

Distribution and Taxonomy of Shallow Marine Ostracods from the Western Coast of the Red Sea, Egypt

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Abstract

A total 5849 individuals of ostracods constituting twenty species were collected from five shallow marine sites along the area from El-Quseir to Marsa Alam on the West Coast of the Red Sea. The twenty ostracod species belonging to sixteen genera and ten different families. The three genera; *Loxoconcha*, *Neonesidea* and *Xestoleberis* have high species diversity. Furthermore, the species *Loxoconcha ghardaqensis*, *Xestoleberis rotunda*, *Paranesidea fracticorallicola*, *Tanella gracilis* and *Neonesidea schulzi* were the best recognized in the collecting region. Otherwise, the distribution of the collected ostracod species in relation to environmental variables and plants were discussed in detail here. Based on this, it is concluded that, vegetation type appears to be the most important factor controlling the distribution of ostracod species in the investigated area. Also, other factors such as, water temperature, salinity, dissolved oxygen, pH and electrical conductivity play an important role. Scanning electron microscope images of valves are delivered of the recorded taxa. These fauna displays close affinities to those of the Red Sea and the Indo-Pacific region.

Keywords

Marine Ostracods, Taxonomy, Distribution, Ecology, Red Sea

1. Introduction

Ostracoda are a class of small crustaceans distinguished by a carapace of two valves enveloping soft parts and appendages. The dorsal margin of the two valves is joined by hingement. Ostracods are inhabiting in all watery environments (marine, brackish, freshwater and terrestrial) and they are playing vital

role in aquatic ecosystems. Besides, they are affected by the variations of ecological characters such as: salinity, water temperature, pH, dissolved oxygen, electrical conductivity and total dissolved salts (TDS).

Ostracods of the Egyptian Red Sea Coast are abundant and diverse, until now little investigations carried out on the taxonomy of ostracods in the Red Sea. [1] studied the taxonomy of some ostracod species on Hurghada and Bonaduce *et al.* [2] and Bonaduce *et al.* [3] recorded some ostracod species from the Gulf of Aqaba (Red Sea). Also, [4] and [5] investigated ostracods in the Safaga Bay and in mangrove ecosystems, respectively.

The current study focused on the taxonomy of shallow ostracods for the first time in the region from Al-Quseir to Marsa Alam along the west Coast of the Red Sea. The objective of the present study is to evaluate the distribution and study the taxonomy of shallow ostracod species in the collection area. In order to recognize the diversity of these taxa and to conclude the appropriate ecological conditions in which they grow and thrive.

2. Materials and Methods

Shallow samples were collected in June, 2016 by nylon net (mesh size 150 μm) from five sites on the West Coast of the Red Sea extends from Al-Quseir to Marsa Alam (**Figure 1**). These sites (**Table 1**) are termed from north to south; (I) North Wadi Syatin, (II) North Wadi Asal contains mangrove trees, (III) South Wadi Um Gerifat, (IV) South Wadi Abu Dabbab and (V) South Wadi Abu Ghusun. Additionally, the sites I and III are covered by macro-algae, while the mangrove trees occurrence in sites II, IV, V. These sites selected to know, if ostracod species preferred to live between macro-algae or between mangrove trees.

Ecological variables such as pH, dissolved oxygen (mg/L), water temperature (C), electrical conductivity [l S/cm], total dissolved salts (TDS) and salinity (ppt) were measured using an environmental Multi Probe System.

In the laboratory, ostracod species were separated, picked, counted and then preserved in an alcohol (70% concentration). For scanning electron microscope studies, ostracod species were fixed in a mixture of three volumes of 4% glutaraldehyde and one volume of 1% of osmium tetroxide. Then they were dehydrated in an ordered series of ethanol and sputter-coated with gold, and viewed under a JSM 5400 LV SEM, at an accelerating voltage of 15 kV at Assiut University.

Table 1. Sampling stations and geographical position.

Sites	Latitude	Longitude
North Wadi Syatin(I)	26°9'51.85"N	34°14'37.96"E
North Wadi Asal (II)	26°2'51.62"N	34°18'58.97"E
South Wadi Um Gerifat (III)	25°39'6.64"N	34°34'49.84"E
South Wadi Abu Dabbab (IV)	24°42'38.30"N	35°5'30.92"E
South Wadi Abu Ghusun(V)	24°27'3.05"N	35°12'15.45"E

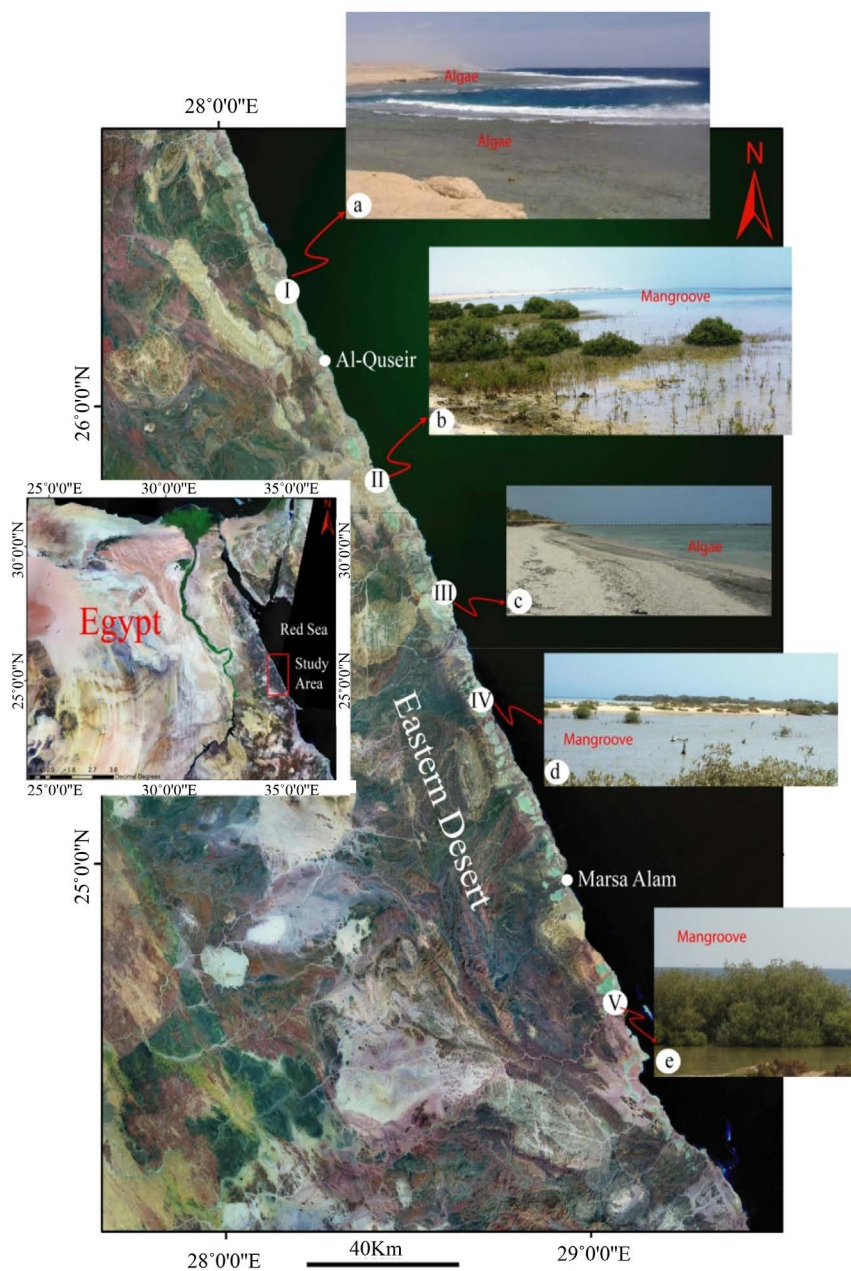


Figure 1. A map study area with photographs of the five collecting sites (from google earth).

Species of ostracods were examined in details to identify to the species level. As well as some references used in of ostracods [1] [6] [7] Bonaduce *et al.* [2]; Bonaduce *et al.* [3] [8] [9] [10]; Nishath *et al.* [11] [12] and [5].

Abbreviations used: RV = right valve, LV = left valve, L = length, H = height.

3. Results

3.1. The Water Parameters

During the present study, sea water temperature, salinity, pH, dissolved oxygen,

electrical conductivity and the total dissolved salts (TDS) are summarized in **Table 2**. The water temperature in the area under investigation ranged between 28.8°C - 34.7°C. Moreover, the salinity is high and fluctuated between 41.22 to 42.75‰. By comparing the pH values in all collection sites showing small variations and ranged from 8.27 to 8.65, this is indicated that the studied area is weakly alkaline. The dissolved oxygen in the study area ranged from 6.9 to 8.8 (mg/l) and the electrical conductivity fluctuates between 63.2 and 64.5. Additionally, the total dissolved salts (TDS) were observed in the range of 37.98 to 39.49 g/l. According to the above result, the ecological factors have an important role in the distribution and numbers of Ostracoda in the Red Sea.

Nishath *et al.* [13] reported that, salinity has a direct effect on the number and abundance of specimens in marine and marginal marine environments. Moreover, [14] stated that dissolved oxygen considered one of the factors contributing to the abundance of some living inhabitants.

3.2. Distribution of Ostracod Species

Twenty ostracod species have been collected from five sites along the region from Al-Quseir to Marsa Alam. The recorded species belong to Order Podocopida, ten families and sixteen genera. The collecting ostracod species were *Loxoconcha ghardagensis*, *Loxoconcha ornatovalve*, *Loxoconcha gisellae*, *Loxoconchella dorsobullata*, *Xestoleberis ghardaqe*, *Xestoleberis rotunda*, *Paranesidea fracticorallicola*, *Neonesidea schulzi*, *Neonesidea aff. michaelsoni*, *Mosella stariata*, *Hiltermannicythere rubrimaris*, *Cyprideis littoralis*, *Hemicytherura vidensaeegyptica*, *Tanella gracilis*, *Callistocythere arcana*, *Leptocythere arinocola*, *Quadracythere borchersi*, *Caudites sublevis*, *Paradoxostoma altecaudatum*, *Ghardaglaia triebeli*. As well as, their distribution over the sites of collection was summarized in **Table 3**.

The most common species in the collecting region are *Loxoconcha ghardagensis*, *Xestoleberis rotunda*, *Paranesidea fracticorallicola*, *Tanella gracilis* and *Neonesidea schulzi*, whereas, *Hemicytherura vidensaeegyptica* and *Caudites sublevis* occurred in few numbers. Ostracods are highly diverse in the first and

Table 2. Water temperature (°C), salinity (pp), dissolved oxygen (DO), pH and total dissolved salts (TDS) and electrical conductivity (mS/cm) at the sampling stations.

Sites	Water T. (°C)	Salinity (‰)	DO (mg/l)	pH	TDS (g/l)	Electrical Conductivity (mS/cm)
North Wadi Syatin (I)	28.8	42.13	6.9	8.27	37.98	63.2
North Wadi Asal (II)	33.4	41.65	7.8	8.65	38.21	64.1
South Wadi Um Gerifat (III)	32.6	41.22	7.2	8.48	38.81	63.7
South Wadi Abu Dabbab (IV)	34.5	42.48	8.8	8.53	39.37	63.9
South Wadi Abu Ghusun (V)	34.7	42.75	8.3	8.61	39.48	64.5

Table 3. Distribution the individual numbers of ostracod species in five collecting sites.

Families	Species	Collection sites					Total
		Site I	Site II	Site III	Site IV	Site V	
Loxoconchidae	1- <i>Loxoconcha ghardaqensis</i>	344	51	189	86	78	748
	2- <i>Loxoconcha ornatovalve</i>	27	-	138	68	35	268
	3- <i>Loxoconcha gisellae</i>	26	12	45	7	-	90
	4- <i>Loxoconchella dorsobullata</i>	154	16	75	35	57	337
Xestoleberdidae	5- <i>Xestoleberis ghardaqe</i>	62	29	34	39	44	208
	6- <i>Xestoleberis rotunda</i>	189	49	247	92	62	639
Baidiidae	7- <i>Paranesidea fracticorallicola</i>	213	62	176	87	49	587
	8- <i>Neonesidea schulzi</i>	44	37	293	34	-	408
	9- <i>Neonesidea aff. Michaelsoni</i>	26	-	14	52	16	108
Trachyleberididae	10- <i>Moosella striata</i>	69	38	68	118	65	358
	11- <i>Hiltermannicythere rubrimaris</i>	75	-	82	41	36	234
Cytherideidae	12- <i>Cyprideis littoralis</i>	21	70	17	-	49	157
Cytheruridae	13- <i>Hemicytherura videns aegyptica</i>	7	-	22	11	4	44
Leptocytheridae	14- <i>Tanella gracilis</i>	206	10	146	57	16	435
	15- <i>Callistocythere arcane</i>	32	80	16	27	37	192
	16- <i>Leptocythere arinecola</i>	83	22	51	15	24	195
Hemicytheridae	17- <i>Quadracythere borchersi</i>	-	91	38	108	79	316
	18- <i>Caudites sublevis</i>	9	-	23	17	-	49
Paradoxostomatidae	19- <i>Paradoxostoma altecaudatum</i>	33	8	49	26	19	135
Paracyprididae	20- <i>Ghardaglaia triebeli</i>	98	20	172	16	35	341
Total		1718	595	1895	936	705	5849
Ratio		29.37	10.17	32.39	16	12.05	

the third sites constituting 29.37% and 32.39%, respectively. While, the second, fourth and fifth sites are less diverse in ostracods constituting 10.17%, 16%, 12.05%, respectively. On the other hand, the three genera *Loxoconcha*, *Neonesidea* and *Xestoleberis* displayed a high diversity of species.

The plants on the sites under study deliver food and shelter for ostracod species [5] [15] [16] [17]. Moreover, [18] noted that the density of ostracods fluctuates according to the grade of structure complexity of algae.

In the current study, it is generally observed that sites which are covered with macro-algae are occupied by dense ostracods (e.g., site I and site III). Similarly, collecting sites which covered with mangrove trees have less numbers of ostracods (e.g., sites II, IV and V).

3.3. Systematic Descriptions

The current study presents identification of twenty species of Ostracoda from

El-Quseir to Marsa Alam on the West Coast of Red Sea. These species belong to one order, ten families and fourteen genera. The total numbers and percentages of all identified species are summarized in **Table 2**.

Class: Ostracoda Latreille 1806.

Order: Podocopa G. W. Müller 1894.

Suborder: Podocopida Sars 1866.

Family: Loxoconchidae Sars 1925.

Subfamily: Loxoconchinae Sars 1825.

Genus: *Loxoconcha* Sars, 1866.

3.3.1. *Loxoconcha ghardagensis* Hartmann, 1964 (Figures 2(a)-(c))

Loxoconcha ghardagensis [1], pl. 15-18, Figures 67-82.

Loxocorniculum ghardagensis Hartmann: [19], p. 254.

Loxoconcha ghardagensis Hartmann: [20], pl. IV, Figure 13.

Loxocorniculum ghardagensis Hartmann: [4], p. 87, pl. 1, Figure 13.

Loxoconcha ghardagensis Hartmann: [12], Figure 8: 121-126.

Measurements: Female; L = 0.57 mm, H = 0.35 mm, Male; L = 0.65 mm, H = 0.39 mm.

Geographical distribution: Red Sea.

Occurrence: *Loxoconcha ghardagensis* is widely distributed species in the Red Sea and occurs with several numbers in the first and third sites.

Ecology: This species found in shallow water and occurred in large numbers in algae. The suitable environmental factors for this species are: Water temperature ranges between 28.8°C - 32.6°C, pH varies between 8.27 and 8.48, salinity fluctuates from 42.13‰ to 41.22‰. Also, dissolved oxygen ranges from 6.9 to 7.2 (mg/l).

Remarks: In our specimens the ornamentation consists of concentrically reticulation arranged in circles, while in *L. ghardagensis* of Bonaduce *et al.* [2] the reticulation is arranged randomly. Also, the caudal process at the posterior margin of our specimen is striated and has a rectangular shape resembling with that of [12], but differs from that of Bonaduce *et al.* [2]. Our specimens are bigger in size than that of [12].

3.3.2. *Loxoconcha ornatovalvae* Hartmann, 1964 (Figure 2(d), Figure 2(e))

Loxoconcha ornatovalvae [1], pl. 20, Figures 92-100.

Loxoconcha ornatovalvae Hartmann: [19], pls. 1, 2, 3, Figures 1k, 2k, 3k.

Loxoconcha ornatovalvae Hartmann: Bonaduce *et al.* [2], pl. 10, Figure 9.

Loxoconcha ornatovalvae Hartmann: [21], p. 236, Figure 2a.

Loxoconcha ornatovalvae Hartmann: [22], p. 1189.

Loxoconcha ornatovalvae Hartmann: [10], p. 66, Figure 32.

Loxoconcha ornatovalvae Hartmann: [12], Figure 8: 109-116.

Dimensions: L = 0.40 mm, H = 0.20 mm.

Geographical distribution: Red Sea, Persian Gulf and the West Coast of India.

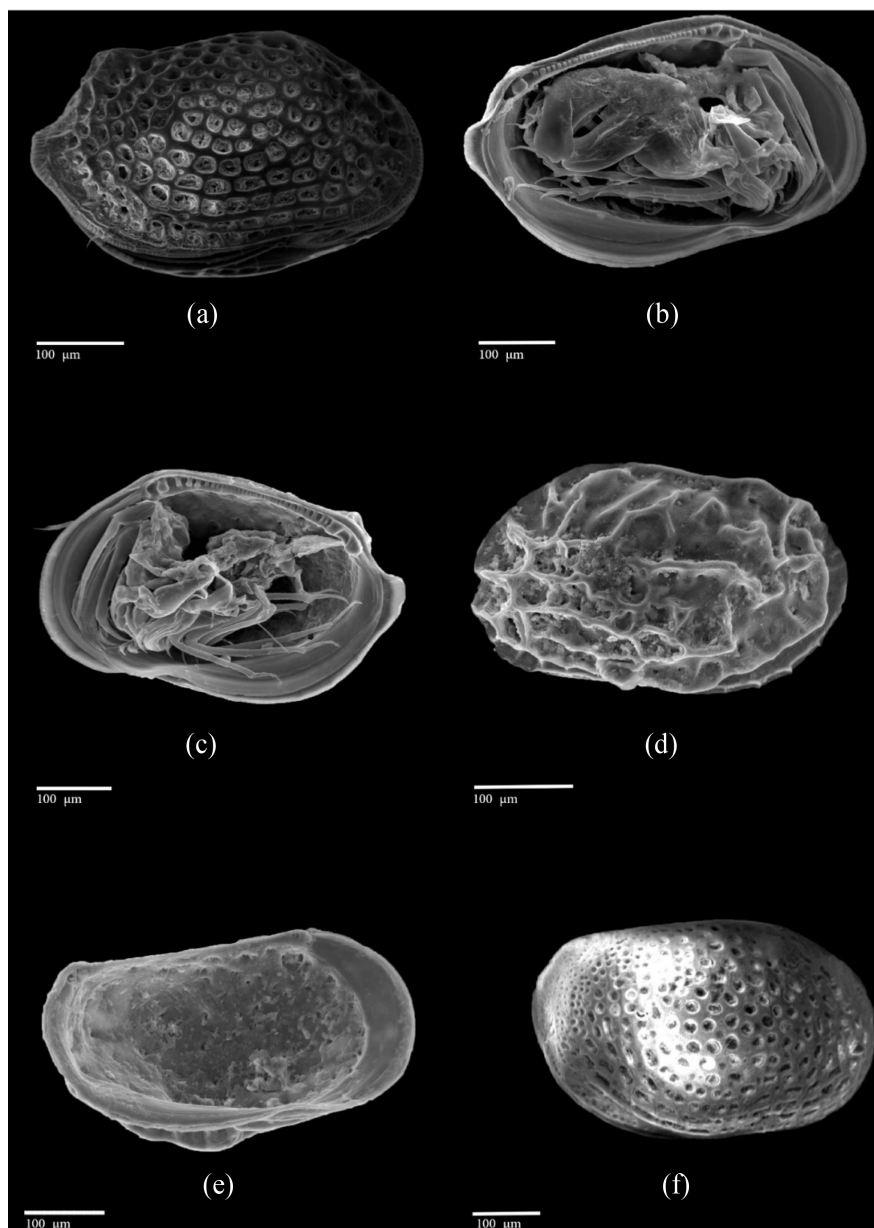


Figure 2. Scanning Electron Microscope showing. (a) External view of female carapace of *Loxoconcha ghardaqensis*; (b): Internal view of left valve of male of *L. ghardaqensis* (c) Internal view of right valve of female of *L. ghardaqensis* (d) External view of left valve of *Loxoconcha ornatovale* (e) Internal view of left valve of *L. ornatovale* (f) External view of right valve of *Loxoconcha gisellae*.

Occurrence: *L. ornatovale* is widely distributed species in the Red Sea and occurs with several numbers in the third site. While, it is occurring in fewer numbers in the first, fourth and fifth sites and absent from the second site.

Ecology: This species found in shallow water and occurred in large numbers in algae. The appropriate environmental factors for this species are: Water temperature equal 32.6°C, pH is 8.48, salinity is 41.22‰. Also, dissolved oxygen is 7.2 (mg/l).

Remarks: The caudal process of our specimen is smaller than that of Bonaduce *et al.* [1] [2] and [12]. As well as, our species differs from that of [10] in the lateral ornamentation and dorsal margin, but resembles it in the shape of caudal process at the dorsal margin.

3.3.3. *Loxoconcha gisellae* Bonaduce *et al.*, 1980 (Figure 2(f))

Loxoconcha gisellae Bonaduce *et al.* [23], pl. 3, Figures 1-8.

Loxoconcha gisellae Bonaduce *et al.*: Munef *et al.* [24], pl. 4, Figures 65-70.

Measurements: Length = 0.58 mm, Height = 0.31 mm

Geographical distribution: Red Sea.

Occurrence: *Loxoconcha gisellae* occurs in small numbers in four sites and absent from the fifth one.

Ecology: *L. gisellae* found in shallow water and the appropriate environmental factors for flourishing this species are: Water temperature equal 32.6°C, pH is 8.48, salinity is 41.22‰. Also, dissolved oxygen is 7.2 (mg/l).

Remarks: The current species are closely related to that of [19] and larger than it. But, the caudal process of our species is shorter than that of [19] and the reticulation of the dorsal margin is less obvious. Also, the present species resemble *Loxoconcha gurneyi* [21], but differ from it in carapace ornamentation and outlines. Our species are closely related to *L. amygdalanux* but differs in the sinus ventral margin.

Genus: *Loxoconchella* Triebel, 1954

3.3.4. *Loxoconchella dorsobullata* Hartmann, 1964 (Figure 3(a), Figure 3(b))

Loxoconchella dorsobullata [1], pls. 21- 22, Figures 101-113.

Loxoconchella sp. [25], Figure 51.

Loxoconchella dorsobullata Hartmann: Bonaduce *et al.* [1], pl. 10: Figure 10.

Loxoconchella dorsobullata Hartmann: [8], pl. 2, Figures 6-9.

Measurements: L = 0.57 mm, H = 0.35 mm

Geographical distribution: Red Sea (Hurghada, Gulf of Aqaba and Jeddah in Saudi Arabia).

Occurrence: *L. dorsobullata* is widely distributed species in the Red Sea and occurs with several numbers.

Ecology: The present species found in shallow water and occurred in large numbers in algae. The suitable ecological factors for this species are: Water temperature equal 28°C, pH is 8.27, salinity is 42.13‰. Also, dissolved oxygen is 6.9 (mg/l).

Remarks: Our specimens (*L. dorsobullata*) is larger than those of [1] and [8]. Moreover, the caudal process of our species resembles that of [8] and more obvious than that of Bonaduce *et al.* [2]. The pores on the carapace of *L. dorsobullata* in [8] are more obvious than our specimen.

Family: Xestoleberididae Sars 1926

Subfamily: Xestoleberidinae Sars 1928.

Genus: *Xestoleberis* Sars, 1866.

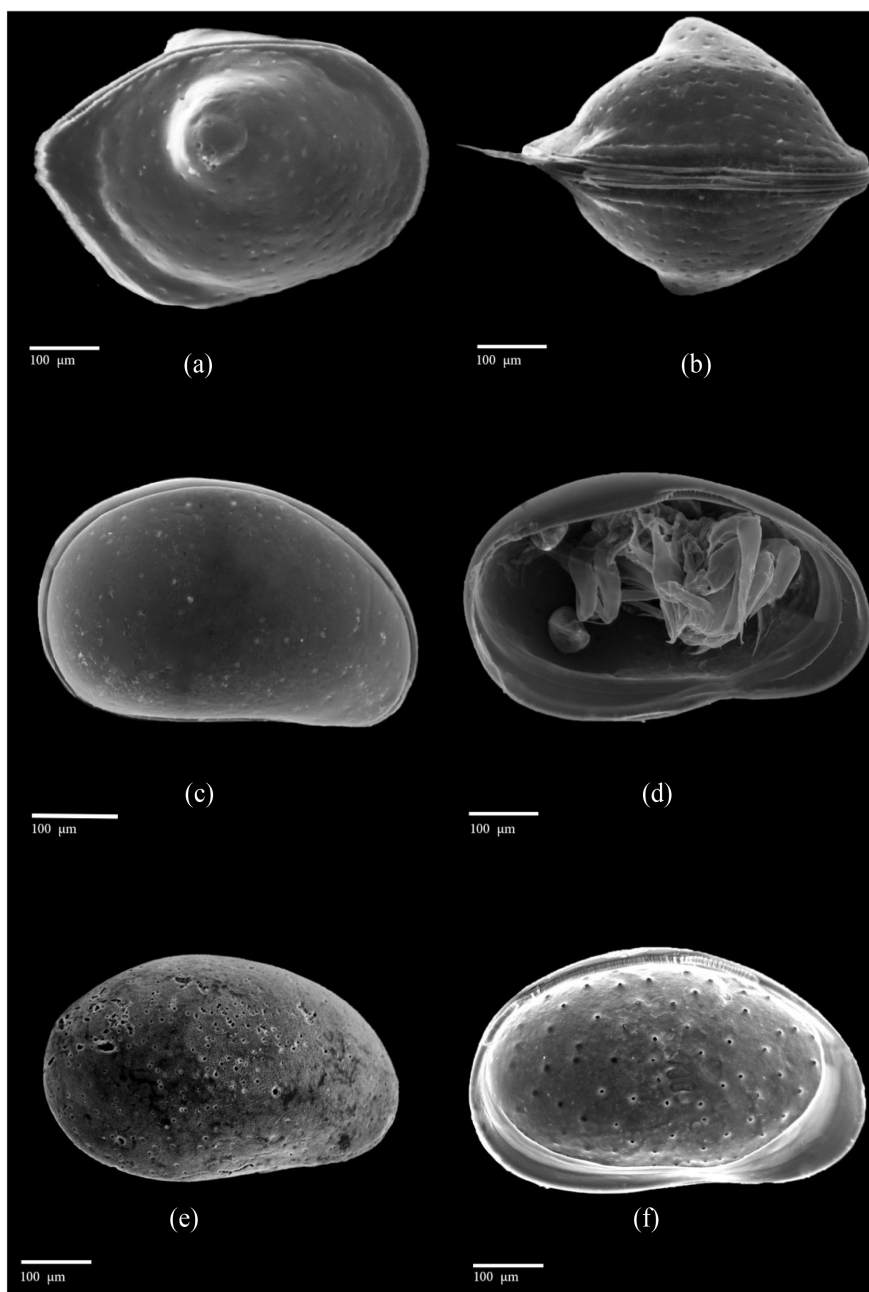


Figure 3. Scanning Electron Microscope showing. (a) Lateral view of carapace of *Loxoconchella dorsobullata* (b) Ventral view of carapace of *L. dorsobullata* (c) Lateral view of carapace *Xestoleberis ghardaqae* (d) Internal view of right valve of female of *X. ghardaqae* (e) External view of left valve of *X. rotunda* (f) Internal view of right valve of *X. rotunda*.

3.3.5. *Xestoleberis ghardaqae* Hartmann, 1964 (Figure 3(c), Figure 3(d))

Xestoleberis ghardaqae [1], pl. 2.

Xestoleberis ghardaqae Hartmann: Bonaduce *et al.* [2], pl. 11: Figure 11.

Xestoleberis ghardaqae Hartmann: [12], Figure 13.

Xestoleberis rotunda Hartmann: [5], pl. 1, Figure 8.

Diementions: L: 0.36 mm, H: 0.20 mm.

Geographical distribution: Red Sea.

Ecology: *X. ghardaqae* occurs in shallow water in moderate numbers in collection sites.

Occurrence: The present species occurred in all collection sites.

Remarks: The dorsal margin of our specimen (*X. ghardaqae*) is less arched and smaller in size than that of [12]. Moreover, the anterior margin of our specimens is wider than that of [12] and Bonaduce *et al.* [2].

3.3.6. *Xestoleberis rotunda* Hartmann, 1964 (Figure 3(e), Figure 3(f))

Xestoleberis rotunda [1], pls.24, 28, 29, Figures 156-163.

Xestoleberis rotunda [19], pls.1, 2, 3, Figures 1c, 2c, 3.

Xestoleberis rotunda Hartmann: Bonaduce *et al.* [2], Pl. 11: Figure 12.

Xestoleberis rotunda Hartmann: [5], Pl. 1, Figure 18.

Xestoleberis rotunda Hartmann: [12], Figure 13: 199-206.

Size: L: 0.57 mm, H: 0.38 mm.

Geographical Distribution: Indian Ocean, Red Sea and Persian Gulf.

Occurrence: is widely distributed species in the Red Sea and occurs with several numbers in the first and third sites.

Ecology: This species found in shallow water and occurred in large numbers in algae. The suitable environmental factors for this species are: Water temperature ranges between 28.8°C - 32.6°C, pH varies between 8.27 and 8.48, salinity fluctuates from 42.13‰ to 41.22‰. Also, dissolved oxygen ranges from 6.9 to 7.2 (mg/l).

Remarks: *Xestoleberis rotunda* is larger than that of [12] and its anterior margin narrower than it. Furthermore, the dorsal margin of *X. rotunda* is more arched than that of our species.

Superfamily: Bairdiacea Sars, 1888.

Family: Bairdiidae Sars, 1888.

Genus: *Paranesidea* Maddocks, 1969.

3.3.7. *Paranesidea fracticorallicola* Maddocks, 1969 (Figures 4(a)-(d))

Paranesidea fracticorallicola Maddocks [6] [7], Figures 16A-I, 17A-D, 18 A.

Paranesidea fracticorallicola Maddocks: Bonaduce *et al.* [3], pls.1, 2, Figure 1F, 5-6.

Paranesidea fracticorallicola Maddocks: [26], pls.3, 11, Figures 7-10.

Paranesidea fracticorallicola Maddocks: [11], pl. 1, Figure 7.

Measurements: L = 0.94 mm, H = 0.7 mm

Geographical Distribution: Nosy Be, Madagascar, Red Sea and Gulf of Oman.

Occurrence: The current species are widely distributed species in the Red Sea and occurs with several numbers in the first and third sites.

Ecology: This species habiting shallow water and occurred in large numbers in algae. The suitable environmental factors for this species are: Water temperature

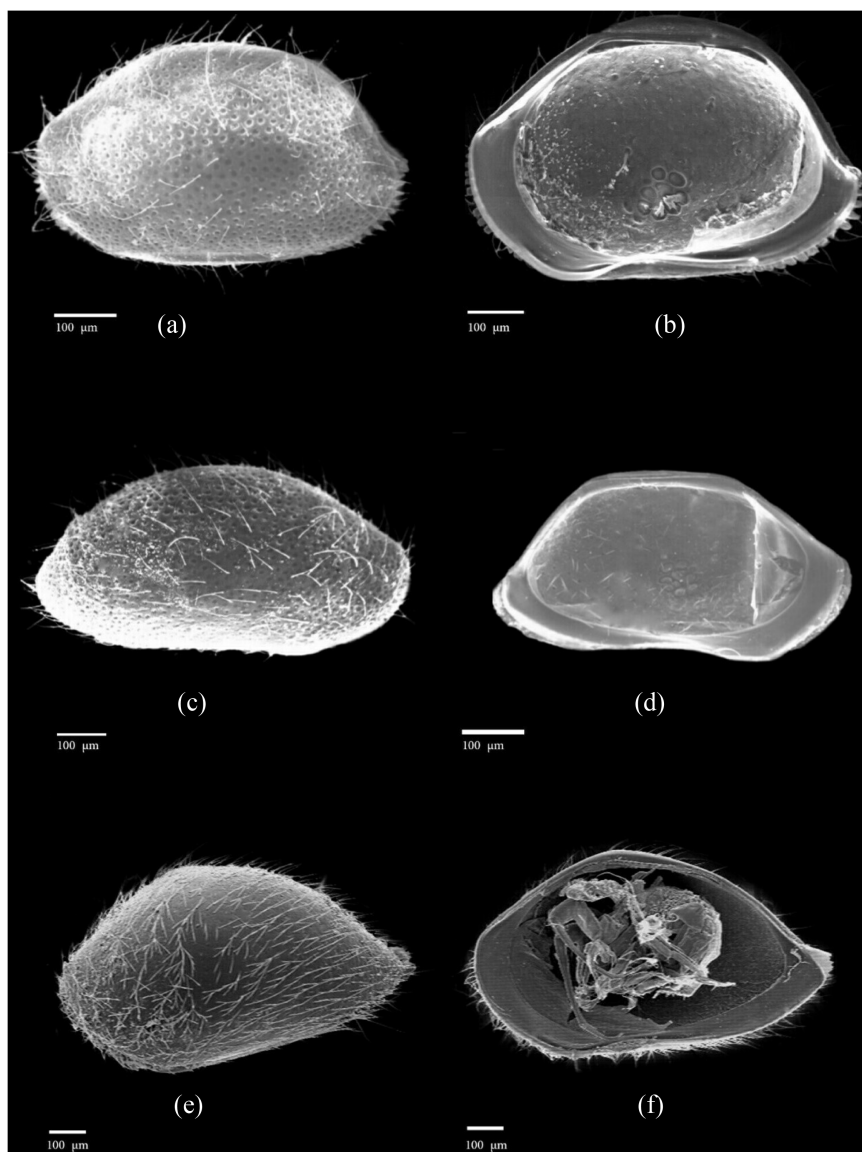


Figure 4. Scanning Electron Microscope showing. (a) External view of left valve of *Paranesidea fracticorallicola* (b) Internal view of left valve of *P. fracticorallicola* (c) External view of right valve of *P. fracticorallicola* (d) Internal view of right valve of *P. fracticorallicola* (e) External view of left valve *Neonesidea schulzi* (f) Internal view of right valve of male of *N. schulzi*.

ranges between 28.8°C - 32.6°C, pH varies between 8.27 and 8.48, salinity fluctuates from 42.13‰ to 41.22‰. Also, dissolved oxygen ranges from 6.9 to 7.2 (mg/l).

Remarks: The ornamentation of *Paranesidea fracticorallicola* carapace consists of circular punctate be wide at the center and narrow at the peripheral margins. The left valve of present species is longer than the right one and overlap it. Our species have blunt spines at the dorsal margin, which are absent from that of Bonaduce *et al.* [27].

Genus: *Neonesidea* Maddocks, 1969a

3.3.8. *Neonesidea schulzi* (Hartmann, 1964) (Figure 4(e), Figure 4(f))

Triebelina schulzi [1], pls. 4-5, Figures 14-22.

Neonesidea schulzi (Hartmann): [6] [7], Figures 4a-d, 5-6.

Neonesidea schulzi (Hartmann): [28], pl. 7, Figures 9-11.

Neonesidea schulzi (Hartmann): Bonaduce *et al.* [2], pl. 4, Figure 6.

Neonesidea schulzi (Hartmann): [29], pl. IV, Figure 2.

Neonesidea schulzi (Hartmann): [30], pl. 2, Figures 1-10.

Neonesidea schulzi (Hartmann): [12], pls. 2-9.

Measurements: L: 1.200 mm, H: 0.68 mm.

Geographical distribution: Gulf of Aden, Red Sea, east coast of Africa, Indo-pacific region.

Occurrence: The current species are distributed species in the Red Sea and occurs with several numbers in the third site.

Ecology: This species found in shallow water and occurred in large numbers in algae. The appropriate environmental factors for this species are: Water temperature equal 32.6°C, pH is 8.48, salinity is 41.22‰. Also, dissolved oxygen is 7.2 (mg/l).

Remarks: This species is widely distributed in the Red Sea and occurred in several numbers. It is characterized by having seven leaf-like setae at its posterior margin as that of [1]. Moreover, our specimen has numerous long sensillae on its carapace surface, while these sensillae absent in *N. schulzi* of [12].

3.3.9. *Neonesidea aff. michaelsoni* Hartmann, 1982 (Figure 5(a))

Neonesidea michaelsoni [31], Figures 5-10, 47-49, pl. 6.

Neonesidea michaelsoni [32], Figures 1-4, 25-28, pl. 1.

Neonesidea michaelsoni Hartmann: [12], Figures 2: 7, 8.

Measurements: L: 0.94 mm; H: 0.62 mm.

Geographical distribution: Australia, Polynesia, Red Sea.

Ecology: This species found in shallow water and occurred in large numbers in algae. The appropriate environmental factors for this species are: Water temperature equal 34.5°C, pH is 8.53, salinity is 42.48‰. Also, dissolved oxygen is 8.8 (mg/l).

Occurrence: This species absent from the second site and occurred in fewer numbers in the remaining sites.

Remarks: The shell shape of this species resembles that of *N. michaelsoni*. Our species are larger than the ones from Polynesia and from Australia. Also, the present species are larger than that of [12].

Family: Trachyleberididae Sylvester-Bradley, 1948

Subfamily: Trachyleberidinae Sylvester-Bradley, 1948

Genus: *Moosella* Hartmann, 1964

3.3.10. *Moosella striata* Hartmann, 1964 (Figure 5(b), Figure 5(c))

Moosella striata [1], pls. 46, 50-51, Figures 270-273, 289-297.

Moosella striata Hartmann: Bonaduce *et al.* [2], p. 382,

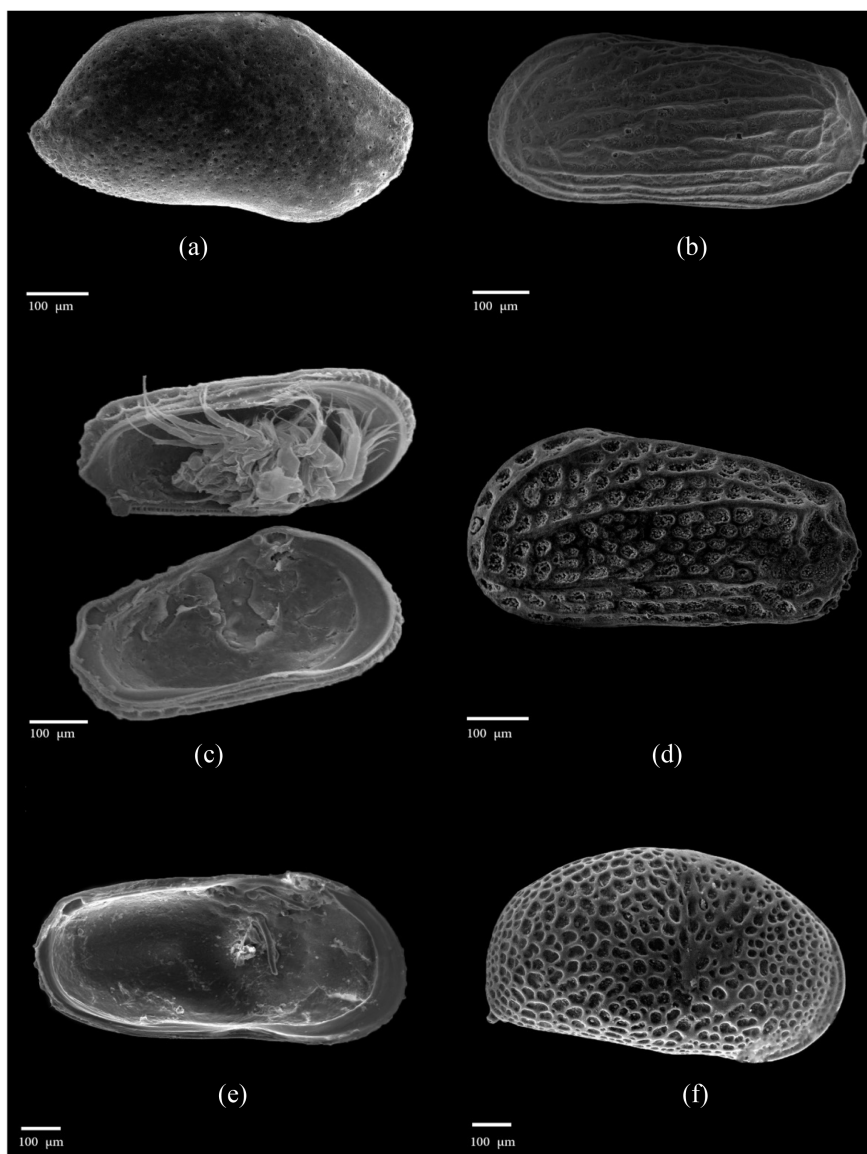


Figure 5. Scanning Electron Microscope showing. (a) External view of right valve of *Neonesidea michaelsoni* (b) External view of left valve of *Moosella striata* (c) Internal view of opening carapace of *Moosella striata* (d) External view of left valve of *Hiltermannicythere rubrimaris* (e) Internal view of left valve *Hiltermannicythere rubrimaris* (f) Internal view of right valve of *Cyprideis littoralis*.

Moosella striata Hartmann: Bonaduce *et al.* [27], pl. 4, Figures 1-4.

Moosella striata Hartmann: [29], pl. IV, Figure 7.

Moosella striata Hartmann: [33], pl. 16, Figures 302-307.

Moosella striata Hartmann: [4], pl. 1, Figure 16.

Moosella striata Hartmann: [12], pls. 11, 175-179.

Size: L: 0.86 mm, H: 0.45 mm.

Geographical distribution: Gulf of Aqaba (Red Sea), Kenya.

Ecology: The current species found in shallow water and occurred in large numbers in algae. The suitable environmental factors for this species are: Water

temperature equal 34.5°C, pH is 8.53, salinity is 42.48‰. Also, dissolved oxygen is 8.8 (mg/l).

Occurrence: This species occurred in large numbers in the fourth site and moderate numbers in the remaining sites.

Remarks: The carapace of *Moosella striata* characterized by the presence of similar striated ridges without fossae, however, the carapace surface of the same species of [12] intercalated with fossae. Moreover, the present species is larger than that of *M. striata* which recorded by [12].

Subfamily: Phacorhabdotinae Gründel, 1969

Genus: *Hiltermannicythere* Bassiouni, 1970

3.3.11. *Hiltermannicythere rubrimaris* (Hartmann, 1964) (Figure 5 (d), Figure 5(e))

Hiltermannicythere rubrimaris (Hartmann), Bonaduce *et al.* [2], pl. 5, Figure 1.

Hiltermannicythere rubrimaris (Hartmann), Bonaduce *et al.* [27], pl. 6, Figure 10.

Hiltermannicythere rubrimaris (Hartmann), [33], pl. 14, Figures 264-269.

Hiltermannicythere rubrimaris (Hartmann), [12], Figure 11: 172-174.

Size: L: 0.86 mm, H: 0.38 mm,

Geographical distribution: Red Sea, Kenya, Yemen.

Occurrence: The current species are moderately distributed species in the Red Sea and occurs with moderate numbers in the first and third sites. While, it is occurring in fewer numbers in the fourth and fifth sites and absent from the second.

Ecology: This species found in shallow water and occurred in large numbers in algae. The suitable environmental factors for this species are: Water temperature ranges between 28.8°C - 32.6°C, pH varies between 8.27 and 8.48, salinity fluctuates from 42.13‰ to 41.22‰. Also, dissolved oxygen ranges from 6.9 to 7.2 (mg/l).

Remarks: The individuals of Genus *Hiltermannicythere* have more resembled to those of Genus *Mosella*. Our specimen *Hiltermannicythere rubrimaris* has more resembled to that of Bonaduce *et al.* [27] and larger than the ones of [12] and those reported from Kenya.

Family: Cytherideidae Sars, 1925

Subfamily: Cytherideinae Sars, 1925

Genus: *Cyprideis* Jones, 1857

3.3.12. *Cyprideis littoralis* Brady, 1868 (Figure 5(f))

Cyprideis littoralis Brady: [1], Figures 41-45, pl. 10.

Cyprideis littoralis Brady: [5], pls. 1, 2, Figures 1, 12.

Diementions: L = 0.78 mm, H = 0.47 mm

Geographical Distribution: Red Sea.

Occurrence: The current species are distributed in four collecting sites and

occurs with large numbers in the second site.

Ecology: This species found in shallow water and occurred in large numbers in algae. The suitable environmental factors for this species are: 33.4°C water temperature, 8.65 pH, 42.13‰ salinity and the dissolved oxygen is 7.8 (mg/l).

Remarks: The present species *Cyprideis littoralis* differs from that of [5] in having a large blunt spine at posterior margin.

Family: Cytheruridae G.W. Müller 1894.

Subfamily: Cytherurinae G.W. Müller 1894.

Genus: *Hemicytherura* Elofson, 1941.

3.3.13. *Hemicytherura videns aegyptica* Hartmann, 1964 (Figure 6(a)-(d))

Hemicytherura videns aegyptica [1], pl. 13, Figures 61, 62, 66.

Hemicytherura videns Hartmann: [34], Figure 1.

Hemicytherura aegyptica Hartmann: [35], pp. 7-12

Hemicytherura videns aegyptica Hartmann: [12], Figure 4.

Size: Male: L = 0.34 mm, H = 0.19 mm, Female: L: 0.28 mm, H: 0.20 mm

Occurrence: It occurred with fewer numbers in four sites and absent from the second one.

Geographical distribution: Red Sea, Persian Gulf and Indian Ocean.

Remarks: This species is closely related to *H. videns* which recorded by [1].

Family: Leptocytheridae Hanai, 1957

Genus: *Tanella* Kingma, 1948.

3.3.14. *Tanella gracilis* Kingma, 1948 (Figure 6(e), Figure 6(f))

Tanella gracilis [36], pl. 10, Figure 7.

Tanella cf. gracilis Kingma: [19], pls. 1-3, Figure 11.

Tanella aff. gracilis Kingma: [37], pl. 2, Figures 35-37.

Tanella gracilis Kingma: [38], pls. 4-13, Figures 108-113.

Tanella gracilis Kingma: [39], pl. 2, Figures J 2-4.

Tanella gracilis Kingma: [40], pl. 7, Figures 11-18.

Tanella gracilis Kingma: [41], pl. 3, Figures 3-7.

Tanella gracilis Kingma: Al-Abdul-Razza *et al.* [42], *et al.*, Figure 7.

Tanella sp. cf. *T. gracilis*. Kingma: [43], pl. 6, Figures 5-6.

Tanella gracilis Kingma: [44], Figure 93.

Tanella gracilis Kingma: [45], pls. 3, 4, Figures 3, 4, 17.

Tanella gracilis Kingma: [46], pl. 4, Figures 13-15.

Tanella gracilis Kingma: [47], pl. 1, Figure 7.

Tanella gracilis Kingma: [48], pl. I, Figure 18.

Tanella gracilis Kingma: [49], pl. I, Figure 10.

Tanella gracilis Kingma: Sridhar *et al.* [50], pl. II, Figure 2.

Tanella gracilis Kingma: Arul *et al.* [51], pl. 1, Figures 5-6.

Tanella gracilis Kingma: [4], pl. 1, Figure 6.

Tanella gracilis Kingma: Hussain *et al.* [52], Figure 6, 5.

Tanella gracilis Kingma: Gopalakrishna *et al.* [53], pl. I, Figure 14.

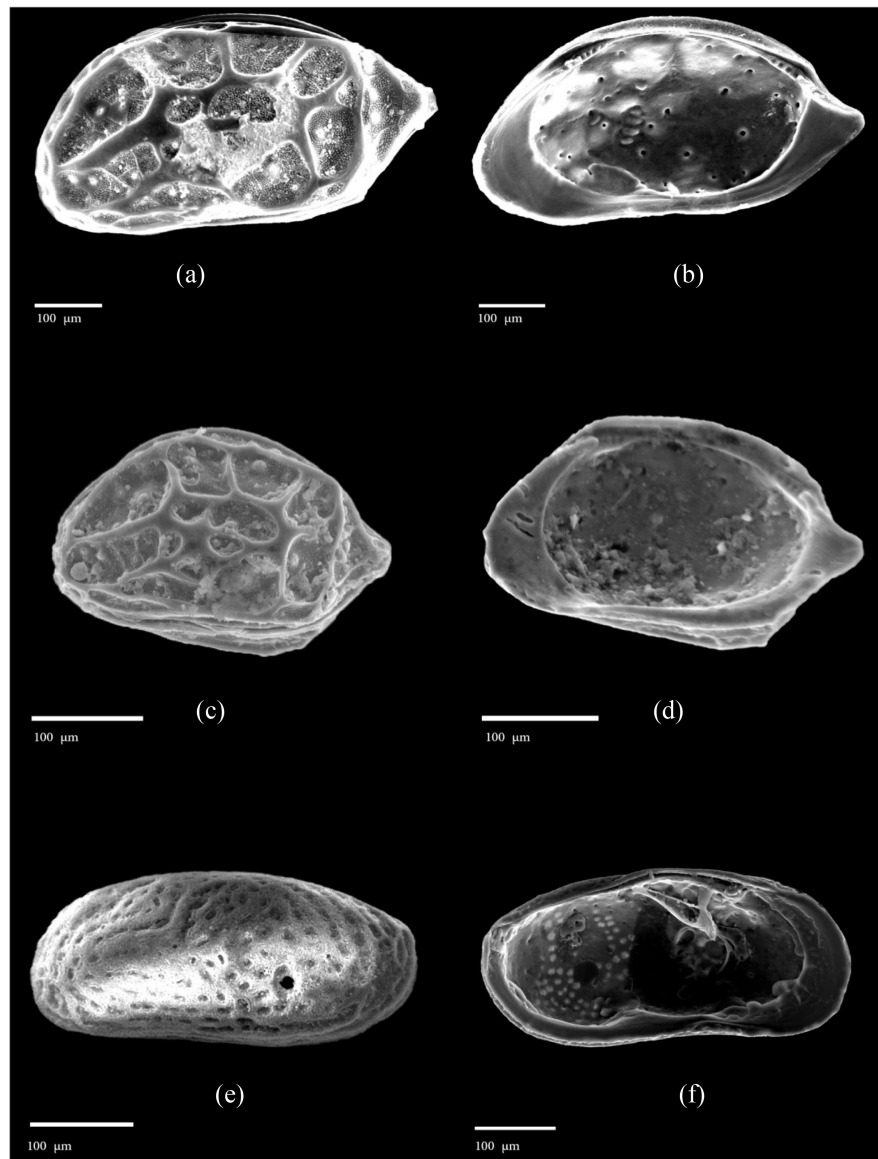


Figure 6. Scanning Electron Microscope showing. (a) External view of left valve of male of *Hemicytherura videns aegyptica* (b) Internal view of right valve of male *H. videns aegyptica* (c) External view of carapace of female of *H. videns aegyptica* (d) Internal view of right valve of female of *H. videns aegyptica* (e) External view of left valve of *Tanella gracilis* (f) Internal view of left valve of *Tanella gracilis*.

Tanella gracilis Kingma: [12], Figure 7: 97-100.

Size: L: 0.45 mm, H: 0.20 mm.

Occurrence: *Tanella gracilis* is widely distributed species in the Red Sea and occurs with several numbers in the first and third sites.

Ecology: This species found in shallow water and occurred in large numbers in algae. The suitable environmental factors for this species are: Water temperature ranges between 28.8°C - 32.6°C, pH varies between 8.27 and 8.48, salinity fluctuates from 42.13‰ to 41.22‰. Also, dissolved oxygen ranges from 6.9 to 7.2 (mg/l).

Geographical distribution: Red Sea, Gulf of Aden, Kuwait, Gulf of Oman, Arabian Gulf, Australia, west African coast, Kenya, Malaya, Andaman Islands, India, Reunion Islands.

Remarks: Our specimens (*Tanella gracilis*) have a narrower circular puncta than the ones reported from the Indo-Pacific and from those of [12].

Genus: *Callistocythere* Ruggieri, 1953.

3.3.15. *Callistocythere arcana* Bonaduce et al., 1976 (Figure 7(a), Figure 7(b))

Callistocythere arcana Bonaduce et al. [2], p. 378, pl. 3, Figures 3-9.

Callistocythere arcana Bonaduce et al., [33], p. 116, pl. 5, Figures 111-113.

Callistocythere arcana Bonaduce, [10], p. 58, Figure 11.

Callistocythere arcana Bonaduce et al., [54], p. 42, pl. 2, Figure 12.

Callistocythere arcana Bonaduce et al., [12], Figure 6: 79-84.

Size: L 0.43 mm, H 0.22 mm.

Occurrence: The current species are distributed in four of collection sites from the Red Sea and occurs with large numbers in the second site.

Ecology: This species found in shallow water and occurred in large numbers in algae. The suitable environmental factors for this species are: 33.4°C water temperature, 8.65 pH, 42.13‰ salinity and the dissolved oxygen is 7.8 (mg/l).

Geographical distribution: Red Sea, Persian Gulf, Kenya, Gulf of Aden.

Remarks: The present species are smaller than those of [12] and its anterior margin is narrower than those collected from the Gulf of Aqaba Bonaduce et al. [2].

Genus: *Leptocythere* Sars, 1925

3.3.16. *Leptocythere arenicola* Hartmann, 1964 (Figure 7(c), Figure 7(d))

Leptocythere (sub. gen. *Callistocythere*) *arenicola* [1], pp. 48-50, pl. 12, Figures 52-57, pl. 13, Figures 58, 59.

Leptocythere arenicola Hartmann: Bonaduce et al. [2], p. 378, pl. 3, Figure 2.

Leptocythere arenicola Hartmann: Pugliese et al. [55], pl. 5, Figure 1.

Leptocythere arenicola Hartmann: Munef et al. [24], Plate 4, Figures 53, 54.

Size: L-0.42 mm, H-0.20 mm.

Geographical distribution: Red Sea (Gulf of Aqaba- El Hameira).

Occurrence: The present species are widely distributed in the Red Sea and occurs with several numbers in the first and third sites.

Ecology: This species found in shallow water and occurred in large numbers in algae. The suitable environmental factors for this species are: Water temperature ranges between 28.8°C - 32.6°C, pH varies between 8.27 and 8.48, salinity fluctuates from 42.13‰ to 41.22‰. Also, dissolved oxygen ranges from 6.9 to 7.2 (mg/l).

Remarks: There is no difference could be itemized between our species and those figured by [1] from the Red Sea and Munef et al. [24], from Yemen.

Subfamily: Trachyleberidinae Sylvester-Bradley, 1948

Genus: *Quadracythere* Hornibrook, 1952

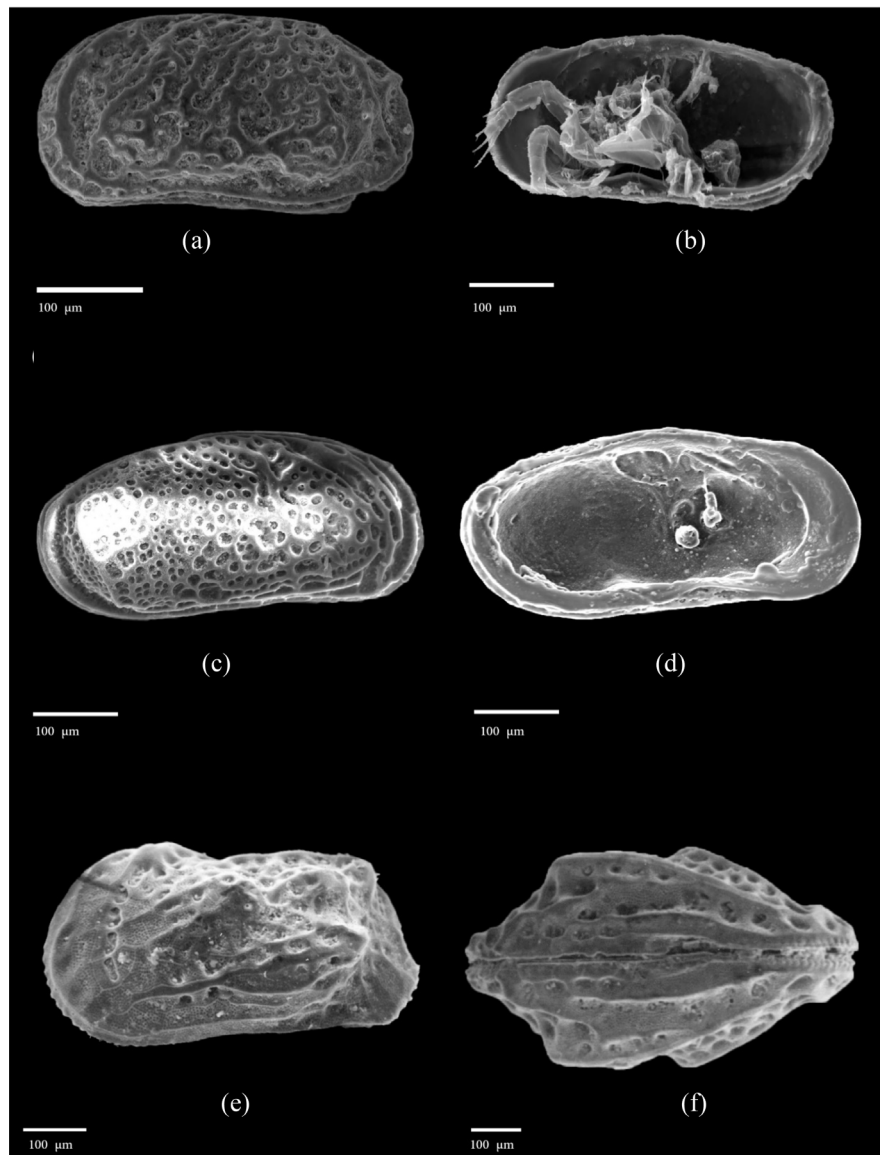


Figure 7. Scanning Electron Microscope showing. (a) External view of carapace of *Callicythere arcana* (b) Internal view of right valve of *Callicythere arcana* (c) External view of right of *Leptocythere arenicola* (d) Internal view of left valve of female of *Leptocythere arenicola* (e) External view of left valve of *Quadracythere borchersi* (f) Ventral view of carapace of *Quadracythere borchersi*.

3.3.17. *Quadracythere borchersi* (Hartmann, 1964) (Figure 7(e), Figure 7(f) & Figure 8(a))

Hemicythere (?) *borchersi* [1], pls. 56,57,58 Figures 318-321, 324-330, 322-323.

Quadracythere borchersi (Hartmann), Bonadouce *et al.* [2], pl. 5, Figures 5-7.

Quadracythere borchersi (Hartmann). Bonadouce, *et al.* [23], p. 478.

Quadracythere borchersi (Hartmann), [5], pls.7: 5,6.

Measurements: L = 0.96 mm, H = 0.68 mm.

Geographical distribution: Red Sea.

Occurrence: *Quadracythere borchersi* present with several numbers in the

second, fourth and fifth sites (mangrove trees) and occurred in less numbers in the first and third sites (covered with macro-algae).

Ecology:

Remarks: The species under investigation was described for the first time by [1] as *Hemicythere borchersi*. Our species have more resembled to *Hemicythere borchersi* [1] especially in the outlines, carapace ornamentation and in the anterior and posterior tubercles. On the other hand our specimens differ from *Quadracythere borchersi* in the carapace ornamentations and the shape of posterior margin.

Family: Hemicytheridae Puri, 1953

Subfamily: Orionininae Puri, 1953

Genus: *Caudites* Coryell and Fields, 1937

3.3.18. *Caudites sublevis* Hartmann, 1974 (Figure 8(b))

Caudites cf. C. knysnaensis [56], pls. 60, 150, Figures 449-458, Figure 4.

Caudites sublevis Bonaduce: [48], pl. II, Figure 16.

Caudites sublevis Bonaduce: [54], pl. 2, Figure 6.

Caudites sublevis Bonaduce: [12], Figure 5: 67-70.

Size: L 0.47 mm, H 0.26 mm.

Occurrence: The studied species occurred in less numbers in three sites only.

Geographical distribution: Red Sea, India, Angola, Gulf of Aden.

Remarks: The ventral margin of the present species is more sinuous than that of [12].

Family: Paradoxostomidae

Subfamily: Paradoxostominae

Genus: *Paradoxostoma* Fischer, 1885.

3.3.19. *Paradoxostoma altecaudatum* Bonaduce et al., 1980 (Figure 8(c))

Paradoxostoma altecaudatum Bonaduce et al. [27], pl. 10, 12, Figure 1, Figure 2, Figure 5.

Size: L = 0.75 mm; H = 0.33 mm.

Geographical distribution: Red Sea.

Occurrence: *Paradoxostoma altecaudatum* occurred in moderate numbers in all collection sites.

Remarks: The valves of Genus *Paradoxostoma* are thin calcified and nearly smooth. *Paradoxostoma altecaudatum* is rare in our samples and is smaller than that of Bonaduce et al. [27] and differs from that in the presence of some striated lines on the carapace surface.

Superfamily: Cypridacea Baird, 1845

Family: Paracyprididae Sars, 1923

Genus: *Ghardaglaia* Hartmann, 1964

3.3.20. *Ghardaglaia triebeli* Hartmann, 1964 (Figure 8(d)-(f))

Ghardaglaia triebeli: [1], pls. 6-9, Figures 23- 40.

Ghardaglaia triebeli Hartmann: Bonaduce et al. [2], pl. 3, Figure 1.

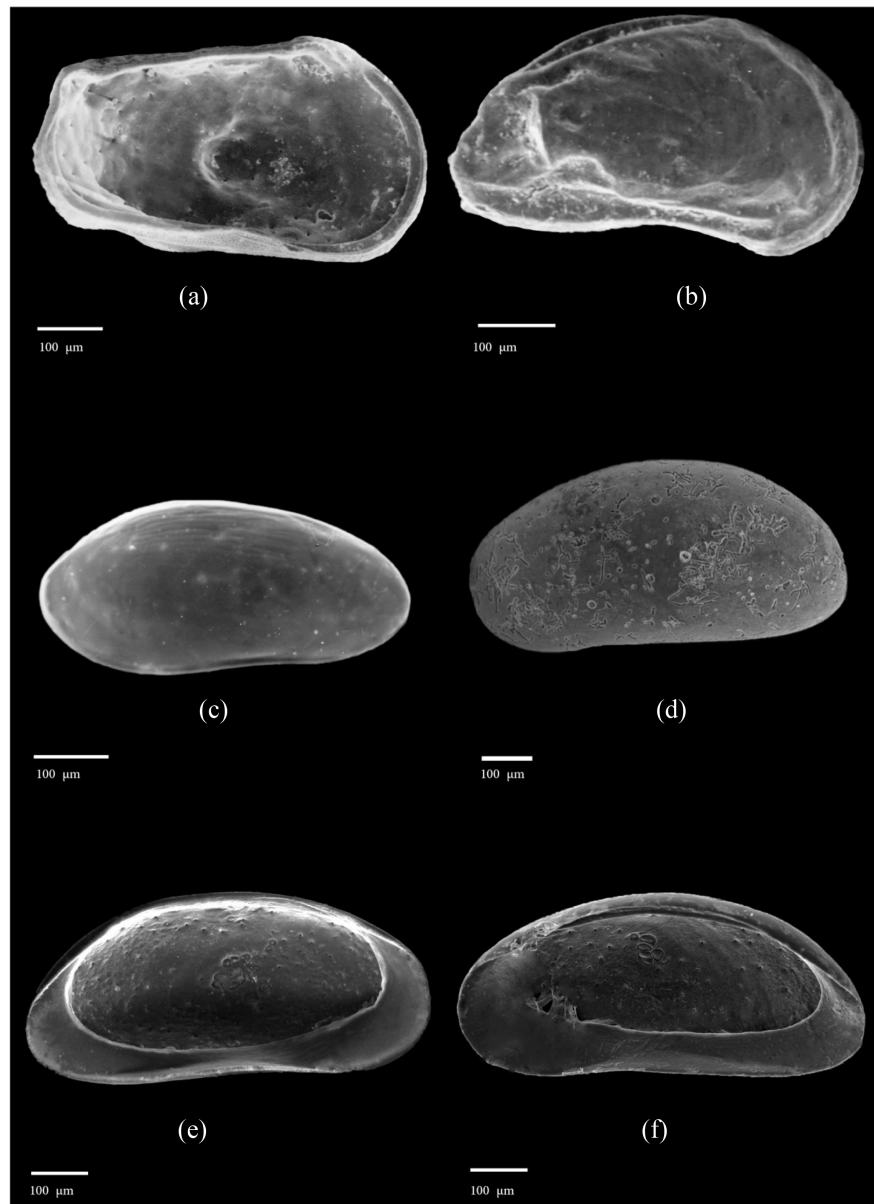


Figure 8. Scanning Electron Microscope showing. (a) Internal view of left valve of *Quadracythere borchersi* (b) External view of right valve of *Caudites sublevis* (c) External view of right valve of *Paradoxostoma altecaudatum* (d) External view of left valve of *Ghardaglaia triebeli* (e) Internal view of left valve of *Ghardaglaia triebeli* (f) Internal view of right valve of *Ghardaglaia triebeli*.

Aglaicypris triebeli (Hartmann): [57], pl. 1, Figure 1w.

Size: L 0.7 mm, H 0.32.

Geographical Distribution: Red Sea.

Occurrence: *Ghardaglaia triebeli* is widely distributed species in the Red Sea and occurs with several numbers in the first and third sites.

Ecology: This species found in shallow water and occurred in large numbers in algae. The suitable environmental factors for this species are: Water temperature ranges between 28.8°C - 32.6°C, pH varies between 8.27 and 8.48, salinity

fluctuates from 42.13‰ to 41.22‰. Also, dissolved oxygen ranges from 6.9 to 7.2 (mg/l).

Remarks: The lateral outlines *Agelaiella* sp. resembles our species, but the latter has a wider inner lamella. On the other hand, there are no differences between the present species and ones of [1] and Bonadouce *et al.* [2].

4. Discussion

Macro-algae and mangrove trees of the Red Sea are inhabited by different ostracod species. The present study recorded and counted the ostracod species from five collection sites (on the Egyptian Red Sea coast), three sites of them are inhabited by mangrove trees and the other two ones are covered with macro-algae. We concluded that, collection sites occupied by macro-algae have yielded larger numbers and diversity of ostracods than those occupied by mangrove trees. So, the diversity and abundance of ostracod species are controlled by the type vegetation. [5] concluded that the areas with the algae contain dense communities of ostracod species.

Twenty Shallow marine ostracods of five samples from Al-Quseir to Marsa Alam on the Egyptian Red Sea Coast were studied. [4] collected twenty-three ostracod species belonging to 21 genera, and 13 families from Safaga bay along the Red Sea coast, Egypt. Similarly, [5] collected 36 and 26 ostracod species from Wadi Gemal area and Abu Ghoson area, respectively. During our study, the most common species in the collecting region are *Loxoconcha ghardaensis*, *Xestoleberis rotunda*, *Paranesidea fracticorallicola*, *Tanella gracilis* and *Neonesidea schulzi*, whereas, *Hemicytherura videns aegyptica* and *Caudites sublevis* occurred in few numbers. [11] reported 83 species belonging to 54 genera from Gulf of Oman at depths ranging from 30 to 103 m. The ostracod species *Hemicytherura aegyptica*, *Tanella gracilis*, *Moosella striata* and *Loxoconcha ornatovalve* are recorded by [11].

The ostracod species *Hiltermannicythere rubrimaris*, *Loxoconcha ghardaensis* are distributed in the Red Sea, the Gulf of Aden and the East African coast (Al-Abdul-Razzaq *et al.* [19] [42]; Bonaduce *et al.* [2], Bonaduce *et al.* [1] [4] [20] [27] [29] [33] [54]).

Tanella gracilis is common in algae in the area under study. [19] and [37] reported this species from the lagoon in the Arabian Gulf and from the deep water of the Gulf of Oman, respectively. [39] also found *T. gracilis* in the western coast of India and [38] found it in Indonesia as well as the western coast of Australia.

The recorded fauna show close affinities to those of the Red Sea and the Indo-Pacific region. Also, *Tanella gracilis* have wide distribution (Red Sea, Gulf of Aden, Kuwait, Gulf of Oman, Arabian Gulf, Australia, west African coast, Kenya, Malaya, Andaman Islands, India, Reunion Islands). Furthermore, *Neonesidea schulzi* occurred in east Coast of Africa and *Neonesidea michaelsoni* found in Australia and Polynesia. *Paranesidea fracticorallicola* occurred in Madagascar and Gulf of Oman. Add to that, *Moosella striata* present in Kenya. Although, most of studied species occurred in red sea and the Indo-pacific region.

This is due to the dispersal of ostracod species by birds and/or ships.

The present study delivers an initial examination of the taxonomy and distribution of some marine water Ostracoda from the Egyptian western Coast of the Red Sea. Though, further detailed studies are required for a better understanding.

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