EGYPTIAN ACADEMIC JOURNAL OF

BIOLOGICAL SCIENCES ZOOLOGY

B

ISSN
2090-0759

WWW.EAJBS.EG.NET

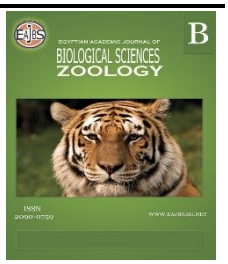
Vol. 14 No. 2 (2022)

www.eajbs.eg.net

Citation: *Egypt. Acad. J. Biolog. Sci. (B. Zoology) Vol. 14(2) pp: 493-508(2022)*
DOI: 10.21608/EAJBSZ.2022.299576

Egypt. Acad. J. Biolog. Sci., 14(2):493-508(2022)

Egyptian Academic Journal of Biological Sciences
B. Zoology
ISSN: 2090 – 0759
http://eajbsz.journals.ekb.eg/



Nature Occurrence of Associated Faunal Assemblages on *Posidonia oceanica* at Salloum Marine Protected Area, Mediterranean Sea, Egypt

Besar, M.H.A.[1]; El Sayed, A.A.M.[2]; Amer, M.A.[2]; Abdalkhalek, A.M.[2] and Abou-Elregal, M.A.[3]

[1]Salloum Marine Protected Area Manager, Egyptian Environmental Affairs Agency, Egypt.
[2]Marine Biology, Zoology Department, Faculty of Science, Al-Azhar University, Cairo, Egypt.
[3]Marine Science, Faculty of Science, Port Said University, Port said, Egypt.
E-mail[*]: awaad@azhar.edu.eg

ARTICLE INFO
Article History
Received:27/9/2022
Accepted:6/12/2022
Available:11/12/2022

Keywords:
Seagrass, *Posidonia oceanica*, rhizomes, leaves, epibenthic, infauna, nekton, Mediterranean Sea, Egypt.

ABSTRACT

The present study describes the natural occurrence of different faunal assemblages recorded among the seagrass, *Posidonia oceanica* meadows at the shallow water coastal zone (2-6 m) of the Salloum Marine Protected Area, Northwestern Egyptian coast, and the Mediterranean Sea. This study was carried out during the period from August 2018 to September 2019. A total of 242 faunal species belong to kingdoms Protista (one phylum) and Animalia (14 phyla), distributed in 32 classes under 75 orders, within 151 families and 200 genera were recorded. The recorded species were classified according to their occurrence into two main categories; the benthic animals comprised 226 species and the nektonic swimmers represented 16 species, comprising turtles (2 species) and fishes (14 species). The benthic animals were also subdivided according to occurrence among seagrass into epibenthic species, which were the dominant and represented by 177 species, followed by 49 infaunal species. Within epibenthic, the creeping animals came in the first order with 93 species, followed by walking (43 species), sedentary or sessile animals with 41 species in the second and third orders, respectively. The results also showed that the epibenthic animals were unequally distributed on plant parts, comprised of erect rhizomes (stems) occupied with the highest number of species (38), followed by 15 species on horizontal rhizomes (roots), and 13 species on leaves; while the co-existing species on leaves and erect rhizomes came last, and were occupied with only 12 species.

INTRODUCTION

The seagrass meadows in the Mediterranean Sea perform complex ecosystems characterized by variable abiotic and biotic factors (Mazzella *et al*., 1989; Hemminga and Duarte, 2000). , occupied with several habitats allowing existing different marine organisms for feeding, shelter, breed, refuge, and even stabilizing sediment, improving water clarity and providing nutrients for coastal phytoplankton and micro and macroalgae ((Hindell *et al.*, 2000; Bowden, *et al.*, 2001; Jackson *et al*., 2001; Bostrom *et al.*, 2006).

Due to the complexity of seagrass meadows of *P. oceanica* in the Mediterranean

Sea which cover about 2 % of the sea bottom and their importance in the marine environment at both ecological and economic importance, they consider a key species endemic to the Mediterranean Sea (Mojetta, 1996; Boudouresque *et al*., 2006). These meadows are unique among seagrasses in that they can thrive on either rock or sand (Procaccini *et al*., 2003) and can fully be developed to build their own substratum – a terraced structure, named matte, which consists of intertwined roots and rhizomes as well as sediment trapped among them (De Falco *et al*., 2000).

The complexity of seagrass meadows of *P. oceanica* in the Mediterranean attracts several marine organisms including more than 500 species of epiphytic invertebrates and fishes, as well as more than 400 species of algae in addition to microalgae occupied those unique habitats (Mojetta, 1996). Therefore, the occurrence of those species had been treated in both the eastern and western basins of the Mediterranean Sea, comprised Ben Brahim *et al*. (2010), Belgacem *et al*. (2011) and Mabrouk *et al*. (2011, 2012, 2013, 2014) on Tunisian coasts, Como *et al*. (2008) on the Italian Coasts, Zenetos *et al*. (1997, 2010), Kocak *et al*., 2002; Cinar (2003, 2009, 2013) in the eastern basin comprised Greek and Cyprus coasts, in addition to Riedl (1983), Idato *et al*. (1983), Gambi *et al*. (1992, 2006), Albano and Sabelli (2000), Buia *et al*. (2000), Balata *et al*. (2007, 2008), and Bedini *et al*. (2015), covering faunal assemblages or certain groups at different localities along the Mediterranean coasts or treated diversity, abundance or richness.

Salloum Marine Protected Area lies at the northwestern Egyptian Mediterranean Sea coasts. No specific or detailed studies about the natural occurrence of the seagrass-associated fauna on *P. ocenica* were detected. Therefore, this study aims to investigate the occurrence of recorded faunal assemblages on different seagrass parts in addition to those that occurred in sediments or sheltered within those meadows.

MATERIALS AND METHODS

A-Study Areas:

The present study was carried out at Salloum Marine Protected Area, Matrouh Governorate. This area lies on the northwestern coast of the Egyptian Mediterranean Sea (Fig. 1) and extends along the coastline from Salloum City (31° 32' 56.09" N, 25° 9' 65.46 "E) at the west to Ras El-Syada (31° 31' 2.71" N, 25° 27' 40.26" E) at the east. In this area, 9 sites were surveyed during this study (Fig. 1). Only four sites (S1, S2, S3, and S8) were occupied with variable stands of the seagrass *Posidonia oceanica* at the shallow water of the first 100 m from the shoreline with water depth varied from 0-6 m. The other 5 sites (S4-S7, and S9) were excluded due to water depth varying from ≥ 7- 10 m and the appearance of seagrass after 700-1000 from the shoreline, which needs diving and other available requirements. Therefore, those sites were surveyed seasonally during the period from autumn 2018 to summer 2019. The exact position of each site, common names, or local (vernacular) names are recorded and represented as follows:

-Site #1(S1): Salloum Bay: It lies at 31° 32' 56.09"N and 25° 9' 65.46"E. It has the highest cover percentages averaging 40.4 at 2-6 m depth.

-Site #2: Water Desalination Station (S2): It lies at 31° 32' 73.39"N and 25° 9' 11.57"E, with a cover percent of 3.2 %, at a depth of 1.8-6 m.

- Site #3: Salloum Military Hospital (S3): It lies at 31°32' 85.20"E and 25°10' 89.11", with cover percent averaged 3.0 %, at depth 2-6 m.

- Site # 8: Ras El- Gara (S8): It lies at 31° 30' 23.02"N and 25° 21'55.23" E with cover percent averaged 3.0 %, at depth 2-6 m.

B- Sample Collection:

The samples of *P. oceanica* and its associated fauna were collected seasonally during snorkeling and skin diving. At each site, 3 samples of seagrass beds with their

associated fauna and soil sediment were collected directly by hand from a quadrate of 25×25 cm^2 using a sharp knife to cut off the deep horizontal rhizomes from the substrate. The collection of these samples was taken along Line Intercept Transects (LIT) at each site according to English *et al*. (1997). All samples were collected during day time between 2-6 m depth and put directly in clear plastic bags including all plants with soil to prevent any associated fauna from escaping. The plastic bags were tightly closed underwater and provided with labels and all *Posidonia* samples of the same site were packed together in a serial sequence with strong soft plastic ribbons. Each sample was preserved in a 10% Formaldehyde solution containing a few drops of Eucine (1%) solution and then transferred to the laboratory for further investigations and analyses.

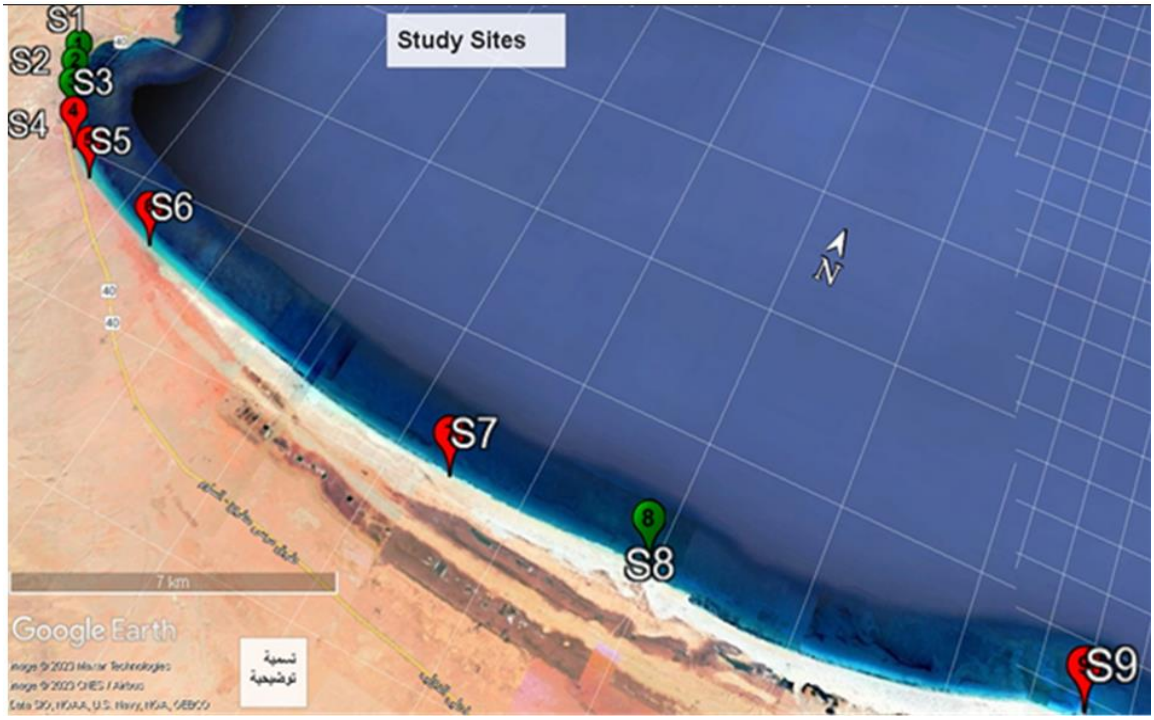


Fig. 1: Shows the surveyed (red) and intensive (green) study sites at Salloum Marine Protected Area, Mediterranean Sea, Egypt, during this study (autumn 2018 - summer 2019).

C- Laboratory Investigation and Data Analyses:

At the laboratory, the collected samples in each plastic bag were sorted and each sample was washed under tap water, and then sieved using manual sieves of 0.1 mm mesh for separation of the associated macrofauna from sediments. All different parts of the seagrass, *P. oceanica* including leaves, erect rhizomes and horizontal rhizomes were examined by the naked eye and using a binuclear dissecting microscope as well as a stereomicroscope and all faunal elements on those parts were sorted and identified to a specific level using all available taxonomical literature and textbooks as Millar (1970) on ascidians, Fauchald (1977) on polychaetes, Campbell (1982) as well as Fischer *et al*. (1987) for all Mediterranean Sea invertebrates and other available textbooks and literature as Abd Elnaby (2008, 2009 a, b, 2019, 2020a, b), Halim, and Abdel Messeih (2016) in addition to those described on web sites. Animal fragments were identified as possible into the nearest genera or groups.

After identification, the number of individuals of each species of faunal elements at each seagrass part (leaves, erect and horizontal rhizomes) was recorded at each site and during different seasons. Then they were grouped together in the major taxonomical taxa,

tabulated and all appropriate available statistical analyses were undertaken. Photos for well-identified specimens were getting either directly or by putting them onto a clear petri dish or on the slide, using a fitted camera Android HUAWEI Y6 Pro Phone Model (HUAWEI TIT-U02).

RESULTS

A- Faunal Assemblages with *P. oceanica*:

The present results indicate that a total of 242 faunal species were recorded from four sites of the sea grass *Posidonia oceanica* meadows distributed in the shallow water of Salloum Marine Protected Area, Egypt, Mediterranean Sea (Fig. 1). The obtained results for all recorded species are given in Table (1). The recorded species belong to 15 phyla, within two kingdoms, including Kingdom Protista (with only one phylum) and Kingdom Animalia (with 14 phyla). They are distributed within **200** genera and 151 families, under 75 orders, within 32 classes. The detailed spatial and temporal fluctuations in faunal composition are preparing for publication in a separate article.

B- The Occurrence of Associated Animals with *P. oceanica:*

The obtained results exhibit that the associated animals among the seagrass *P. oceanica* meadows can be classified based on their occurrence and mode of life into two main types comprised nektonic (visitors) and benthic animals. These groups are treated in detail as follows:

1- Nektonic or Visitor Seagrass Species:

This group comprises all 16 active swimmers of fish and turtles (Table 1), representing 6.61% of all associated fauna. The individuals of larger and medium-sized fish were noticed roaming all over seagrass meadows and other neighboring sandy and rocky habits during day time; while the smaller-sized and juvenile individuals were refuging, particularly in dense meadows. At S1 and S3 only, a single individual of both loggerhead and green turtles was observed during summer and spring, respectively and they were moved rapidly and escaped toward deeper water.

2- Benthic Seagrass-Associated Fauna:

The results in Table (1) illustrate the benthic seagrass-associated fauna, which comprised 226 species (93.39 % of all recorded species). They vary in nature of their occurrence among *P. oceanica* meadows and can be further classified based on their movement into two main categories including epibenthic and infaunal animals.

a- Epibenthic Fauna:

Epibenthic animals comprised all benthic animals occurring on different parts (leaves, horizontal and erect rhizomes) of *P. oceanica*. This group included 177 species from different phyla except Vertebrata (Table 1, & Plates I-IV), which represented 78.32 % of all benthic species, and 73.14 % of all recorded species. Those animals can be also classified based on the site of occurrence into:

i- Sedentary (sessile) or Fixed Epibenthic Associated Species:

The results in Table (1) and Plates II-IV show that there are 41 sedentary or fixed epibenthic species were recorded. They belong to 6 phyla including all 15 species of Porifera (sponges), 6 polychaetes (Annelida), 7 bivalve species (Mollusca), 6 bryozoans (Bryozoa), 4 ascidians (Urochordata), and 3 sea anemones (Cnidaria). This group represented 23.16 % and 18.14 % of all epibenthic and all benthic species, respectively and 16.94 % from all associated animals.

The laboratory examination indicated that all 15 recorded sponge species were attached to stems (erect rhizomes) and exposed parts of roots (horizontal rhizomes), dominated with *Sarcotragus foetidus*. In contrast, the sedentary polychaetes occurred on leaves and stem, characterized by their constructed calcareous white tubes, dominated by

Hydroides norvegica, *Spirorbis* sp., and *Serpula vermicularis*. However, the 6 species of bryozoans were very obvious on leaves particularly on the oldest and at bases of eroded leaves around stems, dominated by *Electra pilosa*, *Membranipora membranacea*, *Disporella hispida* and *Smittina* sp. On the other hand, the sedentary bivalves (7 species) were found attached firmly to seagrass stems, dominated with. *Pinctada imbricata*, *Spondylus gaederopus*, *Brachidontes pharaonis* and *Neopycnodonte cochlear*. For ascidians, only *Botrylloides violaceus* was recorded on both leaves and stems, while the other 3 species were attached to stems which were also occupied with all 3 cnidarians species (Plates II-IV).

Consequently, these results indicated that the majority (38 species) of sedentary epibenthic were attached to erect rhizomes, followed by 15 species on the horizontal rhizome, while leaves came last with only 13 species and 12 species coexisting on, leaves and stems (Table, 1& Plates II-IV).

ii- Movable Seagrass-Associated Animals:

The epibenthic movable associated animals comprised 136 species (Table, 1&Plate, I) representing 76.84 % of all epibenthic species and 56.20% of all associated fauna. These species included all creeping (93) and walking (43) species, which represented 68.38 % and 31.62 %, respectively, from all recorded movable species. These species were recorded either on *P. oceanica* or sheltered among its meadows. The creeping species were dominated by 61 species from gastropods (Mollusca), representing 65.59 % of all epibenthic creeping species. They were occurring on the erected rhizome and sheltered at the bases of seagrass leaves. The obtained results showed that *Bittium reticulatum*, *Alvania discors*, *Cerithium scabridum*, *Cerithium lividulum*, *Tricolia tenuis*, *Rissoa parva* and *Phorcus turbinatus* were the dominant species and represented in Plate (I).

The other creeping groups comprised 32 species, of theme Echinodermata came in second order after gastropods with 10 species, represented by 10.75 % from all creeping epibenthic species (Table 1 & Plate I). They occur at lower parts of rhizomes and among bases of eroded leaves, dominated by *Coscinasterias tenuispina* and *Actinopyga* sp. It is followed by the creeping bivalves (mollusks) with 6 species (% 6.45 from all creeping species), which occur as echinoderms at lower bases of leaves and stems dominated by *Anadara antiquate*, and *Acara sandersonae*. The other creeping species included 4 species of chitons, Nemertean and Sipuncula, declined to 3 foraminiferans (*Ammonia aberdoveyensis*, Ammonia sp., *Rosalina globularis*,), and reached only one species from Platyhelminthes. These were collected from leaves, but bivalves and chitons occurred on both leaves and stem.

On the other hand, all walking species were represented by 43 species comprising 40 Crustacea and 3 Chelicerata species which occurred on leaves and stems. These species use their appendages for walking and sheltering between the bases of stems and plant leaves **(**Plate, I). The most dominant species comprised *Elasmopus rapax*, and *Quadrimaera inaequipes* (amphipods), *Anthura gracilis* (isopods), *Pagurus* sp. (hermit crab) and the spider crab, *Nymphon gracile* (Chelicerata).

Table 1: Mode of life and nature occurrence of faunal elements on *P. oceanica* at Salloum Marine Protected Area.

Categories / Associated groups	Mode of life and nature of occurrence									No. species
	Benthic organisms								Nekton (Visitors)	
	Epibenthic							Infaunal Sediment animals		
	Fixed					Creeping	Walking			
	To	L	ER	HR	LS					
Polychaeta	6	6	6		6	-		31		**37**
Platyhelminthes						1				**1**
Nematoda								1		**1**
Nemertea						4				**4**
Crustacea							40			**40**
Chelicerata							3			**3**
Bivalvia	7		7			6		11		**24**
Gastropoda						61				**61**
Chiton						4				**4**
Cnidaria	3		3							**3**
Echinodermata						10				**10**
Bryozoa	6	6	4		6					**6**
Sipuncula						4				**4**
Foraminifera						3		6		**9**
Sponges	15		15	15						**15**
Ascidia	4	1	3							**4**
Fishes									14	**14**
Turtles									2	**2**
Subtotal	**41**	**13**	**38**	**15**	**12**	**93**	**43**	**49**	**16**	**242**
	41					**136**				
Grand total	**177**									

Notice that: L= leaves, ER= erect rhizome, HR= horizontal rhizome and LS= leaves and stems.

b- Infaunal Sediment Animals:

The present results showed that there are 49 species (Table, 1& Plate, I) that live as infaunal animals recorded from meadows of *P. oceanica*, representing 21.68 % of all recorded benthic species and 20.25 % of all associated species. Infaunal sediment animals comprised both permanent burrowing and temporary berried species. Polychaetes were the dominant and represented by 31 species (63.27% of infaunal animals), followed by 11 Bivalvia (22.45%), and 6 Foraminifera (12.24 %), in addition to Nematoda (2.04%). They occur in the soft sediments around seagrass erect and horizontal rhizomes. Several species of polychaetes were noticed in constructed burrows in seagrass meadows.

These results indicated that the epibenthic species were the dominant, followed by infaunal, then nektonic species. Within the epibenthic species, the creeping animals came in the first order, followed by the walking and sedentary epibenthic species in the second and third orders, respectively. The results showed that the nektonic species were represented with the lowest number of species as indicated in Table (1).

The statistical analyses using Q^2 showed highly significant values for all items. The calculated values of Q^2 recorded 182.23 and 72.50 ($P < 0.01$, df=1) between benthic versus both nekton and infaunal element, respectively. The values of Q2 have highly significant values recorded at 29.41, 78.32 and 183.96 (p 0.01, Df= 2, 3 and 7), within both epibenthic elements, sedentary and all types of occurrences, respectively.

Plate I: Showing representative examples comprising burrowing polychates (1&2), creeping bivalves (3), creeping chitons (4), burrowing Sipuncula (5), walking crustaceans (6-9), creeping gastropods (10-11) and creeping echinoderms (12-13) recorded during this study.

Plate II: Representative species of sedentary associated fauna on seagrass, *P. oceanica* leaves, comprising: Polychaetes (1-2), Bryzoans (3-6), right and left valves of bivalves (7), and ascidian colony (8) at Salloum Marine Protected Area during 2018-2019.

Plate III: Sedentary associated fauna on seagrass, *P. oceanica* erect rhizome (stem), collected from Salloum Marine Protected Area during 2018-1019.

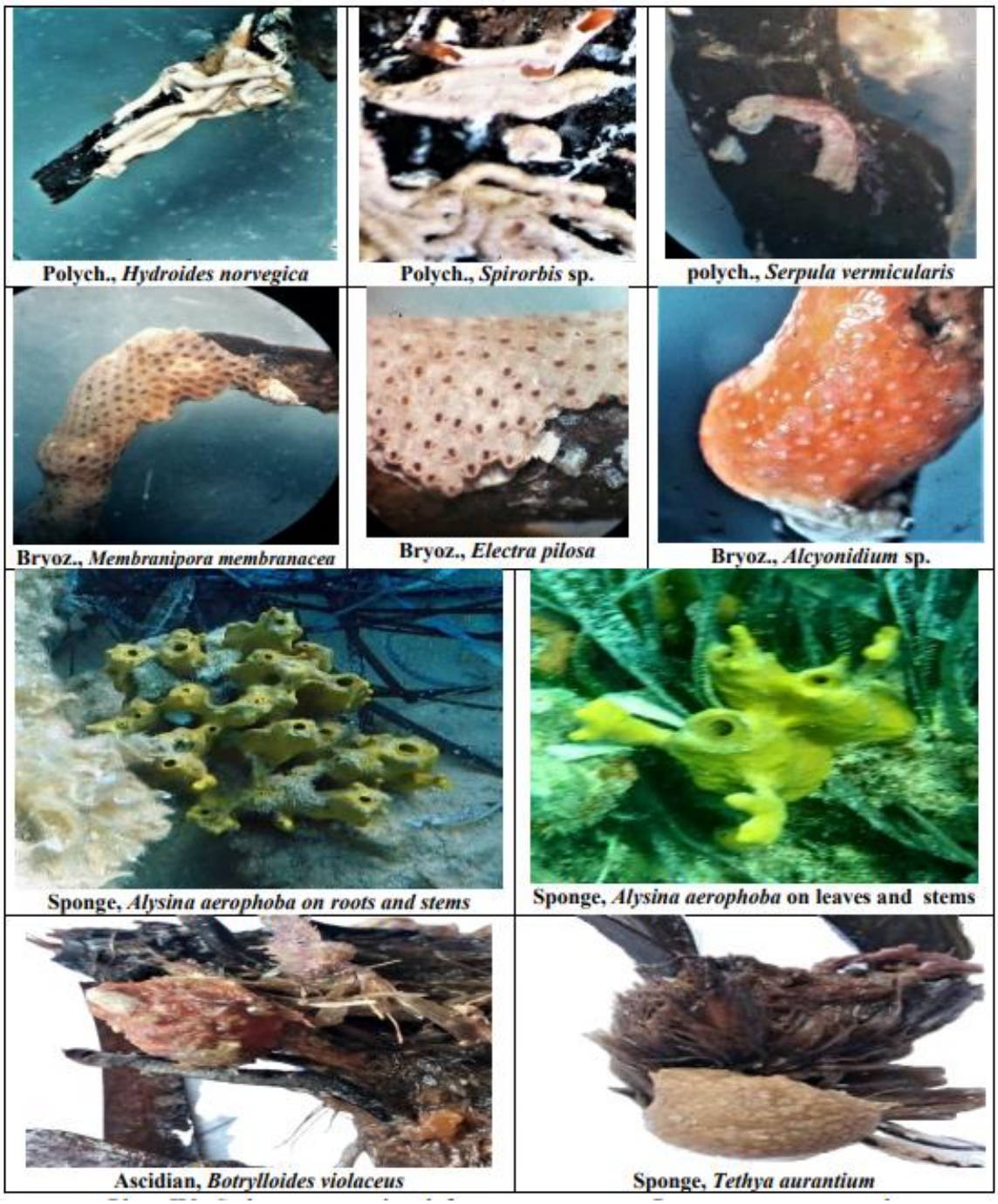


Plate IV: Sedentary associated fauna on seagrass, *P. oceanica* stems and roots, collected from Salloum Marine Protected Area during 2018-2019(Bryo= Bryozoa, and Poly.= Polychaeta).

DISCUSSION

The results of the present study exhibit that, the recorded seagrass-associated animals varied in their occurrence within seagrass meadows of *P. oceanica*. The benthic animals were the dominant, represented by 226 species, compared with only 16 species of active swimmers of fish (14 species) and turtle (2 species). The number of recorded fish during this study is lower than that reported in other studies such as Harmelin-Vivien (1982, 1989) encountered 50 fish species in *P. oceanica* beds, which were classified into resident (56%), transient (22%), or as occasional species (22%). These fishes comprised

the most important families including Labridae, Scorpenidae, Serranidae, and Centracanthidae which account for 41% of the number of species and 87% of the total biomass. Harmelin-Vivien, *et al*. (1995) recorded juveniles of *Diplodus annularis* settled in *Posidonia oceanica* seagrass beds at 5-8 m depth, and observed recruitments of five sparid species in very shallow water (<2 m), which extend to their home range vertically into deeper zones, and laterally in more exposed areas after growing. However, in *P. oceanica* meadows, no grazing marine mammals were recorded, but some large marine herbivores (turtles) spend a large amount of time (90%) at shallow depths in the vicinity of the meadow and ingest seagrass (Hays *et al*., 2002) as already observed during this study.

In the present results, the benthic invertebrates were the dominant (226 species) and had been classified into benthic infaunal sediment inhabitant (49 species) and epibenthic (177 species). The latter group comprised sedentary (41 species), creeping (93 species) and walking (43 species). Among infaunal benthic animals, 31 are polychaetes, comprised of both the permanent burrowing and temporary berried itself in soft bottom-dwelling species, in addition to 11 bivalves, 6 foraminiferans and nematode. The infaunal species occurred in soft sediments around seagrass erect and horizontal rhizomes, particularly those extended at edges of sandy depressions among seagrass meadows. The occurrence of infaunal animals is in agreement with that reported by Peres & Picard (1964), Boero (1981), Campbell (1982), Idato *et al*. (1983), Gambi *et al.* (1995) Mojetta (1996), Claudio (2009) and Mabrouk *et al*. (2012,2013, 2014).

On the other hand, the 177 epibenthic invertebrates species, are dominated by 93 creeping species most of them are gastropods (61 species), followed by echinoderms (10 species), and 6 bivalves, in addition to other few species varied from 1-4 belong to other recorded groups. All recorded creeping species occurred on different parts of seagrass, *P. oceanica* included leaves, bases of eroded leaves and stems which agree well that reported by Peres & Picard (1964), Boero (1981), Idato *et al*. (1983), Templado (1984), Gambi *et al.* (1995) and Albano and Sabelli, (2000), or they may be live in neighbor hard and soft substrates, but refuge for sheltering within seagrass meadows during day time, escaping from predators as reported by several authors as Campbell (1982), Gambi et al. (1995), Mojetta (1996) and Garcia-Gomez (2015). Among mollusk gastropods, *Bittium reticulatum*, *Alvania discors*, *Cerithium scabridum*, *Cerithium lividulum*, *Tricolia tenuis*, *Rissoa parva* and *Phorcus turbinatus*, were the dominant creeping gastropods, which agrees with that reported by Idato *et al*. (1983), Peres & Picard (1964) as well as with Gambi *et al.* (1995).

The occurrence of those species varied on different parts of seagrass *P. oceanica*. Boero (1981) demonstrated that, among 44 species of mollusc species, 14 have been found only on leaves, 16 only on rhizomes and 14 on leaves and rhizomes. Gambi *et al.* (1995) reported that out of the 321 recorded species, 179 species occurred on the leaf stratum, 101 on the rhizomes, and 41 are common. Albano and Sabelli, (2000) found that the assemblages of benthic animals were rich in rhizome (88 species) and the poor on leaves (14 species) with dominant of ten species included *Bittium latreillii*, *Bittium* sp., *Metaxia metaxae*, *Cerithiopsis nana*, *Rissoa violacea*, *Pusillina inconspicua*, *Alvania settepassii*, *Ocinebrina aciculate* and *Chauvetia mamillata*, which is also in agreement with Templado (1984) with rich and diverse assemblages on rhizomes at patchy and meadows of *P. ocneanica* at the southeastern Spain at depths variable depths (1-25 m).

The walking-associated benthic animals comprised 43 species and were restricted only to crustaceans (40) and spiders (3). They were collected from seagrass leaves, erect stems and horizontal rhizomes using their paired appendages for walking. *Elasmopus rapax*, and *Quadrimaera inaequipes* (amphipods), *Anthura gracilis* (isopods), *Pagurus* sp. (hermit crab) and the spider, *Nymphon gracile* (Chelicerata) were the most dominant

species. These results agree with that reported by Claudio (2009). He stated that the more structured habitat in *Scarrupata* seemed favorable to amphipods, which are strictly associated with *Posidonia*, and are the major grazers of the epiphytes on *Posidonia* leaves. Seagrass leaves also support most of the faunal seagrass communities including Amphipoda, Isopoda, and Tanaidacea (Vizzini, *et al*. 2002), while *P. oceanica* rhizome layer and leaves were characteristic and occupied with small crustaceans including amphipods (Michel, 2011).

The 41 sedentary or sessile benthic animals were dominated by sponges (15 species), followed by bivalves (7 specie), polychaeted and brayozoans (6 species for each), 4 ascidians and 3 cnidarians. All these species were firmly attached to hard parts of *P. oceanica* including plant leaves, erect rhizomes (stems) and horizontal rhizomes(roots) which agree with Peres & Picard (1964), Panayotidis (1980), Boudouresque & Meinesz (1982), Gambi *et al*. (1995), Albano and Sabelli, (2000), Kocak, *et al*. (2002), Boudouresque *et al.*(2006), Claudio (2009), Mabrouk *et al.* (2012, 2013, 2014) and Gracia-Gomez (2015) for all sedentary species as well as with Halim, and Abdel Messeih (2016) on Ascidians along the Egyptian coasts of the Mediterranean Sea, Suez Canal, And Gulf of Suez. The sedentary polychaetes, *Hydroides norvegica*, *Spirorbis* sp., and *Serpula vermicularis* were the dominant which agrees with Claudio (2009) and Gracia-Gomez (2015). Claudio (2009) reported that most of the polychaete families were burrowers, carnivores and deposit feeders and only three families of the most abundant ones were herbivores, comprising Eunicidae, Nereididae and Syllidae. Gambi *et al.* (1995) attributed polychaete distribution to differences in food and feeding habits dominated by micro herbivores, in addition to macroherbivores and micro carnivores at variable depths.

For sponges, all 15 recorded species were attached to stems (erect rhizomes) and exposed parts of roots (horizontal rhizomes), dominated by *Sarcotragus foetidus*. These results agree with Peres & Picard (1964), who showed that most Porifera was found on *Posidonia* rhizomes and only two species, *Leucosolenia botryoides* and *Mycale contarenii*, live on the leaves. Mabrouk *et al.* (2014) reported that bryozoans, sponges and ascidians are the rhizome epiphytic fauna on Tunisian coasts.

On the other hand, all 6 species of bryozoans were very obvious on leaves, particularly on the old and at bases of eroded leaves around stems and dominated by *Electra pilosa*, *Membranipora membranacea*, *Disporella hispida* and *Smittina* sp. and their colonies were recorded at different study sites. Kocak *et al*. (2002) reported that bryozoans of the seagrass meadows of *P. oceanica* are more numerous on the rhizomes than on leaves, and was documented by Mabrouk *et al.* (2014) reported that the rhizome epiphytic fauna represents bryozoans, Poriferans and ascidians. These results are very similar to that reported by Boudouresque & Meinesz (1982) and Boudouresque *et al.*(2006). They indicated that brayozoan *Electra posidoniae* was the common epiphyte of the leaves which is exclusively found in this biotope. This flexible and poorly calcified species makes large colonies that grow parallel to the plant's nervure. They are therefore able to follow blade movements, limiting colony breakage.

During this study, erect rhizomes were occupied with the highest number of species (38) followed by horizontal rhizomes with 15 species, then 13 on leaves and the lowest number was 12 coexist between leaves and stem which is in agreement with the previously mentioned authors and all differences were statistically significant

Finally, the occurrence of sessile invertebrates is an important part of *P. oceanica* epiphytic cover. Most of them are suspension feeders. Bryozoans dominate the assemblages, but hydrozoans, foraminiferans, sedentary polychaetes (notably Serpulidae), sponges and tunicates are also found at least in shallowest stands as documented by Templado (1984), Buia *et al.* (2000), Kocak *et al*. (2002) and Mabrouk *et al.* (2011, 2012, 2013, 2014). However, other studies are necessary for following those groups at variable

depths and at other sites to give more information on that previously unstudied area.

Conclusion

During this study, out of 242 recorded species, 16 are nektonic, compared with 226 benthic dwelling species comprising 177 epibenthic and 49 infaunal elements. Eerect rhizomes (stems) were occupied with the highest number of species (38) followed by horizontal rhizomes (roots) with 15 species, then 13 on leaves and the lowest number recorded 12 species coexist on leaves and stem. The movable species included 93 creeping and 43 walking on plant parts.

Acknowledgment: The authors are greatly grateful to the Ministry of Environment and Natural Conservation Sector for financial and technical support and facilities. They also are grateful to all staff of the Laboratory of Marine Invertebrates, Zoology Department, Faculty of Science, Al-Azhar University, Nasr City, Cairo, for their help and support.

REFERENCES

Abd Elnaby, F. A. (2008). New recorded species of Magelonidae & Maldanidae (Annelida: Polychaeta from El-Tina Bay, Mediterranean coast of Egypt. *Egyptian Journal of Aquatic Biology and Fisheries*, 12(4): 119-141.

Abd Elnaby, F. A. (2009a). New records of Polychaetes from the South Part of Suez Canal, Egypt. *World Journal of Fisheries and Marine Science*, 1 (1): 7–19.

Abd Elnaby, F. A. (2009b). Polychaete study in Northeastern Mediterranean Coast of Egypt. *World Journal of Fisheries and Marine Science*, 1 (2): 85–93.

Abd Elnaby, F. A. (2019). New recorded alien polydorid species (Polychaeta: Spionidae) from the Egyptian waters. *Egyptian Journal of Aquatic Biology and Fisheries*, 23(4): 409 - 420.

Abd Elnaby, F. A. (2020 b). Alien Polychaete species and the first record of *Branchiomma bairdi* (McIntosh, 1885) from the Suez Canal and the Mediterranean coast of Egypt. *Egyptian Journal of Aquatic Biology and Fisheries*, 24 (5): 13-32.

Abd Elnaby, F.A.(2020a). On some Nereididae (Polychaeta) with new record for the Egyptian waters. *Egyptian Journal of Aquatic Biology and Fisheries*, 24(2): 47-68.

Albano, P. G. and Sabelli, B. (2000): The molluscan assemblages inhabiting the leaves and rhizomes of a deep water *Posidonia oceanica* settlement in the central Tyrrhenian Sea. *Science Marina,* ISSN 0214-8358. doi: 10-3989/scimar.03396.02C.

Balata, D.; Bertocci, I.; Piazzi, L. and Nesti, N. (2008): Comparison between epiphyte assemblages of leaves and rhizomes of the seagrass *Posidonia oceanica* subjected to different levels of anthropogenic eutrophication. *Estuarine, Coastal and Shelf Science,* 79: 533–540.

Balata, D.; Nesti, U.; Piazzi, L. and Cinelli, F. (2007): Patterns of spatial variability of seagrass epiphytes in the north-west Mediterranean Sea. *Marine Biology,* 151: 2025–2035.

Bedini, R.; Bedini, M.; Bonechi, L. and Piazzi, L. (2015): Patterns of spatial variability of mobile macro-invertebrate assemblages within a *Posidonia oceanica* meadow, *Journal of Natural History,* 2559-2581. Doi. 10.1080/00222933.1021872.

Belgacem, W.; Langar, H.; and Ben Hassine, O.K. (2011). Depth and temporal distribution of vagile fauna associated with *Posidonia oceanica* meadows in Cap Zebib, north-eastern Tunisian coastline. *African Journal of Ecology,* 49: 459–470.

Belgacem, W.; Langar, H.; Pergent G., and Ben Hassine, O.K. (2013): Associated mollusk communities of a *Posidonia oceanica* meadow in Cap Zebib (off North East Tunisia). *Aquatic Botany*, 104: 170–175

Ben Brahim, M.; Hamza, A.; Hannachi, I.; Rebai, A.; Jarboui, O.; Bouain, A. and Aleya, L. (2010): Variability in the structure of epiphytic assemblages of *P. oceanica* in relation to human interferences in the Gulf of Gabes, Tunisia. *Marine Environmental Research,* 70, 411–421.

Boero, F. (1981): Systematics and Ecology of the Hydroid Population of two- *Posidonia oceanica* Meadows. *Marine Ecology*, 2 (3): 181-197.

Bostrom, C.; Jackson, E. L. and Simenstad, C. A. (2006): Seagrass landscapes and their effects on associated fauna: a review. *Estuarine, Coastal and Shelf Science,* 68: 383–403.

Boudouresque, C. F. and Meinesz, A. (1982): Découverte de l'herbier de *Posidonie.* Cahiers du Parc. *National de Port-Cros.* 4: 1– 80.

Boudouresque, C. F.; Bernard, G.; Bonhomme, P.; Charbonnel, E.; Diviacco, G.; Meinesz, A.; Pergent, G.; Pergent-Martini, C.; Ruitton, S. and Tunesi, L. (2006): Préservation et conservation des herbiers à *P. oceanica*. Ramoge, Marseille, 202 pp.

Bowden, D. A.; Rowden, A. A. and Attrill, M. J. (2001): Effect of patch size and in-patch location on the infaunal macroinvertebrate assemblages of *Zostera marina* seagrass beds. *Journal of Experimental Marine Biology and Ecology,* 259: pp. 133–154.

Buia, M. C.; Gambi, M.C. and Zupo, V. (2000). Structure and functioning of Mediterranean seagrass ecosystems: an overview. *Biologia Marina Mediterranea*,7:167–190.

Campbell, A. (1982): The Hamlyn Guide to the flora and fauna of the Mediterranean Sea. Published by Hamlyn, 1982.

Çinar, M. E. (2003). Ecology of Syllidae (Annelida: Polychaeta) from Northern Cyprus (Eastern Med. Sea). *Bulletin of Marine Science*, 72(3): 795–811.

Çinar, M. E. (2009). Alien polychaete species (Annelida: Polychaeta) on the southern coast of Turkey (Levantine Sea, eastern Mediterranean), with 13 new records for the Mediterranean Sea. *Journal of Nature History*, 43: 37-38.

Çinar, M. E. (2013). Alien polychaete species worldwide: Current status and their impacts. *Journal of Marine Biological Association,* UK, 93(5):1257-1278. DOI:10.1017/S0025315412001646.

Claudio, V. (2009): Spatio-temporal variability of plant features and motile Invertebrates in *P. oceanica* seagrass meadows. Ph.D. thesis, The Open University, Naples, Italy, 234 ppt.

Como, S.; Magni, P.; Baroli, M.; Casu, D.; De Falco, G. and Floris A. (2008): Comparative analysis of macrofaunal species richness and composition in *Posidonia oceanica*, Cymodocea nodosa and leaf litter beds, *Marine Biology*, 153:1087–1101.

De Falco, G.; Ferrari, S.; Cancemi, G. and Baroli, M. (2000): Relationship between sediment distribution and *P. oceanica* seagrass, Geo- Marine Letters, 20, pp. 50–57.

English, S.; Wilkinson, C. and Baker, V. (1997): Survey Manual for Tropical Marine Resources. Townsville, Australia, Australian Institute of Marine Science, Townsville Australia: 378pp.

Fauchald, K. (1977). The polychaete worm: Definition and keysto the orders, families and genera. Natural History Museum of Los Angeles County, In Conjunction with The Allan Hancock Foundation, University of Southern California. *Science Series*, 28:188 pp.

Fischer, W.; Schneider, M. and Bauchot, M.L. (1987): Mediterranee Et Mer Noire Zone De Peche 37. Revision 1, Volume 1: Vegetaux Et Invertebres. Fiches FAO

D'identificationdes especes Pour Les Besoins De La Peche. FAO and ECEE, Rome 1987, 760 Pp.

Gambi, M. C.; Giangrande, A.; Martinelli, M. and Chessa, L. A. (1995): Polychaetes of a *Posidonia oceanica* bed off Sardinia (Italy): spatial and seasonal distribution and feeding guild analysis. *Scientia Marina*, 59:129–141.

Gambi, M. C.; Lorenti, M.; Russo, G. F.; Scipione, M. B. and Zuppo, V. (1992). Depth and seasonal distribution of some groups of the vagile fauna of the *Posidonia oceanica* leaf stratum: structural and trophic analyses. *Marine Ecology*, 13:17–39.

Gambi, M. C.; Borg, J. A.; Buia, M. C.; Di Carlo, G.; Pergent-Martini, C.; Pergent, G. and Procaccini G. (eds) (2006): Proceedings Mediterranean Seagrass Workshop, Malta 29 May–4 June 2006. *Biologia Marina Mediterranea*,13(4):1–293.

García-Gómez, J. C. (2015): A guide on environmental monitoring of rocky sea beds in Mediterranean Marine Protected Areas and surrounding zones. UNEP RAC/SPA, Med MPA net Project, Tunis. pp. 482 + annexes.

Halim, Y. and Abdel Messeih, M. (2016): Aliens in Egyptian waters. A checklist of ascidians of the Suez Canal and the adjacent Mediterranean waters. *Egyptian Journal of Aquatic Research*, 42: 449–457.

Harmelin-Vivien, M. L. (1982): Ichtyofaune des herbiers de *posidonies* du parc national de port-Cros: I. Composition et variations spatio-temporelles. *Travaux scientifiques du Parc national de Port-Cros*, 8: 69–92.

Harmelin-Vivien, M. L. (1989): Ichtyofaune des herbiers de *posidonies* du parc naturel r´egional de Corse. In: Boudouresque C., F., Meinesz A, Fresi E and Gravez, V. (eds) International Workshop on *Posidonia* Beds, GIS *Posidonie* publ, France II. pp. 291–301.

Harmelin-Vivien, M. L.; Harmelin, J. G. and Leboulleux, V. (1995): Microhabitat requirements for settlement of juvenile sparid fishes on Medi.rocky shores, *Hydrobiologia*, 300/301: 309-320.

Hays, G. C.; Glen, F.; Broderick, A. C.; Godley, B. J. and Metcalfe, J. D. (2002): Behavioral plasticity in a large marine herbivore: Contrasting patterns of depth utilisation between two green turtle (*Ch. mydas*) populations. *Marine Biology*, 141: 985– 990.

Hemminga, M. A. and Duarte, C. M. (2000): Seagrass Ecology. Cambridge University Press (Cambridge, England).

Hindell, J. S.; Jenkins, G. P. and Keough, M. J. (2000): Evaluating the impact of predation by fish on the assemblage structure of fishes associated with seagrass (*Heterozostera tasmanica*) (Martens ex Ascherson) den Hartog, and unvegetated sand habitats, *Journal of Experimental Marine Biology and Ecology*, 255: pp. 153–174.

Idato, E.; Fresi, E. and Russo, G. F. (1983): Zonazione verticale della fauna vagile di strato foliare in una prateria di *Posidonia oceanica* Delile: I - *Molluschi. Bollettino Malacologico*, 19:109–120

Jackson, E.L.; Rowden, A.A.; Attrill, M.J.; Bossey, S.J. and Jones, M.B. (2001): The importance of seagrass beds as a habitat for fishery species. *Oceanography and Marine Biology: An Annual Review*, 39: 269–303.

Kocak, F.; Balduzzi, A. and Benli, H.A. (2002): Epiphytic bryozoan community of *P. oceanica* (L.) Delile meadow in Northern Cyprus (Eastern Medit.). *Indian Journal of Marine Science*, 31: 235–238.

Mabrouk, L., Hamza, A., Ben Brahim, M. and Bradai, M. N. (2011): Temporal and depth distribution of microepiphytes on *Posidonia oceanica* (L.) Delile leaves in a meadow off Tunisia. *Marine Ecology*, 32:148–161.

Mabrouk, L., Hamza A., Mahfoudi M., Bradai M.N. (2012): Spatial and temporal variations of epiphytic *Ostreopsis siamensis* on Posidonia oceanica (L.) Delile leaves in Mahdia (Tunisia). *Cahiers de Biologie Marine*, 53, 419–427.

Mabrouk L., Hamza A., Ben Brahim M., Bradai M.N. (2013): Variability in the structure of epiphyte assemblages on leaves and rhizomes of Posidonia oceanica in relation to human disturbances in a seagrass meadow off Tunisia. *Aquatic Botany*, 108, 33–40.

Mabrouk, L.; Ben Brahim, M.; Hamza, A. and Bradai, M. (2014): Diversity and temporal fluctuations of epiphytes and sessile invertebrates on the rhizomes *P. oceanica* in a seagrass meadow off Tunisia. *Marine Ecology*, 35: 212–22.

Mazzella, L.; Scipione, M. B. and Buia, M. C. (1989): Spatio-temporal distribution of algal and animal communities in a *Posidonia oceanica* meadow. *Marine Ecology*, 10:107–129.

Michel, L. (2011): Multidisplinary study of trophic diversity and functional role of amphipod crustaceans associated to *P. oceanica* meadows. Ph.D. Thesis, Faculty of Sciences, University of Liege, Liege, 261 ppt.

Millar, R.H.(1970): British Ascidians, Tunicata: Ascidiacea. Keysand notes for identification of the species. A new series, Synopsis of the British Fauna No. 1: 1-88, The Linnaean Society of London, Academic Press, London.

Mojetta, A. (1996). Mediterranean Sea: Guide to the underwater life. Swan Hill Press, UK,167 Pp.

Panayotidis, P. (1980): Contribution `a l'´etude de l'aasociation *Posidonietum oceanicae* Funk, University of Aix-Marseille II. pp. 1–213. PhD Thesis.

Peres, J. M. and Picard, J. (1964): Nouveau Manuel de Bionomie Benthique de la Mer Mediterranée. *Recueil des Travaux de la Station marine d'Endoume*, 31 (47), 5-137.

Procaccini, G.; Buia, M. C.; Gambi, M. C.; Perez, M.; Pergent, G.; Pergent-Martini, C. and Romero, J. (2003): The seagrasses of the Western Mediterranean. In: Green EP and Short FT (eds) World Atlas of Seagrasses, University of California Press, Berkeley. CA. pp. 48–58.

Riedl, R. (1983): Fauna y flora del. Mar. Mediterraneo. Ediciones Omega, Barcelona, 858 pp.

Templado, J. (1984): Las praderas de *Posidonia oceanica* en el sureste espanol y su biocenosis. in International Workshop on. *P. oceanica* Beds, Boudouresque, C. F., Jeudy De Grissac, A. & Olivier J. (Eds.), 1: 159-172.

Vizzini, S.; Sara, G.; Michener, R. H. and Mazzola, A. (2002): The role and contribution of the seagrass *Posidonia oceanica* (L.) Delile organic matter for secondary consumers as revealed by carbon and nitrogen stable isotope analysis, *Acta Oecologica*, 23: 277–285.

Zenetos, A.; Christianidis, S.; Pancucci, M-A.; Simboura, N. and Tziavos, C. (1997): Oceanologie study of an open coastal area in the Ionian Sea with emphasis on its benthic fauna and some zoogeographical remarks, *Acta Oceanologica*,20, 2:437-451.

Zenetos, A.; Gofas, S.; Verlaque, M.; Çinar, M.E.; García Raso, L. E.; Bianchi, C. N.; Morri, C.; Azzurro, E.; Bilecenoğlu, M.; Froglia, C.; Siokou, I.; Violanti, D.; Sfriso, A.; San Martín, G.; Giangrande, A.; Katagan, T.; Ballesteros, E.; Ramos Espla, A.; Mastrototaro, F.; Ocana, O.; Zingone, A.; Gambi, M. C. and Streftaris, N. (2010). Alien species in the Mediterranean Sea. A contribution to the application of European Union's Marine Strategy Framework Directive (MSFD). Part I. Spatial distribution. *Mediterranean Marine Science*, 11 (2): 381-493.