Sessile megabenthic species from Tunisian littoral sites

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Abstract

Structurally complex habitats (e.g. coralligenous habitats, seagrass meadows, biogenic habitats etc.), as well as those relatively undisturbed by natural perturbations, are more adversely affected by human activities, since both kinds have the longest recovery period in terms of recolonization of the habitats by the associated fauna and flora. The disturbance of these habitats (complex and undisturbed) leads to the removal of high-biomass species as their main organisms (such as sponges) increase the topographic complexity of the sea bed.

To document this important interaction between the marine habitats and human activities (mainly fisheries), which might lead to the loss of the associated marine biodiversity, it is crucial to give an overview of the actual state of these habitats. Thus, a general picture of some examples of the main littoral benthic habitats along the Tunisian coast is presented in this document. The distribution of the main benthic species in the Gulfs of Gabès, Hammamet and Tunis is also summarized.

This review emphasizes the gaps that have to be filled by the main INSTM research programme planned for 2002–2006. Furthermore, other important national action plans were identified by Tunisia as crucial steps for the conservation of the marine ecosystems and their associated human activities within the framework of the SAPBIO Project (MAP/RAC–SPA).

All these scientific actions, to be conducted under the overall supervision of INSTM with the collaboration of an associated team of researchers from Tunisia and abroad, will focus on the development of synoptic descriptions of marine benthic biodiversity, and their quantitative analysis in the context of hypotheses derived from ecological theory.

1. Introduction

Marine biodiversity, well represented in the infra- and circalittoral levels, is mainly developed in the two most important Mediterranean benthic assemblages: the sea grass meadows (*Posidonia oceanica*) and the coralligenous. In Tunisia, both habitats have a wide geographical distribution (Topsent 1894; Seurat 1929; Canu and Bassler 1930; Molinier and Picard 1954; Pérès 1954; Ben Mustapha 1967; Ben Alaya 1969, 1972; Rützler. 1973, 1976; Ben Maiz 1984, 1995; Boudouresque *et al.* 1986; Zaouali 1993; Ben Mustapha and El Abed 2002), which is also documented in studies focusing on benthic communities of the trawling areas located over the 50-m isobaths (Anon. 1923; Le Danois 1925; Lubet and Azouz 1969; Azouz and Capapé 1971; De Gaillande 1970a, b; Ktari-Chakroun and Azouz 1971; Azouz 1966, 1973; Ben Othman 1973; etc.).

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The sea bottoms of the littoral zone of the northern Tunisian coast are mainly rocky, while those of the eastern (Hammamet Gulf) and southern (Gabès Gulf) coasts are sandy to sandy-muddy (Le Danois 1925; Azouz 1966, Ben Mustapha 1966; Poizat 1970; Ben Othman 1973; Blanpied *et al.* 1979; Ben Mustapha and Hattour 1992; Pergent and Kempf 1993; Brahim *et al.* 1994; Ben Mustapha and El Abed 2002; Ben Mustapha *et al.* 1999, 2002a).

The rocky bottoms of the northern coast offer the best substratum for colonization by very rich coralligenous assemblages (Azouz 1973; Boudouresque *et al.* 1986; Ben Mustapha *et al.* 2002a; etc.), while in "la petite Syrte" i.e the Gulf of Gabès sensu lato, and in several parts of the Hammamet Gulf, the *Posidonia* meadows show their maximum geographical distribution (Ktari-Chakroun and Azouz 1971; Ben Othman 1973; Ben Mustapha *et al.* 1999; etc.). Nevertheless, it should be emphasized again that both biocenoses are well represented all along the Tunisian coast (Azouz 1966; Pergent and Kempf 1993; Afli et Ben Mustapha 2001; Ben Mustapha and El Abed 2001, 2002; Ben Mustapha *et al.* 2002a).

In the following paragraphs, we shall review samples of Tunisian megabenthos from the circa- and infralittoral zones along the Tunisian coast (Figure 1). These data were gathered from several marine scuba-diving surveys conducted in recent years.

2. Brief overview of the marine biodiversity in the Gulfs of Gabès, Hammamet and Tunis

In a recent working group charged with highlighting the marine biodiversity hitherto recorded in the Gulfs of Gabès, Hammamet and Tunis, several researchers from INSTM made a comprehensive review of the bibliography on this subject (Afli and Ben Mustapha 2001; Bradai 2001, 2002; Ben Mustapha *et al.* 2002b; Afli and Riveill 2002; Langar 2002; Afli 2002; Sellem 2002; Ben Mustapha and El Abed 2002; Ben Mustapha *et al.*[1]). The results are shown in Figure 2.

A comparison of the marine biodiversity of the three main Tunisian gulfs is not possible due to the artifact resulting from the difference between the stronger research programmes developed in the Gulfs of Gabès and Tunis and the lower scientific interest in the biodiversity in the Gulf of Hammamet.

[1] Ben Mustapha, K., Boury-Esnault, N., Kartas, F., El Abed, A., Zarrouk, S. et Souissi, A. Sponge diversity in the Tunisian waters. Società Italiana di Biologia Marina, 34th Congress. Sousse, May 2003 (submitted).

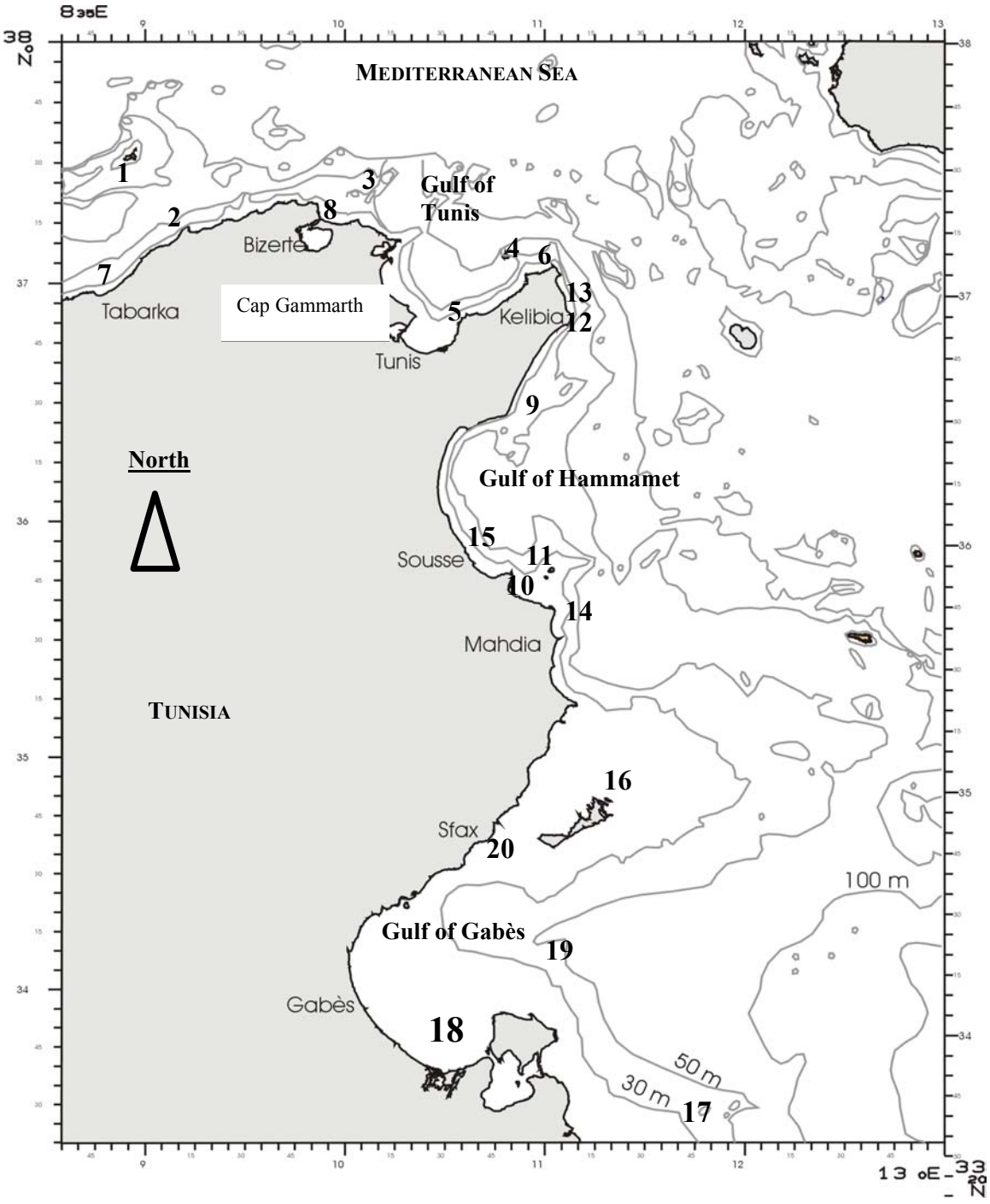

Figure 1. Location of the main areas mentioned in this paper. 1. Galite Island; 2. Fratelli Island; 3. Cani Island; 4. Zembra–Zembretta area; 5 Cap Fartas; 6. Cap Bon area; 7 Tabarka; 8 Bizerte; 9. Maamoura and Korba Banks; 10. Monastir area; 11. Kuriat area; 12. Kelibia area; 13. Kerkouène area; 14. Salakta; 15. Sousse; 16. Kerkennah platier; 17. Zarzis Banks; 18. Djerba Island; 19. Central area of the Gulf of Gabès; 20. Sfax

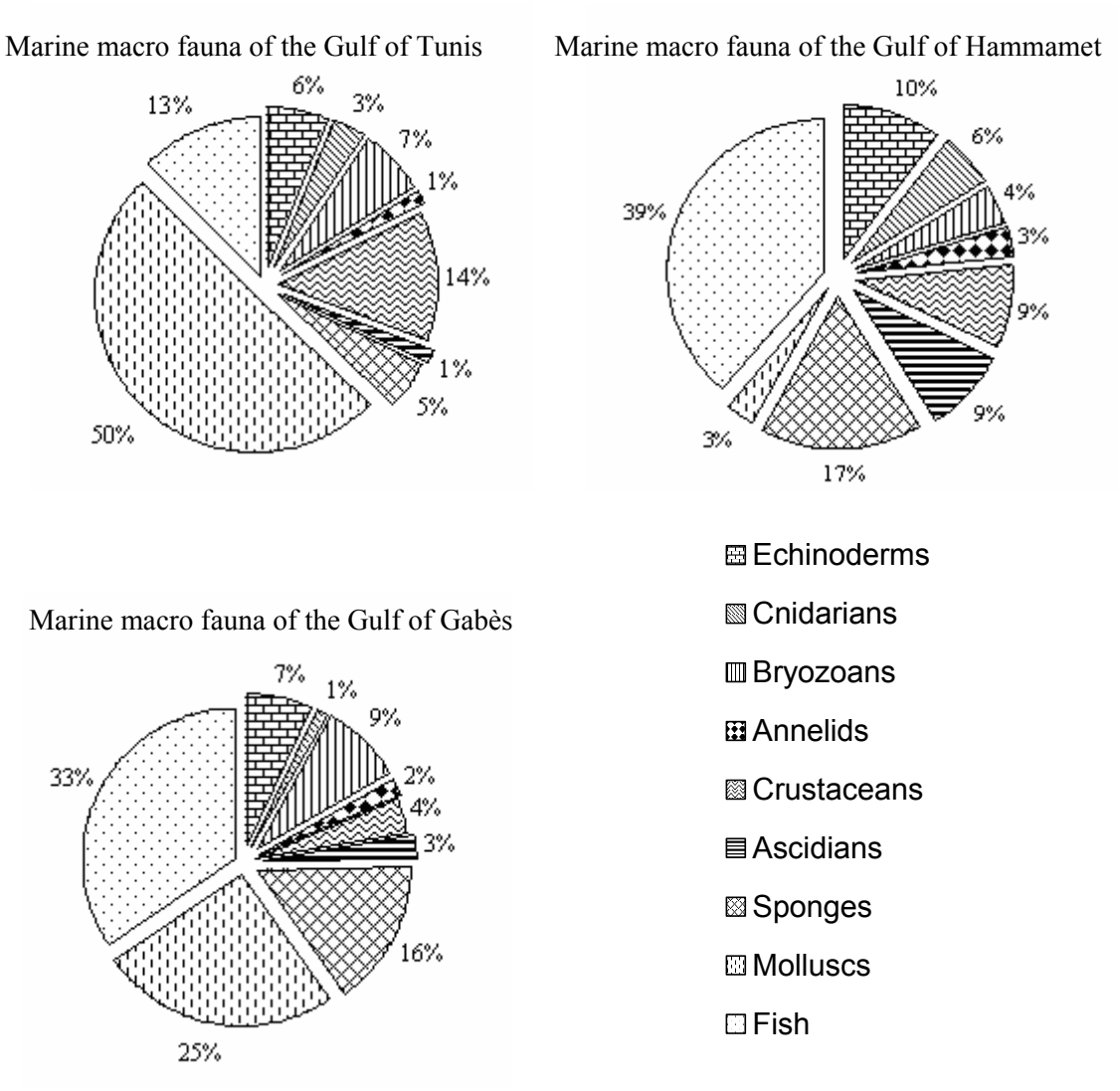

Figure 2. Distribution of the main phyla in the Gulfs of Tunis, Hammamet and Gabès

3. Megabenthic sessile species from several Tunisian sites

3.1 Northern coasts

Posidonia meadows[2]

The presence of *Posidonia oceanica* meadows in this region is well documented (Ostenfeld 1918; Le Danois 1925; Chambost 1928; Molinier and Picard 1954; Lubet and Azouz 1969; Ben Alaya 1969, 1972; Azouz 1973; Boudouresque *et al.* 1986; Ben Mustapha in: Anon 1991; Ben Mustapha and El Abed 2001; Ben Mustapha et al 2002a, c; Ben Mustapha and Hattour 1992).

[2] According to Giraud (1977) *Posidonia* meadows are classified by five types in relation to the density expressed as number of shoots per square metre (type V ≤ 150 shoots/m²; type IV: 150–300 shoots/m²; type III: 300–500 shoots/m²; type II: 500–700 shoots/m²; type I > 700 shoots/m²); Augier (1986) and Meinesz and Laurent (1978) adopted a different classification (types 1, 2 and 3) based on percentage coverage, rhizome position, presence of mattes, colonization of sediments

Geographically, these meadows have a wider distribution off Bizerte and around Cani. The meadows surrounding Cani Islands reach the coast of Sidi Ali Mekki (the north-western limit of the Gulf of Tunis), extend 15 nautical miles south-east and, from that point, westwards to Cap Zebib 15 nautical miles away. Focusing on the mapping of the meadows of that area should be a priority for Tunisia, since they might be more important than the remaining ones presently spreading in the Gulf of Gabès, historically known as the most important ones in the Mediterranean (Ben Mustapha and Hattour, 1992; Pergent and Kempf 1993; Boudouresque 1997; Batisse and Jeudy de Grissac 1998; Ben Mustapha and El Abed 2001).

In Tabarka, la Galite and Fratelli, the lower limit of the meadows was found within the usual Mediterranean limits, at a depth between 30 and 40 m (Boudouresque 1997), while in the case of the meadows off Sidi Daoud (near Cap Bon), the limit varies from 23 to 27 m depth. In Zembra, these meadows reach 34 m depth, with a density varying from 150 shoots/m² (in the deepest limit) to 750 shoots/m² at 14 m depth[3].

Occasionally, the meadows' limits might reach deeper areas, such as those in the Strait of Cani–Sidi Ali Mekki, where they may be found at 41 m depth. The coverage and density of the meadows vary also from one area to another, from a density of 700 shoots/m² in Zembra (Boudouresque *et al.* 1986), 600 shoots/m² in Galite Island (Anon. 1991), 350 to 550 shoots/m² in the Sidi Daoud area and 450 to 500 shoots/m² in the Strait of Cani–Sidi Ali Mekki (Ben Mustapha et al 2002a, b)

Another area of importance is the eastern coast of the Gulf of Tunis; mainly starting from south of Sidi Daoud to Ras Fartas, where the meadows grow on detritic or rocky bottoms. If we compare the distribution of the *Posidonia oceanica* meadows in the Gulf of Tunis, as described by Ben Alaya (1969, 1972), with the data available now, we see no general degradation in terms of area coverage. We found the meadows around Cap Farina/Sidi Ali Mekki (western part of the Gulf) and those extending from Ras Fartas to Sidi Daoud (eastern part of the Gulf). We also found the barrier reef off Sidi Rais to a depth 15 m. But elsewhere, a few patches have been experiencing severe environmental conditions, such as the meadows extending from Salammbô to La Goulette (south-western Gulf of Tunis), which have already disappeared or, if they still exist, are present only as type 2 or 3; i.e meadows in very bad health. Moreover, the meadows off Cap Gammarth seem to have undergone a reduction in their inner limits (Ben Mustapha, in Anon. 1991; Ben Mustapha and Hattour, 1992; Ben Mustapha *et al.* 2002a, b; Zaouali (personal communication).

Coralligenous assemblages and rocky habitats

A number of sites showed a high diversity of sessile macrobenthic organisms representing healthy coralligenous assemblages. However, a few black spots were recorded, mainly in the Gulf of Tunis. Hence, in general, the biota at a few stations are changing from detritic to muddy ones. Consequently, in such areas, the sessile macro-benthic representatives of detritic and rocky bottoms of the circalittoral level, such as the calcareous red algae *Lithothamnionum corallioides, Phymatolithon (Lithothamnium) calcareum,* the sponges *Suberites domuncula, Petrosia ficiformis, Agelas* sp., *Axinella canabina, Spirastrella cunctatrix,* are replaced by representatives of muddy bottoms, e.g the anthozoan *Alcyonium palmatum,* the bryozoan, *Pentapora fascialis*, the echinoderms *Holothuria forksali,*

[3] Mission de zonation des habitats marins benthiques du parc marin de Zembra Zembretta (INSTM–CAR/ASP–APAL)

Ophioderma longicaudum, the ascidian *Microcosmus* sp.*,* and the cnidarian *Amphiura* sp. (Pérès, 1985).

Nevertheless, apart from such local areas and despite the mortality of macrobenthic invertebrates that occurred in the region in 1999 (Ben Mustapha and El Abed 2001), coralligenous assemblages were well represented in the circalittoral zone, both from rocky and detritic bottoms. Indeed, the Cap Bon area shows one of the highest levels of variability of macrobenthic assemblages, with populations of sponges, such as *Clathria* spp., *Raspaciona* sp., *Anchinoe* sp., *Timea* spp., reaching a coverage of up to 1 m² in horizontal and sub-horizontal exposures. Table 1 lists the sponge species recognized in situ.

Table 1. Sponges from coralligenous assemblages

Taxonomic group	**Species**
Sponges	*Ircinia fasciculata*, *I. oros, Ircinia* sp., *Cacospongia mollior, Cacospongia* sp., *Sarcotragus* spp., *Dysidea* sp., *Petrosia ficiformis, Calyx niceansis*, *Haliclona* spp., *Chalinella* spp. Representatives of the Order *Poecilosclerida* were abundant, with several species of *Anchinoe, Clathria, Microciona, Artemisina, Raspaciona, Hemimycale collumela, Crambe crambe, Crambe* sp., *Timea* sp., *Cliona viridis, Cliona* sp., *Agelas oroides, Agelas* sp., *Axinella canabina, A. polypoide, Oscarella lobularis*

In the marine protected area of Zembra–Zembretta, a recent survey showed well developed assemblages of benthic sessile species (unpublished), with a high density (expressed as number of individuals/m²), such as the madreporarians *Eunicella singularis* (30 colonies/m²) and *Astroides calycularis* (2,935 colonies/m²), the bryozoan *Myriapora truncata* (162 colonies/m²) and the green alga *Flabellia petiola* (755 thalli/m²).

Finally, also in this very interesting area (Cap Bon–Zembra/Zembretta–Sidi Daoud), we recorded:

- A rare gorgonian, *Ellisella* sp., recorded only around the Spanish island of Chafarinas off the Moroccan Mediterranean coast (Calvin Calvo, 1995); we found it at a depth of 47 m off Sidi Daoud, on a very rich coastal detritic assemblage.
- *Caulerpa racemosa*, listed for several stations on detritic (e.g. south-east of Zembretta Island at 45 m. depth), sandy (e.g. north of Haouaria at 30 m depth) or rocky bottoms (e.g. Cani Island at 12 m depth; Sidi Daoud at 1.5 m depth), as well as on muddy substrate in the marina of Bizerta, at 2–3 m depth (Djallouli 2000; Ben Mustapha and El Abed 2001). *C. racemosa*, recorded in the marine protected area (MPA) of Zembra Island at 26 m depth in 1999 (unpublished) now reach a depth of 34 m in this MPA.
- *Caulerpa taxifolia* and *C. racemosa*, recorded for the first time at 46 m depth 0.2 nautical miles south of Cap Bon, on coralligenous assemblages, whereas the same location was free of these two algae during a survey made in 1992 (unpublished).
- The caves at 30 m depth, west of "Cathedral Rock" on Zembra Island, where the sponge population was well represented, mainly by species of the Orders *Agelasida, Poecilosclerida,* and *Haplosclerida*. In one of these caves, a living pharetronid sponge, *Petrobiona massilensis*, was recorded for the first time in Tunisia Boudouresque *et al.* 1986; Ben Mustapha and El Abed 2002; (Ben Mustapha, unpublished).

- An anomalous rocky-bottom ridge at 35 m. depth, rising to 28 m depth, and extending from Zembra to Zembretta. The macrobenthic fauna there is very rich, with gorgonians covering all substrata, such as *Eunicella singularis*, with a density of 17–24 colonies/m², *Eunicella cavoloni*, with a low density of 3 colonies/m², and *Leptogorgia sarmentosa*, with a density of < 1/m². Bryozoans are represented mainly by *Myriapora truncata, Pentapora fasciatis* and *Sertella* sp.; and species of the genera *Aplidium* and *Clavellina* are the most common ascidians. The sponge population is well represented, mainly with high densities, by *Axinella canabina, A. damicormis, A. poypoides, Agelas* sp., *Petrosia ficiformis, Spongia officinalis, Hippospongia communis, Sarcotragus muscarum. Sarcotragus* sp., *Ircinia* sp., *Cacospongia mollior,* as well a number of species of the Order Poecilosclerida, such as *Mycale* sp., *Hemimycale columella, Myxilla* sp. and *Anchinoe* sp., *Microciona* sp., *Clathria* sp., *Crambe* sp. *Eudendium racemosum* and species of the Sub-family Aglopheniinae are the most common hydrozoans. Regarding the benthic flora, cystoseirans are the most common representatives of a photophilic population on horizontal substrata that includes a high density of *Dictyota dichotoma*, while *Udotea petiola* and *Halimeda tuna* have a higher density on the vertical faces of the rocky-bottom ridge.

3.2 Eastern and southern coasts

The very large area from Cap Bon to the Tunisian–Libyan border has very interesting bionomic features due to the presence of several banks off the eastern coast of Tunisia, two large islands (Djerba and Kerkennah) and the Kerkennah "platier" (Burollet *et al.* 1979).

Korba and Maamoura Banks

These banks have a depth of 26–33 m east of the Gulf of Hammamet, with patches of dense *Posidonia* meadows. Inter-mattes are coarse detritic bottoms, covering a **rocky slab** (Maamoura Bank) with a coralligenous assemblage (*Phymatolithon (Lithothamnium) calcareum* and *Eunicella singularis*). As recorded by Ben Mustapha and Hattour (1992), the dense meadows growing on mattes are of type III. The sponge and ascidian fauna is very rich (Table 2).

Table 2. Sponge and ascidian species observed on Korba and Maamoura Banks

Taxonomic group	Species
Sponges	*Cliona vastifica, C. viridis, Ircinia oros, I. fasciculata, Sarcotragus muscarum, Cacospongia mollior, Scopalyna lophyropoda, Axinella poypoides, Agelas* sp., *Hemimycale columella, Anchinoe fictitius, Hamigera hamigera, Crambe crambe, Petrosia dura, Disydea fragilis, D. tupha, Aplysilla sulfurea*
Ascidians	*Aplidium conicum, A. tabarquensis, Pseudosdistoma crucigaster, Pseudodistoma* sp., *Didemnum maculosum, Diplosoma* sp., *Polycitor adriaticum, Polycitor* sp.

Sponges, ascidians and bryozoans of the *Posidonia* meadows off the Sahel coasts: Kerkennah platier and Fora Mostafa

The meadows start from the Sahel coasts (i.e. the Sousse–Monastir area), continue eastwards to Kuriat Island, and southwards to the Kerkennah platier (Amari 1984) and bordering it on its eastern and southern sides (Ben Mustapha and El Abed 2002). These very extended

meadows, of types 2 and 3 (coverage between 50% and 100%, generally growing on mattes up to 1 m high) can reach depths of 27–30 m. We consider it a very large area of sea grass development. The species richness of the associated fauna differs from place to place. We briefly focus on the meadows of the Kerkennah platier (i.e. at a depth of 15–25 m and those in a few other places, such as the port of Sousse, Monastir, the channel between Kuriat Island and Monastir at 26 m depth, and Cap Salakta.

Sousse: The *Posidonia* meadows off Sousse are increasingly confronted by the presence of the invasive alga *Caulerpa taxifolia*, reported in Tunisian waters by Langar *et al.* (2000) for the first time. The first investigations revealed the presence of sea grass mattes 2 m high, testimony to a dense and healthy meadow. At present, and in general, the perimeter of the mattes is still occupied by *Posidonia,* while the bottom of the central area, a sandy or muddy–sandy bottom, is covered by dead leaves of *Posidonia*. The limit of the sea grass meadows, at 15–17 m depth, is of type III (a few *Posidonia* rhizomes remain with rare shoots and a coverage of 5–30%, in a muddy bottom), which did not allow the fixation of a pre-coralligenous lower stratum on the rhizomes. We listed only two species of sponges: *Dysidea fragilis* and *Ircinia fasciculata*, and two ascidians, *Aplidium conicum* and *Aplidium* sp.; there is also a very scarce presence of algae such as *Udotea petiola, Halimeda tuna* and *Lithophyllum* sp.; *Codium bursa* was present on the muddy bottom with *Caulerpa prolifera*. This depopulated area, as well as all the space freed by the action of merchant-ship anchors (the anchorage area) is invaded by *Caulerpa taxifolia*, partially replacing the *Caulerpa prolifera* meadow.

Kuriat–Monastir Channel: Despite the presence of type II *Posidonia* meadows, with 600 shoots/m², the macrobenthic sessile fauna was surprisingly impoverished, in comparison with other places such as the banks described before. Other observed species are listed in Table 3.

Table 3. Sponge, ascidians and bryozoans species observed in the Kuriat–Monastir Channel

Taxonomic group	**Species**
Sponges	*Dictionella* sp., *Scopalina lophyropoda, Tethya aurantium, Dysidea avara, Ircinia oros, Sarcotragus muscarum*
Ascidians	*Aplidium conicum*, *Polycitor adriaticum*
Bryozoans	*Sertella septentrionalis*

Salakta: The bottoms in the southern area of Salakta at a depth of 6 m are sandy, with several *Posidonia* meadows and rocky slabs. The mattes of the *Posidonia* meadows (type III, with a density of 750 shoot/m²) may be higher than 2 m. The sandy bottom is covered by *Cymodocea nodosa* or, from place to place, by *Zostera nolti*. *Caulerpa racemosa* and *Caulerpa prolifera* were both recorded. Sponges and ascidians were not abundant (see Table 4); madreporarian skeletons belonging to *Leptopsammia pruvoti* and *Cladocora cespitosa* were also recorded but were very rare**.**

Table 4. Sponge and ascidians species observed in Salakta

Taxonomic group	**Species**
Sponges	*Tethya aurentium, Tethya citrina, Dysidea fragilis, Sarcotragus muscarum*
Ascidians	*Crambe crambe*, *Polycitor adriaticum, Halocynthia papillosa*

Kerkennah platier: Several stations around the platier were visited. Meadows cover a very large area, all around the Kerkennah shallow-water platier. In the north they reach 37 m depth off Chebba, while the eastern and southern limits are less deep, between 18 and 25 m. In these areas, the meadows are less dense than those growing in the northern region, but both have a density (in shoots/m²) typical of type I and II meadows. However, the density is lower than that found in other similar types of meadow (Ben Mustapha and Hattour 1992; Ben Mustapha *et al*. 1999; Ben Mustapha and El Abed 2001), due to illegal trawling all along the eastern coast of Kerkennah Island (Ramos Esplá A., personal communication). These meadows are very rich in sponge, hydrozoan, bryozoan and ascidian species. The most common and representative species are listed in Table 5.

Table 5. Most representative sponge, anthozoan, bryozoan, ascidian and alga species recorded on the Kerkennah platier

Taxonomic group	Species
Sponges	*Cliona vastifica, C. viridis, Cliona* sp., *Aplysilla sulfurea, Chondrilla nucula, Hemimycale columella, Mycale massa, Anchinoe paupertas, A. tenacior, Haliclona mediterranea, Cacopsongia mollior, Hippospongia communis, Ircinia fasciculata, Sarcotragus* sp., *Dysidea fragilis*
Anthozoans	*Caryophyllia* sp., *Cladocora cespitosa, Leptopsammia pruvoti, Balanophyllia* sp., *Plumularia* sp., *Halochordyle disticha*
Bryozoans	*Filograna implexa; Sertella septentrionalis*
Ascidians	*Polycitor* sp., *Botryllus schlosseri, Aplidium conicum, Clavelina nana, Ecteinacidia* sp., *Diazona* sp.
Algae	*Sphaerococcus* sp., *Lithothamnium* sp., *Pseudolithophyllum expansum, Halimeda tuna, Udotea petiola*

Fora Mostafa (central part of the Gulf of Gabès): This small basin is well known as a shrimp-trawling area in the eastern/south-eastern Gulf of Gabès. Despite the muddy bottoms and the intense shrimp trawling in this area (Hattour 1991; Caddy 1993, 1995; Ben Mustapha 1995; El Abed and Hattour 1997; etc.), a few patches of detritic biota, at 40–55 m depth, with coralligenous assemblage, are still present, with numerous calcareous Rhodophyceae, such as *Phymatolithon (Lithothamnium) calcareum* and *Lithothamnion coralloides*. The predominant species recorded were sponges, and the echinoderm *Cucumaria* sp. The most abundant sponges were *Geodia cydonium* and *Fasciospongia cavernosa*. Less predominant species of sponges were *Verongia aerophoba, Dictyonella* sp., *Suberites domuncula, Cacopsongia mollior, Ircinia muscarum, Spongia nitens* and *Hippospongia communis*. The gorgonian *Eunicella singularis* was rarely recorded.

3.3 The banks off the Zarzis coast

These banks are the most important topographical feature of this area. The first bank, Ras Dzira, is 12 nautical miles east of Zarzis at a depth of 6–11 m, followed by Bancacou and Messioua Banks, respectively located at 20 to 30 nautical miles east of Zarzis, at a depth of 20–33 m. The farthest east is El Greco Bank, 35 nautical miles offshore at a depth of 25–35 m. All these banks are covered by sea grass meadows, mainly of *Posidonia oceanica*, while in the sandy bottom of the inter-matte channels, *Cymodocea nodosa* is well represented. Nevertheless, rocky and bio-constructed bottoms are also a notable feature of these banks, especially those of Messioua and El Greco.

Posidonia meadows

We observed several types of development, from type IV (i.e. the least healthy type in terms of shoots/m²) in some parts of Bancacou and at some stations on Messioua Bank at a depth of 20–30 m to type I (i.e. the healthiest one) on the Messioua and El Greco Banks. These meadows may be present as a continuous covering, as seen on the El Greco, Messioua and Ras Dzira Banks, or may be present as large patches, as seen at Bancacou and at some stations on the Messioua and El Greco Banks. The *Posidonia* mattes may be short (30 cm high) or non-existent, mainly near the deepest limit of the meadows (as seen at 30 m depth on Messioua) or even at 20 m depth in Bancacou. Elsewhere, the height of the matte varies between 0.7 and 1.5 m. The coverage also varies from less than 40 % (Messioua and Bancacou) to nearly 100 % (Messioua, Ras Dzira and El Greco). The density (in shoots/m²) is very high in general on the Messioua, El Greco and Ras Dzira Banks, varying from 525 (meadows of type II) to 1,125 shoots/m² (meadows of Type V)[4]. The latter observation means that, for such a range of depth, these meadows have actually the highest density in the whole Mediterranean region (Ben Mustapha *et al.* 2002b). But in several parts of Bancacou and at the deepest stations on Messioua, this density is low, varying from 350 to 500 shots/m² (type III and type II). The presence of such meadows, which in several places are boundary meadows of type I or II in the deep area of the Messioua Bank on detritic bottoms (33 m depth), or in several parts of Bancacou at depths of 20–22 m, can be explained not only by the reduced luminosity with increasing depth, but also, and principally, by illegal trawling in the region, since several trawl tracks were observed.

Macrobenthic assemblages

Rocky bottoms were also encountered on the Messioua and El Greco Banks, but their morphology differs. Messioua's rocky bottoms are mainly of the rock-slab type, even though they may be up to 40 cm high, whereas those of El Greco Bank are of both types: slabs and blocks that may be up to 2 m high. Biotic constructions are also very common, due principally to the action of calcareous corallinacean species.

The macrobenthic sessile fauna (and flora) is very well represented, mainly by filter-feeding invertebrates, such as sponges and ascidians. Over all three banks, hydrozoans, madreporians, sponges, ascidians and bryozoans were represented in various abundances. The recorded species are listed in Table 6.

[4] Ben Mustapha K., Komatsu, T., Sammari, C., Hattour, A., Zarrouk, S. and El Abed, A. (2003). *Posidonia* meadows from Messioua bank (Tunisia). Contribution to the: 3rd Tunisia–Japan Symposium on Science and Technology (TJASST03). Tunis, April 2003. (submitted)

Table 6. Hydrozoan, madreporian, sponge, ascidian and bryozoan species recorded on the Banks off the coast of Zarzis

Taxonomic group	Species	Remarks
Hydrozoans	*Plumularia setaces*, *Halycordyle disticha*	
Madreporians	*Balophyllia europea, Cladocora cespitosa*	
Sponges	Order Dictyoceratida: *Hippospongia communis, Spongia officinalis, S. nitens, Cacospongia mollior, Fascispongia cavernosa, Ircinia fasciculata, I. spinosula, I. chevreuxi, Sarcotragus muscarum*. *Dysidea fragilis*	
	Oscarella lobularis, Cliona viridis, C. celata, Chalinella sp., *Crambe crambe, Anchinoe tenacior, Hemimycale columella, Hamigera hamigera*	
	Petrosia ficiformis	deep area: at 30 m. depth
	Verongia aerophoba, Chondrilla nucula	Very rare
	Tethya aurentium, T. citrinae, Geodia cydonium	Absent or recorded only on Ras Dzira
Ascidians	*Aplidium* sp., *Pseudodistoma* sp., *Didemnum* sp., *Diplosoma* sp., *Polycitor* sp., *Clavelina* sp., *Ecteinacidia turbinata, Botrylloides* sp.	
Bryozoans	*Pentapora fascialis, Raptedeonella* sp., *Sertella septentrionalis, Schizoporella* sp., *Margaretta* sp.	

The sponge population of Messioua comprises 29 common species showing a varying density. For instance, the density range for species of the Order Poecilosclerida is 0.4–2.4 individuals/m², while species of the Order Dictyoceratida have a density range of 0.13–3 individuals/m², which is higher than that of the Salakta sponge beds (Rützler 1976).

Data on Messioua Bank for August 2001 were obtained by scanning *Posidonia* meadows with a multi-beam sonar SEBAT 9001 (Reason and Co.) which can emit several decadal beams from the transducer, to measure not only the bottom depths but also the height distribution of the seagrass beds (Komatsu *et al.* 2001). We tried to harmonize these data from field-truth campaigns (October, 2000; May and August, 2001). The analysis of the first data set, relating to the density as well as the richness of the sponge population, showed no correlation with the values of the *Posidonia oceanica* density (in shoots/m²). Nevertheless, such a correlation may exist only for the commercial sponges of the Family Spongiidae (*Hippospongia communis, Spongia officinalis, S. nitens* and *S. virgultosa*), whereas all other representatives of the Order Dictyoceratida (e.g. *Sarcotragus muscarum, Ircinia fasciculata* etc.) do not show such a correlation.

These field campaigns were also an occasion to note the presence of a disturbed biota on the El Biban Bank (off El Bibane Lagoon), and on another off the coast of Zarzis, where sponges of the Order Dictyoceratida show evidence of disease.

Finally, two algae, both recorded on the Messioua Bank, are listed for the first time:

Caulerpa racemosa, at 24 m depth, covering the detritic substratum produced by the burrowing sponges *Cliona celata* and *C. viridis*. The same biota was also recorded for *Caulerpa racemosa* at several stations off Cap Bon (see above), where the alga was always present near these burrowing sponges and at a depth of 45 m; off the south-eastern coast of Kerkennah Island (Ben Mustapha and El Abed 2001), as well as in the Gulf of Gabès (Hamza *et al.* 1995).

Halymenia dichotoma (Rhodophyceae: Grateloupiacea), at 21 m depth in the precoralligenous assemblage of the circalittoral enclave of *Posidonia* rhizomes. Referring to the review of Ben Maïz (1995) of the Tunisian marine macroalgae, and to Boudouresque (1997), this would appear to be the first record of a species of the *Halymnia* genus in Tunisian waters.

4. Discussion and conclusions

This review of some examples of sessile benthic species from the main macro-benthic assemblages along the Tunisian coast shows that they are not suffering from the impact of human activities. This is especially the case for the Tunisian islands and banks. This brief review was also an occasion to update the list of macrobenthic sessile species in some areas.

However, a few sites showed a slightly disturbed benthic marine environment, while others presented a more disturbed biota, such as the meadows off Sousse and Monastir. The remaining sites of the Gulf of Gabès (El Abed and Hattour 1997; Hattour *et al.* 1998; Ben Mustapha *et al.* 1999) and the coastal detritic biota of the Gulf of Tunis have undergone major changes in their macrobenthic assemblages which could rapidly lead to the establishment of a muddy-bottom biota.

In 1999, the coralligenous biota of some sites, mainly around Cap Bon, underwent significant degradation of some assemblages, owing to massive mortality of their gorgonian representatives. This was supposed to be due to the persistently high temperature in the whole water column down to 60 m depth (Ben Mustapha and El Abed 2001), without either the seasonal thermocline, usually at 20 m depth, or the strong vertical temperature range (10°C; Sammari *et al.* 2001). Nevertheless, prospections carried out in 2000 and 2001 showed a good recovery of these biota.

Other sites, where both *Caulerpa racemosa* and *C. taxifolia* were recorded on a very strong coralligenous assemblage down to a depth of 46 m, show how fast these two species of *Caulerpa* might adapt to new biotic conditions.

We would submit several recommendations to the consideration of the present expert consultation:

- To harmonize data collection and management and delimit the geographical area of the project
- To list all the benthic species/habitats of the area
- To conduct more-specific quantitative studies of the population structure of the main benthic groups (since they are the only tool for studying the impact of human activities on benthic habitats)
- To conduct specific quantitative studies of the sponge population structure at the Tunisian–Libyan border, since the sponge stock is shared there
- To support a standardized scientific assessment of the red coral population in the area
- To conduct specific studies on the coralligenous habitats in the MedSudMed Project area

- To conduct specific quantitative studies of the *Posidonia oceanica* meadows in areas where data are not up to date or do not exist, and to conduct comparative studies in the area.

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