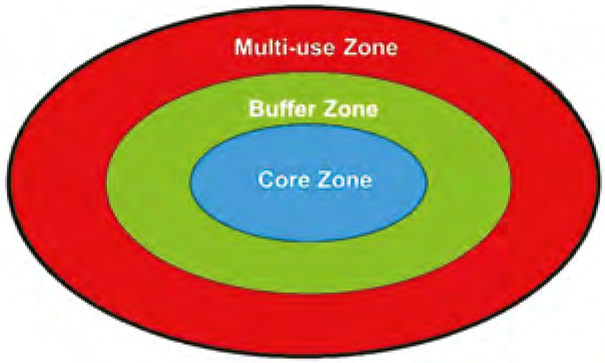

Figure 162. Zoning in the Biosphere Reserves (MaB, UNESCO, 1976): core zone or integral reserve; buffer zone or protection of the core zone; and multi-use or peripheral zone, development area.

With regards to the management of the zones, IUCN (Day *et al.*, 2012) establishes different activities/uses (permit or not) according to the different categories (Table 27). Due to the particular features of the coast of Lebanon (relatively short coast, high human density, high littoral urbanization, high industry, tourism pressure, over-fishing), it is necessary to adapt some of the IUCN categories to the different managed zones:

Core zone: The core zone could correspond to the 'wilderness area' (IUCN category Ib). Usually large unmodified or slightly modified areas, retaining their natural character and influence, without permanent or significant human habitation, protected and managed to preserve their natural condition.

Buffer zone: It could correspond to the 'habitat/species management area' (IUCN category IV). Areas to protect particular species or habitats, where management reflects this priority. Many will need regular, active interventions to meet the needs of particular species or habitats, but this is not a requirement of the category.

Multiuse or peripheral zone: It could correspond to the 'protected areas with sustainable use of natural resources' (IUCN category VI). Areas which conserve ecosystems, together with associated cultural values and traditional natural resource management systems. Generally large, mainly in a natural condition, with a proportion under sustainable natural resource management and where low-level non-industrial natural resource use compatible with nature conservation is seen as one of the main aims.

The case of Raoucheh is different, a small area with a high natural/geological value, as well as landscape. The Natural monument (IUCN category III) must be applied. Areas set aside to protect a specific natural monument, which can be a landform, sea mount, marine cavern, geological feature such as a cave, or a living feature such as an ancient grove.

8.3 Proposed MPAs

In the previous chapter (7. Evaluation of the zones), we have evaluated the different proposed zones (species richness, habitats, interesting species, fish populations, naturalness). According to this evaluation and protected area, we have established four categories with different management measures:

a) Tyre Springs and Ras Chekaa present the highest values (> 4). Ras Chekaa has some pristine areas (central sector) which merit an integral protection. Furthermore, the underwater rocky outcrops from northern Tyre, between 30-50m depth, due to the rarity and the presence of interesting habitats (cold and hot freshwater springs, coralligenous, maerl beds) must be protected.

b) Nakoura and Raoucheh have presented high values (~3.5). Also, in the Nakoura zone, Ras El Bayada represents a pristine area which merits an integral protection (littoral cave, cold freshwater springs, and relatively high fish biomass). Raoucheh shows an impressive landscape with important marine caves and tunnels. This area is small and rounded by the city of Beirut; the adequate protection figure would be Natural Monument.

c) Enfeh and Tyre: Due to the high human presence, they have medium values (~3.0) and an integral protection area would be inoperative. In these cases, the buffer zone could be operative, permitting some regulated uses (fishing, tourism) and applying mitigation measures to the human impacts (sewage treatment, selective fishing methods, no marinas). In the case of the Tyre Coast Nature Reserve, a buffer zone could reinforce the protection of this important area for turtle nesting.

d) Saida: Despite the important cultural value, Saida presents a very impacted and crowded environment,

Table 27: Matrix of marine activities that may be appropriate for each IUCN management category

ACTIVITIES / IUCN Categories	Ia	Ib	II	III	IV	V	VI
Research: non-extractive	Y*	Y	Y	Y	Y	Y	Y
Non-extractive traditional use	Y*	Y	Y	Y	Y	Y	Y
Restoration/enhancement for conservation (e.g. invasive species control, coral reintroduction	Y*	*	Y	Y	Y	Y	Y
Traditional fishing/collection in accordance with cultural tradition and use	N	Y*	Y	Y	Y	Y	Y
Non-extractive recreation (e.g. diving)	N	*	Y	Y	Y	Y	Y
Large scale low intensity tourism	N	N	Y*	Y*	Y	Y	Y
Shipping (except as may be unavoidable under international maritime law)	N	N	Y*	Y*	Y	Y	Y
Problem wildlife management (e.g. shark control programmes)	N	N	Y*	Y*	Y*	Y	Y
Research: extractive	N*	N*	N*	N*	Y	Y	Y
Renewable energy generation	N	N	N	N	Y	Y	Y
Restoration/enhancement for other reasons (e.g. beach replenishment, fish aggregation, artificial reefs)	N	N	N*	N*	*	Y	Y
Fishing/collection: recreational	N	N	N	N	*	Y	Y
Fishing/collection: long term and sustainable local fishing practices	N	N	N	N	*	Y	Y
Aquaculture	N	N	N	N	*	Y	Y
Works (e.g. harbours, ports, dredging)	N	N	N	N	*	Y	Y
Untreated waste discharge	N	N	N	N	N	Y	Y
Mining (seafloor as well as sub-seafloor)	N	N	N	N	N	Y*	Y*
Habitation	N	N*	N*	N*	N*	Y	N*

Key: (N) No; (N*) Generally no, unless special circumstances apply; (Y) Yes; (Y*) Yes because no alternative exists, but special approval is essential; (*)Variable; depends on whether this activity can be managed in such a way that it is compatible with the MPA's objectives (from Day *et al.*, 2012).

with the lowest EV (1.66), where a MPA would be impossible. Nevertheless, the multi-use zone could be applied with an integrated coastal zone management.

8.3.1 Zoning

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 harmful activities;

iii) resource management area (multiuse zone) with regulation of certain uses.

8.3.1.1 Northern sector

The protected-managed areas in the northern sector (Enfeh, Ras Chekaa, Raoucheh) would be (Fig. 163) about 2 km to the shore and following the isobathic limit of 50 m depth. Although the Enfeh-Chekaa and South of Ras Chekaa sectors are very problematic (polluting industries, commercial harbours), it is necessary to integrate them in the management plan of the futures MPAs.

a) Enfeh: The applied figure would be a buffer zone, with some uses for the local population (fishing, tourism) and protection measures (domestic sewage treatment, selective fishing methods such as hand-lines and long-lines, environmental education…). The protected area includes 4 km of the littoral to 30 m (about 4 km^2 of surface).

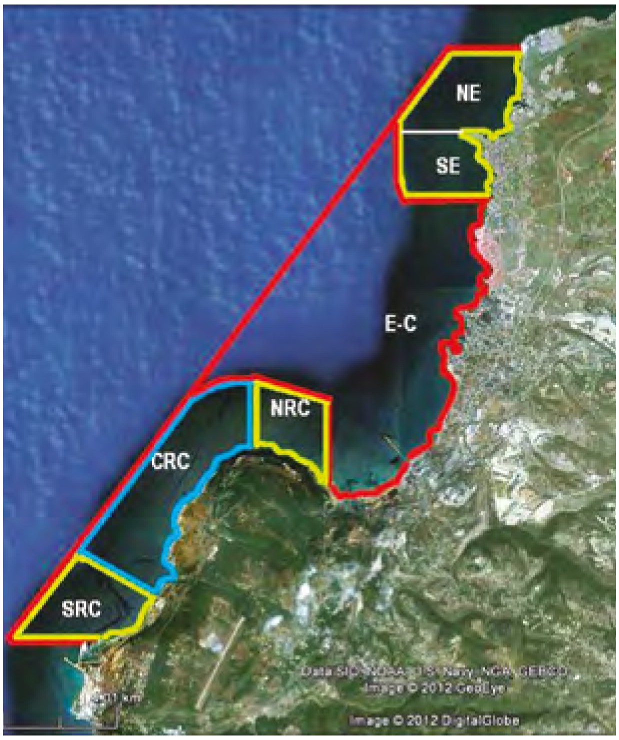

Figure 163. Proposed MPAs and possible zoning: core area (blue), buffer area (green) and multi-use or peripheral area (red)

Zones: (NE) North Enfeh; (SE) South Enfeh; (E-C) Enfeh-El Heri; (NRC) North Ras Chekaa; (CRC) Centre Ras Chekaa); (SRC) South Ras Chekaa (from Google Earth).

b) Ras Chekaa: It represents an extensive area with 3 zones (Fig. 163): north, central and south (~ 16 km^2). The north sector is predominately touristic (beaching, boating, marina), whereas the south one is industrial (commercial harbour of Selaata, mineral industry). Only the central sector is relatively free of human impacts, that's why it has a pristine environment which may be a core zone (~ 10 km^2) from the littoral to a depth of 30 m. The north and south areas could be buffer zones(both ~3 km^2) subject to management measures (fishing and industry controls, terrestrial protection).

c) Enfeh-Ras Chekaa sector: In the middle of the Enfeh peninsula and Ras Chekaa (Fig. 163), the Chekaa zone represents a very impacted area through industrial activities (concrete and thermo-electrical power plants) and very crowded through the tourism in the summer season. This area (~15 km^2) could be a multi-use zone with an integrated coastal zone management.

8.3.1.2 Raoucheh:

It deserves a particular consideration, other than the high aesthetic value (high rocky shore, forming a creek with two large pinnacles of rock and littoral caves), as Natural Monument or a special protected area of about 1 km^2 of surface (Fig. 164):

Figure 164. Raoucheh area (from Google Earth)

i) presence of the littoral caves for the monk seals (*Monachus monachus*), usually,two individuals have been seen in the area in the last few years;

ii) presence of new species in the caves (e.g. a new *Aplysina* sp., *Euryspongia raouchensis*);

iii) important population of bats (*Chiroptera* spp.).

8.3.1.3 Southern sector

a) Saida: The evaluation is low due to the multiple impacts that occur in the area (rubbish, hyper-sedimentation, anthropic pressure, industrial wastes).

However, an integrated coastal zone management is necessary, mainly in the interesting northern zone (historical site and inlets); and the southern zone with the 'rubbish mountain'.

A multi-use zone around the village zone is proposed (~ 8 km^2) with the northern inlets, from the shore to the depth of 20 m. Even, a small buffer zone (~ 1 km^2) between Crusader fortress and northern inlets (Fig. 165a).

b) Tyre (around the city): No core zone due to the proximity of the population. Nevertheless, a Marine Protected Area is proposed with two zones (total of 30 km^2) (Fig. 165b):

- Buffer zone (~10 km^2): Inlets around Tyre and the western part of the northern lagoon (maerl and *Cystoseira* forest). In the southern part, to protect the Tyre Coast Nature Reserve and *Cymodocea* meadows.
- Multi-use zone (~20 km^2): Around Tyre, from the shore to a depth of 20 m.

c) Tyre (submarine freshwater spring): Due to the high interest of this zone a Marine Protected Area (~5 km^2) is proposed with two zones (Fig. 165b, upper part):

- Core zone (~1,75 km^2), including the rocky outcrops with hot and freshwater springs (30-50 m depth).
- Buffer zone (~3,25 km^2): Circle with a radius of 500 m around the core zone.

d) Nakoura: A Marine Protected Area is proposed with 3 zones (Fig. 164c), with a total area of 60 km^2.

- Core zone: Ras El Bayada, from the shore to a 20 m depth (~5 km^2).
- Buffer zone: Nakoura from the shore up to a 20 m depth, around the core zone (~25km^2).
- Multi-use zone: Around the core and buffer zones, from the shore to a 40 m depth (~30 km^2).

The Table 28 summarizes the protected surface of the different observed zones, depending on the protection levels (core, buffer and multi-use zones). The coastline of Lebanon is 225 km, and 2 km from the shore to the open sea, that means 450 km^2. The present proposal for MPAs for Lebanon will represent about the 3 % of its marine environment with a measure of protection.

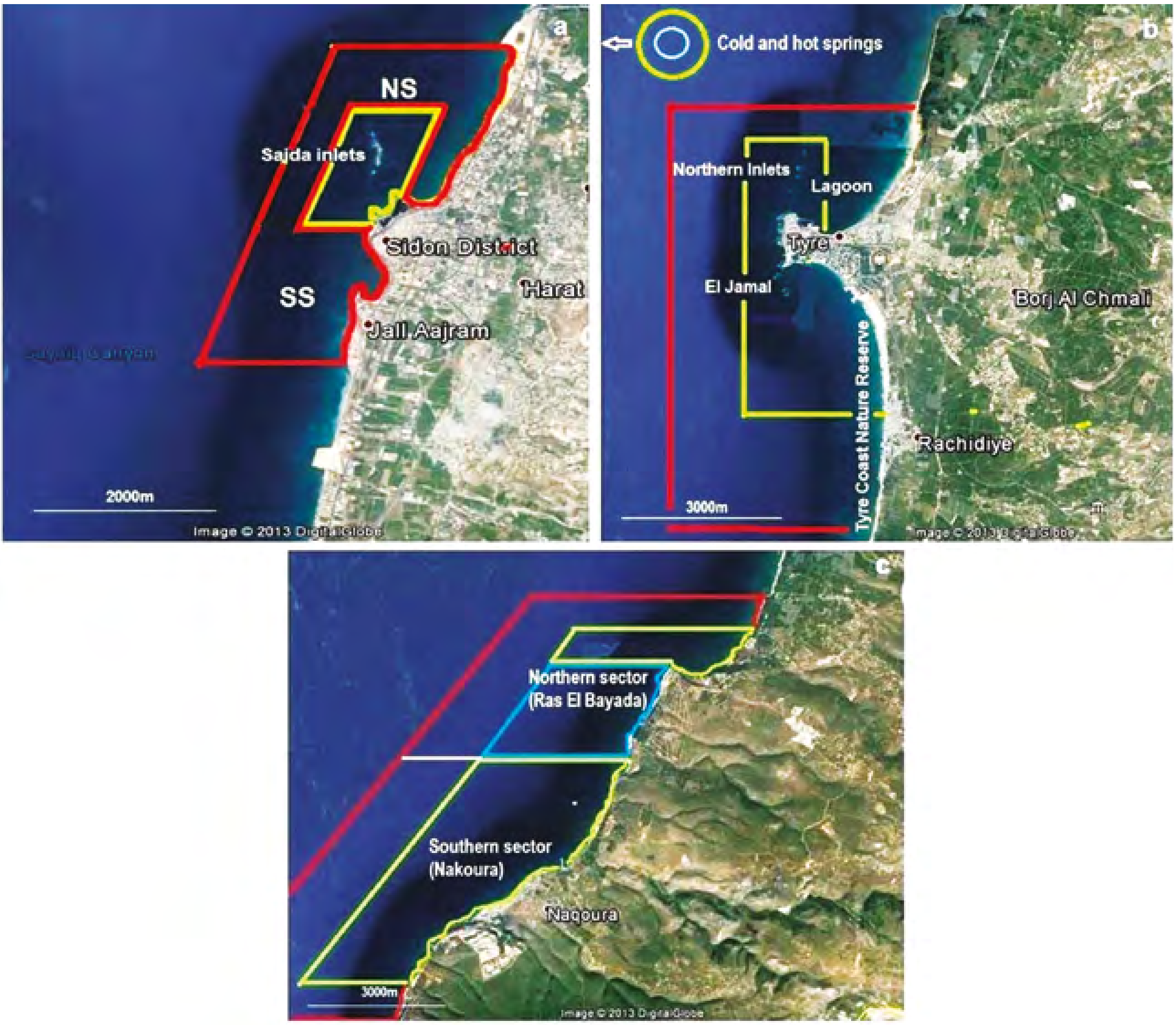

Figure 165. Proposed MPAs and possible zoning: core area (blue), buffer area (green) and multi-use or peripheral area (red). Zones: (a) Saida; b) Tyre; c) Nakoura. (from Google Earth).

Table 28. Surface (in km^2) of the possible MPAs from Lebanon, according to the different management zones

Zones	Core Zone	Buffer Zone	Multi-use Zone	Total
Enfeh	-	4	-	4
Enfeh-Ras Chekaa	-	-	15	15
Ras Chekaa	10	6	-	16
Raoucheh	-	1	-	1
Saida	-	1	7	8
Tyre Springs	1,75	3,25	-	5
Tyre	-	10	20	30
Nakoura	9	21	25	55
Total	20.75	45.25	67	133
%	15.6	34.0	50.4	100

8.4 Management measures

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

In this sense, the 'Protocol concerning Specially Protected Areas (SPA) and Biological Diversity in the Mediterranean' (Barcelona Convention, 1995) mentions in the article 7-1 that: 'The Parties shall, in accordance with the rules of international law, adopt planning, management, supervision and monitoring measures for the SPAs. Later (art. 7-2), it indicates the measures that should be included for each SPA. The table 29 summarizes the possible uses and management measures.

Table 29. Possible uses and management measures of the different zones in the marine protected/managed areas

Uses/Zones	CZ	BZ	MZ
Sportive fishing (nets, traps)	N	N	N
Aquaculture (inshore cages)	N	N	Y
Industry	N	N	Y(1)
Spearfishing	N	N	Y(2)
Dredging	N	N	Y(1)
Sewage dumping	N	N	Y(3)
Boating	N	Y	Y
Beaching/swimming	N	Y	Y
Snorkeling	N	Y	Y
Littoral urbanization	N	Y (4)	Y (4)
Sportive ports	N	Y(5)	Y(5)
Fishery port	N	Y(5)	Y(5)
Mooring	N	Y(6)	Y
Professional fishing	N	Y(7)	Y(7)
Shore angling	N	Y(2)	Y
Research/education	Y	Y	Y
Scuba diving	Y(2)	Y	Y
Tourism, visitors	Y(8)	Y	Y

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

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10. ANNEXES

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10.1 Annex I: Characteristics of the stations of the 2012 and 2013 missions

Station Code	Locality	Date	Depth (m)	Lat. N (i)	Long. E (i)	Lat. N (f)	Long. E (f)	Observers	Meth.	Observations
E-1	Enfeh	19.06.2012	0-8	34°21,701'	35°43,551'	34°21,667'	35°43,741'	G,H,Y	Sk	Rock with *Stypocaulon scoparium* facies
E-2	Enfeh	"	0-3	34°21,658'	35°43,732'	-	-	H,Y	Sk	Muddy sand with *Cymodocea nodosa* meadow
E-3	N-Enfeh	"	20-27	34°22,101'	35°43,734'	34°22,194'	35°43,975'	Ar	Hy	Muddy sand *Cymodocea nodos*a very rare
E-4	N-Enfeh	"	21-31	34°22,300'	35°43,574'	34°21,988'	35°43,642'	C	Hy	Muddy sand with pebbles
E-5	N-Enfeh	"	29-34	34°22,182'	35°43,484'	34°22,191'	35°43,542¡	Af	Hy	Muddy sand with boulders
E-6	NW-Enfeh	"	11-33	34°21,986'	35°43,327'	34°21,715'	35°43,728'	O	Hy	Muddy sand with boulders
E-7	Enfeh	20.06.2012	0-6	34°21,664'	35°43,733'	34°21,719'	35°44,037'	G,H,Y	Sc	Muddy sand, *Cymodocea nodosa*, rock and boulders
E-8	W-Enfeh	"	25-40	34°21,817'	35°43,179'	34°21,834'	35°43,492'	Ar	Hy	Muddy sand
E-9	SW-Enfeh	"	8-47	34°21,631'	35°42,938'	34°21,611'	35°43,424'	C	Hy	Muddy sand and rocks
E-10	S-Enfeh	"	12-29	34°21,479'	35°43,107'	34°21,374'	35°43,690'	O	Hy	Muddy sand
E-11	S-Enfeh	"	4-25	34°21,242'	35°43,104'	34°21,169'	35°43,708'	Af	Hy	Muddy sand, rock and boulders
C-1	Beach Ras Chekaa	"	6-15	34°19,007'	35°42,218'	34°18,660'	35°42,549'	Ar	Hy	Muddy sand
C-2	N-Ras Chekaa	"	7-24	34°18,228'	35°41,942'	34°18,881'	35°41,323	C	Hy	Muddy sand, at the end with pebbles
C-3	El Heri (N-Ras Chekaa)	21.06.2012	0-5	34°18,699'	35°41,740'	34°18,837'	35°40,281'	G,Y	Sk	Bare rock with *Ganonema farinosum*
C-4	W-Cape Ras Chekaa	"	12-27	34°19,136'	35°40,179'	34°18,842'	35°41,010'	O	Hy	Sandy detritic, pebbles, rock
C-5	SW-Cape Ras Chekaa	"	18-40	34°18,986'	35°40,098'	34°18,642'	35°40,735'	Af	Hy	Sandy detritic, pebbles, rock
C-6	SW-Cape Ras Chekaa	"	31-33	34°18,753'	35°39,900'	34°18,809'	35°39,951	Ar	Hy	Sandy detritic, smooth rock, entangled hydroplane
C-7	SW-Cape Ras Chekaa	"	16-46	34°18,866'	35°39,843'	34°18,489'	35°40,561'	C	Hy	Coastal detritic with maerl, pebbles, smooth rock
C-8	S-Ras Chekaa	"	6-43	34°18,464'	35°39,714'	34°18,026'	35°40,007'	O	Hy	Coastal detritic with maerl, pebbles, blocks, rock
C-9	Hannouch	"	20-30	34°18,151'	35°39,451'	34°17,669'	35°40,029'	Af	Hy	Smooth rock with blocks and canals
C-10	El Heri (N-Ras Chekaa)	22.06.2012	0-12	34°17,881'	35°40,174'	34°18,194'	35°40,281'	G,H,Y	Sc	Rock wirh *Corallina* et *Jania*
C-11	Front Port Chekaa	"	0-8	34°18,347'	35°39,650'	-	-	H,Y	Sc	Sand, *Cymodocea nodosa* meadow
C-12	N-Port Selaata	"	17-40	34°17,408'	35°39,650'	34°17,223'	35°39,826'	O	Hy	Muddy sand
C-13	NW-Cape Ras Chekaa	"	28-44	34°19,909'	35°41,295'	34°19,170'	35°41,211'	C	Hy	Muddy sand, smooth rock

Station Code	Locality	Date	Depth (m)	Lat. N (i)	Long. E (i)	Lat. N (f)	Long. E (f)	Observers	Meth.	Observations
E-12	Enfeh	23.06.2013	0-4	34°21,634'	35°43,831'	34°21,657'	35°43,880'	G,H,Y	Sc	Midlittoral caves, littoral rock
E-14	SW-Enfeh	"	8-24	34°21,676'	35°43,181'	-	-	Ar,Af,O,C	Sc,FVC	Rock with *Chama*
E-15	S-Enfeh	"	10-15	34°21,187'	35°43,597'	-	-	Ar,Af,O,C	Sc,FVC	Rock, boulders
C-14	Crique de Hannouch	24.06.2012	0-12	34°18,254'	35°40,321	34°18,481'	35°40,576'	G,H,Y	Sc	Rock with *Corallina* et *Jania*
C-15	SW-Ras Chekaa	"	42-44	34°18,464'	35°39,714'	-	-	Ar,Af,O,C	Sc,FVC	Coastal detritic with maerl
C-16	Front Hannouch	"	20-25	34°18,199'	35°39,949'	-	-	Ar,Af,O,C	Sc,FVC	Rock with *Chama*
C-17	Ras Chekaa	25.06.2012	0-12	34°23,517'	35°40,625'	34°18,733'	35°40,833'	G,H,Y	Sc	Rock with *Corallina* et *Jania*
C-18	SW-Ras Chekaa	"	42-44	34°18,464'	35°39,714'	-	-	Ar,Af,O,C	Sc	Coastal detritic with maerl
C-19	Grotte Chack El Hatab	"	0-5	34°17,641'	35°40,267'	-	-	G,H,Y,Ar,Af,O,C	Sc,FVC	Cave, littoral rock
C-20	Ras Chekaa	26.06.2012	0-8	34°18,859'	35°41,178'	-	-	G,H,Y	Sc	Littoral rock
C-21	SW-Ras Chekaa	"	32-33	34°18,753'	35°39,900'	-	-	Ar,Af,O,C	Sc,FVC	Coastal detritic with smouth rock
C-22	Ras Chekaa (harbour)	"	0-3	34°18,697'	35°41,827'	-	-	H,Y	Sk	Boulders and sandy bottom
C-23	El Heri	"	0-2	34°18,833'	35°41,230'	-	-	G,O,Ar	Sk,W	Littoral rock, boulders
R-1	Grotte Raoucheh	28.06.2012	0-6	33°53,316'	35°28,165'	-	-	G,O,Ar,C,Af	Sc,FVC	Cave, littoral rock
N-1	Nakoura	27.08.2013	0	33°06,265'	35°06,288'	-	-	AR	W	Littoral rock
N-2	Ras El Bayada	28.08.2013	11-14	33°10,087'	35°09,986'	-	-	G,H,Y	Sc	Hard substrata with small sandy patches
N-3	Ras El Bayada	"	0-6	33°09,531'	35°08,869'	-	-	G,H,Y	Sc	Rocky substrata with boulders, cave
N-4	Nakoura	"	13-32	33°07,759'	35°07,050'	33°07,377'	35°07,513'	AR	Hy	Flat rock with coarse sandy canals
N-5	Nakoura	"	26-34	33°08,765'	35°07,480'	33°08,405'	35°07,897'	O	Hy	Flat rock with coarse sandy canals
N-6	Nakoura	"	18-36	33°09,743'	35°07,844'	33°08,912'	35°08,869'	C	Hy	Flat rock and fine sandy patches
N-7	Nakoura	"	5-29	33°10,496'	35°08,944'	33°09,349'	35°09,593'	AF	Hy	Irregular rocky substrata with boulders and sandy bottoms
N-8	Ras El Bayada	29.08.2013	31-37	33°12,382'	35°08,809'	33°12,619'	35°09,497'	C	Hy	Flat rock and sandy bottoms
T-1	Tyre-N	"	3-11	33°17,215'	35°11,738'	33°17,153'	35°11,738'	G,H,Y	Sc	Rocky substrata with boulders and coarse sand patches
T-2	Tyre-S	"	0-5	33°15,898'	35°11,452'	33°16059'	35°11,687'	G,H,Y	Sc,Sk	Rocky substrata with boulders and sand, roman columns
T-3	Tyre-S	"	12-31	33°14,380'	35°10,449'	33°14,436'	35°11,258'	AR	Hy	Muddy-sand and flat rock with canals
T-4	Tyre-S	"	9-22	33°14,535'	35°11,097'	33°14,500'	35°12,217'	O	Hy	Flat and irregular rock, coarse and fine sand
T-5	Tyre-N	30.08.2013	0-6	33°17,017'	35°11,935'	33°17,126'	35°11,806'	G,H,Y	Sc	Coarse sand substrata with boulders and rocky substrata, lagoon

Station Code	Locality	Date	Depth (m)	Lat. N (i)	Long. E (i)	Lat. N (f)	Long. E (f)	Observers	Meth.	Observations
T-6	Tyre-N	"	0-6	33°15,941'	35°11,476'	33°16,051'	35°11,697'	G,H,Y	Sc	Rocky substrata with small sand patches, littoral rock
T-7	Tyre-N	"	1-30	33°19,636'	35°12,490'	33°19,333'	35°13,920'	AF	Hy	Irregular rock with sandy canals, big boulders
T-8	Tyre-N	"	16-28	33°17,387'	35°10,477'	33°17,276'	35°11,434'	C	Hy	Flat rock with small boulders and sandy patches
T-9	Tyre-C	"	13-26	33°16,216'	35°10,262'	33°16,119'	35°11,162'	AR	Hy	Flat rock with sandy canals
T-10	Tyre-S	"	5-21	33°13,691'	35°10,797'	33°13,765'	35°10,158'	O	Hy	Flat and irregular rock, coarse and fine sand
N-9	Nakoura	31.08.2013	8-15	33°06,902'	35°06,850'	33°06,796'	35°06,748'	G,H,Y	Sc	Rocky substrata with small and big boulders, small sandy patches
N-10	Ras El Bayada	"	0-8	33°09,895'	35°10,137'	33°09,875'	35°10.205'	G,H,Y	Sc	Rocky substrata with boulders and cave, seabed cover by sand
N-11	Nakoura	"	33-35	33°08,796'	35°07,497'	-	-	O,AR,C,AF	Sc,FVC	Flat rock with gravel and rhodoliths
N-12	Nakoura	"	21-23	33°07,672'	35°07,422'	-	-	O,AR;C,AF	Sc,FVC	Flat rock with coarse sandy canals
S-1	Saida	01.09.2013	4-14	33°34,285'	35°21,917'	33°34,244'	35°22,004'	G,H,Y	Sc	Rocky substrata with sand patches and boulders
S-2	Saida	"	0-3	33°34,106'	35°22,148'	-	-	G,H,Y	Sc	Rocky substrata
S-3	Saida	"	0-3	33°34,365'	35°22,110'	-	-	G,H,Y	Sk,W	Littoral rock, abrasion platform
S-4	Saida-S	"	20-39	33°33,786'	35°20,911'	33°33,804'	35°21,457'	O	Sc	Muddy-sand bottom
S-5	Saida-C	"	10-30	33°34,354'	35°21,266'	33°34,313'	35°21,951'	C	Hy	Flat rock with small boulders and sandy bottoms
S-6	Saida-N	"	9-17	33°34,697'	35°21,850'	33°34,654'	35°22,718'	AF	Hy	Flat rock, coarse and fine sand
S-7	Saida-N	"	8-22	33°34,978'	35°21,954'	33°34,979'	35°22,742'	AR	Hy	Flat rock and coarse sand
T-11	Tyre-C	02.09.2013	3-7	33°16,813'	35°11,741'	33°16,911'	35°11,736'	G,H,Y	Sc	Coarse sandy rocky bottom with bottom currents, high ripple-marks
T-12	Tyre-C	"	13-15	33°16,954'	35°11,326'	-	-	G,H,Y	Sc	Rocky bottom with small sandy patches
T-13	Tyre-S	"	7-27	33°15,143'	35°10,877'	33°15,078'	35°11,645'	O	Hy	Flat rock with sand
T-14	Tyre-C	"	4-26	33°18,371'	35°11,394'	33°18,091'	35°13,017'	C	Hy	Flat rock with sandy canals
T-15	Tyre-N	"	3-12	33°16,987'	35°11,784'	33°16,819'	35°12,697'	AR	Hy	Lagoon, sandy bottom with cobbles and pebbles
T-16	Tyre-N	"	7-9	33°16,566'	35°11,858'	-	-	Z	Sc	Lagoon, sandy bottom with cobbles and pebbles
T-17	Tyre-N	"	0-2	33°17,028'	35°11,725'	-	-	O	Sk,W	Littoral rocky reefs
N-13	Nakoura	03.09.2013	12-22	33°07,216'	35°06,595'	33°07,055'	35°06,957'	G,H,Y	Sc	Flat rocky bottom
N-14	Nakoura	"	43-44	33°07,613'	35°04,948'	-	-	O,AR;C	Sc,FVC	Detritic bottom with boulders
N-15	Ras El Bayada	"	12-15	33°10,088'	35°10,000'	-	-	O,AR,C	Sc,FVC	Rocky substrata with cold freshwater springs

Station Code	Locality	Date	Depth (m)	Lat. N (i)	Long. E (i)	Lat. N (f)	Long. E (f)	Observers	Meth.	Observations
T-18	Tyre-S	"	0-3	33°15,748’	35°11,593’	33°15,815’	35°11,537’	G,H,Y	Sk	Rocky substrata with boulders and sand
T-19	Tyre-S	04.09.2013	12-18	33°15,995’	35°11,187’	33°15,857’	35°11,609’	G,H,Y	Sc	Flat rocky substrata with some sandy canals
T-20	Tyre-S	"	0-3	33°16,072’	35°10,946’	33°16,016’	35°11,567’	G,H,Y	Sk	Rocky substrata
T-21	Tyre-N	"	32-47	33°19,965’	35°11,323’	-	-	O,AR,C	Sc,FVC	Rocky substrata with cold freshwater springs
T-22	Tyre-N	"	7-9	33°16,939’	35°11,933’	-	-	G,H,Y,O,AR	Sc,FVC	Lagoon, small boulders and cobbles with *Cystoseira* sp.
T-23	Tyre-C	05.09.2013	16-18	33°15,922’	35°11,076’	-	-	G,Y	Sc	Flat rocky substrata with some sandy canals
T-24	Tyre-N	"	6-7m	33°16,939’	35°11,933’	-	-	G,Y	Sc	Lagoon, small boulders and cobbles on sandy bottom
T-25	Tyre-N	"	38-42m	33°19,946’	35°10,624’	-	-	O,AR,C	Sc,FVC	Rocky substrata with warm freshwater springs
N-16	Nakoura	13.09.2013	15-18m	33°07,937’	35°07,483’	-	-	H,Z	Sc	Aeroplane wreck

Code: (C) Ras Chekaa; (E) Enfeh; (N) Nakoura; (R) Raoucheh; (S) Saida; (T) Tyre. (Lat.) Latitude: (i) initial; (f) final. (Long.) Longitude: (i) initial; (f) final. Observers: (Af) A. Forcada; (Ar) A. Ramos;(C) C. Valle; (G) G. Bitar; (H) H. El Shaer; (O) O. Ocaña; (Y) Y. Sghaier; (Z) Z. Samaha. (Meth.) Methodology: (FVS) fish visual census; (Hy) hydroplane; (Sc) scuba diving plot; (Sk) snorkeling; (W) walking.

10.2 Annex II: Inventory of the taxa observed in the 2012 and 2013 missions

TAXA	Synonymy	2012	2013
PROTEOBACTERIA			
Beggiatoa spp.		-	CC
CIANOBACTERIA			
Calothrix sp.		C	-
Phormidium autumnale (C.Agardh) Trevisan ex Gomont, 1892		-	CC
Oscillatoria sp.		-	CC
Rivularia atra Roth ex Bornet & Flahault, 1886		-	C
FUNGI			
Verrucaria amphibia Clemente, 1814		C	C
CHLOROPHYTA			
Bryopsis plumosa C.Agardh, 1823		C	C
Caulerpa prolifera (Forsskål) J.V.Lamouroux, 1809		C	-
**Caulerpa scalpelliformis* (R.Brown ex Turner) C.Agardh, 1817		C	R
Chaetomorpha sp.		-	R
Cladophora pellucida (Hudson) Kützing, 1843	*C. pseudopellucida*	R	-
Cladophora sp.		CC	CC
**Cladophoropsis modonensis* (Kützing) Reinbold, 1905	*Cladophora patentiramea*	R	-
**Codium parvulum* (Bory ex Audouin) P.C.Silva, 2003		-	CC
**Codium taylorii* P.C.Silva, 1960		CC	-
Dasycladus vermicularis (Scopoli) Krasser, 1898		R	-
Flabellia petiolata (Turra) Nizamuddin, 1987		C	-
Palmophyllum crassum (Naccari) Rabenhorst, 1868		R	R
Penicillus capitatus stadio Espera Lamarck, 1813		R	-
Ulva compressa Linnaeus, 1753	*Enteromorpha compressa*	CC	C
Ulva intestinalis Linnaeus, 1753	*Enteromorha intestinalis*	C	CC
Ulva cf. *lactuca* Linnaeus, 1753	*U. fasciata*	CC	-
Valonia utricularis (Roth) C.Agardh, 1823		C	-
OCHROPHYTA			
Arthrocladia villosa (Hudson) Duby, 1830		CC	-
Colpomenia sinuosa (Mertens ex Roth) Derbès & Solier, 1851		CC	-
Cystoseira compressa (Esper) Gerloff & Nizamuddin, 1975	*C. abrotanifolia, C. fimbriata*	C	C
Cystoseira foeniculacea (Linnaeus) Greville, 1830	*C. discors, C. ercegovicii*	-	C
Cystoseira dubia Valiante, 1883		R	-
Dictyota dichotoma (Hudson) J.V.Lamouroux, 1809		R	-
Dictyota fasciola (Roth) J.V.Lamouroux, 1809			CC
Dictyota linearis (C.Agardh) Greville, 1830			C
Hydroclathrus clathratus (C.Agardh) M.A.Howe, 1920			-
Lobophora variegata (J.V.Lamouroux) Womersley ex E.C.Oliveira, 1977			C
**Padina boergesenii* Allender & Kraft, 1983			CC
Padina pavonica (Linnaeus) Thivy, 1960			C
Ralfsia verrucosa (J.E.Areschoug) J.E.Areschoug, 1845			CC
Sargassum trichocarpum J.Agardh, 1848			-
Sargassum vulgare C.Agardh, 1820	*S. vulgare* var. *trichocarpum*		C

TAXA	Synonymy	2012	2013
Sphacelaria sp.		C	-
Sporochnus pedunculatus (Hudson) C.Agardh, 1820		R	-
Stypocaulon scoparium (Linnaeus) Kützing, 1843		C	R
**Stypopodium schimperi* (Buchinger ex Kütz.) Verlaque & Boudour., 1991		C	C
RHODOPHYTA			
**Acanthophora nayadiformis* (Delile) Papenfuss, 1968		R	-
Acrososirum sp.		R	-
Acrosymphyton purpuriferum (J.Agardh) Sjöstedt, 1926		R	-
Amphiroa beauvoisii Lamouroux (1816)		C	C
Amphiroa cryptarthrodia Zanardini, 1843		C	C
Amphiroa rigida J.V.Lamouroux, 1816		CC	CC
**Asparagopsis taxiformis* (Delile) Trevisan de Saint-Leon		R	-
Bonnemaisonia asparagoides (Woodward) C.Agardh, 1822		R	-
Botryocladia botryoides (Wulfen) Feldmann, 1941		C	-
Chylocladia verticillata (Lightfoot) Bliding, 1928		R	-
Ceramium virgatum Roth, 1797	*C. rubrum*	C	C
Ceramium sp.		CC	CC
Corallina elongata J.Ellis & Solander, 1786	*C. mediterranea*	CC	CC
Cryptonemia cf. *lomation* (Bertoloni) J.Agardh, 1851		R	-
**Galaxaura rugosa* (J.Ellis & Solander) J.V.Lamouroux, 1816		C	CC
**Ganonema farinosum* (J.V.Lamouroux) K.C.Fan & Yung C.Wang, 1974	*Liagora farinosa*	CC	R
Gelidium bipectinatum Furnari, 1999		-	C
Gelidium cf. *pusillum* (Stackhouse) Le Jolis, 1863		C	-
Gracillaria sp.		R	-
Haliptylon virgatum Garbary & Johansen (1982)		C	C
Halymenia floresia (Clemente) C. Agardh, 1807		R	-
Halymenia latifolia P.Crouan & H.Crouan ex Kützing 1866		-	R
Halimeniales sp.		-	C
Hildenbrandia rubra (Sommerfelt) Meneghini, 1841		C	C
Hypnea musciformis (Wulfen) J.V.Lamouroux, 1813		C	-
**Hypnea spinella* (C.Agardh) Kützing, 1847	*H. cervicornis*	R	R
Jania adhaerens J.V. Lamaouroux, 1816		-	C
Jania longifurca Zanardini, 1843		C	C
Jania rubens (Linnaeus) J.V.Lamouroux, 1816		CC	CC
Jania rubens var. *corniculata* (Linnaeus) Yendo, 1905		R	R
Laurencia obtusa (Hudson) J.V.Lamouroux, 1813		R	R
**Laurencia* sp.		-	CC
Lithophyllum incrustans Philippi, 1837		CC	CC
Lithophyllum papillosum (Zanardini ex Hauck) Foslie 1900		C	C
Lithophyllum stictaeforme (Areschoug) Hauck, 1877	*Psudolithophyllum expansum*	R	R
Lithothamnion corallioides P.L.Crouan & H.M.Crouan, 1867	*Lithophyllum solutum*	C	C
**Lophocladia lallemandii* (Montagne) F.Schmitz, 1893		CC	-
Mesophyllum alternans (Foslie) Cabioch & Mendoza, 1998	*M. lichenoides*	C	C
Mesophyllum sp.		-	C

TAXA	Synonymy	2012	2013
Neogoniolithon brassica-florida (Harvey) Setchell & L.R.Mason, 1943		CC	CC
Neogoniolithon mamillosum (Hauck) Setchell & L.R.Mason, 1943		CC	CC
Neurocaulon foliosum (Meneghini) Zanardini, 1843		R	-
Palisada perforata (Bory de Saint-Vincent) K.W.Nam, 2007	*Laurencia papillosa*	C	C
Parviphycus pannosus (Feldmann) G. Furnari, 2010	*Gelidiella pannosa*	R	-
Peyssonnelia coriacea Feldmann, 1941		-	R
Peyssonnelia rosa-marina Boudouresque & Denizot, 1973		C	C
Peyssonnelia rubra (Greville) J.Agardh, 1851		CC	CC
Peyssonnelia squamaria (Gmelin) Decaisne, 1841		-	C
Peyssonnelia sp.		-	C
Phymatolithon calcareum (Pallas) W.H.Adey & D.L.McKibbin, 1970	*Lithophyllum calcareum*	R	-
Phymatolithon lenormandii (J.E.Areschoug) W.H.Adey, 1966	*Lithothamnion lenormendii*	C	C
Plocamium cartilagineum (Linnaeus) P.S.Dixon, 1967		R	R
Pterocladiella capillacea (S.G.Gmelin) Santelices & Hommersand, 1997		CC	-
Rodriguezella sp.		-	R
Rhodymenia ardissonei (Kuntze) Feldmann, 1937		C	-
Rhodymenia cf. *pseudopalmata* (J.V.Lamouroux) P.C.Silva, 1952		R	-
Schottera nicaeensis (J.V. Lamouroux ex Duby) Guiry & Hollenberg, 1975		R	-
Scinaia furcellata (Turner) J.Agardh, 1851		R	R
**Solieria filiformis* (Kützing) P.W.Gabrielson, 1985		R	-
Sebdenia dichotoma Berthold, 1884		R	-
Spongites fruticulosus Kützing, 1841		C	C
Tricleocarpa fragilis (Linnaeus) Huisman & R.A.Townsend, 1993	*Galaxaura oblongata*	R	-
MAGNOLIOPHYTA			
Cymodocea nodosa (Ucria) Ascherson, 1870		C	R
FORAMINIFERA			
Amphistegina lobifera Larsen 1976		CC	C
PORIFERA			
Acanthella acuta Schmidt, 1862		R	R
Agelas oroides (Schmidt, 1864)		-	R
Aplysina aerophoba Nardo, 1833	*Verongia aerophoba*	CC	R
Aplysina sp.		CC	C
Axinella polypoides Schmidt, 1862		R	C
Axinella sp.		C	C
Calcarea spp. *(Sycetusa, Vosmaeropsis* spp.*)*		C	C
Chondrilla nucula Schmidt, 1862		C	C
Chondrosia reniformis Nardo, 1847		CC	CC
Cinachyrella levantinensis Vacelet et al, 2007		C	C
Ciocalypta carballoi Vacelet et al, 2007	*Coelocalypta carballoi*	C	C
Clathrina clathrus (Schmidt, 1864)		R	-
Clathrina contorta Minchin, 1905		C	-
Clathrina cf. *coriacea* (Montagu, 1818)		R	-
Clathrina cf. *lacunosa* (Johnston, 1842)	*Guancha lacunosa*	R	-
Clathrina cf. *rubra* Sará, 1958		R	-

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Cliona celata Grant, 1826		C	C
Cliona viridis (Schmidt, 1862)		R	R
Cliona parenzani Corriero & Scalera-Liaci, 1997		C	C
Corticium candelabrum Schmidt, 1862		-	R
Crambe crambe (Schmidt, 1862)		CC	CC
Cymbaxinella damicornis (Esper, 1794)	*Axinella damicornis*	R	-
Cymbaxinella sp.	part *Axinella* spp.	-	C
Dictyonella sp.		-	R
Diplastella sp.		R	-
Dysidea avara (Schmidt, 1862)		-	R
Dysidea fragilis (Montagu, 1818)		R	-
Dysidea tupha (Martens, 1824)		-	R
Euryspongia raouchensis Vacelet *et al.*, 2007		R	-
Gastrophanella phoeniciensis Perez *et al.*, 2004		R	-
Haliclona fulva (Topsent, 1893)		C	C
Haliclona mediterranea Griessinger, 1971		R	-
Haliclona sp.		-	R
Hexadella racovitzai Topsent, 1896		R	-
Ircinia variabilis (Schmidt, 1862)		C	C
Ircinia sp.		C	C
Lyosina blastifera Vacelet, Bitar, Carteron, Zibrowius & Perez, 2007		-	C
Microscleroderma lamina Perez et al. 2004		R	-
Mycale sanguinea Tsurnamal, 1969		R	-
Mycale sp.		R	R
Myrmekioderma spelaeum (Pulitzer-Finali, 1983)		R	R
Niphates toxifera Vacelet *et al,* 2007		CC	R
Oscarella lobularis (Schmidt, 1862)		-	R
**Paraleucilla magna Klautau et al.*, 2004		R	-
Petrosia ficiformis (Poiret, 1789)	*P. dura*	C	C
Phorbas tenacior (Topsent, 1925)	*Anchinoe tenacior*	CC	CC
Phorbas topsenti Vacelet & Perez, 2008	*P. (= Anchinoe) paupertas,*	CC	CC
Placospongia decorticans (Hanitsch, 1895)		R	-
Sarcotragus fasciculatus (Pallas, 1766)	*Ircinia fasciculata*	R	R
Sarcotragus cf. foetidus Schmidt, 1862	*S. muscarum*	R	R
Sarcotragus spinosulus Schmidt, 1862		C	C
Spirastrella cunctatrix Schmidt, 1868		R	R
Spongia officinalis Linnaeus, 1759		R	R
Sycon sp.		C	C
Terpios sp.		R	-
CNIDARIA			
Hydrozoa			
Aglaophenia elongata Menghini, 1845		C	C
Aglaophenia picardi Svoboda, 1979		R	-
Aglaophenia spp.		-	C

TAXA	Synonymy	2012	2013
Eudendrium carneum Clarke, 1882		C	C
Eudendrium glomeratum Picard, 1952		R	R
Eudendrium cf. *merulum* Watson, 1985		-	R
Eudendrium racemosum (Cavolini, 1785)		-	C
Eudendrium spp.		C	C
**Macrorhynchia philippina* Kirchenpauer, 1872	*Lytocarpus philippinus*	C	CC
Pennaria disticha (Goldfuss, 1820)	*Halocordyle disticha*	CC	CC
Sertularia marginata (Kirchenpauer, 1864)		C	C
Anthozoa			
Actinia schmidti Sole-Cava & Thorpe, 1997	part. *Actinia equina*	R	R
Aiptasia mutabilis (Gravenhorst, 1831)		R	R
Anemonia viridis (Forskål, 1775)	*A. sulcata*	R	-
Asterosmilia sp.		-	R
Cerianthidae spp.		R	R
Cladocora caespitosa (Linnaeus, 1767)		-	R
Madracis pharensis (Heller, 1868)		C	R
**Oculina patagonica* de Angelis, 1908		C	CC
Phyllangia americana mouchezii (Lacaze-Duthiers, 1897)		C	C
Polycyathus muellerae (Abel, 1959)		C	C
Telmatactis cricoides (Duchassaing, 1850)		R	R
Scyphozoa			
**Rhopilema nomadica* Galil, 1990		-	C
CTENOPHORA			
**Mnemiopsis leidyi* A. Agassiz, 1865		C	C
ANNELIDA POLYCHAETA			
cf. Ditrupa arietina (O. F. Müller, 1776)		C	-
Filograna sp.		R	R
Hermodice carunculata (Pallas, 1766)		CC	R
**Hydroides* sp.		C	-
Protula sp.		R	-
Sabella spallanzanii (Gmelin, 1791)	*Spirographis spallanzani*	R	-
Sabella pavonina Savigny, 1822		R	-
Sabellidae sp.		C	C
Serpulidae spp.		C	C
**Spirobranchus kraussii* (Baird, 1865)	*Pomatoleios kraussii*	C	-
**Spirobranchus lamarcki* (Quatrefages, 1866)	*Pomatoceros lamarckii*	C	-
**Spirobranchus tetraceros* (Schmarda, 1861)		C	-
Spirorbidae spp.		C	C
SIPUNCULA			
Phascolosoma stephensoni (Stephen, 1942)		-	R
Sipunculus nudus Linnaeus, 1766		-	R
ARTHROPODA CRUSTACEA			
Cirripedia			
Balanus trigonus Darwin, 1854		CC	CC

TAXA	Synonymy	2012	2013
Chthmalus montagui Southward, 1976		C	C
Chthamalus stellatus (Poli, 1795)		CC	CC
Euraphia depressa (Poli, 1791)	*Chthamalus depressus*	R	R
Perforatus perforatus (Bruguière, 1789)	*Balanus perforatus*	CC	CC
Isopoda			
Anilocra physodes (Linnaeus, 1758)		R	-
Ligia italica Fabricius, 1798		C	C
Decapoda			
**Alpheus audouini* Coutière, 1905		-	R
**Atergatis roseus* (Rüppell, 1830)		C	C
Calcinus tubularis (Linnaeus, 1767)	*C. ornatus*	CC	CC
**Callinectes sapidus Rathbun,* 1896 (carapace)		-	R
**Charybdis hellerii* (A. Milne-Edwards, 1867)		R	C
Clibanarius erythropus (Latreille, 1818)	*C. misanthropus*	CC	CC
Diogenes pugilator (Roux, 1829)		CC	C
Eriphia verrucosa (Forskål, 1775)	*E. spinifrons*	R	R
Galatheidae sp.		R	-
**Myra fugax* (Fabricius, 1798) (tests)		R	-
Pachygrapsus marmoratus (Fabricius, 1787)		R	R
Pagurus anachoretus Risso, 1827		C	C
**Percnon gibbesi* (H. Milne-Edwards, 1853)		R	-
Palaemon serratus (Pennant, 1777)		-	C
Pilumnus hirtellus (Linnaeus, 1761)		R	-
Upogebia pusilla (Petagna, 1792) (moult)		-	R
MOLLUSCA			
Polyplacophora			
Acanthochitona fascicularis (Linnaeus, 1767)	*Acanthochiton communis*	R	-
Chiton olivaceus Spengler, 1797		C	-
Gastropoda			
**Aplysia dactylomela* Rang, 1828		-	R
Bittium sp.		-	CC
Bulla striata Bruguière, 1792		-	C
Cratena peregrina (Gmelin, 1791)		R	-
**Cellana rota* (Gmelin, 1791)		-	R
**Cerithium scabridum* Philippi, 1848		CC	CC
Cerithium vulgatum Bruguière, 1792		-	R
Columbella rustica (Linnaeus, 1758)		C	C
**Conomurex persicus* (Swainson, 1821)		CC	C
Conus ventricosus Gmelin, 1791	*C. mediterraneus*	R	R
Dendropoma petraeum (Monterosato, 1884)		C	R
Diodora rueppellii (G. B. Sowerby I, 1835)		R	R
Echinolittorina punctata (Gmelin, 1791)	*Littorina punctata*	CC	CC
**Elysia grandifolia* Kelaart, 1857		C	R
Elysia timida (Risso, 1818)		-	R

TAXA	Synonymy	2012	2013
**Ergalatax junionae* Houart, 2008	*E. obscura*	C	C
Erosaria spurca (Linnaeus, 1758)		R	R
Euthria cornea (Linnaeus, 1758)	*Buccinulum corneum*	R	R
Flabellina affinis (Gmelin, 1791)		R	-
**Flabellina rubrolineata* (O'Donoghue, 1929)		-	R
**Fusinus verrucosus* (Gmelin, 1791)	*F. marmoratus*	C	-
Gibbula spp.		C	C
**Goniobranchus annulatus* (Eliot, 1904)		R	C
Hexaplex trunculus (Linnaeus, 1758)		R	R
**Hypselodoris infucata* Rüppell & Leuckart, 1831		C	C
**Trochus erithreus* (Brocchi, 1821)	*Trochus erythraeus*	C	C
Luria lurida (Linnaeus, 1758)		R	-
Melarhaphe neritoides (Linnaeus, 1758)	*Littorina neritoides*	CC	CC
**Murex forskoehlii forskoehlii* Röding, 1798		C	-
**Nassarius circumcinctus* (A. Adams, 1852)		R	-
Nassarius reticulatus (Linnaeus, 1758)	*Nassa reticulate*	-	R
Nassarius mutabilis (Linnaeus, 1758)	*Nassa (= Sphaeronassa) mutabilis*	C	-
Ocinebrina sp. (shells)		-	R
Patella caerulea Linnaeus, 1758		C	C
Patella rustica Linnaeus, 1758		C	C
Patella ulyssiponensis Gmelin, 1791		C	C
Phorcus articulatus (Lamarck, 1822)	*Osilinus (= Monodonta) articulatus*	R	-
Phorcus turbinatus (Born, 1778)	*Osilinus (= Monodonta) turbinatus*	C	C
**Plocamopherus ocellatus* Rüppell & Leuckart, 1828		R	-
**Purpuradusta gracilis notata* (Gill, 1858)		R	C
**Rhinoclavis kochi* (Philippi, 1848)		CC	C
Semicassis granulata (Born, 1778)	*Phalium undulatum*	R	-
Thylacodes arenarius (Linnaeus, 1758)	*Vermetus gigas*	C	C
Stramonita haemastoma (Linnaeus, 1767)		-	R
**Indothais sacellum* (Gmelin, 1791)	*Thais scacellum*	R	-
Tonna galea (shells) (Linnaeus, 1758)		-	R
Vermetus triquetrus Bivona-Bernardi, 1832	*V. triqueter*	C	C
Bivalvia			
Acanthocardia tuberculata (Linnaeus, 1758)	*Rudicardium tuberculatum*	CC	CC
Arca noae Linnaeus, 1758		-	R
Barbatia barbata (Linnaeus, 1758)	*Arca babata*	-	R
**Brachidontes pharaonis* (P. Fischer, 1870)	*B. variabilis*	CC	CC
**Chama pacifica* Broderip, 1835		CC	CC
Ctena decussata (O. G. Costa, 1829)		C	C
**Dendostrea frons* (Linnaeus, 1758)	*Dendrostrea frons*	C	CC
**Fulvia fragilis* (Forsskal in Neihbur, 1775)		-	R
**Gafrarium savignyi* (Jomas, 1846)	*G. pectinatum*	R	C
Glycymeris nummaria (Linnaeus, 1758)	*G. violascens, G. insubrica*	C	C
Lima lima (Linnaeus, 1758) (shells)		-	R

TAXA	Synonymy	2012	2013
Lioberus agglutinans (Cantraine, 1835)	*Amygdalum agglutinans*	C	CC
Lioberus sp.		-	R
Lithophaga lithophaga (Linnaeus, 1758)		R	R
Lucinella divaricata (Linnaeus, 1758)		C	-
Mactra stultorum (Linnaeus, 1758)	*M. corallina*	-	C
**Malleus regula* Forsskål, 1775	*Malvufundus regulus*	CC	CC
Mimachlamys varia (Linnaeus, 1758)	*Chlamys varia*	-	R
Ostreidae sp.		C	C
**Pinctada imbricata radiata* (Leach, 1814)		R	R
Pinna nobilis Linnaeus, 1758		R	R
Polititapes aureus (Gmelin, 1791)	*Paphia (= Venerupis) aurea*	-	R
**Spondylus spinosus* Schreibers, 1793		CC	CC
Striarca lactea (Linnaeus, 1758)	*Arca lactea*	R	R
Venerupis corrugata (Gmelin, 1791)	*V. geografica*	-	R
Venus casina Linnaeus, 1758		-	R
Venus verrucosa Linnaeus, 1758		C	C
Cephalopoda			
Loligo vulgaris Lamarck, 1798 (eggs)		-	C
Octopus vulgaris Cuvier, 1797		R	-
BRYOZOA			
Adeonella pallasii (Heller, 1867)		R	R
Caberea boryi (Audouin, 1826)		C	C
Caberea sp.		-	R
Cellaria sp.		C	C
Frondipora verrucosa (Lamouroux, 1821)		-	R
Margaretta cereoides (Ellis & Solander, 1786)		C	C
Reptadeonella sp.		R	R
Reteporella sp.		R	R
Rhynchozoon neapolitanum Gautier, 1962		R	R
Schizomavella spp.		R	-
Schizoporella errata (Waters, 1878)		CC	CC
Schizoretepora hassi Harmelin, Bitar, Zibrowius, 2007		R	-
Scrupocellaria sp.		R	-
ECHINODERMATA			
Asteroidea			
**Aquilonastra burtoni* (Gray, 1840)	*Asterina burtoni*	R	-
Coscinasterias tenuispina (Lamarck, 1816)		R	-
Echinaster sepositus (Retzius, 1783)		R	-
Ophiuroidea			
**Ophiactis savignyi* (Müller & Troschel, 1842)		R	R
**Ophiocoma scolopendrina* (Lamarck, 1816)		-	R
Ophiomyxa pentagona (Lamarck, 1816)		R	-
Echinoidea			
Arbacia lixula (Linnaeus, 1758)		C	R

TAXA	Synonymy	2012	2013
Brissus unicolor (Leske, 1778) (tests)		R	R
Echinocardium mediterraneum (Forbes, 1844) (tests)		C	R
Echinocyamus pusillus (O.F. Müller, 1776) (tests)		-	R
Paracentrotus lividus (Lamarck, 1816)		C	R
Holothuroidea			
Holothuria impatiens (Forskål, 1775)		-	R
Holothuria sanctori Delle Chiaje, 1823		R	-
Holothuria tubulosa Gmelin, 1791		R	R
**Synaptula reciprocans* (Forskal, 1775)		CC	C
CHORDATA			
Ascidiacea			
Ascidia cf. mentula Müller, 1776		R	-
Botrylloides cf. leachii (Savigny, 1816)		R	C
Botryllus sp.		R	-
Cystodytes dellechiajei (Della Valle, 1877)		CC	CC
Didemnum coriaceum (Drasche, 1883)		-	R
Didemnidae spp.		CC	CC
Diplosoma sp.		R	R
**Herdmania momus* (Savigny, 1816)		CC	C
**Microcosmus* cf. *exasperatus* Heller, 1878		R	-
**Phallusia nigra* Savigny, 1816		CC	CC
Polyclinidae spp.		R	R
Polysyncraton bilobatum Lafargue, 1968		R	-
Pseudodistoma cyrnusense		C	-
Pycnoclavella sp.		R	-
Pyura dura (Heller, 1877)		R	-
**Rhodosoma turcicum* (Savigny, 1816)		-	R
Styelidae sp.		-	C
**Symplegma brakenhielmi* (Michaelsen, 1904)		C	-
Elasmobranchii			
Dasyatis pastinaca (Linnaeus, 1758)		C	C
Gymniura altavella (Linnaeus, 1758)		R	-
Myliobatis aquila (Linnaeus, 1758)		-	R
Rhinobatos cemiculus Geoffroy Saint-Hilaire, 1817		-	R
Taeniura grabata (E. Geoffroy Saint-Hilaire, 1817)		-	R
Actinopterygii			
Apogon imberbis (Linnaeus, 1758)		R	-
**Apogonichthyoides nigripinnis* (Cuvier, 1828)	*Apogon nigripinnis*	C	C
**Atherinomorus lacunosus* (Forster, 1801)		CC	CC
Belone belone (Linnaeus, 1761)		R	R
Boops boops (Linnaeus, 1758)		CC	CC
Bothus podas (Delaroche, 1809)		C	C
Caranx crysos (Mitchill, 1815)		-	R
**Cheilodipterus novemstriatus* (Rüppell, 1838)		-	R

TAXA	Synonymy	2012	2013
Chromis chromis (Linnaeus, 1758)		CC	CC
Coris julis (Linnaeus, 1758)		C	C
Coryphoblennius galerita (Linnaeus, 1758)	*Blennius galerita*	-	R
Dicentrarchus punctatus (Bloch, 1792)		R	-
Diplodus cervinus (Lowe, 1838)		R	R
Diplodus puntazzo (Walbaum, 1792)		R	R
Diplodus sargus (Linnaeus, 1758)		C	C
Diplodus vulgaris (Geoffroy Saint-Hilaire, 1817)		CC	CC
**Enchelycore anatina* (Lowe, 1841)		R	-
Epinephelus costae (Steindachner, 1878)		R	R
Epinephelus marginatus (Lowe, 1834)		R	R
**Fistularia commersonnii* Rüppell, 1835		-	R
Gobius bucchichi Steindachner, 1870		C	CC
Gobius cobitis Pallas, 1814		R	-
Gobius geniporus Valenciennes, 1837		R	R
Gobius kolombatovici Kovacic & Miller, 2000		-	R
Gobius vittatus Vinciguerra, 1883		R	R
Gymnothorax unicolor Delaroche, 1809		R	-
Labrus merula Linnaeus, 1758		R	-
**Lagocephalus scleratus* (Gmelin, 1789)		-	C
Lipophrys nigriceps (Vinciguerra, 1883)	*Blennius nigriceps*	R	-
Lipophrys trigloides (Valenciennes, 1836)	*Blennius trigloides*	-	R
Lithognathus mormyrus (Linnaeus, 1758)		C	-
Liza aurata (Risso, 1810)		C	-
Mugilidae spp.		CC	CC
Mullus surmuletus Linnaeus, 1758		C	R
Muraena helena Linnaeus, 1758		R	R
Mycteroperca rubra (Bloch, 1793)		C	C
Oblada melanura (Linnaeus, 1758)		CC	CC
Pagrus auriga Valenciennes, 1843		R	R
Pagellus acarne (Risso, 1827)		R	-
Pagellus erythrinus (Linnaeus, 1758)		R	-
Parablennius rouxi (Cocco, 1833)	*Blennius rouxi*	R	R
Parablennius sanguinolentus (Pallas, 1814)	*Blennius sanguinolentus*	-	R
Parablennius zvonimiri (Kolombatovic, 1892)	*Blennius zvonimiri*	C	C
**Pempheris vanicolensis* Cuvier, 1831		CC	CC
**Plotosus lineatus* (Thunberg, 1787)		-	C
Pomadasys incisus (Bowdich, 1825)		R	R
Pomatoschistus sp.		C	-
Pseudocaranx dentex (Bloch & Schneider, 1801)		R	-
**Pteragogus pelycus* Randall, 1981		R	R
**Sargocentron rubrum* (Forsskål, 1775)		CC	CC
**Scorpaena maderensis* Valenciennes, 1833		C	R
Scorpaena porcus Linnaeus, 1758		R	-

TAXA	Synonymy	2012	2013
Serranus cabrilla (Linnaeus, 1758)		C	C
Serranus hepatus (Linnaeus, 1758)		C	R
Serranus scriba (Linnaeus, 1758)		C	C
**Siganus luridus* (Rüppell, 1829)		CC	CC
**Siganus rivulatus* Forsskål, 1775		C	C
Sparisoma cretense (Linnaeus, 1758)		CC	C
**Sphyraena chrysotaenia* Klunzinger, 1884		C	-
Spicara smaris (Linnaeus, 1758)		-	C
**Stephanolepis diaspros* Fraser-Brunner, 1940		C	C
Symphodus mediterraneus (Linnaeus, 1758)		R	-
Symphodus ocellatus (Forsskål, 1775)		R	-
Symphodus roissali (Risso, 1810)		-	C
Symphodus tinca (Linnaeus, 1758)		R	C
Synodus saurus (Linnaeus, 1758)		-	R
Thalassoma pavo (Linnaeus, 1758)		CC	CC
**Torquigener flavimaculosus* (Hardy & Randall, 1983)		C	C
Trachurus sp.		-	CC
Tripterygion melanurum (Guichenot, 1850)		C	C
Tripterygion tripteronotus (Risso, 1810)		C	C
**Upenus moluccensis* (Bleeker, 1855)		R	-
**Upeneus pori* Ben-Tuvia & Golani, 1989		R	R
Xyrichtys novacula (Linnaeus, 1758)		C	C
Reptilia			
Chelonia mydas (Linnaeus, 1758)		-	R
Total		**341**	**303**

(*) Exotic species. Relative abundance: (CC) very common; (C) common; (R) rare.

10.3 Annex III: Species/taxons by station

10.3.1 Enfeh

Stations (Enfeh)	E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9	E-10	E-11	E-12	E-14	E-15	Total
Cyanobacteria															
Calothrix sp.	-	-	-	-	-	-	-	-	-	-	-	-	3	2	5
Chlorophyta															
Bryopsis plumosa C.Agardh, 1823	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Caulerpa prolifera (Forsskål) J.V.Lamouroux, 1809	-	-	-	-	-	-	-	2	-	1	-	-	-	-	3
Cladophora pellucida (Hudson) Kützing, 1843	1	-	-	-	-	-	1	-	-	-	-	-	-	-	2
**Cladophoropsis modonensis* (Kützing) Reinbold, 1905	2	-	-	-	-	-	-	-	-	-	-	2	-	-	4
**Codium taylorii* P.C.Silva, 1960	3	-	-	-	-	-	2	-	-	-	-	2	-	-	7
Ulva compressa Linnaeus, 1753	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Ulva intestinalis Linnaeus, 1753	-	-	-	-	-	-	-	-	-	-	-	3	-	-	3
Ulva cf. *lactuca* Linnaeus, 1753	3	-	-	-	-	-	2	-	-	-	-	3	-	-	8
Valonia utricularis (Roth) C.Agardh, 1823	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1
Ochrophyta															
Arthrocladia villosa (Hudson) Duby, 1830	-	-	-	-	2	-	-	-	-	-	-	-	1	-	3
Colpomenia sinuosa (Mertens ex Roth) Derbès & Solier, 1851	3	-	-	-	-	3	1	-	-	-	3	3	-	-	13
Cystoseira compressa (Esper) Gerloff & Nizamuddin, 1975	2	-	-	-	-	-	1	-	-	-	-	-	-	-	3
Dictyota dichotoma (Hudson) J.V.Lamouroux, 1809	-	-	-	-	2	-	-	-	-	-	-	-	2	-	4
Dictyota linearis (C.Agardh) Greville, 1830	-	-	-	-	1	-	-	-	-	-	2	-	3	-	6
Hydroclathrus clathratus (C.Agardh) M.A.Howe, 1920	-	-	-	-	-	-	-	-	-	-	-	-	-	3	3
Lobophora variegata (J.V.Lamouroux) Womersley ex E.C.Oliveira, 1977	3	-	-	-	-	-	1	-	-	-	-	1	2	2	9
**Padina boergesenii* Allender & Kraft, 1983	2	-	-	-	-	-	-	-	3	-	2	-	3	-	10
Padina pavonica (Linnaeus) Thivy, 1960	2	-	-	-	-	-	1	-	-	-	-	2	3	3	11
Sargassum trichocarpum (J.Agardh, 1848)	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
Sargassum vulgare (C.Agardh, 1820)	2	-	-	1	-	-	1	-	-	-	-	1	-	1	6

Stations (Enfeh)	E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9	E-10	E-11	E-12	E-14	E-15	Total
Stypocaulon scoparium (Linnaeus) Kützing, 1843	3	-	-	-	-	-	2	-	-	-	-	3	-	-	8
**Stypopodium schimperi* (Buchinger) Verlaque & Boudouresque, 1991	2	-	-	-	-	-	1	-	-	-	-	-	3	-	6
Rhodophyta															
**Acanthophora nayadiformis* (Delile) Papenfuss, 1968	2	-	-	-	-	-	-	-	-	-	-	2	-	-	4
Acrosymphyton purpuriferum (J.Agardh) Sjöstedt, 1926	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2
Amphiroa cryptarthrodia Zanardini, 1843	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Amphiroa rigida J.V.Lamouroux, 1816	2	-	-	-	-	-	1	-	-	-	3	2	-	3	11
**Asparagopsis taxiformis* (Delile) Trevisan de Saint-Leon	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Bonnemaisonia asparagoides (Woodward) C.Agardh, 1822	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3
Ceramium virgatum Roth, 1797 (= C. rubrum)	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Corallina elongata J.Ellis & Solander, 1786	3	-	-	-	-	-	3	-	-	-	-	3	-	-	9
**Galaxaura rugosa* (J.Ellis & Solander) J.V.Lamouroux, 1816	2	-	-	-	-	-	2	-	-	-	3	2	-	2	11
**Ganonema farinosum* (J.V.Lamouroux) K.C.Fan & Yung C.Wang, 1974	3	-	-	-	-	-	3	-	-	-	-	3	-	-	9
Gelidium bipectinatum Furnari, 1999	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2
Gracillaria sp.	-	-	-	-	-	-	-	-	-	-	2	-	-	-	2
Hildenbrandia rubra (Sommerfelt) Meneghini, 1841	-	-	-	-	-	-	-	-	-	-	-	3	-	-	3
Hypnea musciformis (Wulfen) J.V.Lamouroux, 1813	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2
**Hypnea spinella* (C.Agardh) Kützing, 1847	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Jania longifurca Zanardini, 1843	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3
Jania rubens (Linnaeus) J.V.Lamouroux, 1816	3	-	-	-	-	-	3	-	-	-	-	3	3	3	15
Jania rubens var. *corniculata* (Linnaeus) Yendo, 1905	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Lithophyllum incrustans Philippi, 1837	3	-	-	-	-	-	3	-	-	-	-	3	-	3	12
Lithophyllum stictaeforme (Areschoug) Hauck 1877	2	-	-	-	-	-	1	-	-	-	-	-	-	-	3
Mesophyllum alternans (Foslie) Cabioch & Mendoza, 1998	1	-	-	-	-	-	-	-	-	-	-	1	-	-	2
Neogoniolithon brassica-florida (Harvey) Setchell & L.R.Mason, 1943	2	-	-	-	-	-	-	-	-	-	-	2	-	-	4
Neogoniolithon mamillosum (Hauck) Setchell & L.R.Mason, 1943		-	-	-	3	-	1	-	-	-	3	-	3	2	12

Stations (Enfeh)	E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9	E-10	E-11	E-12	E-14	E-15	Total
Palisada perforata (Bory de Saint-Vincent) K.W.Nam, 2007	2	-	-	-	-	-	-	-	-	-	-	2	-	-	4
Parviphycus pannosus (Feldmann) G.Furnari, 2010	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Peyssonnelia rosa-marina Boudouresque & Denizot, 1973	**2**	-	-	-	-	-	**2**	-	-	-	-	-	-	-	**4**
Peyssonnelia spp.	2	-	-	-	-	-	2	-	-	-	-	-	2	3	9
Phymatolithon lenormandii (J.E.Areschoug) W.H.Adey, 1966	-	-	-	-	-	-	-	-	-	-	-	3	-	-	3
Plocamium cartilagineum (Linnaeus) P.S.Dixon, 1967	2	-	-	-	-	-	2	-	-	-	-	-	-	-	4
Pterocladiella capillacea (S.G.Gmelin) Santelices & Hommersand, 1997	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Schottera nicaeensis (J.V. Lamouroux ex Duby) Guiry & Hollenberg, 1975	-	-	-	-	-	-	-	-	-	-	-	3	-	-	3
Scinaia furcellata (Turner) J.Agardh, 1851	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2
Tricleocarpa fragilis (Linnaeus) Huisman & R.A.Townsend, 1993	1	-	-	-	-	-	-	-	-	-	-	-	-	1	2
Magnoliophyta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Cymodocea nodosa (Ucria) Ascherson, 1870	1	3	1	-	1	1	3	1	1	1	1	-	-	3	17
Porifera															
Aplysina aerophoba Nardo, 1833	2	-	-	-	3	-	-	2	2	-	-	-	3	2	14
Calcarea spp. (Sycetusa, Vosmaeropsis)	1	-	-	-	-	-	-	-	-	-	-	3	-	-	4
Chondrilla nucula Schmidt, 1862	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1
Chondrosia reniformis Nardo, 1847	3	-	-	-	-	-	3	-	-	-	-	3	-	-	9
Cinachyrella levantinensis Vacelet et al, 2007	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
Clathrina contorta Minchin, 1905	-	-	-	-	-	-	-	-	-	-	-	2	-	-	2
Clathrina cf. *coriacea* (Montagu, 1818)	-	-	-	-	-	-	-	-	-	-	-	2	-	-	2
Clathrina cf. *rubra* Sará, 1958	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Cliona viridis (Schmidt, 1862)	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3
Cliona parenzani Corriero & Scalera-Liaci, 1997	2	-	-	-	-	-	1	-	-	-	-	3	-	-	6
Crambe crambe (Schmidt, 1862)	3	-	-	-	-	-	3	-	-	-	-	3	3	3	15
Cymbaxinela sp.	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
Ircinia variabilis (Schmidt, 1862)	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2

Stations (Enfeh)	E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9	E-10	E-11	E-12	E-14	E-15	Total
Ircinia sp.	-	-	-	-	-	-	-	-	-	-	-	2	1	-	3
Mycale sanguinea Tsurnamal, 1969	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Niphates toxifera Vacelet et al, 2007	2	-	-	-	-	-	1	-	-	-	-	2	2	2	9
Petrosia ficiformis (Poiret, 1789)	-	-	-	-	-	-	-	-	-	-	-	2	-	1	3
Phorbas topsenti Vacelet & Perez, 2008	1	-	-	-	-	-	1	-	-	-	-	2	2	2	8
Sarcotragus fasciculatus (Pallas, 1766)	1	-	-	-	-	-	-	-	-	-	-	1	-	-	2
Sarcotragus spinosulus Schmidt, 1862	1	-	-	-	-	-	-	-	-	-	-	2	1	-	4
Spongia officinalis Linnaeus, 1759	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Sycon sp.	1	-	-	-	-	-	1	-	-	-	-	-	1	-	3
Cnidaria															
Hydrozoa															
Eudendrium carneum Clarke, 1882	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3
**Macrorhynchia philippina* Kirchenpauer, 1872	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Pennaria disticha (Goldfuss, 1820)	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Anthozoa															
Actinia schmidti Sole-Cava & Thorpe, 1997	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Cerianthidae spp.	-	-	-	-	-	-	-	-	-	2	-	-	-	-	2
Polycyathus muellerae (Abel, 1959)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Ctenophora															
**Mnemiopsis leidyi* A. Agassiz, 1865	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
Annelida Polychaeta															
cf. *Ditrupa arietina* (O. F. Müller, 1776)	-	-	-	-	-	3	-	-	-	-	-	-	-	-	3
Hermodice carunculata (Pallas, 1766)	3	-	-	-	-	-	3	1	-	-	-	3	-	-	10
Nereidae indet.	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
**Spirobranchus lamarcki* (Quatrefages, 1866)	2	-	-	-	-	-	-	-	-	-	-	-	-	2	4
Crustacea															

Stations (Enfeh)	E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9	E-10	E-11	E-12	E-14	E-15	Total
Cirripedia															
Balanus trigonus Darwin, 1854	1	-	-	-	-	-	-	-	-	-	-	1	-	-	2
Chthmalus montagui Southward, 1976	**3**	-	-	-	-	-	-	-	-	-	-	**3**	-	-	**6**
Chthamalus stellatus (Poli, 1795)	3	-	-	-	-	-	-	-	-	-	-	3	-	-	6
Perforatus perforatus (Bruguière, 1789)	3	-	-	-	-	-	2	-	-	-	-	3	2	-	10
Decapoda															
**Atergatis roseus* (Rüppell, 1830)	1	-	-	-	-	-	-	-	-	-	-	1	-	-	2
Calcinus tubularis (Linnaeus, 1767)	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3
**Charybdis hellerii* (A. Milne-Edwards, 1867)	2	-	-	-	-	-	1	-	-	-	-	2	-	-	5
Clibanarius erythropus (Latreille, 1818)	3	-	-	-	-	-	-	-	-	-	-	3	-	2	8
Diogenes pugilator (Roux, 1829)	-	-	3	-	-	3	-	1	-	-	-	-	-	-	7
Eriphia verrucosa (Forskål, 1775)	1	-	-	-	-	-	-	-	-	-	-	1	-	-	2
**Myra fugax* (Fabricius, 1798) (tests)	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
Pachygrapsus marmoratus (Fabricius, 1787)	1	-	-	-	-	-	-	-	-	-	-	1	-	-	2
Pilumnus hirtellus (Linnaeus, 1761)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Mollusca															
Polyplacophora															
Acanthochitona fascicularis (Linnaeus, 1767)	1	-	-	-	-	-	-	-	-	-	-	1	-	-	2
Gastropoda															
**Cerithium scabridum* Philippi, 1848	3	-	-	-	-	-	-	-	-	-	-	3	-	-	6
Columbella rustica (Linnaeus, 1758)	2	-	-	-	-	-	1	-	-	-	-	2	-	-	5
**Conomurex persicus* (Swainson, 1821)	3	-	3	-	-	1	3	1	-	3	3	3	3	-	23
Conus ventricosus Gmelin, 1791	1	-	-	-	-	-	1	-	-	-	-	-	-	-	2
Dendropoma petraeum (Monterosato, 1884)	2	-	-	-	-	-	-	-	-	-	-	2	-	-	4
Echinolittorina punctata (Gmelin, 1791)	3	-	-	-	-	-	-	-	-	-	-	3	-	-	6
**Elysia grandifolia* Kelaart, 1857	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1

Stations (Enfeh)	E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9	E-10	E-11	E-12	E-14	E-15	Total
**Ergalatax junionae* Houart, 2008	3	-	-	-	-	-	2	-	-	-	-	3	-	-	8
Flabellina affinis (Gmelin, 1791)	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3
**Fusinus verrucosus* (Gmelin, 1791)	**1**	-	-	-	-	-	-	-	-	-	-	**1**	-	**1**	**3**
Hexaplex trunculus (Linnaeus, 1758)	1	-	-	-	-	-	-	-	-	-	-	1	-	-	2
**Hypselodoris infucata* Rüppell & Leuckart, 1831	1	-	-	-	-	-	1	-	-	-	-	1	-	1	4
**Trochus erithreus* (Brocchi, 1821)	1	-	-	-	-	-	-	-	-	-	-	1	-	-	2
Melarhaphe neritoides (Linnaeus, 1758)	2	-	-	-	-	-	-	-	-	-	-	2	-	-	4
**Murex forskoehlii forskoehlii* Röding, 1798	-	-	2	2	-	-	-	-	-	-	-	-	-	-	4
**Nassarius circumcinctus* (A. Adams, 1852)	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
Patella caerulea Linnaeus, 1758	3	-	-	-	-	-	-	-	-	-	-	3	-	-	6
Patella rustica Linnaeus, 1758	3	-	-	-	-	-	-	-	-	-	-	3	-	-	6
Patella ulyssiponensis Gmelin, 1791	3	-	-	-	-	-	-	-	-	-	-	3	-	-	6
Phorcus turbinatus (Born, 1778)	2	-	-	-	-	-	-	-	-	-	-	2	-	-	4
**Rhinoclavis kochi* (Philippi, 1848) (shells)	-	-	3	-	-	3	-	3	-	-	-	-	-	-	9
Semicassis granulata (Born, 1778) (shells)	-	-	-	-	-	-	-	-	-	3	-	-	-	-	3
Thylacodes arenarius (Linnaeus, 1758) (shells)	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Bivalvia															
**Brachidontes pharaonis* (P. Fischer, 1870)	3	-	-	-	-	-	-	-	-	-	-	3	-	-	6
**Chama pacifica* Broderip, 1835	3	-	-	-	-	-	2	-	-	-	3	3	3	3	17
Ctena decussata (O. G. Costa, 1829) (shells)	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
Glycymeris nummaria (Linnaeus, 1758) (shells)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
Lucinella divaricata (Linnaeus, 1758)	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
**Malleus regula* Forsskål, 1775	3	-	-	-	-	-	2	-	-	-	-	2	-	2	9
**Pinctada imbricata radiata* (Leach, 1814)	1	-	-	-	-	-	-	-	-	-	-	1	1	-	3
Pinna nobilis Linnaeus, 1758 (shell rests)	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
**Spondylus spinosus* Schreibers, 1793	2	-	-	-	-	-	-	-	-	-	-	2	2	2	8

Stations (Enfeh)	E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9	E-10	E-11	E-12	E-14	E-15	Total
Venus verrucosa Linnaeus, 1758 (shells)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Cephalopoda															
Octopus vulgaris Cuvier, 1797	-	1	-	-	-	-	-	-	-	-	-	2	-	-	3
Bryozoa															
Margaretta cereoides (Ellis & Solander, 1786)	3	-	-	-	-	-	-	-	-	-	-	2	-	-	5
Reptadeonella sp.	1	-	-	-	-	-	-	-	-	-	-	1	1	1	4
Reteporella sp.	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Schizoporella errata (Waters, 1878)	2	-	-	-	-	-	-	-	-	-	-	2	1	-	5
Scrupocellaria sp.	3	-	-	-	-	-	3	-	-	-	-	-	-	-	6
Echinodermata															
Asteroidea															
Echinaster sepositus (Retzius, 1783)	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2
Echinoidea															
Arbacia lixula (Linnaeus, 1758)	1	-	-	-	-	-	-	-	-	-	-	1	-	-	2
Brissus unicolor (Leske, 1778) (tests)	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
Echinocardium mediterraneum (Forbes, 1844) (tests)	-	-	-	-	-	-	-	-	-	2	-	-	-	-	2
Paracentrotus lividus (Lamarck, 1816)	1	-	-	-	-	-	1	-	-	-	-	1	-	-	3
Holothuroidea															
Holothuria impatiens (Forskål, 1775)	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Holothuria tubulosa Gmelin, 1791	1	-	-	-	-	-	1	-	-	-	-	-	-	-	2
**Synaptula reciprocans* (Forskal, 1775)	2	-	-	-	-	-	1	-	-	-	-	1	-	-	4
Ascidiacea															
Botrylloides cf. *leachii*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Cystodytes dellechiajei (Della Valle, 1877)	-	-	-	-	-	-	1	-	-	-	-	1	-	-	2
Didemnidae spp.	2	-	-	-	-	-	2	-	-	-	-	3	2	2	11
**Herdmania momus* (Savigny, 1816)	2	-	2	-	-	-	1	2	-	-	-	2	-	2	11

Stations (Enfeh)	E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9	E-10	E-11	E-12	E-14	E-15	Total
**Microcosmus* cf. *exasperatus* Heller, 1878	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1
**Phallusia nigra Savigny, 1816*	2	-	-	-	-	-	-	-	-	-	-	2	-	-	4
Pisces'															
Elasmobranchii															
Dasyatis pastinaca (Linnaeus, 1758)	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Gymnura altavella (Linnaeus, 1758)	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
Actinopterygii															
Apogon imberbis (Linnaeus, 1758)	-	-	-	-	-	-	-	-	-	-	-	1	1	1	3
**Apogonichthyoides nigripinnis* (Cuvier, 1828)	-	-	3	-	-	-	-	-	-	-	-	1	-	-	4
Atherinidae sp.	3	-	-	-	-	-	3	-	-	-	-	-	-	-	6
**Atherinomorus lacunosus* (Forster, 1801)	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Boops boops (Linnaeus, 1758)	3	-	-	-	-	-	-	-	3	-	-	-	-	-	6
Bothus podas (Delaroche, 1809)	1	1	1	-	-	1	-	-	-	-	-	-	-	-	4
Chromis chromis (Linnaeus, 1758)	3	-	-	-	-	-	2	-	3	-	3	3	3	2	19
Coris julis (Linnaeus, 1758)	2	-	-	-	-	-	1	-	2	-	-	2	3	2	12
Diplodus cervinus (Lowe, 1838)	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Diplodus sargus (Linnaeus, 1758)	3	-	-	-	-	-	2	-	1	-	-	3	2	1	12
Diplodus vulgaris (Geoffroy Saint-Hilaire, 1817)	-	-	-	-	-	-	2	-	-	-	-	2	-	-	4
Epinephelus costae (Steindachner, 1878)	-	-	-	-	-	-	-	-	1	-	1	-	1	1	4
Epinephelus marginatus (Lowe, 1834)	1	-	-	-	-	-	-	-	1	-	-	1	1	1	5
Gobius cobitis Pallas, 1814	1	-	-	-	-	-	-	-	-	-	-	1	-	-	2
Gobius geniporus Valenciennes, 1837	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
Gobius sp.	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Lipophrys nigriceps (Vinciguerra, 1883)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Lithognathus mormyrus (Linnaeus, 1758)	2	2	-	-	-	-	2	-	-	-	-	2	-	1	9
Liza aurata (Risso, 1810)	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2

Stations (Enfeh)	E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9	E-10	E-11	E-12	E-14	E-15	Total
Mugilidae spp.	2	-	-	-	-	-	-	-	-	-	-	2	-	-	4
Mullus surmuletus Linnaeus, 1758	2	-	-	-	-	-	-	-	-	-	-	2	-	2	6
Muraena helena Linnaeus, 1758	-	-	-	-	-	-	-	-	1	-	-	1	1	-	3
Mycteroperca rubra (Bloch, 1793)	1	-	-	-	-	-	1	-	-	-	-	1	2	1	6
Oblada melanura (Linnaeus, 1758)	3	-	-	-	-	-	-	-	-	-	-	3	-	2	8
Pagellus acarne (Risso, 1827)	-	-	2	-	-	-	-	-	-	-	-	-	-	-	2
Parablennius zvonimiri (Kolombatovic, 1892)	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1
**Pempheris vanicolensis* Cuvier, 1831	3	-	1	-	-	-	3	-	-	-	-	3	-	-	10
Pomadasys incisus (Bowdich, 1825)	-	-	-	-	-	-	1	-	-	-	-	1	1	1	4
Pomatoschistus sp.	-	-	-	-	-	2	-	-	-	-	-	-	-	-	2
**Sargocentron rubrum* (Forsskål, 1775)	2	-	-	-	-	-	2	-	1	-	2	2	2	2	13
Sciaena umbra (Linnaeus, 1758)	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Scorpaena maderensis Valenciennes, 1833	1	-	-	-	-	-	1	-	-	-	-	1	1	1	5
Scorpaena porcus Linnaeus, 1758	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Serranus cabrilla (Linnaeus, 1758)	-	-	-	1	1	-	-	-	-	-	-	-	2	1	5
Serranus hepatus (Linnaeus, 1758)	-	-	1	3	-	-	-	-	-	-	-	-	-	-	4
Serranus scriba (Linnaeus, 1758)	1	-	-	-	-	-	-	-	-	-	-	2	1	2	6
**Siganus luridus* (Rüppell, 1829)	2	-	-	-	-	-	-	-	3	-	-	-	2	-	7
**Siganus rivulatus* Forsskål, 1775	3	-	-	-	-	-	3	-	3	-	-	-	3	1	13
Sparisoma cretense (Linnaeus, 1758)	3	-	-	-	-	-	2	-	3	-	-	3	2	3	16
**Sphyraena chrysotaenia* Klunzinger, 1884	2	-	-	-	-	-	-	-	-	-	-	2	-	-	4
**Stephanolepis diaspros* Fraser-Brunner, 1940	-	-	1	-	-	-	-	-	-	1	-	-	1	-	3
Symphodus mediterraneus (Linnaeus, 1758)	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Symphodus ocellatus Forsskål, 1775	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2
Symphodus roissali (Risso, 1810)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Symphodus tinca (Linnaeus, 1758)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1

Stations (Enfeh)	E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9	E-10	E-11	E-12	E-14	E-15	Total
Thalassoma pavo (Linnaeus, 1758)	3	-	-	-	-	-	2	-	2	-	2	3	2	2	16
**Torquigener flavimaculosus* Hardy & Randall, 1983	-	-	1	-	-	-	-	-	-	-	-	-	2	1	4
Tripterygion melanurum Guichenot, 1850	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
**Upeneus moluccensis* (Bleeker, 1855)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
**Upeneus pori* Ben-Tuvia & Golani, 1989	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Xyrichtys novacula (Linnaeus, 1758)	-	-	-	-	-	1	-	-	-	1	-	-	-	-	2
Number of species (S)	**123**	**4**	**17**	**6**	**7**	**10**	**62**	**10**	**17**	**8**	**14**	**114**	**60**	**52**	**209**
Relative abundance	**150**	**7**	**28**	**9**	**13**	**19**	**107**	**15**	**32**	**14**	**33**	**221**	**120**	**93**	**861**
Margalef' index	**24,35**	**1,542**	**4,802**	**2,276**	**2,339**	**3,057**	**13,05**	**3,323**	**4,617**	**2,652**	**3,718**	**20,93**	**12,32**	**11,25**	**-**

Code: (C) Ras Chekaa; (E) Enfeh; (N) Nakoura; (R) Raoucheh; (S) Saida; (T) Tyre. Relarive abundance: (3) very common; (2) common; (1) less common. (*) non indigenous species.

10.3.2 Ras Chekaa (hydroplane)

Stations (Ras Chekaa)	C-1	C-2	C-4	C-5	C-6	C-7	C-8	C-9	C-12	C-13	Total
Chlorophyta											
Caulerpa prolifera (Forsskål) J.V.Lamouroux, 1809	-	-	-	-	-	-	-	-	3	-	3
**Caulerpa scalpelliformis* (R.Brown ex Turner) C.Agardh, 1817	-	-	-	-	-	-	3	-	-	-	3
Flabellia petiolata (Turra) Nizamuddin, 1987	-	-	-	-	-	-	3	-	-	3	6
Ochrophyta											
Arthrocladia villosa (Hudson) Duby, 1830	-	-	3	3	3	3	3	-	-	-	15
Colpomenia sinuosa (Mertens ex Roth) Derbès & Solier, 1851	-	-	-	-	-	-	2	-	-	-	2
**Padina boergesenii* Allender & Kraft, 1983	-	-	3	3	3	3	-	2	-	-	14
Padina pavonica (Linnaeus) Thivy, 1960	-	-	2	2	-	-	-	-	-	-	4
Sargassum trichocarpum J.Agardh, 1848	-	-	3	-	-	-	-	-	-	-	3
**Stypopodium schimperi* (Buchinger) Verlaque & Boudouresque, 1991	-	-	-	-	-	2	-	-	-	-	2
Rhodophyta											
Amphiroa rigida J.V.Lamouroux, 1816	-	-	-	-	-	-	3	-	-	-	3
Chylocladia verticillata (Lightfoot) Bliding, 1928	-	-	-	-	3	-	-	-	-	-	3
Spongites fruticulosa Kützing, 1841	-	-	-	-	1	3	3	-	-	2	9
Magnoliphyta											
Cymodocea nodosa (Ucria) Ascherson, 1870	1	-	-	-	-	-	-	-	-	-	1
Porifera											
Aplysina aerophoba Nardo, 1833	-	-	-	-	-	-	2	-	-	-	2
Axinella sp.	-	-	-	-	-	2	-	2	-	-	4
Crambe crambe (Schmidt, 1862)	-	-	-	-	3	-	2	-	-	-	5
Ircinia sp.	-	-	3	-	-	-	-	-	-	-	3
Niphates toxifera Vacelet et al, 2007	-	-	2	2	2	-	-	-	-	-	6
Sarcotragus spinosulus Schmidt, 1862	-	-	-	-	-	-	-	1	-	-	1
Cnidaria											
Hydrozoa											
Sertularia marginata (Kirchenpauer, 1864)	-	-	-	-	-	-	3	-	-	-	3
Polychaeta											
Hermodice carunculata (Pallas, 1766)	-	-	-	-	-	3	-	-	-	-	3
Crustacea											
Cirripedia											
Perforatus perforatus (Bruguière, 1789)	-	-	-	-	-	-	2	-	-	-	2
Decapoda											
Diogenes pugilator (Roux, 1829)	3	-	-	-	-	-	-	-	-	-	3
Mollusca											
Gastropoda											
**Conomurex persicus* (Swainson, 1821)	1	-	-	-	-	-	-	-	-	-	1
**Rhinoclavis kochi* (Philippi, 1848) (shells)	3	-	-	-	-	-	-	-	-	-	3
Bivalvia											

Stations (Ras Chekaa)	C-1	C-2	C-4	C-5	C-6	C-7	C-8	C-9	C-12	C-13	Total
Acanthocardia tuberculata (Linnaeus, 1758) (shells)	2	-	-	-	-	-	-	-	-	-	2
**Chama pacifica* Broderip, 1835	-	-	3	-	-	-	3	-	-	-	6
Echinodermata											
Asteroidea											
Echinaster sepositus (Retzius, 1783)	-	-	-	1	1	-	1	1	-	-	4
Holothuroidea											
**Synaptula reciprocans* (Forskal, 1775)	-	-	-	-	-	1	-	-	-	-	1
Pisces'											
Elasmobranchii											
Dasyatis pastinaca (Linnaeus, 1758)	-	-	-	1	1	-	-	-	1	-	3
Actinopterygii											
**Apogonichthyoides nigripinnis* (Cuvier, 1828)	-	1	-	-	-	-	-	-	-	-	1
Atherinidae sp.	-	-	3	3	-	-	-	-	3	-	9
Chromis chromis (Linnaeus, 1758)	-	-	2	-	-	3	-	-	-	-	5
Coris julis (Linnaeus, 1758)	-	-	-	2	2	2	-	-	-	-	6
Diplodus vulgaris (Geoffroy Saint-Hilaire, 1817)	-	-	-	-	-	-	-	2	-	-	2
Epinephelus costae (Steindachner, 1878)	-	-	-	-	-	1	-	-	-	-	1
Labrus merula Linnaeus, 1758	-	-	-	-	-	-	-	2	-	-	2
Mullus surmuletus Linnaeus, 1758	-	-	-	-	-	2	-	-	-	-	2
Muraena helena Linnaeus, 1758	-	-	2	-	-	1	-	1	-	-	4
Mycteroperca rubra (Bloch, 1793)	1	-	-	-	-	-	-	-	-	-	1
Pomatoschistus sp.	2	-	-	-	-	-	-	-	-	-	2
**Sargocentron rubrum* (Forsskål, 1775)	-	-	2	-	-	3	-	3	-	-	8
Serranus cabrilla (Linnaeus, 1758)	-	-	-	1	2	1	-	-	-	-	4
**Siganus luridus* (Rüppell, 1829)	-	-	-	-	-	2	-	2	-	-	4
**Siganus rivulatus* Forsskål, 1775	-	-	-	-	-	3	3	2	-	-	8
Sparisoma cretense (Linnaeus, 1758)	-	-	-	2	-	3	3	2	-	-	10
**Stephanolepis diaspros* Fraser-Brunner, 1940	1	-	1	1	-	-	-	-	-	-	3
Thalassoma pavo (Linnaeus, 1758)	-	-	-	-	-	2	-	-	-	-	2
**Torquigener flavimaculosus* Hardy & Randall, 1983	-	-	-	-	1	-	-	-	-	-	1
Xyrichtys novacula (Linnaeus, 1758)	-	1	-	-	-	1	-	-	-	-	2
Species richness (S)	8	2	13	12	12	19	14	11	3	2	51
Relative Abondance	14	2	32	24	25	41	36	20	7	5	206
Margalef' index	2,652	1,443	3,462	3,481	3,417	4,847	3,628	3,338	1,028	0,621	-

10.3.3 Ras Chekaa (plot scuba and snorkel dives)

Stations (Ras Chekaa)	C-3	C-10	C-11	C-14	C-15	C-16	C-17	C-18	C-19	C-20	C-21	C-22	C-23	Total
Cyanobacteria														
Calothrix sp.	-	-	-	3	-	2	2	-	-	-	-	-	-	7
Chlorophyta														
Bryopsis plumosa C.Agardh, 1823	2	-	-	-	-	-	-	-	-	-	-	-	2	4
**Caulerpa scalpelliformis* (R.Brown ex Turner) C.Agardh, 1817	-	-	-	-	2	-	-	3	-	-	-	-	-	5
Chaetomorpha sp.	-	-	-	-	-	-	-	-	-	1	-	1	-	2
Cladophora pellucida (Hudson) Kützing, 1843	-	-	-	-	-	-	1	-	-	-	-	-	2	3
**Cladophoropsis modonensis* (Kützing) Reinbold, 1905	-	-	-	2	-	-	-	-	-	-	-	-	-	2
**Codium taylorii* P.C.Silva, 1960	3	2	-	2	-	-	2	-	-	-	-	-	-	9
Dasycladus vermicularis (Scopoli) Krasser, 1898	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Flabellia petiolata (Turra) Nizamuddin, 1987	-	-	-	-	3	-	-	3	-	-	-	-	-	6
Palmophyllum crassum (Naccari) Rabenhorst, 1868	-	1	-	-	-	-	-	-	1	1	-	-	-	3
Penicillus capitatus stadio Espera Lamarck, 1813												1		
Ulva compressa Linnaeus, 1753	-	-	-	-	-	-	-	-	-	-	-	-	3	3
Ulva cf. *lactuca* Linnaeus, 1753	3	-	-	-	-	-	-	-	2	-	-	2	2	9
Valonia utricularis (Roth) C.Agardh, 1823	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Ochrophyta														
Arthrocladia villosa (Hudson) Duby, 1830	-	-	-	-	3	-	-	2	-	-	3	-	-	8
Colpomenia sinuosa (Mertens ex Roth) Derbès & Solier, 1851	3	-	-	-	-	-	-	-	-	-	-	-	-	3
Cystoseira compressa (Esper) Gerloff & Nizamuddin, 1975	1	-	-	-	-	-	-	-	-	-	-	-	1	2
Cystoseira dubia Valiante, 1883	-	-	-	-	2	-	-	2	-	-	1	-	-	5
Cystoseira foeniculacea (Linnaeus) Greville, 1830	2	-	1	-	-	-	-	-	-	-	-	-	-	3
Dictyota dichotoma (Hudson) J.V.Lamouroux, 1809	1	-	-	1	2	-	-	-	-	-	2	-	-	6
Dictyota linearis (C.Agardh) Greville, 1830	-	-	-	-	-	-	-	-	-	-	2	-	-	2
Lobophora variegata (J.V.Lamouroux) Womersley ex E.C.Oliveira, 1977	1	2	-	1	-	2	1	1	-	1	-	-	-	9

Stations (Ras Chekaa)	**C-3**	**C-10**	**C-11**	**C-14**	**C-15**	**C-16**	**C-17**	**C-18**	**C-19**	**C-20**	**C-21**	**C-22**	**C-23**	**Total**
Padina pavonica (Linnaeus) Thivy, 1960	2	-	-	-	-	-	-	-	-	-	3	2	-	7
Ralfsia verrucosa (J.E.Areschoug) J.E.Areschoug, 1845	-	-	-	-	-	-	-	-	-	-	-	-	2	2
Sargassum vulgare C.Agardh, 1820	2	-	1	-	-	-	-	-	-	-	-	-	3	6
Sphacelaria sp.	-	-	-	-	-	-	-	-	-	-	-	-	2	2
Sporochnum pedunculatum (Hudson) C.Agardh, 1820	-	-	-	-	-	-	-	2	-	-	-	-	-	2
Stypocaulon scoparium (Linnaeus) Kützing, 1843	2	2	2	-	-	-	-	-	-	-	-	-	2	8
**Stypopodium schimperi* (Buchinger) Verlaque & Boudouresque, 1991	-	-	-	-	1	-	-	-	-	-	1	-	-	2
Rhodophyta														
**Acanthophora nayadiformis* (Delile) Papenfuss, 1968	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Acrososirum sp.	-	-	-	-	1	-	-	-	-	-	-	-	-	1
Amphiroa beauvoisii Lamouroux (1816)	-	-	-	-	-	2	-	-	-	-	-	-	-	2
Amphiroa cryptarthrodia Zanardini, 1843	-	-	-	-	-	1	-	-	-	-	-	-	-	1
Amphiroa rigida J.V.Lamouroux, 1816	2	2	3	3	-	-	3	-	-	2	-	-	2	17
Botryocladia botryoides (Wulfen) Feldmann, 1941	-	-	-	-	2	-	-	-	-	-	1	-	-	3
Chylocladia verticillata (Lightfoot) Bliding, 1928	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Ceramiales sp.	-	-	-	-	-	-	-	3	-	-	-	-	3	6
Corallina elongata J.Ellis & Solander, 1786	3	3	3	3	-	-	3	-	3	3	-	2	3	26
Cryptonemia cf. *lomation* (Bertoloni) J.Agardh, 1851	-	-	-	-	2	-	-	2	-	-	-	-	-	4
**Galaxaura rugosa* (J.Ellis & Solander) J.V.Lamouroux, 1816	2	-	-	-	-	1	-	-	-	1	-	-	-	4
**Ganonema farinosum* (J.V.Lamouroux) K.C.Fan & Yung C.Wang, 1974	3	1	3	-	-	-	-	-	-	-	-	-	3	10
Gelidium cf. *pusillum* (Stackhouse) Le Jolis, 1863	2	-	-	-	-	-	-	-	-	-	-	-	-	2
Halymenia floresia (Clemente) C. Agardh, 1807	-	-	-	-	1	-	-	-	-	-	1	-	-	2
**Hypnea spinella* (C.Agardh) Kützing, 1847	-	-	-	-	-	-	-	-	-	-	-	-	2	2
Jania longifurca Zanardini, 1843	-	-	-	3	-	3	3	-	-	2	-	-	-	11
Jania rubens (Linnaeus) J.V.Lamouroux, 1816	3	3	3	3	-	-	3	-	3	3	-	2	3	26
Jania rubens var. *corniculata* (Linnaeus) Yendo, 1905	-	-	-	-	-	1	-	-	-	2	-	-	-	3

Stations (Ras Chekaa)	C-3	C-10	C-11	C-14	C-15	C-16	C-17	C-18	C-19	C-20	C-21	C-22	C-23	Total
Laurencia obtusa (Hudson) J.V.Lamouroux, 1813	1	-	-	-	-	-	-	-	-	-	-	-	-	1
Lithophyllum incrustans Philippi, 1837	3	-	-	3	-	-	3	-	-	3	-	-	3	15
Lithophyllum papillosum (Zanardini ex Hauck) Foslie 1900	-	-	-	-	-	-	-	-	-	-	-	-	2	2
Lithophyllum stictaeforme (• • Areschoug) Hauck 1877	-	-	-	2	-	-	-	-	3	-	-	-	-	5
Lithophyllum sp.	-	-	-	-	-	-	-	-	-	2	-	-	-	2
Lithothamnion corallioides P.L.Crouan & H.M.Crouan, 1867	-	-	-	-	2	-	-	2	-	-	-	-	-	4
**Lophocladia lallemandii* (Montagne) F.Schmitz, 1893	-	-	-	2	-	2	2	-	-	1	-	-	-	7
Mesophyllum alternans (Foslie) Cabioch & Mendoza, 1998	1	-	-	2	1	1	1	2	2	2	2	-	-	14
Neogoniolithon brassica-florida (Harvey) Setchell & L.R.Mason, 1943	2	-	3	-	-	-	-	-	-	-	-	-	-	5
Neogoniolithon mamillosum (Hauck) Setchell & L.R.Mason, 1943	-	-	-	2	-	2	2	-	-	2	2	-	-	10
Neurocaulon foliosum (Meneghini) Zanardini, 1843	-	-	-	-	1	-	-	-	-	-	-	-	-	1
Palisada perforata (Bory de Saint-Vincent) K.W.Nam, 2007	3	-	-	-	-	-	-	-	-	-	-	-	3	6
Parviphycus pannosus (Feldmann) G.Furnari, 2010	-	-	-	-	-	-	-	-	-	-	-	-	3	3
Peyssonnelia rosa-marina Boudouresque & Denizot, 1973	2	-	-	-	-	2	-	-	-	3	-	-	-	7
Peyssonnelia rubra (Greville) J.Agardh, 1851	-	-	-	-	3	3	-	3	-	3	-	-	-	12
Peyssonnelia spp.	2	-	-	3	2	-	2	3	3	3	2	-	-	20
Phymatolithon cf. *calcareum* (Pallas) W.H.Adey & D.L.McKibbin, 1970	-	-	-	-	2	-	-	2	-	-	-	-	-	4
Phymatolithon lenormandii (J.E.Areschoug) W.H.Adey, 1966	-	-	-	-	-	-	-	-	-	-	-	-	2	2
Plocamium cartilagineum (Linnaeus) P.S.Dixon, 1967	2	2	-	3	-	-	2	-	3	3	-	-	-	15
Pterocladiella capillacea (S.G.Gmelin) Santelices & Hommersand, 1997	1	-	-	-	-	-	-	-	-	-	-	-	-	1
Rhodymenia ardissonei (Kuntze) Feldmann, 1937	-	-	-	-	2	-	-	2	-	-	2	-	-	6
Rhodymenia cf. *pseudopalmata* (J.V.Lamouroux) P.C.Silva, 1952	-	-	-	-	-	-	-	2	-	-	-	-	-	2
Schottera nicaeensis (J.V. Lamouroux) Guiry & Hollenberg, 1975	-	-	-	-	-	-	-	-	3	-	-	-	-	3
Scinaia furcellata (Turner) J.Agardh, 1851	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Sebdenia dichotoma Berthold, 1884	-	-	-	-	1	-	-	-	-	-	-	-	-	1
Solieria filiformis (Kützing) P.W.Gabrielson, 1985	-	-	-	-	-	-	-	-	-	-	-	-	1	1

Stations (Ras Chekaa)	C-3	C-10	C-11	C-14	C-15	C-16	C-17	C-18	C-19	C-20	C-21	C-22	C-23	Total
Spongites fruticulosa Kützing, 1841	-	-	-	-	3	-	-	3	-	-	1	-	-	7
Tricleocarpa fragilis (Linnaeus) Huisman & R.A.Townsend, 1993	1	1	-	1	-	-	1	-	-	-	-	-	-	4
Magnoliphyta														
Cymodocea nodosa (Ucria) Ascherson, 1870	-	2	-	-	-	-	-	-	-	-	-	1	-	3
Foraminifera														
**Amphistegina lobifera* Larsen 1976	-	-	-	-	-	-	-	-	-	-	3	-	-	3
Porifera														
Acanthella acuta Schmidt, 1862	-	-	-	-	-	-	-	-	1	1	-	-	-	2
Aplysina aerophoba Nardo, 1833	-	-	-	-	-	1	-	-	-	2	-	-	-	3
Axinella sp.	-	-	-	-	1	2	-	1	1	1	-	-	-	6
Calcarea spp. (Sycetusa, Vosmaeropsis)	1	1	-	1	-	-	1	-	2	1	-	-	-	7
Chondrilla nucula Schmidt, 1862	-	2	-	2	-	-	-	-	2	-	-	-	1	7
Chondrosia reniformis Nardo, 1847	2	2	-	2	-	-	3	-	3	2	-	-	2	16
Cinachyrella levantinensis Vacelet et al, 2007	-	-	-	-	-	1	-	-	-	1	-	-	-	2
Ciocalypta carballoi Vacelet et al, 2007	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Clathrina cf. *coriacea* (Montagu, 1818)	-	-	-	-	-	-	-	-	2	-	-	-	-	2
Clathrina cf. *lacunosa* (Johnston, 1842)	-	-	-	-	-	-	-	-	2	-	-	-	-	2
Clathrina cf. *rubra* Sará, 1958	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Cliona viridis (Schmidt, 1862)	-	-	-	-	-	-	-	-	-	-	2	-	-	2
Cliona parenzani Corriero & Scalera-Liaci, 1997	2	2	1	2	-	-	2	-	-	2	-	-	2	13
Corticium candelabrum Schmidt, 1862	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Crambe crambe (Schmidt, 1862)	2	2	-	2	2	3	3	3	2	2	3	-	2	26
Cymbaxinella damicornis (Esper, 1794)	-	-	-	-	-	1	-	-	-	-	-	-	-	1
Cymbaxinela sp.	-	-	-	-	-	3	-	-	2	3	-	-	-	8
Dictyonella sp.	-	-	-	-	-	-	-	-	-	2	-	-	-	2
Diplastella sp.	-	-	-	-	-	2	-	-	1	1	-	-	-	4

Stations (Ras Chekaa)	C-3	C-10	C-11	C-14	C-15	C-16	C-17	C-18	C-19	C-20	C-21	C-22	C-23	Total
Dysidea fragilis (Montagu, 1818)	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Gastrophanella phoeniciensis Perez *et al.*, 2004	-	-	-	-	-	-	-	-	3	-	-	-	-	3
Haliclona mediterranea Griessinger, 1971	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Haliclona sp.	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Ircinia variabilis (Schmidt, 1862)	-	-	-	-	-	2	-	-	-	-	-	-	-	2
Ircinia sp.	-	1	-	-	1	-	1	-	-	-	-	-	-	3
Microscleroderma lamina Perez *et al.*, 2004	-	-	-	-	-	-	-	-	3	-	-	-	-	3
Mycale sanguinea Tsurnamal, 1969	-	-	-	1	-	-	1	-	1	-	-	-	-	3
Mycale sp.	-	-	-	-	2	1	-	-	-	-	-	-	-	3
Myrmekioderma spelaeum (Pulitzer-Finali, 1983)	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Niphates toxifera Vacelet *et al*, 2007	-	1	1	3	-	1	2	-	-	-	1	-	-	9
Petrosia ficiformis (Poiret, 1789)	-	1	-	-	-	3	2	-	2	1	-	-	-	9
Phorbas tenacior (Topsent, 1925)	-	1	-	-	-	-	1	-	1	1	-	-	-	4
Phorbas topsenti Vacelet & Perez, 2008	1	1	-	1	-	2	1	1	1	2	-	-	1	11
Placospongia decorticans (Hanitsch, 1895)	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Sarcotragus fasciculatus (Pallas, 1766)	1	1	-	1	-	-	1	-	1	1	-	-	-	6
Sarcotragus cf. foetidus Schmidt, 1862	-	-	1	-	-	-	-	-	-	-	-	-	-	1
Sarcotragus spinosulus Schmidt, 1862	1	1	-	1	-	-	1	-	1	1	1	-	1	8
Spirastrella cunctatrix Schmidt, 1868	1	-	-	-	-	-	1	-	1	1	-	-	-	4
Spongia officinalis Linnaeus, 1759	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Sycon sp.	2	1	-	1	-	2	2	-	2	1	2	-	1	14
Terpios sp.	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Cnidaria														
Hydrozoa														
Aglaophenia elongata Menghini, 1845	-	-	-	-	-	-	-	-	-	2	-	-	2	4
Aglaophenia sp.	-	-	-	-	-	-	-	-	-	-	2	-	-	2

Stations (Ras Chekaa)	C-3	C-10	C-11	C-14	C-15	C-16	C-17	C-18	C-19	C-20	C-21	C-22	C-23	Total
Eudendrium spp.	-	2	-	2	3	2	2	-	-	2	2	-	-	15
**Macrorhynchia philippina* Kirchenpauer, 1872	1	1	-	-	-	-	1	-	1	1	-	2	-	7
Pennaria disticha (Goldfuss, 1820)	3	2	2	3	-	-	2	-	3	2	-	1	2	20
Plumullaridae sp.	-	-	-	-	3	-	-	-	-	-	-	-	-	3
Sertularia marginata (Kirchenpauer, 1864)	2	-	-	-	-	-	-	-	-	2	-	-	-	4
Anthozoa														
Anemonia viridis (Forskål, 1775)	-	-	-	-	-	-	-	-	-	-	-	3	-	3
Cerianthidae spp.	-	-	-	-	1	-	-	1	-	-	-	1	-	3
Madracis pharensis (Heller, 1868)	-	-	-	-	2	1	1	1	2	3	-	-	-	10
**Oculina patagonica* de Angelis, 1908	2	1	-	-	-	-	-	-	-	-	-	-	1	4
Phyllangia americana mouchezii (Lacaze-Duthiers, 1897)	-	-	-	-	-	-	2	-	2	1	-	-	-	5
Polycyathus muellerae (Abel, 1959)	-	-	-	-	-	-	-	-	2	-	-	-	-	2
Polychaeta														
Hermodice carunculata (Pallas, 1766)	3	3	-	3	-	-	2	1	2	3	-	-	-	17
Protula sp.	-	-	-	-	-	-	-	-	-	2	-	-	-	2
Sabella spallanzanii (Gmelin, 1791)	-	-	-	-	-	-	1	-	-	-	-	-	-	1
Sabella pavonina Savigny, 1822	-	-	-	-	-	-	1	-	-	-	-	-	-	1
Serpulidae spp.	-	-	-	-	-	-	-	-	-	3	-	-	-	3
**Spirobranchus lamarcki* (Quatrefages, 1866)	2	2	-	2	-	-	-	-	1	2	2	-	-	11
**Spirobranchus tetraceros* (Schmarda, 1861)	-	2	-	-	-	-	-	-	-	-	-	-	-	2
Crustacea														
Cirripedia														
Balanus trigonus Darwin, 1854	**1**	**1**	-	**1**	-	-	**1**	-	**1**	**1**	**2**	-	-	**8**
Chthmalus montagui Southward, 1976	**3**	**3**	-	**3**	-	-	**3**	-	**3**	**3**	-	-	**3**	**21**
Chthamalus stellatus (Poli, 1795)	3	-	-	-	-	-	-	-	-	-	-	-	3	6
Perforatus perforatus (Bruguière, 1789)	3	3	2	3	-	-	3	-	3	3	-	2	3	25

Stations (Ras Chekaa)	C-3	C-10	C-11	C-14	C-15	C-16	C-17	C-18	C-19	C-20	C-21	C-22	C-23	Total
Isopoda														
Ligia italica Fabricius, 1798	-	-	-	-	-	-	-	-	-	-	-	-	3	3
Decapoda														
**Atergatis roseus* (Rüppell, 1830)	1	-	-	-	-	-	1	-	1	1	-	-	-	4
Calcinus tubularis (Linnaeus, 1767)	-	-	-	1	-	-	-	-	1	-	-	-	-	2
**Charybdis hellerii* (A. Milne-Edwards, 1867)	2	-	-	2	-	-	2	-	2	-	-	-	-	8
Clibanarius erythropus (Latreille, 1818)	3	-	-	3	-	-	-	-	-	3	-	-	3	12
Diogenes pugilator (Roux, 1829)	-	-	-	-	-	-	-	-	-	-	-	1	-	1
Eriphia verrucosa (Forskål, 1775)	1	-	-	1	-	-	-	-	-	-	-	-	1	3
Pachygrapsus marmoratus (Fabricius, 1787)	1	-	1	-	-	-	-	-	-	-	-	-	1	3
Pagurus anachoretus Risso, 1827	-	-	-	-	-	-	-	-	1	1	-	-	-	2
**Percnon gibbesi* (H. Milne-Edwards, 1853)	2	-	-	-	-	-	-	-	-	-	-	-	-	2
Pilumnus hirtellus (Linnaeus, 1761)	-	-	-	-	-	-	1	1	-	-	-	-	-	2
Mollusca														
Polyplacophora														
Acanthochitona fascicularis (Linnaeus, 1767)	1	1	-	-	-	-	-	-	-	-	-	-	-	2
Chiton olivaceus Spengler, 1797	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Gastropoda														
Cratena peregrina (Gmelin, 1791)	-	-	-	1	-	-	-	-	1	-	-	-	-	2
**Cerithium scabridum* Philippi, 1848	3	3	3	-	-	-	3	-	-	3	-	-	3	18
Columbella rustica (Linnaeus, 1758)	2	2	-	2	-	-	2	-	-	-	-	-	-	8
**Conomurex persicus* (Swainson, 1821)	3	3	3	3	1	2	3	-	2	3	-	-	3	26
Conus ventricosus Gmelin, 1791	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Dendropoma petraeum (Monterosato, 1884)	2	-	-	-	-	-	-	-	-	-	-	-	2	4
Echinolittorina punctata (Gmelin, 1791)	3	-	3	-	-	-	-	-	-	-	-	-	3	9
**Ergalatax junionae* Houart, 2008	3	3	2	3	-	-	3	-	3	3	-	-	3	23

Stations (Ras Chekaa)	C-3	C-10	C-11	C-14	C-15	C-16	C-17	C-18	C-19	C-20	C-21	C-22	C-23	Total
Erosaria spurca (Linnaeus, 1758) (shells)	-	-	-	-	-	-	1	-	-	-	-	-	-	1
Flabellina affinis (Gmelin, 1791)	-	-	-	-	-	1	-	-	-	-	-	-	-	1
**Fusinus verrucosus* (Gmelin, 1791)	-	1	-	-	-	-	-	-	-	-	-	-	1	2
Gibbula spp.	-	-	-	-	-	-	-	-	-	-	-	-	2	2
**Goniobranchus annulatus* (Eliot, 1904)	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Hexaplex trunculus (Linnaeus, 1758)	1	1	-	1	-	-	1	-	-	-	-	-	-	4
**Trochus erithreus* (Brocchi, 1821)	-	1	-	-	-	-	1	-	-	1	-	-	1	4
Luria lurida (Linnaeus, 1758) (shell)	-	-	-	-	-	1	1	-	-	-	-	-	-	2
Melarhaphe neritoides (Linnaeus, 1758)	2	-	-	-	-	-	-	-	-	-	-	-	2	4
**Murex forskoehlii forskoehlii* Röding, 1798	-	1	-	1	-	-	-	-	-	-	-	-	-	2
Nassarius mutabilis (Linnaeus, 1758) (shells)	-	-	-	-	-	-	-	-	-	-	-	1	-	1
Patella caerulea Linnaeus, 1758	3	-	3	-	-	-	-	-	-	-	-	3	2	11
Patella rustica Linnaeus, 1758	3	3	-	-	-	-	-	-	-	-	-	-	3	9
Patella ulyssiponensis Gmelin, 1791	3	-	3	-	-	-	-	-	-	-	-	-	3	9
Phorcus articulatus (Lamarck, 1822)	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Phorcus turbinatus (Born, 1778)	2	2	-	-	-	-	-	-	-	-	-	-	2	6
**Purpuradusta gracilis notata* (Gill, 1858) (shells)	-	-	-	-	-	-	1	-	-	-	-	-	-	1
**Rhinoclavis kochi* (Philippi, 1848) (shells)	-	-	-	-	-	-	-	-	-	-	-	2	-	2
Thylacodes arenarius (Linnaeus, 1758) (shells)	1	-	-	-	-	-	-	-	-	-	-	-	-	1
**Indothais sacellum* (Gmelin, 1791) (= *Thais scacellum*)	-	-	-	1	-	-	-	-	-	-	-	-	-	1
Bivalvia														
**Brachidontes pharaonis* (P. Fischer, 1870)	3	3	3	3	-	-	3	-	3	-	-	3	3	24
**Chama pacifica* Broderip, 1835	3	3	-	3	-	3	3	-	3	3	-	2	3	26
**Dendostrea frons* (Linnaeus, 1758)	-	1	1	1	-	-	1	-	-	2	-	3	-	9
**Gafrarium savignyi* (Jomas, 1846) (shells)	-	-	-	-	-	-	1	-	-	-	-	-	-	1
Lioberus agglutinans (Cantraine, 1835) (shells)	-	-	-	1	-	-	-	-	-	-	-	-	-	1

Stations (Ras Chekaa)	C-3	C-10	C-11	C-14	C-15	C-16	C-17	C-18	C-19	C-20	C-21	C-22	C-23	Total
**Malleus regula* Forsskål, 1775	2	3	1	2	-	2	3	-	2	3	2	-	-	20
Ostreidae sp.	2	-	-	2	-	-	-	-	-	3	-	-	-	7
**Pinctada imbricata radiata* (Leach, 1814)	1	1	1	1	-	1	1	-	-	1	-	-	-	7
Pinna nobilis Linnaeus, 1758 (shell rests)	-	-	-	-	1	-	-	-	-	-	1	-	-	2
**Spondylus spinosus* Schreibers, 1793	2	2	-	2	-	2	2	-	2	2	-	1	1	16
Striarca lactea (Linnaeus, 1758)	-	-	-	-	2	-	-	2	-	-	-	-	-	4
Cephalopoda														
Octopus vulgaris Cuvier, 1797	1	-	-	1	-	1	1	-	-	-	-	1	-	5
Bryozoa														
Adeonella pallasii (Heller, 1867)	-	-	-	-	1	-	-	-	-	-	-	-	-	1
Caberea boryi (Audouin, 1826)	-	-	-	-	-	-	-	-	2	2	-	-	-	4
Cellaria spp.	-	-	-	-	-	-	-	-	3	3	-	-	-	6
Margaretta cereoides (Ellis & Solander, 1786)	-	-	-	2	-	-	-	-	2	-	-	-	-	4
Reptadeonella sp.	1	1	-	1	-	1	1	-	1	1	-	-	-	7
Reteporella sp.	-	-	-	-	-	-	1	-	2	2	-	-	-	5
Rhynchozoon sp.	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Schizomavella spp.	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Schizoporella errata (Waters, 1878)	2	2	-	2	-	-	2	-	2	2	-	3	-	15
Schizoretepora hassi Harmelin, Bitar, Zibrowius, 2007	-	-	-	-	-	-	-	-	1	1	-	-	-	2
Scrupocellaria sp.	-	-	-	2	-	-	1	-	-	-	-	-	-	3
Echinodermata														
Asteroidea														
Coscinasterias tenuispina (Lamarck, 1816)	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Echinaster sepositus (Retzius, 1783)	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Ophiuroidea														
**Ophiactis* sp. (O. parva or O. savignyi)	1	-	-	-	-	-	-	-	-	-	-	-	-	1

Stations (Ras Chekaa)	C-3	C-10	C-11	C-14	C-15	C-16	C-17	C-18	C-19	C-20	C-21	C-22	C-23	Total
Ophiomyxa pentagona (Lamarck, 1816)	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Echinoidea														
Arbacia lixula (Linnaeus, 1758)	-	1	-	2	-	-	1	-	1	1	-	-	-	6
Brissus unicolor (Leske, 1778) (tests)	-	-	-	-	-	1	-	-	-	-	-	-	-	1
Paracentrotus lividus (Lamarck, 1816)	1	2	-	2	-	-	1	-	1	1	-	-	1	9
Holothuroidea														
Holothuria impatiens (Forskål, 1775)	1	-	-	-	-	-	-	-	-	-	-	-	-	1
Holothuria sanctori Delle Chiaje, 1823	1	-	-	1	-	-	1	-	1	-	-	-	-	4
Holothuria tubulosa Gmelin, 1791	-	-	-	1	-	-	-	-	1	-	-	-	-	2
Ascidiacea														
Ascidia cf. *mentula* Müller, 1776	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Botryllus sp.	-	-	-	1	-	-	-	-	-	-	-	-	-	1
Cystodytes dellechiajei (Della Valle, 1877)	-	1	-	-	-	-	1	1	1	-	-	-	-	4
Didemnidae spp.	2	2	-	2	2	2	2	2	3	2	2	-	2	23
Diplosoma sp.	-	-	-	1	-	-	-	-	-	-	-	-	-	1
**Herdmania momus* (Savigny, 1816)	2	2	-	2	3	1	3	2	2	2	-	-	1	20
**Phallusia nigra* Savigny, 1816	2	2	-	2	-	-	1	-	2	2	-	2	2	15
Polyclinidae spp.	-	-	-	-	2	-	-	-	-	-	-	-	-	2
Pyura dura (Heller, 1877)	-	1	-	-	-	-	-	-	-	-	-	-	-	1
**Symplegma brakenhielmi* (Michaelsen, 1904)	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Pisces'														
Actinopterygii														
Apogon imberbis (Linnaeus, 1758)	-	1	-	1	-	-	-	-	1	1	-	-	-	4
Atherinidae sp.	3	-	3	-	3	-	-	-	3	-	3	3	-	18
**Atherinomorus lacunosus* (Forster, 1801)	3	-	-	-	-	-	-	-	-	-	-	-	-	3
Belone belone (Linnaeus, 1761)	1	-	-	-	-	-	-	-	-	-	-	-	-	1

Stations (Ras Chekaa)	C-3	C-10	C-11	C-14	C-15	C-16	C-17	C-18	C-19	C-20	C-21	C-22	C-23	Total
Blennidae spp.	1	-	-	-	-	-	-	-	-	-	-	-	-	1
Boops boops (Linnaeus, 1758)	3	-	-	-	-	-	-	-	1	-	3	-	-	7
Chromis chromis (Linnaeus, 1758)	3	3	3	3	-	2	3	-	3	3	1	-	-	24
Coris julis (Linnaeus, 1758)	2	2	-	2	2	3	2	2	2	2	2	-	3	24
Dicentrarchus punctatus	-	-	-	-	-	-	-	-	-	-	-	2	-	2
Diplodus cervinus (Lowe, 1838)	1	-	-	-	-	-	1	-	1	-	-	1	-	4
Diplodus puntazzo (Walbaum, 1792)	-	-	-	1	-	-	-	-	-	-	-	-	-	1
Diplodus sargus (Linnaeus, 1758)	3	3	3	3	-	2	3	-	3	3	-	1	2	26
Diplodus vulgaris (Geoffroy Saint-Hilaire, 1817)	2	2	2	2	-	-	2	-	-	2	-	1	2	15
Epinephelus costae (Steindachner, 1878)	-	-	-	-	-	-	-	-	1	-	1	-	-	2
Epinephelus marginatus (Lowe, 1834)	1	1	-	1	-	-	1	-	1	1	1	-	1	8
Gobius bucchichi Steindachner, 1870	-	-	-	-	-	2	1	-	-	-	-	-	-	3
Gobius geniporus Valenciennes, 1837	-	-	-	-	-	-	-	2	-	-	1	-	-	3
Gobius kolombatovici Kovacic & Miller, 2000	-	-	-	-	1	-	-	-	-	-	-	-	-	1
Gobius vittatus Vinciguerra, 1883	-	-	-	-	-	-	-	1	-	-	1	-	-	2
Gymnothorax unicolor Delaroche, 1809	-	-	-	-	-	-	1	-	-	-	-	-	-	1
Mugilidae spp.	-	-	-	-	-	-	-	-	-	-	-	2	-	2
Mullus surmuletus Linnaeus, 1758	-	-	-	-	-	-	-	-	1	2	-	-	-	3
Muraena helena Linnaeus, 1758	-	-	-	1	-	1	1	-	-	-	-	-	-	3
Mycteroperca rubra (Bloch, 1793)	1	1	1	1	-	-	1	-	1	-	1	-	-	7
Oblada melanura (Linnaeus, 1758)	3	3	2	3	-	2	3	-	3	2	-	-	-	21
Parablennius zvonimiri (Kolombatovic, 1892)	1	-	-	-	-	-	-	-	-	-	-	-	-	1
**Pempheris vanicolensis* Cuvier, 1831	3	3	-	3	-	-	2	-	3	3	-	-	-	17
Pomadasys incisus (Bowdich, 1825)	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Pseudocaranx dentex (Bloch & Schneider, 1801)	-	-	-	-	-	-	-	-	2	-	-	-	-	2
**Pteragogus pelycus* Randall, 1981	-	-	-	-	-	1	1	-	-	-	-	-	-	2

Stations (Ras Chekaa)	C-3	C-10	C-11	C-14	C-15	C-16	C-17	C-18	C-19	C-20	C-21	C-22	C-23	Total
**Sargocentron rubrum* (Forsskål, 1775)	2	2	-	3	-	3	2	-	3	2	2	-	-	19
Scorpaena maderensis Valenciennes, 1833	1	1	-	1	-	1	1	-	1	1	-	-	-	7
Scorpaena porcus Linnaeus, 1758	-	-	-	1	-	-	-	-	1	-	-	-	-	2
Serranus cabrilla (Linnaeus, 1758)	-	-	-	1	2	1	1	2	1	1	2	-	-	11
Serranus hepatus (Linnaeus, 1758)	-	-	-	-	1	-	-	2	-	-	2	-	-	5
Serranus scriba (Linnaeus, 1758)	2	-	-	2	-	-	1	-	-	2	-	-	-	7
**Siganus luridus* (Rüppell, 1829)	2	2	-	2	-	-	2	-	2	2	-	-	1	13
**Siganus rivulatus* Forsskål, 1775	3	3	-	3	-	-	3	-	3	3	-	2	2	22
Sparisoma cretense (Linnaeus, 1758)	3	3	-	3	2	2	3	-	3	3	1	1	2	26
**Sphyraena chrysotaenia* Klunzinger, 1884	2	-	-	-	-	-	-	-	-	-	-	3	-	5
**Stephanolepis diaspros* Fraser-Brunner, 1940	1	1	-	-	-	1	-	-	-	-	-	-	1	4
Symphodus ocellatus Forsskål, 1775	-	-	-	-	-	1	-	-	-	-	-	-	-	1
Thalassoma pavo (Linnaeus, 1758)	3	3	3	3	1	3	3	-	3	3	-	-	3	28
**Torquigener flavimaculosus* Hardy & Randall, 1983	-	-	-	-	2	1	-	-	-	-	2	-	-	5
Tripterygion melanurum Guichenot, 1850	1	1	-	-	-	-	1	-	1	-	-	-	1	5
Tripterygion tripteronotus (Risso, 1810)	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Species richness (S)	107	77	32	88	42	54	93	36	98	94	44	32	75	271
Relative Abondance	211	141	68	167	77	93	161	66	177	181	75	59	151	1628
Margalef' index	19,81	15,36	7,347	17,0	9,439	11,69	18,11	8,354	18,74	17,89	9,959	7,603	14,75	-

10.3.4 Raoucheh

Station (Raoucheh)	R-1
Chlorophyta	
**Codium taylorii* P.C.Silva, 1960	3
Ulva cf. *lactuca* Linnaeus, 1753 *(= U. fasciata)*	3
Rhodophyta	
Corallina elongata J.Ellis & Solander, 1786	3
Hildenbrandia rubra (Sommerfelt) Meneghini, 1841	3
Lithophyllum incrustans Philippi, 1837	3
Peyssonnelia spp.	2
Phymatolithon lenormandii (J.E.Areschoug) W.H.Adey, 1966	2
Plocamium cartilagineum (Linnaeus) P.S.Dixon, 1967	3
Pterocladiella capillacea (S.G.Gmelin) Santelices & Hommersand, 1997	3
Schottera nicaeensis (J.V. Lamouroux ex Duby) Guiry & Hollenberg, 1975	2
Porifera	
Aplysina sp.	3
Calcarea spp. (Sycetusa, Vosmaeropsis)	3
Chondrosia reniformis Nardo, 1847	3
Clathrina clathrus (Schmidt, 1864)	2
Clathrina contorta Minchin, 1905	3
Clathrina cf. *coriacea* (Montagu, 1818)	3
Clathrina cf. *lacunosa* (Johnston, 1842)	2
Cliona viridis (Schmidt, 1862)	2
Crambe crambe (Schmidt, 1862)	2
Diplastella sp.	2
Euryspongia raouchensis Vacelet *et al.*, 2007	2
Gastrophanella phoeniciensis Perez *et al.*, 2004	2
Haliclona fulva (Topsent, 1893)	3
Hexadella racovitzai Topsent, 1896	1
Ircinia variabilis (Schmidt, 1862)	1
**Paraleucilla magna Klautau et al.*, 2004	1
Petrosia ficiformis (Poiret, 1789)	2
Phorbas topsenti Vacelet & Perez, 2008	2
Spongia officinalis Linnaeus, 1759	1
Sycon sp.	2
Terpios sp.	1
Cnidaria	
Hydrozoa	
Aglaophenia picardi Svoboda, 1979	2
Eudendrium carneum Clarke, 1882	2
Pennaria disticha (Goldfuss, 1820)	3
Sertularia marginata (Kirchenpauer, 1864)	2
Anthozoa	
Phyllangia americana mouchezii (Lacaze-Duthiers, 1897)	3
Polycyathus muellerae (Abel, 1959)	3

Station (Raoucheh)	R-1
Telmatactis cricoides (Duchassaing, 1850)	1
Polychaeta	
Filograna sp.	2
Hermodice carunculata (Pallas, 1766)	2
Hydroides sp.	2
Sabellidae sp.	1
**Spirobranchus kraussii* (Baird, 1865)	2
Spirorbidae sp.	3
Crustacea	
Decapoda	
**Charybdis hellerii* (A. Milne-Edwards, 1867)	1
Galatheidae sp.	1
Mollusca	
Gastropoda	
**Conomurex persicus* (Swainson, 1821)	3
**Ergalatax junionae* Houart, 2008	2
Bivalvia	
**Brachidontes pharaonis* (P. Fischer, 1870)	3
**Chama pacifica* Broderip, 1835	1
**Dendostrea frons* (Linnaeus, 1758)	3
**Malleus regula* Forsskål, 1775	2
Ostreidae sp.	2
**Pinctada imbricata radiata (Leach, 1814)*	1
**Spondylus spinosus Schreibers, 1793*	1
Bryozoa	
Margaretta cereoides (Ellis & Solander, 1786)	3
Reptadeonella sp.	1
Schizoretepora hassi Harmelin, Bitar, Zibrowius, 2007	2
Echinodermata	
Asteroidea	
**Aquilonastra burtoni* (Gray, 1840)	1
Ascidiacea	
Cystodytes dellechiajei (Della Valle, 1877)	3
Didemnidae spp.	3
Diplosoma sp.	2
**Herdmania momus* (Savigny, 1816)	3
**Phallusia nigra* Savigny, 1816	3
Polysyncraton bilobatum Lafargue, 1968	2
Pycnoclavella sp.	1
Pseudodistoma cyrnusense Pérès, 1952	2
Pyura dura (Heller, 1877)	3
**Symplegma brakenhielmi* (Michaelsen, 1904)	2
Pisces'	
Actinopterygii	

Station (Raoucheh)	R-1
Apogon imberbis (Linnaeus, 1758)	1
Atherinidae sp.	3
Chromis chromis (Linnaeus, 1758)	2
Coris julis (Linnaeus, 1758)	2
Diplodus sargus (Linnaeus, 1758)	3
Diplodus vulgaris (Geoffroy Saint-Hilaire, 1817)	1
Mycteroperca rubra (Bloch, 1793)	1
Oblada melanura (Linnaeus, 1758)	1
Pagrus auriga Valenciennes, 1843	1
**Pempheris vanicolensis* Cuvier, 1831	3
**Sargocentron rubrum* (Forsskål, 1775)	1
Scorpaena maderensis Valenciennes, 1833	1
**Siganus rivulatus* Forsskål, 1775	3
Sparisoma cretense (Linnaeus, 1758)	2
Symphodus ocellatus Forsskål, 1775	1
Thalassoma pavo (Linnaeus, 1758)	2
**Torquigener flavimaculosus* Hardy & Randall, 1983	1
Tripterygion melanurum Guichenot, 1850	1
Species richness	**81**
Relative abundance	**179**
Margalef' index	**15,42**

10.3.5 Saida

Stations (Saida)	S-1	S-2	S-3	S-4	S-5	S-6	S-7	Total
Cyanobacteria								
Rivularia atra Roth ex Bornet & Flahault, 1886	-	-	3	-	-	-	-	3
Fungi								
Verrucaria amphibia Clemente, 1814	-	-	3	-	-	-	-	3
Chlorophyta								
Chaetomorpha sp.	-	-	3	-	-	-	-	3
Cladophora sp.	-	-	2	-	-	-	-	2
**Codium parvulum* (Bory ex Audouin) P.C.Silva, 2003	3	3	-	-	-	3	3	12
Ulva intestinalis Linnaeus, 1753	-	-	3	-	-	-	-	3
Ochrophyta								
Cystoseira foeniculacea (Linnaeus) Greville, 1830	-	1	-	-	-	1	1	3
Lobophora variegata (J.V.Lamouroux) Womersley ex E.C.Oliveira, 1977	-	1	-	-	-	-	-	1
Padina pavonica (Linnaeus) Thivy, 1960	2	2	2	-	-	-	2	8
Ralfsia verrucosa (J.E.Areschoug) J.E.Areschoug, 1845	-	-	3	-	-	-	-	3
Stypocaulon scoparium (Linnaeus) Kützing, 1843	1	-	-	-	-	-	-	1
**Stypopodium schimperi* (Buchinger ex Kützing) Verlaque & Boudouresque, 1991	-	-	-	-	-	-	1	1
Rhodophyta								
Amphiroa rigida J.V.Lamouroux, 1816	3	3	-	-	-	-	-	6
Corallina elongata J.Ellis & Solander, 1786	2	1	-	-	-	-	-	3
Jania longifurca Zanardini, 1843	2	-	-	-	-	-	-	2
Jania rubens (Linnaeus) J.V.Lamouroux, 1816	2	3	3	-	-	-	-	8
Laurencia obtusa (Hudson) J.V.Lamouroux, 1813	-	2	-	-	-	-	-	2
**Laurencia* sp.	1	2	-	-	-	-	2	5
Lithophyllum incrustans Philippi, 1837	-	3	-	-	-	-	-	3
Lithophyllum papillosum (Zanardini ex Hauck) Foslie 1900	-	-	2	-	-	-	-	2
Palisada perforata (Bory de Saint-Vincent) K.W.Nam, 2007	-	-	2	-	-	-	-	2
Porifera								
Axinella polypoides Schmidt, 1862	-	-	-	-	1	-	-	1
Chondrosia reniformis Nardo, 1847	2	2	-	-	-	-	-	4
Crambe crambe (Schmidt, 1862)	3	3	-	-	-	-	1	7
Haliclona sp.	-	-	-	-	-	-	-	1
Ircinia variabilis (Schmidt, 1862)	2	-	-	-	-	-	-	2
Ircinia sp.	2	-	-	-	-	-	1	3
Phorbas topsenti Vacelet & Perez, 2008	2	2	-	-	-	-	-	4
Sarcotragus spinosulus Schmidt, 1862	1	1	-	-	-	-	-	2
Cnidaria								
Hydrozoa								
Eudendrium cf. *merulum* Watson, 1985	-	-	-	-	-	-	1	1
Eudendrium spp.	-	-	-	-	-	-	1	1

Stations (Saida)	S-1	S-2	S-3	S-4	S-5	S-6	S-7	Total
**Macrorhynchia philippina* Kirchenpauer, 1872	2	2	-	-	-	-	2	6
Pennaria disticha (Goldfuss, 1820)	2	2	-	-	-	-	2	6
Sertularia marginata (Kirchenpauer, 1864)	2	2	-	-	-	-	-	4
Scyphozoa								
**Rhopilema nomadica* Galil, 1990	-	-	-	-	1	-	1	2
Polychaeta								
Serpulidae spp.	3	3	-	-	-	-	-	6
Sipuncula								
Phascolosoma stephensoni (Stephen, 1942)	-	1	-	-	-	-	-	1
Crustacea								
Cirripedia								
Balanus trigonus Darwin, 1854	3	3	-	-	-	-	-	6
Chthmalus montagui Southward, 1976	-	-	3	-	-	-	-	3
Chthamalus stellatus (Poli, 1795)	-	-	3	-	-	-	-	3
Euraphia depressa (Poli, 1791)	-	-	1	-	-	-	-	1
Perforatus perforatus (Bruguière, 1789)	3	3	-	-	-	-	-	6
Decapoda								
**Charybdis hellerii* (A. Milne-Edwards, 1867)	-	1	-	-	-	-	-	1
Pachygrapsus marmoratus (Fabricius, 1787)	-	-	1	-	-	-	-	1
Mollusca								
Gastropoda								
Bittium spp.	3	1	-	-	-	-	-	4
* cf. *Cellana rota* (Gmelin, 1791)	-	-	1	-	-	-	-	1
**Cerithium scabridum* Philippi, 1848	3	3	-	-	-	-	-	6
**Conomurex persicus* (Swainson, 1821)	2	-	-	-	3	-	-	5
Diodora rueppellii (G. B. Sowerby I, 1835)	1	-	-	-	-	-	-	1
Echinolittorina punctata (Gmelin, 1791)	-	-	3	-	-	-	-	3
**Ergalatax junionae* Houart, 2008 (= E. obscura)	-	2	-	-	-	-	-	2
Erosaria spurca (Linnaeus, 1758) (shells)	1	1	1	-	-	-	-	3
Euthria cornea (Linnaeus, 1758) (shells)	-	1	-	-	-	-	-	1
Hexaplex trunculus (Linnaeus, 1758)	-	1	1	-	-	-	-	2
**Hypselodoris infucata* Rüppell & Leuckart, 1831	1	1	-	-	-	-	-	2
Melarhaphe neritoides (Linnaeus, 1758)	-	3	3	-	-	-	-	6
Ocinebrina sp. (shells)	-	-	1	-	-	-	-	1
Patella caerulea Linnaeus, 1758	-	-	3	-	-	-	-	3
Patella rustica Linnaeus, 1758	-	-	3	-	-	-	-	3
Patella ulyssiponensis Gmelin, 1791	-	2	3	-	-	-	-	5
Phorcus turbinatus (Born, 1778)	-	1	3	-	-	-	-	4
Bivalvia								
Acanthocardia tuberculata (Linnaeus, 1758) (shells)	-	1	-	-	-	-	-	1

Stations (Saida)	S-1	S-2	S-3	S-4	S-5	S-6	S-7	Total
**Brachidontes pharaonis* (P. Fischer, 1870)	3	3	3	-	-	-	-	9
**Chama pacifica* Broderip, 1835	3	1	1	-	-	2	1	8
Ctena decussata (O. G. Costa, 1829) (shells)	1	-	-	-	-	-	-	1
**Fulvia fragilis* (Forsskal in Neihbur, 1775)	**1**	-	-	-	-	-	-	**1**
**Gafrarium savignyi* (Jomas, 1846) (shells)	2	2	-	-	-	-	-	4
Glycymeris nummaria (Linnaeus, 1758) (shells)	**2**	**1**	-	-	-	-	-	**3**
Mactra stultorum (Linnaeus, 1758) (shells)	2	1	-	-	-	-	-	3
**Malleus regula* Forsskål, 1775	-	**2**	-	-	-	-	-	**2**
Ostreidae sp.	-	1	1	-	-	-	-	2
**Pinctada imbricata radiata* (Leach, 1814)	-	**1**	-	-	-	-	-	**1**
Polititapes aureus (Gmelin, 1791)	**1**	**1**	**1**	-	-	-	-	**3**
**Spondylus spinosus* Schreibers, 1793	3	-	-	-	-	-	-	3
Venerupis corrugata (Gmelin, 1791) (shells)	1	-	-	-	-	-	-	1
Venus verrucosa Linnaeus, 1758 (shells)	2	-	-	-	-	-	-	2
Cephalopoda								
Loligo vulgaris Lamarck, 1798 (eggs)	-	-	-	-	1	-	-	1
Bryozoa								
Rhynchozoon sp.	-	1	-	-	-	-	-	1
Schizoporella errata (Waters, 1878)	3	3	-	-	-	-	3	9
Echinodermata								
Echinoidea								
Brissus unicolor (Leske, 1778) (tests)	1	-	-	-	-	-	-	1
Ascidiacea								
Botrylloides cf. *leachii*	-	1	-	-	-	-	-	1
Didemnidae spp.	1	1	-	-	-	-	-	2
**Herdmania momus* (Savigny, 1816)	1	-	-	-	-	-	-	1
**Phallusia nigra* Savigny, 1816	3	3	-	-	-	-	2	8
Styelidae sp.	2	3	-	-	-	-	-	5
Pisces								
Elasmobranchii								
Dasyatis pastinaca (Linnaeus, 1758)	-	-	-	-	1	-	-	1
Rhinobatos cemiculus Geoffroy Saint-Hilaire, 1817	-	-	-	-	1	-	-	1
Actinopterygii								
Chromis chromis (Linnaeus, 1758)	3	3	-	-	-	3	2	11
Coris julis (Linnaeus, 1758)	2	2	-	-	2	2	2	10
Diplodus sargus (Linnaeus, 1758)	2	-	-	-	-	1	1	4
Diplodus vulgaris (Geoffroy Saint-Hilaire, 1817)	-	-	-	-	-	2	-	2
Epinephelus costae (Steindachner, 1878)	-	-	-	-	1	-	-	1
**Fistularia commersonii* Rüppell, 1835	-	-	-	**1**	-	-	-	**1**
Gobius bucchichi Steindachner, 1870	3	-	-	-	-	2	3	8

Stations (Saida)	S-1	S-2	S-3	S-4	S-5	S-6	S-7	Total
Mycteroperca rubra (Bloch, 1793)	1	-	-	-	-	-	-	1
**Plotosus lineatus* (Thunberg, 1787)	-	-	-	-	2	-	-	2
**Sargocentron rubrum* (Forsskål, 1775)	2	-	-	-	3	-	2	7
Serranus cabrilla (Linnaeus, 1758)	-	-	-	-	-	1	2	3
Serranus hepatus (Linnaeus, 1758)	-	-	-	-	-	-	2	2
Serranus scriba (Linnaeus, 1758)	-	1	-	-	-	-	2	3
**Siganus luridus* (Rüppell, 1829)	1	1	-	-	-	-	-	2
**Siganus rivulatus* Forsskål, 1775	3	3	-	-	-	2	2	10
Sparisoma cretense (Linnaeus, 1758)	-	-	-	-	-	2	1	3
**Stephanolepis diaspros* Fraser-Brunner, 1940	-	-	-	-	-	-	1	1
Symphodus tinca (Linnaeus, 1758)	-	-	-	-	-	1	-	1
Thalassoma pavo (Linnaeus, 1758)	3	3	-	-	-	2	-	8
Xyrichtys novacula (Linnaeus, 1758)	-	-	-	1	2	1	1	5
Species richness (S)	**52**	**54**	**28**	**2**	**11**	**14**	**27**	**107**
Relative abundance	**106**	**102**	**62**	**2**	**18**	**25**	**45**	**359**
Margalef' index	**10,94**	**11,48**	**6,542**	**1,443**	**3,46**	**4,039**	**6,83**	**-**

10.3.6 Tyre (Hydroplane)

Stations (Tyre)	T-3	T-4	T-7	T-8	T-9	T-10	T-13	T-14	T-15	Total
Chlorophyta										
**Codium parvulum* (Bory ex Audouin) P.C.Silva, 2003	-	-	-	-	3	-	-	-	-	3
Ochrophyta										
Cystoseira foeniculacea (Linnaeus) Greville, 1830	-	-	-	-	2	-	-	2	3	7
Dictyota fasciola (Roth) J.V.Lamouroux, 1809	-	-	-	-	-	-	-	-	3	3
Dictyota linearis (C.Agardh) Greville, 1830	-	3	-	-	3	2	-	-	-	8
Lobophora variegata (J.V.Lamouroux) Womersley ex E.C.Oliveira, 1977	-	-	-	-	-	-	-	-	3	3
Padina pavonica (Linnaeus) Thivy, 1960	-	2	-	-	-	-	-	-	-	2
**Stypopodium schimperi* (Buchinger ex Kützing) Verlaque & Boudouresque, 1991	-	-	-	-	3	-	-	-	-	3
Rhodophyta										
Amphiroa rigida J.V.Lamouroux, 1816	-	-	-	-	-	-	-	-	3	3
Corallina elongata J.Ellis & Solander, 1786	-	-	-	-	-	3	-	-	-	3
**Galaxaura rugosa* (J.Ellis & Solander) J.V.Lamouroux, 1816	-	-	-	3	3	3	-	3	-	12
Haliptylon virgatum Garbary & Johansen (1982)	-	3	-	-	-	-	-	-	-	3
Halymenial sp.	-	3	-	-	-	-	-	-	-	3
Jania rubens var. corniculata (Linnaeus) Yendo, 1905	-	-	-	-	3	-	-	-	-	3
**Laurencia* sp.	-	-	-	-	-	3	-	-	2	5
Peyssonnelia spp.	-	2	-	-	-	-	-	-	-	2
Magnoliophyta										
Cymodocea nodosa (Ucria) Ascherson, 1870	1	1	-	-	-	-	-	-	-	2
Porifera										
Axinella polypoides Schmidt, 1862	-	-	3	-	-	-	-	-	-	3
Axinella sp.	-	3	-	2	3	2	2	2	-	14
Ciocalypta carballoi Vacelet et al, 2007	-	1	-	-	1	1	-	-	-	3
Cliona viridis (Schmidt, 1862)	-	-	-	-	-	1	-	-	-	1
Crambe crambe (Schmidt, 1862)	-	3	-	-	3	3	3	-	-	12
Ircinia sp.	-	2	-	-	1	2	-	-	-	5
Petrosia ficiformis (Poiret, 1789)	-	2	-	-	-	-	2	-	-	4
Phorbas topsenti Vacelet & Perez, 2008	-	-	-	-	2	-	-	-	-	2
Sarcotragus spinosulus Schmidt, 1862	-	2	-	-	1	2	-	-	-	5
Spongia officinalis Linnaeus, 1759	-	-	-	-	-	1	-	-	-	1
Cnidaria Hydrozoa										
Eudendrium carneum Clarke, 1882	-	2	-	-	2	-	-	-	-	4
Eudendrium cf. *merulum* Watson, 1985	-	-	-	-	-	-	2	-	-	2
Eudendrium spp.	-	-	-	-	-	-	2	-	-	2
**Macrorhynchia philippina* Kirchenpauer, 1872	-	-	-	-	-	2	-	-	-	2
Pennaria disticha (Goldfuss, 1820)	-	1	-	-	-	3	-	-	-	4
Crustacea Decapoda										
Calcinus tubularis (Linnaeus, 1767)	-	-	-	-	-	-	-	-	1	1

Stations (Tyre)	T-3	T-4	T-7	T-8	T-9	T-10	T-13	T-14	T-15	Total
Diogenes pugilator (Roux, 1829)	3	-	-	-	-	-	-	-	-	3
Mollusca										
Gastropoda										
**Cerithium scabridum* Philippi, 1848	-	-	-	-	-	-	-	-	3	3
**Conomurex persicus* (Swainson, 1821)	2	-	-	-	-	-	-	-	1	3
Bivalvia										
Acanthocardia tuberculata (Linnaeus, 1758) (shells)	1	-	-	-	-	-	-	-	-	1
**Brachidontes pharaonis* (P. Fischer, 1870)	-	-	3	-	-	-	-	-	-	3
**Chama pacifica* Broderip, 1835	-	2	2	-	1	3	2	2	3	15
**Gafrarium savignyi* (Jomas, 1846) (shells)	-	-	-	-	-	-	-	-	2	2
Mactra stultorum (Linnaeus, 1758 (shells)	-	-	-	-	-	-	-	-	3	3
**Malleus regula* Forsskål, 1775	-	-	-	-	3	-	-	-	2	5
Ostreidae sp.	-	-	-	-	-	-	-	-	1	1
**Pinctada imbricata radiata* (Leach, 1814)	-	-	-	-	1	-	-	-	-	1
**Spondylus spinosus* Schreibers, 1793	-	3	-	2	2	3	-	-	2	12
Bryozoa										
Schizoporella errata (Waters, 1878)	-	-	-	-	-	-	-	-	1	1
Echinodermata										
Echinoidea										
Echinocardium mediterraneum (Forbes, 1844) (tests)	1	-	-	-	-	-	-	-	-	1
Holothuroidea										
**Synaptula reciprocans* (Forskal, 1775)	-	-	-	-	-	-	-	1	-	1
Ascidiacea										
**Phallusia nigra* Savigny, 1816	-	-	-	-	2	-	-	-	2	4
Pisces'										
Elasmobranchii										
Dasyatis pastinaca (Linnaeus, 1758)	-	-	2	1	-	-	-	-	-	3
Rhinobatos cemiculus Geoffroy Saint-Hilaire, 1817	-	-	-	1	-	-	-	-	-	1
Actinopterygii										
Chromis chromis (Linnaeus, 1758)	-	3	3	2	3	3	-	3	-	17
Coris julis (Linnaeus, 1758)	-	-	-	2	2	2	-	2	-	8
Diplodus puntazzo (Walbaum, 1792)	-	-	-	-	1	-	-	-	-	1
Diplodus sargus (Linnaeus, 1758)	-	-	2	-	-	-	-	2	1	5
Diplodus vulgaris (Geoffroy Saint-Hilaire, 1817)	-	-	-	-	-	-	-	3	-	3
Epinephelus costae (Steindachner, 1878)	-	-	-	-	-	-	-	1	-	1
Gobius bucchichi Steindachner, 1870	-	-	-	-	2	-	-	-	-	2
**Lagocephalus scleratus* (Gmelin, 1789)	-	-	-	1	-	-	-	-	-	1
**Pempheris vanicolensis* Cuvier, 1831	-	-	2	-	-	-	-	-	-	2
**Plotosus lineatus* (Thunberg, 1787)	-	-	-	-	-	1	-	-	-	1
**Sargocentron rubrum* (Forsskål, 1775)	-	3	2	2	-	3	-	2	-	12

Stations (Tyre)	T-3	T-4	T-7	T-8	T-9	T-10	T-13	T-14	T-15	Total
Serranus cabrilla (Linnaeus, 1758)	-	-	2	2	-	-	-	-	-	4
Serranus scriba (Linnaeus, 1758)	-	-	-	-	-	1	-	1	-	2
**Siganus luridus* (Rüppell, 1829)	-	-	2	-	-	-	-	1	-	3
**Siganus rivulatus* Forsskål, 1775	-	2	2	3	-	-	-	2	-	9
Sparisoma cretense (Linnaeus, 1758)	-	-	2	2	2	-	-	2	-	8
Spicara smaris (Linnaeus, 1758)	-	-	-	3	-	-	-	-	-	3
Symphodus tinca (Linnaeus, 1758)	-	1	-	-	-	1	-	1	-	3
Thalassoma pavo (Linnaeus, 1758)	-	2	-	-	-	-	-	3	2	7
Trachurus sp.	-	-	2	-	-	-	-	-	-	2
Tripterygion melanurum Guichenot, 1850	-	-	-	-	-	-	-	-	1	1
Xyrichtys novacula (Linnaeus, 1758)	-	1	-	1	-	-	-	-	-	2
Species richness (S)	**5**	**22**	**13**	**14**	**23**	**21**	**6**	**17**	**19**	**72**
Relative abundance	**8**	**47**	**29**	**27**	**49**	**45**	**13**	**33**	**39**	**290**
Margalef's index	**1,92**	**5,45**	**3,56**	**3,94**	**5,63**	**5,25**	**1,95**	**4,58**	**4,91**	**-**

10.3..7 Tyre (plot scuba and snorkeling dives)

Stations (Tyre)	T-1	T-2	T-5	T-6	T-11	T-12	T-16	T-17	T-18	T-19	T-20	T-21	T-22	T-23	T-24	T-25	Total
Proteobacteria																	
Beggiatoa spp.																3	3
Cyanobacteria																	
Phormidium autumnale (C.Agardh) Trevisan ex Gomont, 1892		3	3	3	3				3								15
Oscillatoria sp.																1	1
Fungi																	
Verrucaria amphibia Clemente, 1814			3	3													6
Chlorophyta																	
Bryopsis plumosa C.Agardh, 1823								2									2
Cladophora sp.								3									3
**Codium parvulum* (Bory ex Audouin) P.C.Silva, 2003										2			1				3
Palmophyllum crassum (Naccari) Rabenhorst, 1868																1	1
Ochrophyta																	
Cystoseira compressa (Esper) Gerloff & Nizamuddin, 1975			2	2				3									7
Cystoseira foeniculacea (Linnaeus) Greville, 1830		2	3	3									3		3		14
Dictyota fasciola (Roth) J.V.Lamouroux, 1809			3										3		3		9
Lobophora variegata (J.V.Lamouroux) Womersley ex E.C.Oliveira, 1977	2	1	3	2	1	1				1			3	2	3		19
**Padina boergesenii* Allender & Kraft, 1983		1	3	2				3									9
Padina pavonica (Linnaeus) Thivy, 1960								2		1							3
Ralfsia verrucosa (J.E.Areschoug) J.E.Areschoug, 1845				3													3
Sargassum vulgare C.Agardh, 1820			2	2				1									5
Stypocaulon scoparium (Linnaeus) Kützing, 1843								2									2
**Stypopodium schimperi* (Buchinger ex Kützing) Verlaque & Boud., 1991													1	1		3	5
Rhodophyta																	
Amphiroa beauvoisii Lamouroux (1816)										2				3			5

Stations (Tyre)	T-1	T-2	T-5	T-6	T-11	T-12	T-16	T-17	T-18	T-19	T-20	T-21	T-22	T-23	T-24	T-25	Total
Amphiroa cryptarthrodia Zanardini, 1843																3	3
Amphiroa rigida J.V.Lamouroux, 1816	3	3	3	3		2							3		3		20
Ceramiales sp.																3	3
Corallina elongata J.Ellis & Solander, 1786	3	3	3	3	3			1	3		3						22
**Galaxaura rugosa* (J.Ellis & Solander) J.V.Lamouroux, 1816	3	1	2	3		3				3			1	3			19
**Ganonema farinosum* (J.V.Lamouroux) K.C.Fan & Yung C.Wang, 1974			1														1
Gelidium bipectinatum Furnari, 1999																2	2
Hildenbrandia rubra (Sommerfelt) Meneghini, 1841	1																1
**Hypnea spinella* (C.Agardh) Kützing, 1847								1									1
Jania rubens (Linnaeus) J.V.Lamouroux, 1816	3	3	3	3	3			3	3		3		3				27
Laurencia obtusa (Hudson) J.V.Lamouroux, 1813	2			1						2							5
**Laurencia* sp.	3	3	3		2	2	1	2					2	3	2		23
Lithophyllum incrustans Philippi, 1837	3	3	3	3	3				3				3		3		24
Lithophyllum papillosum (Zanardini ex Hauck) Foslie 1900				2													2
Lithophyllum stictaeforme (Areschoug) Hauck 1877									1+			1				1	2
Lithothamnion corallioides P.L.Crouan & H.M.Crouan, 1867																3	3
Mesophyllum alternans (Foslie) Cabioch & Mendoza, 1998		3							2			2	2			2	11
Neogoniolithon brassica-florida (Harvey) Setchell & L.R.Mason, 1943			3	3													6
Neogoniolithon mamillosum (Hauck) Setchell & L.R.Mason, 1943																3	3
Palisada perforata (Bory de Saint-Vincent) K.W.Nam, 2007		1	2	3				3									9
Peyssonnelia coriacea Feldmann, 1941									2								2
Peyssonnelia rosa-marina Boudouresque & Denizot, 1973	3	2											3		2	3	13
Peyssonnelia rubra (Greville) J.Agardh, 1851	3	3	3						3			3				3	18
Peyssonnelia squamaria (Gmelin) Decaisne, 1841																3	3
Peyssonnelia spp.		3	3	2	3				3	3			2		3	3	25
Spongites fruticulosa Kützing, 1841																2	2

Stations (Tyre)	T-1	T-2	T-5	T-6	T-11	T-12	T-16	T-17	T-18	T-19	T-20	T-21	T-22	T-23	T-24	T-25	Total
Tricleocarpa fragilis (Linnaeus) Huisman & R.A.Townsend, 1993	1																1
Porifera																	
Acanthella acuta Schmidt, 1862												1					1
Aplysina aerophoba Nardo, 1833				1													1
Axinella polypoides Schmidt, 1862												3				1	4
Axinella sp.						1				2				2			5
Chondrilla nucula Schmidt, 1862	3	2	2	1													8
Chondrosia reniformis Nardo, 1847			3	1	3					1							8
Cinachyrella levantinensis Vacelet *et al*, 2007	1	1				1				1				1		1	6
Ciocalypta carballoi Vacelet *et al*, 2007	1			1	1	2				2				2			9
Clathrina cf. *coriacea* (Montagu, 1818)		2															2
Cliona parenzani Corriero & Scalera-Liaci, 1997	2	3	3	3													11
Corticium candelabrum Schmidt, 1862																1	1
Crambe crambe (Schmidt, 1862)	3	3	3	3	2	3	1		3	3		3	3	3	3	1	37
Dictyonella sp.												2					2
Dysidea avara (Schmidt, 1862)												1					1
Dysidea tupha (Martens, 1824)						1											1
Haliclona fulva (Topsent, 1893)												2				1	3
Ircinia variabilis (Schmidt, 1862)	1	1														1	3
Ircinia sp.	2		2		1	2				2				2			11
Lyosina blastifera Vacelet, Bitar, Carteron, Zibrowius & Perez, 2007														1			1
Mycale sp.												1					1
Niphates toxifera Vacelet *et al*, 2007			1		2	2			1					2			8
Oscarella lobularis (Schmidt, 1862)												2					2
Petrosia ficiformis (Poiret, 1789)						2				2		1		1		1	7
Phorbas tenacior (Topsent, 1925)		1										1					2

Stations (Tyre)	T-1	T-2	T-5	T-6	T-11	T-12	T-16	T-17	T-18	T-19	T-20	T-21	T-22	T-23	T-24	T-25	Total
Phorbas topsenti Vacelet & Perez, 2008	2	2	2		2	2				2				2	1		15
Sarcotragus cf. *foetidus* Schmidt, 1862	1				1	1				1							4
Sarcotragus spinosulus Schmidt, 1862	2	1	2		1	2			1	1				1			11
Spirastrella cunctatrix Schmidt, 1868												1					1
Spongia officinalis Linnaeus, 1759	1																1
Sycon sp.	2											1					3
Cnidaria																	
Hydrozoa																	
Aglaophenia sp.												2					2
Eudendrium cf. merulum Watson, 1985						2				2		2		2			8
Eudendrium spp.						2				2		2		2			8
**Macrorhynchia philippina* Kirchenpauer, 1872	2	2	2	2	1	1				2	2	2		1			17
Pennaria disticha (Goldfuss, 1820)	3	3	2	3	2	1				1	3	3	1				22
Hydrozoa spp.												3					3
Anthozoa																	
Aiptasia mutabilis (Gravenhorst, 1831)									2								2
Asterosmilia sp. (jumped tests)							1										1
Cladocora caespitosa (Linnaeus, 1767)		1	1														2
Madracis pharensis (Heller, 1868)												2					2
**Oculina patagonica* de Angelis, 1908	2	2	1		2				2		2						11
Phyllangia americana mouchezii (Lacaze-Duthiers, 1897)												3					3
Telmatactis cricoides (Duchassaing, 1850)									1						1		2
Polychaeta																	
Filograna sp.												3				2	5
Hermodice carunculata (Pallas, 1766)	1		1												1		3
Sabellidae sp.			1	3													4

Stations (Tyre)	T-1	T-2	T-5	T-6	T-11	T-12	T-16	T-17	T-18	T-19	T-20	T-21	T-22	T-23	T-24	T-25	Total
Serpulidae spp.			1	2	2		1			2			3		3		14
Sipuncula																	
Phascolosoma stephensoni (Stephen, 1942)													2				2
Sipunculus nudus Linnaeus, 1766													1				1
Crustacea																	
Cirripedia																	
Balanus trigonus Darwin, 1854		3			2								2				7
Chthmalus montagui Southward, 1976				3													3
Chthamalus stellatus (Poli, 1795)			3	3													6
Euraphia depressa (Poli, 1791)			1	1													2
Perforatus perforatus (Bruguière, 1789)		3	3		2					3			2				13
Decapoda																	
**Alpheus audouini* Coutière, 1905													1				1
**Atergatis roseus* (Rüppell, 1830)					2	1											3
**Callinectes sapidus* Rathbun, 1896 (carapace)		1															1
**Charybdis hellerii* (A. Milne-Edwards, 1867)						1							2		1		4
Clibanarius erythropus (Latreille, 1818)	3		3	3					3								12
Eriphia verrucosa (Forskål, 1775)									1								1
Pachygrapsus marmoratus (Fabricius, 1787)				1													1
Pagurus anachoretus Risso, 1827	1																1
Palaemon serratus (Pennant, 1777)								1									1
Upogebia pusilla (Petagna, 1792) (moult)														1			1
Mollusca																	
Gastropoda																	
Bulla striata Bruguière, 1792 (shells)															1		1
**Cerithium scabridum* Philippi, 1848	3	3	3	3	3				3	3			3	3	3		30

Stations (Tyre)	T-1	T-2	T-5	T-6	T-11	T-12	T-16	T-17	T-18	T-19	T-20	T-21	T-22	T-23	T-24	T-25	Total
Cerithium vulgatum Bruguière, 1792									1	1							2
**Conomurex persicus* (Swainson, 1821)	1	2	2	2	2					2			2	2		1	16
Echinolittorina punctata (Gmelin, 1791)			2	3													5
**Elysia grandifolia* Kelaart, 1857		1	1						1	1							4
Elysia timida (Risso, 1818)			1														1
**Ergalatax junionae* Houart, 2008	2		2	2									2				8
Erosaria spurca (Linnaeus, 1758) (shells)			1	1													2
Euthria cornea (Linnaeus, 1758) (shells)															1		1
**Goniobranchus annulatus* (Eliot, 1904)	1	1	1	1	2				2					1			9
Hexaplex trunculus (Linnaeus, 1758)					1								1				2
**Hypselodoris infucata* Rüppell & Leuckart, 1831		1	1												1		3
**Trochus erithreus* (Brocchi, 1821)		1	1														2
Melarhaphe neritoides (Linnaeus, 1758)			3	3													6
Nassarius reticulatus (Linnaeus, 1758) (shells)															1		1
Phorcus turbinatus (Born, 1778)			2	2													4
**Purpuradusta gracilis notata* (Gill, 1858) (shells)			1				1			1							3
**Rhinoclavis kochi* (Philippi, 1848) (shells)										1							1
Thylacodes arenarius (Linnaeus, 1758) (shells)										1				1			2
Tonna galea (shells) (Linnaeus, 1758)					1												1
Bivalvia																	
Acanthocardia tuberculata (Linnaeus, 1758) (shells)										2							2
Arca noae Linnaeus, 1758 (shells)						1											1
**Brachidontes pharaonis* (P. Fischer, 1870)	3	3	3	3	3			2	3		3						23
**Chama pacifica* Broderip, 1835	3	2	3	2	2	3				3		2	3	3			26
**Dendostrea frons* (Linnaeus, 1758)	2									1				1			4
**Gafrarium savignyi* (Jomas, 1846) (shells)		1	2	1	1								1		1		7

Stations (Tyre)	T-1	T-2	T-5	T-6	T-11	T-12	T-16	T-17	T-18	T-19	T-20	T-21	T-22	T-23	T-24	T-25	Total
Glycymeris nummaria (Linnaeus, 1758) (shells)			1		1									1			3
Lima lima (Linnaeus, 1758) (shells)			1	1													2
Lioberus agglutinans (Cantraine, 1835) (shells)					1					1							2
Lioberus sp.			2														2
**Malleus regula* Forsskål, 1775	3	2	3	2	2	2						1	3	3			21
Mimachlamys varia (Linnaeus, 1758)					1												1
**Pinctada imbricata radiata* (Leach, 1814)	1	2	2	1		1				1			2			1	11
Pinna nobilis Linnaeus, 1758 (shell rests)							1										1
Polititapes aureus (Gmelin, 1791)			2											1			3
**Spondylus spinosus* Schreibers, 1793	3	2	2	1	2	3				2		2	1	2			20
Venerupis corrugata (Gmelin, 1791) (shells)			1		1												2
Venus casina Linnaeus, 1758 (shells)										1				1			2
Venus verrucosa Linnaeus, 1758 (shells)			2		2								1				5
Bryozoa																	
Caberea sp.												1					1
Reptadeonella sp.	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Schizoporella errata (Waters, 1878)	1						1						1		2		5
Echinodermata																	
Echinoidea																	
Brissus unicolor (Leske, 1778) (tests)														1			1
Echinocyamus pusillus (O.F. Müller, 1776) (tests)																1	1
Holothuroidea																	
Holothuria impatiens (Forskål, 1775)				1													1
Holothuria tubulosa Gmelin, 1791		1															1
**Synaptula reciprocans* (Forskal, 1775)		1										1					2
Ascidiacea																	

Stations (Tyre)	T-1	T-2	T-5	T-6	T-11	T-12	T-16	T-17	T-18	T-19	T-20	T-21	T-22	T-23	T-24	T-25	Total
Botrylloides cf. *leachii*					2												2
Cystodytes dellechiajei (Della Valle, 1877)																3	3
Didemnum coriaceum (Drasche, 1883)																	
Didemnidae spp.		2	2		2		1		1	1		2	2			2	15
**Herdmania momus* (Savigny, 1816)	1	1	1	2		1						2	2		2	1	13
**Phallusia nigra* Savigny, 1816	1		2	2		1				1		2	3	2	2		16
Polyclinidae spp.												1					1
**Rhodosoma turcicum* (Savigny, 1816)															1		1
Styelidae sp.													2		2		4
Pisces'																	
Elasmobranchii																	
Dasyatis pastinaca (Linnaeus, 1758)										1	1						2
Actinopterygii																	
**Apogonichthyoides nigripinnis* (Cuvier, 1828)			1	1					2				3		1		8
**Atherinomorus lacunosus* (Forster, 1801)				3					3		3						9
Belone belone (Linnaeus, 1761)		3															3
Boops boops (Linnaeus, 1758)	2		2						2		3						9
Bothus podas (Delaroche, 1809)													1				1
Caranx crysos (Mitchill, 1815)											1						1
Chromis chromis (Linnaeus, 1758)	3	3		3					3	2	3	2		3		3	25
Coris julis (Linnaeus, 1758)	2	2	3	2		2				2		3	3	2		2	23
Coryphoblennius galerita (Linnaeus, 1758)				1													1
Diplodus cervinus (Lowe, 1838)						1											1
Diplodus sargus (Linnaeus, 1758)		2	2	2		2				3				1			12
Diplodus vulgaris (Geoffroy Saint-Hilaire, 1817)		2	2		1	2				3				3			13
Epinephelus costae (Steindachner, 1878)	1					2				2							5

Stations (Tyre)	T-1	T-2	T-5	T-6	T-11	T-12	T-16	T-17	T-18	T-19	T-20	T-21	T-22	T-23	T-24	T-25	Total
Epinephelus marginatus (Lowe, 1834)		1								1	1						3
Gobius bucchichi Steindachner, 1870	3			3		2				3			3	2		2	18
Gobius vittatus Vinciguerra, 1883																2	2
**Lagocephalus sceleratus* (Gmelin, 1789)														2			2
Lipophrys trigloides (Valenciennes, 1836)				1													1
Mugilidae spp.											2						2
Mullus surmuletus Linnaeus, 1758														2	2		4
Mycteroperca rubra (Bloch, 1793)	1	1	2	2	2	2			1	2	2			2	1		18
Oblada melanura (Linnaeus, 1758)				3					2		2						7
Parablennius rouxi (Cocco, 1833)																1	1
Parablennius sanguinolentus (Pallas, 1814)				1													1
**Pempheris vanicolensis* Cuvier, 1831	2	2		2													6
**Plotosus lineatus* (Thunberg, 1787)			2	2		2											6
**Pteragogus pelycus* Randall, 1981													2				2
**Sargocentron rubrum* (Forsskål, 1775)	2	2	2	2		2				2	2	3		2			19
Scorpaena maderensis Valenciennes, 1833												2					2
Serranus cabrilla (Linnaeus, 1758)						1								1	1	1	4
Serranus scriba (Linnaeus, 1758)			1	1		2				3							7
**Siganus luridus* (Rüppell, 1829)			1	1						3		2	1	1		3	12
**Siganus rivulatus* Forsskål, 1775	3	3	3	3					3	3	3	3	2				26
Sparisoma cretense (Linnaeus, 1758)				2								2				2	6
**Stephanolepis diaspros* Fraser-Brunner, 1940	1								1		1						3
Symphodus roissali (Risso, 1810)	1		1										1			1	4
Symphodus tinca (Linnaeus, 1758)	1		1	1	1					1	2			1			8
Synodus saurus (Linnaeus, 1758)													1				1
Thalassoma pavo (Linnaeus, 1758)	2	2	3	3	2	2				2	2	1	1			2	22

Stations (Tyre)	T-1	T-2	T-5	T-6	T-11	T-12	T-16	T-17	T-18	T-19	T-20	T-21	T-22	T-23	T-24	T-25	Total
**Torquigener flavimaculosus* Hardy & Randall, 1983			2	2						2		1	2		1		10
Tripterygion tripteronotus (Risso, 1810)													1				1
**Upeneus pori* Ben-Tuvia & Golani, 1989		1															1
Xyrichtys novacula (Linnaeus, 1758)			1										1				2
Reptilia																	
Chelonia mydas (Linnaeus, 1758)									1		1						2
Species richness (S)	57	60	83	72	43	40	8	14	32	55	21	42	50	44	30	40	240
Relative abundance	113	117	168	151	79	69	8	29	65	101	45	80	98	79	55	76	1333
Marlafef' index	11,85	12,39	16,0	14,15	9,612	9,211	3,366	3,861	7,399	11,7	5,254	9,356	10,69	9,841	7,237	9,005	-

10.3.8 Nakoura

Stations (Nakoura)	N-1	N-2	N-3	N-4	N-5	N-6	N-7	N-8	N-9	N-10	N-11	N-12	N-13	N-14	N-15	N-16	Total
Cyanobacteria																	
Oscillatoria sp.	-	3	-	-	-	-	-	-	-	-	-	-	-	-	3	-	6
Chlorophyta																	
**Caulerpa scalpelliformis* (R.Brown ex Turner) C.Agardh, 1817	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	2
**Codium parvulum* (Bory ex Audouin) P.C.Silva, 2003	-	-	-	2	-	-	-	-	1	-	1	2	2	-	-	2	10
Ochrophyta																	
Cystoseira foeniculacea (Linnaeus) Greville, 1830	-	2	-	2	-	-	-	-	2	-	-	-	-	-	-	-	6
Dictyota fasciola (Roth) J.V.Lamouroux, 1809	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Lobophora variegata (J.V.Lamouroux) Womersley ex E.C.Oliveira, 1977	-	2	2	-	-	-	-	-	-	2	-	-	-	-	2	2	10
Lobophora sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	3
**Padina boergesenii* Allender & Kraft, 1983	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
Padina pavonica (Linnaeus) Thivy, 1960	-	-	1	2	-	-	-	-	1	1	-	-	2	-	2	1	10
**Stypopodium schimperi* (Buchinger ex Kützing) Verlaque & Boud., 1991	-	-	-	2	-	-	-	-	-	-	1	-	2	2	-	-	7
Rhodophyta																	
Amphiroa beauvoisii Lamouroux (1816)	-	-	-	-	-	-	-	-	-	-	2	3	3	-	3	3	14
Amphiroa cryptarthrodia Zanardini, 1843	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	3
Amphiroa rigida J.V.Lamouroux, 1816	-	3	-	-	-	-	-	-	-	2	-	-	-	-	2	-	7
Corallina elongata J.Ellis & Solander, 1786	-	3	3	-	-	-	-	-	-	3	-	-	-	-	-	-	9
**Galaxaura rugosa* (J.Ellis & Solander) J.V.Lamouroux, 1816	-	3	-	3	-	-	-	-	3	3	1	3	3	-	3	3	25
Gelidium bipectinatum Furnari, 1999	-	2	-	-	-	-	-	-	-	-	2	-	-	2	-	-	6
Halymenia latifolia P.Crouan & H.Crouan ex Kützing 1866	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	2
Hildenbrandia rubra (Sommerfelt) Meneghini, 1841	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	2
Jania adhaerens J.V. Lamaouroux, 1816	-	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	6
Jania longifurca Zanardini, 1843	-	-	-	-	-	-	-	-	-	3	-	2	-	-	-	-	5
Jania rubens (Linnaeus) J.V.Lamouroux, 1816	-	3	3	-	-	-	-	-	-	3	-	-	-	-	-	-	9

Stations (Nakoura)	N-1	N-2	N-3	N-4	N-5	N-6	N-7	N-8	N-9	N-10	N-11	N-12	N-13	N-14	N-15	N-16	Total
Laurencia obtusa (Hudson) J.V.Lamouroux, 1813	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2
**Laurencia* sp.	-	3	2	-	-	-	-	-	3	3	-	3	2	-	3	2	21
Lithophyllum incrustans Philippi, 1837	3	3	3	-	-	-	-	-	-	3	-	-	-	-	3	-	15
Lithophyllum stictaeforme (Areschoug) Hauck 1877	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2	4
Lithothamnion corallioides P.L.Crouan & H.M.Crouan, 1867	-	-	-	-	-	-	-	-	-	-	2	-	-	3	-	-	5
Mesophyllum alternans (Foslie) Cabioch & Mendoza, 1998	-	-	-	-	-	-	-	-	-	-	2	2	-	3	-	-	7
Mesophyllum sp.	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Neogoniolithon mamillosum (Hauck) Setchell & L.R.Mason, 1943	-	3	-	-	-	-	-	-	-	-	-	-	-	-	3	2	8
Palisada perforata (Bory de Saint-Vincent) K.W.Nam, 2007	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Peyssonnelia rosa-marina Boudouresque & Denizot, 1973	-	-	2	-	-	-	-	-	-	-	-	2	-	3	-	-	7
Peyssonnelia rubra (Greville) J.Agardh, 1851	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	2
Peyssonnelia spp.	-	3	3	3	-	-	-	-	3	2	3	-	-	-	-	3	20
Plocamium cartilagineum (Linnaeus) P.S.Dixon, 1967	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Rodriguezella sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Scinaia furcellata (Turner) J.Agardh, 1851	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Spongites fruticulosa Kützing, 1841	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	3
Foraminifera																	
Amphistegina lobifera Larsen 1976	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2
Porifera																	
Agelas oroides (Schmidt, 1864)	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
Aplysina aerophoba Nardo, 1833	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
Aplysina sp.	-	-	3	-	-	-	-	-	-	3	-	-	-	-	-	-	6
Axinella polypoides Schmidt, 1862	-	-	-	3	3	3	-	3	-	-	2	-	-	-	-	-	14
Axinella sp.	-	2	-	3	-	3	3	-	2	-	-	2	2	-	1	3	21
Calcarea spp. (Sycetusa, Vosmaeropsis)	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Chondrilla nucula Schmidt, 1862	-	-	2	-	-	-	-	-	-	2	-	-	-	-	2	-	6

Stations (Nakoura)	N-1	N-2	N-3	N-4	N-5	N-6	N-7	N-8	N-9	N-10	N-11	N-12	N-13	N-14	N-15	N-16	Total
Chondrosia reniformis Nardo, 1847	-	3	3	-	-	-	-	-	2	3	-	-	-	-	-	-	11
Cinachyrella levantinensis Vacelet et al, 2007	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Ciocalypta carballoi Vacelet et al, 2007	-	2	-	1	-	-	-	-	1	1	-	1	3	1	-	2	12
Cliona parenzani Corriero & Scalera-Liaci, 1997	-	2	-	-	-	-	-	-	-	2	-	-	-	-	3	-	7
Corticium candelabrum Schmidt, 1862	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Crambe crambe (Schmidt, 1862)	-	3	3	3	-	-	-	-	3	3	3	3	-	3	3	3	30
Haliclona fulva (Topsent, 1893)	-	-	2	-	-	-	-	-	-	-	2	-	-	2	-	-	6
Ircinia variabilis (Schmidt, 1862)	-	3	2	2	-	-	-	-	1	2	1	-	2	2	-	-	15
Ircinia sp.	-	2	-	-	-	-	-	-	2	2	-	2	2	-	-	2	12
Lyosina blastifera Vacelet, Bitar, Carteron, Zibrowius & Perez, 2007	-	1	-	-	-	-	-	-	1	2	-	-	-	-	2	-	6
Mycale sp.	-	-	-	-	-	-	-	-	-	2	-	-	-	1	-	-	3
Myrmekioderma spelaeum (Pulitzer-Finali, 1983)	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Niphates toxifera Vacelet et al, 2007	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1
Petrosia ficiformis (Poiret, 1789)	-	1	-	2	-	-	-	-	1	1	-	1	2	-	2	1	11
Phorbas tenacior (Topsent, 1925)	-	2	1	-	-	-	-	-	-	-	1	-	-	2	-	-	6
Phorbas topsenti Vacelet & Perez, 2008	-	2	-	-	-	-	-	-	2	2	2	2	-	1	3	-	14
Sarcotragus fasciculatus (Pallas, 1766)	-	-	1	-	-	-	-	-	1	1	-	-	-	-	-	-	3
Sarcotragus cf. *foetidus* Schmidt, 1862	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
Sarcotragus spinosulus Schmidt, 1862	-	2	2	1	-	-	-	-	2	2	-	1	1	-	-	1	12
Spirastrella cunctatrix Schmidt, 1868	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	2
Spongia officinalis Linnaeus, 1759	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
Sycon sp.	-	2	-	-	-	-	-	-	-	2	1	-	-	1	-	2	8
Cnidaria																	
Hydrozoa																	
Aglaophenia elongata Menghini, 1845	-	2	-	3	-	-	-	-	-	-	-	-	-	-	-	-	5
Eudendrium carneum Clarke, 1882	-	3	-	-	-	-	-	-	2	-	-	2	2	-	-	-	9

Stations (Nakoura)	N-1	N-2	N-3	N-4	N-5	N-6	N-7	N-8	N-9	N-10	N-11	N-12	N-13	N-14	N-15	N-16	Total
Eudendrium glomeratum Picard, 1952	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	2
Eudendrium cf. *merulum* Watson, 1985	-	-	-	3	-	-	-	-	-	-	-	-	-	1	3	3	10
Eudendrium racemosum (Cavolini, 1785)	-	-	-	3	-	-	-	-	2	-	-	-	-	-	3	-	8
Eudendrium spp.	-	-	-	3	-	-	-	-	2	-	-	-	-	2	3	3	13
**Macrorhynchia philippina* Kirchenpauer, 1872	-	3	2	-	-	-	-	-	3	2	-	-	3	-	3	1	17
Pennaria disticha (Goldfuss, 1820)	-	3	3	-	-	-	-	-	2	3	-	1	3	-	3	2	20
Sertularia marginata (Kirchenpauer, 1864)	-	-	-		-	-	-	-	-	-	-	1	-	-	-	-	1
Hydrozoa spp.	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	2
Anthozoa																	
Actinia schmidti Sole-Cava & Thorpe, 1997	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	2
Cerianthidae spp.	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
**Oculina patagonica* de Angelis, 1908	-	-	3	-	-	-	-	-	-	3	-	-	-	-	-	-	6
Polycyathus muellerae (Abel, 1959)	-	-	3	-	-	-	-	-	-	2	-	-	-	-	-	-	5
Scyphozoa																	
**Rhopilema nomadica* Galil, 1990	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1
Ctenophora																	
**Mnemiopsis leidyi* A. Agassiz, 1865	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Polychaeta																	
Filograna sp.	-	-	3	-	-	-	-	-	-	3	-	-	-	-	-	-	6
Sabellidae sp.	-	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-	3
Serpulidae spp.	-	-	3	-	-	-	-	-	-	3	-	-	-	-	-	3	9
Crustacea																	
Cirripedia																	
Balanus trigonus Darwin, 1854	-	-	3	-	-	-	-	-	-	3	-	-	-	-	-	3	9
Chthmalus montagui Southward, 1976	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Chthamalus stellatus (Poli, 1795)	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2

Stations (Nakoura)	N-1	N-2	N-3	N-4	N-5	N-6	N-7	N-8	N-9	N-10	N-11	N-12	N-13	N-14	N-15	N-16	Total
Perforatus perforatus (Bruguière, 1789)	-	3	3	-	-	-	-	-	-	3	-	-	-	-	2	3	14
Decapoda																	
Calcinus tubularis (Linnaeus, 1767)	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	3
**Charybdis hellerii* (A. Milne-Edwards, 1867)	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Clibanarius erythropus (Latreille, 1818)	3	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	5
Mollusca																	
Gastropoda																	
**Aplysia dactylomela* Rang, 1828	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1
Bittium spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	3
**Cerithium scabridum* Philippi, 1848	3	3	3	-	-	-	-	-	2	3	-	-	-	-	2	3	19
Cerithium vulgatum Bruguière, 1792	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
Columbella rustica (Linnaeus, 1758)	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
**Conomurex persicus* (Swainson, 1821)	1	2	-	1	-	-	-	-	2	1	-	1	2	-	-	-	10
Conus ventricosus Gmelin, 1791	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	2
Dendropoma petraeum (Monterosato, 1884)	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Echinolittorina punctata (Gmelin, 1791)	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
**Ergalatax junionae* Houart, 2008	-	2	-	-	-	-	-	-	-	-	-	-	-	-	1	-	3
Erosaria spurca (Linnaeus, 1758) (shells)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
**Flabellina rubrolineata* (O'Donoghue, 1929)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2
**Goniobranchus annulatus* (Eliot, 1904)	-	-	1	-	-	-	-	-	1	2	-	-	-	-	-	-	4
Hexaplex trunculus (Linnaeus, 1758)	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
**Trochus erithreus* (Brocchi, 1821)	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	2
Melarhaphe neritoides (Linnaeus, 1758)	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Patella caerulea Linnaeus, 1758	1	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	3
Patella sp.	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	2
**Purpuradusta gracilis notata* (Gill, 1858) (shells)	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1

Stations (Nakoura)	N-1	N-2	N-3	N-4	N-5	N-6	N-7	N-8	N-9	N-10	N-11	N-12	N-13	N-14	N-15	N-16	Total
Thylacodes arenarius (Linnaeus, 1758) (shells)	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Stramonita haemastoma (Linnaeus, 1767) (shells)	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
Vermetus triquetrus Bivona-Bernardi, 1832	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	2
Bivalvia																	
Barbatia barbata (Linnaeus, 1758) (shells)	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	2
**Brachidontes pharaonis* (P. Fischer, 1870)	3	3	3	-	-	-	-	-	3	3	-	-	-	-	-	-	15
**Chama pacifica* Broderip, 1835	-	2	2	3	-	3	-	2	3	3	1	3	3	-	3	3	31
**Dendostrea frons* (Linnaeus, 1758)	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2	4
Glycymeris nummaria (Linnaeus, 1758) (shells)	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Lioberus agglutinans (Cantraine, 1835) (shells)	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Lioberus sp.	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Lithophaga lithophaga (Linnaeus, 1758)	-	-	-	-	-	-	-	-	2	-	-	-	-	-	1	-	3
**Malleus regula* Forsskål, 1775	-	3	3	-	-	-	-	-	3	3	-	-	-	-	2	3	17
Ostreidae sp.	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
**Pinctada imbricata radiata* (Leach, 1814)	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Pinna nobilis Linnaeus, 1758 (shells)	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
**Spondylus spinosus* Schreibers, 1793	-	3	-	2	-	3	-	1	1	1	-	3	1	-	2	1	18
Striarca lactea (Linnaeus, 1758)	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	2
Venerupis corrugata (Gmelin, 1791) (shells)	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Venus verrucosa Linnaeus, 1758 (shells)	-	1	-	-	-	-	-	-	2	-	-	-	-	-	-	-	3
Bryozoa																	
Adeonella pallasii (Heller, 1867)	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Caberea sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Crisia sp.	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Frondipora verrucosa (Lamouroux, 1821)	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Margaretta cereoides (Ellis & Solander, 1786)	-	-	2	-	-	-	-	-	-	2	-	-	-	-	-	-	4

Stations (Nakoura)	N-1	N-2	N-3	N-4	N-5	N-6	N-7	N-8	N-9	N-10	N-11	N-12	N-13	N-14	N-15	N-16	Total
Reptadeonella sp.	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	2
Reteporella sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Schizoporella errata (Waters, 1878)	-	-	2	-	-	-	-	-	-	3	-	-	-	-	-	2	7
Echinodermata																	
Ophiuroidea																	
Ophiocoma scolopendrina (Lamarck, 1816)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2
Echinoidea																	
Arbacia lixula (Linnaeus, 1758)	-	-	1	-	-	-	-	-	-	2	-	-	-	-	1	-	4
Brissus unicolor (Leske, 1778) (tests)	-	-	-	-	-	-	-	-	1	-	-	1	1	-	-	1	4
Paracentrotus lividus (Lamarck, 1816)	-	-	1	-	-	-	-	-	-	2	-	-	-	-	-	-	3
Holothuroidea																	
**Synaptula reciprocans* (Forskal, 1775)	-	-	-	1	1	1	1	-	-	-	1	1	1	-	-	-	7
Ascidiacea																	
Botrylloides cf. *leachii* (yellow)	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	2
Cystodytes dellechiajei (Della Valle, 1877)	-	-	1	-	-	-	-	-	-	-	-	-	-	3	-	-	4
Didemnum coriaceum (Drasche, 1883)	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Didemnidae spp.	-	1	3	-	-	-	-	-	1	3	1	-	-	3	1	-	13
Diplosoma sp.	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
**Herdmania momus* (Savigny, 1816)	-	2	2	-	-	-	-	-	1	2	2	2	1	3	2	2	19
**Phallusia nigra* Savigny, 1816	-	3	1	-	-	-	-	-	1	1	-	-	1	-	1	1	9
Pisces'																	
Elasmobranchii																	
Myliobatis aquila (Linnaeus, 1758)	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
Taeniura grabata (E. Geoffroy Saint-Hilaire, 1817)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
Actinopterygii																	
Apogon imberbis (Linnaeus, 1758)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1

Stations (Nakoura)	N-1	N-2	N-3	N-4	N-5	N-6	N-7	N-8	N-9	N-10	N-11	N-12	N-13	N-14	N-15	N-16	Total
Boops boops (Linnaeus, 1758)	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-	-	6
**Cheilodipterus novemstriatus* (Rüppell, 1838)	-	-	-	-	-	-	-	-	-	-	1	2	-	-	2	-	5
Chromis chromis (Linnaeus, 1758)	-	3	-	3	-	-	2	-	3	3	3	3	3	-	3	3	29
Coris julis (Linnaeus, 1758)	-	2	-	1	2	2	2	2	2	2	2	3	2	2	2	1	27
Diplodus cervinus (Lowe, 1838)	-	-	1	-	-	-	-	-	-	2	-	-	-	-	-	-	3
Diplodus puntazzo (Walbaum, 1792)	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	2
Diplodus sargus (Linnaeus, 1758)	-	-	-	-	-	-	2	-	1	2	1	1	-	-	1	-	8
Diplodus vulgaris (Geoffroy Saint-Hilaire, 1817)	-	-	-	-	-	-	3	-	3	-	-	-	3	-	2	1	12
Epinephelus costae (Steindachner, 1878)	-	-	-	-	-	1	1	-	-	-	1	-	1	-	1	-	5
Epinephelus marginatus (Lowe, 1834)	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	2
Gobius bucchichi Steindachner, 1870	-	3	-	3	-	-	-	-	3	3	-	3	3	-	3	2	23
Gobius geniporus Valenciennes, 1837	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	2
**Lagocephalus sceleratus* (Gmelin, 1789)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Muraena helena Linnaeus, 1758	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	1	3
Mycteroperca rubra (Bloch, 1793)	-	1	1	-	-	-	1	-	2	2	-	1	1	-	1	-	10
Oblada melanura (Linnaeus, 1758)	-	-	3	-	-	-	-	-	-	3	-	-	-	-	-	-	6
Pagellus erythrinus (Linnaeus, 1758)	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Pagrus auriga Valenciennes, 1843	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Parablennius zvonimiri (Kolombatovic, 1892)	-	-	1	-	-	-	-	-	-	1	-	-	-	-	1	-	3
**Pempheris vanicolensis* Cuvier, 1831	-	3	3	-	-	-	-	-	-	3	-	-	2	-	3	3	17
**Plotosus lineatus* (Thunberg, 1787)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3
Pomadasys incisus (Bowdich, 1825)	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2
**Sargocentron rubrum* (Forsskål, 1775)	-	3	2	2	3	2	3	-	3	2	3	2	2	-	2	3	32
Scorpaena maderensis Valenciennes, 1833	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
Serranus cabrilla (Linnaeus, 1758)	-	-	-	2	2	2	2	2	-	-	1	1	2	1	-	-	15
Serranus hepatus (Linnaeus, 1758)	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	2

Stations (Nakoura)	N-1	N-2	N-3	N-4	N-5	N-6	N-7	N-8	N-9	N-10	N-11	N-12	N-13	N-14	N-15	N-16	Total
Serranus scriba (Linnaeus, 1758)	-	-	-	1	-	-	-	-	1	-	1	1	2	-	-	1	7
**Siganus luridus* (Rüppell, 1829)	-	1	-	1	-	-	-	-	-	1	1	-	1	-	3	3	11
**Siganus rivulatus* Forsskål, 1775	-	2	3	-	-	-	3	-	-	2	-	-	2	-	3	-	15
Sparisoma cretense (Linnaeus, 1758)	-	-	-	2	-	-	-	2	-	-	2	2	-	-	1	-	9
Spicara smaris (Linnaeus, 1758)	-	-	-	-	-	-	-	3	-	-	-	-	-	1	-	-	4
Symphodus mediterraneus (Linnaeus, 1758)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
Symphodus ocellatus Forsskål, 1775	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Symphodus tinca (Linnaeus, 1758)	-	-	-	-	-	-	-	-	1	1	-	1	1	-	-	1	5
Thalassoma pavo (Linnaeus, 1758)	-	3	2	-	-	-	2	-	2	2	1	2	2	-	3	2	21
Tripterygion melanurum Guichenot, 1850	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	2
Tripterygion tripteronotus (Risso, 1810)	-	-	-	2	-	-	-	-	-	1	-	-	-	-	1	-	4
Species richness (S)	**14**	**69**	**61**	**34**	**7**	**11**	**14**	**7**	**49**	**78**	**38**	**38**	**41**	**38**	**55**	**48**	**192**
Relative abundance	**34**	**148**	**126**	**70**	**15**	**24**	**27**	**15**	**92**	**161**	**62**	**69**	**76**	**66**	**116**	**95**	**1195**
Margalef' index	**3,687**	**13,61**	**12,41**	**7,767**	**2,216**	**3,147**	**3,944**	**2,216**	**10,62**	**15,15**	**8,965**	**8,739**	**9,236**	**8,831**	**11,36**	**10,27**	**-**

Regional Activity Centre
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