

Taxonomic notes on some tiny, shallow water foraminifera from the northern Gulf of Elat (Red Sea)

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ABSTRACT: Twenty one species of benthic foraminifera with test sizes generally smaller than 0.100mm were isolated and described from the shallow waters of Northern Gulf of Elat (Red Sea). All species belong to suborder Rotaliina, in majority to the family Rotaliellidae and Glabratellidae. Two genera: *Microglabratella* and *Selenita*, and seven species: *Schaferina* (?) *bicornis*, *Rotaliella grelli*, *Rotaliella* (?) *nana*, *Glabratellina saidi*, *Microglabratella tabaensis*, *Selenita megalosphera*, and *Rubratella steinitzi* are new.

INTRODUCTION

Over the past decade John Lee and a number of co-workers (eg. Lee et al. 1979, 1980a, b, c, 1982, 1984, 1988; McEnery and Lee 1981; Lee and Reimer 1984; Reimer and Lee 1984, 1988; Ter Kuile et al. 1987) have been studying various aspects of symbiosis of the larger, symbiont-bearing foraminifera from the shallow waters of the Northern Gulf of Elat. The variation in the endosymbiotic-diatom species that were harbored by specific diatom-bearing host foraminifera raised many questions. One of these: "Are diatom-bearing foraminifera only temporary husbands of the most common diatom species found in the habitat in which they are feeding?" led us to a detailed examination of the diatom flora on substrates on which foraminifera were found (Lee et al. 1989). Substrates included *Halophila stipulacea* leaflets, canvas, and coral rubble. During our studies it became apparent that there were a great many specimens of foraminifera which were less than 0.100mm in the same communities as the larger foraminifera. Although there had been a number of studies of smaller foraminifera from this region (Said 1949, 1950; Reiss et al. 1961; Frenkel 1974; Perelis and Reiss 1975; Zweig-Strykowski and Reiss 1975; Reiss and Hottinger 1984) the "tiny" species (<0.100 mm) present in the epiphytic and "aufwuchs" assemblages seem to have been overlooked in the past. Some of the <0.100mm individuals were the juveniles of small and larger species of foraminifera, but clearly many were not. Some of the tiny specimens were conspecific with previously described rotaliinids (Grell 1954, 1957, 1962, 1979; Weber 1965) others were not. Since we were already cultivating diatoms, chlorophytes, and larger foraminifera in the laboratory, we were encouraged to attempt to grow the tiny species. To our delight they were easily cultivated. Because they completed their life cycle as "tiny" foraminifera they clearly were not juveniles of large species. This whetted our appetite for study of these overlooked forms.

The group of "tiny" foraminifera, also called "microforaminifera" (Haynes 1981) or "nannoforaminifera" (Theil 1983) is generally ignored by micropaleontologists. A few studies are concerned with the microforaminifera which had been isolated from samples treated with hydrochloric acid (Wilson and Hoffmeister 1952; Echols and Schaeffer 1960). Boltovskoy and Wright (1976) suggested, however, that these mostly chitinous

forms were nothing more than immature specimens of ordinary sized species. On the other hand, Schroeder et al. (1987) recently suggested that the smaller-sized benthic foraminifera (0.063-0.125mm) should not be ignored in paleoenvironmental analysis, especially in localities where the larger foraminifera are scarce. The relative abundance of tiny foraminiferal species in 0.032-0.063mm size fraction of surface sediment samples from the Eastern North Atlantic was demonstrated by Pawlowski and Lapierre (1988). Some of these species were used to show the changes in the deep North Atlantic foraminiferal fauna during the last glacial-interglacial period (Pawlowski 1991).

Tiny foraminifera are not easily studied even in the best stereomicroscopes. Many of the details of their morphology and wall structure are not readily observed, even though the magnification may be high enough. The wide availability of SEMs eliminates any impediments to their morphological examination and permits comparisons which were not previously feasible. This paper is the first attempt in that direction.

MATERIAL AND METHODS

The initial substrate samples (100) composed of *Halophila stipulacea* leaflets were collected in January 1988 in Wadi Taba area, Northern Gulf of Elat (Red Sea), at depths ranging from 5 to 25m. The samples were very carefully transported to the laboratory with minimal agitation. Small subsamples were cut with the aid of a scissors and gently fixed in 2% (v/v) glutaraldehyde in sea water. They were post fixed in 1% O₃O₄ and critically point dried before they were sputter coated with 10nm of Au and examined in a Cambridge Stereoscan (model 250) SEM. The specimens were observed and photographed without being removed from the *Halophila* leaves.

Later, in March 1988, more material was obtained by carefully brushing and washing of *Halophila* leaves collected in Wadi Taba area. Forty-four samples of littoral algae (*Enteromorpha*, *Centroceras*, *Padina*, *Colpomenia*, *Sphacelaria*, etc.) and 4 samples of sediments (from the depths of 5, 10, 20 and 30m) were also collected in the site next to the Heinz Steinitz Marine Biology Laboratory in Elat. All samples were stored in 70% alcohol and transferred to the laboratory. There the samples

were treated with ultrasonic cleaner for three minutes, and then washed using distilled water, through 0.125, 0.063 and 0.032mm mesh sized sieves.

The foraminifera were examined using dissecting microscope at magnification maximum going up to 150 times. About 300 specimens from the larger size fractions (>0.125mm and 0.125-0.063mm) of each sample were isolated and identified. Their density and distribution were examined. About 100-200 specimens were isolated from the fine size fraction (0.063-0.032) of each sample. They were compared to the larger sized species, and the clearly juvenile forms were eliminated. A fine 000 brush with only few hairs was used to isolate and transfer the tiny foraminifera. A detailed morphological study has been done using the SEM. The measurements were done with the microscopical preparations of the specimens previously dehydrated and mounted in Eukitt.

A part of the material was used to set up cultures of the living foraminiferids. One species, *Rotaliella* (?) *nana* was described from the living population maintained in laboratory culture.

SYSTEMATIC DESCRIPTIONS

The taxonomy adopted here follows a suprageneric classification of Loeblich and Tappan (1988). Only hyaline benthic foraminifers (suborder Rosaliina) are concerned. A special attention was paid to the species belonging to the superfamilies Discorbacea and Glabratellacea, which dominated in the fine sized fraction of our samples. The principal characteristics of new and little known genera of both superfamilies are presented on text-figure 1.

Our material was compared with the specimens from the Cushman Collection, Smithsonian Institution, Washington, and with the collection of foraminifera from the British Museum (Natural History), London. In the case of rare and uncommon forms comparative material was so scarce that we preferred to use only generic names. The newly described species were represented by at least five specimens and were easily distinguished from all other known foraminiferal species.

Order FORAMINIFERIDA Eichwald 1830
Suborder ROTALIINA Delage and Hérouard 1896
Superfamily BOLIVINACEA Glaessner 1937
Family BOLIVINIDAE Glaessner 1937
Genus BOLIVINA d'Orbigny 1839

Bolivina cf. *doniezi* Cushman and Wickenden 1929
Plate 1, figure 2

Bolivina doniezi CUSHMAN and WICKENDEN 1929, p. 9, pl. 4, fig. 3 a-b. — BUZAS et al. 1977, p. 73-74, pl. 1, figs. 25-28.

Remarks: Compared to the hypotypes of *B. doniezi* illustrated by Buzas et al. (1977), our specimens are smaller and have less chambers. They are probably a juvenile stages of this species. Their wall is perforated only near the basal margin of the chambers, while in the adult forms the perforations are scattered over the general surface of the last chambers (Cushman and Wickenden 1929)

Bolivina cf. *subexcavata* Cushman and Wickenden 1929
Plate 1, figure 1

Bolivina cf. *subexcavata* Cushman and Wickenden. — BUZAS et al. 1977, p. 76, pl. 2, figs. 11-22.

Remarks: The specimens from the *Halophila* leaves resemble a small variety of this species described by Buzas et al. (1977) from *Thalasia* habitats in Jamaica. They are smaller, probably a juvenile forms of this species.

Superfamily DISCORBACEA Ehrenberg 1838
Family DISCORBIDAE Ehrenberg 1838
Genus SCHAFFERINA McCulloch 1977

Schaferina (?) *bicornis* Pawlowski and Lee, n. sp.
Plate 1, figures 4a-d

Diagnosis: Test free, translucent, trochospirally coiled, chambers subglobular with small, bicorned umbilical extension, wall finely perforated.

Description: Test minute, up to 0.080mm in maximum diameter, trochospiral, plano-concave; chambers subglobular, disposed in two to three whorls, six chambers in the final whorl; sutures depressed, slightly curved to radial, periphery broadly rounded, lobate, circular in outline; aperture not observed, probably umbilical, covered with small, bicorned flap, turned about 90° to the plan of coiling in the adult forms, with one extremity pointed upwards, the flaps of former chambers partly visible in the umbilicus; wall calcareous, translucent, smooth, finely perforated, ornated with small denticles near umbilical margin.

Material: Five specimens from samples of *Halophila* leaves collected in Wadi Taba area.

Types: Figured holotype (pl. 1, fig. 4 a-c) is deposited in the Muséum d'Histoire naturelle, Geneva, Switzerland (No. 90-01); one unfigured paratype is deposited in the British Museum (Natural History), London, U.K. (ZF 4886).

Etymology: From the Latin, *bis*, twice, and *corn*, horn, with reference to bicorned shape of the umbilical flap.

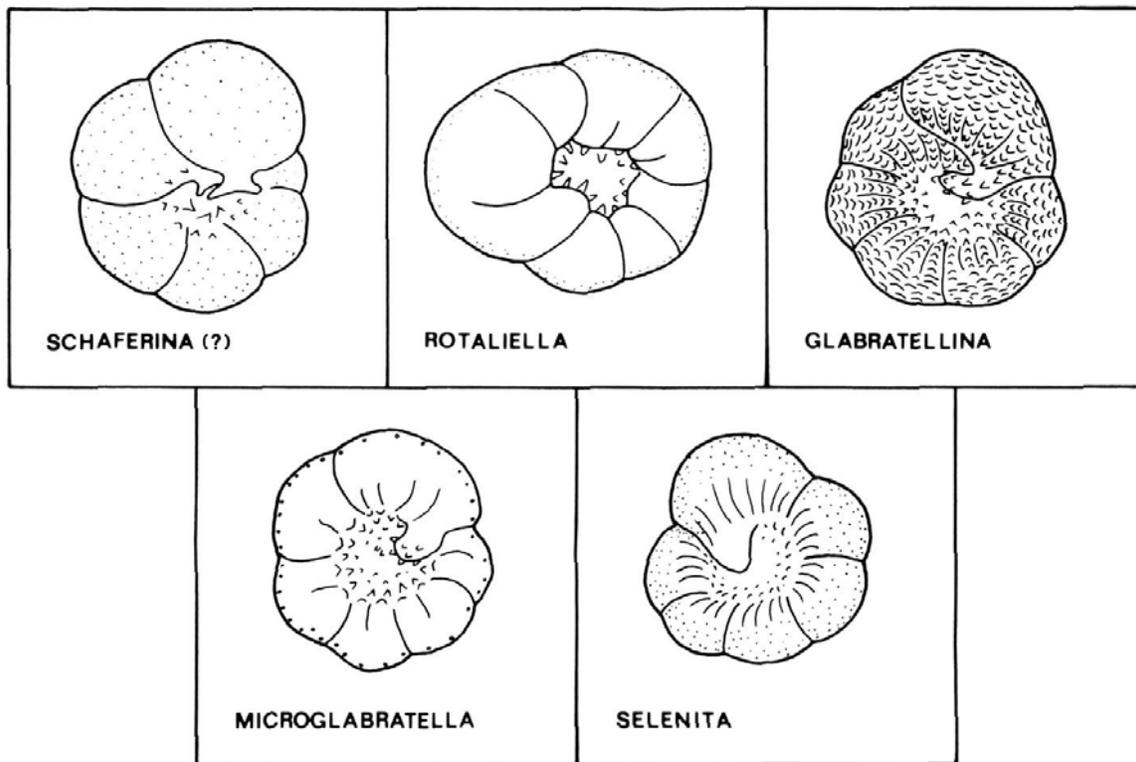
Remarks: This species was tentatively placed in genus *Schaferina*, represented by a single specimen of *S. annamaryae* described by McCulloch (1977). Compared to *S. annamaryae*, our specimens are smaller, but have similar test form, arrangement of the chambers and apparently the same translucent, finely perforated wall. They differ by the form of the umbilical extensions, that of *S. annamaryae* being long and large, in form of lips, which completely cover the umbilicus.

Family ROSALINIDAE Reiss 1963
Genus PSEUDOPATELLINOIDES Krasheninnikov 1958

Pseudopatellinoides cf. *mamilla* (Williamson)
Plate 1, figure 3a-b

Rotalina mamilla WILLIAMSON 1858, p. 54, pl. 4, figs. 109-111.
Asterigerinata mamilla (Williamson). — MURRAY 1972, p. 140-141, pl. 59, figs. 1-6.

Remarks: The specimens collected in the Gulf of Elat are smaller (0.120mm in maximum diameter) than these from the shore of British Islands (0.300mm). Their periphery is rounded rather than subangular. The apertural lip was not observed. The SEM study of *P. mamilla* (Murray 1972) demonstrated that its spiral side is finely perforated and there are some coarse perforations along the ventral sutures. Both characters were not observed in specimens from Elat. Whether these specimens



GENERA:	SURFACE		PERFORATIONS		ORNAMENTATION	
	smooth	rugose	fine	coarse	striae	denticules
SCHAFERINA (?)	●		●			●
ROTALIELLA	●		●		●	●
GLABRATELLINA		●		●	●	●
MICROGLABRATELLA	●			●	●	●
SELENITA	●		●		●	

TEXT-FIGURE 1

Schematic illustrations of umbilical faces and principal characteristics of the wall of five genera of small-sized Discorbacea and Glabratellacea.

represent a juvenile or a dwarf form of *P. mamilla*, or a separate species is questionable.

This species is placed in the genus *Pseudopatellinoides*, represented by a single species *P. primus* Krasheninnikov (1958). Both species have similar, conical test form and large, highly arched aperture. *Pseudopatellinoides*, however, is triserial, while

our specimens have four to five chambers in the whorl. The secondarily formed umbilical plates and coarsely perforated peripheral margin are not mentioned in the original description. They can be observed however on the figured specimens. The genus *Pseudopatellinoides* differs from the genus *Asterigerinata*, in having coarse perforations along the spiral sutures and the peripheral margin.

Family ROTALIELLIDAE Loeblich and Tappan 1964

Genus ROTALIELLA Grell 1954

***Rotaliella heterocaryotica* Grell**

Plate 1, figure 5a-c

Rotaliella heterocaryotica GRELL 1954, p. 268-285, pl. 4, figs. 1-6.—
GRELL 1979, p. 3, pl. 1., figs. 1, 2.

Remarks: This species differs from other Rotaliellidae in having rapidly enlarging, subglobular chambers and slightly convex spiral side. Most of examined specimens have the wall surface ornate with narrow furrows composing an irregular, polygonal network. Similar ornamentation was observed in several tiny species, including *Rotaliella* spp., from the deep North Atlantic samples (Pawlowski 1991). It has not been observed, however, in any other *Rotaliellidae* from the Gulf of Elat. The origin, natural or artificial, of this particular design is uncertain.

***Rotaliella* cf. *roscoffensis* Grell 1957**

Plate 1, figure 6a-b

Rotaliella roscoffensis.— GRELL 1957, p. 151-152, pl. 1, figs. 1, 2.

Remarks: Compared to the microscopical preparations of *R. roscoffensis* kindly offered to us by Prof. Karl Grell, our specimens have a smaller number of chambers, a larger umbilicus, more numerous umbilical striae (five instead of two in the final chamber), and opposite prevailing coiling direction. The wall structure of *R. roscoffensis* is unknown because no specimens were available to be examined with SEM. The cytology and life cycle of this organism must be studied and compared with Grell's (1957) original description before we can be certain that the forms from the Gulf of Elat are really conspecific with *R. roscoffensis*.

***Rotaliella grelli* Pawlowski and Lee, n. sp.**

Plate 2, figure 1a-b

Diagnosis: Test free, translucent, chambers three to four, hemispherical, separated with deep grooves on umbilical side, umbilical margin denticulated.

Description: Test minute, up to 0.090mm in maximum diameter, compressed, trochospiral, chambers few, three to four, hemispherical, rapidly enlarging, arranged in one whorl; proloculus large, oval with broad prolocular chamberlet; sutures depressed, curved on the spiral side, not observed on the umbilical side; periphery rounded, oval in outline; aperture not observed, probably umbilical; wall calcareous, translucent, optically radial, finely perforated on the spiral side, except for the proloculus and the first chamber, umbilical side imperforated, with six deep grooves radiating from the umbilicus to the periphery, visible in form of small peripheric depressions on the spiral side, separating the chambers on the umbilical side into six subtriangular parts, each one ornate with a short, fine stria radiating from umbilicus.

Material: Five specimens in sediment sample collected next to the Marine Biology Laboratory in Elat, at a depth of 5 meters.

Types: Figured holotype (Pl. 2, fig. 1 a-b) is deposited in the Muséum d'Histoire naturelle, Geneva, Switzerland (No. 90-03); one unfigured paratype is deposited in the British Museum (Natural History), London, U.K. (ZF 4887).

Etymology: This species is named in honor of Prof. Karl Grell, who described the genus *Rotaliella* and *Metarotaliella* and studied their life cycles.

Remarks: *R. grelli* differs from other Rotaliellidae in having a compressed test and a deep grooves which separate the chambers on the umbilical side and are visible as the small depressions on the spiral side. The ventral sutures are probably hidden under the umbilical grooves, but localisation of their peripheric depressions, only partly fit with that of the sutures on the spiral side. The prolocular chamberlet, called by Grell (1954) the "Zwischenkammer", is situated next to the first chamber, between the proloculus and the second chamber. It seems to be a characteristic feature of the genus *Rotaliella*.

***Rotaliella* (?) *nana* Pawlowski and Lee, n. sp.**

Plate 2, figure 3a-b

Diagnosis: Test free, globulose, trochospiral, with few chambers arranged in one to two whorls, umbilical margin denticulated.

Description: Test minute, up to 0.035mm in maximum diameter, trochospiral, concavo-convex; chambers few, four to five, subglobular, rapidly increasing in size as added, three chambers in the last whorl; sutures depressed and curved; periphery broadly rounded, lobate, circular in outline; aperture not observed, probably umbilical; wall calcareous, hyaline, smooth, umbilical side densely striated with small denticles at the umbilical margin, perforations not observed.

Measurements: (20 specimens examined)

	mean	S	range
Maximum diameter (µm)	26.6	4.27	20-34
Proloculus diameter (µm)	14.3	1.0	13-16
Total chambers	4.2	0.8	2-4

Coiling direction: dextral

Material: Hundreds of specimens from the sample of *Halophila stipulacea* leaves collected at a depth of 2-3 meters next to Wadi Taba, proliferating in the laboratory culture.

Types: Figured holotype (Pl. 2, fig. 3 a-b) is deposited in the Muséum d'Histoire naturelle, Geneva, Switzerland (No. 90-04); five unfigured paratypes are deposited in the British Museum (Natural History), London, U.K. (ZF 4889).

Etymology: From the Latin *nanus* - dwarf, with reference to the tiny size of the test.

Remarks: *Rotaliella* (?) *nana* is one of the smallest foraminiferal species ever described. It has proliferated in the laboratory cultures. Its affiliation to the genus *Rotaliella* is questionable, as the prolocular chamberlet and the perforations were not observed. This species may reproduce by autogamy, for no mating pairs were observed, or it may have an apogamic life cycle. This can be determined by future life cycle studies.

***Rotaliella* sp. A**

Plate 2, figure 4a-b

Remarks: Two specimens from the sediment sample collected next to the Marine Biology Laboratory in Elat, at a depth of 5m. They resemble *Rotaliella chasteri* (Heron-Allen and Earland 1913). Both species have a small oval umbilicus and few denticles at umbilical margin. *R. chasteri*, however, is larger,

TABLE 1

Four morphotypes of *Glabratellina hexacamerata* (Seiglie and Bermudez) identified in the Gulf of Elat.

	Form A	Form B	Form C	
Maximal test diameter (μm)	110	160	100	80
Total chambers	9-11	12-14	9-11	9-10
Final whorl chambers	5-6	6-7	7-8	5-6
Proloculus size (μm)	18-20	15-22	15-20	12-18
Coiling direction	dextral	dextral	dextral	dextral

has more globular chambers and more numerous umbilical striae.

Rotaliella sp. B

Plate 2, figures 2a-b

Remarks: Three specimens of this type were collected in the algal material, next to the Marine Biology Laboratory in Elat. They resemble *R. heterocaryotica* in general form, but they are larger, with more numerous chambers and more protuberant umbilical flap. Their wall is opaque rather than translucent, and more densely perforated than that of *R. heterocaryotica*.

Genus METAROTALIELLA Grell

Metarotaliella sp.

Plate 2, figure 5

Remarks: Very similar species *Metarotaliella parva* and *M. simplex* were described from the laboratory cultures by Grell (1962, 1979). Only one specimen has been identified on *Halophila* leaves from the Wadi Taba area.

Superfamily GLABRATELLACEA Loeblich and Tappan 1964

Family GLABRATELLIDAE Loeblich and Tappan 1964

Genus GLABRATELLINA Seiglie and Bermudez 1965

Glabratellina erecta (Sidebottom)

Plate 2, figure 6a-c

Discorbina erecta SIDEBOTTOM 1908, p. 16, pl. 5, figs. 6, 7
Glabratella erecta (Sidebottom) - SEIGLIE and BERMUDEZ 1965, p. 30, pl. 2, figs. 1-3.

Remarks: This species dominated in the samples of algal material collected next to the Marine Biology Laboratory in Elat. Our specimens differ from the original description in having lower spire, without a short spine at the apex. The umbilical extension was not described by Sidebottom (1908) but it is visible on one of the original figures. Two morphological forms were distinguished: form A with conical, lobate test, somewhat carinated chambers, and strongly rugose wall with sharp-pointed pustules and denticules at the umbilical side; and form B with more compressed, circular test, and larger, gently rounded umbilical pustules. As all the specimens in the mating pairs belong to the Form A, this form is supposed to be a gamontic stage of *G. erecta* life cycle.

Glabratellina hexacamerata (Seiglie and Bermudez)

Plate 3, figures 1a-f

Glabratella hexacamerata.— SEIGLIE and BERMUDEZ 1965, p. 31, pl. 1, figs. 6a-c, 7a-c.—BUZAS et al. 1977, p. 89, pl. 5, figs. 7-9.

Remarks: This species has been transferred to the genus *Glabratellina* because of the umbilical, linguiform extension, which

has not been observed by the authors of original description. The SEM examination indicated also a presence of denticules at the umbilical margin and a large star-shaped striae radiating from the umbilicus.

Four different morphotypes were distinguished (Table 1). Form A, which is the only morphotype found in the mating pairs, is probably a gamontic stage in *G. hexacamerata* life cycle. Form B, which is larger and has more numerous chambers is considered here to be an agamontic stage. Form C has a thickly calcified wall, which make undistinguished most of the elements of umbilical ornamentation. Rare intermediary forms between form B and C were noticed. Form D resembles a juvenile, gamontic stage, but many specimens have a large umbilicus not observed in the other forms.

Glabratellina saidi Pawlowski and Lee, n. sp.

Plate 2, figure 7a-c

Diagnosis: Test free, trochospiral, lowly conical, with flatten umbilical side, chambers hemispherical with umbilical extension, wall rugose.

Description: Test tiny, up to 0.120mm in maximum diameter, trochospiral, spiral side elevated, umbilical side plano-concave; chambers hemispherical, twice as broad as high, arranged in one to two whorls, five to six chambers in the final whorl; sutures slightly depressed, curved on the spiral side, radial to sigmoidal on the umbilical side; peripheral margin subangular, gently rounded, lobate to circular in outline; aperture not observed, probably umbilical, covered with linguiform extension protruding into the umbilicus; wall calcareous, rugose, coarsely perforated on the spiral side, umbilical side imperforated with few striae and denticules.

Material: Twenty specimens isolated from the sediment sample, collected off the Marine Biology Laboratory in Elat, at a depth of 5 meters.

Measurements: (14 specimens examined)

	mean	S	range
Maximum diameter (μm)	87.1	16.4	70-120
Total chambers	9	1.5	7-11
Coiling direction: predominantly dextral (65%)			

Etymology: This species is named in honor of Dr. Rushdi Said, the first micropaleontologist who described the foraminifers of the Northern Red Sea.

Types: Figured holotype (Pl. 2, fig. 7b-c) is deposited in the Muséum d'Histoire naturelle, Geneva, Switzerland (No. 90-05); three unfigured paratypes are deposited in the British Museum (Natural History), London, U.K. (ZF 4893).

Remarks: This species differs from other *Glabratellina* in having more compressed test, almost circular peripheral outline and few umbilical striae and denticules. It resembles *G. sigali* Seiglie and Bermudez (1965) if looking from the dorsal side, but the trochospire is lower and chambers less numerous. The umbilical face of *G. sigali* presents several rows of pustules and denticules radiating from the umbilicus (Hayward and Buzas 1979). *G. saidi* differs from *Microglabratella* cf. *globosa* described in this paper, in being rugose and less lobate in outline.

***Microglabratella* Pawlowski and Lee, n. gen.**

Type species: *Microglabratella globosa* (Sidebottom)

Diagnosis: Test free, minute, trochospiral, umbilicus deeply open, with denticulate margin, aperture umbilical, covered with linguiform extension, wall smooth, coarsely perforated on the spiral side, striated on the umbilical side.

Description: Test minute, lowly trochospiral, plano- to concavo-convex, chambers hemispherical to subglobular, gradually enlarging as added, arranged in two to three whorls, the last one composed of four to seven chambers; sutures depressed, curved on the spiral side, radial to sigmoidal on the umbilical side; periphery broadly rounded, lobate, circular in outline, umbilicus deeply open with several rows of denticules at umbilical margin, aperture interiomarginal, umbilical, circular in form, covered with bulging flap extending into the umbilicus; wall calcareous, optically radial, smooth, coarsely perforated on the spiral side; umbilical side imperforated, with fine, short striae radiating from the umbilicus; plastogamy common.

Etymology: From the Greek *mikros*, tiny, and *Glabratella*, generic name, with reference to generally small sized test of these *Glabratellidae*.

Remarks: This genus differs from the other *Glabratellidae* in having tiny, smooth test, with coarsely perforated spiral side and short striae radiating from umbilicus. The umbilical margin and basal parts of the striae are ornamented with denticules. The aperture, in the form of a small circle with thicken rim, is situated at the base of the chamber, near the umbilical margin. It is covered with umbilical flap, which has an enlarged, bulging form over the aperture and becomes elongated towards the umbilicus. The elongated part of the flap seems to be removed during formation of successive chambers.

***Microglabratella globosa* (Sidebottom)**

Plate 3, figure 2 a-d

Pulvinulina globosa.—SIDEBOTTOM 1909, p. 9, pl. 4, fig. 3 a-c.

Glabratella globosa (Sidebottom).—SEIGLIE and BERMUDEZ 1965, p. 31, pl. 6, figs. 4, 5a-b.

Remarks: Most of our specimens are smaller than that described by Sidebottom (1909). They look like juvenile forms, but some of them are found in mating pairs. Two morphotypes were distinguished, differing in the size of proloculus, number of chambers and coiling direction. Dextral tests have generally 5-6 chambers and large proloculus (0.028-0.030mm), while sinistral tests have about 7-8 chambers and smaller proloculus (0.020-0.024mm). Both forms have irregularly enlarging subglobular chambers, as noted by Sidebottom (1909).

***Microglabratella* cf. *globosa* (Sidebottom)**

Plate 3, figures 4a-c

Remarks: This form closely resemble *M. globosa*, from which it differs in having white color, opaque test, more elevated spiral side and regularly enlarging chambers. There are usually five instead of six chambers in the final whorl. The wall is sparsely perforated with more numerous rows of denticules than that of *M. globosa*.

***Microglabratella tabaensis* Pawlowski and Lee, n. sp.**

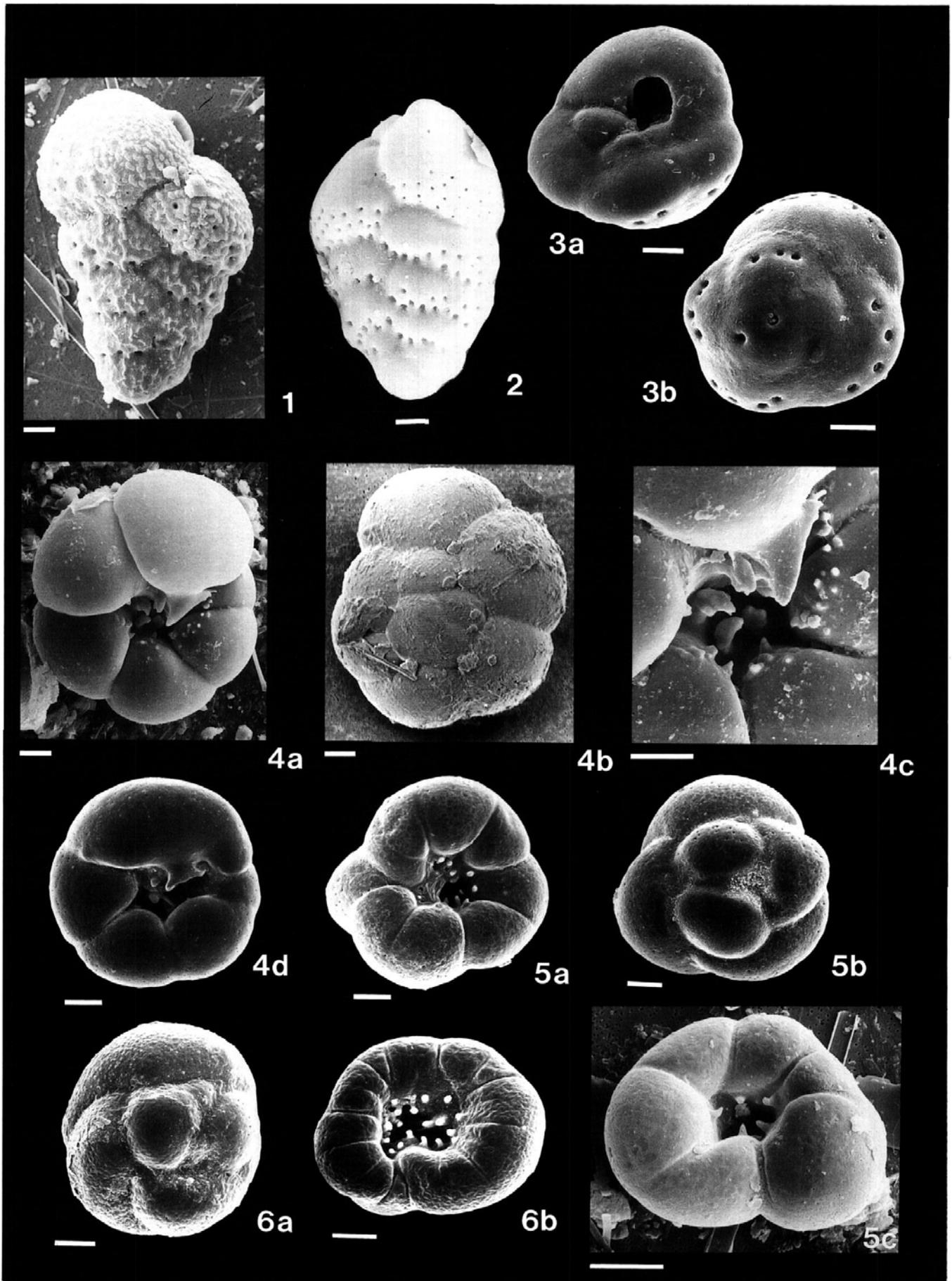
Plate 3, figures 3a-b

Diagnosis: Test free, trochospiral, conical, with four hemispherical chambers in the final whorl, and only slightly lobate peripheral outline.

Description: Test minute, up to 0.080mm in maximum diameter, highly trochospiral, chambers hemispherical, gradually increasing in size as added, all chambers visible on the spiral side, four chambers in the final whorl; sutures slightly depressed, curved on the spiral side, radial on the umbilical side; periphery rounded to subangular, slightly lobate, circular in outline; aperture not observed, probably interiomarginal, umbilical, covered with small, linguiform extension of the final chamber; wall calcareous, translucent, smooth, spiral side coarsely perforated, umbilical side imperforated, with few radial striae radiating from umbilicus.

PLATE 1
(scale bar = 0.010mm)

- | | | | |
|---|---|---|--|
| 1 | <i>Bolivina</i> cf. <i>B. subexcavata</i> Cushman and Wickenden - side view. | (specimen on <i>Halophila</i> leaf), b.dorsal view, c.detail of umbilical aperture; - d. juvenile form, ventral view. | |
| 2 | <i>Bolivina</i> cf. <i>B. doniezi</i> Cushman and Wickenden - side view. | 5 | <i>Rotaliella heterocaryotica</i> Grell - a. ventral view, b. dorsal view, c. juvenile form. |
| 3 | <i>Pseudopatellinoides</i> cf. <i>P. mamilla</i> (Williamson) - a. ventral view, b. dorsal view. | 6 | <i>Rotaliella</i> cf. <i>R. roscoffensis</i> Grell - a. dorsal view, b. ventral view. |
| 4 | <i>Schaferina</i> (?) <i>bicornis</i> n. sp. - holotype, Muséum d'Histoire naturelle, Genève, No. 90-01: a.ventral view | | |



Material: Five specimens from the samples of *Halophila* leaves collected at a depth of 10 meters, in the Wadi Taba site.

Types: Figured holotype (Pl. 3, fig. 3a-b) is deposited in the Muséum d'Histoire naturelle, Geneva, Switzerland (No. 90-07); one unfigured paratype is deposited in the British Museum (Natural History), London, U.K. (ZF 4897).

Etymology: From Wadi Taba, the name of locality where the species was isolated.

Remarks: This species differs from the other species of *Microglabratella* in having a conical test with four chambers in a whorl and only slightly lobate periphery. Its distribution was limited to the *Halophila* zone in Wadi Taba site, while *M. globosa* and *Microglabratella* cf. *M. globosa* were found mostly in the algal material collected off the Marine Biology Laboratory in Elat.

Selenita Pawlowski and Lee n. gen.

Type species: *Selenita megalosphera*, n. sp.

Diagnosis: Test free, trochospiral, chambers subglobular, umbilicus large, partly covered with umbilical flap, wall glossy, colored, densely perforated.

Description: Test tiny, chambers few, arranged in low trochospiral coil; sutures depressed, curved on the spiral side, radial on the umbilical side, periphery broadly rounded, lobate, umbilicus large, open; aperture umbilical, covered with umbilical flap; wall calcareous, primary lamellar, optically radial, spiral side and periphery densely perforated, the umbilical side perforated between periphery and fine striae radiating from umbilicus.

Etymology: This genus is named after Selene, the Greek goddess of the moon

Remarks: *Selenita* differs from other Glabratellidae in having smooth and glossy, densely perforated wall and nondenticulated umbilical margin. The umbilical flap has a form of elongated extension, with narrow opening in its distal part.

Selenita megalosphera Pawlowski and Lee, n. sp.

Plate 4, figure 1a-d

Diagnosis: Test free, trochospiral, with few subglobular chambers, arranged in one or two whorls of low, trochospiral coil, proloculus large, wall glossy, reddish in colour.

Description: Test small, up to 0.130mm in maximum diameter, trochospiral, proloculus large, oval, followed by large first chamber; sutures deep, curved on the spiral side, radial on the umbilical side; periphery broadly rounded, lobate, circular in outline; umbilicus deeply open; aperture interiomarginal, umbilical, covered with linguiform extension, communicated with exterior through a narrow slit at the margin of the flap; wall calcareous, optically radial, smooth, glittering, orange to reddish in color with darker sutures, spiral side and periphery densely perforated, with fine, cone-shaped pores, umbilical side imperforated, with deep striae radiating from the umbilicus, reaching half of the distance towards periphery, some striae oblique to the umbilical margin, in the juvenile forms.

Material: Fifty specimens isolated from the sediment samples collected next to the Marine Biology Laboratory in Elat, at a depth of 5 meters.

Measurements: 22 specimens examined

	mean	S	range
Maximum diameter (µm)	92.7	19.6	60-130
Total chambers	7	2.2	4-12
Coiling direction: senestral (50%), dextral (50%)			

Types: Figured holotype (Pl. 4, fig. 1a-c) is deposited in the Muséum d'Histoire naturelle, Geneva, Switzerland (No. 90-08); three unfigured paratypes are deposited in the British Museum (Natural History), London, U.K. (ZF 4895).

Etymology: From the Greek, *megas*, large and *sphaira*, sphere, with reference to the large, oval proloculus.

Remarks: This species has a large proloculus, similar to that of megalospheric forms of dimorphic foraminiferal species. However the analogous microspheric form, or mating pairs of megalospheric forms have not been observed in our samples.

Superfamily DISCORBINELLACEA Sigal 1952

Family PSEUDOPARRELLIDAE Voloshinova 1952

Subfamily PSEUDOPARRELLINAE Voloshinova 1952

Genus EPISTOMINELLA Husezima and Maruhasi 1944

Epistominella sp.

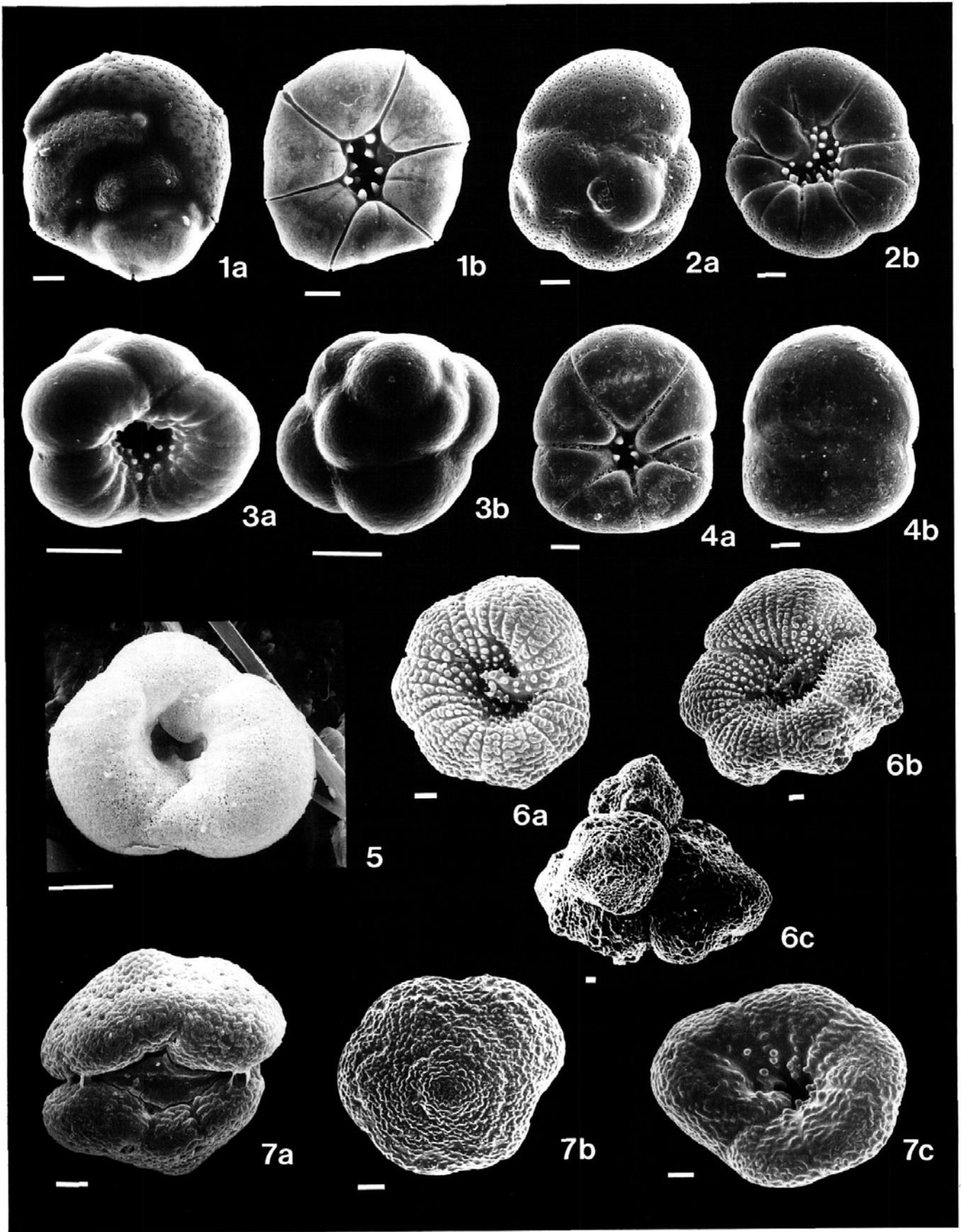
Plate 4, figure 2

Remarks: Our specimens resemble the juvenile forms of *E. vitrea* Parker (Parker et al. 1953), but no larger sized, adult stages have been found in the samples.

PLATE 2
(scale bar = 0.010mm)

- 1 *Rotaliella grelli* n. sp. - holotype No. 90-03 - a. dorsal view, b. ventral view.
- 2 *Rotaliella* sp. B. - a. dorsal view, b. ventral view.
- 3 *Rotaliella* (?) *nana* n. sp. - holotype, Muséum d'Histoire naturelle, Genève, No. 90-04 - a. ventral view., b. dorsal view.
- 4 *Rotaliella* sp. A. - a. ventral view, b. dorsal view.

- 5 *Metarotaliella* sp. - specimen on *Halophila* leaf - ventral view.
- 6 *Glabratellina erecta* (Sidebottom) - a. Form B. (agamont) ventral view, b. Form A (gamont), ventral view, c. group of four mating gamonts.
- 7 *Glabratellina saidi* n. sp. - a. two mating gamonts, side view, - holotype, Muséum d'Histoire naturelle, Genève, No. 90-05, b. dorsal view, c. ventral view.



Superfamily ASTERIGERINACEA d'Orbigny 1839
Family ASTERIGERINATIDAE Reiss 1963
Genus EOEPONIDELLA Wickenden 1949

Eoeponidella nanoconica Seiglie
Plate 4, figure 4a-b

Eoeponidella nanoconica.—SEIGLIE 1965, p. 511-512, pl. 5, figs. 12-15.

Remarks: Two specimens were isolated from the algal material collected next to the Marine Biology Laboratory in Elat, at a depth of 2-3 meters. Both have few, six to seven, chambers, slightly convex spiral side, and highly arched umbilical aperture, covered by small, coarsely perforated plates.

Eoeponidella (?) sp.
Plate 4, figure 3.

Remarks: This species differs from the genus *Eoeponidella* in having coarse perforations only at the sutures of umbilical plates, their surface being imperforated. It resembles *Rubratella steinitzi*, but the umbilical plates are smaller and do not reach the periphery.

Genus RUBRATELLA Grell 1958

Rubratella steinitzi Pawlowski and Lee n. sp.
Plate 4, figure 5a-c

Diagnosis: Test free, trochospiral, appearing biserial because of the large plates extending from the umbilicus over periphery, sutures between the plates coarsely perforated.

Description: Test tiny, up to 0.110mm in diameter, circular to ovate in outline, spiral side slightly elevated; chambers few, rapidly enlarged as added, arranged in one to two whorls of low trochospiral coil, five to six in the final whorl; each chamber with large, highly arched umbilical aperture, only that of the final chamber visible, the apertures of former chambers covered with large umbilical plates, extending from umbilicus over periphery, being visible as a small, triangular portions at the spiral side; sutures depressed, curved, that of umbilical plates coarsely perforated; periphery broadly rounded; umbilicus closed; wall calcareous, optically radial, translucent to opaque, rugose, no other perforations than the sutural observed.

Measurements:

	mean	S	range
Maximum diameter (µm)	71.4	9.5	57-87
Proloculus diameter (µm)	19.4	3.7	11-23
Total chambers	7	1.5	6-11
Coiling direction: predominantly sinistral (67%)			

Material: Fifty specimens from the samples of algal material collected next to the Marine Biology Laboratory in Elat and *Halophila* leaves collected in Wadi Taba area.

Types: Figured holotype (Pl. 4, fig. 5a-b) is deposited in the Muséum d'Histoire naturelle, Geneva, Switzerland (No. 90-09); five unfigured paratypes are deposited in the British Museum (Natural History), London, U.K. (ZF 4896).

Etymology: This species was named in honor of Prof. Heinz Steinitz, marine biologist, founder of the Marine Biology Laboratory in Elat.

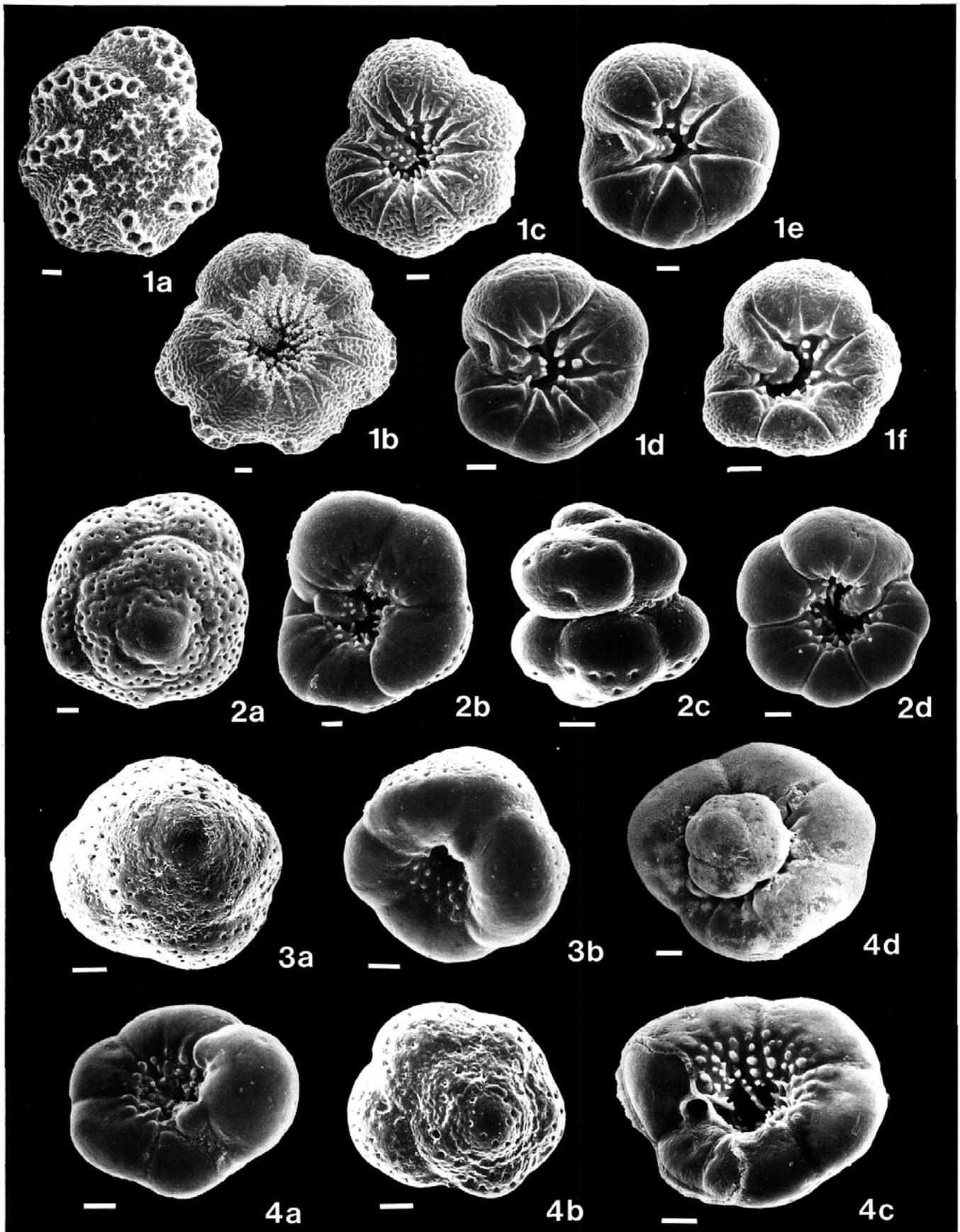
Remarks: *R. steinitzi* differs from *R. intermedia* Grell in having large perforations along ventral sutures, instead of entire ventral plates perforated. Compared to the species described by Grell (1958), our specimens are larger, with more numerous chambers and have an aperture decorated with fine radial striae. *R. intermedia* reproduced sexually by gamontogamy, while the sexual reproduction of *R. steinitzi* is probably absent or of autogamic type, for no mating pairs were found in our samples.

The genus *Rubratella* was transferred here from the family Ceratobuliminidae to the family Asterigerinatidae, because the *Ceratobuliminidae* are characterized by an aragonitic wall (Loeblich and Tappan 1988), while the X-ray diffraction analysis of *R. steinitzi* tests demonstrated that they are composed exclusively of calcite. The genus *Rubratella* was attached to the family *Ceratobuliminidae* because its chambers were supposedly subdivided by internal partitions into ventral and spiral halves. The ventral halves, however, seem more properly interpreted as a large umbilical plates extending over periphery, rather than the subdivisions of chambers.

The elongated umbilical plates give impression of apparently biserial character of *Rubratella* test, resembling somewhat the genus *Cassidulinita* Suzin. However, the original description of *Cassidulinita* (Suzin in Voloshinova and Dain 1952) did not detail whether each chamber has its own aperture, or if the apertures are present only in one series of chambers. Because *R. steinitzi* has apertures only in the spiral series of chambers,

PLATE 3
(scale bar = 0.010mm)

- 1 *Glabratellina hexacamerata* (Seiglie and Bermudez) - Form B - a. dorsal view, b. ventral view; - c. Form A ventral view; - d. Intermediary form, ventral view; - e. Form C, ventral view; - f. Form D, ventral view.
- 2 *Microglabratella globosa* (Sidebottom) - larger size form: a. dorsal view, b. ventral view; - c. two mating gamonts, side view; - d. smaller size form, ventral view.
- 3 *Microglabratella tabaensis*, n. sp. - holotype, Muséum d'Histoire naturelle, Genève, No. 90-07 - a. dorsal view, b. ventral view
- 4 *Microglabratella* cf. *M. globosa* (Sidebottom) - a. ventral view, b. dorsal view; c. specimen with the last chamber broken, showing the intercameral aperture; - d. two mating gamonts.



its affiliation to the family of *Asterigerinatidae* seems reasonable.

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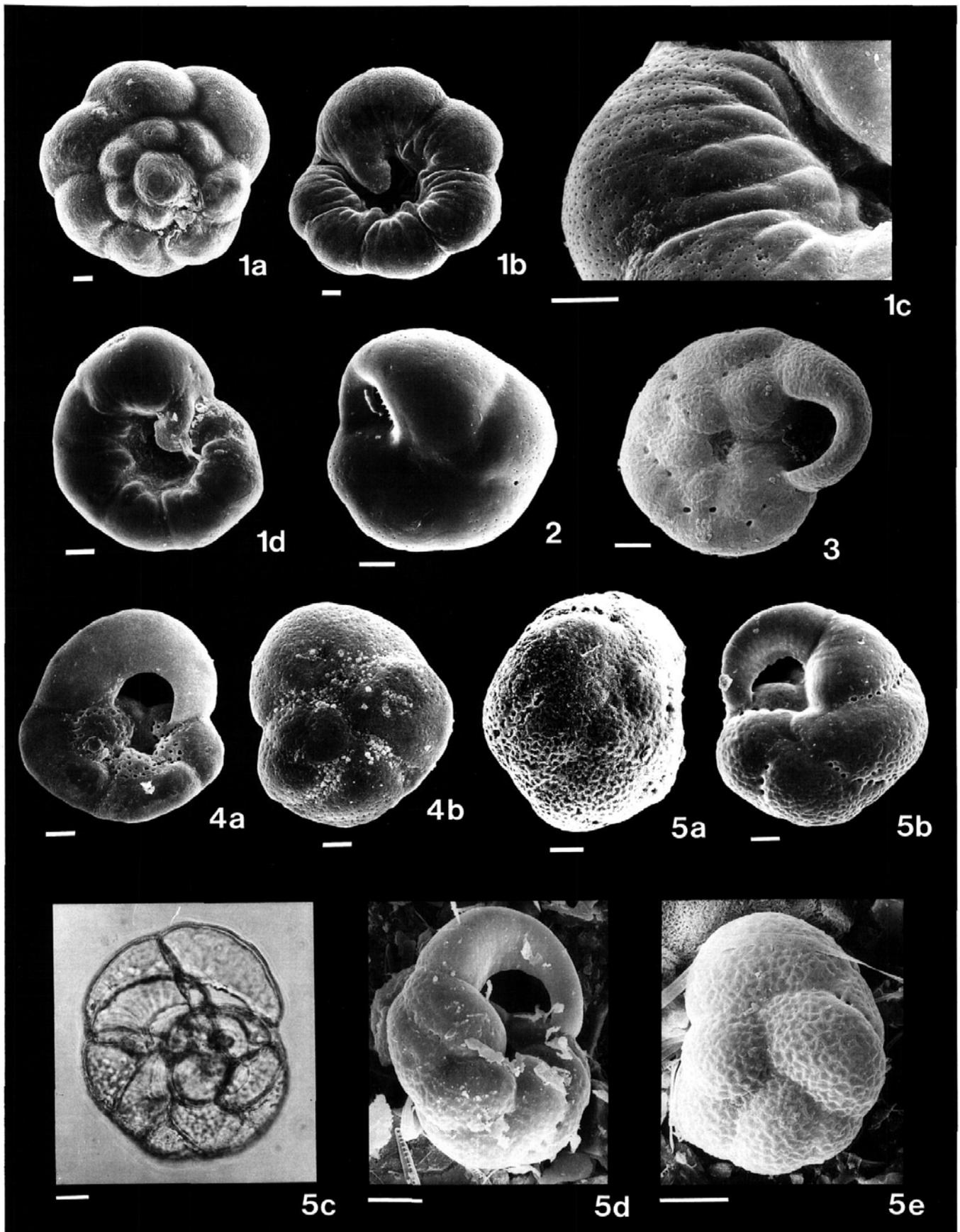
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PLATE 4

(scale bar = 0.010mm)

- 1 *Selenita megalosphera*, n. sp. - holotype, Muséum d'Histoire naturelle, Genève, No. 90-08 - a. dorsal view, b. ventral view, c. detail of aperture; - d. juvenile form- ventral view.
- 2 *Epistominella* sp. - ventral view.
- 3 *Eoeponidella* (?) sp., ventral view.
- 4 *Eoeponidella nanoconica* Seiglie - a. ventral view, b. spiral view.
- 5 *Rubratella steinitzi*, n. sp. - holotype, Muséum d'Histoire naturelle, Genève, No. 90-09: a. spiral view, b. ventral view; - c. adult specimen, view in light microscope, - juvenile forms on *Halophila* leaf: d. ventral view, e. spiral view.



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