Thirty new records of marine benthic Foraminifera from Korean waters

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As a part of a survey of indigenous biological resources of Korea, 30 marine benthic foraminiferal species belonging to 24 genera and seven orders (Astrorhizida, Lagenida, Lituolida, Miliolida, Robertinida, Rotaliida and Textulariida) were identified. Bottom sediment samples were collected from eight stations on the west and east coast of South Korea, in April 2015 and May 2016, respectively. Ten species belonging to nine genera and five orders (Lagenida, Lituolida, Robertinida, Rotaliida, Textulariida) were identified in the Yellow Sea. Among these taxa, Rotaliida was the dominant order, represented by four species: Evolvocassidulina tenuis (Phleger & Parker, 1951), Cibicides mabahethi Said, 1949, Cibicides pseudolabatulus Perelis & Reiss, 1975 and Cibicidoides barnetti Bermudez, 1949. Twenty species belonging to 15 genera and five orders (Astrorhizida, Lagenida, Lituolida, Miliolida, and Rotaliida) were identified from the East Sea and the Lagenida was the dominant order, represented by 11 species: Lagena strumosa Reuss, 1858, Lagena nebulosa (Cushman, 1923), Lagena striata var. semiornata Reuss, 1863, Procerolagena cylindrocostata Albani & Yassini, 1989, Fissurina bispinata Ujiie, 1963, Oolina laevigata d’Orbigny, 1839, Polymorphina amplissima McCulloch, 1977, Polymorphina subelliptica McCulloch, 1977, Guttulina succincta McCulloch, 1977, Guttulina neoproblema McCulloch, 1977 and Lagenosolenia obtecta McCulloch, 1977. The findings described here increased the number of foraminiferal species in Korea to approximately 1060, and contribute to our understanding of the diversity of foraminifera in Korean waters.

Keywords: Benthic foraminifera, East Sea, Korean waters, protists, Yellow Sea

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MATERIALS AND METHODS

Sampling of marine bottom sediment was conducted in April 2015 in the Yellow Sea and in May 2016 in the East sea of Korea from four stations per region, by using a Van Veen grab. (Table 1, Fig. 1) Sediments were stored in 250 mL bottles and treated with an ethanol-Rose Bengal solution to distinguish between living and dead foraminiferal specimens. Samples were gently washed through a 63 μm mesh net with tap water to remove clay, silt and any remaining dye. Obtained fractions were dried at 40°C in a dry oven for one week. Dried samples were qualitatively analyzed using a dissecting microscope (Olympus SZ40) and selected specimens were observed with Scanning Electron Microscopy (SEM, Hitachi S-3400N). Taxonomic identification, systematic classification and a distribution survey were carried out using the following references: Ellis & Messina (1940), McCulloch (1977; 1981), Loeblich & Tappan (1987), Cimerman & Langer (1991), Hottinger et al. (1993), Jones (1994), Debenay (2013), Holbourn et al. (2013), Hayward et al. (2017) and WoRMS (2017). All specimens examined in this study were deposited in the NIBR (National Institute of Biological Resources).

RESULT AND DISCUSSION

A total of 30 marine benthic Foraminifera species belonging to 24 genera and seven orders (Astrorhizida, Lagenida, Lituolida, Miliolida, Robertinida, Rotaliida, and Textulariida) was identified. Ten new records of species belonging to nine genera and five orders (Lagenida, Lituolida, Robertinida, Rotaliida, Textulariida) were identified in the Yellow Sea. Twenty new records of species belonging to 15 genera and five orders (Astrorhizida, Lagenida, Lituolida, Miliolida, and Rotaliida) were identified in the East Sea (Table 2).

SYSTEMATICS

Phylum Foraminifera d’Orbigny 1826
Class Monothalamea Haeckel, 1862
Order Astrorhizida Lankester, 1885
Superfamily Astrorhizoidea Brady, 1881
Family Dendrophryidae Haeckel, 1894
Genus Psammatodendron Norman, 1881

1. Psammatodendron arborescens Norman, 1881 (Plate 1, 1a-f)
Psammatodendron arborescens Norman, 1881 in Brady, 1881, p. 404 (cited from Hayward et al., 2017).

<table>
<thead>
<tr>
<th>Table 1. Information on the sampling stations</th>
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<tbody>
<tr>
<td>Station</td>
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<tr>
<td>30905</td>
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<td>31005</td>
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<td>31105</td>
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<td>E3</td>
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<tr>
<td>E4</td>
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<td>E8</td>
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</table>

Fig. 1. Locations of eight sampling stations in the East and West coast of South Korea. This map is cited from Google Earth Pro.


Diagnosis. Wall finely agglutinated and brownish in color. Test free, elongated, and bifurcating. Early chamber rounded then repeatedly bifurcating tubular portion of constant diameter. Aperture multiple at the end of tubular branches.

Remarks. This is the first report of this species in Korea. Psammatodendron arborescens is the type species of the genus Psammatodendron Norman, 1881. There are only two extant species in this genus: P. arborescens Norman, 1881 and P. indivisum Heron-Allen & Earlend, 1932. The brown colored branched chamber is the typical character of P. arborescens. Psammatodendron
## Table 2. Summary of unrecorded species from the East Sea and the Yellow Sea.

<table>
<thead>
<tr>
<th>Order</th>
<th>Superfamily</th>
<th>Family</th>
<th>Genus</th>
<th>Species</th>
<th>Region</th>
<th>Station</th>
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<td>Astrorhizida</td>
<td>Astrorhizoidea</td>
<td>Dendrophryida</td>
<td>Psammatodendron Norman, 1881</td>
<td>Psammatodendron arborescens Norman, 1881</td>
<td>East Sea</td>
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<tr>
<td></td>
<td>Hippocrepinoaide</td>
<td>Hyperamminida</td>
<td>Hyperammina Brady, 1878</td>
<td>Hyperammina elongata Brady, 1878</td>
<td>East Sea</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Hyperammina friabilis Brady, 1884</td>
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<tr>
<td>Milioliida</td>
<td>Miliolida</td>
<td>Hauerinida</td>
<td>Pyrgo Defrance, 1824</td>
<td>Pyrgo inornata (d’Orbigny, 1846)</td>
<td>East Sea</td>
<td>E3</td>
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<tr>
<td>Lituolida</td>
<td>Lituolida</td>
<td>Lituidae</td>
<td>Ammobaculites Cushman, 1910</td>
<td>Ammobaculites cylindricus Cushman, 1910</td>
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<td>Spiroplectammina Cushman, 1927</td>
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<td>Spiroplectammina biformis (Parker &amp; Jones, 1865)</td>
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<td>Rotaliida</td>
<td>Serioidea</td>
<td>Cassidulinida</td>
<td>Cassidulina d’Orbigny, 1826</td>
<td>Cassidulina limbata Cushman &amp; Hughes, 1925</td>
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<td>Lagenida</td>
<td>Nodosarioidea</td>
<td>Lagenida</td>
<td>Lageno Walker &amp; Boys, 1798</td>
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<td>Lagen stramosa Reuss, 1858</td>
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<td>Lagen striata vari. semiornata Reuss, 1863</td>
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<td>Polymorphina amplissima McCulloch, 1977</td>
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<td>Polymorphina subelliptica McCulloch, 1977</td>
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<td>Homosinoidea</td>
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<td>Trochamminida</td>
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<td>Textulariida</td>
<td>Eggerelloidea</td>
<td>Eggerellida</td>
<td>Eggerella Cushman, 1933</td>
<td>Eggerella pusilla (Goës, 1896)</td>
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<td>Robertinida</td>
<td>Centobuliminoidea</td>
<td>Epistominida</td>
<td>Hoeglundina Broten, 1948</td>
<td>Hoeglundina lucidiformis McCulloch, 1981</td>
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<td>Rotaliida</td>
<td>Serioidea</td>
<td>Cassidulinida</td>
<td>Evolutocassidulina Eade, 1967</td>
<td>Evolutocassidulina tenus (Pheeger &amp; Parker, 1951)</td>
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<td>Planorbulinoidea</td>
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<td>Cibicides mabahethi Said, 1949</td>
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<td>Cibicides pseudolabatulus Perels &amp; Reiss, 1975</td>
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<td>Lagenida</td>
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<td>Lagenida</td>
<td>Cerebrina Patterson, 1986</td>
<td>Cerebrina claricurvulata (McCulloch, 1977)</td>
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<td>Vaginulinida</td>
<td>Lenticulina Lamarck, 1804</td>
<td>Lenticulina tasmanica Parr, 1950</td>
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</table>
Plate 1. 1. (a-f) *Psammatodendron arborescens* Norman, 1881; 2. *Hyperammina elongata* Brady, 1878; 3. (a, b) *Hyperammina friabilis* Brady, 1884; 4. (a-c) *Pyrgo inornata* (d’Orbigny, 1846); 5. (a, b) *Reophax fusiformis* (Williamson, 1858); 6. (a, b) *Nodulina dentaliformis* (Brady, 1881). Scale bar = 100 μm unless indicated otherwise.
indivisum has a long, unbranching, narrow tubular chamber connected to a depressed circular primodal chamber, unlike the branched one in P. arborescens.

**Distribution.** Korea, Arctic Ocean, North Atlantic Ocean.


**Diagnosis.** Test composed of a large proloculus and an undivided tubular chamber of constant diameter, elongated, curved in the middle portion. Wall agglutinated with fine to middle size quartz. Initial end rounded, apert. terminal opened.

**Remarks.** According to Loeblich & Tappan (1987), this species is the type species of the genus Hyperammina Brady, 1878. There are 32 modern species in this genus, only one species was reported in Korea, H. rugosa Verdenius & van Hinte, 1983. Hyperammina elongata has a finer agglutinated test and clearer proloculus than H. rugosa. Hyperammina rugosa has a very rough and coarsely agglutinated test wall, and specimens with a preserved proloculus are very rare.

**Distribution.** Korea, China, Japan, United States, Canada, Gulf of Saint Lawrence, Gulf of Mexico, Bay of Biscay (France), Celtic Sea, North Atlantic Ocean, Norway, Arctic Ocean, Southern Ocean.

3. **Hyperammina friabilis** Brady, 1884 (Plate 1. 3a-b)

Hyperammina friabilis Brady, 1884, p. 258, pl. XXIII, figs. 1-3, 5-6.


**Diagnosis.** Test composed of a large proloculus and an undivided tubular chamber of constant diameter, elongated, curved in the middle portion. Wall agglutinated with medium-sized quartz particles, grey in color. Test free, elongated, and straight. Aperture terminal.

**Remarks.** According to the original description in Ellis & Messina (1940), H. friabilis is larger and the outline is commonly broader and stouter than those of H. elongata. The wall of H. friabilis is conspicuously thick and the cavity has a well-marked preceding chamber, while H. elongata has a uniform and thin wall, and the cavity is slightly widened at the inferior end. Hyperammina friabilis is commonly grey rather than brown in color.

**Distribution.** Korea, China, Japan, New Caledonia, New Zealand, Gulf of Mexico, United States, Mediterranean Sea, Norway.

Class Tubothalamea Pawlowski, Holzmann & Tyszka, 2013
Order Miliolida Defrance, 1824
Superfamily Milioloidae Ehrenberg, 1839
Family Hauerinidae Schwager, 1876
Genus Pyrgo Defrance, 1824

4. **Pyrgo inornata** (d’Orbigny, 1846) (Plate 1. 4a-c)

Biloculina inornata d’Orbigny, 1846, p. 266, pl. 16, figs. 7-9 (cited from Ellis & Messina, 1940).

Biloculina anomala Schlumberger, 1891, p. 569, pl. 11, figs. 84-86, pl. 12, fig. 101 (cited from Hayward et al., 1999); Cushman, 1917, p. 79, pl. 32, fig. 1; Cushman, 1921, p. 474, pl. 96, figs. 1a-c.

**Nummulopyrgo anomala** (Schlumberger, 1891): Loeblich & Tappan, 1994, p. 42, pl. 91, figs. 4-10.

Pyrgo anomala (Schlumberger, 1891): Hayward et al., 1999, p. 97, pl. 4, figs. 1-2.

**Pyrgo inornata** (d’Orbigny, 1846): Debenay, 2013, pp. 117, 276.

**Material examined.** Korea, East Sea, station E3 (37°55′ 4.816°N, 128°51′11.786°E), 20 May 2016, by Van Veen Grab, collected by Raehyuk Jeong and Jisu Yeom. NIBR ID: NIBPR0000107246.

**Diagnosis.** Wall calcareous, porcelaneous. Test ovate, inflated, chamber arrangement biloculine, involute at later portion. Suture depressed. Aperture terminal, wide, with a broad tooth.

**Remarks.** Biloculine and strongly biconvex test and an oval shaped aperture with broad, rounded tooth are the typical features of P. inornata. Our specimen had a slightly more elongated test than specimens reported from New Caledonia (Debenay, 2013) and Jeju island (Kim et al., 2016), but mostly resembles the specimen reported by Cushman in 1921 from the Philippines and the type specimen reported from Austria (Ellis & Messina, 1940).

**Distribution.** Korea, China, Japan, New Caledonia, New Zealand, Sahul Shelf, Gulf of Mexico, North Atlantic Ocean, Bay of Biscay (France), Mediterranean Sea.

Class Globothalamea Pawlowski, Holzmann & Tyszka, 2013
Order Lituolida Lankester, 1885
Superfamily Lituoloidea Ehrenberg, 1839
Family Biloculinae P. inornata
Genus Biloculina Defrance, 1824

ID: NIBRPR0000107236.
Superfamily Hormosinoidea Haekel, 1894
Family Reophacidae Cushman, 1927
Genus Reophax de Montfort, 1808

5. Reophax fusiformis (Williamson, 1858) (Plate 1. 5a-b)
Proteonina fusiformis Williamson, 1858, p. 1, pl. 1, fig. 1 (cited from, Höglund, 1947); Cushman, 1910, p. 41, fig. 39; Höglund, 1947, p. 52, pl. 4, fig. 21, p. 56, figs. 20-21.
Reophax fusiformis (Williamson, 1858): Jones, 1994, p. 37, pl. 30, figs. 7-10; Yassini & Jones, 1995, p. 67, fig. 17; Debenay, 2013, pp. 90, 255.


Diagnosis. Test fusiform, tapering toward both ends, and multichambered. Chambers rounded to pyriform. Wall agglutinated with heterogeneous sediment grains. Aperture terminal and circular produced on a short neck.

Remarks. According to Ellis & Messina Catalogue of Foraminifera (1940), this species was originally classified as Proteonina fusiformis Williamson, 1858, and later Loeblich & Tappan transferred it to R. fusiformis in 1955 (Ellis & Messina, 1940). This species can be mis-identified with the genus Lagenammina Rhumbler, 1911 because of its variable chamber compartment. However, the genus Reophax is multichambered, whereas Lagenammina is unilocular.

Distribution. Korea, China, Japan, New Caledonia, New Zealand, United States, Canada, Gulf of Mexico, Gulf of Saint Lawrence, North Atlantic Ocean, Norway, English Channel, Irish Sea and St. George’s Channel, Bay of Biscay (France), Celtic Sea, Mediterranean Sea.

Genus Nodulina Rhumbler, 1895

6. Nodulina dentaliniformis (Brady, 1881) (Plate 1. 6a-b)
Lituola (Reophax) dentaliniformis Brady, 1881, p. 49 (cited from Debenay, 2013).
Reophax dentaliniformis Brady, 1881: Brady, 1884, p. 193, pl. 30, figs. 21-22 (cited from Cushman, 1910); Cushman, 1910, p. 87, fig. 121; Cushman, 1920, p. 18, pl. 5, figs. 4-5; Cushman, 1921, p. 68, pl. 12, fig. 4; Höglund, 1947, pp. 88, 89, fig. 54, pl. 9, fig. 13; Debenay, 2013, pp. 90, 255.
Hormosina dentaliniformis (Brady, 1881): Brönnimann & Whittaker, p. 265, figs. 8-11 (cited from Debenay, 2013).
Nodulina dentaliniformis (Brady, 1881): Loeblich & Tappan, 1987, p. 58, pl. 44, figs. 10-11.


Diagnosis. Test free, elongated, uniserial, and somewhat curved. Chambers regularly increasing in size as added. Horizontal sutures. Wall agglutinated with medium to coarse sediment particles. Aperture terminal and rounded at the end of short and cylindrical neck.

Remarks. This species is the type species of genus Nodulina Rhumbler, 1895, and the only species included in this genus. According to Loeblich & Tappan (1987), the test of this species is similar to that of Reophax species, but Nodulina has more regular, gradually enlarging chambers, horizontal sutures and a straighter axis than Reophax.

Distribution. Korea, China, Japan, New Caledonia, Canada, United States, Bay of Biscay (France), Celtic Sea, Norway.

Genus Ammobaculites Cushman, 1910

7. Ammobaculites cylindricus Cushman, 1910 (Plate 2. 1a-c)
Ammobaculites cylindricus Cushman, 1910, pl. 441, figs. 15-16 (cited from Jones, 1994).


Diagnosis. Test free, large, elongated, cylindrical and uniserial with a planispiral early portion. Wall coarsely agglutinated. Suture depressed but not distinct due to agglutinated particles. Aperture rounded and terminal.

Remarks. This specimen is similar to A. cylindricus (Jones, 1994, plate 33 fig. 6) in having the long, straight cylindrical outline of test. According to Cushman (1921), this species differs from the ordinary form of A. calcareus by having a cylindrical shape, and differs from A. agglutinans (d’Orbigny, 1846) in the greater proportion of involute coiling portion.


Genus Spiroplectammina Cushman, 1927

8. Spiroplectammina biformis (Parker & Jones, 1865) (Plate 2. 2a-c)
Textularia agglutinans var. biformis Parker & Jones,
Plate 2. 1. (a-c) *Ammobaculites cylindricus* Cushman, 1910; 2. (a-c) *Spiroplectammina biformis* (Parker & Jones, 1865); 3. (a, b) *Nouria sinensis* Zheng & Fu, 2001; 4. *Paratrochammina madeirae* Brönniman, 1979; 5. (a, b) *Eggerella pusilla* (Goës, 1896); 6. (a-c) *Hoeglundina lucidiformis* McCulloch, 1981; 7. (a-c) *Cassidulina limbata* Cushman & Hughes, 1925. Scale bar = 100 μm unless indicated otherwise.


Diagnosis. Test free, elongate and narrow. Chamber arrangement planispiral in early portion, later biserial. Wall coarsely agglutinated, with smoothly finished surface, brownish in color, test small, flat and elongated. Aperture a low interiomarginal arch at the base of last chamber.

Remarks. This species was originally classified as a variety of Textularia agglutinans d’Orbigny (Ellis & Messina, 1940). Planispiral chamber coiling in early stage and biserial arrangement in later stage are the most typical characteristics of the genus Spiroplectammina. Currently 18 extant species are in the genus. In Korea, there are four recorded species.

Distribution. Korea, China, Japan, South Pacific Ocean, New Zealand, New Caledonia, United States, Bay of Fundy, Canada, Gulf of Saint Lawrence, Vineyard Sound, North Atlantic Ocean, Baltic Sea, Norway, Celtic Sea, English Channel, Scotian Shelf, Southern Ocean, North Western Weddell Sea, King George Island.

Family Nouriidae Chapman & Parr, 1936
Genus Nouria Heron-Allen & Earland, 1914

10. Paratrochammina madeirae Brönniman, 1979
(Plate 2. 4)
Paratrochammina madeirae Brönniman, 1979, p. 7, pl. 7, figs. a-c, f, h, pl. 10, figs. b, e (cited from Hottinger et al., 1993).


Diagnosis. Test free, rounded, with slightly lobate peripheral margin. Chamber arrangement low trochospiral, chamber size rapidly increased as added. Wall agglutinated with coarse materials. Final chamber accounts for about one-third of total test surface area. Aperture a low interiomarginal arch.

Remarks. This is the first report of the genus Paratrochammina in Korea. There are 27 extant species recorded. In Loeblich & Tappan (1987), Paratrochammina madeirae Brönniman, 1979 is the type species of the genus Paratrochammina. Paratrochammina differs from Trochammina Parker & Jones, 1859 in having an umbilical-extrumbilical aperture rather than a basal aperture midway between the umbilicus and periphery.

Distribution. Korea, Gulf of California, Gulf of Aqaba, Mediterranean Sea - Eastern Basin.

Order Textulariida Delage & Hérouard, 1896
Superfamily Eggerelloidea Cushman, 1937
Family Eggerelliidae Cushman, 1937
Genus Eggerella Cushman, 1933

11. Eggerella pusilla (Goës, 1896) (Plate 2. 5a-b)
Verneuilina pusilla Goës, 1896, p. 39, pl. 5, figs. 6-8 (cited from Ellis & Messina, 1940).

Material examined. Korea, Yellow Sea, station 30905 (35°51′3.89″N, 125°24′32.39″E), April 2015, collected by Sangjin Kim. NIBR ID: NIBRPR0000107233.

Diagnosis. Test subconical, slightly tapering toward initial end, trochospiral in early stage, and later triserial. Wall finely agglutinated. Chambers inflated, sutures dis-
tinguishable. Aperture a low slit bordered by a narrow lip.

Remarks. The cylindrical outline and the chamber ar-
angement are trochospiral in the initial part and triseri-
al in the later part. The aperture on the internal margin
of last chamber is the typical feature of this species.
There are nine extant species in the genus *Eggerella*
internationally, and two species are reported in Korea: *E.
australis* Collins, 1958, and *E. bradyi* (Cushman, 1911).

**Distribution.** Korea, China, Japan, New Caledonia.

Order Robertinida Loeblich & Tappan, 1984
Superfamily Ceratobuliminoidea Cushman, 1927
Family Epistominidae Wedekind, 1937
Genus *Hoeglundina* Broten, 1948

(Plate 2. 6a-c)

57, fig. 9.

**Material examined.** Korea, Yellow Sea, station 31205
(34°2′38.52″N, 125°29′52.5″E), 11 Apr 2015, by Van
Veen Grab, collected by Sangjin Kim. NIBR ID: NI-
BRPR0000107221.

**Diagnosis.** Test trochospiral, biconvex. Umbilical side
more convex than spiral side. Suture radial, not de-
pressed, but curved backward on spiral side. Wall cal-
careous, perforated, surface smooth. Aperture a long slit-
lke opening along peripheral margin on umbilical side.

**Remarks.** *Hoeglundina lucidiformis* was first reported
from the Atlantic Ocean by McCulloch (1981). Accord-
ing to the original description, this species is similar to
*Hoeglundina mesolucida* McCulloch, 1981 but *H.
lucidiformis* is more compressed, with a more translu-
cent test without elaborate patterns on the surface like *H.
elegans* (d’Orbigny, 1826), or *H. mesolucida* McCull-
och, 1981. Also, the sutures on the spiral (evolute) side
of *H. lucidiformis* are more curved backward.

**Distribution.** Korea, Atlantic Ocean.

Order Rotaliida Delage & Hérouard, 1896
Superfamily Cassidulinoidae d’Orbigny, 1839
Family Cassidulinidae d’Orbigny, 1839
Genus *Cassidulina* d’Orbigny, 1826

13. *Cassidulina limbata* Cushman & Hughes, 1925
(Plate 2. 7a-c)

*Cassidulina limbata* Cushman & Hughes, 1925, p. 12,
pl. 2, fig. 2a-c (cited from Ellis & Messina, 1940).

**Material examined.** Korea, East Sea, station E8 (37°23′
55.665″N, 129°14′57.671″E), 21 May 2016, Van Veen
Grab, by Raehyuk Jeong and Jisu Yeom. NIBR ID: NI-
BRPR0000107248.

**Diagnosis.** Test nearly circular to lenticular in side view
with slightly projecting final chamber. Peripheral margin
carinate and slight lobulate. Chambers distinct, biseri-
ally arranged and clear umbilical boss in the center. Su-
tures distinct, curved, weakly limbate. Wall calcareous,
hyaline, and perforate. Aperture close to inner margin of
the final chamber, narrow elongate, parallel to periphery.

**Remark.** This specimen is superficially similar to *C.
translucens* Cushman & Hughes, 1925, but the umbili-
cal boss, carinate width, and the last chamber shape are
different. There are 76 extant *Cassidulina* species wor-
dide reported, and ten species have been reported from
Korea.

**Distribution.** Korea, California.

Genus *Evolvocassidulina* Eade, 1967

(Plate 3. 1a-e)

*Cassidulinoideae* tenuis Phleger & Parker, 1951, p. 27, pl.
14, figs. 14-17 (cited from Ellis and Messina, 1940);
Jones, 1994, p. 57, pl. 52, figs. 7-8.

*Evolvocassidulina* tenuis (Phleger & Parker, 1951): Eade,
1967, p. 433, fig. 3, Nos., 3, 4.

**Material examined.** Korea, Yellow Sea, station 31205
(34°2′38.52″N, 125°29′52.5″E), 11 April 2015, by Van
Veen Grab, collected by Sangjin Kim. NIBR ID: NIBR
PR0000107229.

**Diagnosis.** Test free, elongate, round in section, early
portion coiled and lenticular then biserial, and slightly
curved. Chambers distinct and increasing in size quite
rapidly as added. Sutures distinctly depressed. Wall cal-
careous, hyaline, and finely perforate. Aperture terminal,
elongated loop extending from base of last chamber.

**Remarks.** This species is the first report of the genus
*Evolvocassidulina* in Korea. There are six extant species
in the genus, and the representative features are enrolled
early stage like *Cassidulina*, and biserial chamber ar-
angement in later stages.

**Distribution.** Korea, Japan, New Zealand, Gulf of Mex-
ico, Bay of Biscay.

Superfamily Planorbuloideidae Schwager, 1877
Family Cibicididae Cushman, 1927
Genus *Cibicidoides* Thalmann, 1939

15. *Cibicidoides barnetti* Bermudez, 1949
(Plate 3. 2a-b)

*Cibicidoides barnetti* Bermudez, 1949, p. 296, pl. 24,
figs. 7-9 (cited from Ellis & Messina, 1940).

**Material examined.** Korea, Yellow Sea, station 31205
Plate 3. 1. (a-e) *Evolvocassidulina tenuis* (Phleger & Parker, 1951); 2. (a, b) *Cibicidoides barnetti* (Bermudez), 1949; 3. (a-c) *Cibicides mahabethi* Said, 1949; 4. (a-c) *Cibicides pseudolabatulus* Perelis & Reiss, 1975. Scale bar = 100 μm unless indicated otherwise.
Genus *Cibicides* de Montfort, 1808

16. *Cibicides mabaethi* Said, 1949 (Plate 3. 3a-c)

*Cibicides mabaethi* Said, 1949, p. 42, pl. 4, fig. 20 (cited from Debenay, 2013); Hottinger et al., 1993, p. 115, pl. 151, figs. 6-12; Debenay, 2013, pp. 190, 315.

Material examined. Korea, South China Sea, Pacific Ocean, Gulf of Mexico, Barbados, Atlantic Ocean.

**Diagnosis.** Umbilical side more convex than spiral side, involute with a raised umbo, spiral side coarsely perforate on chamber side. Wall calcareous, test circular, umbilical side more convex than spiral side. Sutures curved in the spiral side and radial and slightly depressed in the umbilical side. Wall calcareous, coarsely perforate. Aperture a low interiomarginal to equatorial arch.

**Remarks.** This species resembles *C. barnetti* Bermudez, 1949 as shown by Holbourn et al. (2013) but our specimens have a smoother surface on the spiral side unlike the rough surface in the specimen described by Holbourn et al. (2013).

**Distribution.** Korea, South China Sea, Pacific Ocean, Gulf of Aqaba.

18. *Cerebrina claricerviculata* (McCulloch, 1977) (Plate 4. 1a-b)


Material examined. Korea, Yellow Sea, station 31105 (34°2’38.52”N, 125°29’52.5”E), 11 Apr 2015, by Van Veen Grab, collected by Sangjin Kim. NIBR ID: NIBR PR0000107220.

**Diagnosis.** Test free, small and ovate in outline. Distinctly raised trimarginate keel complex at periphery, central keel more extended, starting at the ends of aperture, and lateral keels staring from middle part of apertural edge. Wall calcareous hyaline, and perforate especially on inflated sides. Aperture terminal, fissure, with a lip.

**Remarks.** *Cerebrina claricerviculata* was originally classified within the genus *Lagenosolenia* McCulloch, 1977. There are eight extant species reported in the genus *Cerebrina*, internationally. This is the first record of this genus in Korea. Our specimen is more similar to the specimen reported from Japan by Akimoto et al. (2002) than the specimen reported from New Caledonia by Debenay (2013) in having slightly more broadly rounded basal end.

**Distribution.** Korea, Japan, New Caledonia.
Plate 4. 1. (a, b) Cerebrina claricerviculata (McCulloch, 1977); 2. (a-d) Lagena nebulosa (Cushman, 1923); 3. (a-c) Lagena strumosa Reuss, 1858; 4. (a-c) Lagena striata var. semiornata Reuss, 1863; 5. (a-c) Procerolagena cylindrocostata Albani & Yassini, 1989. Scale bar = 100 μm unless indicated otherwise.
19. *Lagena nebulosa* (Cushman, 1923) (Plate 4. 2a-d)
*Lagena laevis* var. *nebulosa* Cushman, 1923, p. 29, pl. 5, figs. 4-5.
*Lagena nebulosa* (Cushman, 1923): Jones, 1994, p. 62, pl. 56, fig. 12; Lei and Li, 2016, p. 158, fig. 13a-c.

**Material examined.** Korea, East Sea, station E4 (37°55′ 4.816′N, 128°51′11.786′E), 20 May 2016, by Van Veen Grab, collected by Raehyuk Jeong and Jisu Yeom. NIBR ID: NIBRPR0000107243.

**Diagnosis.** Test unilocular, fusiform, with short basal spine. Surface ornamented by distinct longitudinal striae about one-half in length of test. Basal portion of neck irreguarly costate. Wall calcareous, hyaline, and perforate. Aperture terminal at the end of neck with a phialine lip slightly costate.

**Remarks.** Our specimen has a very unusual striae pattern that continues from the bottom of the test to the middle part of the test and reappears throughout the neck. This specimen is different from the original description in having additional striae on the neck, and currently *L. striata* var. *semiornata* is regarded as a fossil species. This specimen is most closely related to *L. striata* var. *semiornata*, however the species has to be reallocated to an extant species in the near future.

**Distribution.** Korea, Germany.

Genus *Procerolagena* Puri, 1954

20. *Lagena strumosa* Reuss, 1858 (Plate 4. 3a-c)

**Material examined.** Korea, East Sea, station E4 (37°55′ 4.816′N, 128°51′11.786′E), 20 May 2016, by Van Veen Grab, collected by Raehyuk Jeong and Jisu Yeom. NIBR ID: NIBRPR0000107240.

**Diagnosis.** Test globular, with a neck ornamented by some raised annuli, and basal spine. Wall calcareous, hyaline, perforate, surface ornamented by longitudinal striae, which end near the beginning part of neck. Aperture at the end of neck, with a phialine lip.

**Remarks.** This species looks quite similar to *L. striata* in having a globular test with longitudinal costae, but can be distinguished because *L. striata* has striae that continue along the neck while *L. strumosa* has several horizontal costae on the neck.

**World distribution.** Korea, Japan, Yellow Sea, New Caledonia, New Zealand, Gulf of Aqaba, Sea of Marmara.

*(Plate 4. 4a-c)*
*Lagena striata* var. *semiornata* Reuss, 1863 p. 341, pl. 3, fig. 45 (cited from Ellis and Messina, 1940).

**Material examined.** Korea, East Sea, station E4 (37°55′ 4.816′N, 128°51′11.786′E), 20 May 2016, by Van Veen Grab, collected by Raehyuk Jeong and Jisu Yeom. NIBR ID: NIBRPR0000107245.

**Diagnosis.** Test unilocular, fusiform, with short basal spine. Surface ornamented by distinct longitudinal striae about one-half in length of test. Basal portion of neck irregularly costate. Wall calcareous, hyaline, and perforate. Aperture terminal at the end of neck with a phialine lip slightly costate.

**Remarks.** Our specimen has a slightly more inflated test than the specimen described from New Caledonia by Debenay (2013). This species and *Lagena substriata* look similar as a whole, but the spaces between striae of *P. cylindrocostata* is wider, the length of some striae is shorter and the basal part is more rounded than *L. substriata*. There are 21 extant species in the genus *Procerolagena*, but only one species has been reported in Korea: *Procerolagena amphora* (Williamson, 1848).

**Distribution.** Korea, Australia, New Caledonia, Bass Strait.

Family Vaginulinidae Reuss, 1860
*Genus Lenticulina* Lamarck, 1804
23. Lenticulina tasmanica Parr, 1950 (Plate 5.1)
Lenticulina tasmanica Parr, 1950, p. 321, pl. 13, figs. 3-4 (cited from Ellis & Messina, 1940).

Material examined. Korea, Yellow Sea, station 31205 (34°2'38.52"N, 125°29'52.5"E), 11 Apr 2015, by Van Veen Grab, collected by Sangjin Kim. NIBR ID: NIBRP0000107219.
Remarks. There are 97 extant species in the genus Lenticulina, and 17 species are reported from Korea. The most typical feature of this genus is the lenticular test shape and the terminal radiate aperture. According to the original description in Elis & Messina (1940), this species differs from L. articulate or L. lucida by its large lobulated slit extending along the full length of the apertural side.

Distribution. Korea, New Zealand, New Caledonia.

24. Polymorphina amplissima McCulloch, 1977 (Plate 5.2a-b)
Polymorphina amplissima McCulloch, 1977, p. 162, pl. 78, figs. 4-7.

Diagnosis. Test elongate, fusiform, with broadly rounded initial end, and rounded periphery. Chamber arrangement biserial, sutures distinct, oblique, and slightly depressed. Wall calcareous, hyaline perforate, surface smooth, transluscent to nearly opaque. Aperture terminal, produced, radiate.
Remark. According to WoRMS and National List of Species of Korea (2012), there are 79 extant species in the genus Polymorphina, and four species are reported from Korea. According to the original description of this species, our specimen seems close to the megalospheric form, which has a broadly rounded initial end.


25. Polymorphina subelliptica McCulloch, 1977 (Plate 5.3a-c)
Polymorphina subelliptica McCulloch, 1977, p. 173, pl. 78, figs. 1-3, 8-10, 14.

Diagnosis. Test free, elongate, periphery lobate, and initial end accurately rounded. Chambers longer than wider, biserial arranged with an initial, extra chamber followed by later chambers overlapping on the raised half of sigmoid form. Chambers of depressed half of each biserial series more elongate. Sutures distinct, oblique, curved and depressed. Wall calcareous, hyaline, surface smooth and glossy. Aperture terminal, radiate, slightly produced with compressed end.
Remark. According to McCulloch (1977), the microspheric form of this species has an acutely rounded initial end and an extra chamber in the initial part followed by additional accurate shaped chambers in a position overlapping on the raised half. Our specimen seems to be a microspheric form. The genus Polymorphina can be confused with the genus Guttulina, but in Guttulina, chambers are added spirally in five planes, whereas Polymorphina has a biserial chamber arrangement.

Distribution. Korea, Gulf of California.
27. Guttulina succincta McCulloch, 1977
(Plate 5. 4a-c)
Guttulina succincta McCulloch, 1977, p. 185, pl. 75, figs. 10, 12-20.


Diagnosis. Test free, elongate, fusiform, initial end somewhat acutely rounded, greatest width slightly below mid-point. Early stage chambers small, 144° apart, later much increased in size, ending near middle part of test or extending to the basal part of test embracing previous chambers, laterally. Sutures distinct, depressed, and periphery lobate. Wall calcareous, hyaline, surface smooth, and slightly translucent to transparent. Aperture terminal, radiate, slightly produced, with bluntly rounded end.

Remark. The present specimen differs slightly from the specimens reported in Eastern Pacific (McCulloch, 1977) in having a more widely rounded initial end.

Distribution. Korea, Cortes Bank, off Santa Barbara, Gulf of California.

Genus Ellipsolagenidae Silvestri, 1923
Genus Fissurina Reuss, 1850

28. Fissurina bispinata Ujiié, 1963 (Plate 6. 2a-c)


Diagnosis. Test small, ovate in outline, with very slight peripheral keel. Basal end mucronate with two very short spines. Wall calcareous, hyaline, surface smooth, and nearly translucent to opaque. Aperture terminal, produced and slit-like.

Remark. This species was originally classified as a subspecies of F. cucurbitasema, but later was separated into an independent species. Fissurina bispinata differs from F. cucurbitasema in having two basal spines. Our specimen looks similar to the specimens reported from New Caledonia and Japan (Ellis & Messina, 1940; Debenay, 2013), but has a slightly more elongated test.

Distribution. Korea, China, Japan, New Caledonia, Sahul Shelf.

Genus Lagenosolenia McCulloch, 1977

30. Lagenosolenia obtecta McCulloch, 1977 (Plate 6. 4)
Lagenosolenia obtecta McCulloch, 1977, p. 67, pl. 64, fig. 23


Diagnosis. Test unilocular, elliptical to ovate, compressed, initial end rounded, periphery slightly keeled. Wall calcareous, hyaline, and perforate especially near the periphery, surface transparent. Greatest width at below middle part, tapering gradually toward basal end, evenly to shoulders tapering toward terminal. Aperture terminal, oval, with a phialine lip.

Remarks. According to the original description of McCulloch (1977), L. obtecta differs from congeners in possessing numerous pores, an incomplete keel, an entoselenian tube not centered a short hyaline neck embraced in a keel, and ending in a phialine lip. There are 142 extant species in the genus Lagenosolenia, but only one species (L. confossa) has been reported in Korea (NIBR, 2012; Kim et al., 2016).

Distribution. Korea, Philippines, Chatham Island, San Miguel Island.
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