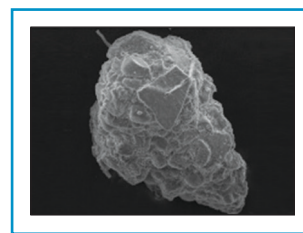


Chapter 3

Foraminifera

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INTRODUCTION

Andaman and Nicobar Islands consist a variety of ecosystems, i.e. coral reef, mangrove, sea grass, wetland and deep sea. Therefore the neritic environment has a dynamic system on the Island, where the benthic ecosystem is well productive one. Among the benthic community, foraminifera are one of the diverse members of the ecosystem and an active participant in the carbon cycle of the marine environment. An addition to the above factors, in the coral reef environment, it is acting as an important component for carbonate resource and an indicator for the health of the corals also. Even though benthic foraminifera studies began by Phleger (1951), but the extensive living benthic foraminifera studies were initiated from last three decades for globally. The Andaman and Nicobar Islands evinced for this important group mainly through the geological studies in the older sediments and rocks for their stratigraphy and age of rocks from the period of early 1960 to till date. However, the studies on the ecology of modern living foraminifera in the present day sediments is very few, and in countable level, according to review the work of Khare *et al.* (2007). The studies on the modern foraminifera ecology were begun in the eastern Andaman waters by Freirich (1970) that also for the deep sea sediments benthic foraminiferans. Next to this, a few studies of Hussain *et al.*, (2006) investigated tsunami sediment deposition on the shore deposits. The study of Saidova (2008) revealed three groups of foraminifera provinces for different range of depth, which was also from the deep sea sediments of the eastern Andaman Sea. Jayaraju *et al.* (2011) studied foraminifera for the investigation of heavy metal pollution. Sarkar *et al.* (2012)

revealed the present and past tsunami imprints through the foraminifera distribution. Mohan *et al.* (2013) studied some living benthic and planktonic foraminifera from the little Andaman and Port Blair Island. Followed by Yuvaraj *et al.* (2013a,b,c,d) reported several studies on coastal foraminifera i.e. distribution, abnormality, Ca/Mg ratio variation dependent on different habitat, bio mineralization and cross breeding of benthic foraminifera. Recently, Muruganantham and Mohan (2015a,b) reported three benthic foraminiferan, which was responding to the monsoonal effect as well as the assemblages of muddy and sandy sediment foraminiferan from the various region of Andaman sediments. The study of Muruganantham *et al.*, (2017a) discussed about the modern assemblages of Car Nicobar shelf foraminifera and their significance with the climate impact on shallow water environment. Muruganantham *et al.*, (2017b) developed a baseline data of distribution and diversity of living larger benthic foraminifera for south Andaman reef sites. Muruganantham *et al.*, (2018) reported a mesopelagic live planktonic foraminifera *Hastigerinella digitata* in the coastal water due to regional monsoonal activities. The above said literature not produce any clarity data base for living benthic foraminifera, so the present research work made an attempt to evaluate the presence of living benthic foraminifera in the inner neritic sediments with their illustrations, morphological features and taxonomy.

MATERIALS AND METHODS

A total of eight sediment samples was collected from different locations from north to south of South Andaman Island. Since, sediments were medium to fine sandy nature, Van Veen grab was operated from the mechanized

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dingly in the depth of 15 meter reef flat regions. An undisturbed 2 cm of surface sediment was collected through 3cm of diameter PVC pipe. The collected duplicate samples were stained with a rose bengal solution and preserved with 4% buffered formalin. Prior to the sediment collection, the basic insitu physico chemical parameters were measured through Quanta Hydrolab and water samples collected for the laboratory measurements of nutrient, using standard protocol. Sediment was processed in the laboratory for foraminiferal studies. The sediments collected were processed in the laboratory and sieved by 500 and 63µm sized standard sieves. The plus 500µm portion of the sediments were handpicked for the larger foraminiferan and their count was also added to other foraminiferan data for the enumeration. A 10gm of the plus 63µm stained sediment were approximately taken for foraminiferal identification, the pink coloured foraminiferal test were picked, air dried and mounted on the micropaleontological slides. The species level identification was carried out by using the generic level

keys of Loeblich and Tappan (1987) and Debenay (2012). Three hundred individual species were counted for the statistic evaluation. If the count is less than 300 numbers, all the available specimens were counted and enumerated for statistical evaluation. However, in the present study only taxonomy and its morphological characters were discussed for all the identified live foraminiferan from these study areas.

RESULT AND DISCUSSION

A total of eight neritic sediments of south Andaman revealed a total of 127 living benthic foraminiferan species belongs to 8 Orders 45 Families and 71 Genera (Table 1). Among the identified foraminiferan, 11 species belongs to agglutinated forms, another 45 species of imperforated high Mg calcite tests belonged to porcelain forms and the rest of 71 species belongs to low Mg calcite tests called hyaline forms. The detailed morphological characters of each species were discussed with its scanning electron microscope photographs.

Table 1. List of species and taxonomical classification.

Sl. No.	Order	Family	Genus	Species
1.	Astrorhizida	Rhabdamminidae	<i>Marsipella</i>	<i>Marsipella</i> sp.
2.	Lituolida	Nouridae	<i>Nouria</i>	<i>Nouria polymrphia</i>
3.				<i>Nouria</i> sp.
4.				<i>Nouria</i> sp.1
5.	Robertinida	Robertinidae	<i>Robertinoides</i>	<i>Robertinodes australis</i>
6.	Textulariida	Psuedogaudrinidae	<i>Pseudoclavulina</i>	<i>Pseudoclavulina</i> sp.
7.		Textulariidae	<i>Bigenerina</i>	<i>Bigenerina nodosaria</i>
8.			<i>Textularia</i>	<i>Textularia agglutinans</i>
9.				<i>Textularia conica</i>
10.				<i>Textularia foliacea</i>
11.				<i>Textularia</i> sp.
12.		Valvulinidae	<i>Clavulina</i>	<i>Clavulina multicamerata</i>
13.	Miliolida	Alveolinidae	<i>Borelis</i>	<i>Borelis schlumberina</i>
14.		Cribrolinoididae	<i>Adelosina</i>	<i>Adelosina</i> sp.
15.		Fischerinidae	<i>Vertebralina</i>	<i>Vertebralina striata</i>
16.		Hauerinidae	<i>Biloculina</i>	<i>Biloculina</i> sp.
17.			<i>Miliolinella</i>	<i>Miliolinella circularis</i>
18.				<i>Miliolinella</i> sp.
19.				<i>Nevillina coronate</i>
20.			<i>Pyrgo</i>	<i>Pyrgo deticulata</i>
21.				<i>Pyrgo</i> sp.
22.			<i>Quinqueloculina</i>	<i>Quinqueloculina bosciana</i>
23.				<i>Quinqueloculina cuvieriana</i>
24.				<i>Quinqueloculina carinatostrata</i>
25.				<i>Quinqueloculina crassicarinata</i>
26.				<i>Quiqueloculina exomouthensis</i>



Table 1 contd.

Sl. No.	Order	Family	Genus	Species
27.				<i>Quinqueloculina latidentalina</i>
28.				<i>Quinqueloculina lizardii</i>
29.				<i>Quinqueloculina seminulum</i>
30.				<i>Quinqueloculina subparkeri</i>
31.			<i>Schlumbergerina</i>	<i>Schlumbergerina alveoliniformes</i>
32.			<i>Triloculina</i>	<i>Triloculina affinis</i>
33.				<i>Triloculina elongotricarinata</i>
34.				<i>Triloculina insignis</i>
35.				<i>Triloculina marshallana</i>
36.				<i>Triloculina rotunda</i>
37.				<i>Triloculina serrulate</i>
38.				<i>Triloculina striatotrigounula</i>
39.				<i>Triloculina tricarinata</i>
40.				<i>Triloculina trigonula</i>
41.		Miliamminidae	<i>Miliammina</i>	<i>Miliammina fusca</i>
42.		Peneroplidae	<i>Ethymonacha</i>	<i>Ethymonacha polita</i>
43.			<i>Monalysidium</i>	<i>Monalysidium confuse</i>
44.			<i>Peneroplis</i>	<i>Peneroplis pertusus</i>
45.				<i>Peneroplis planatus</i>
46.		Riveroinidae	<i>Pseudohauerina</i>	<i>Pseudohauerina involute</i>
47.				<i>Pseudohauerina fragillissima</i>
48.		Spiroloculinidae	<i>Spiroloculina</i>	<i>Spiroloculina antillarum</i>
49.				<i>Spiroloculina communis</i>
50.				<i>Spiroloculina convexa</i>
51.				<i>Spiroloculina depressa</i>
52.				<i>Spiroloculina exima</i>
53.				<i>Spiroloculina mayori</i>
54.				<i>Spiroloculina</i> sp.
55.		Soritidae	<i>Amphisorus</i>	<i>Amphisorus hemprichii</i>
56.			<i>Parasoritus</i>	<i>Parasorites orbitoloides</i>
57.	Rotaliida	Ammonidae	<i>Ammonia</i>	<i>Ammonia convexa</i>
58.		Amphisteginidae	<i>Amphistegina</i>	<i>Amphistegina lobifera</i>
59.				<i>Amphistegina popillosa</i>
60.				<i>Amphistegina radiata</i>
61.		Bolivinitidae	<i>Bolivina</i>	<i>Bolivina spathulata</i>
62.				<i>Bolivina straiata</i>
63.			<i>Bolivinella</i>	<i>Bolivinella translucens</i>
64.			<i>Fursenkoina</i>	<i>Fursenkoina</i> sp.
65.			<i>Hopkinsinella</i>	<i>Hopkinsinella glabra</i>
66.			<i>Loxostomina</i>	<i>Loxostomina limbata</i>
67.			<i>Sagrinella</i>	<i>Sagrinella durrandii</i>
68.				<i>Sagrinella jugosa</i>
69.			<i>Sigmovirgulina</i>	<i>Sigmovirgulina tortuosa</i>
70.		Buliminidae	<i>Bulimina</i>	<i>Bulimina elegans</i>



Table 1 contd.

Sl. No.	Order	Family	Genus	Species
71.				<i>Bulimina marginata</i>
72.				<i>Bulimina striata</i>
73.			<i>Elongobula</i>	<i>Elongobula</i> sp.
74.		Calcarinidae	<i>Calcarina</i>	<i>Calcarina hispida</i>
75.				<i>Calcarina mayorii</i>
76.				<i>Calcarina spengleri</i>
77.			<i>Neorotalia</i>	<i>Neorotalia calcar</i>
78.			<i>Pararotalia</i>	<i>Pararotalia ozawaia</i>
79.		Cancrisidae	<i>Cancris</i>	<i>Cancris auriculus</i>
80.				<i>Cancris sagrum</i>
81.		Cassidulinidae	<i>Cassidulina</i>	<i>Cassidulina</i> sp.
82.		Cibicididae	<i>Cibicides</i>	<i>Cibicides refulgens</i>
83.		Cymbalaporidae	<i>Millettiana</i>	<i>Millettiana millettii</i>
84.		Elphididae	<i>Elphidium</i>	<i>Elphidium advenum</i>
85.				<i>Elphidium crispum</i>
86.				<i>Elphidium excavatum</i>
87.				<i>Elphidium hispidulum</i>
88.				<i>Elphidium indicum</i>
89.				<i>Elphidium macellum</i>
90.				<i>Elphidium sandegoensis</i>
91.				<i>Elphidium</i> sp.
92.		Eponididae	<i>Poroeponides</i>	<i>Poroeponides</i> sp.
93.		Glabratellidae	<i>Angulodiscorbis</i>	<i>Angulodiscorbis pyramidalis</i>
94.			<i>Piliolina</i>	<i>Piliolina</i> sp.
95.		Loxostomatidae	<i>Loxostomum</i>	<i>Laxostomina coastatopertusum</i>
96.		Murrayinellidae	<i>Murrayinella</i>	<i>Murrayinella globosa</i>
97.		Nonionidae	<i>Nonion</i>	<i>Nonion depressulum</i>
98.				<i>Nonion elongatum</i>
99.				<i>Nonion grateloupei</i>
100.		Nummulitidae	<i>Heterostegina</i>	<i>Heterostegina operculinoides</i>
101.			<i>Operculina</i>	<i>Operculina ammonoides</i>
102.				<i>Operculina complanata</i>
103.			<i>Nummulites</i>	<i>Nummulites venosa</i>
104.		Planorbulinidae	<i>Planorbulinella</i>	<i>Planorbulinella larvata</i>
105.		Polymorphinidae	<i>Polymorphina</i>	<i>Polymorphina</i> sp.
106.		Reussellidae	<i>Reussella</i>	<i>Reussella spinulosa</i>
107.		Rosalinidae	<i>Rosalina</i>	<i>Rosalina globularis</i>
108.		Rotaliidae	<i>Rotalia</i>	<i>Rotalia orbicularis</i>
109.		Siphogenerinoididae	<i>Rectobolivina</i>	<i>Rectobolivina raphanus</i>
110.		Trimosinidae	<i>Trimosina</i>	<i>Trimosina milletti</i>
111.		Uvigerinidae	<i>Uvigerina</i>	<i>Uvigerina proboscidea</i>
112.			<i>Neouvigerina</i>	<i>Neouvigerina interrupta</i>
113.	Lagenida	Ellipsolagenidae	<i>Fissurina</i>	<i>Fissurina</i> sp.
114.		Glanduliniidae	<i>Glandulina</i>	<i>Glandulina</i> sp.



Table 1 contd.

Sl. No.	Order	Family	Genus	Species
115.		Lagenidae	<i>Hyalinonetrion</i>	<i>Hyalinonetrion elongata</i>
116.			<i>Lagena</i>	<i>Lagena</i> sp.
117.				<i>Lagena striata</i>
118.				<i>Lagena substriata</i>
119.			<i>Proserolagena</i>	<i>Proserolagena intricata</i>
120.				<i>Procerolagena oceanica</i>
121.				<i>Procerolagena</i> sp.
122.			<i>Pygmaeoseistrion</i>	<i>Pygmaeoseistrion baukalinella</i>
123.		Nodosariidae	<i>Laevidentalina</i>	<i>Laevidentalina advena</i>
124.		Vaginulinidae	<i>Amphicoryna</i>	<i>Amphicoryna scalaris</i>
125.			<i>Lenticulina</i>	<i>Lenticulina</i> sp.
126.	Spirillinida	Spirillinidae	<i>Spirillina</i>	<i>Spirillina</i> sp.
127.				<i>Spirillina</i> sp.1

Phylum FORAMINIFERA

Order ASTRORHIZIDA

Test made up of agglutinated materials, it has branched tubular test.

Family RHABDAMMINIDAE

Agglutinated test wall mostly made up of sponge spicules, radiolarians and other foraminiferal test. May be free living or attached.

Genus *Marsipella*

Test wall made by cemented sponge spicules arranged parallel to the sides of the test. It is an elongate slender tube like structure. Length of the test is more than 0.5 mm.

Marsipella sp. (Fig. 1A)

Agglutinated elongated test made up of sponge spicules like broken oxia and random arrangement of stauractine. Aperture in the terminal .

Order LITUOLIDA

Agglutinated test, wall composed by the mineralized grains and other foreign materials.

Family NOURIIDAE

Agglutinated wall made up of loosely arranged foreign materials like sponge spicules, mineralized materials and sand grains.

Genus *Nouria*

Elongate and oval shaped test and early chambers are spiraled later become may be biserial.

Nouria polymorpinoides (Fig. 1B)

Elongated test and free, chambers are not distinguished, wall made up of coarsely agglutinated by large mineral grains.

Nouria sp. (Fig. 1C)

Test cylindrical and elongate, wall made up of axia spicules arranged in a linear mode. Aperture in terminal.

Nouria sp. 1 (Fig. 1E)

Elongated test, wall made up of large mineral grains and spicules. Early stage of chambers are broad and narrow at the end. Aperture round in the terminal.

Order ROBERTINIDA

Calcareous imperforated hyaline and aragonite test, low trochospiral to high trochospiral chambers.

Family ROBERTINIDAE

Interior chambers are divided by double transverse partition, small supplementary chambers occur due to the infolding of the test wall.

Genus *Robertinoides*

High trochospiral chambers and sutures are oblique, small triangular supplementary opening present in opposite side of the test. Test very finely perforated. Aperture in the preceding main chamber.

Robertinoides australis (Fig.1D)

Irregularly fusiform test. Initial end of test small and blunt. Sutures oblique and depressed, two apertures are appeared as loop shape opening, one in the proximal margin and another one in the end of the chamber.

Order TEXTULARIDA

Agglutinated test mostly fine sand grains and canaliculated chambers cemented with magnesium calcite.

Family PSEUDOGUDRINIDAE

Elongated test, early stage with tri-serial to biserial at the end it become uniserial. Agglutinated test and aperture is in interiomarginal arch.



Genus *Pseudoclavulina*

Elongated agglutinated test, triserial to uniserial chamber formation.

Pseudoclavulina sp. (Fig. 1F)

Globular chambers, small triserial in early stage and become uniserial and larger size of chambers. Aperture round in terminal end without neck.

Family TEXTULARIIDAE

Agglutinated wall and canaliculated chambers, biserial to uniserial chamber formation.

Genus *Bigenerina*

Elongated agglutinated test.

Bigenerina nodosaria (Fig. 1G)

Elongate test, biserial in beginning and later chambers become uniserial. Aperture in the terminal and rounded.

Genus *Textularia*

Biserial chamber arrangement throughout the test and aperture situated at the base of the apertural face as low arc or slit.

Textularia agglutinans (Fig. 2A)

Biserial test, 3 to 4 pairs of chambers are present. Periphery almost rounded, size of the chambers are small in beginning and increasing towards the recent chambers. Aperture at inner margin of the last formed chamber as elongated slit.

Textularia conica (Fig. 2B)

Short and stout test compare than *T. agglutinans*. Numbers of chambers are more (6-7 pairs). Aperture long slit at inner margin of the last chamber.

Textularia foliacea (Fig. 2C)

Test small, chambers are indistinct, very large grains and other materials are framed its test.

Textularia sp. (Fig. 2D)

Elongate test chambers are subglobular partially acute in the margin. More than 7 pairs of chambers. Narrow in the earlier chambers and become broad in the recent chambers.

Family VALVULINIDAE

Initial stage of the test is trochospiral form and in the later stage produce more number of chambers per whorl. It may become uniserial in the later stage. Aperture with valvular tooth or flap. Wall made up of very fine sand grains and agglutinated materials.

Genus *Clavulina*

Test agglutinate with calcareous cement, elongate test and triangular or trochospiral in the early chambers and later it becomes linear cylindrical chambers.

Clavulina multicamerata (Fig. 2E)

Elongate test, first 2 to 3 pairs of chambers arranged as triangle and the later chambers become cylindrical. Total 7 to 8 number of cylindrical chambers are found. A rounded aperture has emerged tooth plate.

Order MILIOLIDA

Test made up of high magnesium calcite and imperforated porcelain. Wall has randomly oriented needle shaped crystals. Quinqueloculine, triloculine forms of test.

Family ALVEOLINIDAE

Globular large fusiform test, coiled about elongate axis. The chambers are flexostyle or quinqueloculine in juvenile, planispiral arrangement in adult. More number of chambers and apertures are small, rounded numerous openings in the apertural face.

Genus *Borelis*

Small test spherical to fusiform test. The chambers are arranged larger and smaller as alternative. Aperture in single row on the apertural face.

Borelis schlumberina (Fig. 2F)

Smaller test, Spherical in shape, numerous chambers and the aperture are numerous in single row.

Family CRIBROLINOIDIDAE

Test mostly ovate, early stage is quinqueloculine or planispirally coiled.

Genus *Adeolosina*

Quinqueloculine or planispirally coiled,

Adelosina sp. (Fig. 2G)

Test small, planispirally coiled and the last formed chamber produce a short neck. Aperture rounded on the small neck with simple strong teeth. The test has ornamentation of minute striae.

Family FISCHERINIDAE

Early chambers are flexostyle, become uniserial and elongate growth. Test wall ornamented with striae or coastae

Genus *Vertebralina*

The early chambers planispiral and involute later become elongate or uncoiled.

Vertebralina striata (Fig. 2H)

The test is flattened, more number of chamber. Test with longitudinal striae, aperture is a wide opening with thickened bordering lip.

Family HAUERINIDAE

Chambers are one to five or planes to coiling. The adults are having always more than two chambers. Aperture is in the open end of the final chamber and bears simple and complex tooth or trematophore.



Genus *Biloculina*

Test is discoidal or ovate in shape, chambers are quinqueloculine arrangement in early stage and biloculine in later stage. Aperture in terminal.

Biloculina sp. (Fig. 2I)

Ovate and slightly elongate test, two chambers are visible in final whorl, Surface smooth, aperture in the terminal of final chamber a broad opening with apertural flap.

Genus *Miliolinella*

Flattened ovate test, early stages of chambers are quinqueloculine arrangement and become planispiral in later stage. More than five chambers are in the final whorl. Aperture always in terminal with apertural flap.

Miliolinella circularis (Fig. 2J)

Test small chambers are milioline, 3 inflated chambers are visible in the final whorl. Large aperture in the terminal, it has well developed lip with plate like tooth.

Miliolinella sp. (Fig. 2K)

Milioline test, 3 to 4 chambers are visible, the chambers are ornamented with elongated striae. Aperture in the terminal.

Nevellina coronata (Fig. 2L)

Elongated subcylindrical test, surface very smooth and very delicate. The recent chambers are envelope the earlier chambers. Aperture is radiate 6 openings with a central rounded opening lied in the terminal.

Genus *Pyrgo*

Globular test with two chambers in the final whorl. Surface smooth and the periphery may be acute. The aperture in arial and large opening with broad lip and teeth.

Pyrgo denticulata (Fig. 3A)

Globular test with two chambers in the final whorl. Surface smooth and the periphery may be acute. Chambers are overlapping, bottom of the final chamber consist projections like denticles. The aperture in arial and large opening in the terminal with plate like tooth.

Pyrgo sp. (Fig. 3B)

Globular elongate test, final chamber with two chambers. Aperture in arial with small lip and simple plate like tooth.

Genus *Quinqueloculina*

The outline view of test is ovate and the early chambers are quinqueloculine. Chambers one half coil in length. Five chambers are visible in final stage where 4 visible one side and 3 chambers visible in opposite side. Aperture in the end of the final chamber with oval shape provide with bifid tooth.

Quinqueloculina bosciiana (Fig. 3C)

Test small and elongate, surface smooth, aperture oval without lip and produce a bifid tooth.

Quinqueloculina cuvieriana (Fig. 3D)

Test ovate to subcircular, 4 chamber are visible in the final stage, chamber length increasing towards the growth. Periphery is acute, chambers are ornamented with a minute striae. Aperture round and provided with a simple tooth.

Quinqueloculina carinatostrata (Fig. 3E)

Test oval, four chambers are visible, chambers are ornamented with slightly emerged longitudinal striae. Aperture in the shortly produced neck provide a simple tooth, in round shape. Aperture enclosed with peristomial lip.

Quinqueloculina crassicarinata (Fig. 3F)

The test is subcircular and triangular in cross section. Acute keels are present in the periphery, test surface smoothly finished and a round shaped aperture present in the shortly produced neck and provide a short simple tooth.

Quinqueloculina exomouthensis (Fig. 3G)

Elongate test, oval in lateral view and triangular in cross section. Truncated peripheral margins are visible, five number of quinqueloculine chambers are present. The test wall ornamented with very fine striation. The aperture rounded present on the long neck with a bifid tooth.

Quinqueloculina latidentalina (Fig. 3H)

Ovate test and quinqueloculine arrangement. Chambers are smooth and rounded periphery. 3 chambers are visible in one side. Aperture surrounded by peristomial rim and bifid tooth on the terminal end.

Quinqueloculina lizardi (Fig. 3I)

Compressed elongated test with 4 chambers of quinqueloculine forms. Test has ornamented by numerous pits. Aperture in the terminal without lip or rim and its provide a simple tooth.

Quinqueloculina seminula (Fig. 3J)

Test small and elliptical in shape. 4 chambers are visible and chambers are smooth. Aperture in the terminal end with small bifid tooth.

Quinqueloculina subparkeri (Fig. 3K)

Compressed subcircular small test. Quinqueloculine chamber arrangement in the primary stage. Wall slightly rough highly ornamented by transverse ribs. Aperture in the terminal with thickened peristomial rim and provided emerged bifid tooth.

Genus *Schlumbergerina*

Elongated tubular chambers, agglutinated wall and



sutures are depressed. Aperture in the terminal of last chamber produced a tremetophore rounded openings.

Schlumbergering alveoliniformis (Fig. 3L)

Tubular chambers with elongated test. Coarsely agglutinated materials are present in the wall. 4 to 5 chambers are visible, the aperture is in the terminal as tremetophore with many openings.

Genus ***Triloculina***

Ovate test in the outline view, triangular to subtriangular in cross section. In the exterior only three chambers are visible. Aperture round in the terminal often produce a bifid tooth.

Triloculina affinis (Fig. 4A)

Slightly subglobular and triloculine test with three chambers in exterior. Wall smooth and the aperture is subglobular with protruding bifid tooth.

Triloculina elongotricarinata (Fig. 4B)

Triangular shape, with three chambers, periphery is acute and longer than wide, an arch shaped aperture in the terminal it produced long simple tooth.

Triloculina insignis (Fig. 4C)

Subglobular triloculine test with smooth surface, small neck produced a round aperture with small bifid tooth.

Triloculina marshallana (Fig. 4D)

Triloculine test, periphery broadly convex and angular shape, wall smooth, aperture in the terminal surrounded by peripheral rim on the neck with thin bifid tooth.

Triloculina rotunda (Fig. 4E)

A rounded test with smooth wall and slightly depressed sutures. The aperture surrounded by thin lip and produced small bifid tooth.

Triloculina serrulata (Fig. 4F)

Small and ovate test, three chambers are visible, periphery has highly emerged carinate shoulders. Surface of the wall ornamented with very minute striae. The aperture is rounded lied in the terminal with strong peripheral rim. Aperture produced a long bifurcating tooth.

Triloculina striatotrigonula (Fig. 4G)

Triloculine elongate test longer than broader. The surface of the wall ornamented with longitudinal striae. Aperture round present on the terminal and it provide a short bifid tooth.

Triloculina tricarinata (Fig. 4I)

Triangular in shape in the cross section with triloculine chambers. Test is broader than longer and wall has smooth surface. Aperture highly arch shape provided with bifid tooth.

Triloculina trigonula (Fig. 4J)

Triloculine test, longer than wide. Test smooth, arch shaped aperture in the terminal with broad bifid tooth.

Family MILIAMMINIDAE

Quinqueloculine chamber arrangement and the test wall composed by the fine grained agglutinated materials.

Genus ***Miliammina***

Test wall agglutinated materials and built with siliceous cement.

Miliammina fusca (Fig. 4K)

Test elongated with quinqueloculine chambers. Test wall made up of very fine grains of sands cemented with siliceous materials. Aperture small rounded in the terminal with a simple tooth.

Family PENEROPLIDAE

The early stage of the test chambers is closely coiled and it becomes uncoiled to annular chambers. Imperforated test wall ornamented with striae, the aperture in the terminal or marginal as slits, many pores and dentritic.

Genus ***Euthymonacha***

Elongated imperforated porcelain test

Euthymonacha polita (Fig. 4L)

Chambers are arranged serially with cylindrical shape. Test wall has series of pseudopores as ornament. The aperture in the terminal as everted and ceranulated lip at out of the test.

Genus ***Monalysidium***

Test small and large planispiral coil, the later chambers are uncoiled, rectilinear and ovoid shape. Aperture in terminal with dentriting and radiating tooth.

Monalysidium confusa (Fig. 5A)

Test small planispiral coiled chambers in early stage and become non spiral rectilinear. Chambers are somewhat compressed, test wall thin and ornamented with pseudopores in several series. Aperture in the terminal with radiating opening and tooth with everted lip.

Genus ***Peneroplis***

Early stage of the the test has planispiral chambers and become flaring chambers in the adult or later stage. Test and sutures slightly compressed and the chambers are not divided as chamberlets. The wall ornamented with grooves are numerous striae. Aperture as large, linear, circular to oval irregular pores.

Peneroplis pertusus (Fig. 5B)

Planispiral coiled test, some time chambers are becoming



non coiled uniserial and flaring test. Test wall ornamented with parallel striae. Aperture in the apertural phase with a series of irregular slits.

Peneroplis planatus (Fig. 5C)

Early chambers are highly planispirally coiled and later stage highly flaring and flattened test. Test ornamented with numerous blunted ribs. Aperture is irregular oval openings in the apertural phase.

Family RIVEROINIDAE

Planispiral chambers, chamber one half coil in length. Test wall smooth or ornamented with striae. Aperture in terminal with trematophor or simple curved openings.

Genus ***Psuedohauerina***

Ovate to subcircular chamber, flattened test, wall ornamented with striae or smooth. Aperture trematophores.

Psuedohauerina involuta (Fig. 5D)

Small flattened test looks ovate in outline, milioline in the early stage and lenticular in over all. Chambers are involute arrangement and wall ornamented with numerous longitudinal striae and ribs. A complex cribrate aperture (many irregular pores) in the terminal.

Psuedohauerina fragillissima (Fig. 5E)

Flattened oval shaped test, milioline in the early and planispiral chamber arrangement in the later stage. Wall smooth without ornamentation, the aperture in the terminal with trematophore.

Family SPIROLOCULINIDAE

Prolocular continuous with cornuspire flexostyle. Two chambers are visible in whorl. Test without ornamentation or with ornamentation of striae, coastae or pits.

Genus ***Spiroloculina***

Test elongate with two chambers in exterior. Test without ornamentation or with ornamentation of striae, coastae or pits. Aperture almost round in the terminal with simple or bifid tooth.

Spiroloculina antillarum (Fig. 5F, I)

An elongate test, test ornamented with numerous longitudinal striae starts from aboral end and appeared up to the apertural end. Aperture on the neck, cylindrical in shape, provide a small bifid tooth.

Spiroloculina communis (Fig. 5G, H)

An elongate test with two chambers in final whorl and some what thickened test. No ornamentation on the wall, the periphery has acute margin. Aperture provided in the cylindrical neck with a bifid tooth.

Spiroloculina convexa (Fig. 5J)

In lateral view the test looks ovate to fusiform, wall looks rough and not ornamented with special feature. The aperture round surrounded by very thin peristomial rim and it has provide a small bifid tooth.

Spiroloculina depressa (Fig. 5K)

Small test depressed and ovate, elliptical to rounded in side view. Flattened periphery and the aboral end has rounded form. Inner side of the carinae produce emerged line. Test ornamented with crossed longitudinal striae. Aperture on the short neck as rounded with small bifid tooth.

Spiroloculina exima (Fig. 5L)

A thickened test with convex periphery, wall granulated and sutures are indistinct in the early stage. The outer edge all chamber projecting above the proceeding chamber. Aperture is round on the small neck produced a peristomial rim and bifid tooth.

Spiroloculina mayori (Fig. 6A)

An elongated test, quinqueloculine chambers in the early stage and two chambers are in the final whorl. The wall smooth and periphery acute, outer edge has emerged. It has little long neck, aperture rounded and no rim, small bifid tooth present.

Spiroloculina sp. (Fig. 6B)

Biloculine test and evolute, the outer chambers are flaring, test wall granulated. One side chambers are curved towards inner end. Shoulder of the chamber projecting thick keels. Aperture in the terminal on the slightly projected neck, it covered by everted lip and provide emerged and elongated tooth.

Family SORITIDAE

Planispiral test, later test may be uncoiled, flaring, rectilinear to flabelliform. The chambers will be numerous with chamberlets. Multiple aperture can be found and it can be in marginal rim.

Genus ***Amphisorus***

Discoidal test, flexostyle to undivided chambers. Later stage of chambers become annular ring and chamberlets.

Amphisorus hemprichii (Fig. 6C)

A large test, discoidal and concave, and thickened rim. Later chambers are cyclic and subdivided by septula. Aperture numerous elongated pores on the peripheral margin which aligned in alternative rows.

Parasorites orbitoloides (Fig. 6D)

Large test and discoidal, flexostyle and planispiral chambers in the early stage, enlarging in the later stage and test becoming reniform. Final stage of the test discoidal with annular chambers. The aperture in the peripheral margin has series of round hole.



Order ROTALIDA

Trochospiral test, made up of low magnesium calcite, the test wall fully perforated. Secondary wall present in some groups. Distinguished sutures almost, more number of chambers. Interseptular systems are present in some groups. Chambers are without ornamentation or ornamentation with striae and coatae. Aperture in the interiomarginal, terminal, slit, with or without tooth.

Family AMMONIDAE

Trochospiral test, peripheral margin mostly rounded and sutures are often oblique. Aperture always in the base of the last chamber.

Genus *Ammonia*

Biconvex low trochospiral test, chambers are arranged as evolute in the spiral side and involute in the umbilical side. Earlier chambers are closed together with umbilical and periphery rounded to carinate.

Ammonia convexa (Fig. 6E)

Low trochospiral and biconvex test, peripheral margin rounded and acute. Sutures curve on the spiral side, 8-10 chambers are visible in the last whorl. Aperture is an arch.

Family AMPHISTEGINIDAE

Low trochospiral test, chambers are more long and curved. Aperture narrow interomarginal slit.

Genus *Amphistegina*

Low trochospiral test lenticular and equilaterally biconvex and large test. Umbilical plug is present, finely perforate and surface smooth.

Amphistegina lobifera (Fig. 6F)

Lenticular test with low trochospiral coiling, the peripheral margin acutely rounded. Highly curved chamber towards backward. Highly lobulated suture in the final whorl. Aperture covered by pustular lip in the umbilical side.

Amphistegina papillosa (Fig. 6G)

Low trochospiral and lenticular test. Highly flattened and outline is subcircular. Peripheral margin is acute, comparatively small test. Numerous pustules are appeared as ornament on both sides. Aperture small rounded in umbilical side.

Amphistegina radiata (Fig. 6H)

A large test with biconvex and low trochospiral arrangement of chambers. planispiral with subangular peripheral margin. Number of chambers are more, width of the chambers are less. It has the supplementary stellar chambers and chamberlets its radial over the previous whorl. Aperture a short slit near to the periphery.

Family BOLIVINITIDAE

Biserial test with flattened. Truncated edges, test finely perforated and ornamented with striae and pustules.

Twisted test sometime, sutures well distinguished. Aperture rounded, high loop, or aerial slit with or without toothplate.

Genus *Bolivina*

Often biserial elongated test. 5 to 10 pairs of chambers, coarse to minute perforation in the test wall. Aperture rounded, high loop, or aerial slit with or without toothplate.

Bolivina spathulata (Fig. 6I)

Biserial elongated and flattened test and the initial portion of the test has rounded. Size of the chambers are increasing as added later chambers. The lower margin of the test has coarsely perforated. Aperture a broad loop on the final chamber.

Bolivina striata (Fig. 6J)

An elongated biserial test with 6-7 pairs of chambers. Test wall highly perforated and ornamented with irregular longitudinal striae. The aperture in the terminal and an elongated opening with tooth plate.

Bolivinella translucens (Fig. 6K)

An elongated small test with biserial chamber arrangement and slightly tapering. Slightly depressed sutures, chambers are subcylindrical and anterior portion has smooth surface and the posterior portion has perforation with slightly serrated. Aperture in terminal as loop shaped with narrow lip linked in internal toothplate.

Genus *Fursenkoina*

An elongated small triserial test, slightly tapering and twisted. Periphery is rounded.

Fursenkoina sp. (Fig. 6L)

An elongated small triserial test, slightly tapering and twisted. Periphery is rounded. wall smooth and very fine perforated. Aperture long slit in the terminal.

Genus *Hopkinsinella*

Hopkinsinella glabra (Fig. 7A)

Biserial elongated test, slightly compressed. Chambers are subcylindrical, sutures are oblique and depressed. Wall smooth and the aperture situated in the subterminal and surrounded by recurved lip.

Genus *Loxostomina*

Biserial test in the early stage and it may become uniserial in the later stage. Mostly the chambers are curved and its covered half of the preceeding chamber.

Loxostomina limbata (Fig. 7B)

An elongated test. More number of chambers, the earlier stage is biserial and it become uniserial in the final stage. Wall has slightly ornamented with longitudinal striae, finely perforated. Aperture found with everted lip in the last chamber.



Genus *Sagrinella*

Elongated test and oval in section. Chambers become biserial to uniserial. The posterial portion of the test may have serrated spines. Aperture in the terminal.

Sagrinella durrandi (Fig. 7C)

A compressed, lanceolate and elongated test. Test wall ornamented with striation and base is serrated spine. The periphery is acute and serrated. Biserial chambers in beginning and become uniserial in later stage. Aperture in the terminal as long slit surrounded with lip.

Sagrinella jugosa (Fig. 7D)

Slightly tapering and compressed test, aboral end of the test subangulate or rounded. The peripheral end has angular. 5-6 pairs of chambers are present. Aperture broad with raised lip.

Genus *Sigmovirgulina*

A biserial elongated test, somewhat stout and the bigging stage of the chambers are twisted.

Sigmovirgulina tortuosa (Fig. 7E)

A biserial elongated test, somewhat stout and the bigging stage of the chambers are twisted. The test wall coarsely perforated. Aperture is slit like opening at the terminal and has a tooth plate.

Family BULIMINIDAE

High trochospiral test, three chambers are visible per whorl, sometime become to biserial test. Chambers have coarse or minute perforation and ornamented with projected spines in the posterior regions of chambers. Aperture as loop on the apertural face with plate like tooth.

Genus *Bulimina*

An elongate, ovate or subcircular test, triserial chamber arrangements. Aperture on the apertural face.

Bulimina elegans (Fig. 7F)

A biserial chamber arrangement of elongated test. Test wall coarsely perforated, chambers are tapered. In the posterial end it has single spine. 5-6 pairs of chambers are visible and aperture in the last formed chamber with wide opening.

Bulimina marginata (Fig. 7G)

Triserial chamber arrangement on the elongated and ovate test. It has the depressed sutures, chamber has spines in the posterior portion. Aperture on the last formed chamber as loop shaped. It is provided internal folded tooth plate.

Bulimina striata (Fig. 7H)

A short triserial test, chambers are highly overlapped each other, smooth in upper portion of chamber, striated in the basal area looks like spines and very finely perforated.

Aperture on the terminal a slit and provide with tooth plate.

Genus *Elongobula*

Chambers arranged as high trochospiral and coiled in the elongated test. Sutures are oblique to the longitudinal axis.

Elongobula sp. (Fig. 7I)

Small and elongated test, tapering and cylindrical. Chambers and sutures are distinct, test wall smooth and very finely perforated. It has broadly round aperture face with deep radial clefts and aperture is in center with partially closed by apertural flap.

Family CALCARINIDAE

Low trochospiral test, chambers with spiny projections. It has can systems over the chambers. Test ornamented with keels and pustules. Aperture at the base or umbilical side.

Genus *Calcarina*

Low trochospiral test, chambers with spiny projections. It has can systems over the chambers. Test ornamented with keels and pustules. Aperture at the base or umbilical side.

Calcarina hispidia (Fig. 7J)

Low Trochospiral large specimen, hispid test, test has ornamented with calcitic boss on both sides. The spines very thick and short. The periphery covered by serrations throughout. Final whorl consist 10-11 chambers, it has a flat apertural face.

Calcarina spengleri (Fig. 7K)

Relatively large specimen with low trochospiral chamber arrangement. Chambers are evolute in spiral side. Well developed calcitic boss present over all test. Each chamber has provide spine with slightly pointed end. The spines are highly serrated.

Calcarina mayori (Fig. 7L)

Low trochospiral test with evolute arrangement of chambers in the spiral side and involute in the umbilical side. Around 9 radial peripheral long spines are available, raised tuberscales are present in the center of the test.

Genus *Neorotalia*

Neorotalia calcar (Fig. 8D)

Low trochospiral biconvex test. 10-11 chambers are present in the last whorl, it provide angular canaliculated spines. Spiral side has a central pustular ornamentation. Slightly depressed sutures and radial on the spiral side.

Genus *Pararotalia*

Test is low trochospiral coiled, plano to biconvex, chambers are flattened but it has elevated in the umbilical side. Umbilical shoulder surrounded through the umbilical boss.

Pararotalia ozawaia (Fig. 8K,L)

Test low trochospiral and biconvex test with carinated periphery. Chambers are elevated in the center of the



umbilical side it provide the umbilical shoulder around them. Sutures curved towards backwards. Aperture in the interiomarginal.

Family CANCRISIDAE

Umbilicus primarily open but obstructed either through umbilical flab or through the presence of umbilical plug.

Genus *Cancris*

Auriculate test in the outline. Periphery angled carinate, chambers are increasing as width as added in flaring trochospiral chambers.

Cancris auriculus (Fig. 8E)

The outline of the test appears as auriculate and umbilical side strongly convex. Acuted peripheral margin, chambers are increasing rapidly in size and sutures strongly curved backwards. Aperture in umbilical side as a slit.

Cancris sagram (Fig. 8F)

Test elliptical in outline and convex in umbilical side. Strong keel has appeared in the margin. Nearly half of the test covered by the last formed chamber. Sutures slightly depressed and arched on the spiral side. Aperture a slit on the umbilical side.

Family CASSIDULINIDAE

Biserial arrangement, in early stage the biserial attained planispiral in later stage chambers become uniserial.

Genus *Cassidulina*

Lenticular to flattened and ovoid test and subangular to carinate periphery. Sutures radial to oblique.

Cassidulina sp. (Fig. 8G)

Flattened and elongated test with biserial arrangement. In beginning of the test the chambers arranged in planispiral coil and final chamber become uniserial. Surface smooth with minute perforation.

Family CIBICIDIDAE

Trochospirally enrolled test, spiral side attached, primary aperture in low equatorial arch. Some time the aperture become terminal.

Genus *Cibicides*

Test mostly attached with substrates, trochospiral to planoconvex and the spiral side has flat to convex. Sutures thickened and may be elevated, strongly convex and involute umbilical side. Aperture in a low interiomarginal.

Cibicides refulgens (Fig. 8H,I)

Planoconvex chambers, emerged chambers in the spiral side, chambers are curved towards backward. Coarsely perforated and smooth.

Family CYMBALPORIDAE

Genus *Milletiana*

Trochospiral and planoconvex test, chambers bordering and become crescentic. Wall coarsely perforated.

Milletiana milletti (Fig. 8J)

Trochospiral chambers, it is broad in the early stage and become crescent in later stage. Later chambers added as cyclic arrangement.

Family ELPHIDIDAE

Test planispiral to trochospiral, sutural canal system open in to sutural pores. Aperture single or multiple at interiomarginal or aerial.

Genus *Elphidium*

Large test as lenticular and planispirally enrolled. Involute or partially evolute, it may have umbilical plug on each side. Sutures are deeply incised, it has vertical umbilical canal.

Elphidium advenum (Fig. 8A)

Planispiral and involute test, biconvex, lenticular and the periphery is bicircular in shape. Peripheral margin is rounded often with a blunt keel, the chambers are slightly curved backward. Boss present in the umbilical region and finely perforated wall.

Elphidium crispum (Fig. 8B)

A large planispiral and biconvex test. Outline has circular appearance and a large umbilical boss present in the center with irregular pits. Numerous chambers are appeared and the chambers are highly curved backward.

Elphidium excavatum (Fig. 8C)

Relatively small test and planispirally enrolled, laterally compressed and acutely rounded periphery. Number of chambers are very less as 9-11. Aperture at the base of the last chamber.

Elphidium hispidulum (Fig. 9A)

Planispirally enrolled test, number of chambers are less with 12-13 in the last whorl, umbilical boss has very less number of pits. Anterior portion of the last chamber and earlier chamber periphery has small papilli like projections.

Elphidium indicum (Fig. 9B)

Test planispiral and very smoothen surface with finely perforation and more number of chambers (more than 20) are in the final whorl. Periphery rounded and the carinae has not much curved.

Elphidium macellum (Fig. 9C)

Relatively large and planispiral test appeared as compressed one and rounded in outline. Acute periphery with a narrow rounded keel. A raised umbilical area with 4-5 pits.

Elphidium sandegoensis (Fig. 9D)

Planispiral and involute small test. Surface smooth very finely perforated. Suture deeply incised and slightly



curved which is have irregular septal bridges. Each suture produce a strong pit on the umblical area. Aperture in the interiomarginal.

Elphidium sp. (Fig. 9E)

Planispirally enrolled chambers. Chamber increasing rapidly in width. Peripheral margin broadly rounded. Suture has short flush sutural bridges and highly hispid ornamentation appeared in the umblical area.

Family EPONIDIDAE

A trochospiral test in the early stage. Aperture an interiomarginal, it may extends from umbilicus to marginal or it may be cribrate or areal.

Genus *Poroeponides*

Trochospiral and planoconvex to biconvex with strongly elevated test in the spiral side. It has depressed umblical region. primary aperture interiomarginal extending from umbilicus to peripheral keel.

Poroeponides sp. (Fig. 9F)

Test trochospiral, elevated and evolute spiral side. Suture curved and oblique in the spiral side but radial on the umblical side. Primary aperture a slit extending at the base of the ultimate chamber.

Genus *Angulodiscorbis*

Pyramidal test and high trochospiral with strongly elevated spiral side.

Angulodiscorbis pyramidalis (Fig. 9G)

Pyramidal test with numerous whorl and provided 4 vertical chambers at each. Suture flush to depressed on the spiral side, radial and depressed on the umblical side. Radially alinged pores and granular striae present in the umblical side. Aperture interiomarginal slit.

Genus *Piliolina*

Piliolina sp. (Fig. 9H)

Trochospiral and planoconvex test. It has raised spiral suture and ornamented spiral side with conical tubercle. Umblical side ornamented with radiated rows of minute tubercles.

Family LOXOSTOMATIDAE

In the early stage appeared as biserial test and recent chambers can become as uniserial. Aperture in the terminal of uniserial final chamber.

Genus *Loxostomum*

Elongated compressed test, sides concave or flat. Chambers are arched in the later stage to tendency for becoming uniserial.

Loxostomina coastatopertusum (Fig. 9I)

Elongated biserial test and appeared as lanceolate. Sutures obscured by the surface coastae. Coarsely perforated wall

and finely ornamented early chambers. Aperture has distinct tooth plate lied in terminal.

Family MURRAYINELLIDAE

Trochospirally coiled small test. Inflated to globular chambers. Peripheral outline lobulated. Surface of the test wall rugous or hispid in nature.

Genus *Murrayinella*

Small test with trochospiral chamber arrangement and 2 to whorl of globular chambers are present.

Murrayinella globosa (Fig. 9J)

Trochospiral test and evolute in the spiral side. Five globular chambers are present with sharp spines. The surface of the wall has hispid or rough and finely perforate. Aperture in the interiomarginal.

Family NONIONIIDAE

Planispiral test in the early stage and trochospiral in the later stage. Chambers are appeared as involute to evolute. Aperture in the interiomarginal.

Genus *Nonion*

Planispiral for through the test. The outline ovate to circular in shape. Laterally compressed and biumblicate. Sutures curved and depressed, outline of the periphery has smooth surface. Test wall smooth and glassy.

Nonion depressum (Fig. 9K)

Elongated and curved chambers in planispiral test. A small central umblical area. Final whole consist 6-7 chambers, surface smooth and has very minute perforation.

Nonion elongatum (Fig. 9L)

Test longer than broad, involute chambers throughout. It has broadly rounded periphery and distinct sutures. Test wall smooth except umblical region, wall smooth and finely perforated. Aperture in the low arched opening at the base of the apertural face.

Nonion greatilaupei (Fig. 10A)

Test low trochospiral and compressed, chambers are tall and narrow. The test evolute in spiral side and involute in umblical side. Test smooth with hispid ornamentation on the umblical depression.

Family NUMMULITIDAE

Planispiral test with involute or evolute chamber arrangement. Median chambers are present, it may become chamberlets. It has complex canal systems are septal, marginal and vertical canal. Aperture an arched and slit on the base apertural face.

Genus *Heterostegina*

Large test with involute or evolute chamber arrangement. The megalospheric test has operculinoid unfolded test as around 13 numbers. The intraseptal canal formed



from part or former marginal canals as new chambers is added. Secondary sutural canals are formed in the septula forming the chamberlet connect successive sutural canal.

Heterostegina operculinoides (Fig. 10B)

Planispiral and evolute chambers. test has very flat appearance and falciform chambers. Chambers are subdivided into rectangular chamberlets. Height of the chambers are increasing towards growth axis. 19-20 chamberlets are visible in the final whole. Wall finely perforated and aperture equatorial at the base of the narrow apertural face.

Genus ***Operculina***

Planispiral and evolute test, flattened size medium to large. Numerous narrow chambers without chamberlets. Septal flap moderately to strongly folded, it has the interseptal canal system.

Operculina ammonoides (Fig. 10C)

Generally large test and compressed, highly flattened test and planispiral chamber arrangement. It has a raised sutures and the test has ornamented with pustules are higher in the umbilical region. Aperture at the base of the apertural face.

Operculina complanata (Fig. 10D)

Large test and evolute chamber arrangement throughout the test and it has rapidly opening spire. The raised pustules are covered in the spiral laminae, the chambers are highly curved backward.

Genus ***Nummulites***

Involute test, marginal cord has appeared as thin and chambers are undivided. Test smooth with very minute perforation. A slit shaped aperture in the apertural face.

Nummulites venosa (Fig. 10E)

A lenticular large test and planispirally coiled chambers. Chambers are slightly curved backward. 14 -15 chambers are visible in the final whorl.

Family **PLANORBULINIDAE**

Trochospiral to planispiral test, both side of the test has partially evolute. Chambers added irregularly in the later stage of test. Test wall coarsely perforated, aperture in the interiomarginal.

Genus ***Planorbulinella***

Early stage of the test has planispirally arranged and become flattened and discoidal. The later chambers are added in annular series.

Planorbulinella larvata (Fig. 10F)

Planispirally arranged chambers in the early stage. Adult test looks flat and discoidal. Chambers of successive annuli altering in position, central portion of the test

ornamented with irregular pustules. Aperture on the periphery two pores in the opposite end.

Family **POLYMORPHINIDAE**

Elongated chambers spirally arranged in vertical axis. Chambers are strongly overlapped with preceding chambers.

Genus ***Polymorphina***

Test elongate fusiform to ovate, biserially arranged chambers, test wall smooth and finely perforated. Aperture in the terminal.

Polymorphina sp. (Fig. 10G)

Ovate and fusiform test, the recent chambers are highly folded with earlier chambers. Test slightly twisted and sutures distinct, flush to depressed.

Family **REUSSELLIDAE**

Triserial chambers in early stage and it may become in to biserial or uniserial. Aperture in the terminal.

Genus ***Reussella***

Test triserial, chambers are optical and smooth with coarsely perforated.

Reussella spinulosa (Fig. 10H)

Pyramidal test, triserial chamber arrangement and triangular throughout the test. The chambers are gradually enlarging. Each chambers has projecting spine, aperture is high arch in base of final chamber.

Family **ROSALINIDAE**

Trochospiral test, most of the test has closed umbilicus or umbonal boss. Chambers are simple and coarsely perforated.

Genus ***Rosalina***

Trochospiral test, planoconvex to concavoconvex, chambers are enlarging towards the growth axis. Sutures are oblique and curved towards the margin.

Rosalina globularis (Fig. 10I)

Trochospiral test and ovate in outline. Highly convex and evolute in the spiral side. Chambers are rapidly increasing size with the growth. The final chamber almost cover the whole test. Coarsely perforated test, carinae highly curved backwards.

Family **ROTALLIDAE**

Genus ***Rotalia***

Rotalia orbicularis (Fig. 10J)

Low trochospiral test, three to four whorls of the chambers are present.

Family **SIPHOGENERINOIDIDAE**

Elongated test, biserial to uniserial chamber arrangement. Aperture with tooth plate.



Genus *Rectobolivina*

Elongated test, slightly compressed and oval in section. In early stage biserial and later it become uniserial. Test wall ornamented.

Rectobolivina raphanus (Fig. 10K)

Cylindrical and tapering and elongated test. Chambers are highly ornamented with longitudinal striae. It increasing size towards the growth, wall very finely perforated. Aperture large opening in the terminal with everted philine lip.

Family TRIMOSINIDAE

Triserial chamber arrangement in the early stage and become biserial in later stage. Strongly angled chambers, wall coarsely perforated and aperture with tooth plate.

Genus *Trimosina*

Triangular chambers through the triserial test. Depressed sutures, basal end angled with spine. Wall coarsely perforated.

Trimosina milletti (Fig. 10L)

Pyramidal test, early stage of chambers are triserial arrangement and later stage become as biserial chamber arrangement. Chambers are angled and provide a spine like projection. 3-4 pairs of biserial chambers are visible. Aperture in the terminal with tooth plate. Wall coarsely perforated.

Family UVIGERINIDAE

Early stage of the chambers are arranged as triserial to biserial and in later stage it may become uniserial. Aperture is terminal, the neck is provided with tooth plate.

Genus *Uvigerina*

Elongate test with rounded chambers. Sutures distinct and depressed. Wall ornamented with longitudinal striae or coastae. It provide neck with rounded aperture and tooth plate in the terminal.

Uvigerina proboscidea (Fig. 11B)

Elongated test, rounded periphery, indistinct chambers and depressed. Test wall ornamented with pustules. Aperture rounded in terminal on the everted neck, aperture produced a lip and toothplate.

Genus *Neouvigerina*

Small and elongated test, chambers are triserial to uniserial. Wall has hispid ornamentation and provide long neck with lip and tooth plate.

Neouvigerina interrupta (Fig. 11C)

Highly elongated test with depressed globular chambers. Test wall has finely hispid ornamentation. Chambers are irregular in the later stage. Test provide long neck and the aperture present in the terminal of the neck as rounded.

Family ELLIPSOLAGENIDAE

Small unilocular test and the aperture has radiating slit in the terminal

Genus *Fissurina*

Small test, rounded to ovate outline. Surface smooth and finely perforated. Aperture on the terminal ovate to slit.

Fissuria sp. (Fig. 11D)

Very small test, ovate in outline and the surface smooth glassy in nature, very finely perforated. the base of the test has broad and it is narrow in the apertural side. Aperture is terminal as slit.

Family GLANDULINIDAE

Test are differentiated as uniserial, biserial or polymorphine. Aperture in terminal as radial or slit like.

Genus *Glandulina*

The test is elongate and ovate and tapering. Biserial arrangement in microspheric specimen and in megalospheric specimen it has uniserial chambers through test. Size of the chambers are increasing as chambers added.

Glandulina sp. (Fig. 11E)

Fusiform test, early stage looks biserial chamber arrangement and the later stage it is as uniserial arrangement. Test wall smooth finely perforated and aperture as radiate in the terminal.

Family HYALINONETRION

Unilocular test, elongated fusiform and tapering in the base. Surface always smooth and not ornamented. Aperture round at end of the long neck.

Hyalinonetrion elongata (Fig. 11F)

Test very thin and elongate, test looks cylindrical in nature. Both the end has elongate long neck.

Family LAGENIDAE

An uniserial small test, With long neck or without neck, wall smooth or ornamented with striae and it has fine perforation.

Genus *Lagena*

Small uniserial test with projection of long neck. Ornamented with longitudinal striae, aperture round in the terminal.

Lagena sp. (Fig. 11G)

Small sub circular and monolocular test, it has two lateral keels and it provide a groove between them. The surface is pitted in the base of the test. Elongated neck has absent and the aperture in terminal as slit.



Lagena striata (Fig. 11H)

Test elongate and subcylindrical, it has long neck, the wall has ornamented with longitudinal coastae which emerged well. Coastae has somewhat twisted in the end of the neck and aperture in the terminal as rounded.

Lagen substriata (Fig. 11I)

Test flask shape and smaller than *L. striata*, wall. wall has coastae which has not emerged much. The coastae are straight throughout the test. Neck with thickened lip around the aperture.

Genus ***Procerolagena***

Unilocular elongate test with cylinder shape. Surface smooth and longitudinal ornamentation. It has slender neck with rounded aperture on the terminal.

Procerolagena intricata (Fig. 11J)

An elongated fusiform test, it has narrow basal end with some short spines and central portion become broad then end portion become narrow with long cylindrical neck. Long neck produce round aperture at end.

Procerolagena oceanica (Fig. 11K)

Almost similar to the *P. intricata* but the basal end has little more number of spines and it provide irregular coastae which is not reach to the anterior portion. Surface smooth, the aperture at end of the long cylinder neck is provided a with.

Procerolagena sp. (Fig. 11L)

Comparatively short oblique test. Cylindrical in base, it has ornamented in basal end it is also provided with a small irregular spine like projection at the basal end. Relatively short neck, it provide several ring in the end portion. Aperture round at the end of the neck.

Genus ***Pygmaeistrion***

Unilocular, globular to ovoid test. Surface smooth and finely hispid. Coastae has absent. Aperture round present at the end of the narrow elongated neck.

Pygmaeistrion baukalinella (Fig. 12A)

A small globular test with broken neck, surface smooth and loosely packed calcite material.

Family NODOSARIDAE

Elongated with uniserial test or rarely biserial and rectilinear. Wall ornamented with striae or coastae and finely perforated.

Genus ***Laevidentalina***

Elongated test, uniserial chamber arrangement, wall smooth and no ornamentation, aperture in the terminal.

Laevidentalina advena (Fig. 12B)

Thin elongated test slightly tapering and slightly curved at the anterior portion. The chambers are subcylindrical,

uniserial arrangement and size increasing towards the growth. Wall smooth very finely perforated. The aperture at the end of final chamber with radial apertural openings.

Family VAGINULINIDAE

Enrolled chambers in the early stage and become uniserial and rectilinear in later stage. Ovate in section and aperture in the terminal either radiat or cribrate.

Genus ***Amphicoryna***

Elongate test and base of the test is apiculate early stage compressed and astacoline coil in the microspheric test.

Amphicoryna scalaris (Fig. 12D)

Test elongate and flattened rectilinear in shape. Early stage is astacoline coil and it become uniserial chambers. It is provided with a long neck and surface of the chambers are ornamented with irregular longitudinal coastae and the aperture in the terminal.

Genus ***Lenticulina***

Planispiral and enroled test, lenticular, asymmetrical or trochoid and biumbonate. Angular to carinate periphery, relatively broad and low chambers and increasing towards growth. The later stage of the test become uncoil. Surface smooth except sutural nodes or elevation. Aperture radiate in the terminal.

Lenticulina sp. (Fig. 12E)

Large test and planispiral chambers, periphery bluntly rounded and involute in the spiral side. Sutures are slightly curved backwards. Surface smooth and the aperture radiate at the peripheral angle.

Order SPIRILLINIDA

Planispiral and enrolled chambers. wall finely perforated, low magnesium calcite.

Family SPIRILLINIDAE

Non septate enrolled tubular chamber. Planispiral, low trochospiral to high trochospiral. Aperture in the open end of the test.

Genus ***Spirillina***

Planispirally coiled chambers, it has tubular uncoiled chambers and may be secondarily subdivided.

Spirillina sp. (Fig. 12F)

Large enrolled test with planispirally coiled. Proloculus is very thin and chambers are enlarging towards the growth. Thickened test and smooth surface, sutures distinct. Very finely perforated. Aperture is in the open end of the tubular test.

Spirillina sp1. (Fig. 12G)

Test comparatively small and planispirally coiled, chambers broad, in beginning stage of the chambers are evolute and later stage involute in spiral side. Wall highly perforated and the aperture is in open end.

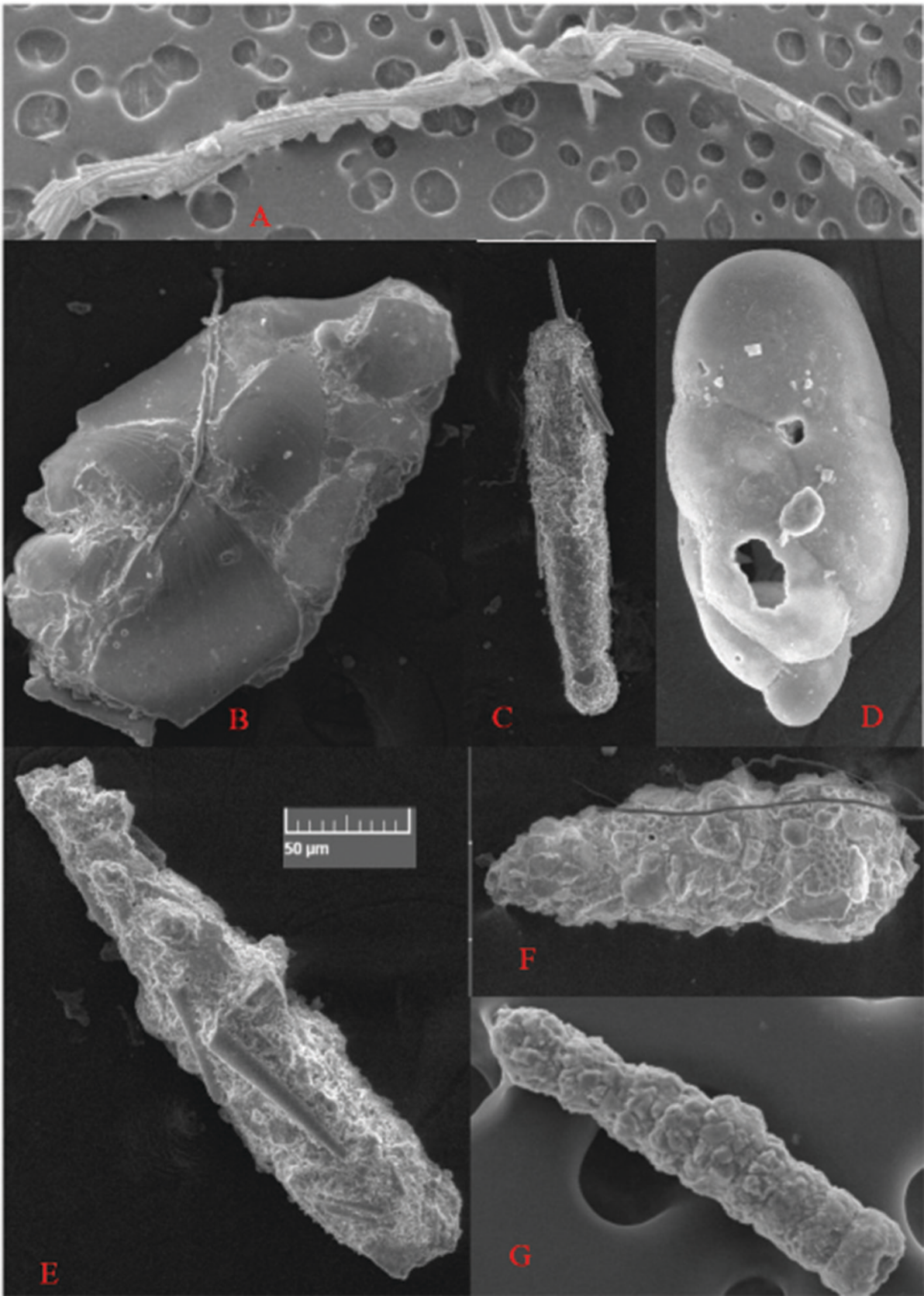


Fig. 1. A. *Marsipella* sp.; B. *Nouria polymorphinoides*; C. *Nouria* sp.; D. *Robertinoides australis*; E. *Nouria* sp.1; F. *Pseudoclavulina* sp.; G. *Bigenerina nodosaria*.

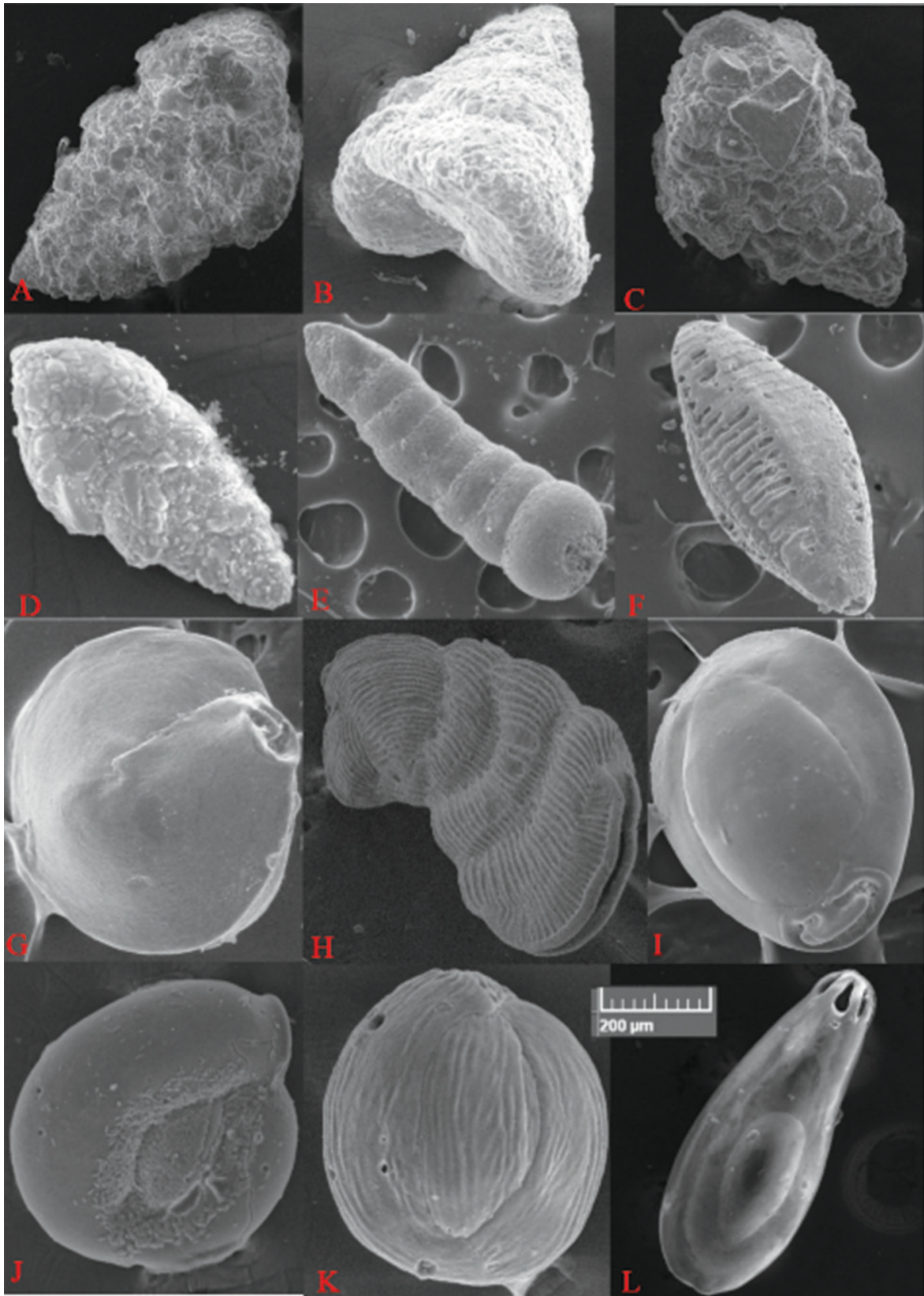


Fig. 2. A. *Textularia agglutinans*; B. *Textularia conica*; C. *Textularia lateralis*; D. *Textularia* sp.; E. *Clavulina multicamerata*; F. *Borelis schlumberina*; G. *Adelosina* sp.; H. *Vertebralina striata*; I. *Biloculina* sp.; J. *Miliolinella circularis*; K. *Miliolinella* sp.; L. *Nevellina coronata*.

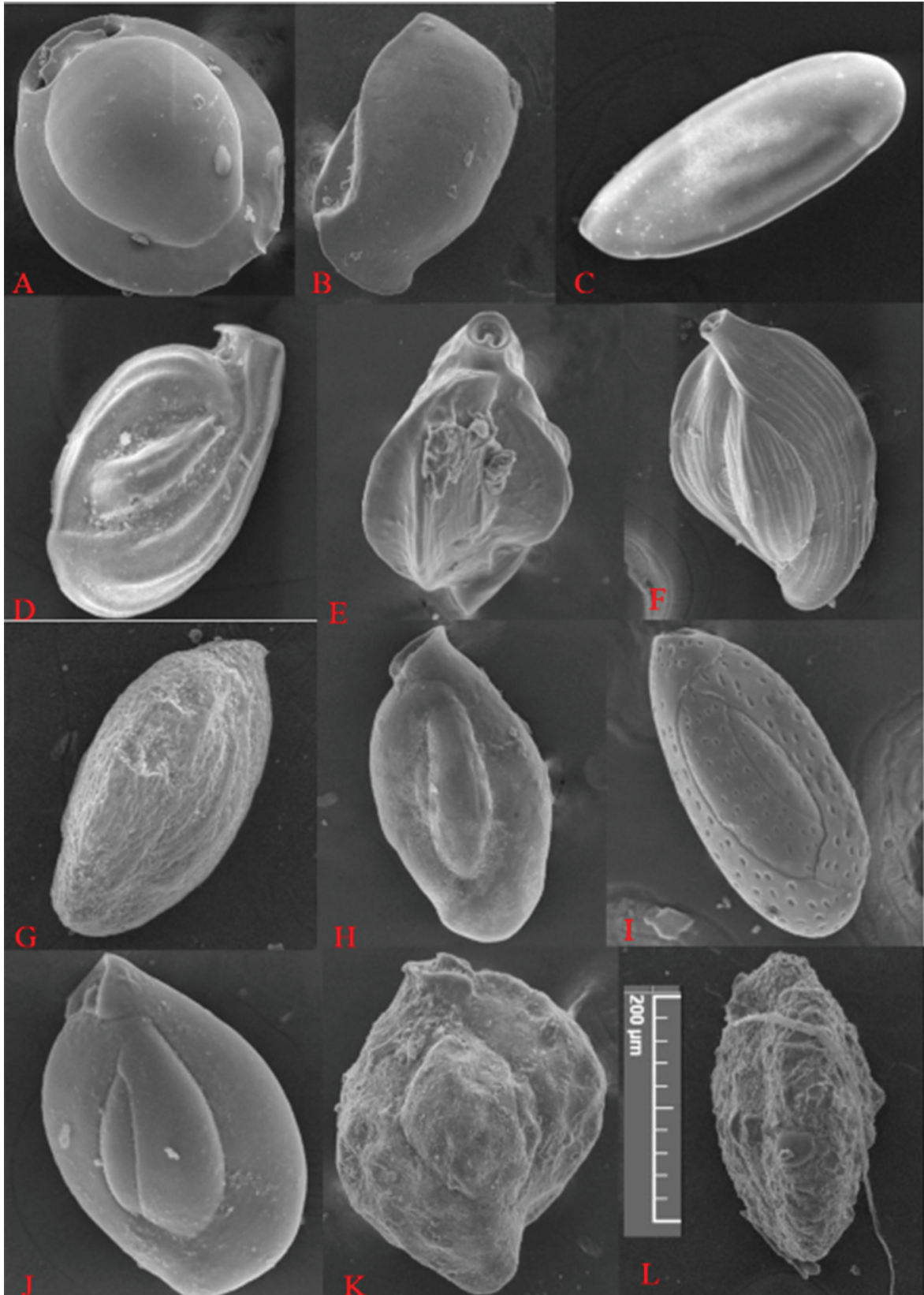


Fig. 3. A. *Pyrgo deticulata*; B. *Pyrgo* sp.; C. *Quinqueloculina bosciana*; D. *Quinqueloculina cuvieriana*; E. *Quinqueloculina carinatostrata*; F. *Quinqueloculina crassicarinata*; G. *Quinqueloculina exomouthensis*; H. *Quinqueloculina latidentalina*; I. *Quinqueloculina lizardi*; J. *Quinqueloculina seminula*; K. *Quinqueloculina subparkeri*; L. *Schlumbergering alveoliniformis*.

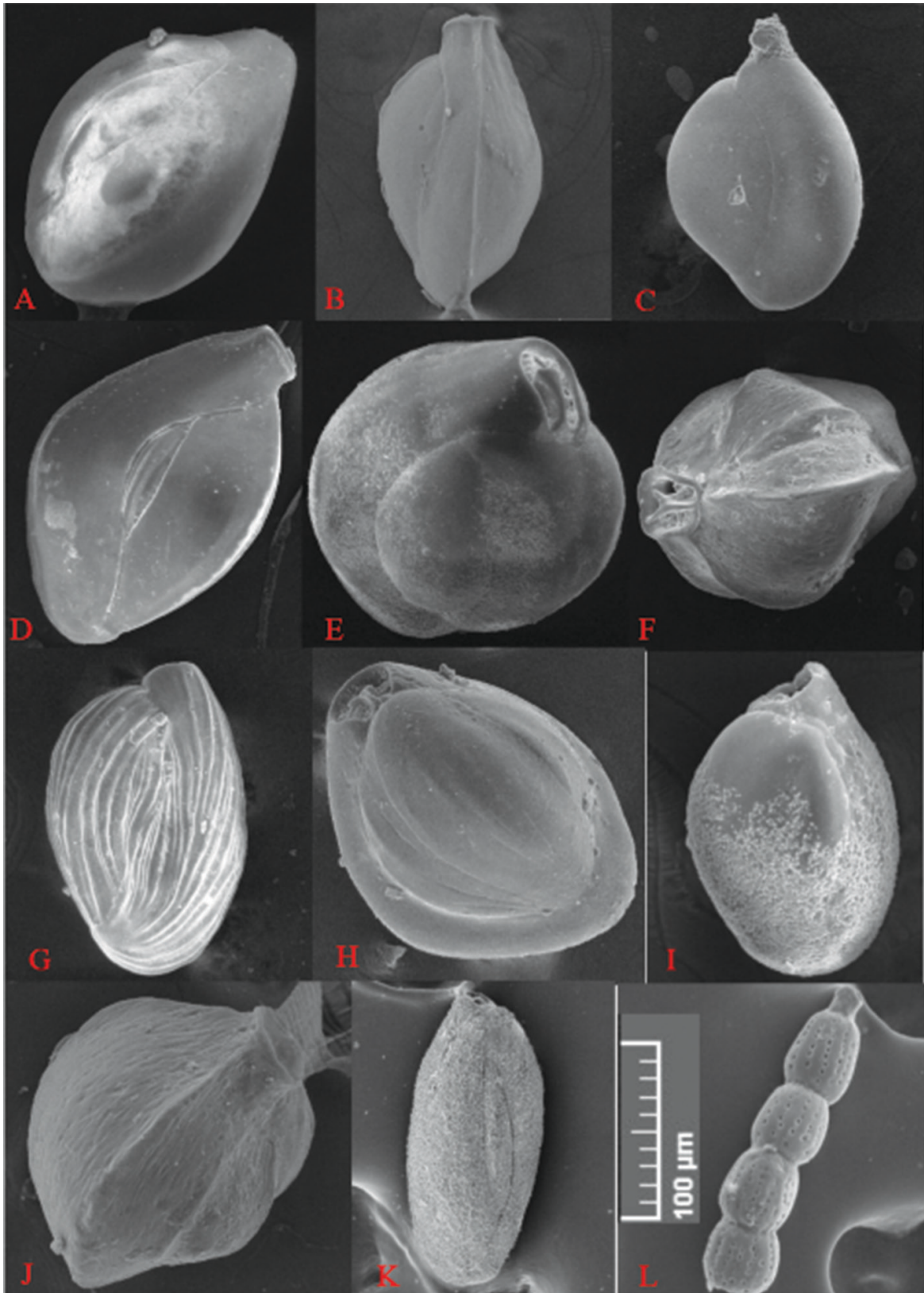


Fig. 4. A. *Trilouculina affinis*; B. *Triloculina elongotricarinata*; C. *Triloculina insignis*; D. *Triloculina marshallana*; E. *Triloculina rotunda*; F. *Triloculina serrulata*; G. *Triloculina striatotrigonula*; I. *Triloculina tricarinata*; J. *Triloculina trigonula*; K. *Miliammina fusca*; L. *Euthymonacha polita*.

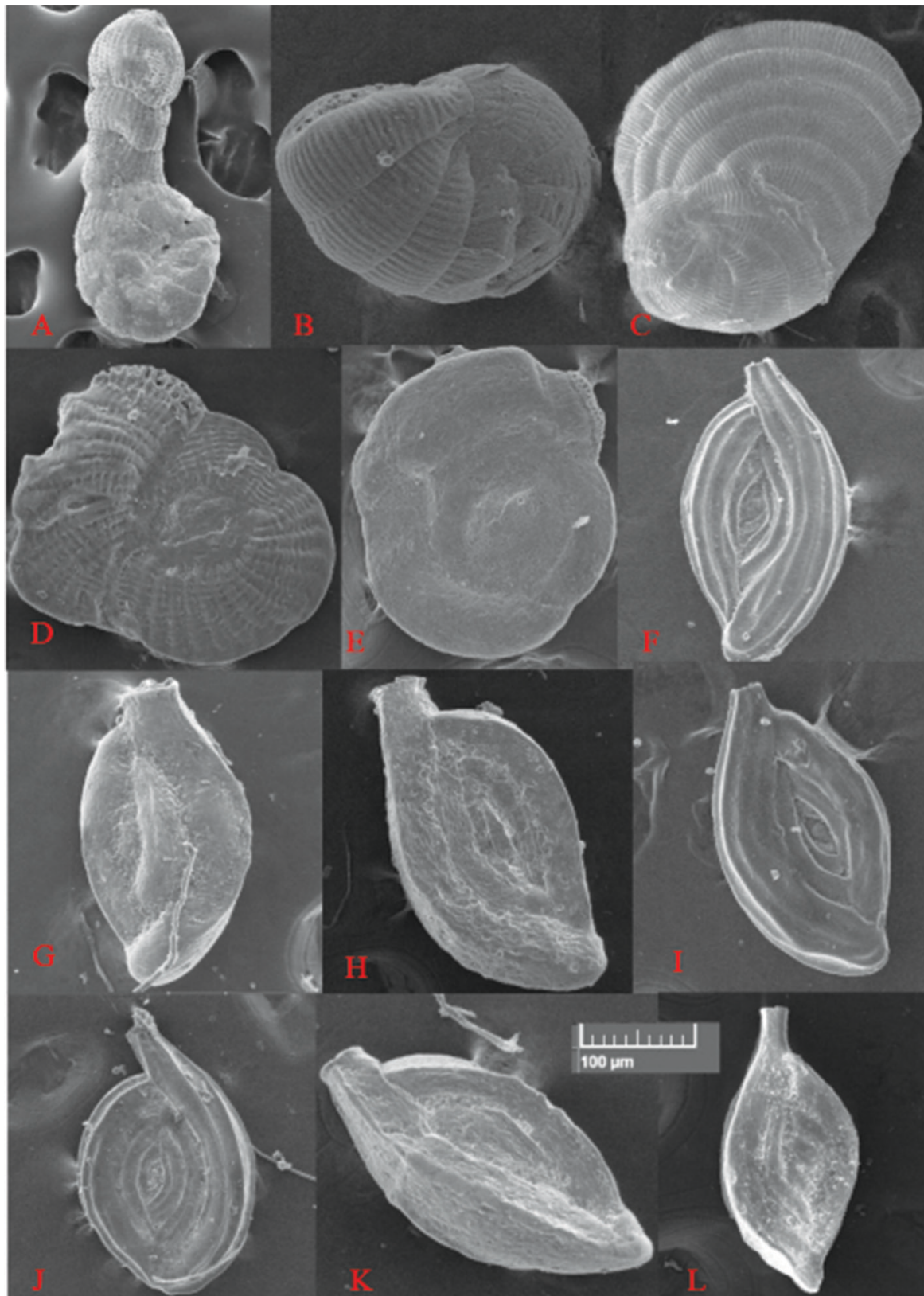


Fig. 5. A. *Monalysidium confusa*; B. *Peneroplis pertusus*; C. *Peneroplis planatus*; D. *Pseudohauerina involuta*; E. *Pseudohauerina fragillissima*; F,I. *Spiroloculina antillarum*; G,H. *Spiroloculina communis*; J, *Spiroloculina convexa*; K. *Spiroloculina depressa*; L. *Spiroloculina exima*

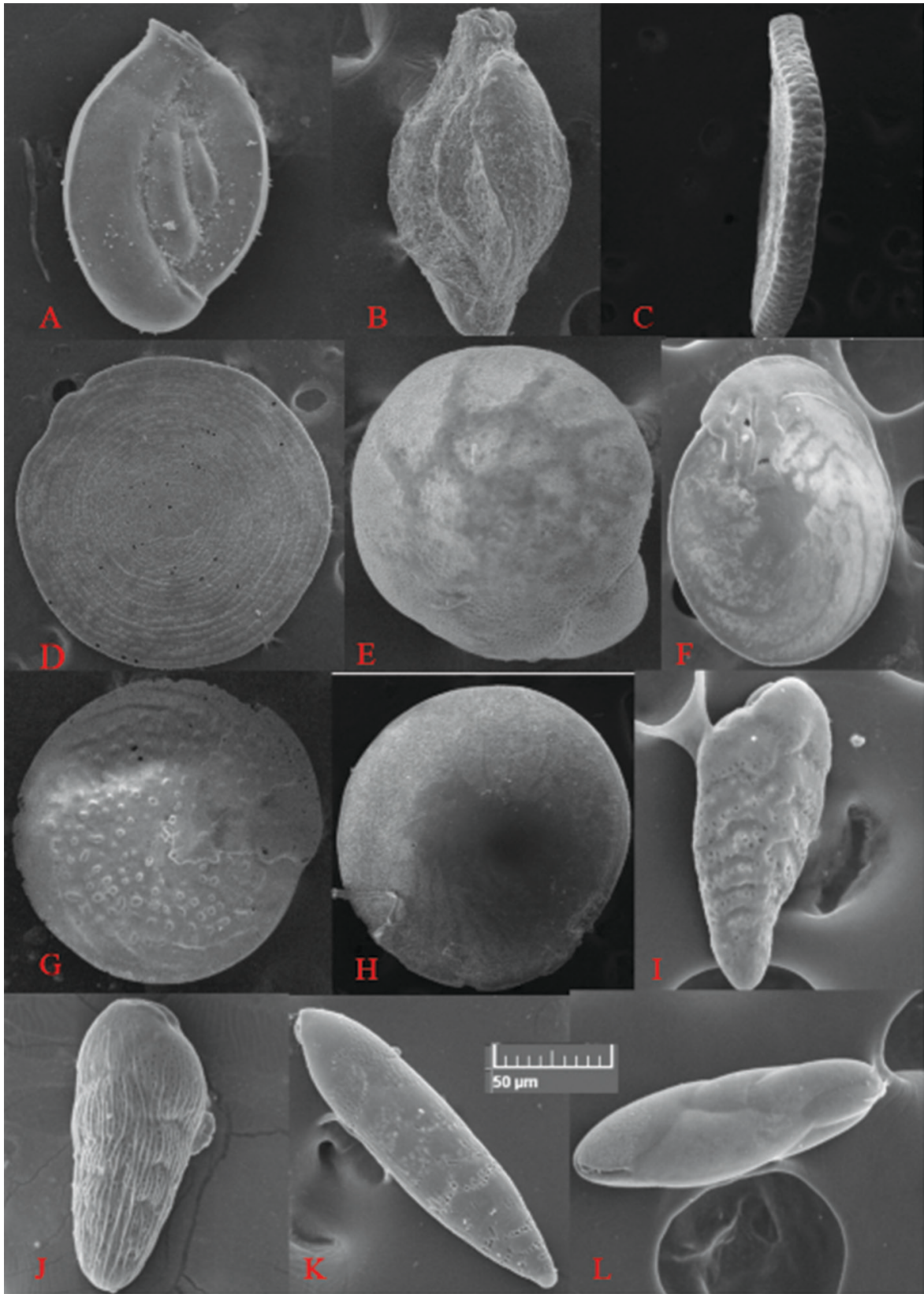


Fig. 6. A. *Spiroloculina mayori*: B. *Spiroloculina* sp.: C. *Amphisorus hemprichii*: D. *Parasorites orbitoloides*: E. *Ammonia convex*: F. *Amphistegina lobifera*: G. *Amphistegina popillosa*: H. *Amphistegina radiata*: I. *Bolivina spathulata*: J. *Bolivina striata*: K. *Bolivina translucent*: L. *Fursenkoina* sp.

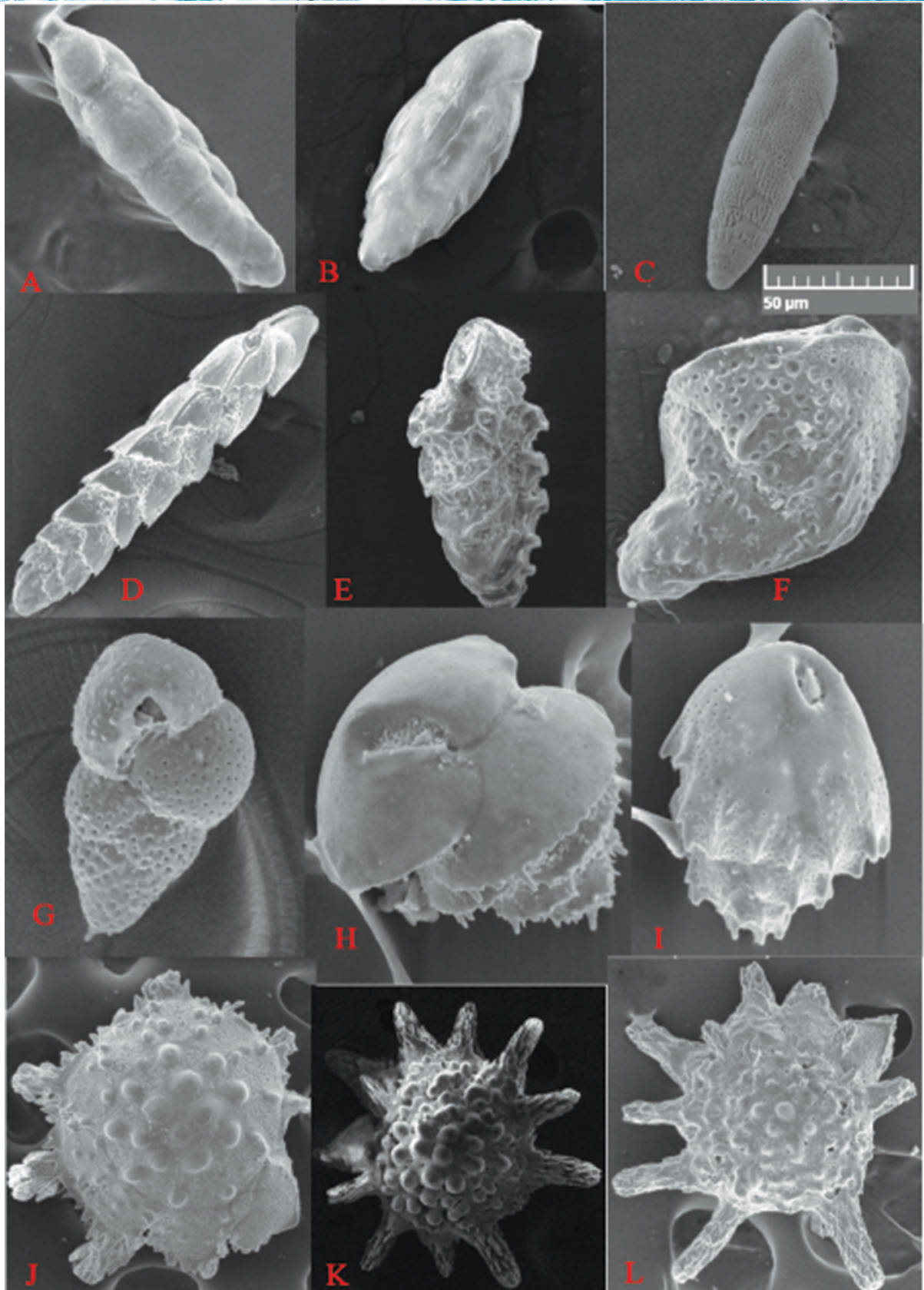


Fig. 7. A. *Hopkinsenella glabra*; B. *Loxostomina limbata*; C. *Sagrinella durrandi*; D. *Sagrinella jugosa*; E. *Sigmovirgulina tortuosa*; F. *Bulimina elegans*; G. *Bulimina marginata*; H. *Bulimina striata*; I. *Elongobula* sp.; J. *Calcarina hispidia*; K. *Calcarina spengleri*; L. *Calcarina mayori*

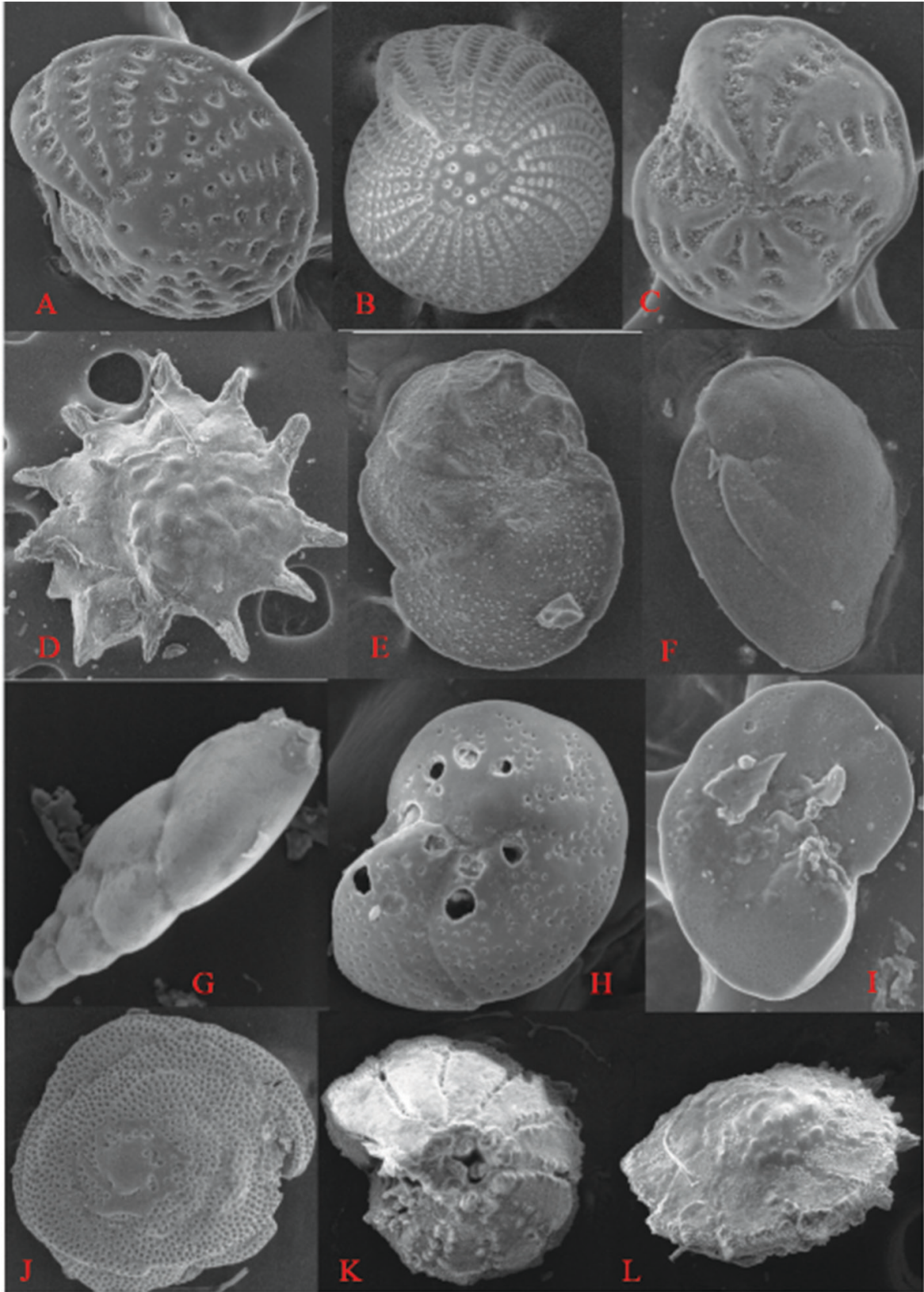


Fig. 8. A. *Elphidium advenum*; B. *Elphidium crispum*; C. *Elphidium excavatum*; D. *Neorotalia calcar*; E. *Cancris auriculus*; F. *Cancris sagrum*; G. *Cassidulina* sp.; H. *Cibicides refulgens* (Dorsal); I. *Cibicides refulgens* (Ventral); J. *Milletiana milletii*; K. *Pararotalia ozawaia* (Ventral); L. *Pararotalia ozawaia* (Dorsal)

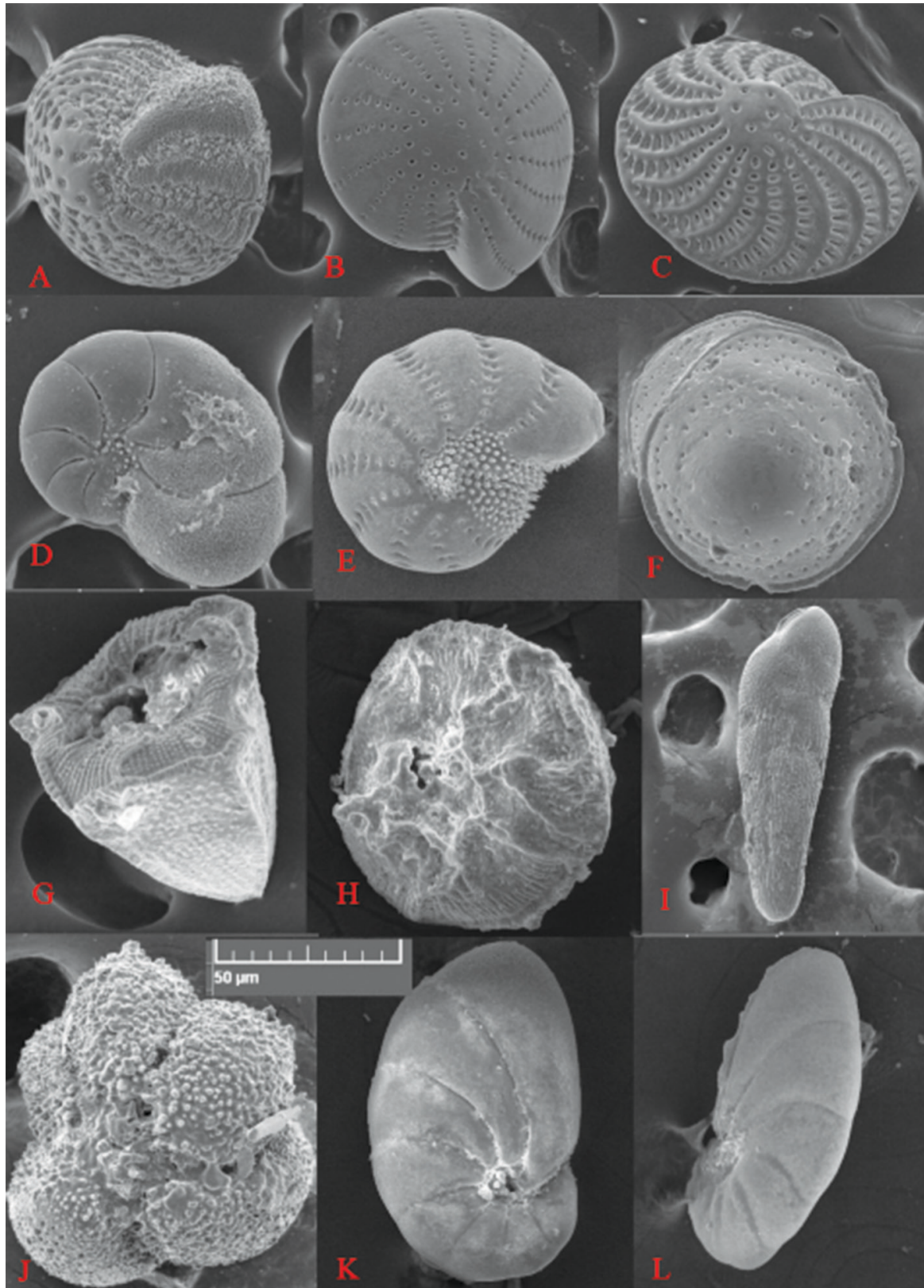


Fig. 9. A. *Elphidium hispidulum*; B. *Elphidium indicum*; C. *Elphidium macellum*; D. *Elphidium sandegoensis*; E. *Elphidium* sp.; F. *Poroepionides* sp.; G. *Angulodiscorbis pyramidalis*; H. *Piliolina* sp.; I. *Loxostomina coastatopertusum*; J. *Murrayinella globosa*; K. *Nonion depressum*; L. *Nonion elongatum*

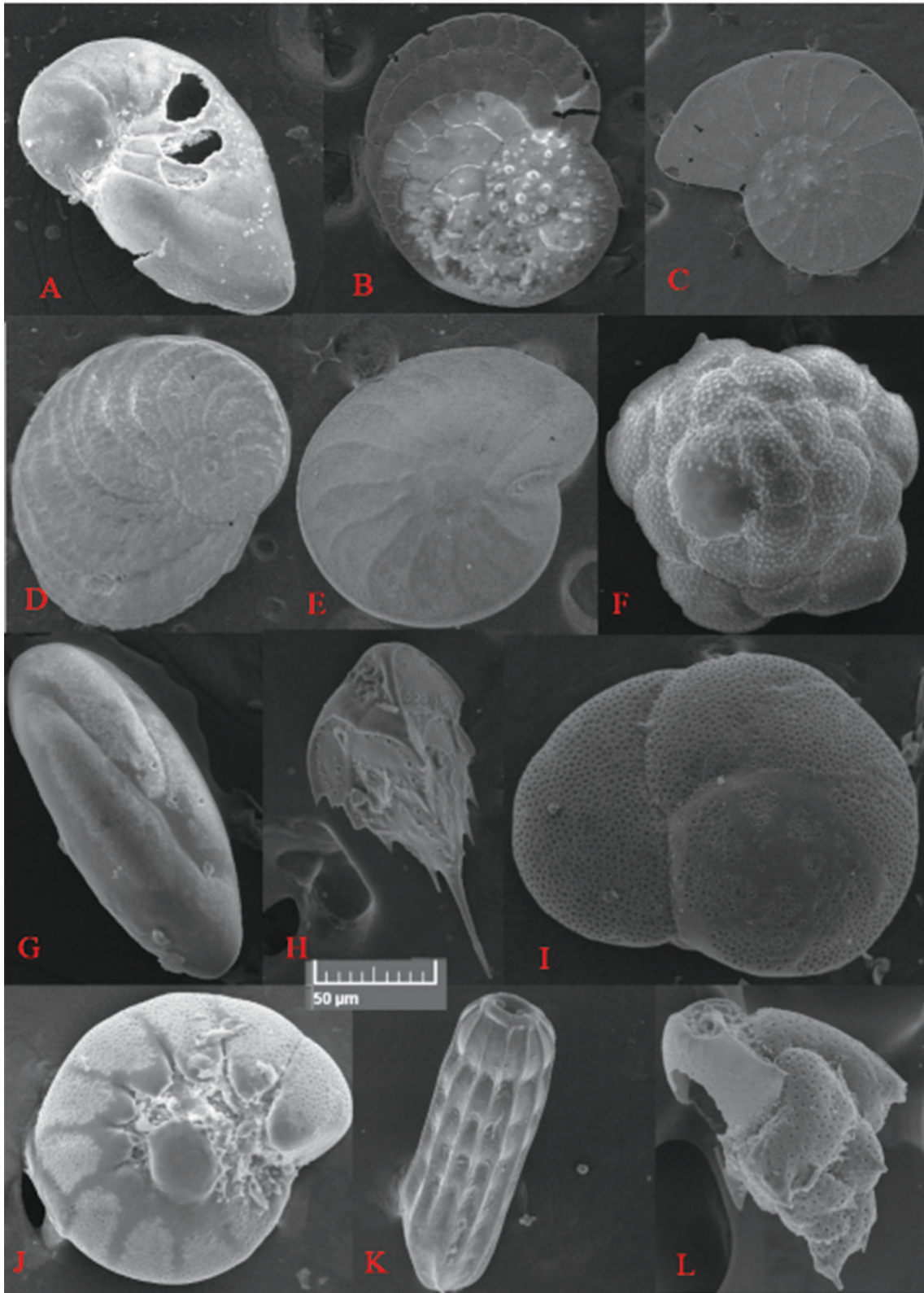


Fig. 10. A. *Nonion greatilaupei*; B. *Heterostegina operculinoides*; C. *Operculina ammonoides*; D. *Operculina complanata*; E. *Nummulites venosa*; F. *Planorbulinella larvata*; G. *Polymorphina* sp.; H. *Reussella spinulosa*; I. *Rosalina globularis*; J. *Rotalia orbicularis*; K. *Rectobolivina raphanus*; L. *Trimosina milletti*

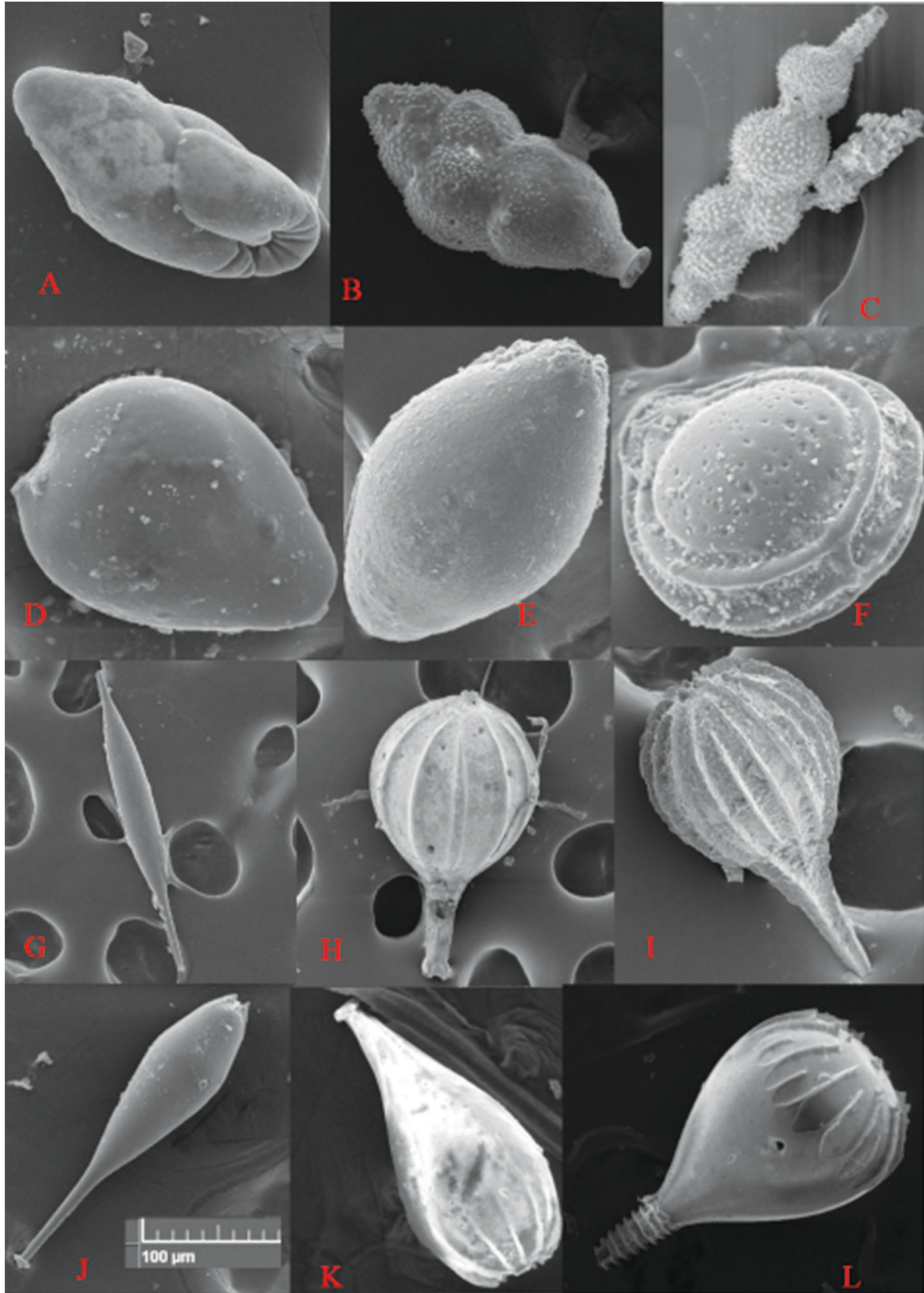


Fig. 11. A. *Elongobula* sp.; B. *Uvigerina proboscidea*; C. *Neouvigerina interrupta*; D. *Fissuria* sp.; E. *Glandulina* sp.; F. *Hyalinonetrion elongata*; G. *Lagena* sp.; H. *Lagena striata*; I. *Lagen substriata*; J. *Procerolagena intricata*; K. *Procerolagena oceanica*; L. *Procerolagena* sp.

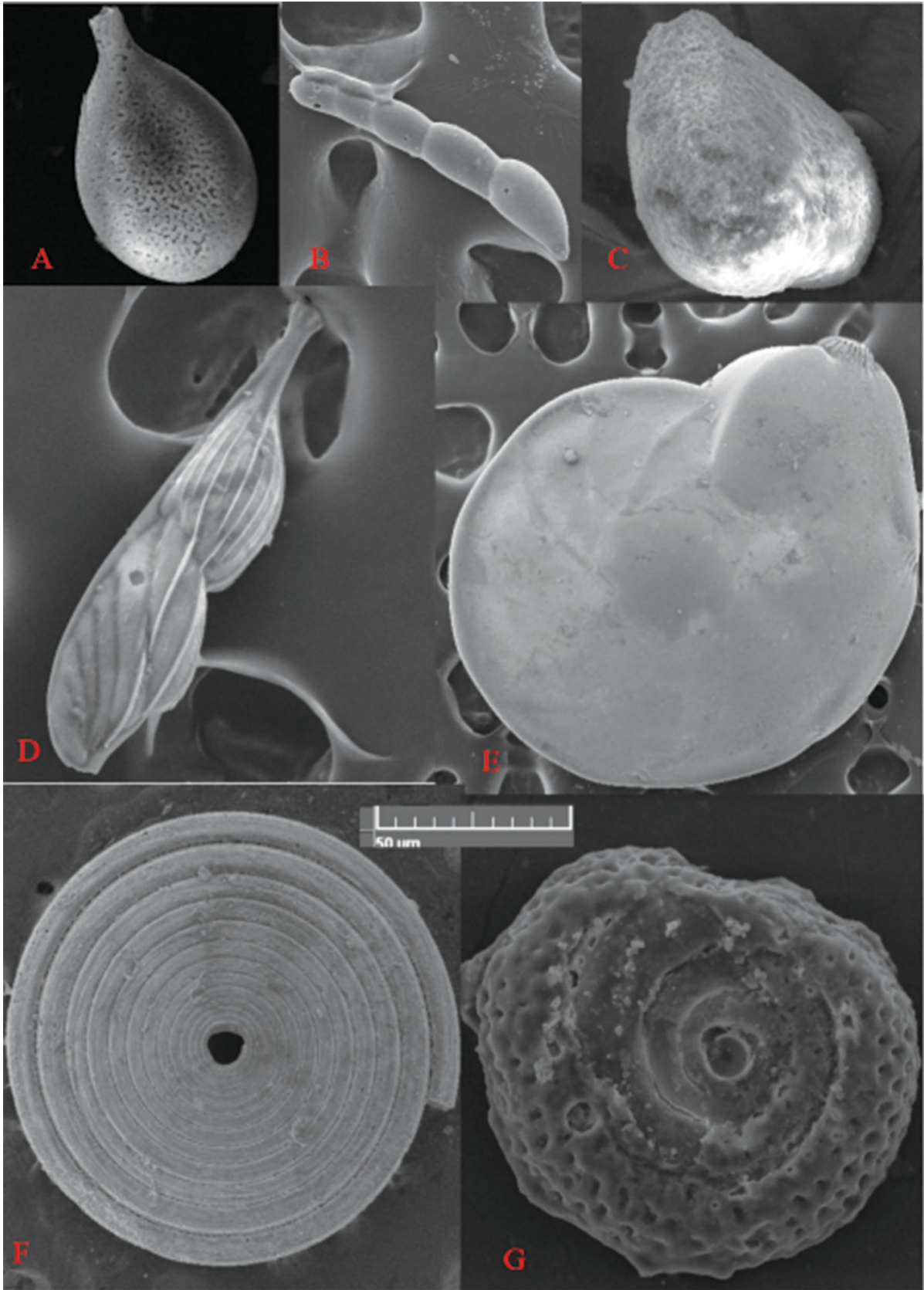


Fig. 12. A. *Pygmaeseistron baukalinella*; B. *Laevidentalina advena*; C. *Sigmoidella* sp.; D. *Amphicoryna scalaris*; E. *Lenticulina* sp.; F. *Spirillina* sp.; G. *Spirillina* sp1.



DISCUSSION

The present study provided a detailed account of living benthic foraminifera in neritic sediment of South Andaman Island. Identified 130 species exhibited high diversity within those studied sediment samples, in a small area of large coast line covered in the South Andaman Island. Further, intensive study is needed to evolve the impact of these organisms in these ecosystems.

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