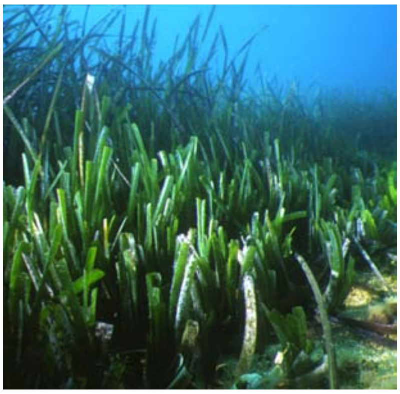
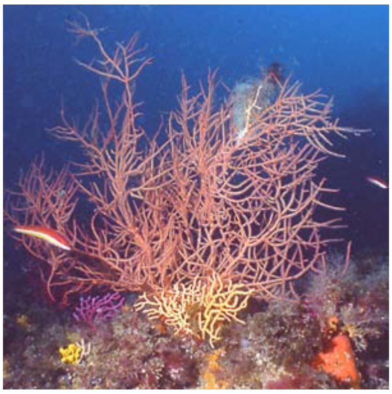
United Nations Environment Programme

Action Plan for the Mediterranean

Regional Activity Centre for Specially Protected Areas

Handbook for interpreting types of marine habitat for the selection of sites to be included in the national inventories of natural sites of conservation interest

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INTRODUCTION

BACKGROUND

The Protocol concerning specially protected areas and biological diversity in the Mediterranean and the Action Plan for the protection of the marine environment and the sustainable development of Mediterranean coastal areas (MAP Phase II), adopted by the Contracting Parties to the Barcelona Convention in 1995, contain arrangements for preparing inventories at national and regional level. In this context, at their Tenth Ordinary Meeting (Tunis, 18-21 November 1997), the Contracting Parties to the Convention for the protection of the Mediterranean Sea against pollution adopted common criteria to establish national inventories of natural sites of conservation interest. During that Meeting, the Regional Activity Centre for Specially Protected Areas (RAC/SPA) was invited to work on elaborating these tools, including a Standard Data Form (SDF) to compile information concerning the sites included in the national inventories of sites of conservation interest. This form is intended to help in decision-making on the management and, if need be, protection of the site described, and to provide a tool for long-term monitoring.

At the Fourth Meeting of National Focal Points for Specially Protected Areas (Tunis, 12-14 April 1999), RAC/SPA elaborated a reference list of types of habitat and a reference list of species for selecting the sites to be included in the national inventories, and a draft Standard Data Form whose general framework was adopted at the Eleventh Ordinary Meeting of the Contracting Parties (Malta, 27-30 October 1999). The draft Standard Data Form for the national inventories of natural sites of conservation interest was finalized in March 2000 in Rome at a Meeting of Experts. However, this tool should be regularly incremented to make it is efficient as possible.

From the technical point of view, the SDF is an adaptation of tools developed in the context of the European Union's and European Council's NATURA 2000 and EMERAUDE network of sites to the specific features of the Mediterranean. This specificity ensures compatibility, as far as is possible, and thus facilitates the sharing of data and information, with database systems established as part of these initiatives. In accordance with the overall aims of the inventories, the SDF was designed with a double objective:

- to give help in decision-making concerning the management and, if need be, protection of the site described
- to provide a tool for the long-term monitoring of the site.

From this angle, the Tunis Regional Activity Centre for Specially Protected Areas initiated the production of this handbook for interpreting the marine habitats that appear on the list of habitats that is appended to the Standard Data Form. The aim was to provide countries with a tool to help them identify and assess these marine habitats. This handbook must satisfy a triple requirement:

- scientific rigour
- readability for non-specialists
- compatibility with existing classification systems (EUR 15 European Union Habitat Directive, CORINE).

To this end, the document has been subdivided into two levels:

- detailed 'habitats/biocenoses' sheets to allow a general description
- more specific 'facies/associations' sheets.

Indeed, it appears to be difficult to fully describe a facies or an association without having first set them within their biocenosis. Similarly, this method of compilation avoids repetition where several facies belong to the same biocenosis.

Some reminders about marine ecology[1]

The biocenosis, defined in the late 19th century by Möbius, corresponds to 'a grouping of living beings corresponding by its composition, by the number of species and individuals, to certain average conditions of the environment, a grouping of beings which are linked by mutual dependence and permanently remain and reproduce in a certain place' (PERES, 1961). Put more simply, this refers to a functional entity, adapted to the average conditions in a particular environment, and to the fluctuations in these, at least within certain limits. The terms populations, associations or communities can also be used with this meaning.

The environment in which species develop and are perpetuated, which constitute a biocenosis, is often referred to by the term biotope or habitat. It contains all the physicochemical features (abiotic factors) of the environment. It should be noted that other definitions are also currently used for the terms biotope and habitat.

The ecosystem brings together the whole set of biotic (biocenosis) and abiotic (biotope) features as functional compartments. It can be defined by a system of complex interactions of species one with another and with the environment.

The idea of scale, and thus even homogeneity, is a recurring difficulty in benthic bionomics. In fact, the field occupied by a biocenosis is often physically heterogeneous, with more or less modest spaces where the prevailing conditions are those which govern the establishment of another population unit. These enclaves cause 'the local existence, for microclimatic reasons, of a biocenosis within an area occupied by another biocenosis' (PERES, 1961).[1]

Still linked to this idea of scale, a biocenosis may, because of a local predominance of certain factors or intense recruitment episodes, present spots with a particular structure resulting from the massive development of one or of a very small number of species. This specific aspect is usually referred to by the term facies (dominant animal species) or association (dominant plant species). These facies or associations

[1] The definitions of the principal terms used in this document, such as were adopted during the meeting of Hyères (from the 18 to November 20, 1998), are moved in Appendix I.

are always infeodated to a specific biocenosis. Thus, the vermetid facies or the association with *Cystoseira amentacea* present specific elements of the biocenosis of infralittoral algae.

List of Mediterranean benthic biocenoses

The biocenosis concept seems to be particularly pertinent for describing coastal and marine environments, especially at benthic level. This concept, initiated and then developed by the Endoume school, is basic to benthic bionomics in the Mediterranean (PERES, 1961; PERES and PICARD, 1964; BELLAN-SANTINI et al., 1994; RELINI, 2000).

The list of main biocenoses, distributed according to their bathymetric position (stages) and the type of substratum, is summed up below2. This list is based on the Classification of types of benthic marine habitat for the Mediterranean region elaborated by the Meeting of Experts on types of marine habitat in the Mediterranean (Hyères, France, 18-20 November 1998) and later revised by the Fourth Meeting of National Focal Points for SPAs (Tunis, 12-14 April 1999). In the context of the Standard Data Form, 18 biocenoses (boxed) and 55 facies (associations or ecomorphoses) are included on the reference list of types of habitat for selecting sites to be included in the national inventories of natural sites of conservation interest.

I. SUPRALITTORAL
- I.1. Muds
  - I.1.1. Biocenosis of beaches with slowly-drying wracks under glassworts
- I.2. Sands
  - I.2.1. Biocenosis of supralittoral sands
- I.3. Stones and pebbles
  - I.3.1. Biocenosis of beaches with slowly-drying wracks
- I.4. Hard beds and rocks
  - I.4.1. Biocenosis of supralittoral rock

II. MEDIOLITTORAL

- II.1. Muds, sandy muds and sands
  - II.1.1. Biocenosis of muddy sands and muds (1)
- II.2. Sands

2

  - II.2.1. Biocenosis of mediolittoral sands
- II.3. Stones and pebbles
  - II.3.1. Biocenosis of mediolittoral coarse detritic bottoms
- II.4. Hard beds and rocks
  - II.4.1. Biocenosis of the upper mediolittoral rock
  - II.4.2. Biocenosis of the lower mediolittoral rock

[2] The complete list of the benthic marine biocénoses of the Mediterranean, such as was adopted with the meeting of Hyères, is presented in the annexe II

II.4.3. Mediolittoral caves

III. INFRALITTORAL

III.1. Sandy muds, sands, gravels and rocks in euryhaline and eurythermal environment

III.1. 1. Euryhaline and eurythermal biocenosis

III.2. Fine sands with more or less mud

III.2.1. Biocenosis of fine sands in very shallow waters

III.2.2. Biocenosis of well sorted fine sands

III.2.3. . Biocenosis of superficial muddy sands in sheltered waters

III.3. Coarse sands with more or less mud

/III.3.1. Biocenosis of coarse sands and fine gravels mixed by the waves/

/III.3.2. Biocenosis of coarse sands and fine gravels under the influence of bottom currents (3)/

III.4. Stones and pebbles

III.4.1. Biocenosis of infralittoral pebbles

III.5. *Posidonia oceanica* meadows

III.5.1. *Posidonia oceanica* meadows

III.6. Hard beds and rocks

III.6.1. Biocenosis of infralittoral algae

IV. CIRCALITTORAL

IV.1. Muds

IV.1.1. Biocenosis of coastal terrigenous muds

IV.2. Sands

IV.2.1. Biocenosis of muddy detritic bottom

IV.2.2. Biocenosis of the coastal detritic bottom

IV.2.3. Biocenosis of shelf-edge detritic bottom

IV.2.4. Biocenosis of coarse sands and fine gravels under the influence of bottom currents (3)

IV.3. Hard beds and rocks

IV.3.11. Coralligenous biocenosis

IV.3.2. Semi-dark caves (4)

IV.3.3. Biocenosis of shelf-edge rock

V. BATHYAL

V.1. Muds

V.1.21. Biocenosis of bathyal muds

V.2. Sands

V.2.1. Biocenosis of detritic sands with Grypheus vitreus

V.3. Hard beds and rocks

V.3.1. Biocenosis of deep sea corals

V.3.2. Caves and ducts in total darkness (5)

VI. ABYSSAL

VI.1. Muds

VI.1.1. Biocenosis of abyssal muds

[(1)] *Lagoon and estuary environments*

[(2)]*May also be found in the circalittoral stage*

[(3)]*Biocenosis present in sectors subject to specific hydrodynamic conditions – straits –, may also be found in the infralittoral stage*

[(4)]*May also be found as an enclave in the upper stages*

[(5)]*May also be found as an enclave in the upper stages*

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I – SUPRALITTORAL STAGE

I.2. SANDS

I.2.1. Biocenosis of supralittoral sands

Biocenosis of supralittoral sands (with or without rapidly-drying wracks)
Reference codes for identification:
RAC/SPA: 1.2.1
EUR 15: 1140
CORINE: 14

1 – Location of the biocenosis

Stage	Supralittoral
Nature of substratum	Fine sand fairly much enriched with fine particles
Bathymetrical distribution	Upper level, rarely submerged
Position	Open sea
Hydrodynamics	Weak to strong
Salinity	Normal, slight lack of saltiness possible
Temperature	Normal, but susceptible to strong variation linked to air temperature

2 – Description of the biocenosis

- Area corresponding to the upper beach which is only humected by the sea during storms; however, certain areas do escape being totally submerged and receive a large amount of spray coming from the surge of the waves further down.
- 2 sets of phenomena are responsible for the dampness: at surface level, the dampness is caused by the salty spray from the breaking of the waves on the coast which is the main cause of the saltiness of the sand and the dampness of the night air. This humification only affects the top 2 or 3 centimetres and disappears quickly under the action of the sun; at depth, the sand is damp because of the proximity of the fairly unsalty ground water.

- The temperature is very variable and the daily differences in temperature may be extremely great: 0 to 20° in the winter, 50° in the summer. These temperatures can be lethal for individuals living in the sand.
- The exogenous contribution of organic matter (wracks) is linked to the nature of what is washed up by the sea during storms or comes from the land. It is variable in time and space: tree trunks, bits of wood, detritic material which make up the wracks, algae, phanerogams, anthropic vegetable debris, dead marine organisms, aeolian-origin elements (leaves, insects), and foam from waves made up of "shaped or unshaped elements" of wind-borne marine plankton. To this can be added a fairly considerable quantity of biodegradable or non-biodegradable human-origin rubbish linked to the sea or to the direct waste from tourists frequenting the upper beach.
- The physiognomy of the upper beach ranges from shifting sand on compact sand to the presence of fairly damp saline patches on coarse sand. The sea wracks contain floating objects basically washed up during storms and are of two major kinds: chips of wood and fairly well-shaped elements stuck in the sand and tree trunks and sizeable rubbish.
- The sedimentary granulometry is relatively variable according to what fine elements have been added. The sediment is thus fairly compact. One can also notice a variability according to the quantity and quality of organic additions (sea foreshores), according to the direction and level of protection of the upper beach considered, and the degree of humectation, different facies can be observed (point 10).

3 – Main recognition criteria

Sandy sediment, fairly compacted, in the upper beach.

4 – Characteristic/indicator species

Insects: *Phaleria provincialis, Cicindela sp, Bledius arenarius, Bledius juvencus, Tridactylus variegatus*
Arachnida: *Arctosa perita*
Isopod crustacean: *Porcellio sp and amphipod crustaceans: Talitrus saltator, Orchestia stephenseni.*
Also exogenous insects finding shelter, and Xylophages.

5 – Associated habitats or those in contact

Higher contact with annual vegetation of the sea foreshores present in the adlittoral
Lower contact with the middle beach (biocenosis of mediolittoral sands) (II.2.1.).

6 – Possible confusion

Confusion is basically altitudinal and may happen when the sea is low with the mediolittoral sands or mid-beach biocenosis (II.2.1.).
Despite everything, the mediolittoral sands remain markedly damper at depth.

7 – Conservation interest

An environment which is transitional with the terrestrial environment. An area where material and pollutants are transferred between earth and sea via rain, wind and

living organisms (animals and man). The production of this habitat is extremely ill known, though probably fairly considerable because of the earth-sea transfers that take place in this area.
A feeding area for birds thanks to the presence of many crustaceans.

8 – Ongoing trends and potential threats

An area particularly affected by trampling and anthropic waste. Trampling modifies the compactness of the sediments and the sand's retentive or drainage power.

An area likely to be harmed when accidents occur at sea (oil slicks).

This area is subject to massive cleaning, not only destroying the fauna associated with the foreshores but depriving the environment of the additions of organic material that it needs (see on this subject the importance of the Posidonia banks).

An area of transfer and where some pollution percolates the land part.

9 – Conservation status and management

Generally speaking, it is recommended that as little as possible be done, preferably planning for preventive management by restricting access and applying strict rules as to waste. Limit cleaning to macrowaste, avoiding the use of heavy methods. Envisage protection plans for possible pollution by hydrocarbons (the Polmar plan).

10 – Facies and associations

Many facies have been described according to the quality of detritus and the level of residual dampness.:

- Facies with plantless sand with dispersed debris (I.2.1.1.)
- Facies with depressions with residual dampness (I.2.1.2.)
- Facies with foreshores with rapid dessication (I.2.1.3.)
- Facies with washed-up tree trunks (I.2.1.4.)
- *Facies with washed-up Phanerogams (upper part) (I.2.1.5.).

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I.2.1.5. Facies with washed-up phanerogams (upper part)

Facies with washed-up phanerogams (upper part)
Reference codes for identification: RAC/SPA: I.2.1.5
Biocenosis of supralittoral sands (with or without rapidly-drying wracks) I.2.1

1 – Location

On sandy beaches, in the supralittoral stage, at a higher level, rarely submerged, in the whole of the Mediterranean.

2 – Description

Present on the upper beach, only humectated by the sea during storms. The temperature is highly variable and the daily differences in temperature may be more than 20°C. These temperatures may be extremely high, reaching 50°C in the summer, and are then lethal for individuals living in the sand. This facies is a relatively particular aspect of 'wracks' and corresponds to the washing up of almost exclusively marine phanerogam debris from nearby meadows and beds. These wracks always include a fairly sizeable part of other additional elements of anthropic or natural origin.
The sediment of the upper beach ranges from shifting sand on compact sand to the presence of more or less damp saline plaques on coarse sand. The sedimentary granulometry varies according to the addition of fine elements.

3 – Main recognition criteria

A fairly compacted sandy sediment, in the upper beach, covered by varied marine phanerogam debris. The species present are those of biocenosis type (I.2.1): Insects: *Phaleria provincialis, Cicindela sp, Bledius arenarius, Bledius juvencus, Tridactylus variegatus*;Arachnida: *Arctosa perita*; isopod crustaceans: *Porcellio* sp and amphipod crustaceans: *Talitrus saltator, Orchestia stephenseni*.

4 – Possible confusion

There may be confusion due to the assessment of the altitudinal level, particularly when the sea is low. Thus, the biocenosis of mediolittoral sands or mid beach (II.2.1.) may also, in a period of continuing calm weather, be covered with plant debris, which will be dispersed by the next storm.
Confusion with the uppermost part of the banks of leaves of Posidonia oceanica and of other phanerogams (II.3.1.1.) does not seem possible, the reliefs of these two types of habitat being different.

5 – Conservation interest

The production of this habitat is very ill known but probably fairly significant, because of the land-sea transfers taking place in this area. Debris of washed-up phanerogams may be reclaimed by the sea during storms and return to the cycle of these phanerogams.
A feeding area for birds thanks to the presence of many arthropods.

6 – Ongoing trends

An area particularly affected by trampling and anthropic waste. An area likely to be harmed when accidents occur at sea (oil slicks).
This area is often subjected to massive cleaning, not only destroying the fauna associated with the phanerogams but depriving the environment of the additions of this organic material. (See on this subject the importance of the Posidonia banks (II.3.1.1.).)

7 – Conservation status and management

Generally speaking, it is recommended that as little as possible be done, preferably planning for preventive management by restricting access and applying strict rules about waste. Restrict cleaning to macrowaste, avoiding the use of heavy methods.

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II – MEDIOLITTORAL STAGE

II.1. MUDS, SANDY MUDS AND SANDS OF LAGOONS AND ESTUARIES

II.1.1. Biocenosis of muddy sands and muds

Biocenosis of muddy sands and muds in the lagoons and estuaries

Reference codes for identification:
RAC/SPA II.1.1
EUR 15
CORINE

1 – Location of the biocenosis

Stage	Mediolittoral
Nature of substratum	Mud, muddy sand and sands
Bathymetrical distribution	River level at times of low-water level or minor flooding
Position	Habitat present in the estuaries and deltas of major coastal rivers
Hydrodynamics	Low to moderate, but linear currents may be violent during flooding
Salinity	Varying from brackish, low-salinity water to nearly normal salinity
Temperature	Variable

2 – Description of the biocenosis

Present in the mediolittoral stage and the upper part of the infralittoral. The banks are relatively stable, but the beds change with the violent winter flooding. Sediment is formed of fine sand, muddy sands and mud according to the course of the river bed. Surface salinity is low (0.03 to 2.5 psu for the Rhône) whereas that of the deep layer, in contact with the benthic fauna, is much higher (16 to 21 psu for the Rhône). A marine salty patch can be seen sunk underneath the fresh water of the river. Tides are weak and only cause minor changes in the water's chlorinity. The winds have a more marked influence on the position of the salty patch. When parts of the estuary

or the estuary lagoons are cut off, either naturally or by human action, the salinity of the water may increase considerably.
Population variations are linked to the topography of the bed, which causes a differential distribution of the various types of sediment, and to anthropic action. These are especially reflected in the size of species populations, which varies with granulometry but can also be greatly reduced when anthropic action is too great. In the absence of the tide effect, the transition is rapid between the (freshwater) limnic environment and the marine environment. Thus there is no gradient in the distribution of the fauna, which occurs patchily. The species present are characterised by very rapid cycles of development that permit accelerated reconquest of the environments.

3 – Main recognition criteria

Located in the estuaries (or deltas) of rivers.

4 – Characteristic species

Cyanophyceae. Polychaete annelids*: Nereis diversicolor*; bivalve burrowing molluscs: *Cerastoderma glaucum, Abra ovata;* gastropods: *Hydrobia* spp.; amphipod crustaceans: *Gammarus locusta, Corophium insidiosum;* isopod *crustaceans: Sphaeroma hookeri.*

5 – Associated habitats or those in contact

Higher contacts with Mediterranean salty meadows (EU: 1410). Lower contacts: infralittoral populations, big coves and shallow bays (EU: 1160) and sand banks with little lasting marine water cover (EU: 1110).

6 – Possible confusion

Not to be confused with the euryhaline and eurythermal biocenosis (III.1.1.). This lagoon population is most frequently subject to a confinement gradient corresponding to the decline of the marine influence and not to the coexistence of two constantly renewed masses of water.

7 – Conservation interest

An environment with low biological diversity, used as a feeding area by birds and some fishes (grey mullet and eels). The typical state, with all the species together, is to be favoured.

8 – Ongoing trends and potential threats

Environments subjected to a great many artificial man-made channels, various additions brought by sea discharge pipes. Possible contamination of organisms by water from watercourses. Along with anthropisation comes the dwindling of biological elements.

9 – Conservation status and management

Management linked to that of the banks, the rate of flow of the watercourse, and the quality of the water; as regards the banks, these should be as little artificial as possible; the rate of flow of the watercourse must be sufficient to avoid too great a concentration of pollutants; the quality of the water must be monitored for the levels of various pollutants (hydrocarbons, pesticides, phosphates, nitrates…).

10 – Facies and associations

-II.1.1.1. Association with Halophytes
-II.1.1.2. Facies of saltworks

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Crédit photographique : J. G. HARMELIN

II.1.1.1. Association with halophytes

Association with halophytes

Reference codes for identification:
RAC/SPA: II.1.1.1

Biocenosis of muddy sands and muds in lagoons and estuaries
II.1.1.

1 – Location

Banks of lagoons and of brackish swamps that can dry out in the summer; basins that remain flooded for long periods and are wet in summer.
Fairly varied Mediterranean region associations with Juncus reed-beds and various higher Graminaceae. These mediolittoral associations can also go up into the supralittoral stage.

2 – Description

Type 1: Formations made up especially or greatly of annuals, in particular halophilous Chenopodiaceae of the *Salicornia* genus or grasses colonising the muds and sands that are periodically flooded in the coastal or inland salt-marshes ('sansouires' and 'enganes'). Polyhaline environments able to undergo sizeable variations in salinity: unsalty, over-salty. A muddy to muddy-sandy substratum, halo-eutrophic, sometimes mixed with remains of shells or organic deposits.
Type 2: Fairly varied assemblages of Mediterranean region reed-beds with high vegetation with *Juncus* spp., *Phragmites*, *Typha*, *Scirpus*, *Aeluropus*, etc., developing in areas of salty muds at the edges of coastal marshes and lagoon ponds, on sandy-silty to silty-muddy substratum. The level of clogging up and the salinity of the substratum may vary greatly according to the topographical position and the extent to which it dries out in the summer.

3 – Main recognition criteria

Type 1: Low herbaceous vegetation, open, dominated by annual species, presenting one stratum only, whose cover is variable. 'Indicator' species of the type of habitat belong to the *Suaeda, Salsola*, *Salicornia* and *Kochia genuses*. The Mediterranean species are often vicarians.
Type 2: High, vegetation, dense with *Juncus*, *Scirpus*. Because of the very great ecological constraints, this habitat includes plant associations which correspond to

permanent vegetation; thus it does not present any particular dynamics. But in areas of contact towards the upper levels, and in the absence of grazing, one can observe the dynamics of colonisation of halophile thickets. The main other plant genuses present: *Aeluropus, Aster, Carex, Eleocharis, Limonium, Oenanthe, Puccinellia, Ranunculus, Senecio and Trifolium.*

4 – Possible confusion

No confusion possible in the Mediterranean.

5 – Conservation interest

These types of habitat have set their stamp on the landscapes of the edges of ponds and of maritime marshes; they correspond to a wide diversity of plant associations, reflecting a great diversity of station conditions linked to the nature of the substratum, the salinity and the length of flooding.
Very many limicolous birds winter and nest in this habitat, particularly that of Type 1 ('sansouires' and 'enganes') or frequent it during migration – particularly ducks.

6 – Ongoing trends, vulnerability and potential threats

Vulnerability to trampling (which remains localised for this type of habitat).
Destruction of the habitat: filling in of coastal wetlands, urbanisation, development of agriculture and fish-farming and the saltworks. These areas may be grazed.
Marked decline on the continental shore, related to the coastal development work being done (tourist or port development, filling in, being turned into rubbish dumps, coastal urbanisation) and changes in the hydrological regime of the coastal marshes (drying out).

7 – Conservation status and management

Maintaining the development potential of this type of habitat by giving it maximum protection from the effects of trampling and overgrazing.
Given the pioneer nature and the extreme fragility of this habitat, non-intervention seems to be the most appropriate mode of management to maintain it in a good state of conservation. Generally speaking, non-intervention is desirable for this type of habitat.

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II.1.1.2. Facies of saltworks

Facies of saltworks

Reference code for identification:
RAC/SPA: II.1.1.2

Biocenosis of muddy sands and muds in lagoons and estuaries
II.1.1.

1 – Location

The farthest parts of the lagoons and marshes, more often than not subject to total confinement due to its being naturally or artificially cut off from the adjacent aquatic environments and to the fact that for long stretches of time (in terms of months) neither salty nor non-salty water can arrive. The saltworks are also bordered by the continental environment. They correspond to the mediolittoral stage.

2 – Description

Evaporative environments in which water with low or normal salinity evaporates either in the summer period (northern Mediterranean: salterns) or the whole year round, except for the rainy season (in the eastern parts of the southern Mediterranean: bahiret, sebkha, chotts). Dessication may be total, with the production of 'salt' (evaporative brine of varied composition, usually sodium chloride (halite) but also potassic salts, magnesian salts, bromates, gypsum, etc.). Temperature plays a crucial part in establishing saltworks.

3 – Main recognition criteria

The gradual formation of these mineral deposits goes hand in hand with a progressive evolution of the plant and animal population until this disappears. There is a passage from brackish environment populations, of the euryhaline and eurythermal type (II.1.1., and its various facies) to an extremely particular population that develops according to the increase in salinity linked to the evaporative brines: mono- or pauci-specific cyanobacterian assemblages including *Lyngbya, Microcoleus* and then *Oscillatoria*, *Spirulina* and the *sulphur* and iron bacteria, Dunaliella viridis Chlorophyceae and then D. salina (red form giving the colouring to active salterns), rotifers, nematodes, and the *Artemia salina* branchiopod crustacean which can withstand salinities of 300 grams per litre.

4 – Possible confusion

None.

5 – Conservation interest

These saltworks are often feeding areas for birds, particularly the pink flamingoes, *Phoenicopterus ruberroseus*, and the *Tadorna tadorna* sheldrake. Most birds only frequent these saltworks when their salinity is low to medium. Only the pink flamingoes are present in sectors with high salinity. *Phoenicopterus ruberroseus* and larus genei are dependent on the salt marshes for reproduction. Also, the economic importance of these saltworks is exceptional and they must therefore by protected from pollutant waste.

6 – Ongoing trends

According to the additional water, or its absence, and the ambient temperature, the salt marshes are developing towards the state of more or less temporary brackish lagoons or becoming like permanent evaporative basins.

7 – Conservation status and management

The saltworks areas are subject to the same risks as the lagoon and estuary biocenoses, i.e. heavy anthropisation. These areas must be maintained as they are by correct management of the water and of the waste that is likely to accumulate there.

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II.3. STONES AND PEBBLES

II.3.1. Biocenosis of mediolittoral detritic bottoms

Biocenosis of mediolittoral detritic bottoms

Reference codes for identification
RAC/SPA II.3.1
EUR 15 1140
CORINE 14

1 – Location of the biocenosis

Stage	Mediolittoral
Nature of substratum	Stones and pebbles
Bathymetrical distribution	Mid-beach, with phases when it is above water
Position	Open sea
Hydrodynamics	Low to extremely great
Salinity	Normal
Temperature	Normal, with variations according to the air temperature

2 – Description of the biocenosis

-Mid-beach with stones and pebbles, with a vertical extension that is usually slight
-Mid-beach pebbles which retain between them plant debris thrown up on the beach as wrack. Possible site for Posidonia banks.
This area goes through periods of alternating submersion in and emergence from the water during calm weather because of variations in the water level, and is frequently moistened by wavelets. The vertical size of the rise and fall of the water, which can be some dozens of centimetres, can mark out strips several metres wide on the beach.
The habitat can present variations according to the granulometric size in the substratum, the hydrodynamic action produced by the backwash and the quantity and quality of detritus thrown up on the beach as wreckage.
The population dynamics vary according to the humectation of the environment and, especially, the level of wave energy since hydrodynamics are the vector of the dampness and of the quality and quantity of detritus that can be used for food as well as sedimentation. Powerful hydrodynamics encourage the laying down of a coarse sediment. The fauna is basically made up of scavengers of detritus and their predators, and so essentially unstable.

3 – Main recognition criteria

Presence of stones and pebbles on mid-beach.

4 – Characteristic/indicator species

The isopod crustacean: *Sphaeroma serratum* and the amphipod crustacean: *Echinogammarus olivii*, plus as accompanying species when algae are present, washed up on the beach
The polychaete: *Perinereis cultrifera,*
The amphipod crustacean: *Parhyale aquilina* (=*Allorchestes aquilinus*) and the decapod crustacean: *Pachygrapsus marmoratus*.

5 – Associated habitats or those in contact

Biocenosis of slowly-drying wracks in the supralittoral stage: high beach pebbles in the upper part (I.3.1.).
Biocenosis of infralittoral pebbles in the lower part (III.4.1).

6 – Possible confusion

Difficult to confuse unless altitudinally, as regards the stage with the supralittoral habitat (I.3.1).

7 – Conservation interest

An unstable biological environment, belonging to the bird feeding area.

The presence of Posidonia banks, where they do exist, encourages the fixing of the littoral.

8 – Ongoing trends and potential threats

An environment subject to strong anthropic artificialisation.
An area of detritus accumulation which is not systematically cleaned up, since this type of shore is not particularly sought after by tourists. When the beaches have Posidonia bank deposits, these banks are more often than not cleaned up mechanically.
The cleaning up of Posidonia banks causes serious harm to the littoral environment insofar as a natural cycle exists for making use of such waste. During the winter storms, the Posidonia leaves are reclaimed by the waves, retted and carried away. They thus serve as support and food supplement in certain populations of the infralittoral and circalittoral, which they enrich. The mechical elimination of Posidonia banks thus causes an overall impoverishment of the littoral ecosystem.

9 – Conservation status and management

The pebbled mid-beach is subject to limited but not negligible anthropic pressure insofar as its management is not bound by rules and regulations. This pressure is exerted in three ways:
-frequentation and trampling
-detritus being thrown away

-activity in the terrestrial part situated above can extend to and run down onto the part below.

10 – Facies and associations

Facies with banks of dead Posidonia oceanica leaves and other phanerogam leaves.

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II.3.1.1. Facies with banks of dead leaves of Posidonia oceanica and other phanerogams

Facies with banks of dead leaves of Posidonia oceanica and other phanerogams

Reference code for identification: RAC/SPA: II.3.1.1

Biocenosis of mediolittoral coarse detritic bottoms II.3.1.

1 – Location

Mediolittoral stage with possible extension into the supralittoral stage when the facies is very developed. The entire Mediterranean.

2 - Description

Accumulation of plant debris made up mostly of dead *Posidonia oceanica* leaves and/or leaves of other phanerogam species (e.g. *Cymodocea nodosa*). This is a belt that is a few centimetres to several metres wide and up to 1 to 2 metres high at the edge of the littoral. These accumulations form on sand, gravels or pebbles and are called 'banks'. The accumulation of banks varies according to the season and the site's hydrodynamic situation. In the winter, part of these banks is reclaimed during storms at the edge of the shore and the leaf debris is once again fragmented, retted and then gradually carried out at depth down to the bathyal level. The fauna existing in these banks is temporary and made up of some detritus-scavenging species.

3 – Main recognition criteria

The presence of fairly sizeable accumulations of dead Posidonia oceanica leaves.

4 – Possible confusion

None.

5 – Conservation interest

At ecological level, these banks (wracks) constitute the basis for a specific trophic network characterised by the presence of many isopod crustaceans (Idothea). At sedimentary level, this facies, especially when it is well represented, constitutes a most effective natural protection for the beach against erosion. Once reclaimed and carried back to the marine bottoms, the dead phanerogam leaves that make up these banks are subject to microbian activity through which they enter the trophic networks, becoming one of the major constitutive elements.

6 – Ongoing trends

Partial natural repossession. Direct destruction by the development of the beaches as resorts.

7 – Conservation status and management

The banks of dead leaves must be left where they are, at least outside the summer season, to ensure the mechanical protection of the beaches. Their mechanical destruction by people managing the littoral area may have disastrous effects, especially on the erosion of the beach and the area behind the beach, and on the entire trophic network in the littoral area.

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II.4. HARD BEDS AND ROCKS

II.4.1. Biocenosis of the upper mediolittoral rock

Biocenosis of the upper mediolittoral rock

Reference codes for identification:
RAC/SPA II.4.1
EUR 15 1170
CORINE 24

1 – Location of the biocenosis

Stage	Mediolittoral
Nature of substratum	Rocky
Bathymetrical distribution	Above mid-level, subject to being uncovered by water and submerged
Position	Open sea
Hydrodynamics	Low to extremely strong
Salinity	Normal
Temperature	Normal, with variations according to the air temperature

2 – Description of the biocenosis

The distribution and type of the populations of the solid substratum in the mediolittoral stage are profoundly marked by the submersion variability due to waves and to the irregular rise in the sea level caused by atmospheric pressure and wind. Two horizons corresponding to different average values of the dominant factors (humectation, light, nutrients, topography and type of substratum) can be made out. The upper horizon corresponds to the area that is only moistened by the tops of the waves and spray. The upper mediolittoral which corresponds to this habitat is the horizon where the environmental conditions are most restrictive. According to the hydrodynamics and the local topography, it can extend over a vertical area of a few centimetres to two metres.
Variations in the environmental conditions affect the vertical extension of the biocenosis of the upper mediolittoral rock, and also the density of its cover and its dominant composition. This habitat also varies according to the nature of the

substratum. Development of endolithic Cyanobacteria (=Cyanophyceae) is intense on the calcareous coasts.
A certain number of facies which may appear as belts can be made out (see point 10).

3 – Main recognition criteria

A rocky area located at sea level, humectated by both spray and the tops of the waves. It may be the site of algal facies.

4 – Characteristic species

Various Cyanobacteria (=Cyanophyceae)
Algae*: Porphyra leucosticta, Rissoella verruculosa, Bangia atropurpurea, Lithophyllum papillosum*
Molluscs*: Patella rustica, Patella ferruginea*
Crustaceans*: Chthamalus stellatus, Chthamalus montagui.*

5 – Associated habitats or those in contact

In the upper part, the habitat follows on from the supralittoral rock (I.4.1); in the lower part, it is immediately in contact with the lower mediolittoral rock (II.4.2) with which it can sometimes be confused.

6 – Possible confusion

It is hard to differentiate between the upper limit of this habitat and the biocenosis of the supralittoral rock (I.4.1) and between its lower limit and the biocenosis of the lower mediolittoral rock (II.4.2).

7 – Conservation interest

Its particular topography makes this habitat – like those immediately above and below it – a biological marker of variations in sea level.

8 – Ongoing trends and potential threats

The greatest threat comes from the pollution of the surface water and spray full of hydrocarbons, surfactants and nutrients, which have a harmful effect on the population. The risk of massive discharge of hydrocarbons must be considered. Frequentation of the coastal verge also represents a serious potential threat along with trampling and – especially – the throwing away of waste it brings.

9 – Conservation status and management

Managing the littoral and respecting the rules concerning building, for this area represents a base for all coastal building and development.

Managing water quality.

10 – Facies and associations

A certain number of facies can be seen, which may appear as belts:

- -Association with *Bangia atropurpurea*
- -Association with *Porphyra leucosticta* in the most exposed areas
- -Association with *Nemalion helminthoides* and *Rissoella verruculosa*
- -Association with *Lithophyllum papillosum* and *Polysiphonia* spp.

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II.4.1.3. Association with Nemalion helminthoides and Rissoella verruculosa

Association with *Nemalion helminthoides* and *Rissoella verruculosa*

Reference code for identification:
RAC/SPA: II.4.1.3

Biocenosis of the upper mediolittoral rock
II.4.1

1 – Location

A horizon present in the bottom part of the upper mediolittoral rock, between 10 and 50 centimetres above the average level of the sea, where there is strong wave action.

2 - Description

This association is present all year round, although it develops fully in winter and spring. The *Rissoella verruculosa* alga is present on siliceous or dolomite substrata. Exceptionally, it can be found on calcareous substrata, but then it exploits the presence of siliceous fragments to attach itself. The main characteristic species are *Nemalion helminthoides, Rissoella verruculosa*, and *Audouininella nemalionis*. The fauna is very impoverished and is essentially composed of Chtamales; where the *Rissoella* are abundant and retain sufficient dampness between the thalli, the *Hyale perieri* amphipods can be found.

3 – Main recognition criteria

Presence of *Nemalion helminthoides* and *Rissoella verruculosa.*

4 – Possible confusion

No confusion where these species dominate the population.

5 – Conservation interest

Rissoella verruculosa is an endemic species of the Mediterranean.

6 – Ongoing trends

Subject to direct or indirect human activity on the littoral rock, particularly to pollutants present in the superficial water layer.

7 – Conservation status and management

Monitoring the quality of the water.

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II.4.1.4. Association with Lithophyllum papillosum and Polysiphonia spp

Association with Lithophyllum papillosum and Polysiphonia spp Reference identification code:

1 –Location

The association with *Lithophyllum (=Goniolithon) papillosum* is distributed throughout the Mediterranean, though mostly found in the western basin and the Adriatic. It is located in the lower part of the mediolittoral stage and constitutes, with the two other melobesie species *Lithophyllum lichenoides* and *Neogoniolithon notarisii,* concretions of widely differing sizes but that are frequent on the coasts of the western basin of the Mediterranean.

2 – Description

Lithophyllum papillosum is a crust-forming mamelon species found with *Lithophyllum lichenoides.*

3 – Main recognition criteria

Presence of *Lithophyllum papillosum* and *Polysiphonia* sp.

4 – Possible confusion

With the other associations nearby, particularly in the lower mediolittoral rock.

5 – Conservation interest

Participates in biogenous constructions in the lower mediolittoral.

6 – Ongoing trends, vulnerability and potential threats

An association that may be subject to anthropic activity, particularly pollutant additions, especially hydrocarbons, and to trampling, which may seriously harm it in certain sectors.

7 – Conservation status and management

Avoid trampling. Restrict pollutant additions.

8 – Bibliographical references

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II.4.2. Biocenosis of the lower mediolittoral rock

Biocenosis of the lower mediolittoral rock

Reference codes for identification:
RAC/SPA: II.4.2
EUR 15 1170
CORINE 1124-1125

1 – Location of the biocenosis

Stage	Mediolittoral
Nature of substratum	Rock
Bathymetrical distribution	Middle level, subject to being out of the water and then being submerged
Position	Open sea
Hydrodynamics	Weak to extremely powerful
Salinity	Normal, able to withstand slight lack of salt
Temperature	Normal, variations according to air temperature

2 – Description of the biocenosis

The lower horizon of the mediolittoral rock results from the coming together of three essential factors: presence of waves, irregular variations in atmospheric pressure, and wind and tide when present. The constant humectation, greater than in the higher horizon, is the dominant factor, followed by light. Its size depends on the morphology of the substratum and – especially – on the intensity of the humectation, and may vary from several centimetres to one metre.
This habitat, particularly characterised by the presence of crust-forming melobesie algae, varies according to the nature of the substratum and the humectation, thus causing the forming of local facies.
This formation is frequent in the western Mediterranean in areas with pure water and rough waters. It constitutes a major and particularly attractive element in the rocky coast landscape. It is found in the area where the waves break; its upper surface may emerge at 20-30 centimetres above the middle level of the sea. It develops on every type of substratum and can be up to 1 to 2 metres wide. The rim is formed by successive, more or less indurate and re-crystallised, layers of alga, with which the calcareous tests of some animals are mixed. The lower side presents many cavities that have been enlarged by rock-destroying organisms and in which a rich sciaphilous fauna finds refuge.

3 – Main recognition criteria

A rocky area located at sea level, moistened by the waves. This habitat is particularly characterised by the presence of calcareous algal formations, particularly the *Lithophyllum lichenoides (=Lithophyllum tortuosum)* rim, whose constructions may be 1 to 2 metres wide and have great aesthetic value.

4 – Characteristic species

Algae: *Lithophyllum lichenoides, Neogoniolithon brassica-florida, and Nemalion helminthoides*
Molluscs*: Lepedochiton corrugata, Patella aspera, Lasea rubra, Gardinia garnoti* and *Oncidiella celtica*
Crustacean: *Campecopea hirsuta.*
In this habitat so rich in cavities, where the retention of water offers the conditions of the infralittoral stage, a rich cryptic fauna can be found which would usually develop in the lower habitat: the Miniacina miniacea foraminifer, the Sertularella ellisi hydrozoan, the Acanthochiton fascicularis, Musculus costulatus and Venerupis irus molluscs, the Phascolosoma granulatum sipuncle, polychaetes and many crustaceans.

5 – Associated habitats or those in contact

In the upper part is found the biocenosis of the upper mediolittoral rock (II.4.1), and in the lower part the biocenosis of photophilous algae (III.6.1).

6 – Possible confusions

The border with the upper habitat (II.4.1) is sometimes hard to determine. As regards the lower habitat, that is, the photophilous algae biocenosis (III.6.1), many elements coexist as an enclave with the species of the lower mediolittoral rock in the cavities of structures formed by melobesies, especially in the *Lithophyllum lichenoides rim.*

7 – Conservation interest

The *Lithophyllum lichenoides rim* is an extremely interesting biogenous construction of great aesthetic value.
This continuing formation is an excellent marker of variations in the sea level and continent level.

8 – Ongoing trends and potential threats

This area is directly subject to the influence of water pollution. The L. lichenoides rim is extremely slowly built up and is often degraded by the trampling of fishermen and tourists who see these ledges as easy landing places in areas whose aesthetic quality makes them attractive.

9 – Conservation status and management

As well as monitoring the quality of the littoral water, it is necessary to educate the public, particularly as regards the rims. Protecting and classifying some of these seems increasingly necessary.

10 – Facies and associations

Many facies or belts have been described, including the most frequent:

- *Lithophyllum lichenoides* rim in areas with very strong wave action (II.4.2.1)
- Facies with *Pollicipes cornucopiae* (II.4.2.5)
- Association with *Neogoniolithon brassica-florida* in conditions close to the above (II.4.2.8)
- Association with *Nemalion helminthoides* (II.4.1.3) in exposed areas
- Association with *Ralfia verruculosa* on coasts with moderately strong wave action
- Polluted association with *Enteromorpha compressa* (II.4.2.6)
- Association with *Fucus virsoides* (II.4.2.7).

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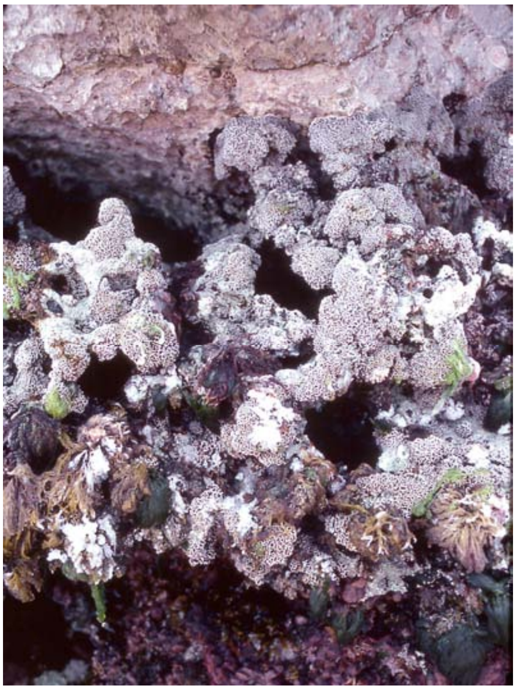
II.4.2.1. Association with Lithophyllum lichenoides (=L. tortuosum rim)



Association with Lithophyllum lichenoides (=L. tortuosum rim)

Reference code for identification:
RAC/SPA: II.4.2.1

Biocenosis of the lower mediolittoral rock
II.4.2

– Location

A formation that is extremely widespread in the western Mediterranean, slightly above the middle level, in the area where the waves break, on rocky coasts with very strong wave action that are exposed to the dominant winds. The species is rare in the eastern Mediterranean and does not form developed bioconstructions there.

2 – Description

The association with the *Lithophyllum lichenoides (=L. tortuosum* rim) is the highest biological construction in the Mediterranean. When the water is calm, the rim emerges completely, and its outer edge extends to 20 to 30 centimetres above the water, a position that is possible because it is present where there is strong wave action and because of the porosity of the formation. The height above the middle level is linked to the local degree of roughness. In crevices and little coves that are open to the swell and sheltered from the direct rays of the sun, it may be of considerable width and thickness. Rims that are over two metres wide have been seen. The rim is formed by the stacking up of calcareous *Lithophyllum lichenoides* thalli with a re-crystallising of the deeper layers. Three successive layers may be seen, whose respective thickness depends on environmental and local history conditions. Only the upper part is alive. At the base of the living part of the *Lichophyllum lichenoides* many endolithic Cyanophyceae *(Brachytrichia, Calothrix* and *Entophysalis* genuses) can be observed. The lower surface of the ledge, often below the average level, is dead and covered with sciaphilous animal and plant assemblages. Destructive animals (*Cliona, Lithophaga*) bore into the rock, creating cavities which contain an upper infralittoral type of fauna and flora. In less favourable environmental conditions, the *Lithophyllum* constructions are mere pads in the mediolittoral area.

3 – Main recognition criteria

Presence of variably sized constructions due to the development of the *Lithophyllum lichenoides species*.

4 – Possible confusion

None.

5 – Conservation interest

This type of bioconstruction is strictly linked to the western Mediterranean. It may be extremely spectacular and thus presents an outstanding 'landscape' interest. It is also evidence of the geological history of the Mediterranean, and is an essential marker of the evolution (elevation) of the sea level during the last Quaternary.

6 – Ongoing trends, vulnerability and potential threats

The normal development of a *L. tortuosum* rim results in its horizontal and, according to the average level of the sea, vertical growth; this growth is extremely slow (about a century). Today, this trend is often reversed as a result of the many human actions that affect it, either directly (trampling by fishermen, tourists, concreting of the coasts, addition of sediment, etc.) or indirectly (pollutants, certain of these, like detergents, being to a great extent concentrated in the superficial water, etc.).

7 – Conservation status and management

The building up of a *Lithophyllum* rim being so very slow, its destruction may be irreversible on a human scale. However, a population can be resumed as long as the structures themselves are not destroyed. Among the management and conservation measures that can be envisaged are, starting from making inventories of a scientific nature, the regulatory classifying of the main edifices as 'natural monuments', particularly in nature reserves, and educating the public, to restrict the direct destruction of the rims.

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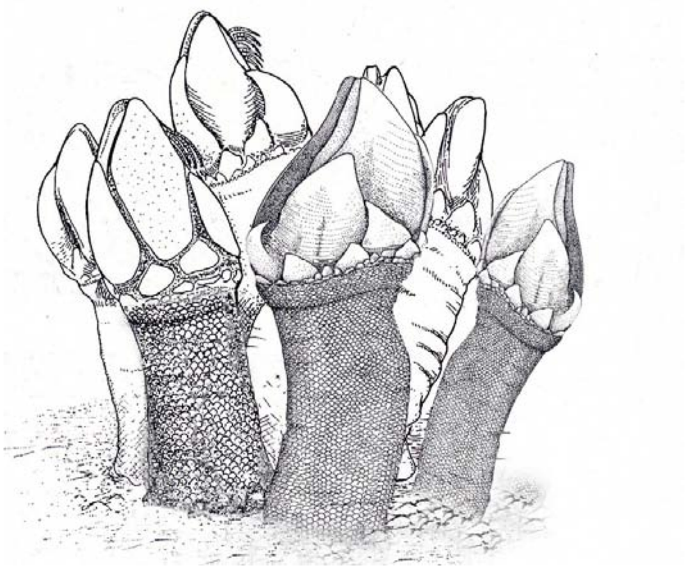
Crédit photographique : J. G. HARMELIN

II.4.2.5. Facies with Pollicipes cornucopiae



Facies with Pollicipes cornucopiae(=P.pollicipes)

Reference code for identification:
RAC/SPA: II.4.2.5

Biocenosis of the lower mediolittoral rock
II.4.2

1 – Location

On the lower mediolittoral rock, along cliffs subject to very powerful hydrodynamics, in the western part of the western Mediterranean influenced by the Atlantic influx, along the coasts of the Maghreb and in southern Spain (Sea of Alboran). This facies has been sighted in the Nice, France, area. Its presence is extremely rare and only concerns isolated sites cut off from each other.

2 – Description

This facies, very rare in the western Mediterranean, is characterised by an aggregation of *Pollicipes cornucopiae* pedunculate Scalpellidae cirripedes on steep rocky walls in areas of pure water and extremely rough waters with waves breaking. Its upper surface may emerge a few decimetres above the middle sea level. It is particularly hard to see, rarely mentioned, and ill known.

3 – Main recognition criteria

Presence of *Pollicipes cornucopiae (=P. pollicipes*).

4 – Possible confusion

None.

5 – Conservation interest

A very rare species in the Mediterranean.

6 – Ongoing trends

A priori, since this facies is only present in areas with extreme hydrodynamics, it is not very likely to be subjected to anthropic attack. But its gastronomic interest could result in this species's being over-collected and its sites destroyed, as happens on certain of Europe's Atlantic coasts.

7 – Conservation status and management

Strict regulation of fishing. The direct destruction of sites is not very likely, given that they are difficult to reach.

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Crédit photographique : d'après P. Lastrico, Fiches FAO Méditerranée et Mer Noire, 1987

II.4.2.7. The association with Fucus virsoides

The association with Fucus virsoides

Reference code for identification:
RAC/SPA: II.4.2.7

Biocenosis of the lower mediolittoral rock
II.4.2.

1 – Location

An association that is exclusive to the eastern (from Albania to Slovenia) and northern coasts of the Adriatic, present in the lower part of the mediolittoral.

2 – Description

The association, when it is present, occupies the entire mediolittoral, related to the presence of the significant tides and the relatively cool, unsalty, eutrophic water that are peculiar to these coasts. According to Giaccone (1991), this is probably a Parathetis relict. The association is basically formed by the *Fucus virsoides*, *Gelidium spathulatum, G. pulvinatum* and *Phormidium flexuosum plants*. There are also *Bangia* spp, and *Rivularia mesenterica*. *Patella coerulea*, *Mytilus galloprovincialis*, *Actinia equina* and *Balanus* spp. are among the animal species found. This is really more like an infralittoral enclave, finding a favourable biotope under the Fucus fronds.

3 – Main recognition criteria

Presence of *Fucus virsoides*.

4 – Possible confusion

None.

5 – Conservation interest

The only Fucus population in the Mediterranean, strictly restricted to the upper Adriatic and a few points in the eastern coast of the Adriatic. Being a pre-Messinian relict, this association is extremely important from the heritage point of view.

6 – Ongoing trends, vulnerability and potential threats

An association that can be subjected to anthropic activity, especially to pollutant additions that can cause it serious harm in certain sectors.

7 – Conservation status and management

Monitoring the quality of the water.

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Crédit photographique : J. G. HARMELIN

II.4.2.8. Neogoniolithon brassica-florida concretion

Neogoniolithon brassica-florida (=N. notarisii) concretion

Reference code for identification:
RAC/SPA: II.4.2.8

Biocenosis of the lower mediolittoral rock
II.4.2

1 – Location

Present on rocky coasts with strong wave action in the Mediterranean, this association was described by Molinier as *Neogoniolitho-Lithophylletum tortuosi (=Lithophyllum lichoides). Neogoniolithon brassica-florida* i*s* usually sighted as a plaque. Molinier (1960) and Giaccone *et al*. (1993) mention that this species precedes the installation of *L. lichenoides* on non-calcareous coasts. The association has also been described, more specially on the French Var and Corsican coasts and in the Balearics, in Sicily, in Tunisia and in Turkey.

2 – Description

The association, when present, occupies the borders of the lower mediolittoral, where there is strong wave action. It may be present as a plaque on this lower mediolittoral rock. With it are found many species of the biocenosis to which it belongs, and, particularly*, Ralfia verrucosa, Rivularia atra and Acrochaetium* spp.

3 – Main recognition criteria

Presence of *Neogoniolithon brassica-florida.*

4 – Possible confusion

With other associations that also contain *Neogoniolithon brassica-florida* in greater or lesser abundance.

5 – Conservation interest

When this association is associated with the *Lithophyllum lichenoides* rim formation (II.4.2.1.), it presents the same interest.

6 – Ongoing trends, vulnerability and potential threats

An association that can be subjected to anthropic activities, particularly pollutant additions, in particular hydrocarbons, and to trampling, which may cause harm to it in some sectors.

7 – Conservation status and management

Avoid trampling. Minimize pollutant additions.

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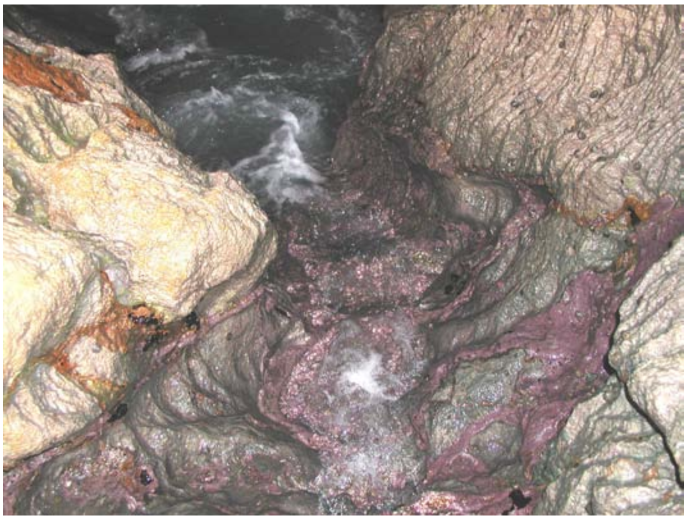
Crédit photographique : d'après M. Denizot et al., 1981

II.4.2.10. Pools and lagoons sometimes associated with Vermetids (infralittoral enclave)

See sheet III.6.1.3. Facies with Vermetids

II.4.3. Mediolittoral caves



Biocenosis of mediolittoral caves

Reference codes for identification:
RAC/SPA: II.4.3
EUR 15 8330
CORINE 1126

1 – Location of the biocenosis

Stage	Mediolittoral
Nature of substratum	Rocky
Bathymetrical distribution	Middle level, subject to being out of the water and then being submerged
Position	Open sea
Hydrodynamics	Weak to powerful
Salinity	Normal
Temperature	Normal, variations linked to air temperature

2 – Description of the biocenosis

Mediolittoral caves correspond to crevices or the entrances of caves that are partially out of the water. These are usually located in karstic or volcanic systems.
These formations can be almost totally covered by the sea, and as one penetrates further into the submerged part two other habitats can be made out – the semi-dark caves (IV.3.2) and the caves in total darkness (V.3.2). In the exposed cavity formations, a terrestrial fauna is found based on acari, pseudo-scorpions and Chilopoda. The supralittoral and – especially – mediolittoral parts are covered with crust-forming algae.
The crevices or the entrances of the caves present variation gradients of the ambient factors that are essential for the distribution of species: reduction in hydrodynamics, and in light. The bottom of these cavities presents an area of very high humidity that encourages organisms that usually live more deeply to live there, and this results in the zonation getting mixed up.
Given the reduced hydrodynamics, there is in this habitat an accumulation of floating detritus and objects.
The variability is linked to both the size of crevice or cave, and the position of the openings in relation to the dominant hydrodynamics. The cave's geomorphology and the possibility of a flow of fresh water also have a big influence on the quality itself of the habitat and its development over time.

3 – Main recognition criteria

This habitat is located in the crevices or the entrances of caves at sea level. It is formed of very shadowy rocky surfaces subject to extremely great humectation.

4 – Characteristic species

Various Cyanobacteria (=Cyanophyceae)
Algae: *Catenella caespitosa*, *Hildenbrandia prototypus, Rivularia atra*.

5 – Associated habitats or those in contact

Contact at the level of the opening with mediolittoral and supralittoral hard substratum biocenoses: biocenosis of the supralittoral rock (I.4.1), biocenosis of the upper mediolittoral rock (II.4.1), and biocenosis of the lower mediolittoral rock (II.4.2).
When the cave extends further down, possible contact with the biocenosis of the semi-dark cave (IV.3.2).

6 – Possible confusion

No confusion possible.

7 – Conservation interest

The value of this type of habitat is especially heritage and aesthetic when the entrances are very big and allow bathers and boats to penetrate.
The intrinsic potential for economic production is probably nil.

8 – Ongoing trends and potential threats

The basic threat is the accumulation of detritus that can cause harm to the pool and to the species present on the rock. The fact that the water is hardly replaced at all makes this phenomenon worse. Frequentation by bathers or boats may also be a risk.

9 – Conservation status and management

Management of the water quality and of the littoral.

10– Bibliographical references

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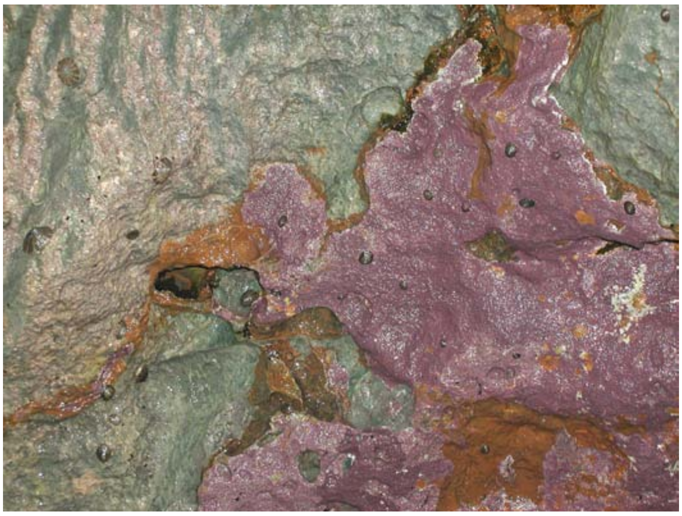
II.4.3.1. Association with Phymatolithon lenormadii and Hildenbrandia rubra



Association with Phymatolithon lenormadii and Hildenbrandia rubra

Reference code for identification: RAC/SPA: II.4.3.1

Biocenosis of the mediolittoral caves II.4.3

1 – Location

The association basically develops under the *Lithophyllum lichenoides* rim (pavement) and at the entrances to the mediolittoral caves.

2 – Description

The association develops in sciaphilous ambiences. Some writers signal it at the level of small cavities in the substratum of *Cystoseira amentacea* var*. stricta*. There it is probably an enclave in the superficial fringe of the infralittoral stage. Characteristic species are few: *Phymatolithon lenormandii, Cruoriella armorica, Hildenbrandia rubra* and *Gymnothamnion elegans*. In the most sciaphilous situations*, Phymatolithon lenormandii* disappears.

3 – Main recognition criteria

Presence of the *Phymatolithon lenormandii* and *Hildenbrandia rubra* algae.

4 – Possible confusion

None.

5 – Conservation interest

The habitat belongs to the fragile groupings, such as the *Lithophyllum lichenoides* rim, or the mediolittoral caves, whose heritage interest is unquestionable.

6 – Ongoing trends, vulnerability and potential threats

This habitat, like those it is associated with, is sensitive to anthropisation in general, by human frequentation, or by the addition of pollutants.

7 – Conservation status and management

Monitoring the quality of the water and the frequentation of sites where the habitat is found.

8– Bibliographical references

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III – INFRALITTORAL

III.1. SANDY MUDS, SANDS, GRAVELS AND ROCKS IN EURYHALINE AND EURYTHERMAL ENVIRONMENT

III.1.1. Euryhaline and eurythermal biocenosis

Euryhaline and eurythermal lagoon biocenosis

Reference codes for identification:
RAC/SPA: III.1.1
EUR 15 1150
CORINE 21

1 – Location of the biocenosis

Stage	Infralittoral
Nature of substratum	Mud, muddy sand and sand
Bathymetrical distribution	0 to several metres
Position	Fairly closed off environment, often cut off from the open sea
Hydrodynamics	Weak to average
Salinity	Varying from low-salinity brackish water to hypersalinity
Temperature	Variable

2 – Description of the biocenosis

A habitat present in salty littoral ponds and also in certain estuary marine areas where the water is irregularly de-salted and where the temperature is variable. These variations evolve in intervals of time that range from one day to a year and, of course, even longer.

The organisms that live in this habitat are subject to great variations of salinity and temperature that are sometimes really erratic. The sediment is usually of muddy or sandy-muddy type.

The variations presented by the biocenosis are linked to climatic conditions, mainly the very great seasonal differences in temperature and salinity, with in the summer particularly warm salty water and in the winter very low temperatures and sometimes very unsalty water, and also to the anthropic action to which most lagoon environments are subject. In the summer, when there is a great lack of wind and thus the waters remain unchanged, certain enriched areas will experience a proliferation of green filamentous algae (*Cladophora* spp., *Enteromorpha* spp.) or foliaceous algae (*Ulva* spp., *Monostroma* spp.) with a proliferation of bacteria and the phenomenon of anoxia (red tides), resulting in a high mortality of the benthic and pelagic species in these areas.

This habitat presents a big spatial diversity of environmental conditions, with several aspects or facies more often than not linked to an epiflora or epifauna species, some of which may be temporary (see point 10).
The term lagoon thus covers very diverse situations linked to the variability of salt water and fresh water additions, both on the tidal sea coasts and in the Mediterranean. Some lagoons are natural, lying in littoral depressions, periodically fed by the sea, and others are former marshes that have been developed by man over very long periods (salterns, euryhaline fish reservoirs, fish-farming basins…). Confronted with the heterogeneity of these physical conditions, there is a great variability of fauna groupings, which are characterised by low specific richness and vast populations of dominant species, being rapidly replaced and widely used by the upper links of the ecosystem.
In all cases, the resident populations can only muster a small number of species that are strongly dominant in number and weight. These are species that are able to withstand violent variations in environmental conditions, among which salinity is only one example. Sudden influxes of salt water and drying up in the summer create recurrent disturbances that sometimes cause populations to disappear. In this case, recolonisation will always be very rapid.

3 – Main recognition criteria

Stretches of fine sand, muddy sand and mud in relatively closed off areas up to a few metres deep.

4 – Characteristic species

Marine phanerogams: *Ruppia cirrhosa, R. maritima, Potamogetum pectinatus, Zostera marina, Z. noltii*
Polychaete annelids*: Hedistes diversicolor, Neanthes succinea*
Bivalve molluscs: *Cerastoderma glaucum, Cardium lamarcki, Abra ovata, Scrobicularia plana, Loripes lacteus, Gastrana fragilis, Tapes* spp*., Ostrea edulis;* gastropod molluscs*: Rissoa* spp*., Nassarius (=Nassa) reticulata, Cyclope (=Cyclonassa) neritea*
Amphipod crustaceans*: Gammarus locusta, Microdeutopus* sp*.;* isopod crustaceans*: Sphaeroma hookeri, Cyathura carinata, Idotea viridis;* decapod crustacean*: Carcinus mediterraneus.*

5 – Associated habitats or those in contact

Contact with muddy sands and lagoon and estuary muds (II.1.1) evolving towards the marine environment.

6 – Possible confusion

The muddy sands in sheltered waters (III.2.3) may sometimes be confused with the muddy sands and lagoon and estuary muds (II:1.1) and with the euryhaline and eurythermal lagoon biocenosis (III.1.1), but in the first case, the habitat is subjected to more regular salinity conditions, and in the second case, the topographical situation makes confusion difficult because this is at another level.

7 – Conservation interest

An environment that feeds native birds and also migrator birds which are stopping over. For fishes, these are nursery areas with seasonal colonisation of young fish and juveniles, apart from resident populations. For birds, these are exceptional sites, stopovers in migration or nesting and feeding areas.

The high productivity of some of these environments favours the development of species that are marketable and therefore widely fished (molluscs and fishes). Environments very favourable to shellfish farming.

8 – Ongoing trends and potential threats

-Disappearance of the habitat because of filling in of surfaces.
-Accumulation of detritus and pollutants (agricultural, urban and industrial) due to the poor level of water replacement and the high sedimentation. The situation may be worsened by graus not being kept up.
-Intensifying of shellfish farming in certain sensitive areas leading to greater risk of eutrophication. But there is a current trend of declining eutrophication in the Mediterranean ponds due to improved purification of effluents.
-A new threat has appeared when these confined environments, the ponds, are used for pond culture. This involves the deliberate or accidental introduction of exotic species, the proliferation of which can transform the environment, lower the biodiversity through occupying the ecological niches and exclude native species.
-Increased urbanization and the use of ponds as leisure bases for water sports, which increases the anthropic pressure in the shape of waste water discharge and various constructions.
The lagoons, environments which are naturally eutrophic, are suffering increasingly from dystrophic crises. These may affect the first links in the pelagic chain (toxic efflorescences) and also the development of macrophytes (green algae). Crises of anoxia then bring about the mortality of the benthos and of the young fishes, the food base for predators like birds.

9 – Conservation status and management

Like all wetlands, the lagoons are subject to heavy anthropic, fish farming, agricultural, tourist and urban etc. pressure.
At the same time, lagoons which used formerly to be developed and confined now suffer from the gradual abandonment of maintenance work, with a modification of the watercourses. According to the types of management and the degree to which they intervene, various scenarios can be made out of ecological successions, with more often than not a development of schorre plants or of paludal vegetation. The functioning of these lagoons thus depends on how far the watercourses are kept up, even maintained. Many lagoon sites are developed as oyster beds (fattening and greening of oysters) and as fish farming basins (molluscs, crustaceans, peneids, fishes…). Others have become ornithological reserves. For the whole package of these sometimes contradictory activities, improved complementarity between them

should be sought, case by case.
The areas in question must be assured a protective type of management, and one that refuses any development that involves filling in. Possible hydraulic modifications can only be made in order to intermingle the waters in areas sensitive to eutrophication.
Shellfish farming areas must be as far away as possible from sensitive sectors, which themselves must receive less effluent (this will be discharged into sectors where the waters are better intermingled).
Monitoring the quality of the water, particularly its physicochemical quality (pollutants and sediment), should be recommended in these areas of great sedimentation and risk of eutrophication.
It is vital to monitor the rates of flow of the watercourses that feed the ponds to guarantee that the water is renewed and the bottoms oxygenated.
It is equally vital to monitor species imported for breeding, to reduce the risk of introducing invasive species.

10 – Facies and associations

-Association with *Ruppia cirrhosa* and/or *Ruppia maritima* epiflora (III.1.1.1.)
-Association with *Pomatogeton pectinatus* (III.1.1.3.)
-Association with *Zostera noltii* in euryhaline and eurythermal environment (III.1.1.4.)
-Association with *Zostera marina* in euryhaline and eurythermal environment (III.1.1.5.)
-Association with *Halopitys incurva* (III.1.8.)
-Facies with *Ficopomatus (=Mercierella) enigmatica* (III.1.1.2.), a sedentary polychaete which can constitute veritable reefs in certain warm littoral ponds. This species, introduced into the French coasts, may experience extremely great temporary developments (colonising several hectares) and then disappear.

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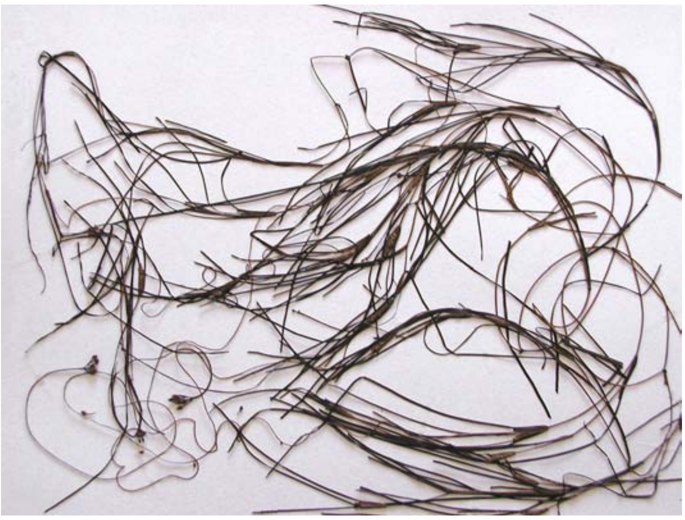
III.1.1.1. Association with Ruppia cirrhosa and/or Ruppia maritima



Association with Ruppia cirrhosa and/or Ruppia maritima

Reference code for identification:
RAC/SPA: III.1.1.1

Euryhaline and eurythermal lagoon biocenosis
III.1.1

1 – Location

This association is found in marshes, ponds and lagoons of very variable salinity in time and place, possibly in estuaries. The salinity varies between a few grams per litre and 35 g/l.

2 – Description

Ruppia are phanerogams which live submerged on sandy or muddy bottoms. This genus is cosmopolitan and the *Ruppia cirrhosa* and *Ruppia maritima* species are present throughout Europe and the Mediterranean.
Ruppia maritima is more frequent in temporary peripheral environments, in shallow water presenting low salinity (basically from 5 to 20 g/l, never more than 30 g/l). It is accompanied by *Zannichellia palustris* and *Chara aspera*. In areas with the highest salinity*, R. maritima* is accompanied by *Althenia filiformis* and *R. cirrhosa* appears. The fauna has affinities with freshwater fauna, and is dominated by insects (Heteroptera, Odonata, Diptera).
Ruppia cirrhosa is found in permanent or semi-permanent (short drying up) environments, subject to conditions of variable salinity, basically between 5 and 35 g/l, but withstanding oversalty environments. According to the salinity, *R. cirrhosa* may be accompanied by *R. maritima, Potamogeton pectinatus* and/or *Zostera noltii* (and *Cymodocea nodosa*). The accompanying fauna is that of the euryhaline and eurythermal brackish environments.

3 – Main recognition criteria

Presence of *Ruppia cirrhosa* and/or *Ruppia maritima.*

4 – Possible confusion

The only possible confusion is linked to the greater or lesser abundance of *Zostera* and *Potamogeton.*

5 – Conservation interest

Ruppia populations offer a major source of food for birds, spawning grounds for fishes, shelter for young fishes and support for many invertebrates.

6 – Ongoing trends, vulnerability and potential threats

This association has the same vulnerability and threats as the biocenosis to which it belongs, particularly filling in of land and urbanization activities.

7 – Conservation status and management

Monitoring the quality of the water and the direct or indirect addition of pollutants and solid matter.

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III.1.1.3. Association with Potamogeton pectinatus

Association with Potamogeton pectinatus

Reference code for identification:
RAC/SPA: III.1.1.3

Euryhaline and enrythermal lagoon biocenosis
III.1.1.

1 – Location

The *Pomatogeton pectinatus* species is present in shallow lagoons. Its rhizomes go deep down into the soil, which gives the plant great resistance to hydrodynamics, in periods of drought and frost.

2 – Description

The association develops in shallow, low salinity (0 to 10 g/l) water on beds that are rich in organic matter.

3 – Main recognition criteria

Presence of *Potamogeton pectinatis*.

4 – Possible confusion

None, except when colonisation by the *Ruppia*s tends to become dominant.

5 – Conservation interest

The stems, leaves and seeds of *Potamogeton* are eaten by ducks as they winter. This is a spawning and development area for young fishes.

6 – Ongoing trends, vulnerability and potential threats

The vulnerability of and threats to this association are the same as for the biocenosis to which it belongs, particularly filling in and urbanisation activities.

7 – Conservation status and management

Monitoring the quality of the water and the direct or indirect addition of pollutants and solid matter.

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III.1.1.4. Association with Zostera noltii in a euryhaline and eurythermal environment

Association with Zostera noltii in a euryhaline and eurythermal environment

Reference code:
RAC/SPA: III.1.1.4

Euryhaline and eurythermal biocenosis III.1.1

1 – Location

Present throughout the Mediterranean, particularly in the western Mediterranean and the Adriatic, in water whose salinity is between 20 and 25 g/l. *Zostera noltii* can also be present in water whose salinity is less than 20 g/l.

2 – Description

The association with *Zostera noltii* develops in lagoons that are subject to wide ranges of salinity, on varied loose substrata, from sand to mud, either at the entrances to the lagoons (graus) or even within the lagoons, where it develops monospecific phanerogam populations. It withstands a certain amount of hydrodynamics but is very sensitive to eutrophication, turbidity and pollution of the water. Given its wide potential, it constitutes the epiflora of various habitats. In the case of this association of the euryhaline and eurythermal lagoon biocenosis, the fauna is rich and is made up of brackish water species of the biocenosis to which it belongs with some addition of marine water species.

3 – Main recognition criteria

Presence of *Zostera noltii* in a lagoon environment.

4 – Possible confusion

With the related species *Zostera marina*, with which it may constitute mixed populations. It is also possible to confuse it with the association with *Zostera noltii* on superficial muddy sands in sheltered waters in an open environment (III.2.3.5.).

5 – Conservation interest

A protected marine species on the French coasts. It contributes relatively little to feeding birds, but acts as a refugee for a diversified aquatic fauna. The vulnerability of and threats to this association are the same as for the biocenosis to which it belongs, particularly filling in and urbanisation activities.

6 – Conservation status and management

Monitoring the quality of the water and the direct or indirect addition of pollutants and solid matter.

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III.1.1.5. Association with Zostera marina in a euryhaline and eurythermal environment

Association with Zostera marina in a euryhaline and eurythermal environment

Reference code for identification:
RAC/SPA III.1.1.5

Euryhaline and eurythermal lagoon biocenosis
III.1.1

1 – Location

Present throughout the Mediterranean, particularly in the western Mediterranean and the Adriatic. The stations are localized in water whose salinity is close to that of the sea, between 20 and 40 g/l, but can also be present in water whose salinity is less than 20 g/l.

2 – Description

The association with *Zostera marina* develops in lagoons that are subject to wide ranges of salinity, on varied loose substrata, from sand to mud, near the entrances to lagoons (graus), even inside the lagoons, where it develops remarkably at greater depths than *Z. noltii*, in 'marinized' lagoons and, more rarely, in the open sea, in sheltered stations. It withstands a certain amount of hydrodynamics but is very sensitive to eutrophication, turbidity and pollution of the water. The fauna is rich and is made up of brackish water species of the biocenosis to which it belongs, with sizeable additions of sea water species.

3 – Main recognition criteria

Presence of the *Zostera marina* aquatic phanerogam.

4 – Possible confusion

With the related species *Zostera noltii*, with which it may constitute mixed populations, but its leaves are larger.

5 – Conservation interest

A marine species that is protected by international conventions (Barcelona, Berne, the Habitats Directive). It contributes relatively little to feeding birds, but acts as a refuge for a diversified aquatic fauna. The vulnerability of and threats to this association are the same as for the biocenosis to which it belongs, particularly filling in and urbanisation activities.

6 – Conservation status and management

Monitoring the quality of the water and the direct or indirect addition of pollutants and solid matter.

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III.1.1.8. Association with Halopitys incurva

Association with Halopitys incurva (Halopitys incurvus)

Reference code for identification:
RAC/SPA: III.1.1.8

Euryhaline and eurythermal lagoon biocenosis
III.1.1

1 – Location

The association with *Halopitys incurva* is present in the shape of 'rafts' that drift more or less at random close to the bed, in thermophilous lagoons with accentuated marine character.

2 – Description

The association with *Halopitys incurva* is present in the most marine sectors of Mediterranean lagoons. The salinity there is identical or close to that of the open sea, the differences in termperature are strictly seasonal, the oxygenation of the environment is normal, the concentrations of organic matter and pollutants in the water are low, and depth is of the order of 3 to 5 metres or more, according to the clearness of the water.
The main plant species belong to the Rhodophyceae: *Halopitys incurva, Rythiphloeia tinctoria* and *Alsidium corallium. H. incurvus* is more common in the Etang de Thau (southern coasts of France) and *Rythiphloeia tinctoria* in the Stagnone de Marsala (western Sicily, Italy).
The fauna, especially studied in Sicily, is typically that of the fronds of algae of the upper part of the infralittoral stage: Polychaete annelids *Syllis* spp., *Perinereis cultrifera, Platynereis dumerilii*; the mollusc *Nodolus contortus*; the amphipod crustaceans *Elasmospus pocillimanus, Maera inaequipes, Lysiannassa longicornis*, and the tanaidaceans *Leptochaelia guttatus, L. savignii, Apseudes latreilli* and *Parapseudes latifrons.*

3 – Main recognition criteria

Presence of rafts of *Halopitys incurva, Rythiphloeia tinctoria.*

4 – Possible confusion

The association with *Halopitys incurva* present in Mediterranean littoral ponds and lagoons should on no account be confused with the association with *Halopitys incurva* (according to Boudouresque, 1971, a sub-association of the association with *Cystoseira crinitae* belonging to the biocenosis of photophilous algae) which forms locally, in the open sea, on a solid substratum, very dense populations which exclude most other big algae.

5 – Conservation interest

A type of association that is fairly rarely met with, but which prospers in certain lagoons where it shelters sizeable populations of invertebrates which reproduce there, and fishes which use it for food.

6 – Ongoing trends, vulnerability and potential threats

An association that is sensitive to variations in water salinity and oxygenation, and to additions of pollutants and fine matter, it requires good circulation of water between the lagoon and the open sea and cannot withstand the closing of the 'graus'.

7 – Conservation status and management

Monitoring the quality of the water and the direct or indirect addition of pollutants and solid matter.

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Compiled by: D. BELLAN-SANTINI, G. BELLAN and J. G. HARMELIN

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III.2. FINE SANDS WITH MORE OR LESS MUD

III.2.2. Biocenosis of well sorted fine sands

Biocenosis of well sorted fine sands (WSFS)

Reference codes for identification:
RAC/SPA: III.2.2
EUR 15: 1110-6
CORINE: 11.22

1 – Location of the biocenosis

Stage	Infralittoral
Nature of substratum	Sand
Bathymetrical distribution	2 to 25 metres
Position	Open sea
Hydrodynamics	Average
Salinity	Normal, able to withstand slight lack of salt
Temperature	Normal

2 – Description of the biocenosis

Stretches of fine sands continuing at greater depth the biocenosis of fine sands at high level (III.2.1); the sediment is usually of homogeneous granulometry and terrigenous origin. The biocenosis begins at around 2-2.5 metres and may reach a depth of 25 metres; sometimes it occupies vast areas along the coasts or in wide bays.
Locally, the biocenosis of well sorted fine sands tolerates a slight lack of saltiness in the water near estuaries and surrounding some Mediterranean ponds. It thus presents a certain impoverishment, offset by the presence of some euryhaline species. When the wave action is too strong, the biocenosis can also be impoverished. Locally, the *Cymodocea nodosa* phanerogam can colonise certain areas, where it will constitute a local facies with epiflora. The fairly localized presence of some species (*Caulerpa prolifera, Halophila stipulacea*…) also determines the forming of local facies.

3 – Main recognition criteria

Stretches of fine sand at depths of between 2 and 25 metres that can present facies with epiflora.

4 – Characteristic/indicator species

Polychaete annelids: *Sigalion mathildae, Onuphis eremita, Exogone hebes, Diopatra neapolitana*
Bivalve molluscs*: Acanthocardia tuberculata (=Cardium tuberculatum), Mactra corallina (=stultorum), Tellina fabula, T. nitida, T. pulchella, Donax venustus*
Gastropod molluscs: *Acteon tornatilis, Nassarius (=Nassa) mutabilis, Nassarius pygmaea, Neverita josephinia*
Decapod crustaceans: *Macropipus barbatus*; amphipod crustaceans: *Ampelisca brevicornis, Hippomedon massiliensis, Pariambus typicus*; the isopod crustacean: *Idothea linearis*
Echinoderms: *Astropecten* spp., *Echinocardium cordatum*
Fishes: *Gobius microps, Callionymus belenus.*

5 – Associated habitats or those in contact

Above are the high level fine sands (III.2.1); the *Posidonia* meadow (III.5.1) is sometimes in contact, and often present as isolated tufts on the sand.

6 – Possible confusion

Confusion can only be altitudinal; the transition from the fine sands in very shallow waters (III.2.1) to the well sorted fine sands (III.2.2) is not clear and often constitutes an area where there is mixing, particularly during hydrodynamic episodes with sharp contrasts (whether a high degree of hydrodynamics or prolonged calm).

7 – Conservation interest

An area which has its part in maintaining the balance of the beaches; its being trimmed when the undertow is formed endangers the middle and high beaches, and its consolidation strengthens these.
Feeding area for flat fish.

8 – Ongoing trends and potential threats

Areas subject to additions and to sedimentation of fine particles from watercourses or from anthropic waste. The hydrodynamics are usually not strong enough to prevent this sedimentation.

9 – Conservation status and management

The habitat is directly subject to anthropic activity on the littoral: pollution emissions, turbid water, badly done development. It is also necessary to make sure that the traditional fishing carried on there is well managed. Bottom trawling, which may be a fishing practice in this habitat, must be regulated in this habitat.

10 – Facies and associations

-Association with *Cymodocea nodosa* (III.2.2.1.)
-Association with *Halophila stipulacea* (III.2.2.2.)

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Compiled by: D. BELLAN-SANTINI, G. BELLAN and J. G. HARMELIN

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III.2.2. Association with Halophila stipulacea

Association with Halophila stipulacea

Reference code for identification:
RAC/SPA: III.2.2.2

Biocenosis of well sorted fine sands (III.2.2)

1 – Location

An association corresponding to the development as an epiflora of the *Halophila stipulacea* (Forsskål) Ascherson phanerogam species on sandy beds that are fairly much enriched with fine particles. The species has been sighted in the eastern Mediterranean (up to 50 metres down) and, more recently, on the coasts of Albania and Sicily, where it has been sighted up to 30 metres down. A species that is originally from the Indian Ocean.

2 – Description

Its phytosociological name: the Giaccone 1968 association with *Halophiletum stipulaceae*. It can be associated with *Cymodocea nodosa, Caulerpa prolifera* an*d Caulerpa racemosa.* The epiphytic flora has been described; it is very typical of the phanerogams, by and large fairly poor, probably related to the fairly frequent renewal of its leaves. The fauna is probably made up of species met with among the photophilous algae, found in most phanerogam meadows. The sediment fauna is the same as that of the biocenosis of well sorted fine sands.

3 – Main recognition criteria

A phanerogam with flattened, pedunculated, slightly dentated leaves that are 3 to 6 cm. long, fasciculated in three. The foliar tufts are about 2.6 cm. high, and there are several thousands per square metre. A robust rhizome, creeping, with internodes of about 1.7 cm., and single, not branched, roots. It constitutes meadows on the sand, sometimes at the edge of a *Posidonia oceanica* meadow.

4 – Possible confusion

A species that is hard to confuse with other phanerogams.

5 – Conservation interest

Identical to that of the biocenosis of well sorted fine sands, even greater in that this is a migrant, non-invasive, species.

6 – Ongoing trends, vulerability and potential threats

In Sicily, the species has been found mixed with *Caulerpa racemosa*. The threats are those of sedimentary shallow beds that can be subject to heavy anthropic pressure.

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Crédit photographique : J. G. HARMELIN

III.2.3. Biocenosis of superficial muddy sands in sheltered waters

Biocenosis of muddy sands in sheltered waters (MSSW)

Reference codes for identification:
RAC/SPA: III.2.3
EUR 15: 1160
CORINE: 1122

1 – Location of the biocenosis

Stage	Infralittoral
Nature of substratum	Muddy sand
Bathymetrical distribution	1-3 metres
Position	Open sea
Hydrodynamics	Weak
Salinity	Normal, slight lack of salt possible
Temperature	Normal

2 – Description of the biocenosis

A habitat located in protected coves, in a sheltered environment, where fine sedimentation can happen that gives a muddy-sandy sediment sometimes mixed with a small amount of gravels. Its depth is more often than not around 1 metre, rarely more than 3 metres. These shallow areas receive very variable environmental conditions and may present facies with epiflora or major developments of filtering or burrowing species.

These variations in the environment are linked to fairly strong sedimentation conditions, to climatic conditions, with very great differences in temperature between winter and summer and even during the same day, to the possibility of rainwater runoff or ground water seepage, and to anthropic action.

3 – Main recognition criteria

Quality of sediment, sheltered area, shallow.

4 – Characteristic/indicator species

Polychaete annelids: *Phyloaricia foetida, Paradoneis lyra, Heteromastus filicornis*
Bivalve molluscs*: Loripes lacteus, Paphia (=Tapes) aurea, Tapes decussatus*
Gastropod molluscs: *Cerithium vulgatum, C. rupestre*
Decapod crustaceans: *Upogebia pusilla, Clibanarius misanthropus, Carcinus*

mediterraneus
Sipunculid: *Golfingia vulgare.*

5 – Associated habitats or those in contact

Contact with the fine sands in very shallow waters (III.2.1) and the well sorted fine sands (III.2.2) in areas where the hydrodynamics are variable in space: bays that are partially sheltered by natural or artificial protection.
Contact with the euryhaline and eurythermal lagoon biocenosis (III.1.1) when there is desalination.
Finally, the presence of this habitat can be seen behind a *Posidonia* barrier reef (III.5.1), a scenario that now only exists very rarely in certain countries.

6 – Possible confusion

The muddy sands in sheltered waters can sometimes be confused with the lagoon and estuary muddy sands and muds (II.1.1) and with the euryhaline and eurythermal lagoon biocenosis (III.1.1), but in both cases the habitats are present in markedly more desalinated environments. Confusion is only possible in rare geomorphological situations: the entrance of a lagoon and a watercourse emptying into a shallow bay.

7 – Conservation interest

An environment where birds can feed. Certain facies are exploited either for molluscs (*Paphia aurea =Tapes aureus*), whose market value for consumption is great, or for fishing bait *(Upogebia, Marphysa, Arenicola, Perinereis cultrifera*, etc.).
Always a very productive environment, mainly because of very intense phytoplanktonic and microphytobenthic developments. The productive capacity is often exploited by humans (fishing for clams and cockles, or collecting bait).

8 – Ongoing trends and potential threats

The disappearance of the habitat because the area is filled in.
Intense fishing for molluscs or bait (*Upogebia, Marphysa, Arenicola, Perinereis*), causing anarchic modification of the sedimentary bed.
Accumulation of detritus and pollutants because the water is insufficiently renewed and because of strong sedimentation at certain periods and in certain sectors.
Increased eutrophication by using sites for shellfish farming (*Mytilus galloprovincialis*).
Destruction of the habitat by eliminating the natural or artifical barriers to facilitate the movement of water or of boats.

9 – Conservation status and management

The areas must be given protective management with a refusal of any development that involves filling in or hydraulic modification. In the Mediterranean, the facies with *Cymodocea nodosa, Caulerpa prolifera* and *Zostera noltii* enjoy legal status and an array of legal devices that protect all marine phanerogams.

Monitoring the quality of the water, particularly its physicochemical quality (pollutants able to become attached to the sediments that afterwards remain undisturbed because of the weak hydrodynamics) is to be recommended in these heavy-sedimentation areas.
The cleaning up of waste washed up by the sea or coming from the land is to be done with care in order not to destroy the biotope.

10 – Facies and associations

Variations in the environment result in the development of a set of facies, the most important of which are:

-Facies of epiflora with *Cymodocea nodosa* when the water is actively renewed and there is no trace of desalination (III.2.3.4.)
-Facies of epiflora with *Caulerpa prolifera* in the warmest areas (III.2.3.6)
-Facies of epiflora with *Zostera noltii* when sedimentation is very active and when there are traces of desalination (III.2.3.5.)
-Facies with *Upogebia pusilla* in areas without epiflora and where the soil is compacted at depth, allowing crustaceans to tunnel
-Facies with *Paphia (=Tapes) aurea*, located mainly in channels and ponds, with a marked addition of organic matter
*-Facies with *Loripes lateus, Tapes* spp. (III.2.3.3.)
-Facies with melobesies in balls.

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III.2.3.3. Facies with Loripes lacteus, Tapes spp.

Facies with Loripes lacteus, Tapes spp.

Reference code for identification:
RAC/SPA: III.2.3.3

Biocenosis of muddy sands in sheltered waters (MSSW)
III.2.3

1 – Location

Sandy-muddy beds protected from the waves

2 – Description

Greater development of several bivalve mollusc species: *Loripes lacteus, Tapes decussatus, Paphia (=Tapes) aurea*

3 – Main recognition criteria

Relative abundance of the above-mentioned bivalves.

4 – Possible confusion

With the other facies with muddy sands in sheltered waters (III.2.3) or well sorted fine sands (III.2.2).

5 – Conservation interest

The interest lies in the presence of bivalves which can be exploited. A feeding area for juvenile fishes.

6 – Ongoing trends, vulnerability and potential threats

The progressive trend with the anthropisation of the coast is that silting up becomes worse, making bivalve development difficult. Potential threats lie in the exploitation of the bivalves by methods that destroy the habitat.

7 – Conservation status and management

Monitoring that there is sufficient renewal of the water. Managing the anthropisation of these areas, which may undergo filling in or intensive exploitation.

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Crédit photographique : J. G. HARMELIN

III.2.3.5. Association with Zostera noltii on superficial muddy sands in sheltered waters

Association with Zostera noltii

Reference code for identification:
RAC/SPA: III.2.3.5

Biocenosis of muddy sands in sheltered waters (MSSW)
III.2.3

1 – Location

The association with the *Zostera noltii* Magnoliophyta phanerogam on muddy sands in sheltered waters**.**

2 – Description

The *Zostera noltii* Magnolophyta constitutes a bed in areas where there is an active deposit of fine matter. The epifauna of the frondage is poor. The population can tolerate a slight local lack of salt.

3 – Main recognition criteria

The main feature for recognition is the presence of beds of the *Zostera noltii* species.

4 – Possible confusion

Not to be confused with the *Cymodocea nodosa* bed (III.2.3.4), which constitutes a different association of the same biocenosis in more open, less muddy environments, and with *Zostera noltii* (III.1.1.4) and *Zostera marina* beds (III.1.1.5) associated with the euryhaline and eurythermal biocenosis in a markedly desalinated environment, which are accompanied by a different set of endogean species (*Scrobicularia plana, Hediste diversicolor, Gammarus insensibilis*).

5 – Conservation interest

A fragile environment, part of the wetlands that are important for feeding birds. An environment representing an important nursery area, especially for *Sparus aurata.*

6 – Ongoing trends, vulnerability and potential threats

An environment that is vulnerable to becoming very muddy and is subject to heavy anthropic pressure, even to the point of drying out.

7 – Conservation status and management

Keeping the water moving sufficiently. Monitoring the quality of the water and of the presence of detritus in the concerned areas.

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III.2.3.7. Facies of hydrothermal oozes with Cyclope neritea and nematodes

Facies of hydrothermal oozes with Cyclope neritea and nematodes

Reference code for identification:
RAC/SPA: III.2.3.7

Biocenosis of muddy sands in sheltered waters (MSSW)
III.2.3

1 – Location

Areas of fine sands between 3 and 15 metres deep with great hydrothermal activity resulting in a very specific environment at sediment level: the temperature can vary between 15°C at the surface and over 80°C 30 cm. under the surface of the sediment; the salinity recorded can go from 40psu to 58psu 5 cm. down. There are also strong concentrations of hydrogen sulphide and a pH of between 6 and 7.6. The sediment is extremely sparse and mattes of bacteria may be present. These areas are surrounded by *Cymodocea nodosa* beds, the detritus from which enriches the hydrothermal areas with organic matter.

2 – Description

The facies is characterized by hydrothermal springs, which constitute a very special environment: greatly reduced sediment, poor macrofauna, and meiofauna dominated by a rich community of nematodes.

3 – Main recognition criteria

A great wealth of nematode meiofauna dominated by the *Oncholaimus campylocercoides* species. The macrofauna is especially marked by the abundance of the *Cyclope neritea* gastropod.

4 – Possible confusion

Little confusion is possible because of the really special hydrothermal conditions. A narrow transitional area exists between the hydrothermal areas and those where an association with *Cymodocea nodosa* (III.2.3.4) lives.

5 – Conservation interest

The great originality of these areas, only two examples of which are known today (Greece: Milos and Italy: Naples) and which could be similar to the deep hydrothermal springs. The meiofauna deserves to be studied in greater detail, as does the bacterial community.

6 – Progressive trends, vulnerability and potential threats

Areas subject to the anthropic pressure of the very shallow waters; there is a temptation to see them as local sources of harm and wish to destroy them.

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III.3. COARSE SANDS WITH MORE OR LESS MUD

III.3.1. Biocenosis of coarse sands and fine gravels mixed by the waves

Biocenosis of coarse sands and fine gravels mixed by the waves

Reference codes for identification:
RAC/SPA: III.3.1
EUR 15: 1110
CORINE: 1123

1 – Location of the biocenosis

Stage	Infralittoral
Nature of substratum	Coarse sand and gravels
Bathymetrical distribution	Under 1 metre
Position	Open sea
Hydrodynamics	Very strong
Salinity	Normal
Temperature	Normal

2 – Description of the biocenosis

This habitat is found in coves which cut into the rocky coasts with more or less strong wave action; it goes no more than a few decimetres down. This habitat is very ill known. The population is dominated by the *Saccocirrus papillocercus* archiannelid and the *Lineus lacteus* nemerte, whose populations fluctuate strongly according to variations in the ambient factors, in particular the local hydrodynamics.

3 – Main recognition criteria

Beaches with coarse sand and gravels in small wave-beaten coves.

4 – Characteristic/indicator species

Archiannelid: *Saccocirrus papillocercus*
Nemertea: *Lineus lacteus*
Three nemertes of the *Cephalothrix* genus have been sighted.

5 – Associated habitats or those in contact

The habitats in contact with this habitat are the populated rocky substrata (III.6.1) of the biocenosis of photophilous algae, and the mediolittoral and infralittoral rock (II.3.1 and III.4.1).

6 – Possible confusion

Confusion with another habitat seems difficult because of its location and low altitudinal size, the quality of its sediment, made up of coarse sands and fine gravels that is practically devoid of fine parts, and the two characteristic species which seem to be quite infeodated to it.

7 – Conservation interest

A rare habitat, interesting for the species which characterize it and the very special conditions found there.

8 – Ongoing trends and potential threats

Since this is a habitat that cannot withstand the slightest degree of muddiness, the quality of the water, particularly its load of fine particles, is of great importance. The summer presence of bathers may contribute to the deterioration of this habitat.

9 – Conservation status and management

Given the hydrodynamic conditions pertaining to this habitat, and its small area, it is not very vulnerable to natural degradation. It can, nevertheless, suffer some damage from the accumulation of detritus and pollution by hydrocarbons. Measures applied for the sustainable management of the littoral seem to be sufficient.

10 – Facies and associations

-Association with rhodolithes.

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III.3.1.1. Association with rhodolithes

Association with rhodolithes

Reference code for identification:
RAC/SPA: III.3.1.1/3.2.2

Biocenosis of coarse sands and fine gravels mixed by the waves (III.3.1.) and under the influence of bottom currents (III.3.2.)

1 – Location

Beds of coarse sand and fine gravels subject to strong hydrodynamics, either by the action of the waves (biocenosis III.3.1.) or by that of currents (biocenosis III.3.2.). This association is thus not associated with one single biocenosis.

2 – Description

Presence of 'balls' of Corallinaceae. Balls of unattached calcareous algae attach themselves to a small mineral or organic surface and then grow in successive layers to form balls (rhodolithes) of more or less nodulous shape and varying size.

3 – Main recognition critera

Presence of rhodolithes on a coarse sediment bed.

4 – Possible confusion

No confusion is possible, including between the two types of association, because of the very different situation and fauna of the two biocenoses.

5 – Conservation interest

Rare beds. These populations are of great quality as geological markers of local conditions and levels.

6 – Conservation status and management

Monitoring the quality of the water, since the algae are extremely sensitive to particle concentrations.

7 – Bibliographical references

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III.3.2. Biocenosis of coarse sands and fine gravels under the influence of bottom currents (also found in the circalittoral)

Biocenosis of coarse sands and fine gravels under the influence of bottom currents (CSFG) (sands with Amphioxus)

Reference codes for identification:
- RAC/SPA: III.3.2
- EUR 15 1110
- CORINE 1122

1 – Location of the biocenosis

Stage	Infralittoral
Nature of substratum	Coarse sands and fine gravels
Bathymetrical distribution	3-25 metres, exceptionally down to 70 metres
Position	Open sea
Hydrodynamics	Strong, frequent unidirectional currents
Salinity	Normal
Temperature	Normal

2 – Description of the biocenosis

This habitat is usually found in the Mediterranean between 3-4 metres and 20-25 metres down, but can, locally, go down to 70 metres. It lies thus on two, infra- and circalittoral, stages. It is frequent in channels between islands that are subject to frequent, violent currents, which constitute the main factor on which its existence depends. It is also found in the 'intermatte' channels dug out by the currents in the *Posidonia* meadows. This habitat, strictly subject to bottom currents, can change if the movement of the water is artificially or naturally modified, for example during long periods of calm weather. Its extension downwards, into the circalittoral stage, is linked to particularly intense hydrodynamic phenomena, either directly below rocky shelf-edge banks (the Banc des Blauquières) or in straits (the Bouches de Bonifacio). It may, in these conditions, present qualititative and quantitative modifications in its habitual population. Seasonal variations are marked by differences in the abundance, and the replacement, of species.

3 – Main recognition criteria

A habitat made up of coarse sands and fine gravels, of partially organogenous origin, practically devoid of fine parts and subject to powerful linear currents, which occur in particular areas, channels and straits.

4 – Characteristic/indicator species

Polychaete annelids: *Sigalion squamatum, Armandia polyophthalma, Euthalanessa occulta (=Dendrolepis)*
Bivalve molluscs: *Venus casina, Glycimeris glycimeris, Laevicardium crassum, Donax variegatus, Dosinia exoleta*
Echinoderms: *Ophiopsila annulosa, Spatangus purpureus*
Crustaceans: *Cirolana gallica, Anapagurus breviaculeatus, Thia polita*
Cephalochorde: *Amphioxus lanceolatum.*

5 – Associated habitats or those in contact

The habitats in contact with the coarse sands and fine gravels under the influence of bottom currents can be the *Posidonia* meadow (III.5.1), the biocenosis then being able to occupy the intermatte channels, or the populated hard substrata of the biocenosis of photophilous algae (III.6.1) or the Coralligenous biocenosis (IV.3.1). At depth, contact with the circalittoral biocenosis of the coastal detritic bottom (IV.2.2) and, particularly, its facies with maerl (IV.2.2.2). A mixture of these two biocenoses can then result.

6 – Possible confusion

Confusion with another habitat seems difficult because of its location and depth, in the channels, the quality of its sediment, made up of coarse sands and fine gravels practically devoid of fine parts, and its very specific fauna. When it occurs at depth, because of exceptional hydrological conditions, the mixture of this biocenosis with the biocenosis of the coastal detritic bottom (IV.2.2) can easily be recognised.

7 – Conservation interest

A habitat with certain heritage value because of the presence of the Amphioxus (*Amphioxus lanceolatum*), which is a rare species in the Mediterranean. This biocenosis, whose sediment presents a very high degree of porosity, is extremely rich in meiofauna and in mesopsammon, ecological groups that are ill known but are very important in feeding other organisms.

8 – Progressive trends and potential threats

A habitat that cannot withstand the slightest degree of muddiness. The quality of the water, and particularly the quantity of suspended matter, are thus extremely important.

9 – Conservation status and management

Given the hydrodynamic conditions prevailing at the level of this habitat, and its generally reduced area, and possibly depth, it is not very vulnerable to particular degradation like that of the extraction of gravel. The general measures applied for the sustainable management of the littoral and the quality of the water seem to be sufficient.

10 – Facies and associations

A facies with maerl (III.3.2.1.) that can also be found as a facies of the biocenosis of the coastal detritic bottom (IV.2.2) in the circalittoral.
An association with rhodolithes which also develops in the biocenosis of coarse sands and fine gravels mixed by the waves (III.3.1), and in the biocenosis of the coastal detritic bottom (IV.2.2.1).

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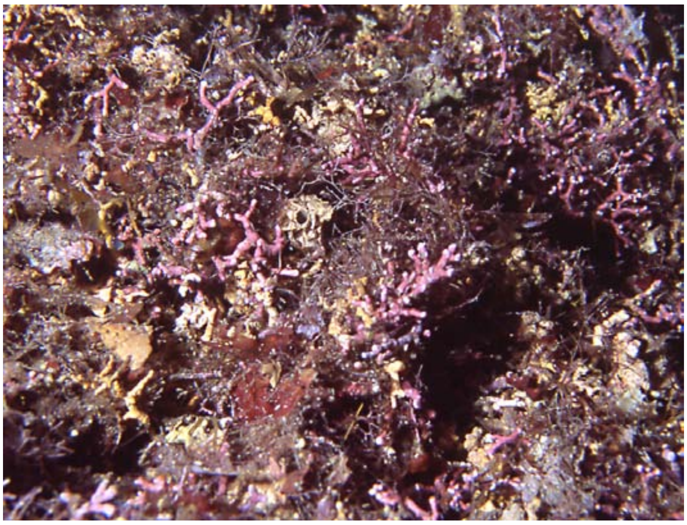
III.3.2.1. Facies with maerl (=Association with Lithothamnion corallioides and Phymatolithon calcareum) (can also be found as a facies of the biocenosis of the coastal detritic bottom)



Facies with maerl *(=Lithothamnion corallioides and Phymatolithon calcareum)* association

Reference code for identification:
RAC/SPA: III.3.2.1/IV.2.2.2

Biocenosis of coarse sands and fine gravels under the influence of bottom currents(SGBC) III.3.2
Biocenosis of the coastal detritic bottom IV.2.2.

1 – Location

On beds of coarse sands and fine gravels mixed with detritic elements, between 25 and 65 metres when the water is clear.

2 – Description

An association characterised by the presence of two small many-branched calcareous algae species, *Lithothamnion corallioides* and *Phymatolithon calcareum*, unattached on sediments made up of coarse sands and gravels with a high proportion of detritic elements. Given their many-branched shape, these Lithothamnia never constitute bioconstructions or rhodolithes. Small Rhodophyceae may be present as epiphytes on the Lithothamnia.

3 – Main recognition criteria

Presence of the two algae, *Lithothamnion corallioides* and *Phymatolithon calcareum.*

4 – Possible confusion

No possible confusion. The only confusion comes when determining which biocenosis it belongs to, which is done by bearing in mind the faunal set that is characteristic to each biocenosis.

5 – Conservation interest

This facies is rare, given the particular conditions of the current and light.
These beds contain a rich and varied fauna.

6 – Ongoing trends

This facies is affected when the concentration of particles in the water is too high, resulting in sedimentation and a reduction of the light, which are conditions that are not favourable to Lithothamnia.

7 – Conservation status and management

These beds are much sought after in the Atlantic as a source of high-quality limestone to enrich soil. Although this harvesting is not widespread in the Mediterranean, it is preferable that the harvest be regulated. Besides, since maerl is extremely sensitive to the quality of the water, this must be monitored.

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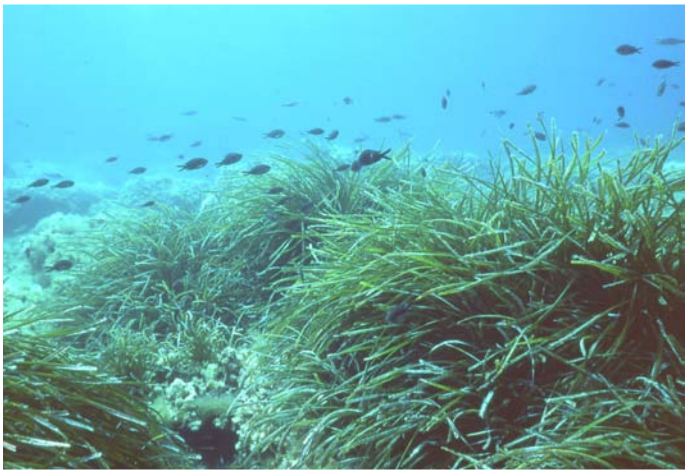
III.3.2.2. Association with rhodolithes

See sheet III.3.1.1. Association with rhodolithes -

See sheet IV.2.2.7., the association with Laminaria rodriguezii on detritic bottom

III.5. POSIDONIA OCEANICA MEADOW

III.5.1. *Posidonia oceanica* meadows (=Association with *Posidonia oceanica*)



Biocenosis of the Posidonia oceanica meadows

Reference codes for identification:
RAC/SPA: III.5.1
EUR 15 1120
CORINE 1134

1 – Location of the biocenosis

Stage	Infralittoral
Nature of substratum	Mixed (coarse sands to muddy), hard (standing rock, mass of fallen rock)
Bathymetrical distribution	0.5 to 40 metres
Position	Open sea, exceptionally in a lagoon environment
Hydrodynamics	Variable
Salinity	Normal (minimum 36 psu) to hyperhaline (43 psu)
Temperature	9 to 29°C

2 – Description of the biocenosis

Posidonia oceanica (Linnaeus) Delile is a marine Magnoliophyta phanerogam, endemic in the Mediterranean. It constitutes characteristic formations called 'meadows' between the surface and 30 to 40 metres down. The structure of this plant allows an epigean part to be seen, corresponding to the foliar fascicles (from 30 to 80 cm. high on average), and an endogean part, a true underwater terrace: the matte. This matte, made up by the intermingling of rhizomes, roots and the sediment which fills in the interstices, specific to the *Posidonia oceanica* meadows, presents a vertical growth that can attain one metre per century. These meadows, veritable underwater prairies, correspond to one of the main Mediterranean climaxes.

3 – Main recognition criteria

The *Posidonia oceanica* meadow represents over one quarter of the photophilous biotopes of the Mediterranean infralittoral. These formations are present on all types of substratum, even if the major meadows develop on a mixed substratum where they constitute mattes several metres thick. Sensitive to the lack of salt, *Posidonia oceanica* disappears at the mouths of rivers, in brackish lagoons and near the Strait of Gibraltar. Even if the number and length of the leaves present a seasonal variation, this species is present all year round.

4 – Characteristic/indicator species

The species associated with the *Posidonia oceanica* meadow can be compartmentalized into three assemblages:

Species living within the thickness of the matte (endofauna): polychaetes *(Mediomastus capensis, Nereis irrorata, Lumbriconereis paradoxa, Pontogenia chrysocoma*), molluscs (*Modiolus phaseolinus, Hiatella arctica, Lima hians, Venus verrucosa*), crustaceans (*Upogebia deltaura, Callianassa minor, Leptochelia*).

Species living at the base of the foliar fascicles (under the sciaphilous strata): algae (*Peyssonnelia, Udotea petiolata*), the foraminifer (*Miniacina miniacea*), echinoderms *(Paracentrotus lividus, Sphaerechinus granularis, Holothuria tubulosa, Echinaster sepositus*), the mollusc (*Pinna nobilis*), and the ascidian (*Halocynthia papillosa*).

Species living at the level of the leaves (phyllosphere): crust-forming calcareous algae (*Hydrolithon, Pneophyllum*), erect algae (*Giraudya*), hydrozoans *(Monotheca posidoniae, Sertularia perpusilla*), bryozoan (*Electra posidoniae*), gastropods (*Rissoa* spp., *Bittium reticulatum*), crustaceans (*Idotea hectica, Achaeus cranchii, Pisa nodipes*), fishes (*Sarpa salpa, Symphodus ocellatus, Symphodus rostratus*).

5 – Associated habitats or those in contact

The *Posidonia oceanica* meadow is usually a continuation at greater depth of the biocenosis of muddy sands in sheltered waters (III.2.3.) or the biocenosis of fine sands in very shallow waters (III.2.1.) and the biocenosis of infralittoral algae (III.6.1.). The matte may be eroded by the hydrodynamics, and the currents then dig out intermatte channels whose population is specific and corresponds to one aspect of the biocenosis of coarse sands and fine gravels under the influence of bottom currents (III.3.2.).

6 – Possible confusion

No possible confusion. The other underwater meadows are made up of a smaller species (*Cymodocea nodosa*), disappearing in winter and not presenting true mattes.

7 – Conservation interest

The *Posidonia oceanica* meadow is considered to be the most important Mediterranean ecosystem, both as regards its extent and the part it plays (i) at ecological level (high primary production partially exported to other ecosystems, oxygenation of the water, biodiversity centre), (ii) at sedimentary level (stabilizing the bottoms and protecting beaches from being eroded), and (iii) at economic level (spawning ground, nurseries, temporary or permanent habitat for many species of commercial interest). It is also an excellent indicator of the overall quality of the natural environment.

8 – Ongoing trends and potential threats

Because of their position at the edge of the littoral, the *Posidonia oceanica* meadows are directly subject to various anthropic activities. Given that this plant grows extremely slowly, destruction is often irreversible on a human scale.
The main decline observed is linked to the development of the littoral (recovery, modification of the currents and of the sedimentary addition, increased turbidity), boating (anchoring), and the exploiting of living resources (trawls, fish farming). A new potential threat has appeared fairly recently due to competition between *Posidonia oceanica* and the introduced species *Caulerpa taxifolia*.

9 – Conservation status and management

The *Posidonia oceanica* meadow comes under a specific legislative framework:
In France (put on the list of protected species by the 19 July 1988 decree; protected biocenosis in the Town Planning Code by the 20 September 1989 decree)
In Spain (Catalan Region in 1991; Valencia Region in 1992)
In Europe (a 1992 'Fauna-Flora-Habitats' Directive Priority Habitat).

Also to be mentioned are the Action Plan for the Conservation of Marine Vegetation in the Mediterranean, adopted in October 1999 by the Contracting Parties to the Barcelona Convention, which provides for the passing of national laws to protect *Posidonia oceanica* and the meadows it forms.

Management of the *Posidonia oceanica* meadow requires the setting up of target management plans for all sensitive areas:

Controlling the quality of the water

Banning recreational mooring and the introduction of facilities in the sites where boats congregate

Banning any trawling over the entire meadow, controlling fishing and restricting fishing to those activities that do not destroy the habitat

Respect for the ban on development over the meadows and the restriction near them

Strong awareness action for people using or visiting the meadow

Setting up meadow monitoring networks.

10 – Facies and associations

The dynamics of the *Posidonia oceanica* meadows are strongly influenced by a whole set of abiotic factors (hydrodynamics, underwater morphology, light, salinity, temperature, nutriments) and biotic factors (competition with other macrophytes, being grazed by herbivorous species, essentially the *Sarpa salpa* fish and the *Paracentrotus lividus* sea urchin). Two structures are particularly interesting:

-the ecomorphosis of 'barrier reef' meadows, formed in the beds of sheltered bays, and

-the ecomorphosis of striped meadows, identified for the first time around the Kerkennah Islands in Tunisia.

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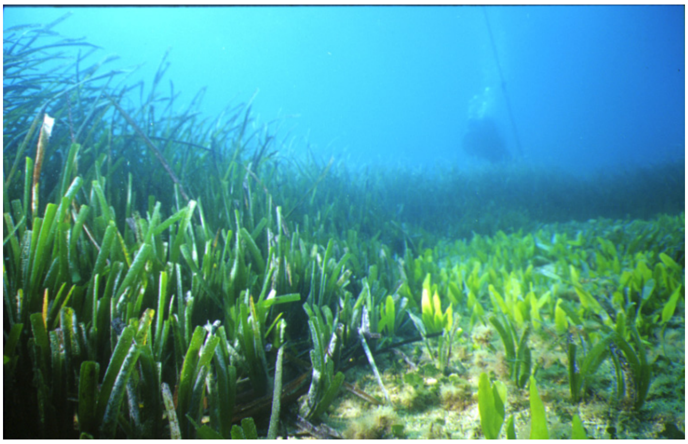
III.5.1.1. Ecomorphosis of striped meadows



Ecomorphosis of striped meadows

Reference code for identification:
RAC/SPA: III.5.1.1

Biocenosis of Posidonia oceanica meadows III.5.1

1 – Location

The striped meadow is particularly well developed in the Gulf of Gabès, near the Kerkennah Islands (Tunisia). It can be found in more localized fashion in Italy (Sicily) and France (Corsica). The micro-atolls often associated with these structures have also been observed in Turkey (the Aegean coast).

2 – Description

The striped *Posidonia oceanica* meadow develops between 0.5 and 3 metres down. It appears as fairly narrow ribbons (1 to 2 metres wide) that can be several dozen metres long, rectilinear or meandering in shape, rarely branched. These ribbons are separated by stretches of dead matte colonised by a mixed bed of *Cymodocea nodosa* and *Caulerpa prolifera*. In a cross-section, these ribbons are asymmetrical, with a little drop of the matte on one side and a gentle slope on the other. These ribbons are dynamic structures, moving parallel to each other against the current, at a speed estimated at about ten centimetres a year.
A meadow structure, often present in the same sectors, is called a *Posidonia* micro-atoll. It develops between 0.5 and 2.5 metres down and appears in the shape of a 3 to 6 metre-diameter crown in the centre of which is the dead matte. These atolls are separated by dead mattes colonised by a mixed meadow of *Cymodocea nodosa* and photophilous algae (*Stypocolon scoparium, Padina pavonica, Caulerpa prolifera*).

3 – Main recognition criteria

The specific structure of these ribbon and crown formations in superficial biotopes, and the presence of dead matte separating these structures.

4 – Possible confusion

No possible confusion.

5 – Conservation interest

This ecomorphosis only appears in very localized sectors; it is thus rare on a Mediterranean scale. Its structure and dynamics are unique, and have not been signalled in other magnoliophyte species.

6 – Ongoing trends

These structures present a dynamic balance the maintenance of which can only be endangered by a change in the currents and/or sedimentation.

7 – Conservation status and management

Because of their location at the edge of the littoral and in very superficial sectors, these structures are particularly sensitive to human impact. The overall degradation of the environment in the Gulf of Gabès (causing a massive dwindling of the *Posidonia* meadows), and the projects for developing the littoral more generally, are likely to cause the disappearance of these absolutely outstanding ecomorphoses. The fact that this ecomorphosis appears in the Gérard Vuignier Red Book of Threatened Mediterranean Marine Plants, Populations and Landscapes confirms these potential threats. Endowing it with specific conservation status appears vital.

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Crédit photographique : G. PERGENT

III.5.1.2. Ecomorphosis of 'barrier reef' meadows

Ecomorphosis of 'barrier reef' meadows

Reference code for identification:
RAC/SPA: III.5.1.2

Biocenosis of Posidonia oceanica meadows
III.5.1

1 – Location

The reefs formed by the *Posidonia oceanica* meadow develop in the beds of sheltered bays. Fewer than twenty of these structures have been inventoried over the last few decades, mainly in the western Mediterranean (Spain, France, Italy, Algeria and Tunisia).

2 – Description

In the beds of sheltered bays, the vertical growth of the rhizomes leads to the rising of the matte, thus enabling the meadow to reach the surface; this structure is called a 'fringing reef'. Between the front where the reef emerges and the coast, conditions become unfavourable (high variations in salinity, in temperature), and the meadow dies, letting a kind of 'lagoon' appear that is cut off from the open sea by a 'barrier reef'. This lagoon is usually occupied by small magnoliophyta (*Cymodocea nodosa* and *Zostera noltii*) that develop on the dead matte. At the level of the barrier reefs, which may be several metres wide, the leaves emerge from the water and spread out on the surface, particularly in spring and summer. The reef continues as a gentle slope out to sea, where it constitutes a meadow with a continuous base. The standard form of these reefs, with a front lying parallel to the shore, is most widespread; however, more extended specific structures (reef platforms) have been sighted in Sicily and Corsica.

3 – Main recognition criteria

The presence of a reef made up of leaves emerging from the water on the surface, cut off from the coast by a shallow lagoon.

4 – Possible confusion

No confusion possible.

5 – Conservation interest

The few structures so far identified, in very localized, little anthropised, sectors, have little in common with the past extent of this ecomorphosis. Today, it is clear that most of the *Posidonia oceanica* barrier reefs have disappeared, while they constitute a unique structure in the biosphere. These structures are also the original cause of the forming of eurythermal and euryhaline biotopes (with the biocenosis belonging to them) that are quite specific (lagoons).

6 – Ongoing trends

In optimum environmental conditions, these structures would extend out to sea; however, given their fragility (sedimentary balance and hydrodynamics) and their location at the edge of the littoral, it is highly unlikely that they will remain if no measure is envisaged.

7 – Conservation status and management

This ecomorphosis has long paid a heavy price for coastal development. Indeed, as sought-after mooring areas, most of the beds of the sheltered bays have inexorably been occupied by ports, covering almost all of the existing barrier reefs. The few reefs still present all present declining dynamics, due to the many attacks made on them (boating, pollution, development). Also included in the Gérard Vuignier Red Book of Threatened Mediterranean Marine Plants, Populations and Landscapes, this 'relict' ecomorphosis must be given specific status or it will disappear forever from the shores of the Mediterranean.

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III.6. HARD BEDS AND ROCKS

III.6.1. Biocenosis of infralittoral algae

Biocenosis of infralittoral algae

Reference codes for identification:
RAC/SPA III.6.1
EUR 15 1170-13
CORINE 1124-1125

1 – Location of the biocenosis

Stage	Infralittoral
Nature of substratum	Hard beds
Bathymetrical distribution	From the surface down to 35 to 40 metres
Position	Open sea
Hydrodynamics	Weak, average, strong, very strong
Salinity	Normal
Temperature	Normal

2 – Description of the biocenosis

This biocenosis is located in the infralittoral stage. The infralittoral stage extends from areas where only accidentally does something emerge above the water, to the survival limit of the marine phanerogams and the photophilous algae. This lower limit depends on the penetration of light, and thus varies greatly with the topography and the quality of the water. In areas of very clear water, it can go down to 35-40 metres, whereas it is restricted to only a few metres in turbid areas. All the rocky substrata of the infralittoral stage where the conditions of the stage prevail are covered with different facies of the biocenosis of photophilous algae, an extremely rich population.

3 – Main recognition criteria

The biocenosis of photophilous algae is a biocenosis that is extremely rich and of great complexity, due to the strong physical gradients existing at its level. Three horizons can be made out:
-an upper horizon (0-1 metre) where the light and the hydrodynamic energy are strong
-a middle horizon (1-15 metres) where the light and hydrodynamic factors are attenuated
-a deep horizon (15-40 metres) where the light and hydrodynamics are extremely weak.

For each of these horizons there are corresponding vegetal associations with very characteristic facies; the main ones are:

- Upper horizon:
  * The association with *Cystoseira amentacea* var. *stricta* (III.6.1.2.), in pure, rough waters, strong luminosity
  * The association with *Cystoseira crinita* (III.6.1.16.), in pure, sheltered waters, strong luminosity
  * The association with *Schottera nicaeensis* (III.6.1.29.), in pure, rough waters, attenuated luminosity
  * The association with *Stypocaulon scoparium* (III.6.1.23.), in pure, sheltered waters, strong luminosity
  * The association with *Sargassum vulgare* (III.6.1.20.), in pure, rough waters, strong luminosity
  * The association with *Dictyopteris polypodioides* (III.6.1.21.), in pure, rough waters, strong luminosity
  * The association with *Corallina elongata* (III.6.1.5.), average waters, strong luminosity
  * The association with crust-forming algae (*Lythophyllum* spp.), in waters with strong wave action
  * The facies with *Mytilus galloprovincialis* (III.6.1.4.) in areas with strong organic addition

- Middle horizon:
  Facies with big hydrozoans (III.6.1.27.): *Aglaophenia* spp. and *Eudendrium* spp. dominant

- Lower horizon
  Association with *Cystoseira spinosa* (III.6.1.19).

4 – Characteristic/indicator species

These are very abundant, and include:
Algae*: Lithophyllum incrustans, Tenarea tortuosa, Goniolithon byssoides, Padina pavonica, Stypocaulon scoparia, Laurencia obtusa, Amphiroa rigida, Jania rubens, Cystoseira amentacea stricta, Codium bursa*
Cnidarians*: Actinia equina, Anemonia sulcata, Eudendrium* spp.*, Sertularella ellisi, Aglaophenia octodonta*
Molluscs: *Acanthochitona fascicularis, Patella aspera, Vermetus triqueter, Dendropoma petraeum, Columbella rustica, Mytilus galloprovincialis*
Polychaetes: *Amphiglena mediterranea, Branchiomma (Dasychone) lucullana, Hermodice carunculata, Lepidonotus clava, Eunice vittata, Lumbrinereis gracilis, Lysidice ninetta, Perinereis cultrifera, Platynereis dumerilii, Polyophthalmus pictus, Syllis* spp.
Crustaceans: *Balanus perforatus, Amphithoe ramondi, Dexamine spiniventris, Hyale* spp., *Acanthonyx lunulatus*
Echinoderms*: Amphipholis squamata, Arbacia lixula, Paracentrotus lividus.*

5 – Associated habitats or those in contact

On the rocky coasts, the upper contact is with the biocenosis of the lower mediolittoral rock (II.4.2.) into which certain species rise when conditions permit. The lower contact is with the coralligenous (IV.3.1.), with sometimes exchanges towards the lower horizon.

6 – Possible confusion

The limit of the lower horizon is sometimes hard to distinguish from the coralligenous (IV.3.1.).

7 – Conservation interest

The biocenosis is extremely rich as regards both quality and quantity, containing several hundred species. Its production is great and its biomass can attain several kilogrammes per square metre. Its seasonal dynamics are strong. The trophic network there is very complex and opens onto other habitats by exporting organisms and organic matter. Many fishes feed on the plants and animals living in this habitat.

8 – Progressive trends and potential threats

This biocenosis includes associations that are very sensitive to pollution*; Cystoseira amentacea stricta* is thus considered to be an excellent indicator of the quality of the water and its disappearance is linked to an increase in pollution. It is also very sensitive to the quantity of suspended matter for two basic reasons: turbid water decreases photosynthesis and thus affects the algal population; sedimentation fills in the microcavities between the algae and eliminates the small cryptic fauna. This biocenosis is also highly subject to the pressure of more or less invasive introduced species (*Caulerpa taxifolia, Stypopodium schimperi*) which can harm it or even

destroy it. The ichthyofauna living at the level of this biocenosis is diverse and rich; it is thus subject to heavy pressure from commercial and leisure fishing. Among the other uses of the elements of this biocenosis are the gathering of sea urchins and the exploiting of natural mussel beds. Mussels are also reared in this habitat on artificial substrata.
The biocenosis intervenes in feeding a great number of fishes either directly, or indirectly, by dispersing vegetal and animal detritus into other bottoms.

9 – Conservation status and management (management context)

Monitoring the quality of the littoral water. Restricting coastal development. Monitoring and education regarding tourist frequentation. Monitoring the development of *Caulerpa taxifolia*.

10 – Facies and associations

III.6.1.2. Association with *Cystoseira amentacea* (var*. amentacea*, var. *stricta*, var. *spicata*)
III.6.1.3. Facies with vermetids
III.6.1.10 Association with *Cystoseira tamariscifolia* and *Saccorhiza polyschides*
III.6.1.14. Facies with *Cladocora caespitosa*
III.6.1.15. Association with *Cystoseira brachycarpa*
III.6.1.16. Association with *Cystoseira crinita*
III.6.1.17. Association with *Cystoseira crinitophylla*
III.6.1.18. Association with *Cystoseira sauvageauana*
III.6.1.19. Association with *Cystoseira spinosa*
III.6.1.20. Association with *Sargassum vulgare*
III.6.1.25. Association with *Cystoseira compressa*
III.6.1.35. Facies and associations of the Coralligenous biocenosis (in enclave)

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Compiled by: G. BITAR

Crédit photographique : J. G. HARMELIN

III.6.1.2. Association with Cystoseira amentacea (var. amentacea, var. stricta, var. spicata)

Association with *Cystoseira amentacea* *(var. amentacea, var. stricta, var. spicata)*

Reference code for identification:
RAC/SPA: III.6.1.2

Biocenosis of infralittoral algae
III.6.1

1 – Location

This association is located in the first metre of the infralittoral (from –20 to –30 cm.). It requires pure water.

2 – Description

This association, described by Molinier in 1958, forms belts in the photophilous biotopes where there is strong wave action, and whose rocky substratum is subvertical. It is often accompanied by *Cystoseira compressa*, which may replace it completely in places.
The association with *Cystoseira amentacea* is represented in the three major areas of the Mediterranean by different geographical varieties of this Cystoseira. The association with *Cystoseira amentacea amentacea* is endemic in the eastern Mediterranean, whereas *Cystoseira amentacea stricta* is found in the north-western Mediterranean and the *spicata* variety in the Adriatic. The three varieties of this Cystoseira are good indicators of the upper limit of the infralittoral stage.
In the Sea of Alboran, all along the North African coast (Morocco, Algeria, Tunisia) and in the Strait of Messina, *Cystoseira tamariscifolia* is found instead of *Cystoseira amentacea.*

3 – Main recognition criteria

This is a perennial, caespitose alga with leaves (spines on the branches). In exposed biotopes, it forms associations in dense belts with a greenish iridescence. The active vegetation period extends from February to July; in the winter, only the basal part covered with epiphytes remains. The young branches are iridescent.

4 – Possible confusion

Cystoseira amentacea can be confused with certain other species of the same genus.

5 – Conservation interest

This association, usually found in clean areas, participates in the balance of the environment, being a refuge for small vagile fauna on which fishes feed. It also maintains biodiversity: this association, including many strata, is characterised by great specific richness; it shelters epibiont organisms and substratum organisms. Species mainly belonging to the algae, polychaetes, molluscs and crustaceans are found there. Production is high there.

6 – Ongoing trends, vulnerability and potential threats

Essentially, the potential threats come from pollution from urban, agricultural, industrial and port areas, and from oil pollution related to the great navigational highways, like the Aegean Sea, where a marked dwindling of the *Cystoseira amentacea* belts has been noticed. The association is also affected by coastal development, concreting and the destruction of vermetid platforms. It is also sensitive to being over-grazed by herbivores. The deliberate or accidental introduction of species that are foreign to the environment, and which in some cases adapt to the new conditions of this environment and then become invasive species, affects it. This is the case with *Caulerpa taxifolia* in the western Mediterranean and *Stypopodium schimperi* in the eastern Mediterranean. The status of the species is vulnerable, and the threat is considered serious, at least locally.

7 – Conservation status and management

Being linked to pure water, the *amentacea, stricta* and *spicata* varieties of *Cystoseira amentacea* are dwindling in the Mediterranean and have disappeared from areas subject to heavy pollution. Monitoring anthropic activities and the quality of the littoral water is thus necessary.

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Crédit photographique : J. G. HARMELIN

III.6.1.3. Facies with vermetids

Facies with vermetids

Reference code for identification:
RAC/SPA: III.6.1.3

Biocenosis of infralittoral algae
III.6.1

1 – Location

The facies with vermetids is located in the middle level of the sea water and sometimes it forms well-developed vermetid platforms in Corsica, Sicily and – especially – on the Levantine coast.

2 – Description

Vermetids are sessile gastropods which develop near the middle level of the sea. These organisms, associated with the *Neogoniolithon brassica-florida* calcareous algae, build up organogenous formations in three shapes:
-The cornice or rim form: below the middle level of the sea on a subvertical rocky slope. In the north-western Mediterranean, these formations are covered with the *Neogoniolithon brassica-florida* and *Lithophyllum lichenoides* calcareous algae.
-The atoll form: observed in the eastern Mediterranean (Israel and Crete), and in the Bermudas. These are rounded structures, depressed in the centre.
-The ‘pavement’ or ‘platform’ form: the standard structure described in Sicily is a horizontal corroded surface developed in the standing calcareous rock. The platform is pitted with shallow pools whose crests, as well as the outside edges (in the shape of pads or ledges) of the platform, are covered with *Dendropoma petraeum* Vermetids, often called *Vermetus cristatus*. In addition, the bottoms of the bowls of the platform can be colonised by *Vermetus triqueter*, also known as *Vermetus gregarius.*
Although in the western Mediterranean the position of the platform is below the middle level of the sea and is located at the upper limit of the infralittoral stage, it is always mediolittoral in the eastern Mediterranean, where the platform develops at 0.2-0.3 metres above mid-wave level.

3 – Main recognition criteria

The particular shape of the biological constructions. Usually, *Dendropoma petraeum* develops on the outer edges and crests of the platforms, whereas *Vermetus triqueter* covers the bottoms of the bowls of the platforms.

4 – Possible confusion

The fairly deep bowls of the platforms constitute enclaves for a flora and a fauna that belong to the biocenosis of photophilous algae. In well exposed places, the limit with the upper horizon of the infralittoral stage is sometimes hard to make out, due to the presence of a series of little half-cup pools between the level of the low tides and that of the platform as such.

5 – Conservation interest

The interest of this habitat lies in its special structure as a biological marker of variations of water level and as a good indicator of the shoreline, precise and reliable. In the Mediterranean, fossile platforms from the Holocene can often be found, the best conserved being those of Lebanon and Syria. These pavements, about 0.8 metres above the present level, were made between the start of the Hellenistic epoch and the second or third century of our own era. The vermetid pavement constitutes a major element in the rocky coasts landscape, particularly in the eastern Mediterranean. The outer edge of the pavement shelters a rich fauna of annelids and destructive organisms such as Sipunculi.

6 – Ongoing trends, vulnerability and potential threats

This facies is directly subject to the action of diverse-origin pollutants, like the pollution from the asbestos mines or factories producing phosphate fertilizers. Also, vermetid platforms are in some places destroyed by coastal area development: factories, seaside resorts and other concreting. The use by fishermen of toxic products to get worms to come out of their holes in the pools of the pavement to be used as bait is another source of mortality. Eutrophication of the water in urban areas leads to an invasion of the platforms by Ulvaceae.
The platform is a place of choice for the deliberate or accidental settlement of introduced species, the development of which is rarely controlled. We mention the case of the Lessepsian bivalve *Brachidontes pharaonis*, which has replaced the *Mytilus galloprovincialis* mussels mentioned by Gruvel in 1931 in the platforms of the Lebanese and Syrian coasts.

7 – Conservation status and management

As well as monitoring the quality of the littoral water, it is necessary to educate the public to make best use of the vermetid platforms, the building up of which is an extremely slow phenomenon. These platforms constitute a national and international natural heritage, and the *Dendropoma petraeum* species appears on the list of threatened species in the Annexes of the International Conventions.

Promoting and creating protected areas to protect biodiversity.
In order to discover the state of vitality of the vermetid pavements, diverse studies should be envisaged or developed: an inventory of the associated fauna and flora, formation dynamics, cementing, biodestruction, dating, etc.

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Crédit photographique : J. G. HARMELIN

III.6.1.10 Association with Cystoseira tamariscifolia and Saccorhiza polyschides

Association with *Cystoseira tamariscifolia* and *Saccorhiza polyschides*

Reference code for identification:
RAC/SPA: III.6.1.10

Biocenosis of infralittoral algae III.6.1

1 – Location

Cystoseira tamariscifolia is very localized in the Mediterranean: the Sea of Alboran, Spain, North Africa, Sicily, the Gulf of Genoa and the Aegean Sea. It is often associated with *Saccorhiza polyschides* in areas influenced by the waters of the Atlantic. The association with *Cystoseira tamariscifolia* and *Saccorhiza polyschides* was described for the first time in the Strait of Messina and in the Sea of Alboran.

2 – Description

The association with *Cystoseira tamariscifolia* and *Saccorhiza polyschides* is characteristic of the higher infralittoral area (near the surface up to 2 metres down) where it lives in the photophilous biotopes where there is strong wave action. It is found in biotopes where the water is cooled by the rising of deep water.
On the European Atlantic coast and that of Morocco in the Strait of Gibraltar, *Cystoseira tamariscifolia* constitutes an autonomous association*.* *Saccorhiza polyschides* also exists, with *Laminaria ochroleuca* in detritic bottoms between 45 and 85 metres down.

3 – Main recognition criteria

Cystoseira tamariscifolia is a perennial, spiny plant, with a thallus that has no tophules; it has one erect axis. The primary branches are cylindrical, bearing many short spiny ramuli, and present, in the water, a blueish-greenish iridescence that is sometimes extremely pronounced. The presence of aerocysts; the receptacles are not very compact.
Saccorhiza polyschides is a big annual alga (3 to 4 metres long) with a hollow, bulbous, verrucose base; its stipe is flat in adulthood, and the alga ends in a fan-shaped blade.

In the Strait of Messina and the Sea of Alboran, this association is characterised by the presence of: *Phyllariopsis brevipes, Asparagopsis armata, Mesophyllum lichenoides, Schyzimenia dubyii, Desmarestia ligulata, Halurus equisetifolius.*

4 – Possible confusion

Cystoseira tamariscifolia is related to its vicarian *Cystoseira mediterranea,* which, differently, has a flexible thallus and more obvious receptacles.

5 – Conservation interest

Use: like all the other big Cystoseiras, *Cystoseira tamariscifolia* participates in constituting wrack, and thus in the uses made of this natural product.
As well as being used as a fertilizer with other algae, *Saccorhiza polyschides* is used to make paper pulp.

6 – Ongoing trends, vulnerability and potential threats

The association with *Cystoseira tamariscifolia* and *Saccorhiza polyschides* is very sensitive to urban-, agricultural- and industrial-origin surface pollution. When they dwindle this is always a sign of environmental degradation.

7 – Conservation status and management

Monitoring anthropic activities and the quality of the littoral water is necessary.

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Crédit photographique : J. G. HARMELIN

III.6.1.14. Facies with Cladocora caespitosa

Facies with Cladocora caespitosa

Reference code for identification:
RAC/SPA: III.6.1.14

Biocenosis of infralittoral algae
III.6.1

1 – Location

Known throughout the Mediterranean and in the Ibero-Moroccan gulf, *Cladocora caespitosa* is found from very superficial water to as much as about 50 metres down.

2 – Description

The facies with *C. caespitosa* exists from very superficial water (in the little bowls in the vermetid platforms) to as much as about 50 metres down in both sheltered and rough biotopes. It can withstand slightly lower salinity, as in the northern Adriatic. It can also be found in both relatively warm (25°C) areas and those where the temperature of the water in the winter is under 10°C. It is met in the biocenosis of photophilous algae, the *Posidonia* meadow, the coralligenous, at the entrances to caves and in the detritic bottoms. It is a polymorphous species, able to develop on rock, on concretion-forming calcareous algae, on artificial substrata or unattached in the *Posidonia* meadow and sandy and muddy beds. The species does not exist beyond a certain threshold of light. Indirect and diffuse light is sufficient to ensure the existence of the zooxanthellates of this hermatypic scleractinian.

3 – Main recognition criteria

Cladocora caespitosa, a hermatypic colonial scleractinian, is present in various forms such as crust-forming colonies with very short corallites, spindly tufts, unattached balls, massive blocks, etc. Corallites in the thick colonies can be over 10 cm. high and their diameter is usually about 4-5 mm. The calyces are circular or slightly elongated. The number of septa is variable: 34 or 36 is the common number. The presence of zooxanthellates gives the tissues a brown colour. This species can form extended clumps and colonies that are over one metre in diameter and several dozens of centimetres thick. In shallow waters, it is associated with crust-forming corallinaceous algae and invertebrates like *Crambe crambe, Chondrosia reniformis* and crust-forming bryozoans, and shelters a rich vagile fauna. At depth, however, it is associated with sciaphilous species (*Eunicella singularis, Balanophyllia europea, Flabellia petiolata, Peyssonnelia squamaria*).

4 – Possible confusion

Possible confusion with *Cladocora debilis, Polycyathus muellerae* and *Galaxea fascicularis.*

5 – Conservation interest

Because of its rarity, aesthetic value for underwater tourism, contribution to increasing biodiversity both on a hard bed and on a loose bed, since it shelters a fauna that belongs to all zoological groups, and its contribution to producing limestone and its primary production, given that it is a species with zooxanthellates, *Cladocora* deserves to be monitored in the context of conservation.

6 – Ongoing trends, vulnerability and potential threats

Because of its ability to form extended colonies, the main factors which restrict the proliferation of *Cladocora caespitosa* are: various kinds of pollution, muddiness, competition with algae, thermal anomalies, shallow traditional fishing and leisure diving activities. Also, it is the host of the parasitical cirriped *Megatrema anglicum* and of the gastropod *Corallophila babelis (Catiaxis babelis).* It appears on the list of threatened species (Berne Convention).

7 – Conservation status and management

Monitoring the quality of the littoral water. Very strict management of traditional fishing. Management of and education for underwater tourism, particularly underwater diving.

In the sectors where, exceptionally, extended meadows exist (as in Mljet, Croatia), it can be envisaged that a reserve be instituted or collection and sale forbidden.

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Compiled by: G. BITAR

Crédit photographique : J. G. HARMELIN

III.6.1.15. Association with Cystoseira brachycarpa

Association with *Cystoseira brachycarpa*

Reference code for identification: RAC/SPA: III.6.1.15

Biocenosis of infralittoral algae III.6.1

1 – Location

An endemic of the Mediterranean, *Cystoseira brachycarpa* is particularly present in the western Mediterranean and in the Strait of Sicily. It is found in the infralittoral, from near the surface to 15-25 metres down.

2 – Description

The association forms dense meadows in different levels of the infralittoral, in exposed and rough places. It can be found with *Cystoseira amentacea.*

3 – Main recognition criteria

Cystoseira brachycarpa is a caespitose alga, with spiny secondary and tertiary branches. There are two varieties: *Cystoseira brachycarpa* var*. brachycarpa* (a synonym of *Cystoseira balearica* and *Cystoseira caespitosa)*, which is found in the upper infralittoral in well-lit, exposed places, and *Cystoseira brachycarpa* var*. claudiae* which, unlike *Cystoseira brachycarpa* var. *brachycarpa*, has hemitophules at the base of the primary branches and is found in the lower infralittoral.

4 – Possible confusion

Cystoseira brachycarpa has been mentioned in Corsica as *Cystoseira balearica* and on the Catalan coast as *Cystoseira caespitosa*, but some people sometimes see these species as synonyms, or *C. caespitosa* as a variety of *Cystoseira brachycarpa*.

5 – Conservation interest

This association is characterised by a certain floral and faunal richness. It participates in the balance of the environment, the maintenance of biodiversity, and provides refuge for a small vagile fauna on which fishes feed. Production is important there.

6 – Ongoing trends, vulnerability and potential threats

It is sensitive to urban-origin and thermal pollution. The deliberate or accidental introduction of species that are foreign to the environment, which in certain cases adapt to the new conditions of this environment and then become invasive species. This is the case for *Caulerpa taxifolia* in the western Mediterranean and *Stypopodium schimperi* in the eastern Mediterranean.

7 – Conservation status and management

Monitoring anthropic activities and the quality of the littoral water is necessary.

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Compiled by: G. BITAR

Crédit photographique : J. G. HARMELIN

III.6.1.16. Association with *Cystoseira crinita*

Association with *Cystoseira crinita*

Reference code for identification:
RAC/SPA: III.6.1.16

Biocenosis of infralittoral algae
III.6.1

1 – Location

An endemic of the Mediterranean, the association with *Cystoseira crinita* is found in the upper infralittoral, from the surface to two metres down in sheltered places.
It was described for the first time in Corsica.

2 – Description

In the western Mediterranean, this association is found in superficial photophilous biotopes in both rough and sheltered places (0 to 0.5 metres down). In places with weak hydrodynamics, it tolerates sedimentation. In the Aegean Sea, it is known in both exposed and sheltered stations, whereas in Syria it can descend to 3 metres down on an exposed subhorizontal substratum. In other parts of the Mediterranean, its vicarians can be found: *Cystoseira mediterranea* (in the western Mediterranean), *Cystoseira crinitophylla* and *Cystoseira sedoides* in the Strait of Sicily*, Cystoseira sedoides* in Algeria, Tunisia and Pantelleria, and
Cystoseira barbata in the Venice lagoon. In the eastern Mediterranean are *Cystoseira barbatula* and *Cystoseira corniculata* and others with localized distribution like *Cystoseira susanensis, Cystoseira hyblaea, Cystoseira rayssiae.*

3 – Main recognition criteria

Cystoseira crinita is a caespitose, non-spiny alga with no tophules or aerocysts, or few on certain individuals, with long (10-30 cm.) naked principal stems. The tip of the stem is prominent and spiny. Many very long adventive branches, arranged laterally on the axis. Compact, bumpy, cylindrical or oval terminal receptacles. In the summer, the alga dwindles and only its base part remains.

4 – Possible confusion

Cystoseira crinita can be confused with certain other species of the same genus.

5 – Conservation interest

This association participates in offering a refuge for small vagile fauna and thus in feeding fishes. It contains algines and antibacterial and antiviral substances.

6 – Ongoing trends, vulnerability and potential threats

The *Cystoseira crinita* species is sensitive to both anthropic-origin pollution and the increase in sedimentation.
Threats are:
-littoral development, represented by building, concreting, riprap, sedimentary filling in and moving sediment
-every kind of waste that pollutes the environment and thus causes a disbalance in the biocenoses
-collecting, either using dynamite or a pneumatic drill, commercial species like, for example, the *Lithophaga lithophaga* date shell, thus destroying the biotopes and harming the associations
-the deliberate or accidental introduction of species foreign to the environment which, in certain cases, adapt to the new conditions in this environment and then become invasive species. This is the case for *Caulerpa taxifolia* in the western Mediterranean and *Stypopodium schimperi* in the eastern Mediterranean.

7 – Bibliographical references

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Compiled by: G. BITAR

Crédit photographique : J. G. HARMELIN

III.6.1.17. Association with Cystoseira crinitophylla

Association with *Cystoseira crinitophylla*

Reference code for identification:
RAC/SPA: III.6.1.17

Biocenosis of infralittoral algae
III.6.1

1 – Location

An endemic of the Mediterranean, this association is localized in the upper infralittoral, between 1 and 8 metres down, forming mixed populations with other Cystoseiras on a rocky, sandy bed.

2 – Description

Cystoseira crinitophylla was first thought to be an endemic of the Adriatic, but has been found more or less throughout the Mediterranean, always associated with other Cystoseiras in the upper infralittoral. It has been sighted in the Gulf of Trieste (as *Cystoseira crinita*) in the association with *Cystoseiretum barbatae*, with *Cystoseira barbatula* in the Aegean Sea, with *Cystoseira crinita* or *Cystoseira brachycarpa* in Corsica, in the Tyrrhenian Sea, in the Strait of Sicily, and in the Ionian Sea. What could be meant is a stenotherm sciaphilous morphotype of a group of species (*Cystoseira crinita, Cystoseira pelagosae, Cystoseira crinitophylla*) in an advanced state of speciation. It is thought that the association with *Cystoseira crinitophylla* can be considered to be a facies found in turbid water whose temperature is not above 18°C.

3 – Main recognition criteria

This is a dense association dominated by *Cystoseira crinitophylla* bushes associated with other brown algae.

4 – Possible confusion

Cystoseira crinitophylla can be confused with certain other species of the same genus.

5 – Conservation interest

This species, which does not form an autonomous association, is not thought to be important for conservation.

6 – Ongoing trends, vulnerability and potential threats

This association is sensitive to urban waste and to thermal anomalies in superficial water.

7 – Conservation status and management

Monitoring is requested as regards anthropic activities and the quality of littoral water.

8 – Bibliographical references

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Compiled by: G. BITAR

Crédit photographique : J. G. HARMELIN

III.6.1.18. Association with *Cystoseira sauvageauana*

Association with *Cystoseira sauvageauana*

Reference code for identification:
RAC/SPA: III.6.1.18

Biocenosis of infralittoral algae
III.6.1

1 – Location

An endemic of the western Mediterranean (Spain, France, Sicily, Algeria and Tunisia), the association with *Cystoseira sauvageauana* has been described in the Gulf of Catania. It is found in subhorizontal beds characterised by moderate hydrodynamics.

2 – Description

This biocenosis is found in very sheltered superficial photophilous biotopes (from 0 to 1 metre) and around 15 metres into the Posidonia meadow. It forms dense prairies that cover, as substratum, a well developed sciaphilous population. In the eastern Mediterranean, it is replaced by its vicarian *Cystoseira spinosa v. tenuior.*

3 – Main recognition criteria

A perennial alga whose branches fall off in autumn; one big erect axis with a discoid base and a prominent spiny apex; in the winter, it presents little spiny tophules; the branches are covered with spiny ramuli; absence of aerocysts; the cylindrical, compact-terminal, long (up to 3 cm.) receptacles are single or ramified, without thorns or spiny.

4 – Possible confusion

Related to *Cystoseira mediterranea*, which lives instead in superficial biotopes where there is strong wave action and which has no little winter tophules and long receptacles.

5 – Conservation interest

This association participates in the balance of the environment, the maintenance of biodiversity and offers a refuge for small vagile fauna on which fishes feed. There is major production there.

6 – Ongoing trends, vulnerability and potential threats

Threats are:
-littoral development, represented by building, concreting, riprap, sedimentary filling in and moving sediment
-every kind of waste that pollutes the environment and thus causes a disbalance in the biocenoses
-collecting, either using dynamite or a pneumatic drill, commercial species like, for example, the *Lithophaga lithophaga* date shell, thus destroying the biotopes and harming the associations
-the deliberate or accidental introduction of species foreign to the environment which, in certain cases, adapt to the new conditions in this environment and then become invasive species. This is the case for *Caulerpa taxifolia* in the western Mediterranean.

7 – Conservation status and management

It is necessary to monitor anthropic activities and the quality of littoral water. Any kind of mechanical attack regarding this association must be forbidden.

8 – Bibliographical references

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Compiled by: G. BITAR

Crédit photographique : J. G. HARMELIN

III.6.1.19. Association with Cystoseira spinosa

Association with *Cystoseira spinosa*

Reference code for identification:
RAC/SPA: III.6.1.19

Biocenosis of infralittoral algae
III.6.1

1 – Location

A Mediterranean endemic, *Cystoseira spinosa* is found throughout the Mediterranean, in the infralittoral stage, where it can descend to 40 metres down.

2 – Description

This is a perennial species whose thalli may be up to 20-50 cm. high*.* The *compressa* variety is localized in the lower infralittoral in limpid water with marked hydrodynamics. This variety, as well as the *spinosa* variety, cannot withstand an increase in sedimentation. However, the *tenuior* variety tolerates a certain instability of environment and is spread right through the infralittoral; in the eastern Mediterranean and the Adriatic it can replace *Cystoseira sauvageauana* and associate with *Cystoseira brachycarpa* and *Cystoseira foeniculacea* in the upper and middle infralittoral.

3 – Main recognition criteria

Cystoseira spinosa: not caespitose, spherical or oblong tophules, spiny, 'leaves'/'spines', absence of aerocysts, main stem is long (up to 30 cm.) and spiny. The tip of the stem is not prominent but very spiny. Sometimes foliaceous branches. Stations are sheltered and at depth. Thick conceptacles on the leaves, then grouped in terminal receptacles.

4 – Possible confusion

Cystoseira spinosa can be confused with certain other species of the same genus.

5 – Conservation interest

This association, usually found in clean areas and sometimes near *Cymodocea nodosa* and *Halophila stipulacea* meadows, participates: in the balance of the environment, the maintenance of biodiversity, and offers refuge to little vagile fauna on which fishes feed. There is major production there.

6 – Ongoing trends, vulnerability and potential threats

Pollution, trawling and being over-grazed by echinoderms are the main threats and explain why the species is becoming rare in several parts of the French coast and other places too. The intensity of the threat is serious in much of the Mediterranean, and the status of this species is seen as vulnerable.

7 – Conservation status and management

Unlike *Cystoseira spinosa* var. *tenuior*, the other two varieties *Cystoseira spinosa* var*. spinosa* and *Cystoseira spinosa* var*. compressa* are dwindling in the Mediterranean. Thus, monitoring anthropic activities and the quality of the littoral water is turning out to be necessary. Trawling as regards this association must be forbidden and punished.

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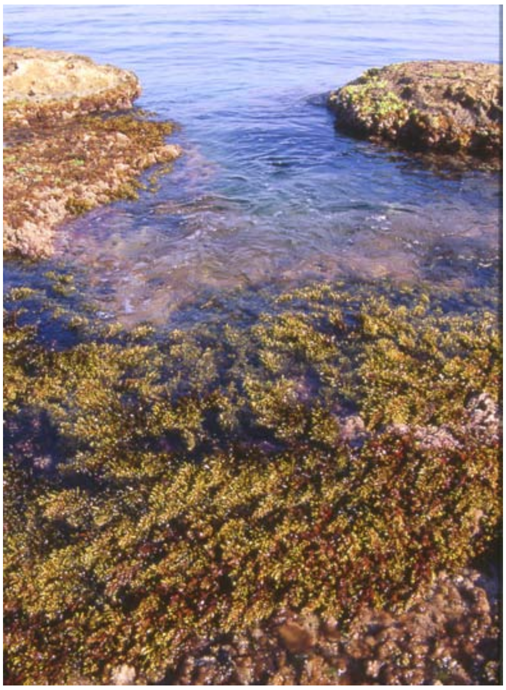
Compiled by: G. BITAR

Crédit photographique : J. G. HARMELIN

III.6.1.20. Association with Sargassum vulgare



Association with *Sargassum vulgare*

Reference code for identification:
RAC/SPA: III.6.1.20

Biocenosis of infralittoral algae
III.6.1

1 – Location

In the upper infralittoral, from the surface to 3 metres down, and sometimes in the deep bowls of vermetid platforms. It is especially widespread in the eastern Mediterranean.

2 – Description

The *Sargassum vulgare* association, described for the first time in Syria, achieves maximum development in rough, shady biotopes, up to 3 metres down. It grows on substrata whose slopes vary from the subvertical to the horizontal. At surface level, it forms, with *Cystoseira compressa* or *Cystoseira amentacea,* a dense belt whose substratum is made up of sciaphilous flora. At about 3 metres deep, it is accompanied by *Cystoseira barbatula* and *Cystoseira crinita*. In the eastern Mediterranean *Sargassum trichocarpum* is also found, going down into the lower infralittoral and the circalittoral. This association replaces the association with *Cystoseira amentacea stricta* in areas with moderately strong wave action.

3 – Main recognition criteria

It is present as a dense belt whose fronds are extremely subject to hydrodynamic action. It is characterised by a short stem bearing primary (20 to 70 cm.) and secondary (5 to 10 cm.) branches. The 'leaves' are elongated, crossed by a median nervure, and denticulated, bearing at the base yellow, spherical, hollow vesicles that constitute floaters. The receptacles are made up of unisexual conceptacles.

4 – Possible confusion

Can be confused with certain species of the same genus.

5 – Conservation interest

This association, that includes several strata, is characterised by a certain specific richness; it shelters epibiont organisms and substratum organisms. In it are found species that in the main belong to the algae, the polychaetes, the molluscs and the crustaceans. The alga itself is used in feeding human beings, in industry to produce algines and phycocolloides, and has vermifugal properties.

6 – Ongoing trends, vulnerability and potential threats

The association with *Sargassum vulgare,* like any other association of the biocenosis of infralittoral algae, is very important due to its high level of primary production, and its richness in associated fauna which participates in the secondary and tertiary levels of the littoral trophic network. It is fragile and sensitive to damage to the environment.
Threats are:
-littoral development, represented by building, concreting, riprap, sedimentary filling in and moving sediment
-every kind of waste that pollutes the environment and thus causes a disbalance in the biocenoses
-collecting, either using dynamite or a pneumatic drill, commercial species like, for example, the *Lithophaga lithophaga* date shell, thus destroying the biotopes and harming the associations
-the deliberate or accidental introduction of species foreign to the environment which, in certain cases, adapt to the new conditions of this environment and then become invasive species. This is the case for *Caulerpa taxifolia* in the western Mediterranean and *Stypopodium schimperi* in the eastern Mediterranean.

7 – Conservation status and management

The association is directly subject to anthropic activities: emission of pollution, ill done development, destruction of vermetid platforms. Thus the monitoring of anthropic activities and of the quality of the water is turning out to be necessary.

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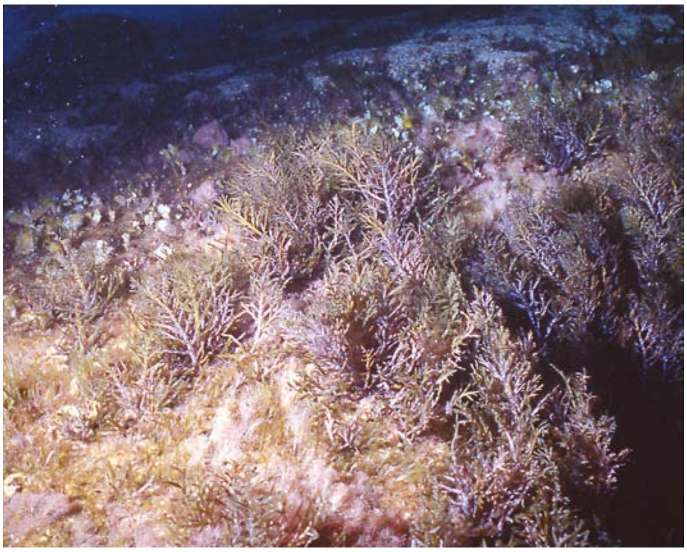
Compiled by: G. BITAR

Crédit photographique : J. G. HARMELIN

III.6.1.25. Association with Cystoseira compressa



Association with Cystoseira compressa

Reference code for identification:
RAC/SPA: III.6.1.25

Biocenosis of infralittoral algae
III.6.1

1 – Location

An endemic of the Mediterranean, the association with *Cystoseira compressa* was described for the first time in Corsica. It can form dense prairies in the first metre of the infralittoral.

2 – Description

Cystoseira compressa is not an indicator of either a mode or a well-determined level, since it is found, in the first metre, in both areas with strong wave action at mid-wave level and in sheltered areas. In the eastern Mediterranean, it is met, with *Sargassum vulgare* and *Laurencia papillosa*, at the outside edges of the vermetid platforms where *Dendropoma petraeum* forms kinds of pads.

3 – Main recognition criteria

C. compressa: caespitose, absence of tophules and 'leaves'/'spines', presence of aerocysts, very short (1 cm.) and naked main stems. Smooth tip of the stem. Flattened primary branches arranged in a rosette. Terminal receptacles. The appearance of the branches varies according to the hydrodynamics and the season.

4 – Possible confusion

Cystoseira compressa can be confused with certain other species of the same genus.

5 – Conservation interest

This association, that includes several strata, is characterised by a certain specific richness; it shelters epibiont organisms and substratum organisms. In it are found species that in the main belong to the algae, the polychaetes, the molluscs and the crustaceans.
The alga itself is used in industry; as well as iodine, it contains algines and various compounds.

6 – Ongoing trends, vulnerability and potential threats

The association with *Cystoseira compressa,* like any other association of the biocenosis of infralittoral algae, is very important due to its high level of primary production, and its richness in associated fauna which participates in the secondary and tertiary levels of the overall littoral trophic network. It is fragile and sensitive to damage to the environment.
Threats are:
-littoral development, represented by building, concreting, destroying vermetid platforms, riprap, sedimentary filling in and moving sediment
-every kind of waste that pollutes the environment and thus causes a disbalance in the biocenoses
-the deliberate or accidental introduction of species foreign to the environment which, in certain cases, adapt to the new conditions of this environment and then become invasive species.

7 – Conservation status and management

The association is directly subject to anthropic activities: emission of pollution, ill done development, destruction of vermetid platforms. Thus the monitoring of anthropic activities and of the quality of the water is turning out to be necessary.

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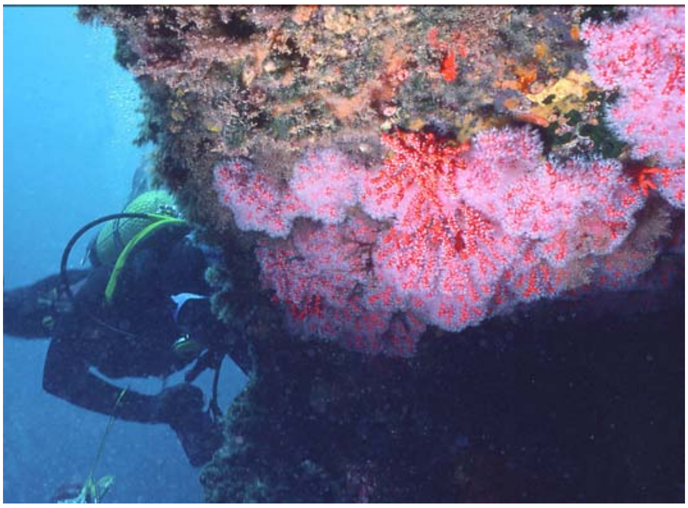
Compiled by: G. BITAR

Crédit photographique : J. G. HARMELIN

III.6.1.35. Facies and associations of the Coralligenous biocenosis (in enclave)



Facies and associations of the Coralligenous biocenosis (in enclave)

Reference code for identification:
RAC/SPA: III.6.1.35

Biocenosis of infralittoral algae
III.6.1

1 – Location

The Coralligenous belongs to the circalittoral stage, but can exceptionally be found as an enclave in the biocenosis of infralittoral algae, due to very special environmental conditions (topography of the substratum or high biological stratum) that favour shade.

2 – Description

As a rule, the Coralligenous biocenosis (IV.2.2) is extremely rich and varied. It can be found as an enclave in cavities in the infralittoral in the habitat of infralittoral algae, and also at the level of the substratum of the dense *Posidonia oceanica* meadow. In both cases, the facies is found in conditions where the light is extremely dim. The Coralligenous as an enclave in the infralittoral can also form small discontinuous organogenous formations that are sparser than those of the circalittoral.

3 – Main recognition criteria

When it is in enclave, the Coralligenous is impoverished and only the least shade-loving (=least sciaphilous) species survive.
-In the Posidonia meadow, the Coralligenous covers both the rhizomes and the surface of the mattes when there is much leaf shade. It is essentially represented by: *Peyssonnelia* spp., *Udotea petiolata, Halimeda tuna* and *Pseudolithophyllum expansum.*

4 – Possible confusion

It is sometimes difficult to situate the transition with the lower horizon of the photophilous algae, since many coralligenous species go up into this horizon.

5 – Conservation interest

The heterogeneous topography (blocks) which often exists at the level of the infralittoral algae habitat allows the presence of coralligenous species, sometimes of great heritage or commercial value, in the shallow beds. The Coralligenous is seen as an ecological crossroads. It has great aesthetic value; the presence of certain elements, even when very impoverished, represent certain additional value for the very shallow waters.
The economic resources brought by these enclaves in the shallow infralittoral beds are of two kinds:
-fishing for species of great economic value: big crustaceans and choice fish
-exploiting the habitat for underwater tourism.

6 – Ongoing trends, vulnerability and potential threats

The Coralligenous is a biocenosis which develops in pure water and is governed by bioconstruction/biodestruction dynamics. The impoverished aspect constituted by little surface areas in enclave is extremely fragile. Some environmental disbalances, like the pollution of the water, may considerably lessen the constructive activity of certain groups and encourage the development of borers.
Pollution action is shown in a drop in the overall specific richness, a reduced density of individuals, a slowing down of constructive activity and an accelerated action of borers. Diving without apparatus or scuba diving may well break off fragile species. Invasion by the *Caulerpa taxifolia, C. racemosa* or *Stypopodium schimperi* invasive species may be seen as a serious potential threat.

7 – Conservation status and management (management context)

Monitoring the quality of the littoral water. Management of and education for underwater tourism, particularly underwater diving. Monitoring the expansion of the invasive species.

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IV – CIRCALITTORAL

IV.2. SANDS

IV.2.2. Biocenosis of the coastal detritic bottom

Biocenosis of the coastal detritic bottom (CD)

Reference codes for identification:
RAC/SPA: IV.2.2
EUR 15 1160
CORINE 1160H

1 – Location of the biocenosis

Stage	Circalittoral
Nature of substratum	Organogenous gravel with a sandy-muddy filling
Bathymetrical distribution	30-35 metres to 90-100 metres
Position	Big bays and open sea
Hydrodynamics	Weak to nonexistent; the appearance of facies can depend on certain currents
Salinity	Normal
Temperature	Normal

2 – Description of the biocenosis

Stretches of organogenous gravels and coarse sands, more or less filled in with a sandy-muddy sediment, usually an extension at depth of the biocenosis of well sorted fine sands (III.2.2). The sediment is of heterogeneous granulometry and of mixed origin: terrigenous and organogenous. The gravels and sands may come from the neighbouring (infralittoral and circalittoral) rocks, or be made up of fragments of mollusc shells, big calcified bryozoans, or tests of echinoderms or of dead melobesies. The intervals between these coarse sands and gravels are filled in with finer, sandy-muddy elements. The muddy portion is usually less than 20%, but various more or less muddy types exist. Fragmentation of the debris is not due to the always weak hydrodynamics, but to the action of organisms that attack the limestone (*Cliona* spp., *Polydora* spp., lithophagous Pelecypoda, etc. However, the regular or intermittent existence of bottom currents has frequently been stressed.

3 – Main recognition criteria

Stretches of heterogenous sediment at depths of between 30 and 100 metres (margins that vary according to geographical sector) may present facies with epiflora and epifauna.

4 – Characteristic/indicator species

Several dozen species belonging to many groups of the phytobenthos and zoobenthos can be considered as characteristic of this particularly rich biocenosis. These include:

Phytobenthos: *Cryptonemia tunaeformis*, the many-branched calcareous rhodophytes (*Phymatholithon calcareum, Mesophyllum coralloides, Lithothamnion fruticulosum*), *Peyssonnelia* spp.

Zoobenthos: *Bubaris vermiculata, Suberites domuncula* (sponges): *Sarcodyctyon catenatum* (cnidarians); *Astropecten irregularis, Anseropoda placenta, Genocidaris maculata, Luidia ciliaris, Ophioconis forbesi, Psammechinus microtuberculatus, Paracucumaria hyndmani* (echinoderms*); Limea loscombei, Propeamussium incomparabile, Chlamys flexuosa, Laevicardium oblungum, Cardium deshayesi, Tellina donacina, Eulima polita, Turitella triplicata* (molluscs); *Hermione hystrix, Petta pusilla* (polychaetes); *Conilera cylindracea, Paguristes oculatus, Anapagurus laevis, Ebalia tuberosa, Ebalia edwardsi* (crustaceans); *Molgula oculata, Microcosmus vulgaris, Polycarpia pomaria, Polycarpia gracilis* (ascidians).

A certain number of these species can give rise to facies with epiflora and epifauna.

Given the heterogeneity of the sediment, some species can be abundant in the biocenosis of the coastal detritic bottom. These are indicators of more particular environmental conditions. Here is meant, for example, the gravellicolous *(Echinocyamus pusillus, Spatangus purpureus, Astarte fusca*), the mixticolous (*Cardium minimum, Venus ovata, Dentalium inaequicostatum*), the sabulicolous (*Philine aperta*), or species with a wide ecological distribution in loose substrata.

5 – Associated habitats or those in contact

Above are the biocenoses of well sorted fine sands (III.2.2.), of coarse sands and fine gravels under the influence of bottom currents (III.3.2 and/or IV.2.4.), and the *Posidonia oceanica* meadow (III.5.1.), and below are the biocenosis of the shelf-edge detritic bottom (IV.2.3.), and, laterally, the biocenosis of the muddy detritic bottom (IV.2.1.) under the influence of the terrigenous additions from the coastal rivers.

6 – Possible confusion

With the biocenosis of the muddy detritic bottom (IV.2.1.), according to the respective percentage of mud in each; a gradual transition from one to the other when the increase in sedimentary additions is felt. With the biocenosis of the shelf-edge detritic bottom (IV.2.3.): contact, at depth, of the two biocenoses.

7 – Conservation interest

The biocenosis of the coastal detritic bottom occupies a considerable area on the continental shelf throughout the Mediterranean. This is a biocenosis with very high specific diversity. Influenced by various environmental factors, it develops many facies linked to the – sometimes luxuriant – expansion of particular species. It is an important fishing area, particularly for 'small craft', and thus represents an essential portion of the halieutic resources in the Mediterranean.

8 – Ongoing trends and potential threats

The coastal detritic bottoms are subject to varied sedimentary additions brought down either by permanent rivers or by rivers with an intermittent flow (oueds) which cyclically increase the concentration of fine sediments and organic matter. Here there is the possibility of a natural evolution towards the biocenosis of the muddy detritic bottom, even, at depth, towards altitudinal crossing into the biocenosis of the shelf-edge detritic bottom. The hydrodynamics that affect the biocenosis of the coastal detritic bottom are only exceptionally strong enough to avoid the sedimentation of fine terrigenous-origin particles.

Today, however, this natural variability is obscured by the increase in anthropic action, which constitutes a considerable threat. Anthropic action can be direct, by the overall muddying of the continental shelf, the main causes of which are non-purified urban waste, major building work in the maritime field, and leaching from soil that has lost its covering during big fires. This hypersedimentation finally increases the expansion of other circalittoral detritic bottoms. Worse still, these additions of fine particles are usually loaded with various pollutants, particularly in wastewater, pollutants which act directly on the characteristic species of the biocenosis. The most harmful induced effects cause many facies to disappear (Lithothamnia, big bryozoans, ascidian beds, etc.), species with a wide ecological distribution to become gradually dominant, beds to undergo a generalised monotonization, biodiversity to be lost, and exploitable living resources to dwindle.

9 – Conservation status and management

Protecting this biocenosis basically involves drastically reducing anthropic-origin additions, particularly non-purified domestic and industrial wastewater that is still loaded with fine matter, pollutants and organic matter. Correct management of the development of hillside slopes should also allow better conservation of the quality of this biocenosis.

10 – Facies and associations

The main facies and associations identified in the Mediterranean are:

IV.2.2.1. Association with rhodolithes
IV.2.2.2. Facies with maerl (*Phymatolithon calcareum* and *Lithothamnion coralloides*)
IV.2.2.3. Association with *Peyssonnelia rosa-marina*

IV.2.2.4. Association with *Arthrocladia villosa*
IV.2.2.5. Association with *Osmundaria volubilis*
IV.2.2.6. Association with *Kallymenia patens*
*IV.2.2.7. Association with *Laminaria rodriguezii* on detritic
IV.2.2.8. Facies with *Ophiura texturata*
IV.2.2.9. Facies with Synascidies
IV.2.2.10. Facies with large bryozoans

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IV.2.2.7. Association with Laminaria rodriguezii on detritic

Association with *Laminaria rodriguezii* on detritic

Reference code for identification:
RAC/SPA: IV.2.2.7

Biocenosis of the coastal detritic bottom
IV.2.2.

1 – Location

This association corresponds to the development as an epiflora of the Fucophycea Laminarial species *Laminaria rodriguezii* on beds of the biocenosis of the coastal detritic bottom, scattered with big fragments of shells or calcareous rhodophyceae of the 'rhodolithe' or 'praline' kind. It is located at depths of between 30 and 100 metres, but seems to be at its best between 50 and 80 metres. This association, absent from neritic water, is present near rocky banks or at the level of the rocky continental slope, bathed by the water of the open sea, very pure and very low in particles. The hydrodynamics there are probably weak to moderate, but the presence can be noticed of unidirectional currents that can in certain circumstances become strong. The temperature of the water is stable, usually around 13 to 15°C. This association is probably more common than it seems in the western Mediterranean, in the western Aegean Sea and in the Sicilian-Tunisian strait.
It is also found on hard coralligenous beds.

2 – Description

The phytosociological name: association with *Cystoseiretum zosteroides* sub-association with *Laminaria rodriguezii*, association with *Laminaria rodriguezii* on detritic bed, Giaccone 1973. This association is very often associated with unattached melobesies referred to as big rhodolithes or, formerly, 'pralines'. The hooks of *L. rodriguezii* often take root in these rhodolithes. The endobiosis of the sediment is that of the biocenosis of the coastal detritic bottom, possibly slightly impoverished, with a certain abundance of gravellicolous species. The epibiosis is also that of the standard biocenosis, enriched by calcareous Rhodophyceae such as *Peyssonnelia rosa-marina, Neurocolon* spp., and by species of the coralligenous biocenosis

(IV.3.1.) and of its facies, particularly the association with *Cystoseira zosteroides* (IV.3.1.1). Many epibionts (hydrozoans and bryozoans, particularly, and also sponges, polychaetes and ascidians) are present on the oldest part of the fronds, one side being clearly more populated than the other because the thalli are laid down flat on the bed.

3 – Main recognition criteria

Presence of the *Laminaria rodriguezii* species.

4 – Possible confusion

None. The stem of this *Laminaria* is stoloniferous and not erect; also, the other Mediterranean Laminarials are present in other habitats.

5 – Conservation interest

This endemic species is thought to be a palaeoendemic, and its origin to be the northern Pacific. Some writers have noticed the abundance of rock lobsters (*Palinurus elephas*) on beds occupied by this association.

6 – Ongoing trends, vulnerability and potential threats

This association is extremely vulnerable to possible terrigenous additions, which it does not seem to be able to withstand. Such additions, linked to climatic phenomena, fires and deforestation, as was indicated for the biocenosis of origin, could doom this Laminarial in sectors subject to this.

7 – Conservation status and management

Protecting this association essentially involves a drastic reduction in anthropic-origin additions. Correct management of the development of the hillside slopes should also permit better conservation of its quality.

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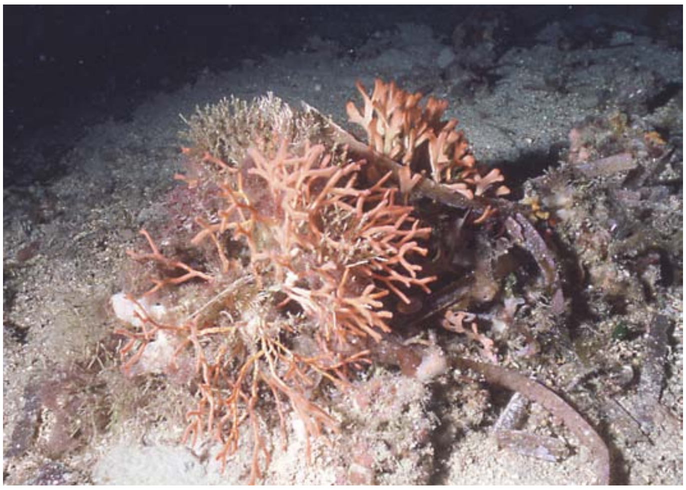
IV.2.2.10. Facies with large bryozoans



Facies with large bryozoans

Reference code for identification:
RAC/SPA: IV.2.2.10

Biocenosis of the coastal detritic bottom
IV.2.2

1 – Location

Clean detritic beds, between 30 and 100 metres down, well supplied by currents, bearing a rich epiflora and epifauna.

2 – Description

The facies is characterised by the frequent presence of major colonies of arborescent bryozoans, unattached or fixed to small substrata. These bryozoans are mainly *Pentapora fascialis, Smittina cervicornis, Reteporella* spp., *Myriapora truncata, Cellaria* spp. Cheilostomes, and also Cyclostomes such as *Hornera lichenoides* and *H. frondiculata*. These species are also frequent on ill-lit rock faces and are then associated with the coralligenous biocenosis. Colonies of large bryozoans can form plurispecific aggregates and are often associated with concretions and nodules of calcified algae, sciaphilous soft algae like *Halarachnion spatulatum, Vidalia volubilis*, and big fixed invertebrates like the hydrozoans, the alcyonarians and simple ascidians.

3 – Main recognition criteria

A coastal detritic bearing many big highly colourful colonies of arborescent bryozoans.

4 – Possible confusion

None if there is really an association of detritic sands with the big colonies of bryozoans.

5 – Conservation interest

These species of big erect bryozoans are sensitive to pollution and to human activities that are likely to modify the sedimentation rate and that of sedimentary additions. They are indicators of clean environments. They are also counted among the heritage species.

6 – Ongoing trends, vulnerability and potential threats

This facies has disappeared from urbanised areas (increase in turbidity and pollution) and survives on the cleanest detritic beds that are well supplied with currents. Trawling has a very harmful effect on this facies.

7 – Conservation status and management

Monitoring the quality of the littoral water. Strict management of fishing, particularly bottom trawls.

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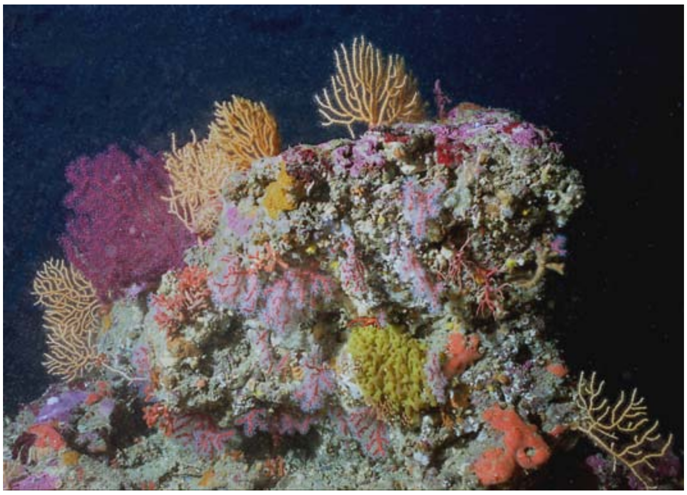
IV.3. HARD BEDS AND ROCKS

IV.3.1. Coralligenous biocenosis



Coralligenous biocenosis

Reference codes for identification:
RAC/SPA: IV.3.1
EUR 15 1170
CORINE 11251

1 – Location of the biocenosis

Stage	Circalittoral
Nature of substratum	Rocky, organogenous
Bathymetrical distribution	10-90 metres
Position	Open sea
Hydrodynamics	Average
Salinity	Normal
Temperature	Normal

2 – Description of the biocenosis

The distribution of the coralligenous population is subject to a combination of decisive biotic and abiotic factors. The main factors are light, movement of the water, temperature, the deposit of sediment and biological interactions.
The coralligenous is found on rock faces or on rocks where calcareous algae can form biogenous constructions. Due to their sensitivity to light, these calcareous algae are restricted upwards by strong illumination and have an extension downwards, restricted by the quantity of luminous energy needed for their photosynthesis. The average depth of this habitat is between 30 and 90 metres. When the water is very clear, the coralligenous begins and ends very deep (60-130 metres), but when the water is turbid, it rises to shallower depths (10/15-40 metres). Such a rise may also be seen along dimly lit rock faces (north-facing, for example). The thermal scope of seasonal variation for this habitat is variable, and a certain tolerance of fluctuation in salinity has been observed; however, the sedimentation of fine particles is particularly harmful.

The coralligenous can present various physiognomical types between the two most typical forms on our coasts, which are:

- the rock wall coralligenous which covers the rocky substrata beyond the photophilous algae (III.6.1.), with more or less thick concretions and an abundance of big erect invertebrates, such as the *Paramuricea clavata, Eunicella* spp., *Lophogorgia sarmentosa* gorgonians and the *Axinella polypoides* sponge
- the coralligenous concretion forming biogenous clumps that can be several metres thick and cover big horizontal or non-horizontal surfaces. The essential species are the constructive Corallinaceae and Peyssonneliaceae species; the structure of these clumps is highly anfractuous, with many cavities of great richness (parts of the biocenosis of semi-dark caves, IV.3.2.).

3 – Main recognition criteria

Greater or lesser biogenous constructions on rock faces or as clumps on the bed. Abundance of big erect invertebrates. This habitat is located mainly between 30 and 90 metres and forms landscapes of great aesthetic value.
Phytosociological nomenclature: alliances: *Lithophyllion grandiusculi* Giaccone 1965; associations: *Lithophyllo-Halimedetum tunae* Giaccone 1965, *Rodriguezelletum strafforelli* Augier and Boudouresque 1975, *Phymatholitho-Lithothamnietum coralloides* Giaccone 1965.

4 – Characteristic/indicator species

The biodiversity in this habitat is very high; the most typical species are:
Corallinaceae algae: *Mesophyllum alternans, Lithophyllum cabiochae, L. frondosum, Pseudolithophyllum expansum*
Peyssonneliaceae algae: *Peyssonnelia rosa-marina, Peyssonnelia rubra*
Soft algae: *Cystoseira usneoides, C. opuncioides, C. zosteroides, C. funkii, Halimeda tuna, Flabellia petiolata*
Sponges: *Axinella polypoides, Spongia agaricina*
Cnidarians: *Paramuricea clavata, Eunicella cavolinii, E. singularis, E. verrucosa, Lophogorgia sarmentosa, Alcyonium acaule, Gerardia savaglia, Parerythropodium coralloides*
Bryozoans: *Adeonella calveti, Hornera lichenoides, H. frondiculata, Myriapora truncata, Pentopora fascialis, Smittina cervicornis, Schizomavella mamillata*
Polychaetes: *Amphitrite rubra, Bispira volutacornis, Eunice aphroditois, E. oerstedii, E. torquata, Haplosyllis spongicola, Glycera tesselata, Trypanosyllis zebra, Palola siciliensis*
Molluscs: *Lithophaga lithophaga, Luria lurida, Triphora perversa, Muricopsis cristatus, Chlamys multistriatus, Pteria hirundo*
Sipunculids: *Phascolosoma granulatum, Aspidosiphon* sp.
Echinoderms:*Astrospartus mediterraneus, Antedon mediterraneus, Centrostephanus longispinus, Echinus melo*
Crustaceans: *Palinurus elephas, Homarus gammarus, Lissa chiragra, Periclimenes scriptus, Scyllarides latus*

Ascidian: *Microcosmus sabatieri*
Fishes: *Anthias anthias, Labrus bimaculatus, Scorpaena scrofa, Acantholabrus palloni, Lappanella fasciata*.

5 – Associated habitats or those in contact

Possible contact with the following biocenoses: photophilous algae (III.6.1.), *Posidonia* meadows (III.5.1.), semi-dark caves (IV.3.2.), coastal detritic bottom (IV.2.2.).

6 – Possible confusion

The border with the lower horizon of the photophilous algae (III.6.1.) is sometimes difficult to place, since many coralligenous species rise into this horizon and can constitute a facies in enclave (III.6.1.35.).
Similarly, the transition to the semi-dark caves (IV.3.2.) is difficult to determine, since this can form a mosaic in substratum of the big erect invertebrates and in the anfractuosities.

7 – Conservation interest

The coralligenous is considered to be an ecological crossroads that brings together, thanks to the habitat's extreme structural heterogeneity, a large number of cenotic compartments from the biocenosis of infralittoral algae to that of the bathyal muds. The growth of calcareous algae, consolidated and compacted by constructor invertebrates, shapes anfractuosities which, remodelled by borers, will constitute networks of cavities that shelter a rich and varied fauna with often very diverse relationships and needs.
This richness and great diversity make the coralligenous one of the most ecologically valuable habitats in the Mediterranean.

8 – Progressive trends and potential threats

The existence of the coralligenous is dominated by bioconstruction/biodestruction dynamics. The Corallinaceae and Peyssonneliaceae algae, as well as some constructor invertebrates or those with calcareous tests, participate in the biogenous construction of the formation, while a set of species (*Cliona* spp. sponges, sipunculids, boring molluscs, and more rarely polychaetes) eat away at and destroy the calcareous constructions. Certain environmental disbalances, such as pollution of the water, can considerably diminish the constructive activity of certain groups and favourise the development of the borers.
Like all littoral habitats, the coralligenous is subject to the effects of pollution, fishing and underwater tourism.
Basically, pollution of the water acts on the coralligenous in two ways: through the chemical quality of the water and the concentration of suspended matter in that water.
The action of the pollution is shown in a dwindling of the overall specific richness (45%), a drop in the density of individuals (75% reduction); the constructive activity

slows down and that of the borers speeds up. The cavities are filled in with sediment. Unchecked fishing has modified the structure of the populations, with certain species of crustacean (rock lobster, lobster and slipper lobster) and fish (grouper, brown meagre) becoming rare.
The increase of mooring in certain areas can damage the epibiosis of the rocks. Excessive frequentation can have a harmful effect: deliberate or accidental pulling out, removal of species, displacement of rocks, disturbance of some big species.
Invasion by *Caulerpa taxifolia* can be considered as a serious potential danger.

9 – Conservation status and management

Monitoring the quality of the littoral water. Strict management of fishing, particularly moratoriums for certain species, like the grouper, to make sure that populations that have been practically destroyed can be reconstituted. Management of and education for underwater tourism, especially underwater diving.
Some areas have coralligenous concretions of great aesthetic value and must be protected by being listed as a protected site or reserve.
Monitoring the expansion of *Caulerpa taxifolia*.

10 – Facies and associations

Various facies and associations have been described in this habitat, among these being:

-Association with *Cystoseira zosteroides* – IV.3.11.
-Association with *Cystoseira usneoides* – IV.3.1.2.
-Association with *Cystoseira dubia* – IV.3.1.3
-Association with *Cystoseira corniculata* – IV.3.1.4.
-Association with *Sargassum* spp. (indigenous) – IV.3.1.5
-Association with *Laminaria ochroleuca* – IV.3.1.8.
-Association with *Rodriguezella strafforelli* – IV.3.1.9.
-Facies with *Eunicella cavolinii* – IV.3.1.10.
-Facies with *Eunicella singularis* – IV.3.1.11.
-Facies with *Lophogorgia sarmentosa* – IV.3.1.12.
-Facies with *Paramuricea clavata* – IV.3.1.13.
-Coralligenous platforms – IV.3.1.15.

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IV.3.1.1. Association with Cystoseira zosteroides

Association with *Cystoseira zosteroides*

Reference code for identification:
RAC/SPA: IV.3.1.1.

Coralligenous biocenosis
IV.3.1.

1 – Location

Ill-lit hard substrata, always below 15 metres down, subject to strong currents and oligotrophic conditions..

2 – Description

Presence of the *Cystoseira zosteroides* Fucophycea. The association can include in its higher levels both sciaphilous and photophilous species such as *Phyllariopsis brevipes, Arthrocladia villosa, Sporochnus pedunculatus, Cutleria monoica, Dictyota dichotoma, Dictyopteris membranacea, Halopteris filicina* and *Polysiphonia foeniculacea*. Sciaphilous adnate forms such as *Lithophyllum incrustans, Mesophyllum alternans* and *Peyssonnelia rosa-marina* represent a great part of the population. The association is mixed with the big erect invertebrate species of the coralligenous, like the *Axinella polypoides* sponge and the *Paramuricea clavata* and *Eunicella cavolinii* gorgonians.

3 – Main recognition criteria

Coralligenous with *Cystoseira zosteroide*s in a raised stratum, sometimes associated with gorgonians. *Cystoseira zosteroide*s is characterised by a raised thallus with thin distal branches, and thick vesicles (tophules) on the lower branches.

4 – Possible confusion

Possible confusion with other associations with *Cystoseira* in the coralligenous.

5 – Conservation interest

The *Cystoseira zosteroides* species is a perennial species, endemic in the Mediterranean, and, like all *Cystoseiras*, is sensitive to the quality of the water. Like other aspects of the coralligenous, this population has a high biodiversity.

6 – Ongoing trends

This association has probably dwindled markedly with the urbanisation of the littoral. Today it is especially present in deep rocky sites bathed in the shelf-edge waters.

7 – Conservation status and management

Monitoring the quality of the littoral water. Very strict management of fishing. Management of and education for underwater tourism, particularly underwater diving.

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IV.3.1.2. Association with Cystoseira usneoides

Association with *Cystoseira usneoides*

Reference code for identification:
RAC/SPA: IV.3.1.2.

Coralligenous biocenosis
IV.3.1

1 – Location

Relatively deep rocky areas crossed by currents.

2 – Description

Presence of the *Cystoseira usneoides* Phaeophycea. Giaccone, who described the association, mentions the *Laminaria ochroleuca, Phyllariopsis purpurascens, Ulva olivascens, Callophyllis laciniata* and *Phyllophora heredia* algae.

3 – Main recognition criteria

Presence of *Cystoseira usneoides.*

4 – Possible confusion

Possible confusion with other associations with *Cystoseira* in the coralligenous.

5 – Conservation interest

Like all the aspects of the coralligenous, this population has a high biodiversity.

6 – Conservation status and management

Monitoring the quality of the littoral water. Very strict management of fishing. Management of and education for underwater tourism, particularly underwater diving.

7 – Bibliographical references

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IV.3.1.3. Association with Cystoseira dubia

Association with *Cystoseira dubia*

Reference code for identification:
RAC/SPA: IV.3.1.3.

Coralligenous biocenosis
IV.3.1.

1 – Location

Hard substratum subject to weak hydrodynamics; relatively strong sedimentation. The association has been described between 25 and 45 metres.

2 – Description

Presence of the *Cystoseira dubia* Phaeophycea. The association was described with *Nithophyllum tristomaticum, Peyssonnelia rubra, Ceramium bertholdii* and *Kallymenia patens*. According to Giaccone, only *C. dubia, N. tristomaticum* and *K. patens* are characteristic species. Three vegetal strata can be made out in the population: a raised stratum with various scattered *Cystoseira*s *(C. spinosa, C. zosteroides)* and *Sargassums (S. acinarium, S. vulgare*); a very dense intermediary stratum with *C. dubia*, rich in epiphytes, and a crust-forming stratum of calcareous algae. A very rich fauna made up of bryozoans, molluscs and polychaetes lives in these different strata.

3 – Main recognition criteria

Coralligenous with *Cystoseira dubia* as a very dense stratum.

4 – Possible confusion

Possible confusion with other associations with *Cystoseira* in the coralligenous.

5 – Conservation interest

The *Cystoseira dubia* species is an endemic of the Mediterranean and, like all the *Cystoseira*s, is sensitive to the quality of the water. Like all the aspects of the coralligenous, this population has a high biodiversity.

6 – Conservation status and management

Monitoring the quality of the littoral water. Very strict management of fishing. Management of and education for underwater tourism, particularly underwater diving.

7 – Bibliographical references

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IV.3.1.4. Association with Cystoseira corniculata

Association with *Cystoseira corniculata*

Reference code for identification:
RAC/SPA: IV.3.1.4.

Coralligenous biocenosis
IV.3.1.

1 – Location

Hard substrata in the circalittoral stage.

2 – Description

Giaccone thinks that this is merely a phytosociological grouping, not an association.

3 – Main recognition criteria

Coralligenous with *Cystoseira corniculata*.

4 – Possible confusion

Possible confusion with other associations with *Cystoseira* in the coralligenous.

5 – Conservation interest

The *Cystoseira corniculata* species is an endemic of the Mediterranean and, like the other *Cystoseira*s, sensitive to the quality of the water. Like all the aspects of the coralligenous, this population has a high biodiversity.

6 – Conservation status and management

Monitoring the quality of the littoral water. Very strict management of fishing. Management of and education for underwater tourism, particularly underwater diving.

7 – Bibliographical references

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IV.3.1.5. Association with Sargassum spp. (indigenous)

Association with *Sargassum* spp.

Reference code for identification:
RAC/SPA: IV.3.1.5.

Coralligenous biocenosis
IV.3.1.

1 – Location

Hard substratum, simultaneously relatively deep and well-lit, in the oligotrophic environment.

2 – Description

A raised stratum of *Sargassum hornschuchii* in a relatively well-lit area. Giaccone *et al.*, 1994, think that this species is an alliance characteristic and that it is common with other associations: associations with *Cystoseira zosteroides* (IV.3.1.1.), with *C. usneoides* (IV.3.1.2.) and with *C. dubia* (IV.3.1.3.).

3 – Main recognition criteria

Coralligenous with a raised stratum of *Sargassum hornschuchii*.

4 – Possible confusion

Possible confusion with the infralittoral *Sargassums*: association with *Sargassum vulgare* (IV.6.1.20.), corresponding to the biocenosis of infralittoral algae.

5 – Conservation interest

A species of great aesthetic interest.

6 – Conservation status and management

Monitoring the quality of the littoral water. Management of and education for underwater tourism, particularly underwater diving.

7 – Bibliographical references

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IV.3.1.8. Association with Laminaria ochroleuca

Association with *Laminaria ochroleuca*

Reference code for identification:
RAC/SPA: IV.3.1.8.

Coralligenous biocenosis
IV.3.1.

1 – Location

Hard or detritic substratum, with sparse rocks between 30 and 80 metres down in areas with a strong current (Strait of Messina, Alboran, Algerian coasts) affected by the Atlantic influx. It would appear that the densest populations are located at about 50 metres down.

2 – Description

Dense populations of big *Laminaria ochroleuca*: stipes that can be 6 metres high and fronds in wide blades that can form a continuous canopy; densities of the order of one adult per 2 square metres or more. The substratum population is sciaphilous, with the substrata and spikes heavily covered in calcareous algae, sponges, bryozoans and ascidians. The three-dimensional development of this kelp offers habitats to a diversified fish fauna. Giaccone thinks that this association is probably a sub-association of the association with *Cystoseira usneoides.*

3 – Main recognition criteria

Presence of *Laminaria ochroleuca*.

4 – Possible confusion

No confusion possible.

5 – Conservation interest

These are extremely rare populations, restricted to a few sites in the south-western Mediterranean.

6 – Conservation status and management

Protecting areas where trawling is carried on.

7 – Bibliographical references

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Compiled by: D. BELLAN-SANTINI, G. BELLAN and J. G. HARMELIN

Crédit photographique : J. G. HARMELIN

IV.3.1.9. Association with Rodriguezella strafforelli

Association with *Rodriguezella strafforelli*

Reference code for identification:
RAC/SPA: IV.3.1.9.

Coralligenous biocenosis
IV.3.1.

1 – Location

Hard ill-lit substratum, in a sheltered environment, about 30-45 metres down.

2 – Description

The association was described in 1975 by Augier and Boudouresque and contains as other characteristic plant species *Blastophysa rhizopus, Ceramium bertholdii, Polysiphonia subulifera*, *Rodriguezella pinnata, Spermothamnion johannis* and *Sphacelaria plumula.*

3 – Main recognition criteria

Coralligenous with the red alga *Rodriguezella strafforelli* in a raised stratum.

4 – Possible confusion

Possible confusion with the other raised algal stratum associations.

5 – Conservation interest

A species of great aesthetic interest.

6 – Conservation status and management

Monitoring the quality of the littoral water.

7 – Bibliographical references

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Crédit photographique : M. VERLAQUE

IV.3.1.10. Facies with Eunicella cavolinii

Facies with *Eunicella cavolinii*

Reference code for identification:
RAC/SPA: IV.3.1.10.

Coralligenous biocenosis
IV.3.1.

1 – Location

Rocky areas, usually vertical or overhanging faces, with variable current conditions and able to withstand a very slight sedimentary deposit; can descend to 150 metres down.

2 – Description

A raised stratum of *Eunicella cavolinii* on a surface that is often built into a concretion by algae associated with various animal species such as the crust-forming and erect bryozoans *Schizomavella* spp., *Pentapora fascialis, Turbicellepora avicularis, Celleporina caminata* and *Myriapora truncata*, Serpulidae, cnidarians like *Parerythropodium coralloides, Alcyonium acaule, Leptopsammia pruvoti* and *Caryophyllia smithii*, ascidians like *Halocynthia papillosa* and *Microcosmus sabatieri*.

3 – Main recognition criteria

Coralligenous with a raised stratum dominated by *Eunicella cavolinii* **(**a yellow gorgonian).

4 – Possible confusion

Possible confusion with the facies with the sometimes similarly coloured *Lophogorgia sarmentosa* gorgonians.

5 – Conservation interest

Gorgonian landscapes have great aesthetic value for underwater tourism.

6 – Ongoing trends

Cases of mass mortality associated with positive anomalies in the temperature, which were observed in the north-western Mediterranean in 1999, could indicate a trend towards the dwindling of the least deep populations of *E. cavolinii*.

7 – Conservation status and management

Monitoring the quality of the littoral water. Management of and education for underwater tourism, especially underwater diving.

8 – Bibliographical references

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Compiled by: D. BELLAN-SANTINI, G. BELLAN and J. G. HARMELIN

Crédit photographique : J. G. HARMELIN

IV.3.1.11. Facies with Eunicella singularis

Facies with *Eunicella singularis*

Reference code for identification:
RAC/SPA: IV.3.1.11.

Coralligenous biocenosis
IV.3.1.

1 – Location

Rocky areas, with usually not much of a slope and relatively well-lit, where the water is generously renewed by the currents; may descend to 70 metres down.

2 – Description

A raised stratum of *Eunicella singularis* (= *E. stricta*). Often associated with erect brown algae.

3 – Main recognition criteria

Coralligenous with a raised stratum dominated by *Eunicella singularis* **(**a white or greenish gorgonian).

4 – Possible confusion

Difficult to confuse with other facies with gorgonians, which are differently coloured.

5 – Conservation interest

Gorgonian landscapes have great aesthetic value for underwater tourism.

6 – Ongoing trends

Cases of mass mortality associated with positive anomalies in the temperature were observed in the north-western Mediterranean in 1999; these could indicate a trend towards the dwindling of the least deep populations of *E. singularis*.

7 – Conservation status and management

Monitoring the quality of the littoral water. Management of and education for underwater tourism, especially underwater diving.

8 – Bibliographical references

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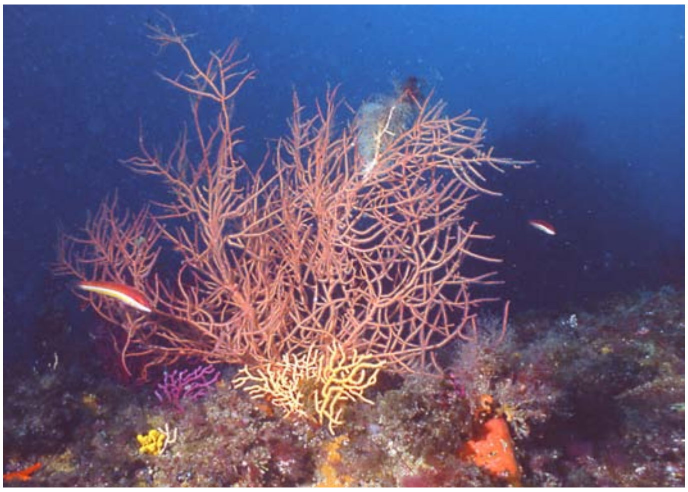
Crédit photographique : J. G. HARMELIN

IV.3.1.12. Facies with *Lophogorgia sarmentosa*



Facies with Lophogorgia sarmentosa

Reference code for identification:
RAC/SPA: IV.3.1.12.

Coralligenous biocenosis
IV.3.1.

1 – Location

Rocky or loose areas, with scattered rocky blocks or detritic, with moderate-to-strong currents, often subject to heavy sedimentation with fine particles.

2 – Description

Big *Lophogorgia sarmentosa (=Leptogorgia ceratophyta)* gorgonians with thin branches that are usually developed at several levels; yellow to orange colour, forming sparse groups on rocky beds with or without concretions, or on substrata scattered over loose beds, from 15 to 300 metres down.

3 – Main recognition criteria

Abundant presence of *Lophogorgia sarmentosa,* a big, flexible gorgonian of light yellow to brick red colour, with bushy ramification and thin terminal branches varying in colour from white and yellow to red.

4 – Possible confusion

Possible confusion with the facies with yellow *Eunicella cavolinii* gorgonians.

5 – Conservation interest

Gorgonian landscapes have great aesthetic value for underwater tourism.

6 – Ongoing trends

Their increasing abundance may correspond to an increase in fine sedimentation or to a greater influence of Atlantic-origin elements.

7 – Conservation status and management

Monitoring the quality of the littoral water. Management of and education for underwater tourism, especially underwater diving.

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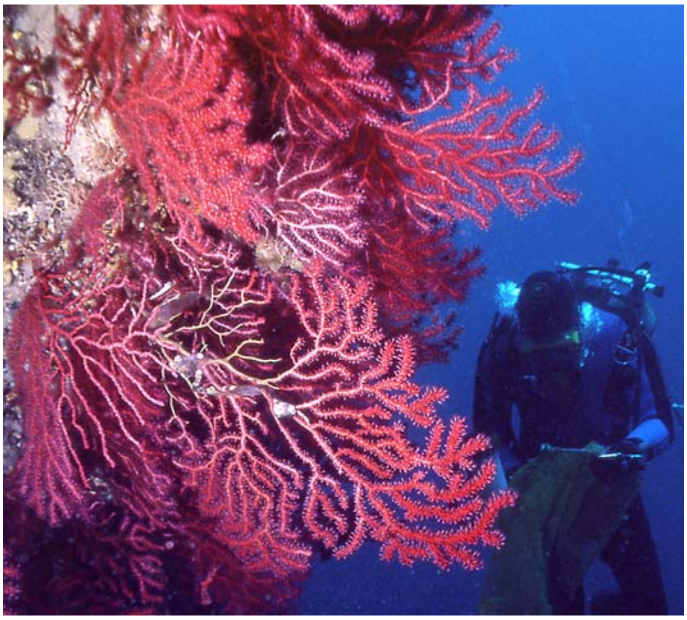
Crédit photographique : J. G. HARMELIN

IV.3.1.13. Facies with *Paramuricea clavata*



Facies with *Paramuricea clavata*

Reference code for identification:
RAC/SPA: IV.3.1.13.

Coralligenous biocenosis
IV.3.1.

1 – Location

Uneven rocky areas, often on vertical or overhanging faces, very well shaded, with moderate-to-strong currents, between 10 and 100 metres down.

2 – Description

A raised stratum dominated by the *Paramuricea clavata* gorgonian. The lower stratum is very rich; there are found the cnidarians *Caryophyllia smithii, Hoplangia durotrix, Leptopsammia pruvoti, Corallium rubrum*, the bryozoans *Celleporina caminata, Schizomavela mamillata, Smittina cervicornis, Myriapora truncata*, Serpulidae, the sponges *Ircinia variabilis, Spongia officinalis, Sarcotragus spinosula, Cacospongia scalaris, i, Aplysina cavernicola, Erylus euastrum* and *Agelas oroides*, and the molluscs *Serpulorbis arenarius* and *Lithophaga lithophaga*. An intermediary level includes invertebrates colonising parts of the branches, such as the cnidarian *Parerythropodium coralloides*, the bryozoans *Adeonella calveti, Turbicellepora avicularis, Reteporella* spp. and *Pentapora fascialis*, and the molluscs *Pteria hirundo* and *Anomia ephippium.*

3 – Main recognition criteria

Coralligenous with raised stratum dominated by *Paramuricea clavata*, a purplish red gorgonian, big (0.5 to over 1 metre), fragile, branching on one level, forming high-density groups.

4 – Possible confusion

Little confusion possible with the other facies with gorgonians.

5 – Conservation interest

Gorgonian landscapes have great aesthetic value for underwater tourism.
The facies with *Paramuricea clavata* has a major structuring role for the coralligenous biocenosis. It is seen as a good indicator of environmental quality.

6 – Ongoing trends

This facies is subject to impacts from mooring, nets and careless frequentation of sites by divers. Worse, an increase in pollution can eliminate it. This gorgonian also seems very sensitive to the rise in temperatures in the summer, as was shown by a recent catastrophic mortality episode after a long positive anomaly of the temperature in the 0-40 metres area.

7 – Conservation status and management

Monitoring the quality of the littoral water. Management of and education for underwater tourism, especially underwater diving. Restricting mooring on the sites bearing this facies.

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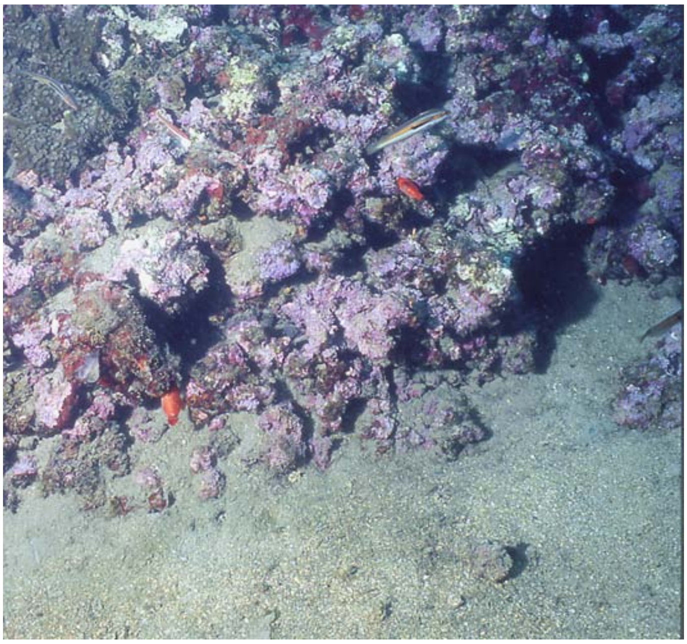
IV.3.1.15 Coralligenous platforms



Coralligenous platforms

Reference code for identification:
RAC/SPA: IV.3.1.15.

Coralligenous biocenosis
IV.3.1.

1 – Location

Horizontal coralligenous formations developing within sedimentary beds that are well supplied by currents, up to over 100 metres down in clear water.

2 – Description

Concretion formations within detritic or loose beds and usually horizontal. These formations are not usually built on rocky substrata but result from the active development of constructor organisms (calcified algae, hard-skeleton invertebrates) from scattered figured elements on loose beds, shells, stones and gravels. The thickness of these coralligenous formations can vary between a few centimetres and several metres. This type of coralligenous then constitutes slab platforms, thus giving its name to this very specific facies.

3 – Main recognition criteria

Coralligenous in a horizontal position, not associated with big rocky formations.

4 – Possible confusion

Possible confusion with the coralligenous present on horizontal rocky slabs.

5 – Conservation interest

These rare landscapes have great aesthetic value for underwater tourism. A habitat that shelters species of great commercial value (fishes, big crustaceans, red coral).

6 – Ongoing trends

Given the horizontal position, these beds are subject to sedimentation. When this is more active than the organisms' construction activity, muddiness causes this type of coralligenous to die. Vulnerable to trawling.

7 – Conservation status and management

Monitoring the quality of the littoral water, particularly sedimentation. Management of and education for underwater tourism, especially underwater diving.

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IV.3.2. Semi-dark caves (also in enclave in upper stages)

Biocenosis of semi-dark caves

Reference code for identification:
RAC/SPA: IV.3.2
EUR 15 8330
CORINE 1126

1 – Location of the biocenosis

Stage	Circalittoral, but possible rise into the infralittoral
Nature of substratum	Rocky, bioconstruction
Bathymetrical distribution	3 to 60 metres at least
Position	Open sea
Hydrodynamics	Low
Salinity	Normal
Temperature	Normal

2 – Description of the habitat

The front parts of caves and tunnels, overhangs and vertical faces. This habitat constitutes the transition between the beds of hard substrata with concretions, where the calcareous algae and other sciaphilous algae play a basic part, and the caves in total darkness, where the physical environment is extremely selective and the population is exclusively animal. In this habitat, light and water movement diminish rapidly the greater the distance from the entrance to the cave (i.e. the open sea) and according to topographical factors. As a result, there is a tendency to environmental stability, which increases with the distance from the entrance, and a drop in the presence and abundance of certain groups of organisms (like passive filterers). This biocenosis is characterised by a frequent juxtaposition of facies, partly linked to the variability of the habitat caused by the environmental topography, but also certainly resulting from historical recruitment events. The biocenosis of semi-dark caves only contains a few rare sciaphilous algae, restricted to the area that is nearest to the outside environment, and has no herbivores. The trophic network is thus composed of filterers, scavengers and carnivores only. A confinement appears following a gradient that goes from the outside to the inside of the cave, with a drop in external additions, and a development of organisms that are not very demanding or are well adapted to exploiting a weak, unpredictable trophic resource.

3 – Main recognition criteria

The front parts of caves, overhangs and steep rock faces, where the light is greatly dimmed, populated by many sessile invertebrate species, and constituting landscapes of great aesthetic value.

4 – Characteristic/indicator species

This biocenosis is essentially animal, with a marked dominance of sessile invertebrates like sponges, madrepores and bryozoans.
Sponges: *Petrosia ficiformis, Aplysina cavernicola, Oscarella lobularis, Agelas oroides, Reniera fulva, R. viscosa*
Cnidarians: *Parazoanthus axinellae, Caryophyllia inornata, Corallium rubrum, Leptopsammia pruvoti, Hoplangia durotrix, Phyllangia mouchezi, Eudendrium racemosum, Campanularia biscupidata, Halecium beani*
Bryozoans: *Celleporina caminata, Adeonella calveti, Escharoides coccinea, Reteporella mediterranea, Smittoidea reticulata*
Crustaceans: *Lysmata seticaudata, Scyllarides latus, Scyllarus arctus*
The ascidian: *Pyura vittata*
Fishes: *Phycis phycis, Apogon imberbis, Thorogobius ephippiatus*
Plants: *Peyssonnelia* sp., *Palmophyllum crassum.*

5 – Associated habitats or those in contact

Following the light gradient, which is often found at depth or according to the distance from the entrances to the cavities, the coralligenous biocenosis (IV.3.1.), the semi-dark caves (IV.3.2.) and the caves and ducts in total darkness (V.3.2.) are found in succession.

6 – Possible confusion

When this biocenosis occupies the cavities in the coralligenous concretion (IV.3.1.) or the substratum of big arborescent invertebrates (mainly gorgonians) in the coralligenous, it may not be recognised, and could be confused with this.

7 – Conservation interest

This habitat is extremely interesting in that it contains species of great heritage value. These species also enable *in situ* observation of the action of certain dominant factors on organisms and their life cycles.

8 – Ongoing trends and potential threats

The caves constitute landscapes of great aesthetic value. They are thus frequently visited by divers, particularly when they are richly coloured and easily reached, like the semi-dark caves. Over-frequentation can stir up the mud on the floors, cause bubbles to accumulate on the roofs, and multiply contacts with the organisms, thus endangering the population balance.
The exploiting of red coral, with its great market value for jewelry, is regulated at national and international level, but these management measures must be strictly enforced since current data shows variable, but usually extremely weak, growth rates. Facies with coral have recently experienced mass mortalities, the most often mentioned causes of which are water quality or thermal anomalies (excessive warming).

9 – Conservation status and management

Correct management of this habitat involves three sets of measures:
-monitoring the quality of the water and pollution, particularly concentrations of organic matter
-managing frequentation and educating those people who carry on underwater activities
-strictly respecting the rules and regulations on coral fishing.

10 – Facies and associations

-Facies with *Parazoanthus axinellae* (IV.3.2.1.) when the water is very rough and the light less dim
-Facies with *Corallium rubrum* (IV.3.2.2.), covers the walls of the caves, the cavities with coralligenous concretions, and the semi-dark overhangs
-Facies with *Leptopsammia pruvoti* and *Agelas oroides* (IV.3.2.3.) under the overhangs and at the entrances to the caves
-Facies with the scleractinians *Polycyathus muellerae, Caryophyllia inornata* and *Hoplangia durotrix*, located in the crevices or the cavities of the walls of the caves where the darkness is greatest
-Facies with big bryozoans such as *Adeonella calveti* near the entrances to the caves
-Impoverishment facies linked to more intense hydrodynamics, with an abundance of hydrozoans: *Sertularella, Eudendrium.*

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IV.3.2.2. Facies with Corallium rubrum

Facies with *Corallium rubrum*

Reference code for identification:
RAC/SPA: IV.3.2.2.

Biocenosis of semi-dark caves
IV.3.2

1 – Location

Semi-dark areas, walls of caves, cavities with coralligenous concretions, overhangs and deep sea rocks. Vertical distribution from 10 to over 200 metres.

2 – Description

Aggregations of *Corallium rubrum* colonies able to cover large areas, usually associated with many sponges (e.g. *Reniera fulva, R. viscosa, Crella mollior, Aplysina cavernicola, Petrosia ficiformis, Pleraplysilla spinifera*), scleractinians *(Leptopsammia pruvoti, Caryophyllia inornata, Hoplangia durotrix*), and bryozoans (e.g. *Smittina cervicornis, Smittoidea reticulata, Celleporina caminata, Disporella neapolitana*).

3 – Main recognition criteria

Red coral present in abundance.

4 – Possible confusion

No possible confusion. The false coral (*Myriapora truncata*), which can abound in habitats that are favourable to red coral, is an erect bryozoan that is quite recognisable by its more orange colour and its very cylindrical ramifications.

5 – Conservation interest

The walls with coral are of great aesthetic value for underwater tourism and high market value if correctly exploited (selective removal of branches of a certain size), since this cnidarian grows extremely slowly.

6 – Ongoing trends

Over-frequentation by divers in the caves and overhangs that are rich in red coral can provoke the breaking of colonies and stir up the mud of the bed into suspension, which harms the coral. The aesthetic quality of the sites can be destroyed by poaching and the excessive professional harvesting of little colonies.

7 – Conservation status and management

Correct management of this habitat involves three sets of measures:
-monitoring the quality of the water and pollution, particularly the concentrations of organic matter
-managing frequentation and educating those who dive for pleasure
-strictly respecting the regulations on coral fishing and enforcing a minimum size and/or depth of exploitation.
The coral facies has recently experienced massive mortalities probably due to thermal anomalies (excessive warming in the summer) for superficial populations and to the action of a contaminant for populations at greater depths.

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V – BATHYAL

V.1. MUDS

V.1.1. Biocenosis of bathyal muds

Biocenosis of bathyal muds

Reference code for identification:
RAC/SPA: V.1.1.

1 – Location of the biocenosis

Stage	Bathyal
Nature of substratum	Fluid to compact mud, sometimes a bit sandy
Bathymetrical distribution	Below 150 to 250 metres down to the lowest depths
Position	Open sea, wide
Hydrodynamics	Calm in the bathyal plains, currents more marked on the continental slope, tops and sides of canyons
Salinity	Normal
Temperature	Homoeothermy around 13°C

2 – Description of the biocenosis

Vast stretches of clayey mud, usually compact, yellowish or bluish grey, relatively substantial, continuing at greater depth the biocenosis of coastal terrigenous muds (IV.1.1.) or the biocenosis of shelf-edge detritic bottom (IV.2.3.). The biocenosis of bathyal muds is characterised by a constant homoeothermy of around 13°C and an almost total absence of light. The granulometry and thickness of the sediment is not homogeneous. The sides of the canyons are covered with a fluid mud, sometimes merely a simple film. Sandy muds are quite frequent in the upper horizon but more exceptional underneath. Modifications in the granulometry and thickness of the mud, and additions of exogenous organic matter, result in the appearance of special facies.

3 – Main recognition criteria

Stretches of mud at depths greater than 150-250 metres.

4 – Characteristic/indicator species

The foraminifer *Cyclamina cancellata*
The sponges *Asconema setubalense, Pheronema grayi* and *Thenea muricata* (and its epibiont *Parazoanthus marioni*)
The cnidarians *Funiculina quadrangularis, Isidella elongata, Hormathia coronata* and *Actinauge richardi*
The polychaetes *Aphrodite alta = Aphrodita alta, Harmothoe johnstoni, Panthalis oerstedi, Leocrates atlanticus, Neoleanira tetragona, Ophelina aulogaster, Asychis biceps, Nephtys paradoxa*
The crustaceans *Calocaris macandreae, Polycheles typhlops, Pagurus variabilis = Pagurus alatus, Munida* spp., *Paromola cuvieri, Ebalia nux, Geryon tridens = Geryon longipes, Parapenaeus longirostris, Aristeus antennatus* and *Aristeomorpha foliacea*
The molluscs *Dentalium agile, Siphonodentalium quinquangulare = Entalina quinquangularis, Abra longicallus, Modiolus politus = Amygdalum politum, Chlamys septemradiata = Pseudamussium clavatum, Propeamussium vitreum = Delectopecten vitreus, Platydoris dura, Calliostoma suturale, Ranella gigantea = Ranella olearia, Sipho torus, Xenophora mediterranea = Xenophora crispa, Sepietta oweniana, Rossia caroli = Neorossia caroli, Bathypolypus sponsalis*
The pogonophore *Siboglinum carpinei*
The echinoderms *Odontaster mediterraneus, Ceramaster hystricis = Ceramaster grenadensis, Brisingella coronata, Ophiocten abyssicolum, Mesothuria intestinalis, Leptometra celtica*.
Plus a large number of fishes such as: *Capros ater, Macrorophus serratus, Pristiurus melanostomus, Notacanthus bonaparte, Sebastes dactylopterus*.

5 – Associated habitats or those in contact

Above is the biocenosis of shelf-edge detritic bottom (IV.2.3.) and more generally the biocenosis of coastal terrigenous muds (IV.1.1.). Exceptionally adjacent to the biocenosis of bathyal detritic sands (V.2.1.). In the deepest plains and the shafts, below 2,500-3,000 metres, the biocenosis of bathyal muds is enriched by species with abyssal affinities. However, this original population does not seem to form a well characterised biocenosis of abyssal muds, despite the presence of many endemics.

6 – Possible confusion

Given the major faunistic change that appears between the circalittoral and bathyal stages, the possibility of confusion with the biocenosis of coastal terrigenous muds (IV.1.1.) is limited. The same holds good for the biocenosis of bathyal detritic sands (V.2.1.).

7 – Conservation interest

This biocenosis is characterised by a great many species which are infeodated to it, among which are numerous endemics, some of which can be considered as pre-Messinian relicts.

Apparently poor as regards quantity, the bathyal muds do contain populations of deep sea shrimps and fishes that are exploited for their great commercial value.

8 – Ongoing trends and potential threats

The higher levels may be affected by terrigenous additions linked to continental gully erosion, especially after big fires. Also stressed have been major transfers at depth of potentially polluting products, particularly phosphates and organic matter, all of which taken together is suspected of reducing the concentrations of dissolved oxygen in the deep waters; this would be disastrous for the entire benthos. However, the most serious threat today is intensive trawling to fish for the big shrimps and deep-water fish, which not only over-fishes but causes the destruction of facies with epifauna.

9 – Conservation status and management

If possible, using fishing gear that is less destructive of the habitat. Creating reserves.

10 – Facies and associations

V.1.1.1. Facies of sandy muds with *Thenea muricata*
V.1.1.2. Facies of fluid muds with *Bryssopsis lyrifera*
*V.1.1.3. Facies of soft muds with *Funiculina quadrangularis* and *Apporhais seressianus*
*V.1.1.4. Facies of compact muds with *Isidella elongata*
V.1.1.5. Facies with *Pheronema grayi*.

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Compiled by: D. BELLAN-SANTINI, G. BELLAN and J. G. HARMELIN

Crédit photographique : J. G. HARMELIN

V.1.1.3. Facies of soft muds with *Funiculina quadrangularis and Apporhais seressianus*

Facies of soft muds with *Funiculina quadrangularis and Apporhais seressianus*

Reference code for identification:
RAC/SPA: V.1.1.3
Biocenosis of bathyal muds
V.1.1.

1 – Location

The upper part of the continental slope, accentuated slope.

2 – Description

Important development of the cnidarian *Funiculina quadrangularis* and the mollusc *Apporhais seressianus* on soft muds with a fluid superficial film, presence of crustaceans *Parapenaeus longirostris, Nephrops norvegicus.*

3 – Main recognition criteria

Abundance of *Funiculina quadrangularis.*

4 – Possible confusion

In theory, impossible.

5 – Conservation interest

These beds contain abundant populations of marketable crustaceans, particularly *Parapenaeus longirostris* and *Nephrops norvegicus*, and cephalopods (*Eledone cirrosa, Illex illecebrosus coindetii* and *Todaropsis eblanae*) without it being certain whether the *Funiculina quadrangularis* have a particular role.

6 – Ongoing trends, vulnerability and potential threats

Frequent trawling causes the gradual disappearance of this facies.

7 – Conservation status and management

Reducing the pressure of trawling; creating reserves.

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Compiled by: D. BELLAN-SANTINI, G. BELLAN and J. G. HARMELIN

Crédit photographique : J. G. HARMELIN

V.1.1.4. Facies of compact muds with *Isidella elongata*

Facies of soft muds with *Isidella elongata*

Reference code for identification:
RAC/SPA: V.1.1.4

Biocenosis of bathyal muds
V.1.1.

1 – Location

The base of the continental slope and bathyal plain; the slope of the bed cannot be greater than 5%.

2 – Description

Important development of the cnidarian *Isidella elongata* (a white gorgonian with hard joints) on compact muds with little or no slope. Presence of a film of fluid mud above the compact mud, stirred up by the big shrimps. The facies is located between 400 and 800 metres down. The *Isidella elongata* present an epibiosis formed of the actinia *Gephyra (Amphianthus) dohrni*, of *Scalpellum scalpellum,* of a *Chlamys* and of *Scyliorhinidae* eggs. This is a favourite area for the big *Aristeus antennatus* and *Aristeomorpha foliacea* shrimps, which themselves are food for various cephalopods (*Rossia macrosoma, Bathypolypus sponsalis, Sepietta oweniana, Pteroctopus tetracirrhus*) and – especially – fishes.

3 – Main recognition criteria

Presence of *Isidella elongata*.

4 – Possible confusion

In theory, impossible.

5 – Conservation interest

These beds contain abundant populations of marketable crustaceans, particularly *Aristeus antennatus* and *Aristeomorpha foliacea*, without it being certain whether the *Isidella elongata* have a particular role.

6 – Ongoing trends, vulnerability and potential threats

Frequent trawling causes the gradual disappearance of this facies.

7 – Conservation status and management

Reducing the pressure of trawling; creating reserves.

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Compiled by: D. BELLAN-SANTINI, G. BELLAN and J. G. HARMELIN

Crédit photographique : H. ZIBROWIUS

V. 3. HARD BEDS AND ROCKS

V.3.1. Biocenosis of deep sea corals

Biocenosis of deep sea corals

Reference code for identification:
RAC/SPA: V.3.1

1 – Location of the biocenosis

Stage	Bathyal
Nature of substratum	Rocky
Bathymetrical distribution	Below 200 metres
Position	Open sea, slopes of canyons
Hydrodynamics	Subject to currents, including upwellings
Salinity	Normal
Temperature	Homoeothermy at 13°C

2 – Description of the biocenosis

The biocenosis of deep sea corals, also called white corals, imperfectly known in the Mediterranean, basically includes two major ramified forms: *Lophelia prolifera* and *Madrepora oculata*, which are relicts of the cold fauna of the Quaternary. These white coral clumps only exist at appreciable depth, starting from 200 metres down, on the edges of canyons, where the slope and turbulence are sufficient for the hard substratum (standing rock or consolidated thanatocoenosis) to carry little sediment. The living parts of these clumps usually seem to be reduced to the tips of the branches. The dead parts that are not under mud are very much colonised by bryozoans, brachiopods and serpulid polychaetes, and constitute centres of diversity for the sessile fauna of the continental slope.

3 – Main recognition criteria

Presence of *Lophelia prolifera* and *Madrepora oculata*.

4 – Characteristic/indicator species

Cnidarians: *Caryophyllia arcuata = Caryophyllia calveri, Desmophyllum cristagalli, Lophelia prolifera = Lophelia pertusa, Madrepora oculata, Villogorgia bebrycoides*
Polychaetes: *Eunice floridana, Omphalopomopsis fimbriata, Placostegus tridentatus, Acanthicolepis asperrima (= A. cousteaui), Neolagisca drachi*
Molluscs: *Arca nodulosa (=Asperarca nodulosa), Arca obliqua, Spondylus gussonii, Chlamys bruei, Hanleya hanleyi*.

5 – Associated habitats or those in contact

The biocenosis of bathyal muds (V.1.1.).

6 – Possible confusion

None.

7 – Conservation interest

A little represented biocenosis, with very rare and characteristic species.

8 – Ongoing trends, vulnerability and potential threats

Muddiness, particularly during mudslides linked to microseisms. Risk of total destruction linked to trawling.

9 – Conservation status and management

Systematic searching for and precise locating of the concerned populations; banning fishing in the concerned sectors.

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Compiled by: D. BELLAN-SANTINI, G. BELLAN and J. G. HARMELIN

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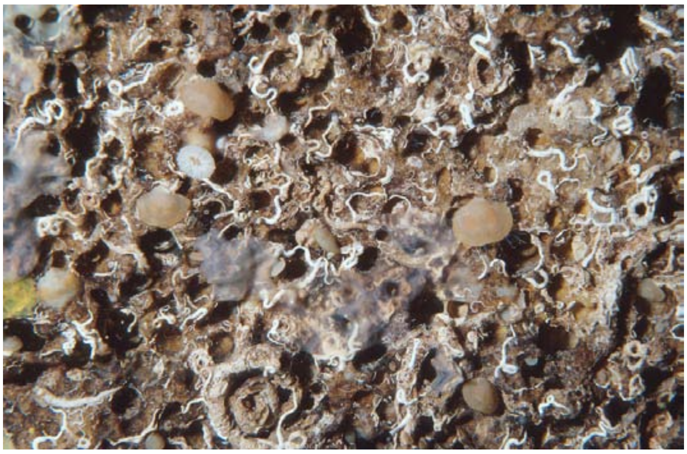
V.3.2. Caves and ducts in total darkness (in enclave in the upper stages)



Biocenosis of caves and ducts in total darkness (CD)

Reference codes for identification:
RAC/SPA: V.3.2
EUR 15 8330

1 – Location of the biocenosis

Stage	Bathyal, rising into the circalittoral
Nature of substratum	Rocky, bioconcretions
Bathymetrical distribution	
Position	More or less confined
Hydrodynamics	Very weak, unless exceptionally
Salinity	Normal, sometimes freshwater seepage
Temperature	Possible anomalies

2 – Description of the habitat

Very large submerged cavities especially present in drowned karstic networks, isolated little cavities and microcavities in heaps of stones and within certain concretions.
The caves in total darkness are enclaves of the aphotic area in the littoral area; they present extremely original environmental conditions, close to those found on the continental slope. The two key factors are the absence of light, which rules out photosynthetic organisms, and confinement, which rules out organisms which have a strong trophic requirement. Water renewal in the dark chambers is usually very slight or occasional and depends on local topographical, bathymetrical and geographical factors. The great hydrological stability is indicated by anomalies of temperature, extremely oligotrophic conditions, and biochemical parameters. Positive thermal anomalies are typical of caves with a rising profile (a frequent case in karstic caves) and negative anomalies have been noticed in the rare caves with a descending profile. The very great reduction in the trophic addition from the outside brings about a drastic selection of the animals established in this habitat. The rate of biological cover of the walls of this habitat may be 80 to 50% in the richest areas but can be almost nil in the

most confined parts. The selection of trophic groups and morphological groups, as well as the spatial organisation, are governed by environmental conditions that are peculiar to each cave. This biocenosis includes a significant portion of typically deep-sea species, the most original of these being found in caves with a descending profile, with a thermal regime similar to that of the Mediterranean deeps.

3 – Main recognition criteria

Crevices and caves that are totally deprived of light, where the prevailing water renewal, temperature and trophic conditions are particularly reminiscent of those of the great depths. The cover rate of the sessile fauna can be very low. The walls are blackened by a coating of iron oxides and manganese oxides.

4 – Characteristic/indicator species

Foraminifers: *Discoramulina bollii*
Sponges: *Petrobiona massiliana, Discoderma polydiscus, Corallistes masoni, Oopsacas minuta, Asbestopluma hypogea, Spirastrella cunctatrix, Merlia deficiens*
Cnidarians: *Guynia annulata, Ceratotrochus magnaghii*
Serpulid polychaetes*: Janita fimbriata, Filogranula annulata, Metavermilia multicristata, Vermiliopsis monodiscus*
Chaetognaths*: Spadella ledoyeri*
Bryozoans: *Puellina pedunculata, Ellisina gautieri, Setosella cavernicola, Liripora violacea, Annectocyma indistincta*
Brachiopods: *Tethyrhynchia mediterranea, Argyrotheca cistellula*
Crustaceans: *Hemimysis speluncula, H. margalefi, Stenopus spinosus, Herbstia condyliata*
Fishes: *Oligopus ater, Gammogobius steinitzi.*

5 – Associated habitats or those in contact

The caves in total darkness (V.3.2.) are usually a continuation of the semi-dark caves (IV.3.2.) when one goes further into a cavity.

6 – Possible confusion

In transitional areas, particularly in well-drained totally dark tunnels, it is sometimes difficult to make out the limits between the semi-dark caves (IV.3.2.) and the caves in total darkness (V.3.2.).

7 – Conservation interest

The caves in total darkness, given the particular conditions prevailing there, are refuge environments for low-competitivity organisms which can withstand the sparse local trophic resources, unlike more dynamic organisms. This refuge effect is spectacularly illustrated in the conservation of relict species (‘living fossils’ of very ancient origin, like the hypercalcified sponge *Petrobiona massiliana*), also favoured by the environmental

stability. The caves are also refuges for organisms that might be chased by diurnal predators (the case of the cavernicolous Mysidaceae).
The presence of species usually living further down (bathyal species) is explained by the fact that they find in this habitat conditions of light, environmental stability and food that are similar to those of the continental slope.

8 – Ongoing trends, vulnerability and potential threats

The caves constitute landscapes of great aesthetic value, and are often visited by divers. These can disturb the particular environment in this habitat by breaking the confinement situation, stirring up the mud on the floor into suspension, and emitting bubbles that then stagnate on the ceiling, and also by multiplying the contacts with organisms on the walls, which are very fragile, and the renewal of which takes an extremely long time.

9 – Conservation status and management

Correct management of this habitat involves two sets of measures:
-monitoring the quality of the water and of pollution, particularly the concentrations of organic matter
-managing frequentation and educating those people who carry on underwater activities.

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APPENDIX I

Definitions of the main terms used at the Hyères Meeting (18-20 November 1998)

Association: The permanent aspect of a biocenosis with vegetal physiognomic dominance where the species are linked by an ecological compatibility and a chorological affinity.

Biocenosis (or biocoenosis): A grouping of living organisms, linked by relationships of interdependence within a biotope with relatively homogeneous major characteristics; each biocenosis comprises mainly the phytocenosis, which includes flora, and the zoocenosis, which includes fauna. The notions of community or association in the phytosociological sense of the word are very close to the notion of biocenosis although they cannot exactly replace it.

Biotope: A geographical area with variable surface or volume subjected to ecological conditions where the dominant elements are homogeneous.

Characteristics: A species is considered as characteristic when it is exclusive or preferential for the biotope considered, whether it is represented widely or not, sporadic or not.

Community: A grouping of living organisms linked by interdependence relationships within a biotope, typically characterized with respect to one or several dominant species.

Ecomorphosis: A particular morphology linked to local ecological conditions.

Enclave: The local existence, for microclimatic reasons, of a habitat within a surface normally occupied by another habitat or another stage.

Euryhaline: Which exhibits a wide range of variation of the salinity.

Facies: An aspect exhibited by a biocenosis when the local predominance of certain factors causes the prevalence of either one or a very small number of species, essentially animal ones.

Habitat: An area distinguished by geographic, abiotic and biotic features (definition of EEC Directive 92/43). The definition of the habitat can be compared herein to that of a biocenosis, facies and association.

Introduced species: A species whose remote (not marginal) extension of the range is linked, directly or indirectly, to human activity. Within its new area, populations of individuals are born *in situ*, without human assistance (it is naturalized).

Invasive species: This is an introduced species which has become a key species, or which has a significant impact on key species, functional groups or landscape, and/or a species which has a negative economic impact.

Stage: A vertical space of the marine benthic domain where the ecological conditions, as a function of its situation with respect to the sea level, are notably constant or fluctuate regularly between the two critical levels which indicate the boundaries of the stage.

APPENDIX II

Complete list of Mediterranean benthic marine biocenoses (Hyères, 18-20 November 1998)

I. SUPRALITTORAL

I.1. MUDS

I.1.1. Biocenosis of beaches with slowly-drying wracks under glassworts

I.2. SANDS

I.2.1 Biocenosis of supralittoral sands

I. 2. 1. 1. Facies of sands without vegetation, with dispersed debris

I. 2. 1. 2. Facies of depressions with residual humidity

I. 2. 1. 3. Facies of beaches with rapidly-drying wracks

I. 2. 1. 4. Facies of washed up tree trunks

I. 2. 1. 5. Facies of phanerogams which have been washed ashore (upper part)

I.3. STONES AND PEBBLES

I.3.1. Biocenosis of beaches with slowly-drying wracks

I.4. HARD BEDS AND ROCKS

I.4.1. Biocenosis of the supralittoral rock

I.4.1.1. Association with Entophysalis deusta and Verrucaria amphibia

I.4.1.2. Pools with variable salinity (mediolittoral enclave)

II. MEDIOLITTORAL

II.1. MUDS, SANDY MUDS AND SANDS

II.1.1. Biocenosis of muddy sands and muds

II.1.1.1. Association with halophytes

II.1.1.2. Facies of saltworks

II.2. SANDS

II.2.1. Biocenosis of mediolittoral sands

II.2.1.1. Facies with Ophelia bicornis

II.3. STONES AND PEBBLES

II.3.1. Biocenosis of mediolittoral coarse detritic bottom

II.3.1.1. Facies of banks of dead leaves of Posidonia oceanica and other phanerogams

II.4. HARD BEDS AND ROCKS

II.4.1. Biocenosis of the upper mediolittoral rock

II.4.1.1. Association with Bangia atropurpurea

II.4.1.2. Association with Porphyra leucosticta

II.4.1.3. Association with Nemalion helminthoides and Rissoella verruculosa

II.4.1.4. Association with Lithophyllum papillosum and Polysiphonia spp.

II.4.2. Biocenosis of the lower mediolittoral rock

II.4.2.1. Association with Lithophyllum lichenoides (= entablature with L. tortuosum)

II.4.2.2. Association with Lithophyllum byssoides

II.4.2.3. Association with Tenarea undulosa

II.4.2.4. Association with Ceramium ciliatum and Corallina elongata

II.4.2.5. Facies with Pollicipes cornucopiae

II.4.2.6. Association with Enteromorpha compressa
II.4.2.7. Association with Fucus virsoides
II.4.2.8. Neogoniolithon brassica-florida concretion
II.4.2.9. Association with Gelidium spp.
II.4.2.10. Pools and lagoons sometimes associated with vermetids (infralittoral enclave)

II.4.3. Mediolittoral caves

II.4.3.1. Association with Phymatolithon lenormandii and Hildenbrandia rubra

III. INFRALITTORAL

III.1. SANDY MUDS, SANDS, GRAVELS AND ROCKS IN EURYHALINE AND EURYTHERMAL ENVIRONMENT

III.1.1. Euryhaline and eurythermal biocenosis

III.1.1.1. Association with Ruppia cirrhosa and/or Ruppia maritima
III.1.1.2. Facies with Ficopomatus enigmaticus
III.1.1.3. Association with Potamogeton pectinatus
III.1.1.4. Association with Zostera noltii in euryhaline and eurythermal environment
III.1.1.5. Association with Zostera marina in euryhaline and eurythermal environment
III.1.1.6. Association with Gracilaria spp.
III.1.1.7. Association with Chaetomorpha linum and Valonia aegagropila
III.1.1.8. Association with Halopithys incurva
III.1.1.9. Association with Ulva laetevirens and Enteromorpha linza
III.1.1.10. Association with Cystoseira barbata
III.1.1.11. Association with Lamprothamnium papulosum
III.1.1.12. Association with Cladophora echinus and Rytiphloea tinctoria

III.2. FINE SANDS WITH MORE OR LESS MUD

III.2.1. Biocenosis of fine sands in very shallow waters

III.2.1.1. Facies with Lentidium mediterraneum

III.2.2. Biocenosis of well sorted fine sands

III.2.2.1. Association with Cymodocea nodosa on well sorted fine sands
III.2.2.2. Association with Halophila stipulacea

III.2.3. Biocenosis of superficial muddy sands in sheltered waters

III.2.3.1. Facies with Callianassa tyrrhena and Kellia corbuloides
III.2.3.2. Facies with fresh water resurgences with Cerastoderma glaucum and Cyathura carinata
III.2.3.3. Facies with Loripes lacteus, Tapes spp.
III.2.3.4. Association with Cymodocea nodusa on superficial muddy sands in sheltered waters
III.2.3.5. Association with Zostera noltii on superficial muddy sands in sheltered waters
III.2.3.6. Association with Caulerpa prolifera on superficial muddy sands in sheltered waters
III.2.3.7. Facies of hydrothermal oozes with Cyclope neritea and nematodes

III.3. COARSE SANDS WITH MORE OR LESS MUD

III.3.1. Biocenosis of coarse sands and fine gravels mixed by the waves

III.3.1.1. Association with rhodolithes[3]

III.3.2. Biocenosis of coarse sands and fine gravels under the influence of bottom currents (also found in the circalittoral)

III.3.2.1. Maerl facies (= Association with Lithothamnion corallioidies and Phymatolithon calcareum) (can also be found as facies of the biocenosis of coastal detritic)

III.3.2.2. Association with rhodolithes

III.4. STONES AND PEBBLES

III.4.1. Biocenosis of infralittoral pebbles

III.4.1.1. Facies with Gouania wildenowi

III.5. POSIDONIA OCEANICA MEADOWS

III.5.1. Posidonia oceanica meadows (=Association with Posidonia oceanica)

III.5.1.1. Ecomorphosis of striped meadows

III.5.1.2. Ecomorphosis of 'barrier-reef' meadows

III.5.1.3. Facies of dead 'mattes' of Posidonia oceanica without much epiflora

III.5.1.4. Association with Caulerpa prolifera

III.6. HARD BEDS AND ROCKS

III.6.1. Biocenosis of infralittoral algae3

III.6.1.1. Overgrazed facies with encrusting algae and sea urchins

III.6.1.2. Association with Cystoseira amentacea (var. amentacea, var. stricta, var. spicata)

III.6.1.3. Facies with Vermetids

III.6.1.4. Facies with Mytilus galloprovincialis

III.6.1.5. Association with Corallina elongata and Herposiphonia secunda

III.6.1.6. Association with Corallina officinalis

III.6.1.7. Association with Codium vermilara and Rhodymenia ardissonei

III.6.1.8. Association with Dasycladus vermicularis

III.6.1.9. Association with Alsidium helminthochorton

III.6.1.10. Association with Cystoseira tamariscifolia and Saccorhiza polyschides

III.6.1.11. Association with Gelidium spinosum v. hystrix

III.6.1.12. Association with Lobophora variegata

III.6.1.13. Association with Ceramium rubrum

III.6.1.14. Facies with Cladocora caespitosa

III.6.1.15. Association with Cystoseira brachycarpa

III.6.1.16. Association with Cystoseira crinita

III.6.1.17. Association with Cystoseira crinitophylla

III.6.1.18. Association with Cystoseira sauvageauana

III.6.1.19. Association with Cystoseira spinosa

III.6.1.20. Association with Sargassum vulgare

III.6.1.21. Association with Dictyopteris polypodioides

III.6.1.22. Association with Calpomenia sinuosa

III.6.1.23. Association with Stypocaulon scoparium (= Halopteris scoparia)

III.6.1.24. Association with Trichosolen myura and Liagora farinosa

3 3. Facies and associations in the biocenosis of infralittoral algae are presented according to the two dominant factors that act on this biocenosis, hydrodynamics and light, and according to the decreasing levels of these factors.

III.6.1.25. Association with Cystoseira compressa
III.6.1.26. Association with Pterocladiella capillacea and Ulva laetevirens
III.6.1.27. Facies with large Hydrozoans
III.6.1.28. Association with Pterothamnion crispum and Compsothamnion thuyoides
III.6.1.29. Association with Schottera nicaeensis
III.6.1.30. Association with Rhodymenia ardissonei and Rhodophyllis divaricata
III.6.1.31. Facies with Astroides calycularis
III.6.1.32. Association with Flabellia petiolata and Peyssonnelia squamaria
III.6.1.33. Association with Halymenia floresia and Halarachnion ligulatum
III.6.1.34. Association with Peyssonnelia rubra and Peyssonnelia spp.
III.6.1.35. Facies and association of the coralligenous biocenosis (in enclave)

IV. CIRCALITTORAL

IV. 1. MUDS
IV.1.1. <u>Biocenosis of coastal terrigenous muds</u>
IV.1.1.1. Facies of soft muds with Turritella tricarinata communis
IV.1.1.2. Facies of sticky muds with Virgularia mirabilis and Pennatula phosphorea
IV.1.1.3. Facies of sticky muds with Alcyonium palmatum and Stichopus regalis

IV.2. SANDS
IV.2.1. <u>Biocenosis of muddy detritic bottom</u>
IV.2.1.1. Facies with Ophiothrix quinquemaculata
IV.2.2. <u>Biocenosis of the coastal detriti</u>c
IV.2.2.1. Association with rhodolithes
IV.2.2.2. Maerl facies (Lithothamnion corallioides and Phymatolithon calcareum)
IV.2.2.3. Association with Peyssonnelia rosa-marina
IV.2.2.4. Association with Arthrocladia villosa
IV.2.2.5. Association with Osmundaria volubilis
IV.2.2.6. Association with Kallymenia patens
IV.2.2.7. Association with Laminaria rodriguezii on detritic
IV.2.2.8. Facies with Ophiura texturata
IV.2.2.9. Facies with Synascidies
IV.2.2.10. Facies with large Bryozoans
IV.2.3. <u>Biocenosis of shelf-edge detritic bottom</u>
IV.2.3.1. Facies with Neolampas rostellata
IV.2.3.2. Facies with Leptometra phalangium
IV.2.4. <u>Biocenosis of coarse sands and fine gravels under the influence of bottom currents (biocenosis present in localities under special hydrodynamic conditions – straits-; also present in the infralittoral)</u>

IV.3. HARD BEDS AND ROCKS
IV.3.1. <u>Coralligenous biocenosis</u>
IV.3.1.1. Association with Cystoseira zosteroides
IV.3.1.2. Association with Cystoseira usneoides
IV.3.1.3. Association with Cystoseira dubia

IV.3.1.4. Association with Cystoseira corniculata
IV.3.1.5. Association with Sargassum spp. (indigenous)
IV.3.1.6. Association with Mesophyllum lichenoides
IV.3.1.7. Association with Lithophyllum frondosum and Halimeda tuna
IV.3.1.8. Association with Laminaria ochroleuca
IV.3.1.9. Association with Rodriguezella strafforelli
IV.3.1.10. Facies with Eunicella cavolinii
IV.3.1.11. Facies with Eunicella singularis
IV.3.1.12. Facies with Lophogorgia sarmentosa
IV.3.1.13. Facies with Paramuricea clavata
IV.3.1.14. Facies with Parazoanthus axinellae
IV.3.1.15. Coralligenous platforms

IV.3.2. Semi-dark caves (also in enclave in upper stages)

IV.3.2.1. Facies with Parazoanthus axinellae
IV.3.2.2. Facies with Corallium rubrum
IV.3.2.3. Facies with Leptosammia pruvoti

IV.3.3. Biocenosis of shelf-edge rock

V. BATHYAL

V.1. MUDS

V.1.1. Biocenosis of bathyal muds

V.1.1.1. Facies of sandy muds with Thenea muricata
V.1.1.2. Facies of fluid muds with Brissopsis lyrifera
V.1.1.3. Facies of soft muds with Funiculina quadrangularis and Apporhais seressianus
V.1.1.4. Facies of compact muds with Isidella elongata
V.1.1.5. Facies with Pheronema grayi

V.2. SANDS

V.2.1. Biocenosis of bathyal detritic sands with Grypheus vitreus

V.3. HARD BEDS AND ROCKS

V.3.1. Biocenosis of deep sea corals

V.3.2. Caves and ducts in total darkness (in enclave in the upper stages)

VI. ABYSSAL

VI.1. MUDS

VI.1.1. Biocenosis of abyssal muds

1. Definitions of the main terms used in this document, as adopted at the Hyères Meeting (18-20 November 1998), are given in Appendix I.
2. The complete list of Mediterranean benthic marine biocenoses, as adopted at the Hyères Meeting (18-20 November 1998), is given in Appendix II.