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DISTRIBUTION OF PODOCOPID OSTRACODS IN MANGROVE ECOSYSTEMS ALONG THE EGYPTIAN RED SEA COAST

BY

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ABSTRACT

The distribution of recent shallow marine species of Ostracoda was recorded from 46 bottom samples collected from two mangrove ecosystems along the Egyptian Red Sea coast, i.e., the regions Wadi El Gemal and Abu Ghoson. Four communities of Ostracoda were determined and examined, recorded from recent intertidal, lagoon, swamp, and downstream sediments, respectively. The distribution patterns of the Ostracoda are affected primarily by the conditions of the vegetation and the bottom. Areas with dense vegetation and/or muddy sand bottoms contain the more abundant and more diverse assemblages. Statistical analysis showed three clusters of species at each site. These results coincide with the observed physiographic assemblages, except at Wadi El Gemal where we have three clusters of species and only two communities. This can be explained through the more dense growth of mangroves in the southeastern and southwestern parts, as well as the fact that the substrate there is muddy sand instead of the sandy substrate found in the northern parts.

Key words. — Ostracoda, Recent marine sediment, Red Sea, mangrove ecosystem, Wadi El Gemal, Wadi Abu Ghoson, Egypt

RÉSUMÉ

La répartition des espèces marines récentes d'Ostracodes d'eaux peu profondes a été étudiée à partir de 46 échantillons du fond collectés dans deux écosystèmes de mangrove de la côte égyptienne de la mer Rouge, Wadi El Gemal et Abu Ghoson. Quatre communautés d'Ostracodes ont été déterminées et examinées, en provenance d'intertidal actuel, de lagune, de marais et de sédiments aval, respectivement. Les modèles de distribution d'Ostracodes sont affectés principalement par la végétation et le type de fond. Les zones à végétation dense et/ou à fond de sable vaseux contiennent les assemblages les plus abondants et les plus diversifiés. L'analyse statistique a montré trois groupes d'espèces à chaque site. Ces résultats coïncident avec les assemblages physiographiques observés, sauf à Wadi El Gemal où nous avons trois groupes d'espèces et seulement deux assemblages. Ceci peut s'expliquer par la croissance plus dense des mangroves dans les parties sud-est et sud ouest, ainsi que par le fait que le substrat est du sable vaseux alors qu'il est sableux dans les régions septentrionales.

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INTRODUCTION

Ostracoda assemblages of the Egyptian Red Sea regions are diverse and abundant, yet they are not well studied except from geographically distant and isolated locations such as Hurghada Bay (Hartmann, 1964); the Gulf of Aqaba (Bonaduce et al., 1976, 1980, 1983); southern parts of the Red Sea (Bonaduce et al., 1983); and Safaga Bay (Helal & Abd El Wahab, 2004; Abd El Wahab et al., 2011). The number of previous studies about the distribution and diversity of such an important group in this region is low and does not allow understanding of the ecological factors controlling such distribution or diversity patterns.

The aim of the present paper is to record the Ostracoda assemblages and occurrences in two mangrove ecosystems, one in the Wadi El Gemal region and one in the Abu Ghoson region, and to investigate the ecological factors involved in their distribution and microhabitat in those regions. This paper presents an introduction to a better understanding of the spatial distribution of Ostracoda in the Red Sea. A detailed taxonomic study is outside the scope of the present work and has been dealt with in another study (Helal & Abd El Wahab, 2010).

The Red Sea encompasses a variety of different habitats, mangrove communities, intertidal mud flats, lagoons and wadis, which support a diverse fauna and flora. The shores of the study regions are heterogeneous in nature, encompassing gravelly, sandy and muddy beaches. The coastal plain is relatively wide with a gentle seaward slope. Mangrove communities or mangals have a rather patchy pattern of distribution, extending from the north of the Red Sea (Gulf of Suez and Gulf of Aqaba) to the south (Bab El Mandeb Strait), and they are found on both sides of the Red Sea. The sampling localities of the present study are two well-developed mangrove communities in the Wadi El Gemal and Abu Ghoson regions (figs. 1-2). Wadi El Gemal is situated to the south of Marsa Alam (24°40.37′-24°41.13′N 35°05.18′-35°4.57′E). Abu Ghoson is located 40 km south of Wadi El Gemal on the Red Sea coast (24°2.29′-24°21.32′N 35°18.23′-35°18.13′E).

ENVIRONMENTAL SETTINGS

Mangrove communities are assemblages of halophytic trees, shrubs, palms and creepers that form dense thickets covering the intertidal and shallow subtidal zones of tropical and subtropical areas. They thrive in protected embayment areas, tidal lagoons and estuaries (Michael et al., 1994). Mangroves play an important role in shore stabilization, from the export of organic materials to the surrounding coastal habitats and nutrients to the neighbouring coastal waters (Fouda, 1995). The mangrove root systems and their associated biota act to capture, accumulate and stabilize sediments suspended in the intertidal waters.

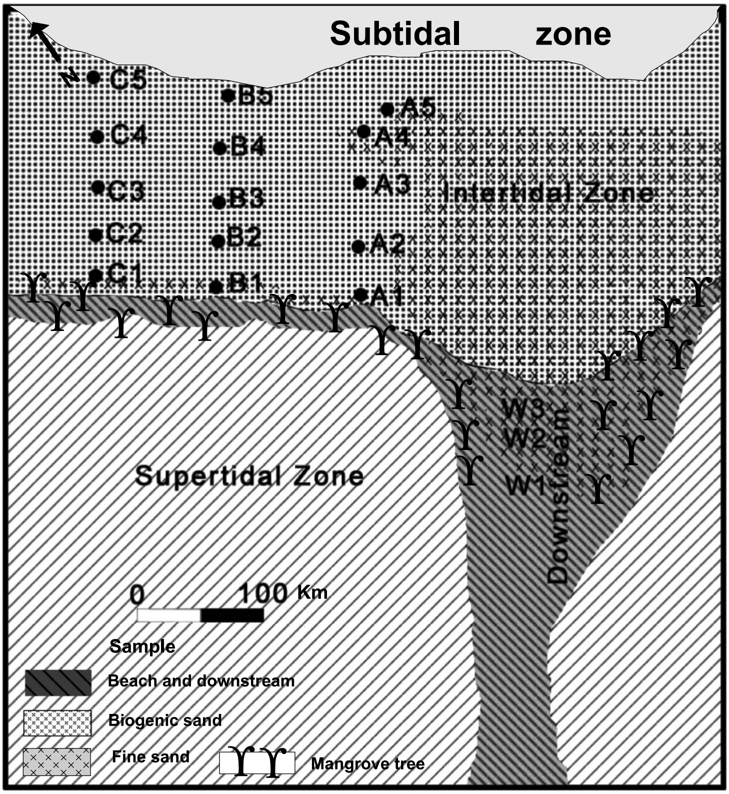

Fig. 1. Map of the Wadi Gemal area showing sample sites and bottom facies.

Several ecological aspects of the Red Sea mangrove concerning the vegetation have been studied previously (Dor & Por, 1977; Por et al., 1977; Dor & Levy, 1984). Mangrove surveys have also been undertaken in other parts of the Egyptian shores of the Red Sea (Zahran, 1965, 1967, 1974; Kassas & Zahran, 1967; Mansour, 1992; Madkour & Mohammed, 2005). The mangroves of the Red Sea represent a composite habitat growing on both hard and soft substrates, each inhabited by a typical fauna (Price et al., 1987). The mangrove community is highly productive, from 350 to 500 gc/m^2 per year (Golley et al., 1962; Michael et al., 1994), and supports a wide variety of animals that depend upon plant detritus as a source of food (Heald, 1971; Odum, 1971).

In the study area, algae and seagrasses are widely distributed. At Wadi Gemal, the macro algae were found at a depth of 50-60 cm, in a scattered pattern. The creeping green algae, such as *Caulerpa racemosa* (Forsskål) J. Agardh, 1873, were found in small aggregations covering vast areas of the sandy substrate and some dead corals as well. Also, small quantities of the green algae *Halimeda tuna* (Ellis & Solander) Lamouroux, 1812 were found in-between branches of

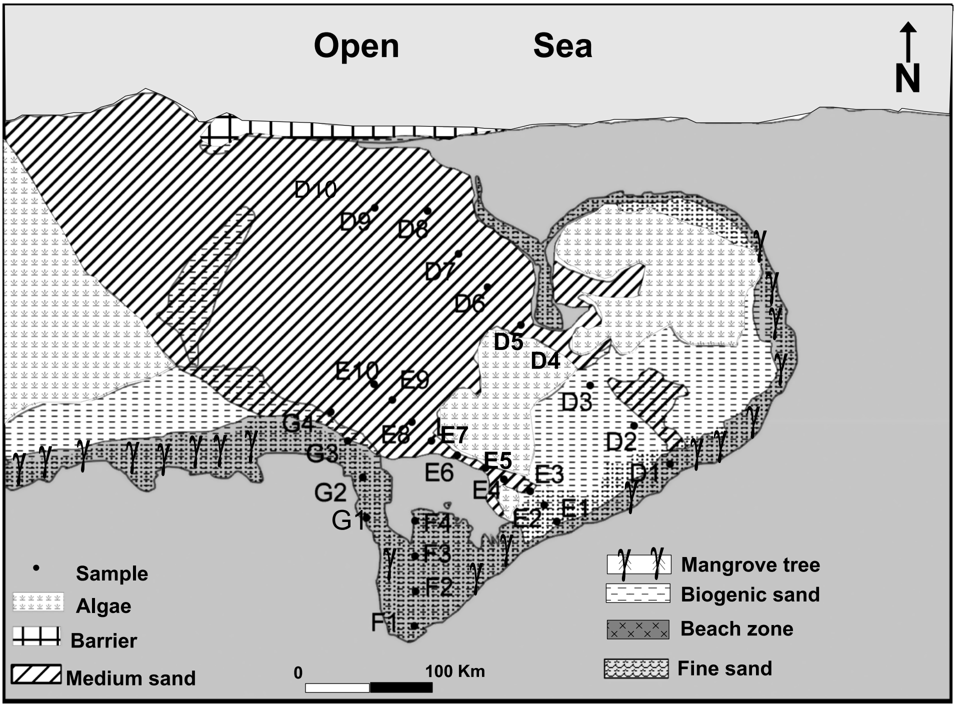

Fig. 2. Map of the Abu Ghoson area showing sample sites and bottom facies.

corals. Seagrass species, such as *Halophila stipulacea* (Forsskål, 1775) Ascherson, 1867 and *Halodule uninervis* (Forsskål) Ascherson, 1882, were found as spots forming large meadows, growing in sandy mud substrates. The seagrass *Halophila stipulacea* was the dominant species, forming separated patches.

In the Abu Ghoson area, the green algae formed a low dense mat that covered some of the swamp floor. *Cystoseira myrica* (S. G. Gmelin) C. Agardh, 1820, *Sargassum dentifolium* (Turner) C. Agardh, 1820 and *Turbinaria triquetra* (J. Agardh) Kützing, 1849 were observed, forming scattered vegetation. The seagrass vegetation was very limited, only spots of *Halophila stipulacea* were found in the sandy depressions around the corals. Also, the seagrass *Thalassia hemprichii* (Ehrenberg) Ascherson, 1871 formed small scattered patches that occupied wide areas of the sandy flats.

Mangrove sediments of the investigated area are composed basically of slightly gravelly muddy sand, whereas fine sand fractions are dominant in the intertidal zone. Mangrove sediments are characterized by being poorly sorted, nearly symmetrical to coarse skewed and mesokurtic to leptokurtic fine sand. Distribution of gravel, sand and mud fractions is related to the bottom facies and the type of sediment source. This reflects the trapping of fine material by plants and supply of coarse material by mollusca particles.

The Wadi El Gemal site

Wadi El Gemal is about 40 km long with the high, exposed basement rocks. Wadi El Gemal and its delta are the central zone of the Wadi El Gemal protectorate (fig. 1). It is the third largest valley in the Eastern Desert, draining into the Red Sea, and one of the best vegetated areas, with an estimated watershed area of about 1840 km^2 (GEF, 1998). The mangrove trees are followed by a wider tidal flat, with a gentle slope seaward and a steep slope that continuing up to the reef edge. The beach is rocky, cemented by carbonates, and covered with gravel, and coarse to medium sand with abundant shell fragments. Two bottom facies were recorded at the Wadi El Gemal site, downstream facies and intertidal facies.

The downstream area follows the main asphalt road with a gentle seaward slope followed by the beach. It has three shallow wells located in a row perpendicular to the shoreline, reaching a depth of about 100 cm, and filled with brackish water. Clay and mud represent the main sediments of the downstream area, which is inhabited by some short mangrove trees, dates and some desert plants.

The intertidal zone is 100 m wide, with a gentle seaward slope, and the water level covering it reaches 50 cm at high tide. The bottom floor is rocky, covered with a thin layer of biogenic coarse sand. Diseased mangrove trees are distributed parallel to the shoreline on both sides of the downstream entrance. Also, there are many mangrove roots growing on the rocky bottom. Coral reefs have not been recorded.

The Abu Ghoson site

This site includes a semi-closed lagoon with one inlet towards the north, three rocky barriers at the northern margin of this lagoon, a wide back reef, and a large land swamp connected with the sea at high tide. The southern and eastern sides of the beach are rocky while the northern and western parts are sandy. The area is one of the largest mangroves on the Egyptian Red Sea coast. In this area, the mangrove swamp is healthy and its density increases from north to south, the height of mangrove trees exceeding 8 m. The swamp and its surrounding areas are flat plains with a gentle seaward slope. Three facies were recorded at Abu Ghoson: intertidal facies, swamp facies and lagoon facies.

The intertidal zone facies is situated toward the sea behind the swamp; it is very wide, nearly flat, and normally exposed during the low tide period, while during the high tide the water reaches the swamp. Some unhealthy mangrove trees aerobic roots are distributed in this zone. Sediments of this zone are mainly of biogenic origin in addition to a low percentage of terrigenous deposits.

The swamp is a wide area in the supratidal zone, and builds a lake surrounded by healthy mangrove trees, up to 8 m high, from the south, west and northwards.

Eastwards is the main inlet towards the sea. The bottom floor is covered with clay and mud sediments, and the water is 120 cm deep during the high tide. The swamp is inhabited by fish larvae, young craps and shrimps. No corals were observed.

The lagoon is semi-closed, wide and surrounded by three conglomerate barriers seawards. Its maximum depth lays in the central part and is about 150 cm, while other sides are very shallow and usually exposed during the low tide, especially on the eastern side. The lagoon has medium to fine sand deposits with a high percentage of mud. The eastern side is rich with aerobic roots due to the abundance of mud fractions, as well as high organic matter content. No corals or algae were observed in this lagoon.

MATERIAL AND METHODS

In January 2004, 46 marine sediment samples were collected along transects perpendicular to shoreline from Wadi El Gemal (18 samples) and Wadi Abu Ghoson (28 samples) (figs. 1-2). About 500 g of sediment was collected from each site using grab sampler or by pushing steel boxes into sediments. All samples were washed over a 63 μm mesh sieve and dried overnight at 60°C. About 200 g of each dried sample was studied at 40× magnification using a stereomicroscope. Ostracoda species were identified and counted. Single valves and articulated specimens of both juveniles and adults were counted as a single individual in determining the total population.

Most oceanographic parameters such as water depth, water temperature, salinity, dissolved oxygen (DO), hydrogen ion concentration (pH), total dissolved salts (TDS), oxidationreduction potential (E_h) and specific conductivity (SPC) were measured for each sample in situ using Surveyer[4] 1997 (Hydrolab Instrument) (table I). For the abbreviations: BCMMP, BMMP and BMP, please see Note Added in Proof.

OSTRACODA DISTRIBUTION

General distribution pattern

The actual role of Ostracoda in the mangrove ecosystem is not fully understood. Due to the ecology of the mangrove forests ostracod species must be highly adapted to the photic, shallow and nutrient-rich environment. Algae and seagrasses are important elements of this community. Hence, phytal and plant dwelling ostracods are abundant.

Ostracoda have evolved in a wide variety of nutrition systems, including filter feeding and deposit feeding (Pokorny, 1978). In captivity, most forms will live

TABLE I
Oceanographic parameters in the study area

Sample	Depth (cm)	Temperature (°C)	Bottom facies	Salinity (%)	DO (mg/l)	pH	TDS (g/l)	E_h (mV)	SPC (Ms/cm)
W1	80	20.16	Coarse sand	12.29	7.17	8.48	13.14	348	20.65
W2	120	19.32	Medium sand	25.75	5.84	8.08	25.79	370	40.56
W3	80	24.66	Sandy gravel	40.02	7.43	8.31	38.28	343	50.02
A1	Beach	24.95	Biogenic coarse sand	40.57	7.29	8.42	30.70	334	60.45
A2	50	25.08	Biogenic coarse sand	40.33	8.42	8.45	38.49	334	60.05
A3	50	24.89	Biogenic medium sand	41.12	8.69	8.96	39.16	337	61.16
A4	40	24.50	Biogenic medium sand	41.14	8.59	8.48	39.18	338	61.18
A5	40	24.60	Mixed coarse sand	41.16	8.62	8.46	39.21	339	61.22
B1	Beach	25.18	Gravelly sand	40.75	7.15	8.41	38.79	338	60.42
B2	50	25.00	Biogenic coarse sand	40.66	8.16	8.54	38.79	339	60.57
B3	50	24.95	Biogenic coarse sand	41.33	9.36	8.48	39.33	340	61.43
B4	40	24.98	Biogenic medium sand	41.31	9.60	8.49	39.32	345	61.46
B5	40	24.51	Biogenic medium sand	41.40	9.55	8.50	39.40	345	61.53
C1	Beach	24.59	Gravelly sand	41.26	7.83	8.47	39.29	332	61.40
C2	50	22.86	Biogenic muddy sand	41.49	9.48	8.50	39.43	339	61.65
C3	50	21.75	Biogenic medium sand	41.50	9.72	8.51	39.45	336	61.61
C4	40	23.18	Biogenic medium sand	41.61	9.43	8.52	39.53	345	61.75
C5	40	23.68	Biogenic coarse sand	41.52	8.90	8.53	39.47	345	61.64
D1	Beach	20.25	Biogenic coarse sand	40.42	6.01	8.42	38.75	270	60.43
D2	80	20.29	Biogenic coarse sand	40.44	6.00	8.64	38.81	271	60.73
D3	100	21.90	Biogenic medium sand	40.72	6.43	8.50	38.80	270	60.72
D4	100	20.46	Biogenic medium sand	40.61	6.25	8.51	38.68	278	60.50
D5	120	20.51	Biogenic medium sand	41.06	6.18	8.53	39.05	307	60.98
D6	140	20.28	Biogenic medium sand	41.17	5.89	8.53	39.11	310	61.18
D7	70	20.52	Biogenic fine sand	41.26	6.07	8.53	39.23	312	61.27
D8	30	20.64	Biogenic fine sand	41.28	6.55	8.53	39.25	313	61.32
D9	30	21.83	Biogenic medium sand	41.32	6.42	8.54	39.26	315	61.34
D10	20	23.23	Biogenic medium sand	41.00	7.71	8.57	39.07	278	61.02
E1	Swamp	22.38	Medium sand	41.42	6.60	8.55	39.39	324	61.60
E2	Swamp	22.39	Muddy sand	41.35	6.69	8.55	39.33	322	61.48
E3	Swamp	21.97	Muddy sand	41.30	7.43	8.55	39.32	318	61.40
E4	Swamp	22.44	Muddy sand	41.06	6.64	8.54	39.06	316	61.06
E5	Beach	22.02	Mixed gravelly sand	41.22	7.24	8.53	39.22	313	62.21
E6	Beach	21.63	Mixed gravelly sand	41.31	6.40	8.51	39.29	311	61.37
E7	20	22.42	Biogenic medium sand	44.29	5.24	8.46	41.80	310	65.36
E8	20	20.13	Biogenic medium sand	43.12	5.50	8.46	40.80	309	63.80
E9	30	20.11	Biogenic medium sand	43.10	5.40	8.44	40.60	309	63.70
E10	50	20.15	Biogenic medium sand	43.15	5.43	8.42	40.40	308	63.60
F1	Swamp	20.10	Muddy sand	43.10	5.30	8.40	40.60	325	63.50
F2	Swamp	22.44	Muddy sand	44.13	5.86	8.40	41.71	325	65.18
F3	Swamp	23.68	Muddy sand	44.54	6.12	8.43	42.01	328	65069
F4	Swamp	23.67	Muddy sand	44.52	6.18	8.45	42.20	330	65.70

TABLE I
(Continued)

Sample	Depth (cm)	Temperature (°C)	Bottom facies	Salinity (%)	DO (mg/l)	pH	TDS (g/l)	E_h (mV)	SPC (Ms/cm)
G1	Swamp	26.69	Muddy sand	45.29	7.96	8.48	42.70	330	66.71
G2	Swamp	26.65	Muddy sand	45.28	7.90	8.40	42.60	330	66.70
G3	Swamp	26.63	Muddy sand	45.27	7.86	8.38	42.50	330	66.69
G4	Swamp	26.61	Muddy sand	45.26	7.81	8.36	42.40	330	66.65

on a diet of algae, tomatoes or raw potatoes, as well as on crushed snails, copepods or fresh raw meat (Van Morkhoven, 1962). Recent marine benthic forms tend to be either crawlers or burrowers. They filter feed on detritus, diatoms, foraminifers and small polychaete worms. Such ostracods thrive best in muddy sands and silts, or algae and sea grasses (Brasier, 1979). The mouth parts of Paradoxostominae are specially adapted to sucking, and they use it to suck the juices from water plants. The majority of ostracods are omnivorous and most often scavengers (Van Morkhoven, 1962; Schmit et al., 2007). The scavenger ostracods, through their nutrition habits, will consume and disturb the excess accumulation of the organic matter. This will contribute to preventing the change of the environment to euxinic conditions. Normally, other biota support this role, especially the burrowers, filter-feeding and deposit-feeding organisms. Beside Ostracoda, the environment is inhabited by rich communities of benthic forams, molluscs, bryozoans, echinoderms, crabs, fishes, sea turtles, algae and sea grasses.

All the Ostracoda species recorded are forms adapted to shallow, sheltered and vegetated environments. The most common Ostracoda are *Xestoleberis* Sars, 1866 (42.11% at Wadi El Gemal and 29.6% at Abu Ghoson, respectively), *Ghardaglaia* Hartmann, 1964 (11.1% and 24.23%), *Loxoconcha* Sars, 1866 (9.57% and 11.88%), *Quadracythere* Hornibrook, 1952 (11.4% and 8.43%), *Hiltermannicythere* Bassiouni, 1970 (2.5% and 5.82%), *Loxocorniculum* Benson & Coleman, 1963 (6.59% and 2.23%), *Paranesidea* Maddocks, 1969 (3.4% and 1.74%) and *Neonesidea* Maddocks, 1969 (2.63% and 1.52%) (figs. 3 and 4).

The plant dominant environments not only offer food, but also protection for ostracods (Benson, 1961; Benzie, 1989; Paterson, 1993; Kiss, 2007). Moreover, the type of algae and seagrass determines the associated Ostracoda species. Benson (1961) noted that a filigreed coralline algae growing in a tide pool can teem with species of *Xestoleberis* and *Cythere* Müller, 1785 whereas a neighbouring different type of alga may be associated with numerous individuals of *Loxoconcha* or *Hemicythere* Sars, 1925.

In this study, it is generally noted that the samples with higher percentages of Ostracoda are those associated with algae and seagrasses (e.g., samples C3, C4,

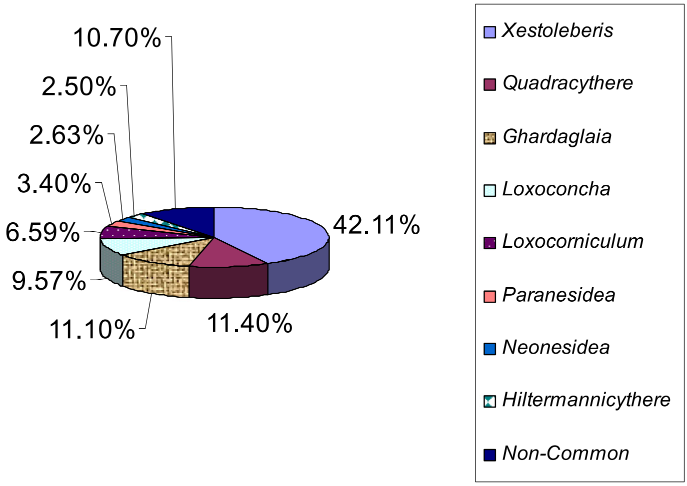

Fig. 3. Pie diagram showing the ratio of the Ostracoda species at Wadi El Gemal. This figure is published in colour in the online edition of this journal, which can be accessed via http://booksandjournals.brillonline.com/content/15685403.

E1, E10, D3, D4 and D5). The patches occupied by the turtle seagrass *Thalassia hemprichii* (Ehrenb.) Ascherson, 1867 and *Halophila stipulacea* have yielded dense communities of *Ghardaglaia triebeli* (Hartmann, 1964), followed by *Hiltermannicythere rubrimaris* (Hartmann, 1964) and *Sclerochilus rectomarginatus*. The areas with the green creeping algae *Caulerpa racemosa* have yielded dense communities of *Xestoleberis* spp. followed by *Loxoconcha* spp. and *Loxocorniculum* spp. (e.g., samples A2, B3 and C4). The scattered vegetation of *Cystoseira myrica*

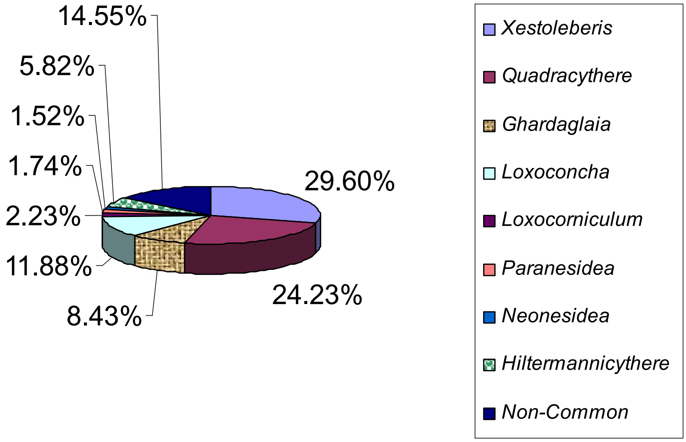

Fig. 4. Pie diagram showing the ratio of the Ostracoda species at Abu Ghoson. This figure is published in colour in the online edition of this journal, which can be accessed via http://booksandjournals.brillonline.com/content/15685403.

and *Sargassum dentifolium* is inhabited by fairly high numbers of *Xestoleberis* spp., *Ghardaglaia triebeli*, *Quadracythere borchersi*, *Loxoconcha ornatovalvae* (Hartmann, 1964), *Moosella striata* (Hartmann, 1964) and *Hiltermannicythere rubrimaris* (samples D2 and D3).

The dense vegetation of *Halophila stipulacea*, *Cystoseira myrica*, *Caulerpa racemosa* (Forsskål) J. Agardh and *Sargassum dentifolium* is inhabited by high numbers of *Ghardaglaia triebeli*, *Hiltermannicythere rubrimaris*, *Xestoleberis* spp., *Miocyprideis* cf. *spinulosa* and *Loxoconcha* spp. (e.g., samples D4 and D5). The presence of *Turbinaria triquetra* is accompanied by a fairly high number of *Callistocythere arcuata*, *Ghardaglaia and Hiltermannicythere* (e.g., sample D6). Also, this is associated with less abundant occurrences of *Callistocythere arenicola*, *Neonesidea* spp., *Paranesidea* spp., and *Triebelina* sp.

The substrate exerts a strong influence on benthic Ostracoda. It has often been observed that the size, shape and sculpture of benthic Ostracoda broadly reflects the stability, grain size and pore size of the substrate on or in which they live (Brasier, 1979). Coarse-grained sediments, like clean sands or oolites, support only a small ostracode population, whereas mud-mixed sands and pelitic sediments usually have a larger and much more diversified ostracode fauna (Pokorny, 1978). They are scarcer in *Globigerina* oozes and scarcest in euxenic black mud, evaporites, well-sorted quartz sands and calcareous sand (Brasier, 1979).

Generally, the mangrove sediments in the study area are composed of a combination of both organic and terrestrial materials. Organic material is either developed in situ or from Red Sea landward migration, whereas terrestrial materials are derived from the hinterland old rocks and transported to the sea by different ways of transportation.

In this study, it is generally observed that samples with a muddy sand substrate are inhabited by dense ostracods communities (e.g., samples D9, D8, D5, E10, E9, E8, C3, C4 and B5). The samples with sandy mud substrates showed poor benthic ostracod communities (e.g., samples F3, F4, G1, G2 and G3). Moreover, ostracods in the muddy gravels were very low in number to totally absent. The recorded carapaces are mostly reworked or damaged (e.g., samples W1, W2 and W3).

Ostracoda assemblages

The following assemblages have been observed in the study area:

The intertidal assemblage.— This assemblage comprises 36 species in the Wadi Gemal area and 26 species in the Abu Ghoson area. It is composed of the following species: *Loxoconcha ornatovalvae* Hartmann, 1964, *L. idkui* Hartmann, 1964, *L.* sp. A Bate, 1971, *Loxocorniculum ghardaquensis* (Hartmann, 1964), *Neonesidea schultzi* (Hartmann, 1964), *Paranesidea fracticorallicola* Maddocks, 1969, *P.* n. sp. 2 Bonaduce et al., 1983, *Pontocypris* sp. Bate, 1971, *Quadracythere borchersi* (Hartmann, 1964), *Cyprideis littoralis* Brady, 1868, *Hiltermannicythere rubrimaris* (Hartmann, 1964), *Ghardaglaia triebeli* Hartmann, 1964, *Triebelina sertata* Triebel, 1948, *Caudites levis* Hartmann, 1964, *Moosella striata* Hartmann, 1964, *Leptocythere arenicola* Hartmann, 1964, *Callistocythere* cf. *littoralis* (G. W. Müller, 1894), *Callistocythere arcuata* Bonaduce et al., 1980, *Sclerochilus rectomarginatus* Hartmann, 1964, *Alocopocythere reticulata* (Hartmann, 1964), *Paracytheridea remanei* Hartmann, 1964, *P. aqabaensis* Bonaduce et al., 1976, *Loxocorniculum* aff. *L. algicola* (Hartmann, 1974), *Xestoleberis multiporosa* Hartmann, 1964, *X. rotunda* Hartmann, 1964, *X. rhomboidea* Hartmann, 1964, *Paranesidea fortificata* (Brady, 1880) [currently as *Neonesidea f.*], *Cytherois gracilis* Hartmann, 1964, *Cytherelloidea* sp. A Bate, 1971, *Paradoxostoma punctatum* Hartmann, 1964, *P. parabreve* Hartmann, 1964, *P. breve* G. W. Müller, 1894, *P. longum* Hartmann, 1964, *Lankacythere* sp. Bonaduce et al., 1983, *Loxocorniculum* n. sp. 1 Bonaduce et al., 1983, *Cyprideis torosa* Jones, 1857 and *Miocyprideis* cf. *spinulosa* (G. S. Brady, 1868).

The last 11 species are present in Wadi Gemal and not recorded from Abu Ghoson area. However, these species are rare (>5 carapaces) and only two species, *Xestoleberis multiporosa* Hartmann, 1964 and *X. ghardaqae* Hartmann, 1964, are abundant. In Wadi Gemal, 16 species are rare (table II and fig. 3), 8 of which only represented by one carapace. At Abu Ghoson, 8 species are rare and 5 of which are represented by only one carapace (table III and fig. 4).

The swamp assemblage.— This assemblage is composed of 24 species as follows: *Ghardaglaia triebeli* Hartmann, 1964, *Neonesidea schulzi* (Hartmann, 1964), *Quadracythere borchersi* (Hartmann, 1964), *Loxocorniculum ghardaquensis* (Hartmann, 1964), *Paranesidea fracticorallicola* Maddocks, 1969, *P.* n. sp. 2 Bonaduce et al., 1983, *Moosella striata* Hartmann, 1964, *Sclerochilus rectomarginatus* Hartmann, 1964, *Hiltermannicythere rubrimaris* (Hartmann, 1964), *Loxoconcha ornatovalvae* Hartmann, 1964, *L. idkui* Hartmann, 1964, *Alocopocythere reticulata* (Hartmann, 1964), *Xestoleberis rotunda* Hartmann, 1964, *X. rhomboidea* Hartmann, 1964, *X. simplex* Hartmann, 1964, *Miocyprideis* cf. *spinulosa* (G. S. Brady, 1868), *Cytherois gracilis* Hartmann, 1964, *Caudites levis* Hartmann, 1964, *Paracytheridea remanei* Hartmann, 1964, *Leptocythere arenicola* Hartmann, 1964, *Callistocythere arcuata* Bonaduce et al., 1980, *C.* cf. *littoralis* (G. W. Müller, 1894), *Xestoleberis multiporosa* Hartmann, 1964 and *Xestoleberis ghardaqae* Hartmann, 1964.

The first 15 species are totally absent from the western part of the swamp, while the eastern part is inhabited by a more dense and diversified community. This may be due to the connection between the swamp and the nearby intertidal zone on the eastern side of the swamp. Four species of the association are rare: *Leptocythere*

TABLE II

Cluster analysis performed using SPSS for abundance and frequency of species at Wadi El Gemal

	Ghardaglaia triebeli		*Quadracythere borchersi*		*Hiltermannicythere rubrimaris*		*Neonesidea schulzi*		*Paranesidea fracticorallicola*		*Paranesidea* n. sp. 2		*Triebelina sertata*		*Paranesidea fortificata*		*Loxocorniculum* aff. *algicola*		*Loxocorniculum ghardaquensis*		*Loxoconcha ornatovalvae*	
	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n
A1	2	5	1	1	1	1	0	1	1	3	1	1	0	1	0	0	1	0	2	6	0	0
A2	3	7	4	11	2	0	1	2	0	0	0	0	1	3	1	0	0	0	5	13	7	19
A3	1	1	3	11	0	2	0	3	1	2	0	0	1	1	0	0	0	0	2	6	3	9
A4	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
A5	4	11	2	3	1	2	1	1	0	1	0	0	1	2	0	0	0	0	0	0	1	4
B1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
B2	2	2	1	5	0	0	1	4	1	3	0	0	1	1	0	0	0	0	1	2	1	1
B3	0	0	2	8	0	2	1	3	2	3	0	0	0	0	0	0	0	1	1	3	4	12
B4	0	1	2	3	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1
B5	1	1	3	10	0	0	1	2	1	4	0	0	0	0	0	0	0	0	1	2	1	3
C1	2	5	8	27	0	1	0	1	0	2	0	1	0	1	0	0	0	0	1	2	2	7
C2	5	16	2	5	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	2	3	10
C3	18	57	5	13	1	4	1	1	1	3	0	0	0	0	0	0	0	0	1	2	5	23
C4	8	25	13	36	6	14	2	6	2	7	0	0	1	1	0	0	0	0	1	4	8	21
C5	1	3	5	14	2	2	1	1	1	4	0	1	0	0	0	0	0	0	0	1	1	0
W1	0	2	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
W2	1	6	1	3	0	1	0	1	0	2	0	0	0	0	0	0	0	0	1	1	1	5
W3	1	2	0	0	0	0	0	0	1	2	0	1	0	1	0	0	0	0	0	2	1	1
Total s + n	195		201		44		36		52		6		16		1		2		62		156	
%	11.1		11.4		2.5		2		3		0.34		0.91		0.06		0.1		3.53		8.9	

	Loxoconcha idkui		*Loxoconcha* n. sp. 1 BCMMP		*Caudites levis*		*Cytherelloidea* sp. Bate		*Moosella striata*		*Leptocythere arenicola*		*Sclerochilus rectomarginatus*		*Neonesidea* n. sp. 1 BCMMP		*Lankacythere* sp. BCMMP		*Paradoxostoma punctatum*		*Paradoxostoma parabreve*	
	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n
A1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A2	0	1	0	0	2	6	1	0	1	1	1	0	2	7	0	0	0	0	0	0	0	0
A3	0	2	0	0	1	6	0	0	0	1	0	1	1	1	1	2	0	0	0	1	0	0
A4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A5	1	1	0	0	0	1	0	0	0	2	0	0	0	1	0	1	0	0	0	0	0	1
B1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0
B2	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	0	0	0	0	0	0
B3	1	1	0	0	1	6	0	0	1	0	0	0	1	4	1	0		1	0	0	0	0
B4	0	0	0	0	1	2	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
B5	0	2	0	0	1	4	0	0	0	0	0	0	1	5	0	0	0	0	0	0	0	0
C1	0	0	0	0	0	0	0	0	1	2	0	0	1	2	0	0	0	0	0	0	0	0
C2	0	0	0	0	2	4	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
C3	0	0	0	0	5	12	0	0	0	0	1	0	1	4	0	0	0	0	0	0	0	0
C4	0	0	1	1	4	13	0	0	0	0	1	0	2	3	1	0	0	0	0	0	0	0
C5	0	0	0	0	1	1	0	0	0	1	0	0	1	3	1	1	0	0	0	0	0	0
W1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W2	0	0	0	0	0	2	0	0	0	1	0	0	1	2	0	0	0	0	0	0	0	0
W3	0	0	0	1	0	1	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0
Total s + n	9		3		76		1		16		4		48		11		1		1		1	
%	0.5		0.17		4.3		0.06		0.91		0.23		2.73		0.63		0.06		0.06		0.06	

TABLE II
(Continued)

	Abditacythere subterranea		*Paradoxostoma longum*		*Callistocythere* cf. *littoralis*		*Paracytheridea remanei*		*Alocopocythere reticulata*		*Cytherois gracilis*		*Paracytheridea aqabaensis*		*Xestoleberis rotunda*		*Xestoleberis rhomboidea*		*Xestoleberis simplex*		*Xestoleberis multiporosa*		*Xestoleberis ghardaqae*		*Xestoleberis rubrimaris*		*Loxocorniculum* n. sp. 1 BCMMP		*Cyprideis littoralis*		*Cyprideis torosa*		Total
	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	
A1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	8	2	6	1	5	0	0	0	0	0	0	1	5	0	0	1	2	61
A2	0	0	0	0	0	0		1	0	0	0	0	0	0	4	13	1	5	1	3	5	15	1	3	1	5	2	8	1	1	0	0	171
A3	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	0	0	0	0	71
A4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
A5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	1	6	0	1	0	2	0	1	0	0	0	0	0	0	0	0	57
B1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
B2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	1	3	0	0	0	0	0	0	1	1	1	3	0	0	0	0	46
B3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	7	3	8	1	5	1	7	1	2	0	1	1	1	0	0	0	0	99
B4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18
B5	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	2	1	1	0	0	0	0	0	1	0	0	1	3	0	0	0	0	55
C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	20	3	11	3	9	2	6	1	2	0	0	2	2	0	0	0	0	135
C2	0	0	0	1	0	0	1	1	1	0	0	0	0	0	9	19	2	8	4	14	2	11	1	2	0	0	1	2	0	0	0	0	134
C3	0	0	0	0	1	0	0	2	0	0	0	0	1	0	13	45	8	20	12	27	9	21	2	7	0	0	1	1	0	0	0	0	328
C4	0	1	0	0	0	1	0	0	0	0	1	0	0	0	18	64	19	45	10	18	12	32	1	7	0	0	1	3	0	0	0	0	414
C5	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	6	1	5	1	2	1	2	1	1	0	0	0	1	0	0	0	0	70
W1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	1	0	1	0	1	0	0	0	2	0	0	0	0	14
W2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	0	1	0	2	0	0	1	0	0	0	0	1	0	0	0	0	39
W3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	10	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	31
Total s + n	4		2		2		5		3		1		1		278		166		122		129		36		9		52		2		3		1757
%	0.23		0.1		0.1		0.28		0.17		0.06		0.06		15.82		9.45		6.94		7.34		2.05		0.5		2.96		0.1		0.17		100

Abbreviations: s, stained; n, not stained.

TABLE III

Cluster analysis performed using SPSS for abundance and frequency of species at Abu Ghoson

	Ghardaglaia triebeli		*Quadracythere borchersi*		*Hiltermannicythere rubrimaris*		*Neonesidea schulzi*		*Paranesidea fracticorallicola*		*Paranesidea* n. sp. 2 BCMMP		*Triebelina sertata*		*Tuberculocythere* n. sp. 1 BCMM		*Cyprideis torosa*		*Loxocorniculum ghardaquensis*	
	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n
E1	12	20	3	5	4	7	0	0	1	2	0	0	0	0	0	0	1	2	1	2
E2	5	8	2	4	3	6	0	0	1	1	0	0	0	0	0	0	1	3	0	2
E3	2	3	1	1	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E4	7	15	3	2	1	1	2	3	3	4	0	1	0	0	0	1	1	2	1	3
F1	4	6	6	8	2	5	1	1	1	3	0	0	0	0	0	0	0	0	1	2
F2	0	0	4	5	1	2	0	0	1	1	0	1	0	0	0	0	1	2	0	0
F3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
F4	4	9	0	1	2	4	0	1	0	1	0	0	0	0	0	0	1	1	0	0
G1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	3	0	0
G2	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
G3	0	0	1	1	1	0	0	0	0	0	0	0	0	0	1	0	1	2	0	1
G4	1	3	1	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
E5	0	0	7	10	6	9	0	2	1	4	1	2	0	0	0	0	0	0	2	4
E6	4	9	5	8	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	2
E7	0	0	2	2	1	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0
E8	0	0	17	21	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	3
E9	0	0	19	29	1	3	1	3	1	4	0	1	0	0	0	1	0	0	1	3
E10	16	27	18	32	12	18	9	14	3	6	1	1	1	2	0	0	0	0	1	3
D1	2	3	1	3	1	1	1	2	1	2	0	0	0	0	0	0	0	0	1	2
D2	13	21	4	8	1	3	1	2	1	2	0	0	0	0	0	0	0	0	0	0
D3	16	23	6	10	3	7	1	1	1	2	0	0	0	0	0	0	0	0	1	2
D4	74	195	1	3	36	83	2	3	1	4	0	0	0	0	0	0	0	0	1	1
D5	26	67	0	3	24	69	1	3	1	3	0	1	0	0	0	0	0	0	0	0
D6	10	21	0	3	7	20	0	2	0	2	0	0	0	0	0	0	0	0	0	0
D7	27	70	36	69	7	13	5	12	2	5	1	2	0	0	0	0	1	2	3	7
D8	62	87	2	4	1	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0
D9	98	144	2	5	0	2	0	0	1	3	0	0	0	0	0	0	0	0	1	1
D10	12	30	6	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Total	1169		406		280		75		73		12		3		4		25		59	
%	24.2		8.43		5.82		1.56		1.51		0.23		0.06		0.08		0.52		1.23	

	Loxoconcha ornatovalve		*Loxocorncha idkui*		*Loxocorniculum* aff. *L. algicola*		*Ruggieria ? danielopoli*		*Caudites levis*		*Cyprideis littoralis*		*Moosella striata*		*Leptocythere arenicola*		*Sclerochilus rectomarginatus*	
	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n
E1	2	4	0	0	1	0	0	0	1	1	0	1	8	15	0	0	1	1
E2	3	7	0	0	1	1	0	0	0	0	1	2	1	4	0	0	2	4
E3	1	3	1	2	0	0	0	0	0	1	0	0	0	0	0	0	0	1
E4	8	12	0	2	0	1	0	0	1	3	0	1	4	11	0	0	3	3
F1	2	8	1	1	0	1	0	0	0	0	1	1	2	6	0	0	1	2
F2	0	0	0	2	0	0	0	0	0	0	1	3	2	6	0	0	0	0
F3	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0
F4	2	3	1	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0
G1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
G4	2	5	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0
E5	8	21	0	0	1	2	0	0	0	1	0	0	1	2	0	0	5	12
E6	2	5	0	0	0	1	0	0	0	0	0	0	1	3	0	0	0	0
E7	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	1	1
E8	4	11	0	0	0	1	0	0	1	1	0	0	1	2	0	1	2	2
E9	18	34	0	0	0	2	0	0	1	2	0	0	1	3	1	2	0	0
E10	17	42	1	5	0	1	0	0	5	14	0	0	0	0	1	1	3	9
D1	3	8	0	0	0	1	0	0	3	5	0	0	0	0	0	0	0	0
D2	2	9	0	2	0	0	1	1	0	1	0	0	1	4	1	3	1	3
D3	4	8	0	0	0	1	0	0	0	0	0	0	3	7	0	0	2	5
D4	4	14	0	0	0	0	2	6	1	4	0	0	1	3	1	5	3	11
D5	3	10	0	0	0	0	1	4	0	0	0	0	0	0	2	8	2	3
D6	1	5	0	0	0	0	1	3	1	2	0	0	1	2	1	2	1	3
D7	18	31	2	6	1	3	2	5	1	3	0	0	16	34	0	1	5	15
D8	2	4	1	1	0	0	0	0	1	1	0	0	1	3	1	3	2	1
D9	2	4	0	0	1	0	0	0	0	0	0	1	1	1	0	0	2	4
D10	1	3	0	0	0	1	1	1	1	1	0	0	0	0	0	0	2	5
Total	362		31		20		28		58		15		153		35		124	
%	7.52		0.64		0.42		0.58		1.2		0.31		3.18		0.73		2.58	

TABLE III
(Continued)

	Neonesidea n. sp. 1		*Lankacythere* sp.		*Loxoconcha* sp. A Bate		*Paradoxostoma breve*		*Abditacythere subterranea*		*Paradoxostoma longum*		*Cytheroma dimorpha*		*Callsttocythere* cf. *littoralis*		*Paracytheridea remanei*		*Alocopocythere reticulata*		*Callistocythere arcuata*		*Miocyprideis* cf. *spinolusa*		*Pontocypris* sp. Bate		*Xestoleberis rotunda*		*Xestoleberis rhomboida*		*Xestoleberis simplex*		*Xestoleberis multiporosa*		*Xestoleberis ghardaqae*		*Cytherella* cf. *punctata*		Total
	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	
E1	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	1	2	4	0	0	0	0	0	0	9	17	4	10	2	5	1	5	1	1	0	1	173
E2	0	0	0	0	1	4	0	0	0	0	0	0	0	0	0	0	0	1	2	3	0	0	1	3	0	0	4	12	4	6	1	4	1	1	0	0	0	0	110
E3	0	0	0	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	1	2	1	3	0	0	0	0	0	1	0	0	37
E4	0	0	0	0	2	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	6	0	0	1	2	0	0	112
F1	0	0	0	0	2	6	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	4	6	3	11	1	3	0	0	0	0	0	0	110
F2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	3	1	2	2	2	0	0	0	0	0	0	45
F3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
F4	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	4	1	3	0	0	0	0	0	0	48
G1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
G2	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	9
G3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	0	0	0	0	0	0	0	0	0	12
G4	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	3	1	1	0	0	0	0	0	0	0	0	29
E5	0	0	0	0	4	11	0	0	0	0	0	0	0	0	0	0	0	0	1	4	0	0	0	0	0	1	4	9	2	6	4	8	1	2	0	0	0	0	158
E6	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	2	0	1	0	0	0	0	0	0	0	0	46
E7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	14
E8	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	2	0	0	0	0	2	3	0	0	1	3	0	0	0	0	0	0	90
E9	0	0	0	0	7	15	0	0	0	0	0	0	0	0	1	1	0	0	1	2	1	3	0	0	0	0	2	9	1	1	1	2	0	0	0	0	0	0	178
E10	0	1	0	0	7	17	1	1	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34	96	19	51	29	55	0	0	0	0	0	0	578
D1	0	0	0	0	2	6	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	3	9	2	4	1	2	0	0	1	3	0	0	73
D2	0	0	1	2	1	4	0	0	0	0	0	0	0	0	0	0	0	0	1	3	1	4	0	0	0	0	11	29	8	22	5	13	0	0	1	2	0	0	193
D3	0	0	0	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	7	21	3	9	2	4	0	0	1	1	0	0	159
D4	0	0	0	0	3	9	2	6	3	7	1	4	1	2	0	1	0	0	1	2	3	9	4	15	0	0	6	12	5	17	7	17	0	0	1	5	0	0	603
D5	0	0	0	0	2	7	1	4	2	5	1	3	1	3	0	0	0	0	1	5	3	7	7	20	0	0	4	10	3	10	0	0	0	0	4	14	0	0	357
D6	0	0	0	0	0	1	1	2	1	1	1	1	1	1	0	0	0	0	6	19	3	12	8	17	0	0	3	6	3	8	1	5	0	0	0	0	0	0	192
D7	0	0	0	0	9	24	0	1	1	0	1	1	0	0	0	0	0	0	3	7	0	2	0	2	0	0	16	37	9	29	5	12	0	0	4	12	0	0	580
D8	0	0	0	0	0	1	0	0	0	0	1	2	0	0	0	0	0	0	1	2	0	0	0	0	0	0	29	115	29	55	14	36	0	0	0	0	0	0	439
D9	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28	101	26	59	6	18	0	0	0	0	0	0	490
D10	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	2	6	1	1	0	0	0	0	0	0	98
Total	1		3		179		19		21		23		9		4		3		78		57		80		1		626		445		287		11		55		1		4814
%	0.02		0.06		3.72		0.4		0.44		0.46		0.19		0.08		0.06		1.62		1.18		1.66		0.02		12.6		9.24		5.96		0.23		1.56		0.02		

Abbreviations: s, stained; n, not stained.

arenicola Hartmann, 1964, *Cytherelloidea* sp. A Bate, 1971, *Paranesidea* n. sp. 2 Bonaduce et al., 1983 and *Cytherois gracilis* Hartmann, 1964.

The downstream assemblage.— This assemblage is the least diversified in the study area. It comprises the following species: *Triebelina sertata* Triebel, 1948, *Loxocorniculum ghardaquensis* (Hartmann, 1964), *Ghardaglaia triebeli* Hartmann, 1964, *Neonesidea schulzi* (Hartmann, 1964), *Quadracythere borchersi* (Hartmann, 1964), *Paranesidea fracticorallicola* Maddocks, 1969, *P.* n. sp. 2 Bonaduce et al., 1983, *Loxoconcha ornatovalvae* Hartmann, 1964, *L.* n. sp. 1 Bonaduce et al., 1983, *Loxocorniculum* aff. *L. algicola* (Hartmann, 1974), *Caudites levis* Hartmann, 1964, *Moosella striata* Hartmann, 1964, *Sclerochilus rectomarginatus* Hartmann, 1964, *Xestoleberis rotunda* Hartmann, 1964, *X. rhomboidea* Hartmann, 1964, *X. simplex* Hartmann, 1964, *X. ghardaqae* Hartmann, 1964 and *Hiltermannicythere rubrimaris* (Hartmann, 1964).

The species recoded in this zone are mostly damaged or badly worn. Out of 19 species, 7 species are represented by only one carapace; 9 species are represented by less than 5 carapaces; the remaining three species are *Ghardaglaia triebeli* Hartmann, 1964 (12 carapaces), *Xestoleberis rotunda* Hartmann, 1964 (21 carapaces) and *Loxoconcha ornatovalvae* Hartmann, 1964 (8 carapaces).

The lagoon assemblage.— This assemblage has a relatively greater species abundance and diversity in the study area. It is inhabited by 24 species. Although the intertidal assemblage is more diversified (36 species), the lagoon assemblage is the denser. The intertidal assemblage in Wadi Gemal comprises 16 rare species, while the lagoon assemblage comprises only 4 rare species. The lagoon assemblage is composed of the following species: *Xestoleberis rotunda* Hartmann, 1964, *X. rhomboida* Hartmann, 1964, *X. simplex* Hartmann, 1964, *X. ghardaqae*, Hartmann, 1964, *Loxoconcha ornatovalvae* Hartmann, 1964, *L. idkui* Hartmann, 1964, *Loxocorniculum ghardaquensis* (Hartmann, 1964), *Rugieria? danielopoli* Bonaduce et al., 1976, *Ghardaglaia triebeli* Hartmann, 1964, *Quadracythere borchersi* (Hartmann, 1964), *Hiltermannicythere rubrimaris* (Hartmann, 1964), *Neonesidea schulzi* (Hartmann, 1964), *Paranesidea fracticorallicola* Maddocks, 1969, *Paranesidea* n. sp. 2 Bonaduce et al., 1983, *Caudites levis* Hartmann, 1964, *Moosella striata* Hartmann, 1964, *Lankacythere* sp. Bonaduce et al., 1983, *Abditacythere subterranea* Hartmann, 1964, *Cytheroma dimorpha* Hartmann, 1964, *Callistocythere* cf. *littoralis* (G. W. Müller, 1894), *Callistocythere arcuata* Bonaduce et al., 1980, *Alocopocythere reticulata* (Hartmann, 1964) and *Miocyprideis* cf. *spinulosa* Hartmann, 1964.

CLUSTER ANALYSIS

The Wadi El Gemal site

Cluster treatments (cluster analyses) were done using SPSS for abundance and frequency of species in the sample locations. This analysis shows that the studied samples of the Wadi El Gemal site can be separated into 3 clusters (fig. 5 and table II). The first has the highest value (57.14%) of total Ostracoda. This cluster includes 20 species, belonging to the following genera: *Triebelina*, *Cytherelloidea*, *Paradoxostoma*, *Miocyprideis*, *Tanella*, *Paranesidea*, *Loxoconcha*, *Triebelina* and

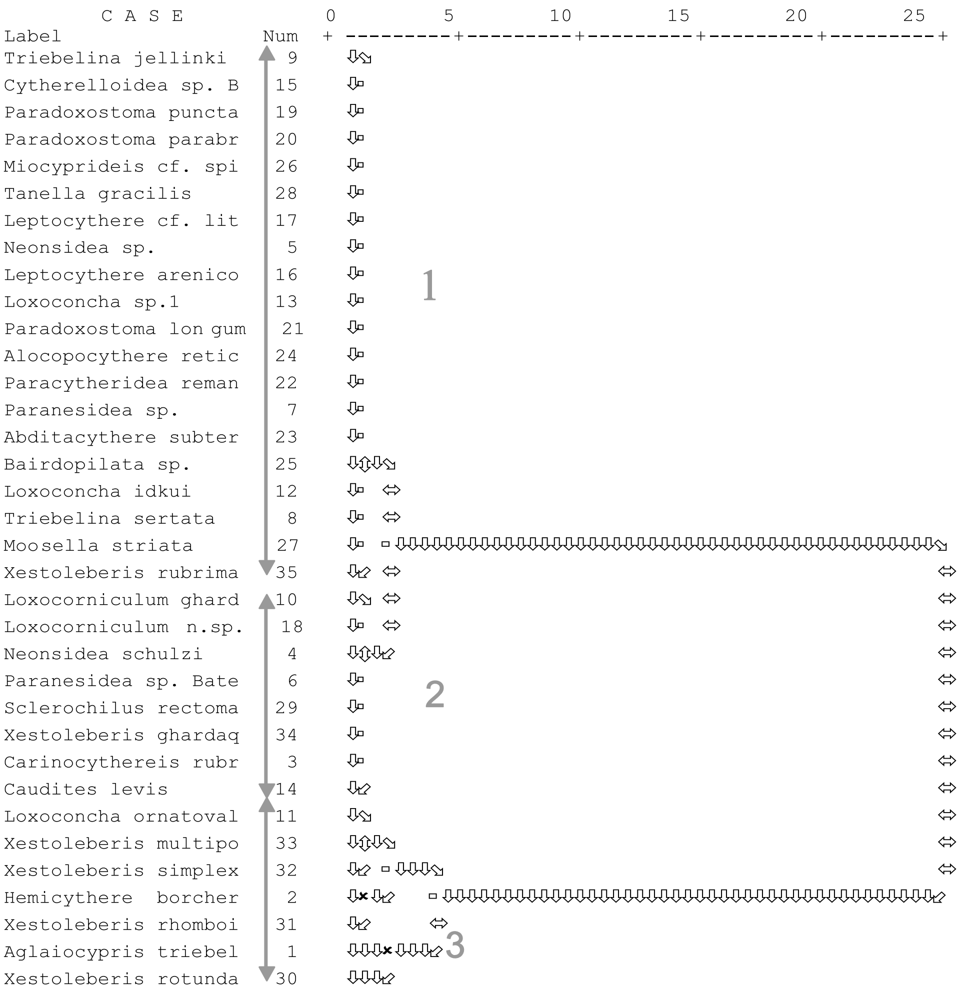

Fig. 5. Dendogram derived from cluster analysis (Ward's method) of the Ostracoda species at Wadi El Gemal.

Moosella. It is characterized by a low similarity due to their low abundance and also by their presence in different bottom facies.

The second cluster (8 species) comprises 22.86% of the total Ostracoda, and is characterized by a medium similarity. All species in this cluster inhabit bottom facies characterized by abundance of biogenic sand. Their abundance is relatively higher than the one recorded in the first cluster. The species belong to the genera *Loxocorniculum*, *Neonesidea*, *Paranesidea*, *Xestoleberis*, *Caudites*, *Carinocythereis* and *Sclerochilus*.

The third cluster represents 20% of the total Ostracoda (7 species) and can be distinguished by a high similarity and high frequency of Ostracoda which are common in the biogenic sand facies. The majority of these species belong to the genera *Loxoconcha*, *Xestoleberis*, *Hemicythere* and *Aglaiocypris*.

The Abu Ghoson site

In this area; four main clusters were distinguished, based on 36 variables of Ostracoda species (fig. 6 and table III).

The first cluster represents 75% (27 species) of the total studied Ostracoda species. It includes most species from swamp, beach and very shallow stations. This cluster shows low similarity due to low abundance of Ostracoda species which belong to different genera, such as *Loxoconcha*, *Moosella* and *Sclerochihus*.

The second cluster contains 3 species, 8.33% of the total studied Ostracoda species. This cluster has the highest ratio of the genus *Xestoleberis*, compared with other bottom facies, in particular in samples E10, D8 and D9.

The third cluster represents 11.11% (4 samples) characterized by the highest abundance of Ostracoda species, in descending order: *Hemicythere*, *Loxoconcha*, *Carinocythereis* and *Cyprideis*. The fourth cluster contains two Ostracoda species making up 5.56% of the total studied Ostracoda species. This cluster includes the highest ratio of *Aglaiocypris* and *Xestoleberis*, concentrated in samples D4 and D9 (fig. 6).

TAXONOMIC LIST

The following is a list of the identified Ostracoda. The detailed taxonomic study, description and illustrations of the recorded taxa is part of another study (Helal & Abd El Wahab, 2010). Compare also figs. 7-8.

Order: Podocopida Müller, 1894.
Suborder: Podocopina Sars, 1866.
Superfamily: Bairdiacea Sars, 1888.
Family: Bairdiidae Sars, 1888.

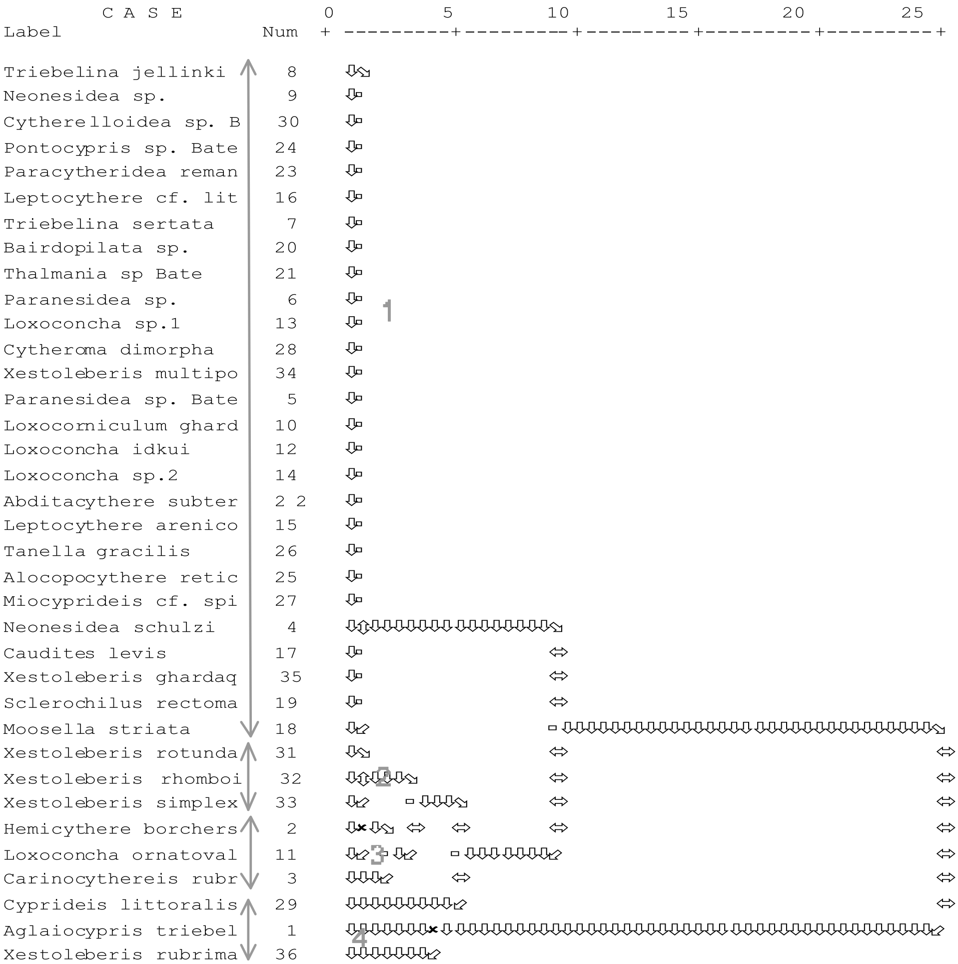

Fig. 6. Dendogram derived from cluster analysis (Ward's method) of the Ostracoda species at Abu Ghoson.

Genus: *Paranesidea* Maddocks, 1969.

Paranesidea fracticorallicola Maddocks, 1969.

1983 *Paranesidea fracticorallicola* Maddocks. Bonaduce, Ciliberto, Minichelli, Masoli & Pugliese, p. 477, fig. 3: 7-9.

Paranesidea fortificata (Brady, 1868)

1983 *Paranesidea fortificata* (Brady).-Bonaduce, Ciliberto, Minichelli, Masoli & Pugliese, p. 477, fig. 3: 4-6.

Paranesidea sp. 2 BCMMP, 1983

1983 *Paranesidea* sp. 2 Bonaduce, Ciliberto, Minichelli, Masoli & Pugliese, p. 477, fig. 3: 10-13.

Genus: *Neonesidea* Maddocks, 1969

Neonesidea schulzi (Hartmann, 1964)

1964 *Triebelina schulzi* Hartmann, p. 44, pl.4, 5, figs. 14-22.

1971 *Neonesidea schulzi* (Hartmann).-Bate, p. 246, pl. 1, fig. 1i.

Neonesidea sp. 1 BCMMP, 1983

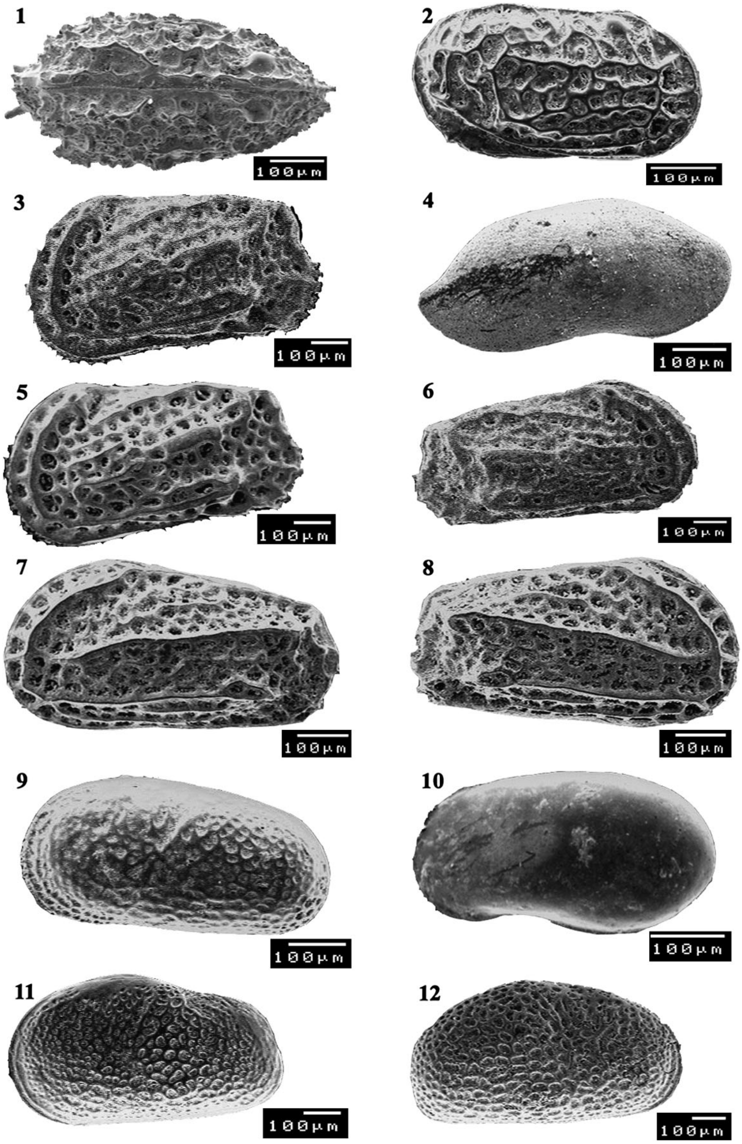

Fig. 7. 1, *Thalmania* sp., dorsal view, female carapace, sample D2; 2, *Callistocythere arcuata* BMMP, 1980, right view carapace, sample D3; 3, *Quadracythere borchersi* Hartmann, 1964, left view carapace, ♀, sample C5; 4, *Triebelina jellinki* Malz & Lord, 1988, right view carapace, sample A2; 5, *Quadracythere borchersi* Hartmann, 1964, left view carapace, ♂, sample C5; 6, *Quadracythere borchersi* Hartmann, 1964, right view carapace, ♂, sample C5; 7, *Hiltermannicythere rubrimaris* (Hartmann, 1964), left view carapace, ♂, sample D4; 8, *Hiltermannicythere rubrimaris* (Hartmann, 1964), right view carapace, ♂, sample D4; 9, *Miocyprideis spinulosa* (G. S. Brady, 1868), left view carapace, ♂, sample D4; 10, *Cytheroma dimorpha* Hartmann, 1964, right view carapace, ♀, sample D2; 11, *Cyprideis* sp., left view carapace, sample D4; 12, *Cyprideis littoralis* G. S. Brady, right view carapace, ♀, sample D4.

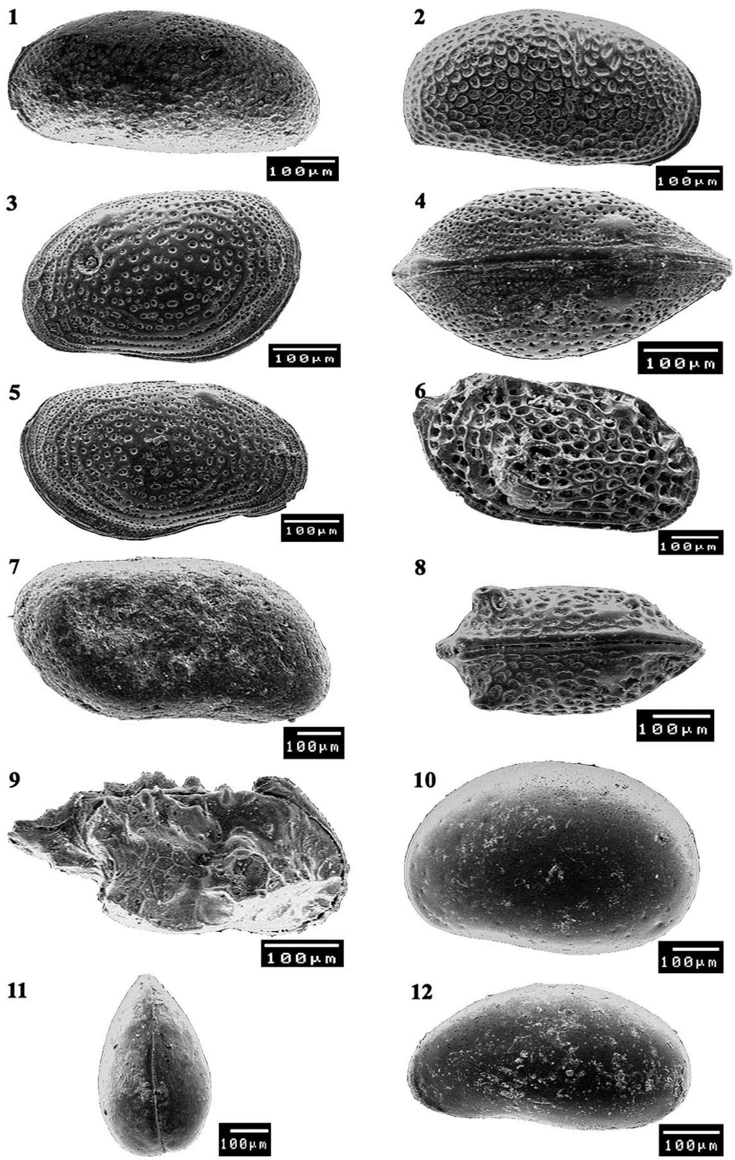

Fig. 8. 1, *Cyprideis torosa* (Jones, 1850), left view carapace, ♂, sample E2; 2, *Cyprideis littoralis* G. S. Brady, left view carapace, ♂, sample D7; 3, *Sclerochilus rectomarginatus* Hartmann, 1964, left view carapace, ♂, sample A2; 4, *Sclerochilus rectomarginatus* Hartmann, 1964, dorsal view carapace, sample A2; 5, *Sclerochilus rectomarginatus* Hartmann, 1964, right view carapace, sample A2; 6, *Loxocorniculum ghardaquensis* (Hartmann, 1964), right view carapace, sample A1; 7, *Cytherelloidea* sp., left view carapace, sample A2; 8, *Loxoconcha* sp., dorsal view carapace, ♂, sample A3; 9, *Paracytheridea remanei* Hartmann, 1964, right view carapace, sample A1; 10, *Xestoleberis rhomboidea* Hartmann, 1964, right view carapace, sample A1; 11, *Xestoleberis rubrimaris* Hartmann, 1964, dorsal view carapace, sample A3; 12, *Xestoleberis ghardaqae* Hartmann, 1964, right view carapace, ♂, sample A2.

1983 *Neonesidea* sp. 1 Bonaduce, Ciliberto, Minichelli, Masoli & Pugliese, p. 478, fig. 4: 6-9.

Genus: *Triebelina* Van den Bold, 1946

Triebelina jellinki Malz & Lord, 1988

1988 *Triebelina jellinki* Malz & Lord, p. 68, pl. 1, figs. 8-10; pl. 2, figs. 8-9.

Triebelina sertata Triebel, 1975

1975 *Triebelina sertata* Triebel. Teeter, p. 422, Text-fig. 31.

Superfamily: Cypridacea Baird, 1845

Family: Paracyprididae Sars, 1923

Genus: *Ghardaglaia* Hartmann, 1964

Ghardaglaia triebeli Hartmann, 1964

1964 *Ghardaglaia triebeli* Hartmann, p. 41, pl. 6-9, figs. 23-40.

Family: Pontocyprididae Müller, 1894

Genus: *Pontocypris* Sars, 1866

Pontocypris sp. B Bate, 1971

1971 *Pontocypris* sp. B Bate, p. 264, pl. 1, fig. 1h.

Superfamily: Cytheracea Baird, 1850

Family: Leptocytheridae Hanai, 1957

Genus: *Leptocythere* G. O. Sars, 1925

Leptocythere arenicola (Hartmann, 1964)

1964 *Leptocythere* (subgen. *Callistocythere*) *arenicola* Hartmann, pl. 12, figs. 52-57, pl. 13, figs. 58-59.

1983 *Leptocythere arenicola* Hartmann.-Bonaduce, Ciliberto, Minichelli, Masoli & Pugliese, p. 478.

Genus: *Callistocythere* Ruggieri, 1953

Callistocythere arcuata BMMP, 1980

1983 *Callistocythere arcuata* Bonaduce, Minichelli, Masoli & Pugliese. Bonaduce, Ciliberto, Minichelli, Masoli & Pugliese, p. 478, fig. 6: 1-3.

Callistocythere cf. *C. littoralis* (G. W. Müller, 1894)

1964 *Leptocythere* cf. *littoralis* (G. W. Müller). Hartmann, p. 64, pl. 11, figs. 46-51, pl. 13, fig. 60.

1983 *Callistocythere* cf. *C. littoralis* (G. W. Müller, 1894).-Bonaduce, Ciliberto, Minichelli, Masoli & Pugliese, p. 481.

Family: Hemicytheridae Puri, 1953

Subfamily: Oriononinae Puri, 1974

Genus: *Caudites* Coryell & Fields, 1937

Caudites levis Hartmann, 1964

1964 *Caudites levis* Hartmann, p. 117, pl. 55, figs. 311-316.

Family: Campylocytheridae Puri, 1960

Genus: *Alocopocythere* Siddiqui, 1971

Alocopocythere reticulata (Hartmann, 1964)

1964 *Bradleya reticulata*. Hartmann, p. 108, pl. 46, fig. 269; pl. 47-49, figs. 274-288.

1971 *Alocopocythere reticulata* (Hartmann).-Bate, p. 246, pl. 1, fig. 2PP.

Family: Cytheruridae Müller, 1894

Genus: *Tuberculocythere* Colalongo & Pasini, 1980

Tuberculocythere sp. 1 BCMMP, 1983

1983 *Tuberculocythere* sp. 1 Bonaduce, Ciliberto, Minichelli, Masoli & Pugliese, p. 485, fig. 7: 12.

Family: Trachyleberididae Sylvester-Bradley, 1948
Subfamily: Trachyleberidinae Sylvester-Bradley, 1948
Genus: *Quadracythere* Hornibrook, 1952
Quadracythere borchersi (Hartmann, 1964)
1964 *Hemicythere ? borchersi* sp. Hartmann, p. 119, pl. 56, figs. 318-221; pl. 57, figs. 322-323; pl. 58, figs. 324-330.
1983 *Quadracythere borchersi* (Hartmann). Bonaduce, Ciliberto, Minichelli, Masoli & Pugliese, p. 478.
Genus: *Ruggieria* Keij, 1957
Ruggieria ? danielopoli BMP, 1976
1983 *Ruggieria? danielopoli* Bonaduce, Masoli & Pugliese (BMP). Bonaduce, Ciliberto, Minichelli, Masoli & Pugliese, p. 482, fig. 6: 4-8.
Genus: *Hiltermannicythere* Bassiouni, 1970
Hiltermannicythere rubrimaris (Hartmann, 1964)
1964 *Cythereis ? rubrimaris* Hartmann, p. 115, pl. 54, figs. 306-310; pl. 56, figs. 317.
1983 *Hiltermannicythere rubrimaris* (Hartmann).-Bonaduce, Ciliberto, Minichelli, Masoli & Pugliese, p. 481.
Genus: *Moosella* Hartmann, 1964
Moosella striata Hartmann, 1964
1964 *Moosella striata* Hartmann, pl. 46, figs. 270-273; pl. 50-51, figs. 289-297.
Genus: *Lankacythere* Bhatia & Kumar, 1979
Lankacythere sp. BCMMP, 1983
1983 *Lankacythere* sp. Bonaduce, Ciliberto, Minichelli, Masoli & Pugliese, p. 482, fig. 6: 9-12.

Family: Cytherideidae Sars, 1925
Subfamily: Cytherideinae Sars, 1925
Genus: *Cyprideis* Jones, 1857
Cyprideis littoralis G. S. Brady, 1868
1964 *Cyprideis littoralis* G. S. Brady. Hartmann, p. 46, pl. 10, figs. 41-45.
Cyprideis torosa (Jones, 1850)
1985 *Cyprideis torosa* (Jones). Guillaume, Peypouquet & Tetart, p. 342, figs. 1-2.
Genus: *Miocyprideis* Kollmann, 1960
Miocyprideis cf. *spinulosa* (G. S. Brady, 1868)
1868 *Cytheridea spinulosa* G. S. Brady, p. 182-183, pl. 8, figs. 1-6.
1960 *Miocyprideis spinulosa* (Brady). Kollmann, p. 178, pl. 18, figs. 12-13, pl. 19, fig. 16.

Family: Cytheridea Baird, 1850
Subfamily: Loxoconchinae Sars, 1825
Genus: *Loxoconcha* Sars, 1866
Loxoconcha idkui Hartmann, 1964
1964 *Loxoconcha idkui* Hartmann, p. 55, pl. 18, figs. 83-85; pl. 19, figs. 86-91.
Loxoconcha ornatovalvae Hartmann, 1964
1964 *Loxoconcha ornatovalvae* Hartmann, p. 58, pl. 20, figs. 92-100.
Loxoconcha sp. 1 BCMMP, 1983
1983 *Loxoconcha* sp. 1 Bonaduce, Ciliberto, Minichelli, Masoli & Pugliese, p. 489, fig. 9: 1-4.
Loxoconcha sp. A Bate, 1971
1971 *Loxoconcha* sp. A Bate, p. 246, pl. 1, fig. 1, l.
Genus: *Loxocorniculum* Benson & Coleman, 1963
Loxocorniculum ghardaquensis (Hartmann, 1964)
1964 *Loxoconcha ghardaquensis* Hartmann, p. 52, pl. 15, figs. 67-72; pl. 16, figs. 73-76; pl. 17, figs. 77-79; pl. 18, figs. 80-82.

1971 *Loxocorniculum ghardaquensis* (Hartmann). Bate, p. 254.
Loxocorniculum aff. *L. algicola* (Hartmann, 1964)
1983 *Loxocorniculum* aff. *L. algicola* (Hartmann). Bonaduce, Ciliberto, Minichelli, Masoli & Pugliese, p. 489, fig. 8: 5-8.
Loxocorniculum sp. 1 BCMMP, 1983
1983 *Loxocorniculum* sp. 1 Bonaduce, Ciliberto, Minichelli, Masoli & Pugliese, p. 486, fig. 8: 1-4.

Family: Paracytherideidae Puri, 1957
Subfamily: Paracytherideinae Puri, 1957
Genus: *Paracytheridea* G. W. Müller, 1894
Paracytheridea aqabaensis Bonaduce, Masoli & Pugliese, 1976
1983 *Paracytheridea aqabaensis* Bonaduce, Masoli & Pugliese. Bonaduce, Ciliberto, Minichelli, Masoli & Pugliese, p. 482, fig. 6: 13.
Paracytheridea remanei Hartmann, 1964
1964 *Paracytheridea remanei* Hartmann, p. 65, pl. 23, figs. 114-120; pl. 24, figs. 121-124.

Family: Paradoxostomidae
Subfamily: Paradoxostominae
Genus: *Paradoxostoma* Fischer, 1885
Paradoxostoma breve G. W. Müller, 1894
1964 *Paradoxostoma breve* G. W. Müller. Hartmann, p. 83, pl. 36, figs. 204-209.
Paradoxostoma parabreve Hartmann, 1964
1964 *Paradoxostoma parabreve* Hartmann, p. 84, pl. 38, figs. 222-225; pl. 39, figs. 231-233.
Paradoxostoma longum Hartmann, 1964
1964 *Paradoxostoma longum* Hartmann, p. 87, pl. 37, figs. 210-216.
Paradoxostoma punctatum Hartmann, 1964
1964 *Paradoxostoma punctatum* Hartmann, p. 89, pl. 39, figs. 226-230.
Genus: *Cytherois* G. W. Müller, 1894
Cytherois gracilis Hartmann, 1964
1964 *Cytherois gracilis* Hartmann, p. 91, pl. 40, figs. 234-239; pl. 41, figs. 240-241.
Genus: *Sclerochilus* G. O. Sars, 1866
Sclerochilus rectomarginatus Hartmann, 1964
1964 *Sclerochilus rectomarginatus* Hartmann, p. 93, pl. 41, figs. 242-243; pl. 42, figs. 244-250.

Subfamily: Cytherominae
Genus: *Cytheroma* G. W. Müller, 1894
Cytheroma dimorpha Hartmann, 1964
1964 *Cytheroma dimorpha* Hartmann, p. 96, pl. 43, figs. 251-255; pl. 44, figs. 256-259.
Genus: *Abditacythere* Hartmann, 1964
Abditacythere subterranea Hartmann, 1964
1964 *Abditacythere subterranea* Hartmann, p. 100, pl. 45, pl. 260-268.

Family: Xestoleberididae Sars, 1928
Subfamily: Xestoleberidinae G. O. Sars, 1928
Genus: *Xestoleberis* G. O. Sars, 1866
Xestoleberis ghardaqae Hartmann, 1964
1964 *Xestoleberis ghardaqae* Hartmann, p. 71, pl. 27, figs. 142-148; pl. 28, figs. 149-153.
Xestoleberis multiporosa Hartmann, 1964
1964 *Xestoleberis multiporosa* n. sp. Hartmann, p. 69, pl. 25, figs. 132-134, pl. 26, figs. 135-141.
Xestoleberis simplex Hartmann, 1964
1964 *Xestoleberis simplex* Hartmann, p. 80, pl. 25, figs. 125-131.

Xestoleberis rhomboidea Hartmann, 1964
1964 *Xestoleberis rhomboidea* Hartmann, p. 75, pl. 32, 33, figs. 177-186.
Xestoleberis rotunda Hartmann, 1964
1964 *Xestoleberis rotunda* Hartmann, p. 81, pl. 24, figs. 162-163; pl. 29, figs. 156-161; pl. 28, figs. 154-155.
Xestoleberis rubrimaris Hartmann, 1964
1964 *Xestoleberis rubrimaris* Hartmann, p. 77, pl. 34-35, figs. 187-203.
Suborder: Platycopina Sars, 1866
Family: Cytherellidae Sars, 1866
Genus: *Cytherella* Jones, 1849
Cytherella cf. *punctata* Brady, 1868
1971 *Cytherella* cf. *punctata* Brady.-Bate, 1971: 246, pl. l, fig. 1u.
Genus: *Cytherelloidea* Alexander, 1929
Cytherelloidea sp. A Bate, 1971
1971 *Cytherelloidea* sp. A Bate, p. 246, pl. l, fig. 1s.

SUMMARY AND CONCLUSIONS

The Red Sea mangrove ecosystem is inhabited by a unique ostracod fauna. The ostracod community and factors controlling its distribution are studied in two mangrove sites on the Egyptian Red Sea coast. The natural protected areas at Wadi El Gemal and Wadi Abu Ghoson comprise four subenvironments which are inhabited by four distinctive ostracod assemblages, i.e., intertidal, swamp, lagoon and downstream assemblages.

The Ostracoda are dominated by phytal, plant dwelling and shallow water forms. The distribution patterns of the Ostracoda species, abundance and diversity are found to be controlled mostly by the vegetation and/or the bottom conditions. From our study the following conclusions can be drawn:

1. Some locations occupied by the turtle seagrass *Thalassia hemprichii* and *Halophila stipulacea* have yielded dense communities of *Ghardaglaia triebeli*, followed by *Hiltermannicythere rubrimaris* and *Sclerochilus rectomarginatus* (e.g., samples C3 and E10).
2. The areas with the green creeping algae *Caulerpa racemosa* have yielded dense communities of *Xestoleberis* spp. followed by *Loxoconcha* spp. and *Loxocorniculum* spp. (e.g., samples A2, B3 and C4).
3. The scattered vegetations of *Cystoseira myrica* and *Sargassum dentifolium* are inhabited by fairly high numbers of *Xestoleberis* spp., *Ghardaglaia triebeli*, *Quadracythere borchersi*, *Loxoconcha ornatovalvae*, *Moosella striata* and *Hiltermannicythere rubrimaris* (samples D2 and D3).
4. The dense vegetations of *Halophila stipulacea*, *Cystoseira myrica*, *Caulerpa racemosa* and *Sargassum dentifolium* are inhabited by high numbers of *Ghardaglaia triebeli*, *Hiltermannicythere rubrimaris*, *Xestoleberis* spp., *Miocyprideis* cf. *spinulosa* and *Loxoconcha* spp. (e.g., samples D4 and D5).

5. The presence of *Turbinaria triquetra* is accompanied by a fairly high number of *Callistocythere arcuata*, *Ghardaglaia and Hiltermannicythere* (e.g., sample D6). Also, this is associated with less abundant occurrences of *Callistocythere arenicola*, *Neonesidea* spp., *Paranesidea* spp. and *Triebelina* sp.
6. With respect to the bottom facies, it is generally observed that samples with gravelly muddy sand substrates are inhabited by dense communities of benthic ostracods (e.g., samples D9, D8, D5, E10, E9, E8, C3, C4 and B5).
7. The samples with gravelly sandy mud substrates showed a low number of benthic Ostracoda communities (e.g., samples F3, F4, G1, G2 and G3).
8. Ostracods in sandy muddy gravels are very low to totally absent. The recorded carapaces are mostly reworked or badly worn (e.g., samples W1, W2 and W3).
9. Statistical analysis showed three clusters at each site. These results coincide with the physiographic assemblages, except at Wadi El Gemal where we have three clusters and only two assemblages. This is explained by the more dense growth of mangroves in the southeastern and southwestern parts. Also, the substrate is muddy sand instead of sand substrate in the northern parts.

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NOTE ADDED IN PROOF

The extensive authorship of some species names has been abbreviated in various places where the authorities have been indicated, as follows:

BCMMP = Bonaduce, Ciliberto, Minichelli, Masoli & Pugliese, 1983

BMMP = Bonaduce, Masoli, Minichelli & Pugliese, 1980

BMP = Bonaduce, Masoli & Pugliese, 1976

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