

No. 9 — *Foraminifera Species Off Portsmouth, New Hampshire*<sup>1</sup>

By FRANCES L. PARKER

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INTRODUCTION

The species discussed in this paper are, for the most part, those used by Phleger in his study of the ecology of Foraminifera off Portsmouth, N. H. Some species groups that he has combined have been divided for discussion because of interesting occurrences. A few rare species are included for the same reason. The types are deposited at the U.S. National Museum in Washington, D. C.

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Locations of the samples are in Phleger's paper (see above). The area between latitudes  $43^{\circ}7'N$  and  $42^{\circ}41'N$  and longitudes  $70^{\circ}04'W$  and  $70^{\circ}47'W$  has been very extensively sampled with the exception of the southeastern portion in the vicinity of Jeffreys Ledge. This area is shown on the U. S. Coast and Geodetic chart, Portsmouth to Cape Ann, published in May, 1941 (5th edition).

### PLANKTONIC FAUNA

The planktonic fauna of the Gulf of Maine is almost negligible and the species are not discussed. The specimens are mostly immature forms occurring in about 5 per cent of the samples. The species represented are: *Globigerina bulloides* d'Orbigny, *G. eggeri* Rhumbler, *G. pachyderma* (Ehrenberg), and *Globigerinoides rubra* (d'Orbigny).

### BENTHONIC FAUNA

#### General Statement

The benthonic fauna is closely related to Arctic faunas to the north and to the faunas south of the Cape Cod barrier. Approximately 25 per cent of the species discussed are found in the Arctic, 35 per cent occur only south of Cape Cod and 30 per cent occur in both regions. The fauna is not a large one since the area is relatively small and the greatest depths are less than 200 m. For this reason it is difficult to give an adequate comparison with the southern fauna. It is well known, however, that Cape Cod forms a barrier for many of the warmer water species occurring to the south.

No samples were taken in the small bays of the area and species characteristic of such environments only are not present. An example of this is *Eponides frigidus* (Cushman) var. *calidus* Cushman and Cole which is abundant in some shallow bays of the area. A few species, however, usually associated with marsh or river faunas are found near the mouths of the rivers, such as *Trochammina macrescens* H. B. Brady and *Miliammina fusca* (H. B. Brady).

In addition to the 71 species from the Portsmouth area discussed below, two new species, *Labrospira arctica* and *Trochamminella atlantica*, have been described from the Arctic. Cushman's classification has been followed in the arrangement of the genera.



Discussion of species

Family ASTRORHIZIDAE

CRITHIONINA PISUM Goës var. HISPIDA Flint

(Plate 1, figure 1)

*Crithionina pisum* Goës var. *hispida* Flint, 1897 (1899), Ann. Rept., U. S. Nat. Mus., p. 267, pl. 6, fig. 2.

The Portsmouth specimens have fewer sponge spicules in the wall of the test than those figured by Flint. This is true also of specimens found by Höglund (1947, p. 36) in Swedish waters. The species is found at scattered stations in the North Atlantic. It is very rare in the Portsmouth area.

Family SACCAMMINIDAE

PROTEONINA ATLANTICA Cushman

(Plate 1, figure 2)

*Proteonina atlantica* Cushman, 1944, Spec. Publ. 12, Cushman Lab. Foram. Res., p. 5, pl. 1, fig. 4.

*Reophax difflugiformis* H. B. Brady (part), 1884, Rept. Voy. CHALLENGER, Zool., vol. 9, p. 289, pl. 30, fig. 5 (not figs. 1-4).

*Proteonina difflugiformis* (part) of authors.

This species is much more coarsely arenaceous, is less flask-like in shape, and has a less pronounced neck than *P. difflugiformis* (H. B. Brady). A study of paratypes at the Cushman Laboratory showed that many of the specimens have a more prolonged neck than does the holotype. The wall of the Portsmouth specimens is very rough and is formed of angular quartz grains, sometimes up to 0.5 mm. in length, cemented with fine siliceous cement. The species is a common one south of Cape Cod and also occurs in the Arctic.

PROTEONINA DIFFLUGIFORMIS (H. B. Brady)

(Plate 1, figure 3)

*Reophax difflugiformis* H. B. Brady, 1879, Quart. Jour. Micr. Sci., vol. 19, p. 51, pl. 4, figs. 3a-b.; 1884 (part), Rept. Voy. CHALLENGER, Zool., vol. 9, p. 289, pl. 30, figs. 1-4 (not fig. 5).



This species differs from *P. atlantica* in its flask-like shape with a definite neck and in having a fairly fine-grained, smoothly finished wall. Occasional large grains are included in the surface of the wall but they are usually cemented flush with the surface. It is not common in the Portsmouth area. It is difficult to give the distribution of the species owing to its having been so often combined with *P. atlantica*. Apparently the latter is the more common species in northern waters of the Atlantic.

#### URNULINA COMPRESSA Cushman

(Plate 1, figure 4)

*Urnulina compressa* Cushman, 1930, Bull. 4, Florida State Geol. Surv., p. 15, pl. 1, figs. 2a, b.

*Millettella spinata* Cushman and McCulloch (not Cushman and Cahill), 1939,

Allan Hancock Pacific Exped., vol. 6, no. 1, p. 43, pl. 2, figs. 1, 2.

Only a single specimen of this species was found. The only previously reported occurrence is from the Miocene of Florida. This specimen is identical with the holotype, with which it was compared at the Cushman Laboratory. The form figured by Cushman and McCulloch as *Millettella spinata* from the Pacific is apparently identical. The aperture of these forms appears to be more terminal than is that of the holotype as figured by Cushman and Cahill. The species is also found in rivers flowing into Long Island Sound. Since the Portsmouth specimen occurs at a station at the mouth of the Merrimack River it is probable that the form is limited to a brackish water environment.

#### Family HYPERAMMINIDAE

##### HIPPOCREPINA INDIVISA Parker

(Plate 1, figure 5)

*Hippocrepina indivisa* Parker, 1870, in Dawson, Canadian Nat., n. ser., vol. 5, p. 176, fig. 2.

This species is very rare. It is interesting to note that Cushman (1944, p. 6) found it to be very abundant at one station in the Gulf of Maine, off Eastport. It is recorded to the north ranging to the Arctic and from Albatross station D2018, off the coast of Maryland at 1440 m. (Cushman, 1918, p. 58).



HYPERAMMINA ELONGATA H. B. Brady

(Plate 1, figure 10)

*Hyperammina elongata* H. B. Brady, 1878, Ann. Mag. Nat. Hist., ser. 5, vol. 1, p. 433, pl. 20, figs. 2a, b.

This species is rare in the Portsmouth area. It appears to have a widespread distribution.

Family REOPHACIDAE

HORMOSINA sp.

(Plate 1, figures 8, 9)

I have not been able to find this species in the literature, but have insufficient material to make an adequate study of it. It is very small, 0.28–0.6 mm. in length, usually composed of three to four chambers, the early chambers being globular, the last more elongate. It occurs only rarely in the Portsmouth area.

REOPHAX ARCTICA H. B. Brady

(Plate 1, figures 6, 7)

*Reophax arctica* H. B. Brady, 1881, Ann. Mag. Nat. Hist., ser. 5, vol. 8, p. 405, pl. 21, fig. 2.

*Bigenerina arctica* Cushman (part) 1948, Spec. Publ. 23, Cushman Lab. Foram. Res., p. 31, pl. 3, fig. 9 (not figs. 10, 11).

Examination of specimens by transmitted light shows that this species is uniserial throughout. Cushman's plesiotypes figured in his monograph on the Arctic were examined. The first figured specimen (fig. 9) is typical. The other two are unrelated forms. Figure 10 is a small specimen of the new species *Textularia torquata* (q. v.) and figure 11 is apparently an immature form of *Spiroplectammina biformis*.

This species occurs at many stations in the Portsmouth area. It occurs in the Arctic but is not reported from south of Cape Cod.

REOPHAX CURTUS Cushman

(Plate 1, figures 11–19)

*Reophax curtus* Cushman, 1920, Bull. 104, U. S. Nat. Mus., pt. 2, p. 8, pl. 2, figs. 2, 3.

*Reophax scorpiurus* Balkwill and Wright (not Montfort), 1885, Trans. Roy. Irish. Acad., vol. 28, Sci., p. 328, pl. 13, figs. 5a, b; Goës (part), 1894,



Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, p. 24, pl. 5, figs. 160-167 (?not 158, 159, 168, 169).

?*Reophax subfusiformis* Earland, 1933, Discovery Repts., vol. 7, p. 74, pl. 2, figs. 16-19.

*Reophax subfusiformis* Höglund, 1947, Zool. Bidrag från Uppsala, bd. 26, p. 82, pl. 9, figs. 1-4; pl. 26, figs. 1-36; pl. 27, figs. 1-19; text figs. 43-50.

*Reophax* cf. *pilulifer* Cushman (not H. B. Brady), 1944, Spec. Publ. 12, Cushman Lab. Foram. Res., p. 10, pl. 1, fig. 21.

The holotype has not been seen, but from material at hand from the Gulf of Maine, where Cushman has reported the species, its characteristics can be studied. The species is a very variable one. Many specimens can be found without a neck, as described by Cushman. Many others, however, have a neck which is composed of fine material and is probably easily broken. Specimens occur with from three to five, or even six, chambers, although the majority have four. The relative size of the last chamber varies, the chambers in some specimens increasing much more gradually in size than in others. The specimens with chambers increasing most rapidly in size are usually the larger forms having very large proloculi and probably represent the megalospheric generation. It is apparently specimens of this type that Cushman used to illustrate the species.

Until Earland's specimens from the Antarctic can be seen, his species *R. subfusiformis* cannot be definitely placed in the synonymy under *R. curtus*, but it seems probable that it should be. The main difference between the two species as described and figured, aside from the presence of a neck and the number of chambers, is in the character of the wall. The holotype of *R. curtus* has a very rough, coarsely arenaceous wall. Earland's species is described as having a wall that is "thin and smoothly finished externally". In the Gulf of Maine there is a relatively small number of specimens having such a wall. One of these forms is figured (pl. 1, fig. 17). Whether or not this is a separate species or even a variety is very questionable. It is identical with the specimens of typical *R. curtus* in every other respect. Höglund's Swedish species appears to be identical with Cushman's although I have not examined specimens.

Specimens occur which are very similar to the species from Vineyard Sound referred to *R. scoriurus*? by Cushman (1944, p. 10). The chambers increase much more slowly in size as added, but are inflated. In the ecologic study of the Portsmouth area these forms have been combined with *R. curtus* to which they appear to be closely related (pl. 1, figs. 15, 16, 18). A second form, which I am at present regarding as a variant of *R. curtus*, is very small, with uninflated chambers and a prolonged neck (pl. 1, fig. 19). It is usually associated with the typical



form, but is very rare and it has been impossible to obtain enough material for study.

REOPHAX GRACILIS (Kiaer)

(Plate 2, figure 1)

*Nodulina gracilis* Kiaer, 1900, Rept. Norwegian Fish Mar. Invest., vol. 1, no. 7, p. 24, 2 text figs. (the left-hand one is questionable).

This species is very rare in the Portsmouth area. It is not reported elsewhere in the western Atlantic.

REOPHAX SCOTTII Chaster

(Plate 2, figure 2)

*Reophax scottii* Chaster, 1890-91 (1892), First Rept. Southport Soc. Nat. Sci., p. 57, pl. 1, fig. 1.

*Reophax catella* Höglund, 1947, Zool. Bidrag från Uppsala, bd. 26, p. 97, text figs. 77, 78.

This species is present at a number of stations in the Portsmouth area. Höglund (1947, p. 11) has wrongly interpreted the species because of having no access to Chaster's original description. He based his interpretation of the species on Cushman's (1920, p. 11) description which also appears to be in error. The original description is given here for the benefit of those who have not seen it. "Test elongate, narrow, composed of a large number (10-20) of segments which gradually increase in size; segments generally somewhat pyriform, and abruptly truncate below; aperture small; texture very delicate and transparent, the test being built up of thin scales of mica or other material neatly joined at their margins by chitinous material. The test when moist is quite flexible. Length .4-.625 mm." There is no mention of compression of the test as asserted by Cushman and later by Höglund nor of a wall composed of mica flakes "imbricately attached to a chitinous membrane" as described by Höglund. Höglund's *R. catella* seems to be identical with Chaster's form.

The species has been observed in Buzzards Bay and Long Island Sound south of Cape Cod but is not reported from the Arctic.



## Family AMMODISCIDAE

## AMMODISCUS CATINUS Höglund

(Plate 2, figures 3, 4)

*Ammodiscus catinus* Höglund, 1947, Zool. Bidrag från Uppsala, bd. 26, p. 122, pl. 8, figs. 1, 7; pl. 28, figs. 19-23; text. figs. 82-84, 105-107, 109.

This species is widespread in the Portsmouth area. Its concavo-convex character and narrow whorls distinguish it easily from the following species. It is reported only from the Swedish areas studied by Höglund.

## AMMODISCUS MINUTISSIMUS Cushman and McCulloch

(Plate 2, figure 5)

*Ammodiscus minutissimus* Cushman and McCulloch, 1939, Allan Hancock Pacific Exped., vol. 6, p. 70, pl. 5, figs. 3, 4.

The Portsmouth specimens apparently are identical with the types examined at the Cushman Laboratory. The original description also seems to agree in all respects. This species is reported by Cushman (1944, p. 11) from shallow water, 18-33 m., in this area and at a few localities south of Cape Cod at 11 m. and 15 m.

## GLOMOSPIRA GORDIALIS (Jones and Parker)

(Plate 2, figure 6)

*Trochammmina squamata* var. *gordialis* Jones and Parker, 1860, Quart. Jour. Geol. Soc., vol. 16, p. 304; Parker and Jones, 1865, Phil. Trans. Roy. Soc. London, vol. 155, p. 408, pl. 15, fig. 32.

This species is rare.

## Family LITUOLIDAE

## AMMOBACULITES CASSIS (Parker)

(Plate 2, figures 8-10)

*Lituola cassis* Parker, 1870, in Dawson, Canadian Nat., n. ser., vol. 5, pp. 177, 180, fig. 3.

This species was named from specimens collected in Gaspé Bay, Gulf of St. Lawrence. It shows its best development in the Arctic.



Portsmouth specimens are less broad and more elongate, the chambers not extending so far down on the inner side, although steeply slanting as in normal specimens. In spite of these differences there seems no doubt that the specimens should be referred to Parker's species. It is suggested that this abnormal variation may be caused by minimum conditions for survival of the species obtaining in the Portsmouth area. It is not found farther south than Massachusetts Bay where it shows similar variations with even greater elongation of the test.

#### HAPLOPHRAGMOIDES BRADYI (Robertson)

(Plate 2, figure 11)

*Trochammina robertsoni* Brady, 1887 (not Brady, 1876), Jour. Roy. Micr. Soc., p. 893.

*Trochammina bradyi* Robertson, 1891, Ann. Mag. Nat. Hist., ser. 6, vol. 7, p. 388.

This species is fairly abundant in deeper parts of the Portsmouth area. It has been observed east of Cape Cod at stations deeper than 85 m. (Parker, 1948) but is not reported elsewhere in the western Atlantic, although it is found farther south in the Gulf of Mexico.

#### HAPLOPHRAGMOIDES GLOMERATUS (H. B. Brady)

(Plate 2, figures 13, 14)

*Lituola glomerata* H. B. Brady, 1878, Ann. Mag. Nat. Hist., ser. 5, vol. 1, p. 433, pl. 20, figs. 1a-c.

This species is widespread in the Portsmouth area. It is not found on the continental shelf south of Cape Cod, although, like the previous species, it is found in the Gulf of Mexico. It also occurs abundantly in the Arctic.

#### LABROSPIRA ARCTICA n.sp.

(Plate 2, figures 7, 12)

*Trochammina trullissata* H. B. Brady (part) (not H. B. Brady, 1879, Quart. Jour. Micr. Sci., vol. 19 (n.s.), no. 73, p. 56, pl. 5, figs. 10a, b, 11), 1884, Rept. Voy. CHALLENGER, Zool., vol. 9, p. 342, pl. 40, figs. 14a, b (not figs. 13a, b, 15, 16).

Test small, compressed, partially evolute; periphery rounded, slightly lobulate; chambers 6-7 in the adult whorl, slightly inflated;



sutures straight, slightly depressed; wall very smooth, polished, finely arenaceous; aperture small, narrow, slightly curved, with a broad protuberant lip. Maximum diameter 0.4 mm., maximum thickness 0.11 mm.

Holotype from station 12, Baffin Bay at a depth of 629 m.; Lat. 74°46'N., Long. 74°25'W.

This species differs from other described species such as *L. jeffreysii* in the smooth, highly polished wall. It also differs from *L. jeffreysii* in the more regular, less lobulate periphery, straighter sutures, and smaller size. It has the same type of wall as *Haplophragmoides bradyi* and this feature makes it very distinctive. It has been observed only in samples from Baffin Bay, from water depths greater than 250 m. It is of interest to note that figures 10a, b of *Trochammina trullissata* Brady 1879 are identical with the CHALLENGER Report figures, pl. 40, figs. 13a, b, which Cushman (1910, p. 113, text figs. 174a, b) renamed *Cyclammina bradyi*. This form should, therefore, retain the specific name *trullissata*. Brady's figure 11 of 1879 is a section which was not reproduced in the CHALLENGER Report and apparently represents a *Haplophragmoides*. Whether or not this figure represents the same species as his figures 10a, b is somewhat questionable and the genus may be referable to *Cyclammina* as stated by Cushman.

#### LABROSPIRA CRASSIMARGO (Norman)

(Plate 2, figures 16a, b)

*Haplophragmium crassimargo* Norman, 1892, Mus. Normanianum, pt. 8, p. 17.

*Haplophragmium canariense* Brady (part) (not d'Orbigny), 1884, Rept. Voy.

CHALLENGER, Zool., vol. 9, p. 310, pl. 35, fig. 4 (not figs. 1-3, 5).

*Haplophragmoides major* Cushman, 1920, Bull. 104, U. S. Nat. Mus., pt. 2, p. 39, pl. 8, fig. 6.

*Labrospira crassimargo* Höglund, 1947, Zool. Bidrag från Uppsala, bd. 26, p. 141, pl. 11, fig. 1; text figs. 121-125.

Study of a paratype specimen of *Haplophragmoides major* at the Cushman Laboratory shows it to have the "intereo-areal" aperture designated by Höglund (1947, p. 141) as the distinguishing characteristic of the genus *Labrospira*. Since, as Höglund points out (1947, p. 143), Cushman's characterization of the aperture of *H. major* as "an elongate semicircular slit at the base of the final chamber, the upper portion forming a thin lip" is the only apparent basis for a separation of this form from Norman's, the two species would seem to be synonymous. I have compared the paratype specimens with Arctic specimens from Greenland as well as with the Portsmouth



forms and all appear to be identical. As Höglund points out, the detection of the presence of the lower lip is sometimes difficult.

There is a possibility that d'Orbigny incorrectly analyzed the character of the aperture of *Haplophragmoides canariensis* (*Nonionina canariensis* d'Orbigny, 1839, in Barker-Webb and Berthelot, Hist. Nat. Iles Canaries, vol. 2, pt. 2, "Foraminifères," p. 128, pl. 2, figs. 33, 34) which was designated by Cushman as the genotype of *Haplophragmoides* (1910, p. 99). A study of material from the Canary Islands or of type material (if possible) should clarify this point and is necessary to determine the final validity of Höglund's genus.

This species is very common in the Portsmouth area. It is found at shallow depths (15 m.-90 m.) but occurs only rarely in the area farther south (Parker, 1948, p. 222). It is common in the Arctic.

#### LABROSPIRA JEFFREYSII (Williamson)

(Plate 2, figures 15, 17-20)

*Nonionina jeffreysii* Williamson, 1858, Rec. Foram. Great Britain, p. 34, pl. 3, figs. 72, 73.

*Haplophragmoides columbiensis* Cushman 1944, (not Cushman, 1925), Spec. Publ. 12, Cushman Lab. Foram. Res., p. 11, pl. 2, fig. 1; Parker, 1948, Bull. Mus. Comp. Zoöl., vol. 100, no. 2, p. 238, pl. 4, fig. 17.

The Portsmouth specimens are somewhat larger than those described by Williamson, with a diameter up to 0.83 mm., and have 6-7 chambers in the adult whorl rather than 7-8 as described by him. In other respects the two species appear to be identical. *H. columbiensis* (Cushman) has a more smoothly polished surface and more flexuose sutures. There is considerable variation in the amount of involution.

This species is widespread in the Portsmouth area, usually occurring at low frequencies. It is found east of Cape Cod but is not reported farther south. Similar specimens occur in the Arctic.

#### LABROSPIRA cf. NITIDA (Goës)

(Plate 2, figures 21, 22)

*Haplophragmium nitidum* Goës, 1896, Bull. Mus. Comp. Zoöl., vol. 29, p. 30, pl. 3, figs. 8, 9.

The tests of the Portsmouth specimens do not appear to be as finely arenaceous or as polished as those of Goës's Caribbean form. They are more smoothly finished and have a more polished surface, however, than such forms as *L. crassimargo*. The species is very rare in this



area and has not hitherto been reported in the western Atlantic north of South Carolina.

RECURVOIDES TURBINATUS (H. B. Brady)

(Plate 2, figures 23, 24)

*Haplophragmium turbinatum* H. B. Brady, 1881, Quart. Jour. Micr. Sci., n. s., vol. 21, p. 50; 1884, Rept. Voy. CHALLENGER, Zool., vol. 9, p. 312, pl. 35, figs. 9a-c.

This species seems to fit Brady's description and figures very well, the only apparent discrepancy being in size. The Portsmouth specimens attain a maximum diameter of 0.4 mm. Brady describes specimens up to 0.75 mm. Brady describes the species as having six chambers in the final whorl which is true also of the Portsmouth specimens. Cushman (1920, pp. 81, 82) says that it may have up to eight chambers. It seems probable that he has confused Brady's form with another, possibly *R. contortus* Earland, or that he has included more than one species under this name. Höglund's species *R. trochaminiiformis* (1947, p. 149) also shows some resemblance to this species but apparently has somewhat more inflated chambers. It is possible, though, that it should be placed in the synonymy under this species.

The species is a very common one in the Portsmouth area and has also been observed at stations in the vicinity of Greenland. It is reported by Parker (1948, p. 238) from the continental shelf east of Cape Cod.

Family TEXTULARIIDAE

SPIROPLECTAMMINA BIFORMIS (Parker and Jones)

(Plate 3, figures 1, 2)

*Textularia agglutinans* d'Orbigny var. *biformis* Parker and Jones, 1865, Phil. Trans. Roy. Soc. London, vol. 155, p. 370, pl. 15, figs. 23, 24.

*Spiroplectammina* sp. Parker, 1948, Bull. Mus. Comp. Zoöl., vol. 100, no. 2, p. 239, pl. 4, fig. 21.

This species is common at many stations. There is a good deal of size variation in the specimens from different stations. Microspheric specimens vary from 0.07–0.14 mm. in width and 0.25–0.54 mm. in length; megalospheric individuals from 0.11–0.14 mm. in width and 0.21–0.36 mm. in length. I have seen specimens from off Greenland with a maximum length of 0.65 mm. and maximum width of 0.21 mm. This species is recorded by Cushman (1944, p. 13) from just south of Cape Cod.



SPIROPLECTAMMINA TYPICA Lacroix

(Plate 3, figures 3-8)

*Spiroplectammina typica* Lacroix, 1931, Bull. Instit. Ocean., Monaco, no. 582, p. 14, fig. 9; 1932, *ibid*, no. 591, p. 6, text figs. 2, 3.

The specimens from the Portsmouth area are larger than those figured by Lacroix. His specimens, figured in 1932, are approximately 0.22 mm. and 0.13 mm. in length and 0.08 mm. and 0.06 mm. in width. The Portsmouth specimens have a maximum length of 0.65 mm. and maximum width of 0.25 mm. In other respects the forms seem to be identical. This size discrepancy is a large one but it does not give a sufficient basis for the erection of a new species. *S. typica* is a much more compressed form than *S. biformis*. It has been reported previously only from the Mediterranean.

TEXTULARIA TORQUATA n.sp.

(Plate 3, figures 9-11)

*Bigenerina archica* Cushman (part) (not H. B. Brady), 1948, Spec. Publ. 23, Cushman Lab. Foram. Res., p. 31, pl. 3, fig. 10 (not figs. 9, 11).

Test small, compressed and frequently somewhat twisted, rapidly tapering from the broadest part near the apertural end; periphery slightly lobulate due to the overlapping of the chambers; chambers 5-6 pairs in the biserial portion, slightly inflated; sutures slightly depressed, slanting downward at an angle of about 45°; wall rough, coarsely arenaceous; aperture narrow, loop-shaped, extending up into the apertural face almost to the apex of the test. Maximum length 0.29 mm., maximum width 0.15 mm., maximum thickness 0.07 mm.

Holotype from station 114 at a depth of 93 m., Lat. 42°45.7'N, Long. 70°29.3'W.

This species most closely resembles *T. contorta* Höglund but differs in having clearly visible, somewhat depressed sutures; in the aperture which is an elongate loop instead of horseshoe-shaped; and in the fact that many individuals show a definite coil at the initial end.

This species is widespread in the Portsmouth area and is found off Greenland where it has been observed in samples from Baffin Bay and the Kane Basin.



## Family VALVULINIDAE

## EGGERELLA ADVENA (Cushman)

(Plate 3, figures 12, 13)

*Verneuilina advena* Cushman, 1921 (1922), Contr. Canadian Biol., no. 9, p. 141.

*Verneuilina polystropha* Cushman (not Reuss), 1920, Rept. Canadian Arctic Exped., vol. 9, pt. M, p. 8, pl. 1, fig. 5.

*Eggerella arctica* Höglund, 1947, Zoöl. Bidrag från Uppsala, bd. 26, p. 193, pl. 16, fig. 4; text figs. 166-168.

This species was first referred to *Verneuilina polystropha* Cushman, 1920, as pointed out by Cushman (1948, p. 32). The fact that he also included a reference to *V. polystropha* Heron-Allen and Earland, 1913, in a later paragraph does not alter the fact that the Arctic specimens should form the basis for the conception of the species. The specimen figured by Cushman in 1920 is 0.42 mm. long. Oddly enough the drawing shows a hint of multiple chambers in the initial portion of the test although Cushman described it originally as triserial throughout. The species is common in the Portsmouth area. It occurs on the continental shelf south of Cape Cod at depths of less than 90 m. (Parker, 1948, p. 221) and is also found in the Arctic.

## VALVULINA CONICA Parker and Jones

(Plate 3, figures 14, 18)

*Valvulina triangularis* d'Orbigny var. *conica* Parker and Jones, 1865, Phil. Trans. Roy. Soc. London, vol. 155, p. 406, pl. 15, fig. 27.

*Valvulina triangularis* Parker and Jones (not d'Orbigny), 1857, Ann. Mag. Nat. Hist., ser. 2, vol. 19, p. 23 (295), pl. 11, figs. 15, 16.

This species is found in small percentages at many stations. South of Cape Cod it is found in the deepest facies, 300-680+m., in small numbers (Parker, 1948, p. 226). It occurs as far north as the Gulf of St. Lawrence (Cushman, 1922, p. 62).

## Family SILICINIDAE

## MILIAMMINA FUSCA (H. B. Brady)

(Plate 3, figures 15, 16)

*Quinqueloculina fusca* H. B. Brady, 1870, Ann. Mag. Nat. Hist., ser. 4, vol. 6, p. 47 (286), pl. 11, figs. 2a-c, 3.



*Quinqueloculina fusca* H. B. Brady var. *groenlandica* Cushman 1944 (not Cushman, 1933), Spec. Publ. 12, Cushman Lab. Foram. Res., p. 14, pl. 2, fig. 21.

This species is somewhat more coarsely arenaceous than the other reported species of the genus. In other respects it is typical. There is some variation in size, but the maximum observed length is 0.5 mm. It is found only at nearshore stations in the Portsmouth area. It is reported in England from brackish water near the mouths of rivers and by Phleger and Walton (1950, p. 280) from Barnstable Harbor. The species has also been observed south of Cape Cod in Long Island Sound in brackish and nearshore water. The form from the Arctic figured under this name by Cushman (1948, p. 33, pl. 3, figs. 16, 17) does not belong to this species.

In connection with the study of *M. fusca* at the Cushman Laboratory, specimens of "*Quinqueloculina groenlandica*" Cushman were examined and found to belong to the genus *Miliammina*.

## Family MILIOLIDAE

### PYRGO SUBSPHAERICA (d'Orbigny)

(Plate 3, figure 17)

*Biloculina subspheerica* d'Orbigny, 1839, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 162, pl. 8, figs. 25-27.

This species is rare. It has not been previously reported from north of Cape Cod. It is rare in the facies from 90-300 m. south of Cape Cod (Parker, 1948, p. 224).

### QUINQUELOCULINA ARCTICA Cushman

(Plate 3, figures 19a, b)

*Quinqueloculina arctica* Cushman, 1933, Smithsonian Misc. Coll., vol. 89, no. 9, p. 2, pl. 1, figs. 3a-c.

Typical specimens occur in the Portsmouth area. A few reach a length of 1.0 mm. although Cushman gives the maximum length of Arctic specimens as 0.65 mm. (Cushman, 1948, p. 35). The species is not common but is of interest as being the first noted occurrence south of the Arctic. A few specimens have been observed south of Cape Cod near Block Island.



## QUINQUELOCULINA FRIGIDA n.sp.

(Plate 3, figures 20a, b)

Test medium in size, periphery rounded but not broad; chambers protruding on the four-chambered side but with rounded angles, the center chamber on the three-chambered side narrow, in a concave area formed by the outer chambers; wall somewhat rough, the outer layer formed of medium-sized sand grains set in a ferruginous calcareous cement; aperture rounded on a slightly projecting neck, with a simple tooth. Maximum length 0.8 mm.; maximum width 0.6 mm.; maximum thickness 0.4 mm.

Holotype from station 610 at a depth of 37 m.; Lat. 43°04.6'N, Long. 77°33.6'W.

This species somewhat resembles *Q. agglutinata* Cushman, which was described from off Alaska. It is smaller and the chambers are less sharply angled and much narrower at the outer periphery making the test less thick in proportion to the width. Cushman described *Q. agglutinata* (1917, p. 43) as 0.9 mm. in length but specimens have been observed from Dundas Harbor, near Greenland, more than 1.0 mm. in length. *Q. frigida* occurs at several stations in the Portsmouth area but is not abundant.

## QUINQUELOCULINA SEMINULA (Linné)

(Plate 3, figures 21a, b, 22a, b; pl. 4, figures 1, 2)

*Serpula seminulum* (Linné), 1758, Syst. Nat., ed. 10, p. 786.

This species is rare. It is apparently more common at Cushman's shallow water stations in the Gulf of Maine (Cushman, 1944, p. 13). On the continental shelf south of Cape Cod it is found in the facies from 15-90 m. (Parker, 1948, p. 221). It is also reported from the Arctic.

## QUINQUELOCULINA SUBROTUNDA (Montagu)

(Plate 4, figures 4a, b)

"*Serpula subrotunda dorso elevato*" Walker and Boys, 1784, Test. Min., p. 2, pl. 1, fig. 4.

*Vermiculum subrotundum* Montagu, 1803, Test. Brit., pt. 2, p. 521.

*Vermiculum disciforme* Macgillivray, 1843, Hist. Moll. Anim. Aberdeen, p. 319.

*Miliolina seminulum* (Linné) var. *disciformis* Williamson, 1858, Rec. Foram. Great Britain, p. 86, pl. 7, figs. 188, 189.



Occasional specimens are seen with *Massilina*-like chambers as pointed out by Cushman (1948, p. 35). This characteristic and the character of the aperture make the inclusion of the species in the genus *Quinqueloculina* somewhat questionable. It is reported from the Arctic and also occurs south of Cape Cod. It is rare in the Portsmouth area. Many forms referred to "*Quinqueloculina secans* d'Orbigny" and "*Triloculina circularis* Bornemann" in the literature may be referable to *Q. subrotunda*.

#### TRILOCULINA TRICARINATA d'Orbigny

(Plate 4, figure 5)

*Triloculina tricarinata* d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 299, no. 7; Modèles no. 94.

The Portsmouth specimens are slightly more rounded at the periphery than d'Orbigny's model. The species is rare. It is difficult to get accurate information on its distribution elsewhere in the western Atlantic although Parker (1948, p. 227) reports it as rare south of Cape Cod in her deepest facies at 300-680 m. It is also reported from the Arctic but the reliability of these reports is doubtful.

#### Family TROCHAMMINIDAE

##### TROCHAMMINA ADVENA Cushman

(Plate 4, figures 3a, b)

*Trochammina advena* Cushman, 1922, Carnegie Instit. Washington, Publ., p. 20, pl. 1, figs. 2-4.

?*Trochammina* cf. *rotaliformis* Höglund, 1947 (not Wright, 1911), Zoöl. Bidrag från Uppsala, bd. 26, p. 198, pl. 17, figs. 1, 2; text figs, 180, 181.

This species is found in small numbers at many stations. It is identical with Cushman's species except for a slightly greater inflation of the chambers. It is reported from the Tortugas region off Florida, from the Gulf of Mexico and as *T. globulosa* Cushman, by Parker (1948, p. 240) from the continental shelf east of Cape Cod.

##### TROCHAMMINA INFLATA (Montagu)

(Plate 4, figures 6, 10).

*Nautilus inflatus* Montagu, 1808, Test. Brit., Suppl., p. 81, pl. 18, fig. 3.

The specimens from the Portsmouth area are small but otherwise typical. They are found only at nearshore stations. The species is found south of Cape Cod but is not reported from the Arctic.



## TROCHAMMINA LOBATA Cushman

(Plate 4, figures 7a, b)

*Trochammina lobata* Cushman, 1944, Spec. Publ. 12, Cushman Lab. Foram. Res., p. 18, pl. 2, fig. 10.

This species was described from the Gulf of Maine. It also occurs south of Cape Cod at depths shallower than 90 m. (Parker, 1948, p. 221).

## TROCHAMMINA MACRESCENS H. B. Brady

(Plate 4, figures 8a, b)

*Trochammina inflata* (Montagu) var. *macrescens* H. B. Brady, 1870, Ann. Mag. Nat. Hist., ser. 4, vol. 6, p. 51, pl. 11, figs. 5a-c.

This species is rare at two shallow stations. It also occurs in brackish water in Long Island Sound. The species reported by Phleger and Walton (1950, p. 280) from Barnstable Harbor, north of Cape Cod, should be referred to *Jadammina polystoma* Bartenstein and Brand. The two forms appear to be distinct and have not been found together at the same locality.

## TROCHAMMINA QUADRILOBA Höglund

(Plate 4, figures 9a, b)

*Trochammina quadriloba* Höglund, 1948, Contr. Cushman Lab. Foram. Res., vol. 24, pt. 2, p. 46.

*Trochammina pusilla* Höglund, 1947 (not Geinitz, 1848), Zoöl. Bidrag från Uppsala, bd. 26, p. 201, pl. 17, figs. 4a-c; text figs. 183, 184.

This species appears to be identical with Höglund's. It is rare at many stations. The species has also been observed in material from Lancaster Sound, off Greenland. It has not been previously reported except by Höglund in his Swedish material.

## TROCHAMMINA SQUAMATA Parker and Jones and related species

(Plate 4, figures 11-16)

*Trochammina squamata* Parker and Jones, 1865, Phil. Trans. Roy. Soc. London, vol. 155, p. 407, pl. 15, figs. 30, 31a-c.

*T. squamata* and its allied species are treated as a unit in analyzing the faunal distribution. This is done because of the difficulty of



differentiating the forms in counting without causing great delay. Since they usually appear to act as a faunal unit it does not seem worthwhile to attempt a separation. Some of the species of this group, which are represented, are: the typical species (pl. 4, figs. 11, 12) which seems to be identical with "*T. propria* Cushman" (1944, p. 19, pl. 2, fig. 11); *T. ochracea* (Williamson) (*Rotalina ochracea* Williamson, 1858, p. 55, pl. 4, fig. 112; pl. 5, fig. 113) (pl. 4, figs. 13, 14); and *T. (Remaneica) helgolandica* Rhumbler (1938, p. 195, figs. 38-45) (pl. 4, figs. 15, 16).

Representatives of this group are found in the Arctic and in shallow water samples south of Cape Cod. They are widespread in the Portsmouth area.

*TROCHAMMINELLA ATLANTICA* n.sp.

(Plate 4, figures 17a, b, 18, 19)

Test small, slightly compressed, with a low trochoid spire; periphery rounded, very lobulate; chambers 5-6 in the adult whorl, more commonly 5, inflated, especially toward the outer part; sutures distinct, depressed, slightly curved; wall thin, slightly rough, composed of medium sand grains of varying size; aperture an elongate slit near the inner margin of the chamber, with a distinct lip. Maximum diameter 0.47 mm., maximum thickness 0.22 mm.

Holotype from Core 16, Melville Sound, off Canada, at 124 m., Lat. 74°34'N, Long. 110°40'W.

This species is often found associated with *T. bullata* Höglund but may be distinguished easily by its somewhat larger size, lower spire and more numerous, less globose chambers. Some specimens appear distorted owing to the uneven inflation of the chambers. Except for the character of the aperture the species shows a rather close resemblance to *Trochammina advena* Cushman.

Family LAGENIDAE

*OOLINA COSTATA* (Williamson)

(Plate 4, figures 20, 21)

*Entosolenia costata* Williamson, 1858, Rec. Foram. Great Britain, p. 9, pl. 1, fig. 18.

*Lagena costata* Cushman, 1944, Spec. Publ. 12, Cushman Lab. Foram. Res., p. 21, pl. 3, fig. 4.

*O. costata* is not reported elsewhere in the western Atlantic. A few specimens have been observed in material from off Greenland.



## Family POLYMORPHINIDAE

## PSEUDOPOLYMORPHINA NOVANGLIAE (Cushman)

(Plate 5, figure 1)

*Polymorphina lactea* (Walker and Jacob) var. *novangliae* Cushman, 1923, Bull. 104, U. S. Nat. Mus., pt. 4, p. 146, pl. 39, figs. 6-8.

This species was described from the Gulf of Maine. It is found south of Cape Cod and is reported from Gaspé Bay.

## Family NONIONIDAE

## ASTRONONION STELLATUM Cushman and Edwards

(Plate 5, figures 2, 3)

*Nonionina elegans* d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 294, no. 10 (nomen nudum).

Fornasini, 1899 (not Williamson, 1858), Mem. Accad. Sci. Bologna, ser. 5a, vol. 7, p. 655, fig. 5.

*Nonionina stelligera* d'Orbigny (part) of authors.

*Astrononion stellatum* Cushman and Edwards, 1937, Contr. Cushman Lab. Foram. Res., vol. 13, pt. 1, p. 32, pl. 3, figs. 9-11.

*Astrononion stelligerum* Cushman, 1948 (not d'Orbigny, 1839), Spec. Publ. 23, Cushman Lab. Foram. Res., p. 55, pl. 6, fig. 6.

d'Orbigny's species was based on specimens collected from "le banc de 'Terre-Neuve'"; since there is no accompanying designation it is a *nomen nudum*. Fornasini's figure, one of d'Orbigny's unpublished figures, shows the species to be identical with *Astrononion stellatum* Cushman and Edwards described from off southern Iceland. The latter name stands owing to the appearance of Williamson's "*Nonionina*" *elegans* before Fornasini's publication of the figure of d'Orbigny's species. The species bears a close resemblance to the Mediterranean form *Astrononion stelligerum* (d'Orbigny) but is more compressed and has a more lobulate periphery caused by the greater inflation of the chambers. It commonly has 7-8 chambers although occasional specimens have more.

The species has not been found south of Cape Cod in the western Atlantic.



ELPHIDIUM ADVENUM (Cushman) var. MARGARITACEUM Cushman

(Plate 5, figure 4)

*Polystomella advenum* Cushman var. *margaritaceum* Cushman, 1930, Bull. 104, U. S. Nat. Mus., pt. 7, p. 25, pl. 10, fig. 3.

This species is very rare in the Portsmouth area. On the continental shelf south of Cape Cod it is reported in shallow water samples by Cushman (1944, p. 26).

ELPHIDIUM ARTICULATUM (d'Orbigny)

(Plate 5, figures 5-7)

*Polystomella articulata* d'Orbigny, 1839, Voy. Amér. Mérid., vol. 5, pt. 5, "Foraminifères," p. 30, pl. 3, figs. 9, 10.

*Nonion orbiculare* Cushman (not H. B. Brady), 1944, Spec. Publ. 12, Cushman Lab. Foram. Res., p. 24, pl. 3, fig. 24.

A comparison with specimens from the Falkland Islands, one of the localities from which d'Orbigny described the species, shows the Portsmouth species to be almost identical although slightly less compressed. Specimens are found with opaque and translucent tests, the latter being the forms which Cushman called *N. orbiculare* in this area. His plesiotype of this form was studied and found to be different from the plesiotype of *N. orbiculare* from the Arctic (Cushman, 1948, pl. 6, fig. 3). The retral processes, though present in the translucent forms, are much less prominent. This feature may be observed in other species of *Elphidium*, notably *E. incertum*, where a superficial examination of a large group of specimens has suggested that several species are present depending on the degree of translucence of the test. *E. articulatum* has the supplementary apertures on the apertural face characteristic of *Criboelphidium* Cushman and Bronnimann. They appear in varying degree in many species of *Elphidium* and if a division of the genus on this basis is necessary, as seems improbable, it should more appropriately appear as a subgeneric one.

*E. articulatum* appears to be closely related to *E. bartletti* Cushman. The adult forms of the latter species have a maximum of 12 chambers instead of the 10 or less of the former. The young specimens of *E. bartletti*, however, appear to be identical with *E. articulatum*. It is possible that *E. bartletti* represents the Arctic development of *E. articulatum*, which is not reported from that area.



## ELPHIDIUM EXCAVATUM (Terquem)

(Plate 5, figure 8)

*Polystomella excavata* Terquem, 1875, Essai Class. Anim. Dunkerque, pt. 1, p. 25, pl. 2, figs. 2a-f.

The few specimens found are very similar to specimens at the Cushman Laboratory from Bognor, England. The species is reported from shallow waters north of Cape Cod by Cushman (1944, p. 26). It also occurs south of Cape Cod in the Long Island Sound-Buzzards Bay area.

## ELPHIDIUM INCERTUM (Williamson) var. CLAVATUM Cushman

(Plate 5, figures 10, 11)

*Elphidium incertum* (Williamson) var. *clavatum* Cushman, 1930, Bull. 104, U. S. Nat. Mus., pt. 7, p. 20, pl. 7, figs. 10a, b.

This variety is the commonest form of Williamson's species found in the Portsmouth area. It is variable, however, and some specimens may not belong to the variety. Most of the specimens have a ventral plug or plugs of varying size which do not appear in Williamson's figure or description. South of Cape Cod in the shallow water of Long Island Sound and nearby bays the species is even more variable. *E. incertum* and variants are reported in the western Atlantic from the coast of Maryland to the Arctic.

## ELPHIDIUM SUBARCTICUM Cushman

(Plate 5, figure 9)

*Elphidium subarcticum* Cushman, 1944, Spec. Publ. 12, Cushman Lab. Foram. Res., p. 27, pl. 3, figs. 34, 35.

*Nonion pauciloculum* Cushman, *ibid.*, p. 24, pl. 3, fig. 25.

This species is very common. It shows the same variable characteristics of the other species of this genus. The sutures, though typically not depressed, sometimes appear as sharp, deep incisions where the amorphous material usually filling in the area is absent. The retral processes are frequently concealed by this amorphous material and it is specimens of this type which Cushman calls by the name *Nonion pauciloculum*. A study of large suites of specimens, however, shows that this species cannot be isolated. Retral processes could be observed in autotypes kindly furnished by Cushman.

Stunted specimens with four or five chambers have been observed from nearshore stations in Long Island Sound and Massachusetts Bay,



apparently living at the minimum conditions for survival. This form is widespread on the continental shelf south of Cape Cod and is also found in the Arctic.

NONION LABRADORICUM (Dawson)

(Plate 5, figure 12)

*Nonionina labradorica* Dawson, 1860, Canadian Nat., vol. 5, p. 191, fig. 4.

This species occurs in its typical form. Its range extends northward to the Arctic but it is not found south of Cape Cod.

NONIONELLA AURICULA Heron-Allen and Earland

(Plate 5, figures 13a, b, 14a, b)

*Nonionella auricula* Heron-Allen and Earland, 1930, Jour. Roy. Micr. Soc., vol. 50, p. 192, pl. 5, figs. 68-70.

The Portsmouth specimens are about twice as large as those described by Heron-Allen and Earland, with a maximum length of 0.5 mm. The species is rare. Cushman (1944, p. 25) reports it from a few stations just south of Cape Cod, although *N. atlantica* seems to be better represented in that area. Similar, though considerably larger, specimens have been observed in the Arctic.

NONIONELLA TURGIDA (Williamson) var. DIGITATA Nørvang

(Plate 5, figures 15, 16)

*Nonionella turgida* (Williamson) var. *digitata* Nørvang, 1945, Zoöl. Iceland, vol. 2, pt. 2, Foraminifera, p. 29, text. fig. 4.

This variety is very rare. The only previous report is by Nørvang from off Iceland in 141 m.

Family BULIMINIDAE

ANGULOGERINA ANGULOSA (Williamson)

(Plate 5, figures 18, 19)

*Uvigerina angulosa* Williamson, 1858, Rec. Foram. Great Britain, p. 67, pl. 5, fig. 140.

Most of the specimens are smaller and less sharply angled than those seen from the vicinity of Ireland. At some stations, however,



larger, more typical specimens are found. South of Cape Cod it is not found shallower than 63 m. (Parker, 1948). Cushman (1944, p. 30) reports it from shallow areas in the Gulf of Maine from 18 m. to 33 m., but it is found only rarely in the Portsmouth area.

*BOLIVINA PSEUDOPLICATA* Heron-Allen and Earland

(Plate 5, figure 17)

*Bolivina pseudoplicata* Heron-Allen and Earland, 1930, Jour. Roy. Micr. Soc., vol. 50, p. 81, pl. 3, figs. 36-40.

This species is rare in the Portsmouth area. It is apparently found only in shallow water of less than 90 m. as reported by Cushman (1944, p. 29) and Parker (1948, p. 221). The same is true of most of the reported occurrences around the British Isles although in the vicinity of Sweden Höglund reports its greatest frequency at 200 m. in the Skagerak (Höglund, 1947, p. 263).

*BOLIVINA PSEUDOPUNCTATA* Höglund

(Plate 5, figures 20, 21)

*Bolivina pseudopunctata* Höglund, 1947, Zoöl. Bidrag från Uppsala, bd. 26, p. 273, pl. 24, fig. 5; pl. 32, figs. 23, 24; text figs. 280, 281, 287.

This species is rare. It does not exceed the 0.4 mm. length described by Höglund as typical. Larger specimens have been seen from the vicinity of Greenland, where the species is found in greater abundance. It has not been observed elsewhere in the western Atlantic.

*BOLIVINA SUBAENARIENSIS* Cushman

(Plate 5, figure 22)

*Bolivina subaenariensis* Cushman, 1922, Bull. 104, U. S. Nat. Mus., pt. 3, p. 46, pl. 7, fig. 6.

The species is rare in the Portsmouth area, being more common in the deeper water of the area. South of Cape Cod it does not occur in the percentage counts shallower than 114 m. (Parker, 1948, p. 225).



## BULIMINA ACULEATA d'Orbigny

(Plate 5, figures 23-25)

*Bulimina aculeata* d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 269, no. 7; — Fornasini, 1901, Mem. Accad. Sci. Bologna, ser. 5, vol. 9, p. 373, text. fig. 4.

*Polymorpha pineiformia* Soldani (part), 1791, Testacea, vol. 1, pt. 2, p. 118, pl. 127, fig. 1?; pl. 130, fig. vv.

*Bulimina pupoides* d'Orbigny var. *spinulosa* Williamson, 1858, Rec. Foram. Great Britain, p. 62, pl. 5, fig. 128.

This species varies considerably in the amount of ornamentation. Some forms are almost smooth while others have well-developed spines at the initial portion of the test and occasional spines at the margins of the chambers which sometimes overhang slightly. There is no sharp undercutting at the margins of the chambers as in *B. marginata* d'Orbigny. South of Cape Cod *B. marginata* reaches its peak of frequency at shallower depths than *B. aculeata*. There seems to be no evidence in these localities for the combining of the two species advocated by Höglund (1947, p. 227). *B. aculeata* in the Portsmouth area has a maximum length of 0.54 mm. (excluding the basal spines).

## BULIMINA MARGINATA d'Orbigny

(Plate 5, figure 26)

*Bulimina marginata* d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 269, no. 4, pl. 12, figs. 10-12.

*Bulimina pulchella* d'Orbigny, 1839, Voy. Amér. Mérid., vol. 5, pt. 5, "Foraminifères," p. 50, pl. 1, figs. 6, 7.

*Bulimina serrata* Bailey, 1851, Smithsonian Contr., vol. 2, p. 12, pl., figs. 32-34.

This species shows great variation in its character in different parts of the world but is fairly uniform in the Portsmouth area. It is smaller and slightly more spinose than the typical Rimini specimens, never attaining a length greater than 0.5 mm. Similar forms are found along the continental shelf to the south but are distinct from the *B. marginata* var. of Parker (1948, p. 225) found at the outer edge of the shelf. These forms are much more spinose and are distinct from the more typical *B. marginata* which usually attains its greatest frequency at around 100 m. It is possible that a relationship between the deep-water variety and a very spinose form of *B. aculeata*, with which it is frequently associated, might be traced.



## BULIMINELLA ELEGANTISSIMA (d'Orbigny)

(Plate 5, figures 27, 28)

*Bulimina elegantissima* d'Orbigny, 1839, Voy. Amér. Mérid., vol. 5, pt. 5, "Foraminifères," p. 51, pl. 7, figs. 13, 14.

This species is rare in the Portsmouth area. I have observed it in Long Island Sound and Buzzards Bay south of Cape Cod and it is reported from Vineyard Sound by Cushman (1944, p. 27).

## GLOBOBULIMINA (DESINOBULIMINA) AURICULATA (Bailey)

(Plate 5, figure 29)

*Bulimina auriculata* Bailey, 1851, Smithsonian Contr., vol. 2, p. 12, pl., figs. 25-27.

*Bulimina pyrula* Flint (not d'Orbigny), 1899, U. S. Nat. Mus. Rept., 1897, p. 290, pl. 36, figs. 4, 5.

Höglund (1947, p. 252) places this species in the genus *Globobulimina*. The subgeneric name is retained for this species, which is the subgenotype. Höglund suggests that future revision of this genus may reveal that the subgeneric restriction is unnecessary. If, as he suggests (Höglund, 1947, p. 242), forms like *Bulimina pyrula* d'Orbigny are to be included in the genus, it seems reasonable that forms of the type of Bailey's species should be given subgeneric distinction.

This species is abundant in the Portsmouth area. It occurs also south of Cape Cod at depths greater than 90 m. (Parker, 1948, p. 225). It is replaced in the Arctic by the variety *arctica* named by Höglund (1947, p. 254).

## "ROBERTINA" cf. CHARLOTTENSIS (Cushman)

(Plate 5, figures 30a, b)

*Cassidulina charlottensis* Cushman, 1925, Contr. Cushman Lab. Foram. Res., vol. 1, pt. 2, p. 41, pl. 6, figs. 6, 7.

The species is too rare in this area to identify it with certainty. It appears to resemble closely Höglund's "*Robertina arctica*" d'Orbigny (Höglund, 1947, p. 219). I cannot agree with his interpretation of d'Orbigny's species. An examination of d'Orbigny's figure shows that the aperture extends into the face of the last-formed chamber well above the suture marking the chamber division while in Höglund's species the aperture extends into the chamber from the point of the chamber division. In Höglund's genus *Robertinoides*, on the other hand, the upper part of the main aperture is well up in the upper half



of the chamber while the smaller one is at the boundary of the two chamber parts, the so-called "lip" coming in between. This is apparently the case in d'Orbigny's figure although he draws the suture of the division of the chamber and does not indicate the presence of any apertural opening at that point. The specimens assigned to *Robertina arctica* by Cushman and Parker (1947, p. 74) appear to be identical with d'Orbigny's figured form except that there is a narrow apertural opening along the inner part of the chamber division. I believe that it would have been easy for d'Orbigny to overlook this, merely believing it to be a part of the dividing suture. Höglund's detailed study of the two genera is an interesting one and reveals the morphological differences between them. If my interpretation of d'Orbigny's figure is correct Höglund's genus *Robertinoides* should be placed in the synonymy under *Robertina* and a new genus erected for the single-apertured form.

I have observed a single specimen of *R. cf. charlottensis* in material from Greenland.

#### VIRGULINA COMPLANATA Egger

(Plate 6, figures 1a, b, 2a, b)

*Virgulina schreibersiana* Czjzek var. *complanata* Egger, 1893, Abhandl. k. bayer. Akad. Wiss. München, Cl. 2, bd. 18, p. 292, pl. 8, figs. 91, 92.

*Virgulina* sp., Parker, 1948, Bull. Mus. Comp. Zool., vol. 100, no. 2, p. 240, pl. 5, fig. 14.

The Portsmouth specimens are smaller than those from the Pacific, the longest being about 0.5 mm. They are also somewhat less attenuated than the Pacific specimens. Specimens sent to the Cushman Laboratory by Earland from Drake Strait in the Antarctic are very similar. The species also resembles *V. concava* Höglund, which is perhaps synonymous with Egger's species. The form figured by Cushman from Nigare, Greece (Cushman, 1937, pl. 4, fig. 17 (not figs. 14, 15)), which was examined at the Cushman Laboratory, does not belong to this species.

The species occurs on the continental shelf south of Cape Cod and somewhat more compact specimens have been observed from off Greenland.

#### VIRGULINA FUSIFORMIS (Williamson)

(Plate 6, figures 3-6)

*Bulimina pupoides* d'Orbigny var. *fusiformis* Williamson, 1858, Rec. Foram. Great Britain, p. 63, pl. 5, figs. 129, 130.

This species is common in the Portsmouth area. It is found south of Cape Cod and also occurs in material from off Greenland.



## Family ROTALIIDAE

## DISCORBIS COLUMBIENSIS Cushman

(Plate 6, figures 7a, b, 8a, b, 9a, b)

*Discorbis columbiensis* Cushman, 1925, Contr. Cushman Lab. Foram. Res., vol. 1, pt. 2, p. 43, pl. 6, figs. 13a-c; Cushman and Todd, 1947, Spec. Publ. 21, Cushman Lab. Foram. Res., p. 20, pl. 3, figs. 14-16.

*Discorbis bertheloti* (d'Orbigny) var. *floridensis* Cushman, 1944 (not Cushman, 1931), Spec. Publ. 12, Cushman Lab. Foram. Res., p. 31, pl. 4, fig. 17.

*Discorbis obtusa* Cushman (not *Rosalina obtusa* d'Orbigny), 1944, Spec. Publ. 12, Cushman Lab. Foram. Res., p. 31, pl. 4, fig. 15.

*Discorbis subaraucana* Cushman 1944 (not Cushman, 1922), Spec. Publ. 12, Cushman Lab. Foram. Res., p. 31, pl. 4, fig. 18.

The Portsmouth specimens appear to be identical with the holotype from Queen Charlotte Sound, British Columbia. They occur only at nearshore stations. In this area they show comparatively little variation or abnormality of growth. Specimens from Long Island Sound, however, vary greatly and show abnormalities similar to those described by Cushman and Todd from Friday Harbor (1947, p. 20, pl. 3, figs. 14-16). These forms may be identical with *Discorbis valvulata* (d'Orbigny). The forms so referred by Cushman from the shallow water of the Atlantic coast (1944, p. 31) are not identical, but specimens from Porto Rico so labeled by him are very close to my specimens. D'Orbigny's species was described from Martinique. This question must be left open until further study of West Indian specimens can be made. Adult forms from the Portsmouth area have five chambers in the last-formed whorl, young specimens about six.

## DISCORBIS SQUAMATA n.sp.

(Plate 6, figures 10a, b, 11)

Test small, flat, slightly convex on the dorsal side, concave on the ventral, usually with a small ventral plug, composed of 2 to  $2\frac{1}{2}$  whorls; periphery subacute, non-lobulate; chambers 5 to 6 in the adult whorl, slightly curved, increasing gradually in size as added, on the ventral side often with lip-like processes extending into the umbilical area; sutures narrow, flush with the surface, slightly curved on the dorsal side, on the ventral side depressed, flexuose; wall thin, often translucent, finely perforate on both sides; aperture normal. Maximum diameter 0.14-0.25 mm.; minimum diameter 0.11-0.21 mm.

Holotype from station 356 at a depth of 29 m., N. Lat.  $42^{\circ}49.8'$ , W. Long.  $70^{\circ}45.0'$ .



This species occurs at a few stations shallower than 50 m. It is smaller and more compressed than *D. subaraucana* Cushman, has fewer chambers to the whorl and a more finely perforate test. Unlike *D. columbiensis* in the same general area, it shows little variation. Somewhat larger specimens closely resembling this species but having seven to eight chambers have been observed from Block Island Sound south of Cape Cod. It is probable that the conception of the species should be expanded to include these forms.

#### EPONIDES FRIGIDUS (Cushman)

(Plate 6, figures 12a, b)

*Pulvinulina karsteni* H. B. Brady (not Reuss), 1864, Trans. Linn. Soc. London, vol. 24, p. 470, pl. 48, fig. 15; 1878, Ann. Mag. Nat. Hist., ser. 5, vol. 1, p. 436, pl. 21, fig. 11.

*Pulvinulina repanda* (Fichtel and Moll), var. *karsteni* Parker and Jones, 1865, Phil. Trans. Roy. Soc. London, vol. 155, p. 396, pl. 14, figs. 14, 15, 17.

*Pulvinulina frigida* Cushman, 1921 (1922), Contr. Canadian Biol., p. 144.

The Portsmouth specimens are much smaller than those of the Arctic region. They reach a maximum diameter of 0.32 mm. Although Cushman states the maximum diameter to be 0.4 mm., specimens up to 0.6 mm. have been observed from the Arctic. Otherwise, the species in the Portsmouth area appears to be typical. It is interesting that all the specimens obtained by Cushman (1944, p. 34) from the shallow waters of this area belong to the variety *calidus*. I examined these specimens at the Cushman Laboratory and found them to be very typical and quite different from the deeper-water form with its acute periphery.

This species is reported as *E. frigidus* var. *calidus* by Parker (1948, p. 238) from all facies south of Cape Cod.

#### EPONIDES UMBONATUS (Reuss)

(Plate 6, figures 13a, b)

*Rotalina umbonata* Reuss, 1851, Zeitschr. deutsch. geol. Ges., vol. 3, p. 75, pl. 5, figs. 35a-c.

*Truncatulina tenera* H. B. Brady, 1884, Rept. Voy. CHALLENGER, Zool., vol. 9, p. 665, pl. 95, figs. 11a-c.

This species is rare. It is not reported from the Arctic but is found south of Cape Cod at stations deeper than 90 m. (Parker, 1948, p. 225).



## EPONIDES WRIGHTII (H. B. Brady)

(Plate 6, figures 14, 15)

*Discorbina parisiensis* J. Wright (part) (not d'Orbigny), 1876-77 (1877), Proc. Belfast Nat. Field Club., App. p. 105, pl. 4, figs. 2a-c.

*Discorbina wrightii* H. B. Brady, 1881, Ann. Mag. Nat. Hist., ser. 5, vol. 8, p. 413, pl. 21, figs. 6a-c.

This species is very rare in this area. It is more abundant in shallow water samples of the Long Island Sound area.

## PATELLINA CORRUGATA Williamson

(Plate 6, figures 16, 17)

*Patellina corrugata* Williamson, 1858, Rec. Foram. Great Britain, p. 46, pl. 3, figs. 86-89.

This species is rare. It occurs in the Arctic and in the Long Island Sound - Buzzards Bay area.

## PNINAELLA (?) PULCHELLA n.sp.

(Plate 6, figures 18a, b, 19, 20)

Test small, compressed, very slightly convex on the dorsal side, slightly concave on the ventral side, with secondary plates forming over the apertures extending  $\frac{1}{2}$ - $\frac{2}{3}$  of the way to the periphery forming a star-shaped central portion; periphery narrow, rounded; chambers 7-9 in the last-formed whorl, narrow, increasing very gradually in size as added, uninflated, the secondary plates somewhat inflated, each one successively covering the aperture of the previous chamber; sutures on the dorsal side flush with the surface, slightly curved, slightly limbate, on the ventral side somewhat depressed; wall thin, finely perforate, often translucent; aperture loop-shaped, variable in size, extending up into the chamber on the ventral side, occasionally absent when a secondary chamber has formed after the last-formed chamber. Maximum diameter 0.22 mm.; maximum thickness 0.07 mm.

Holotype from station 356 at a depth of 29 m., Lat. 42°49.8'N., Long. 70°45.0'W.

This species is questionably placed in the genus *Pninaella* because of its close resemblance to *Pninaella nitidula* (Chaster) which was placed in this genus by Brotzen (1948, p. 120). There can be no question of the generic similarity of the two species. I have had considerable difficulty, however, in discovering from Brotzen's description



the relationship between *P. nitidula* and his generic description and genotype *P. scanica* Brotzen. He makes no mention of the secondary plates formed over the apertures, which would seem to be an important generic character. They are apparently not present in the genotype. Specimens of *P. nitidula*, however, sent by Heron-Allen to Cushman show the secondary plates. The problem cannot be solved until Brotzen's types of *P. scanica* can be studied and compared with those of the Recent species.

*P. (?) pulchella* differs from *P. nitidula* in having a rounded, non-keeled periphery, in the secondary plates which do not extend to the periphery, and in having a maximum of 9 instead of 8 chambers in the last-formed whorl. Although our specimens of *P. (?) pulchella* are larger than the described specimens of *P. nitidula*, larger specimens of that species have been observed from the Mediterranean. Some of the Mediterranean specimens have  $2\frac{1}{2}$  whorls.

*P. (?) pulchella* is found only at a few stations at less than 50 m. It also occurs near Fishers Island, at the entrance to Long Island Sound. In both places it is associated with *Discorbis squamata* n.sp.; although the two species show some similarities there seems to be no doubt of their independent identities.

### Family CASSIDULINIDAE

#### CASSIDULINA ALGIDA Cushman

(Plate 6, figures 21a, b)

*Cassidulina algida* Cushman, 1944, Spec. Publ. 12, Cushman Lab. Foram. Res., p. 35, pl. 4, fig. 24.

This species is easily identified by its inflated chambers. This feature is not emphasized by Cushman but study of the types and the abundant specimens from the Portsmouth area shows it to be one of the most outstanding characteristics. I have also observed the species in material from Baffin Bay, Greenland. It is not reported elsewhere.

#### CASSIDULINA ISLANDICA Nørvang var. MINUTA Nørvang

(Plate 6, figures 22a, b, 23)

*Cassidulina islandica* Nørvang var. *minuta* Nørvang, 1945, Zoöl. Iceland, vol. 2, pt. 2, Foraminifera, p. 43, text figs. 8a-c.

This variety apparently is identical with Nørvang's. It has the triangular tooth described by him. Although the chambers are some-



what inflated, the inflation is much less than in *C. algida*. The specimens correspond in size with Nørvang's figured specimens (0.24–0.26 mm. in length). Somewhat larger specimens have been observed from Dundas Harbor and North Devon Harbor, off Greenland (up to 0.32 mm. in length).

#### CASSIDULINA NORCROSSI Cushman

(Plate 6, figures 24, 25)

*Cassidulina norcrossi* Cushman, 1933, Smithsonian Misc. Coll., vol. 89, no. 9, p. 7, pl. 2, figs. 7a-c.

This species is reported from the Arctic and the Gulf of Maine by Cushman (1944, p. 35). South of Cape Cod it occurs in zones 3 and 4, 90 m. to 680 m., but reaches its peak of frequency beyond 300 m. (Parker, 1948, p. 225). It is not common in the Portsmouth area.

#### Family ANOMALINIDAE

##### CIBICIDES LOBATULUS (Walker and Jacob)

*Nautilus lobatulus* Walker and Jacob, 1798, Adams Essays, Kannmacher's ed., p. 642, pl. 14, fig. 36.

This species is very abundant in this area. It is found at all latitudes in the north Atlantic.



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