# CONTRIBUTIONS
## FROM THE
# CUSHMAN FOUNDATION
## FOR
# FORAMINIFERAL RESEARCH

Volume VI, Part 4
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## Contents

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
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VOLUME VI, PART 4, OCTOBER, 1955

# 141. BATHYMETRIC POSITION OF SOME CALIFORNIA PLIOCENE FORAMINIFERA

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In the October, 1954, number of these Contributions, James C. Goodwin and John N. Thomson discussed a foraminiferal faunule from the Purisima Pliocene formation in the Halfmoon Bay area with a zonation into an upper *Uvigerina juncea* zone and an underlying *Elphidiella hannai* zone. They state: "The majority of the common species found in the Purisima formation are represented in the Pliocene to Recent sediments of the Pacific Coast. A comparison with Natland's work on the temperature and depth distribution of Recent and fossil Foraminifera in the Southern California region indicates that the Purisima assemblage existed at a depth near that of the boundary of Natland's zones II and III, that is, about 125 feet, with a possible deepening of the basin of sedimentation as the four species restricted to the *Uvigerina juncea* zone became abundant. Rather than a deepening of the basin, however, it may be that a colder water environment enabled these typical deeper colder water forms in the *Uvigerina juncea* zone to exist in the shallower waters. If, then, temperature was the controlling factor, the forms of the *Elphidiella hannai* zone which continue into the *Uvigerina juncea* zone would have to be types that could tolerate this lowering of temperature. If any depth change occurred, it left no lithologic expression in the sediments and therefore the writers believe that a slight temperature change is the most likely mechanism to account for the faunal change." They state that the megafossil content of the associated beds confirms the depth estimate based on the Foraminifera.

In the April, 1955, number of these Contributions, Orville L. Bandy, commenting on the probable depths of deposition in the two zones, is in agreement as to the depth of the *Elphidiella hannai* (Cushman and Grant) zone, but suggests that "the assignment of the *Uvigerina juncea* Cushman and Todd assemblage to a shallow water environment under cooler temperature conditions may be a possibility, but it represents only one of at least three possibilities and does not explain adequately the presence of bathyal species. A second possibility is that some of the deeper water species of the *Uvigerina juncea* zone were reworked from Miocene assemblages; however, none of these is diagnostic of the Miocene. A third possibility is that bathyal conditions existed during the deposition of the sediments of the *Uvigerina juncea* zone, as evidenced by the presence there of considerable numbers of *Epistominella pacifica, Nonion pompilioides* and others. The presence of *Nonion pompilioides* suggests that the depth of water was about 5000 feet deep or more (Natland, 1933; Bandy, 1953). *Epistominella pacifica* is the most abundant of the deep water species and occurs between depths of about 1000 and 3000 feet off southern California, and much deeper than this off San Francisco (Bandy, 1953). It seems reasonable to assume that the associated shoal water species of the *Uvigerina juncea* zone were displaced into deeper water, a phenomenon observed often in Recent faunas (Phleger, 1951; Bandy, 1953)."

Bandy (fig. 1) divided into three groups the Foraminifera listed by Goodwin and Thomson in their Table I: those of the inner shelf zone to include most of their species, those of the outer shelf, and those of the bathyal zone as follows: (notes on relative abundance are from Goodwin and Thomson, Table I.)

Outer Shelf Zone

| | |
|---|---|
| *Cassidulina californica* | Very common. |
| *Cassidulina limbata* | Rare, found in 3 only of 11 samples. |
| *Lagena striata* | Very common, rare toward top of section also rare in 1 sample from *E. hannai* zone. |
| *Uvigerina juncea* | Abundant. |

Bathyal Zone

| | |
|---|---|
| *Epistominella pacifica* | Very common. |
| *Nonion pompilioides* | Rare, and occurs only in one sample. |
| *Robulus* sp. | Rare, and occurs only in one sample. |
| *Siphonodosaria* sp. | Rare, and occurs only in one sample. |
| *Uvigerina* cf. *U. gesteri* | Rare, occurring in three samples. |

In an excellent and comprehensive depth-temperature-thickness diagram, Bandy (in his figure 2) indicates the depth of the *Elphidiella hannai* zone to be from 0-300 feet, its temperature range from 8-13°C., and the stratigraphic thickness from 0 to 1500 feet in the measured section; corresponding figures for the *Uvigerina juncea* zone are 1000-6000 feet, 2-8°C., and 1800 feet to the top (3000 feet) of the measured section, with a transition zone of temperatures and depths between 1500 and 1800 feet stratigraphically. There is only a slight change in the fauna in this transition interval.

Natland (1933, p. 227) states: "Thus it would seem that temperatures have a far greater influence than depth on some Foraminifera." Phleger (1952, p. 326) says of the ecological study made off Portsmouth, N. H.: "In this area there is a close correspondence between the distribution of most of the species and the type of sediment on which it is found." It is natural then that within their temperature ranges, with sedimentary environment unchanged, many species of the *Elphidiella hannai* zone would carry through into the *Uvigerina juncea* zone.

*Uvigerina juncea* Cushman and Todd is the most abundant form in the *U. juncea* zone. It is a shelf rather than a deep water species as it was found by Cushman and Todd in two samples from the Puget Sound area at a depth of 157 feet.

Present temperatures at Halfmoon Bay range from 9° to 12°C., (Sverdrup, 1942, figs. 54 and 63), corresponding to Bandy's outer shelf zone. Possibly even colder waters occur there due to upwelling, so that some of his outer shelf forms are found in beach sands at the north end of the bay near Pillar Point. *Cassidulina limbata* Cushman and Hughes is fairly common; *Lagena striata* Orbigny is rare. (*C. limbata* is reported in the nearby Merced formation, but the specimens found in beach sands were not reworked.) Other species shown by Bandy (1953, p. 169) as bathyal with water temperatures of 4° to 7°C., but not in the Goodwin and Thomson list, were also found in these beach sands. These include *Uvigerina peregrina* Cushman, *Poroeponides cribrorepandus* Asano and Uchio, *Quinqueloculina lamarckiana* Orbigny, and *Q. angulostriata* Cushman and Valentine and at least half a dozen other forms occur which were found by Loeblich and Tappan (1953) in Arctic waters where temperatures are probably below 5°C. due to the ever present offshore ice. Of the forms of the Halfmoon Bay Pliocene listed as bathyal, *Nonion pompilioides* (Fichtel and Moll) and two species of *Robulus* are found in Recent beach sands from the east coast of Japan, at the latitude of Tokyo, associated with *Rotalia beccarii* var., cf. *R. beccari* (Linné) var. *tepida* Cushman.

These shallow water occurrences of some species, which are considered as normally occurring in cold deep water, do not disprove that the *Uvigerina juncea* sediments were laid down in deep water, but do indicate that, as Goodwin and Thomson state, no great deepening of the sea was necessary.

Table I of Goodwin and Thomson makes it apparent that *Elphidium hughesi* Cushman and Grant var. *obesum* Cushman, *Eponides* cf. *E. exigua* (Brady), and *Pseudononion cushmani* persist in about equal abundance from the lower through the overlying presumably colder *Uvigerina juncea* zone. Other species that are common in the *Elphidiella hannai* zone become rare or disappear in the overlying beds, but reappear about 250 feet below the top of the measured section. These include *Quinqueloculina akneriana* Orbigny var. *bellatula* Bandy, *Nonionella miocenica* Cushman, and *Buliminella elegantissima* (Orbigny). *Elphidiella hannai* (Cushman and Grant)* disappears completely, not reappearing in the upper 250 feet. The absence of these abundant forms, while others of the lower zone persist, certainly suggests that none were transported by turbidity currents but that these were less tolerant of colder water than the other species. Their reappearance 250 feet from the top might indicate activity of turbidity currents were it not for the fact that the cold water forms, *Lagena striata* (Orbigny) and *Cassidulina californica* Cushman and Hughes, disappear and *Epistominella pacifica* (Cushman) becomes less abundant in this interval, perhaps suggesting a slight warming of the sea. It is, of course, recognized that the presence or absence of these and other foraminiferal species may be due to other factors than temperature changes.

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* Loeblich and Tappan (1953) discuss the nomenclature of a number of species among which (**op. cit.**, pp. 107-108) are **Elphidiella hannai** (Cushman and Grant) 1927, and **Elphidiella nitida** Cushman, 1941. They supplement the description by Cushman (1941, p. 55) of **E. nitida**, who separated it from **E. hannai** on the basis of its very narrow sutures, with very fine pores and highly polished wall, mentioning that **E. nitida** has a smooth surface "except for numerous fine granules on the periphery of the previous whorl for a short distance just in front of the aperture and up the apertural face. . . . The fine granules present on the apertural face and on the periphery of the preceding whorl just in front of the aperture have apparently been shown in the illustration by Cushman and McCulloch, but have never been mentioned in any description of this species. Cushman and Grant stated that the aperture consisted of a series of pores at the base of the face and in addition of other pores scattered over the apertural face. We have been unable to see these scattered pores on any of the types in the Cushman collection or in our own specimens, and suspect that the above mentioned pustules may have been mistaken for apertural pores.

In 1941, Cushman described the present species as

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Sverdrup, H. U., 1942. Oceanography for meteorologists. 235 pp., 70 figs., 4 charts.

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distinct from **E. hannai** (Cushman and Grant) and placed in the synonymy of **E. nitida** the above listed references of Cushman and Grant, 1927, Cushman, 1939, and Cushman and McCulloch, 1940. However, in 1947 all these references were again listed in the synonymy of **E. hannai** by Cushman and Todd and no mention was made of **E. nitida**, apparently through an oversight. The specimens shown by Cushman and Todd seem also to belong to **E. nitida**."

Cushman, (1941, p. 35) lists fig. 2, pl. 19 of U.S. Geol. Surv. Prof. Paper 191, 1939 as being a figure of **E. nitida** Cushman, the implication being that fig. 1 of this plate is of **E. hannai** (Cushman and Grant) as described in that paper.

On the basis of the foregoing, figs. 27 and 28 of plate 32 of Goodwin and Thomson are of **Elphidiella nitida** Cushman, and all of the references of this paper as well as those of Bandy and of Goodwin and Thomson to **Elphidiella hannai** (Cushman and Grant) were incorrect and should have been to **Elphidiella nitida** Cushman. It appears almost certain that a great many references to **E. hannai** (Cushman and Grant) in the literature of West Coast Foraminifera are in error, unless **E. nitida** is placed in synonymy with **E. hannai**, as is done by Bandy, (1950, p. 277), "inasmuch as the only distinction is the amount of surface polish along with finer pores in the former and these features may be functions of preservation." Examination of a large series of Recent **E. nitida** from Halfmoon Bay and Moss Beach, Calif., varying from fresh to badly worn, fails to disclose any specimens with the septal pore pattern of the holotype (Cushman and Grant, 1927, pl. 8, fig. a), or of the Recent Farallon specimen, (Cushman, 1939, pl. 19, fig. 1a), of **E. hannai**.

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# 142. *DISCOPULVINULINA CUSHMANI* HOFKER, A NEW NAME FOR *HANZAWAIA CONCENTRICA* (CUSHMAN)

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## ABSTRACT

*Hanzawaia concentrica* Cushman is studied and it is shown that *Hanzawaia* is part of the genus *Discopulvinulina* (*Discopulvinulina* with more or less overlapping chambers on the dorsal side).

A new name is necessary for *Truncatulina concentrica* Cushman. *Discopulvinulina cushmani,* new name, is here proposed.

## DISCUSSION

In 1944, Asano established the genus *Hanzawaia* with the genotype *Hanzawaia nipponica* Asano (Jour. Geol. Soc. Japan, vol. 51, no. 606, p. 2, pl. 4, figs. 1, 2) from the Pliocene of Japan. It was pointed out by Bermudez that several species hitherto described as *Cibicides,* belong to this genus, and he mentions especially *Truncatulina* (*Cibicides*) *concentrica* Cushman from the Tertiary of America. (Bermudez. 1952, Bol. Geol. Venezuela, vol. 2, no. 4, pp. 88). Bermudez' description is:

"Concha trochoide, plano-convexa, lado ventral convexo, lado dorsal plano, borde periférico subcarinado; cámeras numerosas, diez a doce en la última vuelta de espira, aumentando gradualmente de tamaño segûn se forman; región umbilical tipicamente ocupada por una lámina calcárea irregularmente lobulada que tiende á cubrir el ombligo; suturas fuertemente limbadas y arqueadas; pared calcárea, perforada; abertura como una ranura corta en la base de la última cámara. Dimension, 1 mm. Terciario, Reciente."

Through the kindness of Dr. Bermudez it was possible to study specimens of *Hanzawaia concentrica* (Cushman) from the uppermost Oligocene of Panama, Central America.

At the ventral side of the test, which is nearly flat, each chamber shows at its suture a real protoforamen, a large tenon and the peripheral deuteroforamen; the tenon is poreless, the whole wall is pierced by fine pores, which are lacking at the margin. The tenons of the chambers together form the "lamina calcárea". On the dorsal side, the chambers are strongly overlapping with rounded sutures, leaving the first chambers free. A transverse section revealed that the species undoubtedly belongs to *Discopulvinulina* Hofker with dorsally overlapping chambers (Hofker, Siboga-Foraminifera, Part 3, *Discopulvinulina pseudolobatula* Hofker; *Discopulvinulina hyalina* Hofker).

Of the species of this group of *Discopulvinulina* there are some with completely overlapping chambers on the dorsal side, whereas others only partially overlap this side with their chambers, while still others show such slight overlapping, that it is not evident whether they belong to the overlapping group or not. All species with the apertural conditions mentioned are called *Discopulvinulina.* It was pointed out that species with overlap form a special group called the lobatula-group, since they somewhat resemble *Cibicides lobatula.*

Conspicuous in the Discopulvinulinae with overlap are the hyaline chamber-walls and the fine protopores, both quite different from those of *Cibicides.*

It must be pointed out that the dorsal side is the overlapping one, and the ventral side that with the typical protoforamen at the sutures. In the description by Bermudez these sides have been confused, since he says that the ventral side is the convex one, the dorsal side the flattened one; the flattened side always is the side with the protoforamina, and sections always reveal that side is ventral.

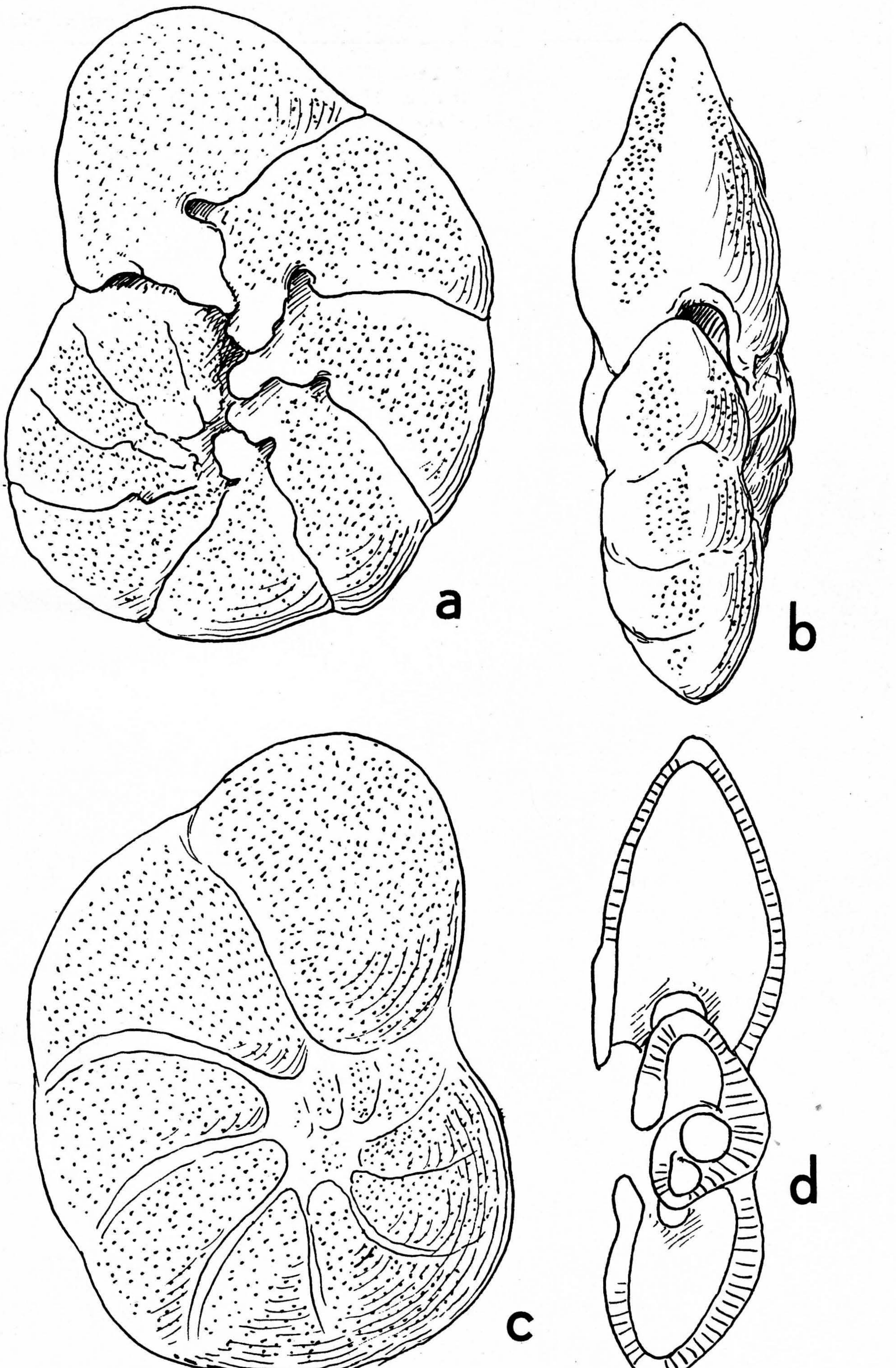
Consequently, all species of *Discopulvinulina* with typical overlapping chambers on the dorsal side of the tests, could be called *Hanzawaia;* but some forms remain in which the chambers are so slightly overlapping that there is some doubt as to their taxonomic status if the genus *Hanzawaia* is maintained. On the other hand the genus *Hanzawaia* cannot be used for those forms which show no overlapping chambers; they must be called *Discopulvinulina.*

To avoid further confusion it would be much better to suppress the genus *Hanzawaia* and to call all species with the typical features *Discopulvinulina,* without regard to the overlapping on the dorsal side, so that there would be only a single typical genus instead of two poorly defined genera.

Species belonging to typical *Discopulvinulina* without overlapping chambers are: *Discopulvinulina pacifica* Hofker, *D. bradyi* (Cushman), *D. globularis* (Orbigny), *D. macropora* Hofker, *D. bertheloti* (Orbigny) var. *floridensis* Cushman, *D. obtusa* (Orbigny), *D. candeina* (Orbigny), *D. concentrica* (Parker and Jones), etc.

Species with overlapping chambers are: *Discopulvinulina concentrica* (Cushman), *D. pseudolobatula* Hofker, *D. hyalina* Hofker, etc. Many Tertiary species also belong to these two groups of *Discopulvinulina: D. danvillensis* (Howe and Wallace), *D. mississippensis* (Cushman), *D. subaraucana* (Cushman), *D. bracteata* (Le Calvez), *D. vesicularis* (Lamarck), *D. reinholdi* (Ten Dam), etc.

There is confusion in the nomenclature of some species of *Discopulvinulina* in that in 1918 Cushman described and figured *Truncatulina concentrica* (U.S. Geol. Surv., Bull. 676, p. 64, pl. 21, fig. 3) = (*Hanzawaia concentrica*) which is a typical *Discopulvinulina* with somewhat overlapping chambers. In 1864, Parker and Jones (Linn. Soc. Zool., vol. 24, p. 270, pl. 48, fig. 14) described *Pulvinulina concentrica* which was later erroneously called *Mississippina concentrica,* but according to this study is a true *Discopulvinulina* in which the sutural and marginal thickenings of the chambers have overlapped large parts of the original chamber walls, leaving only very small portions of the test free, the slight apparent openings below which were mistakenly thought to be apertures. To this group of *Discopulvinulina, D. binkhorsti* from the uppermost Cretaceous (Hofker, 1951, On Foraminifera from the Dutch Cretaeous, Natuurhist, Genootsch., Limburg. Publ., vol., IV, pp. 20-22, figs. 22, 23) also belongs. There are thus two species referable to *Discopulvinulina,* one without overlapping dorsal parts of chambers, *D. concentrica* (Parker and Jones), and the other with slightly overlapping chambers, *D. concentrica* (Cushman). Since Asano's genus *Hanzawaia* can not be maintained, Cushman's species must be renamed. There is proposed for this conspicuous Tertiary and Recent species *Discopulvinulina cushmani,* new name.



TEXT FIGURE 1.

*Discopulvinulina cushmani,* [*Hanzawaia concentrica* (Cushman)], new name.

Uppermost Oligocene. Panama, Central America. a. Ventral side, with protoforamina, tenons and deuteroforamen. b. Apertural face with deuterofor amen and poreless margin. c. Dorsal side with overlapping chambers. d. Transverse section with um bilical openings under the tenons. All × 151.

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# 143. A RECENT FORAMINIFERAL FAUNULE FROM THE BAY OF FUNDY

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In June, 1951, about a pint of fine silty to muddy sand collected from tide flats near the wharf at Kingsport, Nova Scotia, about 20 feet below high tide level, was received from Donald G. Crosby, Jr. Kingsport is on Minas Basin, an arm of the Bay of Fundy. At Mr. Crosby's request a determination was made of the Foraminifera in this sample and a list of the species found as well as a faunal slide was prepared and given to him. He included this list in his doctoral thesis, presented at Stanford University, on "The Wolfville Map-Area, Kings and Hants Counties, Nova Scotia."

It is believed that it is somewhat unusual for a faunule of over 35 benthonic species and varieties of shallow, cold water Foraminifera to be found in a single small sample, and the list is given below. The genus *Elphidium* was represented by the greatest number of individuals, and probably by the greatest number of species. *Quinqueloculina seminulum* and its variety *jugosa* were common; somewhat less common were *Eggerella advena* and individuals of species of *Trochammina*. Other Foraminifera were present in very small numbers.

The species found include:

*Angulogerina angulosa* Williamson
*Bolivina pseudoplicata* Heron-Allen and Earland
*Bolivina* cf. *B. variabilis* Williamson
*Buliminella elegantissima* (Orbigny)
*Cibicides lobatula* (Walker and Jacob)
*Dentalina* cf. *D. mucronata* Neugeboren
*Discorbis* cf. *D. obtusa* (Orbigny)
*Eponides ?* sp. (A worn and broken test.)
*Eggerella advena* (Cushman)
*Elphidium advena* Cushman
*Elphidium incertum* (Williamson) var. *clavatum* Cushman
*Elphidium* spp. (At least two additional species.)
*Fissurina lucida* (Williamson)
*Fissurina* sp. (A smaller but thicker species than *F. lucida*)
*Globigerina bulloides* Orbigny
*Glomospira* sp.
*Guttulina lactea* (Walker and Jacob)
*Haplophragmoides* sp. (Juvenile and very small)
*Lagena clavata* Orbigny
*Lagena mollis* Cushman
*Lagena substriata* Williamson
*Nonion pauciloculus* Cushman
*Nonion* sp. (A small, juvenile specimen distinct from the preceding.)
*Patellina corrugata* Williamson
*Psammatodendron arborescens* Norman
*Oolina squamosa* (Montagu) var. *scalariformis* Williamson
*Quinqueloculina agglutinata* Cushman
*Quinqueloculina seminulum* (Linné)
*Quinqueloculina seminulum* (Linné) var. *jugosa* Cushman
*Silicosigmolina groenlandica* (Cushman)
*Spiroplectammina biformis* (Parker and Jones)
*Trochammina inflata* (Montagu)
*Trochammina* sp. (Light colored ventrally and dorsally on outer whorl.)
*Trochammina squamata* Parker and Jones, var. *adaperta* Rhumbler
*Trochammina* sp. (one or more species related to preceding.)
*Webbinella* sp.

Many of these species were found by Dawson (1870) from the Saint Lawrence River and Gulf. Cushman has described most of them in his monograph (1918-1931) on "The Foraminifera of the Atlantic Ocean", in the "Foraminifera from the shallow water of the New England Coast (1944), and in "Arctic Foraminifera" (1948). Other papers are by Phleger (1954), Parker (1948 and 1952), and by Loeblich and Tappan (1953).

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# 144. EOCENE LARGER FORAMINIFERA NEAR GUADALUPE, SANTA CLARA COUNTY, CALIFORNIA

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## INTRODUCTION

An assemblage of Eocene larger Foraminifera is described from limestones occurring near the old Guadalupe quicksilver mine, Santa Clara County, California. Six genera are recognized and described, one of them new. The age of the assemblage is interpreted as medial Eocene, although the possibility of its being late Eocene in age cannot be excluded.

The author is indebted to J. J. Graham for pointing out some of the limestones occurring in this general area, to H. G. Schenck for discussion of the age, to H. E. Thalmann and G. L. Harrington for many helpful suggestions during the preparation of this paper. Thanks are due to the Shell Foundation for Fundamental Research in Geology at Stanford University for financial assistance.

## LOCALITY

Limestone samples containing this faunule were collected near the old Guadalupe quicksilver mine, Santa Clara County, California. On the U. S. Geological Survey topographic sheet of the New Almaden, California, Quadrangle (1919 edition, scale 1:62500), the limestone is found as float in a vineyard at the eastern end of a low ridge located South 72° West from Pioneer School, South 44° East of Lone Hill and South 9° West of Hill 405. This is exactly the same locality from which *Discocyclina californica* Schenck was described. There are no other outcrops of this limestone, but some very small outcrops of lithologically different limestones are present in the immediate vicinity of the fossiliferous float. The geological relations between the different formations are obscure and with few and limited outcrops there is no possibility of determining the stratigraphic position of the fossiliferous bed.

The faunule contained in the limestone is listed below; those forms which could not be studied in more detail because of lack of favorable sections are marked with an asterisk:

?*Amphistegina* sp.
*Eofabiania grahami* Küpper, n. gen., n. sp.
*Asterocyclina* sp.
? *Pseudophragmina* sp.
*Discocyclina californica* Schenck
*Operculinoides* sp.
* *Sphaerogypsina* sp.
* *Textularia* sp.
* *Cristellaria* sp.
* *Quinqueloculina* sp.
* *Bryozoa*
* *Algae*

## AGE

The genera and species described in this paper are neither by themselves nor in their association characteristic of any subdivision of the Eocene. Indirect evidence, however, seems to indicate that *Eofabiania* should be expected to have at least the same stratigraphic range as *Fabiania* if not extending further downward. This would make likely a medial or early Eocene age for this peculiar assemblage. Should the form here described as *Amphistegina* sp. prove to be a representative of the genus *Tremastegina* Bronnimann, a correlation with the Central American Eocene sequence would be possible, again indicating a medial Eocene age. Whether the absence of such late Eocene time indicators as *Helicolepidina, Helicostegina,* and *Lepidocyclina* can be used as evidence that we are not dealing with an upper Eocene formation is doubtful since their absence might be due to the high latitude of our outcrops. Summarizing the faunistic evidence, there seems to be at present no possibility of narrowing the age of the limestone to either medial or late Eocene. The possibility of an early Eocene age can be excluded; the morphology of *Discocyclina californica* Schenck is too advanced for such an age. This author believes, however, that the evidence points to a medial rather than late Eocene age, but this statement must be qualified as a subjective interpretation based on insufficient data.

Schenck mentions that a few mollusks were collected which "appear to be Tejon Eocene species" and he, comparing the foraminiferal assemblage with some from upper Eocene limestones of the American Province, "is of opinion that the California formation just described is of that age."

U. S. Grant, IV (1944, p. 557, in Weaver *et al.*), when discussing the Simi Valley area, California, mentions that "the Sierra Blanca is the lower part of the transition of Clark and Vokes and represents the time of widespread middle Eocene seas with *Discocyclina californica* Schenck, *Discocyclina psila* Woodring, *Discocyclina cloptoni* Vaughan, *Dictyoconus* sp., *Amblypygus subhemisphericus* Israelsky, *Eoagassizia alta* A. Clark, etc". This statement, although in agreement with the present author's interpretation, is open to question. *Discocyclina californica* has not yet been described from the Sierra Blanca limestone, nor been observed by me in the samples available from that formation. The association of the three species of *Discocyclina* has not yet been recorded from any place, therefore, it seems to be doubtful whether the mention of *Discocyclina californica* Schenck by Grant can be used as evidence for a medial Eocene age of that species.

These results may seem to be disappointing, but it should be realized that the study of larger Foraminifera in California Eocene limestones has been neglected and that no basis for comparison within California is available.

## SYSTEMATICS

### Family AMPHISTEGINIDAE

### Genus **Amphistegina** Orbigny, 1826

### **Amphistegina** sp.

Plate 19, figs. 8, 9, 10

Sections of a robust species of ?*Amphistegina* are found occasionally. It is asymmetric in vertical centered section (Pl. 19, fig. 10) and has two to three whorls. The septa are strongly curved judging by the oblique section (Pl. 19, fig. 9).

## EXPLANATION OF PLATE 19

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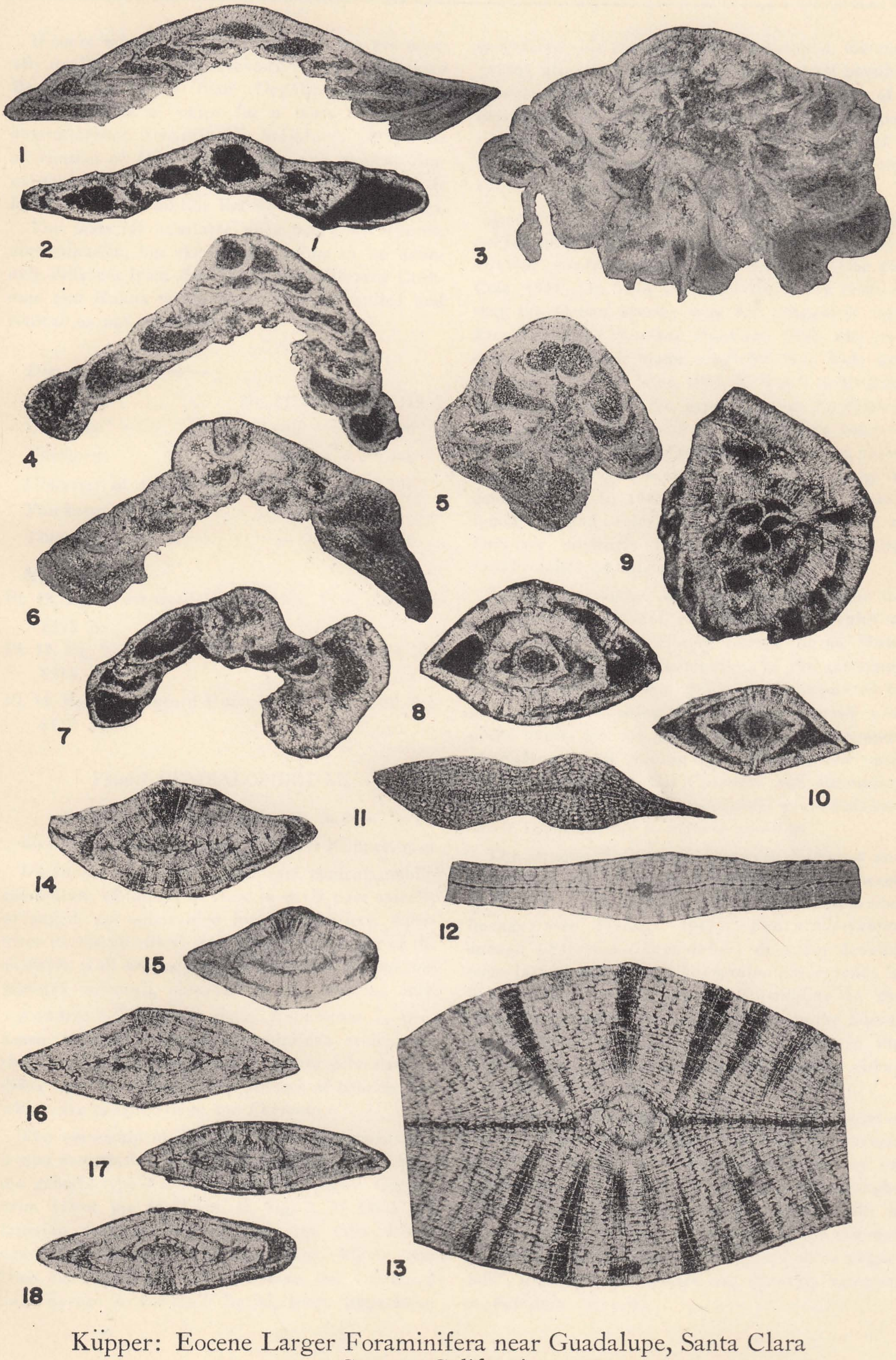
All figures are unretouched photomicrographs approximate magnification × 38.




Küpper: Eocene Larger Foraminifera near Guadalupe, Santa Clara County, California

If more material should prove that we are actually dealing with a representative of *Tremastegina* Bronnimann rather than *Amphistegina* Orbigny this would be of value for a more precise age determination. According to Stainforth (1953) the association of *Discocyclina, s.s.,* with conical Amphisteginas (genus *Tremastegina* Bronnimann) is indicative of the middle Eocene of middle America.

The material available does not allow specific determination, but the species seems to be definitely different from *Amphistegina californica* Cushman and Hanna which is not as thick walled and conical as our specimens.

*Dimensions in mm.—*

| | No. 8318 B | No. 8319 A |
|---|---|---|
| Diameter | 1.040 | 0.890 |
| Thickness | 0.640 | 0.448 |
| Diameter of proloculus | 0.140 | 0.156 |
| Thickness of pillar | 0.036 | — |
| Thickness of wall | — | 0.026-0.066 |

*Hypotypes*

Pl. 19, fig. 8, Stanford Univ. Paleo. Type Coll. No. 8318 B.

Pl. 19, fig. 9, Stanford Univ. Paleo. Type Coll. No. 8318 A.

Pl. 19, fig. 10, Stanford Univ. Paleo. Type Coll. No. 8319 A.

## Family CYMBALOPORIDAE

### Genus **Eofabiania** Küpper, n.gen.

*Generic type.—Eofabiania grahami* Küpper, n.sp.

*Diagnosis*—Calcareous, perforate, conical, umbilicus hollow, chambers at least in early part spirally arranged, not subdivided into chamberlets. Apertures on the umbilical side with a thickening of the chamber wall around the slitlike opening. External features unknown, observed in thin sections only.

*Remarks.*—The new genus *Eofabiania* is proposed to include those Foraminifera which are closely related to the genus *Fabiania* Silvestri but differ from the latter in the absence of chamberlets which are characteristic for *Fabiania.*

The taxonomy of *Fabiania* is rather confusing; it was described originally by Silvestri (1926) with the generic type *Patella* (*Cymbiola*) *cassis* Oppenheim (1896, pp. 55-56, pl. II, fig. 2, 3) from the Lutetian (middle Eocene) from the Case Pozza near San Giovanni Illarione, Mte. Merlo and from the Auversian near Fontana del Cavaliere near Sarego in the Colli Berici, Italy. Oppenheim considered this species to be a gastropod. Silvestri (1926) after a careful consideration of all possibilities thought this form to be the representative of a new genus of tetracorals and excluded the possibility of its being a foraminifer because of a marked bilateral symmetry. This generic name was apparently forgotten for some time thereafter.

In 1936 Cushman and Bermudez described a conical foraminifer from the Cuban Eocene as *Pseudorbitolina cubensis* Cushman and Bermudez (see also Cole, 1941). In 1944 Cole and Bermudez realized that the Cuban species was not congeneric with *Pseudorbitolina marthae* Douville, 1910, and proposed the generic name *Eodictyoconus* Cole and Bermudez. A year later, 1945, Keijzer's publication appeared in which the generic name *Tschoppina* was proposed, also with *Pseudorbitolina cubensis* as generic type. Thus *Tschoppina* becomes a junior synonym of *Eodictyoconus* because of identity of generic types. In 1948 Cushman noted the correct synonymy and referred this whole complex to *Fabiania* Silvestri; Bermudez (1952) and Cole (1953) followed this nomenclature.

The present author was reluctant to propose the new genus *Eofabiania,* considering the wealth of names available for closely related forms. However, after a careful evaluation of the taxonomy and systematics of this group, there seems to be no possibility of using any of the previously proposed names for our genus, since all are synonyms of *Fabiania,* all having the same generic type *Pseudorbitolina cubensis* Cushman and Bermudez. That this last species is congeneric with *Fabiania cassis* (Oppenheim) is without question.

The structural differences between *Fabiania* and *Eofabiania* are of the same magnitude as between *Coskinolina* and *Dictyoconus* in the *Dictyoconus* lineage (see Frizzell, 1949). The *Chapmanina* lineage (*Ferayina-Chapmanina*) does not develop secondary chamberlets. *Chapmanina* corresponds in its chamber development to *Coskinolina* in the *Dictyoconus* lineage and to *Eofabiania* in the *Fabiania* lineage. There are no forms known in the *Fabiania* lineage which would correspond to either *Lituonella* or *Ferayina.*

Judging by the figures only, one might consider the possibility of including *Fabiania saipanensis* Cole, 1953 in the new genus *Eofabiania* as no chamberlets are visible on his photomicrographs (pl. 15, fig. 1,2). However in the text (p. 28) it is stated explicitly: "From the inside of the internal wall two or more plates project into these chambers", therefore, the species was correctly assigned to *Fabiania* Silvestri.

**Eofabiania grahami** Küpper, n.sp.

Plate 19, figs. 1-7, Textpl. 1, figs. 1-7

*Holotype.*—Pl. 19, fig. 4, Textpl. 1, fig. 1, Stanford Univ. Paleo. Type Coll. No. 8315.

*Paratypes.*—Pl. 19, fig. 1, Textpl. 1, fig. 5, Stanford Univ. Paleo. Type Coll. No 8317; Pl. 19, fig. 2, Textpl. 1, fig. 4. Stanford Univ. Paleo Type Coll. No. 8318 C; Pl. 19, fig. 3, Textpl. 1, fig. 6, Stanford Univ. Paleo Type Coll. No. 8318 D; Pl. 19, fig. 5, Textpl. 1, fig. 3, Stanford Univ. Paleo. Type Coll. No. 8316 A; Pl. 19, fig. 6, Textpl. 1, fig 2, Stanford Univ. Paleo. Type Coll. No. 8319 B; Pl. 19, fig. 7, Stanford Univ. Paleo. Type Coll. No. 8319 C; Textpl. 1, fig. 7, Stanford Univ. Paleo. Type Coll. No. 8318 E.

*Derivatio nominis.*—Named after J. J. Graham, Professor at Stanford University, who first pointed out some of the Eocene limestone occurrences near Los Gatos to the writer.

*Locus typicus.*—L.S.J.U. Loc. No. 309, of which a detailed description is given above.

*Stratum typicum.*—Middle Eocene, age assignment uncertain.

*Description.*—Shape flat to high conical. External walls up to 0.084 mm. in thickness, coarsely perforated. Internal walls (on the umbilical side) thinner, maximum thickness measured 0.44 mm. Chambers are spirally arranged at least in the earlier part of the test, later possible annular or irregular growth, (compare Pl. 19, fig. 3, 7). The proloculus is spherical and is followed by a second spherical chamber (see Pl. 19, fig. 5), later chambers are all slightly elongated and compressed. The specimen figured on Pl. 19. fig. 4, shows the spherical proloculus and the chamber immediately following is already compressed. This is the chamber following the spherical second one. There is some overlap of later over earlier chambers as indicated by the double layer over the top of the specimen figured on Pl. 19, fig. 5, and Textpl. 1, fig. 3, and there is even a lumen between the two walls in the specimen figured on Textpl. 1, fig. 7, which unfortunately could not be photographed. This overlap might be interpreted as involution in the earlier chambers. In the later formed chambers no overlap was observed, they are evolute.

The shape and position of the apertures had to be reconstructed from thin sections only. They are located on the umbilical side and are slits at the base of the chambers on the proximal side. Some sections show a thickening of the wall bordering the aperture (Pl. 19, fig. 1. Textpl. 1, fig. 5).

*Measurements.*—see Table 1.

Family DISCOCYCLINIDAE
Genus **Discocyclina** Gümbel, 1870

**Discocyclina californica** Schenck, 1929

Plate 19, fig. 13

1929. *Discocyclina californica* Schenck. Trans. San Diego Soc. Nat. Hist., vol. V., no. 14, pp. 224-227; pl. 27, figs. 3, 4, 6; pl. 28, figs. 2-6; pl. 29, figs. 1-3; pl. 30, figs. 2-3, textfigs. 8, 9, 10.

*Discocyclina californica* is the most characteristic species in this assemblage of Eocene larger Foraminifera. Nothing can be added to the very detailed description of Schenck (1929).

*Hypotype.*—Stanford Univ. Paleo. Type Coll., No. 8316 B

Genus **Pseudophragmina** Douvillé, 1923

**? Pseudophragmina** sp.

Plate 19, fig. 12

Occasionally a very slender specimen probably belonging to the genus *Pseudophragmina* Douvillé is found in thin sections. It is very characteristic and easy to recognize because of its very thin median layer and its proportionally very long median chambers overlain by only five tiers of lateral chambers. A small pillar may be occasionally found in the umbo. The habitus of the vertical sections suggests a representative of the genus *Pseudophragmina;* horizontal or oblique sections have not been observed, therefore the generic determination is still open to question.

TABLE 1

Measurements of *Eofabiania grahami* Küpper in mm.

| Specimen number: | 8315 | 8316A | 8318E | 8318C | 8318D | 8317 | 8319C | 8319B |
|---|---|---|---|---|---|---|---|---|
| Largest diameter | 1.684 | 1.020 | 1.640 | 1.796 | 1.828 | 2.192 | 1.352 | 1.760 |
| Greatest height | 0.880 | 0.996 | 0.744 | 0.390 | 1.188 | 0.604 | 0.756 | 0.880 |
| Diameter of proloculus internal | 0.124 | 0.152 | | 0.244 | | | | |
| Thickness of wall of proloculus | 0.032 | 0.035 | | 0.060 | | | | |
| Thickness of dorsal wall | 0.048 | 0.076 | 0.052 | 0.040 | 0.056 | 0.084 | 0.076 | 0.052 |
| Thickness of ventral wall | 0.044 | | 0.040 | 0.040 | 0.040 | 0.040 | 0.032 | 0.044 |

Measurements in mm. (hypotype):

| | |
|---|---|
| Length | 2.908 |
| Thickness in center | 0.312 |
| Diameter of proloculus | 0.070 |
| Length of median chambers | |
| proximal | 0.026 |
| distal | 0.058 |
| Thickness of pillar in umbo | 0.030 |

*Hypotype.*—Stanford Univ. Paleo. Type Coll. No. 8319 D

Family ASTEROCYCLINIDAE

Genus **Asterocyclina** Gümbel, 1870

**Asterocyclina** sp.

Plate 19, fig. 11

Specimens representing the genus *Asterocyclina* Gümbel occur rather frequently. Unfortunately it is impossible even to attempt a specific determination because oriented sections are not available. It is evident, however, that we are not dealing with the species *Asterocyclina aster* (Woodring), the only other species of *Asterocyclina* described from California so far.

Measurements of Hypotype in mm.

| | |
|---|---|
| Length | incomplete |
| Thickness in ray | 0.326 |
| Thickness in depression | 0.216 |
| Thickness of median layer | |
| in ray | 0.036 |
| in depression | 0.016 |

*Hypotype.*—Stanford Univ. Paleo Type Coll. No. 8319 G.

Family NUMMULITIDAE

Genus **Operculinoides** Hanzawa, 1935

**Operculinoides** sp.

Plate 19, figs. 14, 15, 16, 17, 18

Sections of *Operculinoides* are common in thin sections, however, although about thirty specimens have been found, none of them was sectioned through the center. Therefore, no specific identification is attempted; better sections might show interesting relations with the Gulf Coast and Caribbean representatives of this genus and might give additional evidence as to the age of this Californian limestone.

Measurements of Hypotypes in mm.

| | 8320A | 8319E | 8320B | 8318F | 8319F |
|---|---|---|---|---|---|
| Diameter | 1.164 | 0.622 | 1.244 | 0.968 | 1.144 |
| Thickness | 0.508 | 0.414 | 0.456 | 0.340 | 0.372 |
| Thickness of pillar | 0.192 | 0.150 | 0.172 | — | 0.116 |

*Hypotypes.*—

Pl. 19, fig. 14, Stanford Univ. Paleo. Type Coll. No 8320 A

Pl. 19, fig. 15, Stanford Univ. Paleo. Type Coll. No. 8319 E

Pl. 19. fig. 16, Stanford Univ. Paleo. Type Coll. No. 8320 B

Pl. 19, fig. 17, Stanford Univ. Paleo. Type Coll. No. 8318 F

Pl 19, fig. 18, Stanford Univ. Paleo. Type Coll. No. 8319 F

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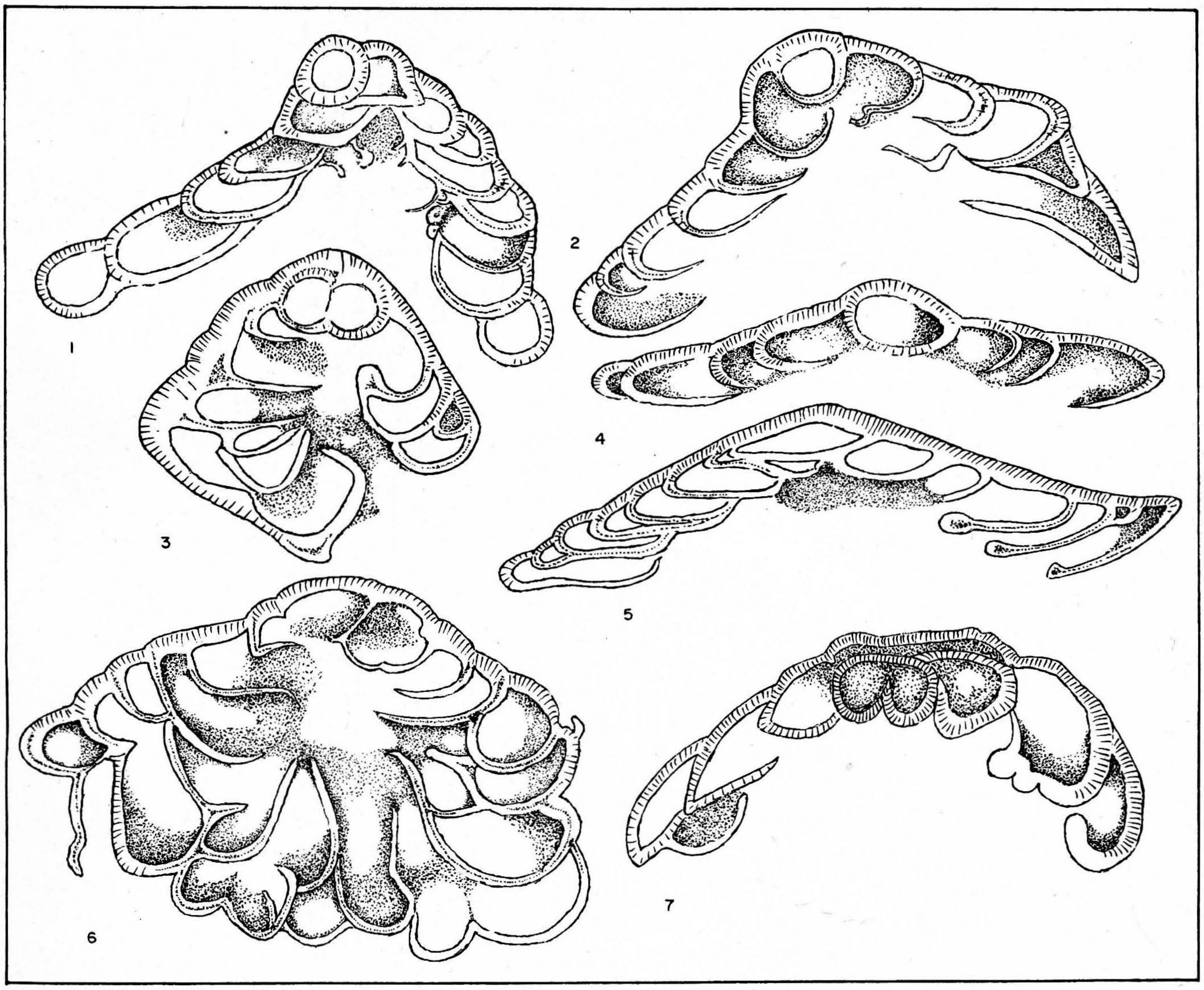


EXPLANATION OF TEXT PLATE 1

1. *Eofabiania grahami* Küpper, gen. nov. et spec. nov., vertical centered section, (pl. 19, fig. 4). holotype, Stanford Univ. Paleo. Type Coll. No. 8315
2. *Eofabiania grahami* Küpper, gen. nov. et spec. nov., vertical centered section, (pl. 19, fig. 6), paratype, Stanford Univ. Paleo. Type Coll. No. 8319 B
3. *Eofabiania grahami* Küpper, gen. nov. et spec. nov., oblique centered section, (pl. 19, fig. 5), paratype, Stanford Univ. Paleo. Type Coll. No. 8316 A
4. *Eofabiania grahami* Küpper, gen. nov. et spec. nov., vertical centered section, (pl. 19, fig. 2), paratype, Stanford Univ. Paleo. Type Coll. No. 8318 C
5. *Eofabiania grahami* Küpper, gen. nov. et spec. nov., vertical not centered section, (pl. 19, fig. 1) paratype, Stanford Univ. Paleo. Type Coll. No. 8317
6. *Eofabiania grahami* Küpper, gen. nov. et spec. nov., oblique section, (pl. 19, fig. 3), paratype, Stanford Univ. Paleo. Type Coll. No. 8318 D
7. *Eofabiania grahami* Küpper, gen. nov. et spec. nov., oblique not centered section, paratype, Stanford Univ. Paleo. Type Coll. No. 8318 E.

All figures are magnified approximately 36 ×.

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CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
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# 145. BRACKISH-WATER FORAMINIFERA OF THE NEW YORK BIGHT

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## INTRODUCTION

Sediments from ten brackish-water bays and lagoons of the New York Bight (waters lying between Montauk Point, Long Island, N. Y., and Cape May, N. J.) were sampled to determine the foraminiferal fauna native to that habitat, as part of a study of the sedimentary environment of these waters. Field work was done in the summer of 1951. Samples were taken from small craft or from shore with a hand-operated dredge. Salinity and temperature were recorded at each collecting station. The foraminiferal fauna is described qualitatively and for some samples quantitatively. Sixty-eight different species and varieties of Foraminifera were found. Of these thirty-one are considered as typical of the environment, and discussed in this paper.

The writer wishes to express his sincerest gratitude to Dr. Brooks F. Ellis, Curator of Micropaleontology, American Museum of Natural History, for his valuable suggestions during the course of the study. He wishes also to express his thanks to Dr. Paul Bronnimann for his criticism and suggestions during the preparation of the manuscript. He is indebted to John A. Sulek for the photographic work.

## FAUNA AND ENVIRONMENT

The brackish-water lagoons and bays of the New York Bight support a restricted foraminiferal fauna consisting exclusively of benthonic forms. Eleven genera, because of their distribution and abundance, can be considered typical of the lagoonal environment of the New York Bight. They are: *Ammobaculites, Ammoastuta, Eggerella, Miliammina, Quinqueloculina, Triloculina, Trochammina, Nonion, Elphidium, Buccella* and *Rotalia.*

The genus *Elphidium,* represented by seventeen different species and varieties, exhibits the greatest variation of the entire fauna. *Trochammina* is represented by ten species and *Ammobaculites* by nine species and varieties. *Nonion* occurs in two species. *Rotalia beccarii* (Linné), appearing in three distinct varieties, was found to be the most widely distributed form, occurring in all of the ten lagoons. *Trochammina inflata* (Montagu) and *Elphidium orbiculare* (Brady) were found in nine of the collecting localities. The species most abundant in any one sample (see table) was *Elphidium incertum* (Williamson). The numerical abundance of twenty-three species in representative samples from each of the ten lagoons is given in the accompanying Table 1. The apparent greater abundance of arenaceous forms in the New Jersey lagoon may be attributed to the sampling procedure which prohibited taking equal numbers from similarly located stations in Long Island and in New Jersey marginal lagoons because of pollution.

The arenaceous Foraminifera, in an environment grading from fresh to brackish water, may be divided into three types inhabiting three overlapping zones. The first type, confined mainly to cold, clear waters of an extremely low chloride ion content (300 ppm.) is characterized by forms having minute tests composed of very fine quartz grains. Protozoa of the order Testacea, genus *Difflugia, Rheophax moniliforme* Siddall, and several species of the genus *Ammobaculites* possessing small tests, are representative of this type.

The second type of arenaceous fauna found in cool, slightly turbid water of low chloride ion content (1.800 ppm.) consists of agglutinated Foraminifera with large tests. The larger species of the genus *Ammobaculites* and species of *Hyperammina,* as well as the coarse forms of *Miliammina,* fall in this group.

The third category of arenaceous forms is found in warm, turbid, brackish waters (11,000-14,000 ppm. chloride ion content) and is comprised of species of the genera *Trochammina, Ammoastuta* and the finer grained forms of *Miliammina.* Tests of some of the Foraminifera of this fauna are more chitinous than those of the other two groups.

Chlorinity varies within each lagoon as well as from one body of water to another. Almost all chlorinity readings were found to be smaller than those of the open ocean, ranging from 11,000 ppm. to 17,000 ppm. in the lagoon proper. In the fresh

# TABLE-I

| Locality | Sample Number | Ammobaculites rostratus | Ammoastuta salsa | Eggerella advena | Triloculina trigonula | Miliammina fusca | Trochammina inflata | Trochammina nitida | Trochammina macrescens | Trochammina squamata | Nonion pauciloculum | Nonion tisburyensis | Elphidium | Elphidium frigidum | Elphidium bartletti | Elphidium subarcticum | Elphidium incertum | Elphidium clavatum | E. clavatum brooklynense | E. advenum margaritaceum | E. advenum depressulum | E. gunteri galvestonense | Rotalia beccarii | Buccella frigida |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Napeague Harbor | 1 | | | | 0-5 | | less than 1 | | | | | | less than 1 | less than 1 | 0-5 | | | | | | 0-5 | | less than 1 | less than 1 |
| Great Peconic Bay | 3 | | | | 0-5 | | | | | | | | | less than 1 | 0-5 | | 0-5 | | | | 0-5 | | less than 1 | |
| Shinnecock Bay | 4 | | | less than 1 | | | | | | less than 1 | 10-20 | 10-20 | 5-10 | less than 1 | less than 1 | | 100-125 | 30-40 | 10-20 | 40-50 | | | less than 1 | 5-10 |
| Great South Bay | 10 | less than 1 | | | | | | | | | 0-5 | 0-5 | less than 1 | | less than 1 | | 125-150 | 5-10 | 10-20 | 0-5 | | less than 1 | 5-10 | 10-20 |
| Oyster Bay Harbor | 15 | less than 1 | | | | less than 1 | | | | | 30-40 | 70-80 | 0-5 | less than 1 | less than 1 | | 0-5 | 10-20 | 0-5 | 0-5 | | | 0-5 | 10-20 |
| Greenwich Cove | 17 | 10-20 | | | | 20-30 | 10-20 | | | 0-5 | | 0-5 | 5-10 | | | | | 0-5 | | 0-5 | | | 5-10 | 0-5 |
| Barnegat Bay | 22 | | | | | | | | less than 1 | less than 1 | 10-20 | 0-5 | | 0-5 | | 0-5 | 20-30 | 10-20 | 10-20 | 0-5 | | | 20-30 | 0-5 |
| Great Bay | 27 | | 0-5 | 0-5 | 0-5 | 0-5 | 10-20 | 0-5 | less than 1 | 5-10 | 0-5 | | less than 1 | 0-5 | | | 20-30 | less than 1 | | | | | 5-10 | |
| Great Egg Bay | 30 | 5-10 | 0-5 | 0-5 | 0-5 | 10-20 | 0-5 | 0-5 | less than 1 | 0-5 | 5-10 | 5-10 | 0-5 | 0-5 | | 0-5 | 5-10 | 10-20 | | 0-5 | | 5-10 | 5-10 | |
| Jenkins Sound | 31 | | | | | 5-10 | 10-20 | 0-5 | 0-5 | less than 1 | | 30-40 | | less than 1 | | | less than 1 | 10-20 | 5-10 | less than 1 | | 5-10 | 70-80 | |

– NUMBER OF SPECIMENS IN 2.75 CUBIC CENTIMETERS OF SEDIMENT –

LESS THAN 1 · 0-5 · 5-10 · 10-20 · 20-30 · 30-40 · 40-50 · 50-60 · 60-70 · 70-80 · 80-90 · 90-100 · 100-125 · 125-150

DISTRIBUTION OF FORAMINIFERA IN BOTTOM SAMPLES.

water creeks, chlorinities varying from 300 ppm. above the reach of tidal influence to 13,800 ppm. at the mouth were determined.

During the collecting period, temperatures of the New York Bight bays and lagoons did not exhibit a great amount of variation. However, they change radically with the seasons. From June to September, temperatures of 20°C. to 25°C. were found to prevail in the lagoonal waters. Fresh water streams had a lower temperature than the lagoons.

Silt, mud, and sand, and mixtures of these, were the predominant types of sediments in the bays and lagoons. Frequent facies changes, the result of the normal physical processes of the environment, do not appear to exert any noticeable control over faunal assemblages, in the relatively shallow waters sampled.

The factors that control faunal assemblages seem to be a combination of ecologic conditions including salinity, organic content of sediments, currents affecting sedimentation, and possibly temperature. Further examination of such factors as carbonate content, food supply, and the chemical and physical properties of the waters, may shed new light on the problem.

Family REOPHACIDAE

Genus **Reophax** Montfort, 1808

**Reophax moniliforme** Siddall

Plate 20, fig. 1

1885. *Reophax* sp., Balkwill and Wright (part), Trans. Roy. Irish Acad., vol. XXVIII, pl. XIII, figs. 22, 24.

1886. *Reophax moniliforme* Siddall, Lit. Phil. Soc. Liverpool, Proc., vol. 40, app., p. 54.

Siddall's specimens were dredged from Colwyn Bay, Wales, and the species has been reported from other localities in the British Isles and from the Falkland Islands. It is quite abundant in the highly brackish waters of Oyster Creek and Cedar Creek, Barnegat Bay, New Jersey.

Family LITUOLIDAE

Genus **Ammobaculites** Cushman, 1910

**Ammobaculites dilatatus** Cushman and Bronnimann

Plate 20, fig. 2

1948. *Ammobaculites dilatatus* Cushman and Bronnimann, Contr. Cushman Lab. Foram. Res., vol. 24, p. 39.

Most of the specimens are not perfect, the uncoiled portion having been broken off. Some of the specimens resemble *A. americanus* Cushman; however, the sutures are indistinct and the specimens approximate *A. dilatatus* more closely. Cushman and Bronnimann described it from the Gulf of Paria, Trinidad, B.W.I., from 0-2 fathoms, in brackish water. It is abundant in Oyster Bay Harbor, Long Island, N. Y., and occurs in Great Peconic Bay and Shinnecock Bay, Long Island.

**Ammobaculites exiguus** Cushman and Bronnimann

Plate 20, fig. 3

1948. *Ammobaculites exiguus* Cushman and Bronnimann, Contr. Cushman Lab. Foram. Res., vol. 24, p. 38.

This species was described by Cushman and Bronnimann from brackish waters, Gulf of Paria, Trinidad, B.W.I., in 0-2 fathoms. It occurs in Greenwich Cove, Connecticut, and is also found in Oyster Creek, Cedar Creek, Great Egg Bay, and Jenkins Sound, New Jersey.

**Ammobaculites rostratus** Heron-Allen and Earland

Plate 20, fig. 4

1929. *Ammobaculites rostratus* Heron-Allen and Earland, Roy. Micr. Soc. Jour., ser. 3, vol. 49, t. 4, art. 27, p. 326.

All localities given by the authors are in the South Georgia area, in the South Atlantic. The species occurs in Shinnecock Bay, Great South Bay, and Oyster Bay Harbor, Long Island, N. Y.; it is most abundant in Greenwich Cove, Conn.; and is also found in Great Bay and Great Egg Bay, New Jersey.

Genus **Ammoastuta** Cushman and Bronnimann, 1948

**Ammoastuta salsa** Cushman and Bronnimann

Plate 20, fig. 5

1948. *Ammoastuta salsa* Cushman and Bronnimann. Contr. Cushman Lab. Foram. Res., vol. 24, p. 17.

Cushman and Bronnimann described the species from the brackish water of a mangrove swamp, Trinidad, B.W.I. It occurs in Cedar Creek, and Oyster Creek, Barnegat Bay, New Jersey; and in Great Bay and Great Egg Bay, New Jersey.

Family VALVULINIDAE

Genus **Eggerella** Cushman, 1933

**Eggerella advena** Cushman

Plate 20, fig. 6

1920. *Verneuilina polystropha* Reuss. Cushman, Rep. Canadian Arctic Exped., vol. 9, pt. M, p. 6mn, pl. 1, fig. 5.
1920. *Verneuilina polystropha* Reuss, dwarf form *V. pusilla* Goes. Heron-Allen and Earland, Proc. Roy. Irish Acad., vol. 35, sect. B. no. 3, pp. 172-174, pl. 16, fig. 11; pl. 17, figs. 12-13.
1922. *Verneuilina advena* Cushman, Contr. Canadian Biol. (1921), no. 9, p. 9, (141).
1937. *Eggerella advena* (Cushman). Cushman (part), Cushman Lab. Foram. Res. Spec. Publ. No. 8, p. 51, (not pl. 5, figs. 12-15).
1948. *Eggerella advena* (Cushman) Cushman Lab. Foram. Res., Spec. Publ. No 23, p. 32

All specimens of this area are light in color. Cushman reports the species from the Arctic and extending southward in the Atlantic Ocean to New England and the British Isles; he also describes it as occurring on the eastern coast of the Pacific from Alaska to California. Specimens occur in Shinnecock Bay, Long Island, N. Y., Great Bay and Great Egg Bay, New Jersey.

Family SILICINIDAE

Genus **Miliammina** Heron-Allen and Earland, 1930

**Miliammina fusca** (H. B. Brady)

Plate 20, fig. 7

1865. *Quinqueloculina agglutinans* Brady, Nat. Hist. Trans. Northumb. and Durham. vol. 1, pp. 87, 95.
1870. *Quinqueloculina fusca* Brady, Ann. Mag. Nat. Hist., ser. 4, vol. 6, p. 286
1936. *Miliammina fusca* (Brady). Rhumbler, Kiel, Meeresf., Bd. 1 (1936-37) Heft 1, pp. 179-242, tfs. 147-246.

Specimens agree with Brady's description except that they were not calcareous. They are therefore placed in the family Silicinidae, genus *Miliammina*. Texture is variable, grading from very fine to coarse. Brady reports this species from brackish waters in England. They were found to be abundant in Greenwich, Cove, Conn., Great Egg Bay, and Jenkins Sound, New Jersey. They also occur in Shinnecock Bay, Great South Bay, Oyster Bay Harbor, Long Island, and in Barnegat Bay, New Jersey.

Family MILIOLIDAE

Genus **Quinqueloculina** Orbigny, 1826

**Quinqueloculina seminulum** (Linné)

Plate 20, fig. 8

*Conchula minima* etc. Plancus, Coch., t. 2, fig. 1.
*Tubulus* etc. Gualtiere, Testac.. t. 10, fig. S.

1758. *Serpula seminulum* Linné, *Systema naturae*. Ed. 10. tomus 1, p. 786.
1826. *Quinqueloculina seminula* (Linné), Cushman, Cushman Lab. Foram. Res., Spec. Publ. No. 23, p. 34.

Cushman reports this species to be extremely common and very widely distributed, but reported occurrences may include more than one species. Specimens were found in Shinnecock Bay, Long Island, N. Y., Barnegat Bay and Jenkins Sound, New Jersey.

**Quinqueloculina seminulum** (Linné) var. **jugosa** Cushman

Plate 20, fig. 9

1944. *Quinqueloculina seminula* (Linné) var. *jugosa* Cushman. Cushman Lab. Foram. Res., Spec. Publ., no. 12, p. 13.

Cushman reports this variety as being widely distributed south of Cape Cod, but not found to the northward. Specimens were found in Napeague Harbor, Great Peconic Bay, and Shinnecock Bay, Long Island, N. Y., and in Jenkins Sound, New Jersey.

Genus **Triloculina** Orbigny, 1826

**Triloculina trigonula** (Lamarck)

Plate 20, fig. 10

1804. *Miliolites trigonula* Lamarck, Paris Mus. National Hist. Nat., Ann., tome 5 (pl. 17, tome 9, 1807), p. 351.
1826. *Triloculina trigonula* (Lamarck). Orbigny, Ann. Sci. Nat., ser. 1, tome 7, pp. 96-314. pls. 10-17.
1858. *Miliolina trigonula* Williamson, Rec. Foram. Gt. Britain, p. 84, pl. 7, figs. 180-182; Brady, H. B., 1884, Rep. Voy. *Challenger*, zoology, vol. 9, p. 164, pl. 3, figs. 14-16.
1929. *Triloculina trigonula* (Lamarck). Cushman,

U. S. Nat. Mus., Bull. no. 104, p. 56, pl. 13.

Lamarck described the species from the Eocene of the Paris Basin. Cushman reported it from the Atlantic Ocean. It was found in Napeague Harbor, Great Peconic Bay, Shinnecock Bay, and Great South Bay, Long Island, N. Y., and in the Great Bay and Great Egg Bay, New Jersey.

Family TROCHAMMINIDAE

Genus **Trochammina** Parker and Jones, 1860

### **Trochammina inflata** (Montagu)

Plate 20, fig. 11

1808. *Nautilus inflatus* Montagu, Testacea Britannica, Supplement, p. 81.
1858. *Rotalina inflata* Williamson, Rec. Foram. Great Britain, p. 50, pl. 4, figs. 93, 94.
1862. *Trochammina inflata* (Williamson). Carpenter, Parker and Jones, Int. Foram., p. 141, pl. 11, fig. 5.
1865. *Trochammina inflata* (Montagu). Brady, H. B., Nat. Hist. Trans. Northumb. and Durham, vol. 1, p. 95.
1920. *Trochammina inflata* (Montagu). Cushman U.S. Nat. Mus., Bull. no. 104, p. 73.
1944. *Trochammina inflata* (Montagu). Cushman, Cushman Lab. Foram. Res., Spec. Publ. no. 12, pl. 2, fig. 8.

Most specimens are reported from shallow waters of the Atlantic Ocean, and were found in all localities excepting Great Peconic Bay, Long Island, N. Y.

### **Trochammina macrescens** Brady

Plate 20, fig. 12

1870. *Trochammina inflata* (Montagu) var. *macrescens* Brady. H. B., Ann. Mag. Nat. Hist. ser. 4, vol. 6, p. 290
1878. *Trochammina macrescens* Brady, Soc. Acad. Nantes, ser. 6. vol. 8, pp. 222.

In some cases there was noted a similarity between the deflated tests of *T. macrescens* and the convex tests of other species of *Trochammina.* Some specimens have the appearance of deflated *T. nitida.* while others will approximate deflated *T. inflata.* However, the problem remains as to why certain specimens of *Trochammina* in a given sample would deflate while others retained their characteristic convexity. Brady reports the species from brackish waters in the British Isles. Specimens were obtained from the following localities: Shinnecock Bay, Great South Bay, Long Island, N. Y. and Barnegat Bay, Great Bay, Great Egg Bay and Jenkins Sound, New Jersey.

### **Trochammina nitida** Brady

Plate 20, fig. 13

1881. *Trochammina nitida,* Brady, Quart. Journ. Micr. Sc., n.s., vol. 21, p. 52.
1920. *Trochammina nitida* Brady, Cushman. U.S. Nat. Mus., Bull. no. 104, p. 75.
1938. *Trochammina nitida* Brady, Bartenstein, Senckenbergiana, vol. 20, no. 5, p. 392.

Bartenstein's distinction between *T. nitida* and *T. inflata* is valid. Furthermore, it was found that in the case of *T. inflata* the spire is always darker than the outer whorl, while *T. nitida* is uniform in color.

Brady reports the species from the South Atlantic Ocean. Bartenstein describes the form from brackish waters of the Jade-Gebiet. All present specimens are from New Jersey localities.

### **Trochammina squamata** Jones and Parker

Plate 20, fig. 14

1860. *Trochammina squamata* Jones and Parker. Geol. Soc. London, Quart. Journ., vol. 16, p. 304.
1948. *Trochammina squamata* Jones and Parker. Cushman, Cushman Lab. Foram. Res., Spec. Publ. No. 23, p. 41.

Jones and Parker report this form from the Mediterranean Sea. Cushman's specimens are from the Canadian Arctic, although he states that it does not seem to be typically an Arctic species. It occurs in all localities except Napeague Harbor, Great Peconic Bay, and Great South Bay, Long Island, N. Y.

Family NONIONIDAE

Genus **Nonion** Montfort, 1808

### **Nonion pauciloculum** Cushman

Plate 21, fig. 2

1944. *Nonion pauciloculum* Cushman, Cushman Lab. Foram. Res., Spec. Publ., Sharon, Mass., no. 12. p. 24.

Several variations of this species were found. In the same sample, there occurred opaque as well as translucent tests. Except for one station the aperture was always found to be divided and in this respect the species approaches *Elphidium orbiculare.* This characteristic indicates that these specimens might very well be placed under the genus *Elphidium.* At Station '27 the characteristic slit aperture, described by Cushman, was found to be evident. Differentiation between *N. pauciloculum, N. tisburyensis* and *E. orbiculare* is on the basis of the lesser number of chambers being present in *N. pauciloculum,* as well as the generally smaller size of the test. Cushman describes the species from Buzzards Bay, Massachusetts. It was found in all localities except Napeague Harbor, Long Island, N. Y. and Greenwich Cove, Connecticut.

### **Nonion tisburyensis** Butcher

Plate 21, fig. 3

1948. *Nonion tisburyensis* Butcher, Contr. Cushman Lab. Foram. Res., vol. 24, p. 21.

Specimens tend to agree with Butcher's description except for the aperture, which is always divided. Some specimens of this species approach *Elphidium subarcticum* in external appearance, the difference between the two forms being the absence of retral processes in *N. tisburyensis.* Butcher reports the species from brackish tidal ponds off Cape Cod, Massachusetts, and nearby islands. Said (1951, p. 76) reports this species from Narragansett Bay, Rhode Island. It was found in all localities except Great Peconic Bay, Great South Bay, Long Island, N. Y., and Jenkins Sound, New Jersey.

## Family ELPHIDIIDAE

## Genus **Elphidium** Montfort, 1808

### **Elphidium orbiculare** (Brady)

Plate 21, fig. 1

1881. *Nonionina orbicularis* Brady, K. Akad. Wiss. Wien, math.-naturw. Cl., Denkschr. Bd. 43, Abt. 2, p. 105.

1930. *Nonion orbiculare* (Brady). Cushman, J. A., U.S. Nat. Mus., Bull. 104, p. 12.

1953. *Elphidium orbiculare* (Brady). Loeblich and Tappan. Arctic Foraminifera, Smithsonian Misc. Coll. vol. 121, no. 7, p. 102-103, pl. 19, figs. 1-4.

*Elphidium orbiculare, Nonion pauciloculum,* and *N. tisburyensis* appear to be very similar externally. In this study, these three species were found to have the divided aperture characteristic of the genus *Elphidium.* Furthermore there seems to be a suggestion of transitional stages between these three, as well as between them, *Elphidium bartletti,* and *Elphidium frigidum.* The essential difference between *E. orbiculare* and the two species of *Nonion* is the greater number of chambers in *E. orbiculare.* Primitive retral processes were found in some specimens. Brady described the species from the Arctic. It has also been reported from Hudson Bay and the west coast of Scotland. In the brackish waters of the New York Bight, the species occurs in all localities except Great Peconic Bay, Long Island, N. Y.

Loeblich and Tappan (1953) considered that this species was an *Elphidium* after having studied the wall structure and found it to be radiate. Since the wall structure of *Nonion* is granular, not radiate, they also considered *Elphidium* and *Nonion* to belong to distinct families. The two *Nonion* species should obviously be studied further.

### **Elphidium advena** Cushman var. **depressulum** Cushman

Plate 21, fig. 4

1933. *Elphidium advenum* (Cushman) var. *depressulum* Cushman, U.S. Nat. Mus., Bull. 161, p. 51.

Cushman reports this species from the Tonga Islands, South Pacific Ocean. It occurs in Napeague Harbor, Great Peconic Bay and Shinnecock Bay, Long Island, N. Y.

### **Elphidium advena** (Cushman) var. **margaritaceum** Cushman

Plate 21, fig. 5

1930. *Elphidium advenum* (Cushman) var. *margaritaceum* Cushman, U.S. Nat. Mus., Bull., no. 104, p. 25.

Some specimens tend to resemble *E. clavatum,* but they differ in coloration, in the size and spacing of the pores, and in the shape of the terminal chamber. *E. advena margaritaceum* has a pink translucent test, the pores are large and numerous, and the inflation of the terminal chamber is marked, while *E. clavatum* has a yellowish-brown translucent test, smaller and fewer pores, and a less inflated terminal chamber. Cushman reports this species from Newport, Rhode Island. It is quite abundant in the brackish waters of the New York Bight. It occurs in all localities with the exception of Napeague Harbor and Great Peconic Bay, Long Island, N. Y.

### **Elphidium bartletti** Cushman

Plate 21, fig. 6

1933. *Elphidium bartletti* Cushman, Smithsonian Inst. Misc. Coll., vol. 89, no. 9, (pub. 3221), p. 4.

1948. *Elphidium bartletti* Cushman Lab. Foram. Res., Spec. Publ., no. 23., p. 59.

This species is somewhat similar externally to both *Nonion tisburyensis* and *Elphidium orbiculare.* It differs from these two in having a slight uncoiled portion at the umbilical area and in having distinct retral processes. The specimens collected in Oyster Bay Harbor had a yellowish-brown test. Cushman gives Labrador as the type locality. It was found in all Long Island localities.

**Elphidium clavatum** Cushman

Plate 21, fig. 7

1930. *Elphidium incertum* (Williamson) var. *clavatum* Cushman, U.S. Nat. Mus., Bull., no. 104, p. 20.

1938. *Elphidium incertum* Cushman, Cushman Lab. Foram. Res., Spec. Publ., Sharon, Mass., no. 23, p. 57, pl. 6.

1934. *Elphidium florentinae* Shupack, Amer. Mus. Novitates, no. 737, p. 9, pl. 1, figs. 5a, b.

(Shupack. *op. cit.,* p. 10): "This species would be a *Nonion* were it not for the pores that begin to appear indistinctly in the next to the last suture and show quite distinctly in the last suture."

After examination of Shupack's holotype material of *E. florentinae,* it would seem that this species should be placed in synonymy with *E. clavatum.* Weiss (1954, pp. 159, 160) describes *E. clavatum* as having a white opaque test and *E. florentinae* as differing from it in having a yellowish-brown translucent test. This, however, does not agree with the original description of the variety given by Cushman, (1930). The white opaque forms should be placed as a distinct variety of *E. clavatum.* This species has been reported from the northern coasts of the Atlantic Ocean. It is widespread in the New York Bight localities, having been found in all waters with the exception of Napeague Harbor, Great Peconic Bay, and Great South Bay, Long Island, N. Y.

**Elphidium clavatum** Cushman (opaque variety)

Plate 21, fig. 8

Variety differs from the typical in having a white opaque test. This may be due to ecologic conditions or to alteration of the test after death.

**Elphidium clavatum** Cushman var. **brooklynense** Shupack

Plate 21, fig. 9

1934. *Elphidium brooklynense* Shupack, B., Amer. Mus. Nat. Hist., Novitates, no. 737, p. 10.

Shupack's holotype does not agree with his type description, and *E. brooklynense* should be made a variety of *E. clavatum,* differing from *E. clavatum* in the irregularly arranged bosses in the umbilical region and in having bosses filling the pores along the sutures. The test is usually yellowish-brown in color; in some localities it is opaque, which may be due to ecologic conditions or to alteration after death. The form attains gigantic proportions in some localities. This variety was reported from New York Harbor and Long Island, N. Y. Specimens were found in all localities with the exception of Napeague Harbor, and Great Peconic Bay, Long Island, N. Y., Greenwich, Conn., and Great Egg Bay, New Jersey.

**Elphidium ? ellisi** Weiss

Plate 21, fig. 10

1954. *Elphidium (?) ellisi* Weiss, Origin of the Gardiners Clay (Pleistocene) in Eastern Long Island, New York. U.S. Geol. Surv., Prof. Paper no. 254-G, pp. 159. pl. 32, figs. 5, 6.

Type description by Weiss: "Test small, slightly longer than broad, compressed, periphery rounded, margin entire except for last three or four cham-

EXPLANATION OF PLATE 20

All magnifications are linear.

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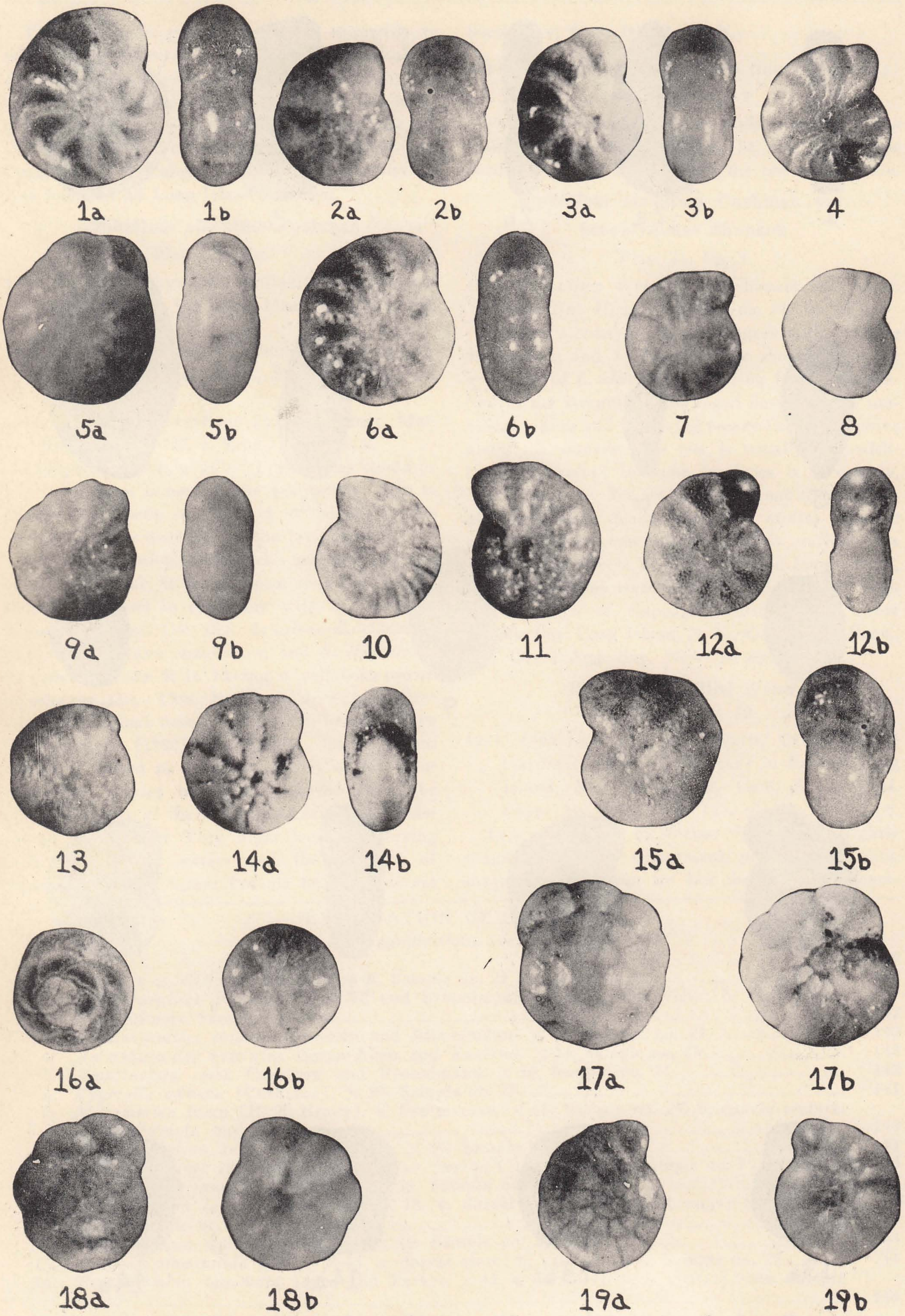
| 1. | *Reophax moniliforme* Siddall. × 45. Sample no. 23 | 142 |
| 2. | *Ammobaculites dilatatus* Cushman and Bronnimann. × 45. a, side view; b, view showing thickness. Sample no. 14 | 142 |
| 3. | *Ammobaculites exiguus* Cushman and Bronnimann. × 54. Sample no. 23 | 142 |
| 4. | *Ammobaculites rostratus* Heron-Allen and Earland. × 54. Sample no. 25 | 142 |
| 5. | *Ammoastuta salsa* Cushman and Bronnimann. × 54. Sample no. 21 | 142 |
| 6. | *Eggerella advena* (Cushman). × 50. Sample no. 29 | 143 |
| 7. | *Miliammina fusca* (H. B. Brady). a, fine texture. × 65. Sample no. 29. b, coarse texture. × 45. Sample no. 17 | 143 |
| 8. | *Quinqueloculina seminulum* (Linné). × 59. Sample no. 31 | 143 |
| 9. | *Quinqueloculina seminulum* (Linné) var. *jugosa* Cushman. X 36. Sample no. 7 | 143 |
| 10. | *Triloculina trigonula* (Lamarck). × 59. Sample no. 1 | 143 |
| 11. | *Trochammina inflata* (Montagu). × 36. a, dorsal view; b, ventral view; c, apertural view. Sample no. 28 | 144 |
| 12. | *Trochammina macrescens* Brady. × 36. Sample no. 28 | 144 |
| 13. | *Trochammina nitida* Brady. × 45. a, dorsal view; b, ventral view. Sample no. 28 | 144 |
| 14. | *Trochammina squamata* Jones and Parker. × 45. a, dorsal view; b, ventral view. Sample no. 17 | 144 |


Ronai: Brackish-Water Foraminifera of the New York Bight




Ronai: Brackish-Water Foraminifera of the New York Bight bers slightly lobulate, umbilical regions with a large boss of clear calcite, often slightly raised. Chambers numerous, 14 to 16 in the last whorl, very slightly inflated, distinct. Sutures distinct, straight to very slightly curved, early sutures limbate, flush with surface of test, last three or four sutures depressed and show the characteristic septal pores, about five on each side of the test. As seen in the apertural view, the last septal face is slightly canted, giving the test a somewhat asymetrical appearance. This is due to the difference in length of the alar prolongations. This species has a tendency towards becoming slightly evolute—more so on that side of the test where the shorter alar prolongations do not extend to the umbilical boss —and the first few chambers of the previous whorl may be seen. Where the umbilical area is raised, there is often a slight depression or trench on both sides of the test between the ends of the chamber and the large boss. Wall calcareous, hyaline, smooth, coarsely perforate. Aperture a row of small pores at the base of the last septal face, often with a few supplementary pores on the septal face itself. Length to 0.32 mm.; breadth to 0.24 mm.; thickness 0.12 mm. In overall appearance, this is similar to *Nonion chapapotense* Cole in possessing the large central boss and the groove area between the boss and the inner end of the chambers. However, the presence of septal pores and the characteristic aperture clearly place this form in the genus *Elphidium*".

The specimens seem to agree with Weiss' type figure. He reports this species from the Pleistocene of Long Island. Specimens were found only in Barnegat Bay, New Jersey.

### **Elphidium excavatum** (Terquem)

Plate 21, fig. 11

1858. *Polystomella umbilicatula* Williamson, (not Walker and Jacob), Rec. Foram. Gt. Britain, p. 42, pl. 3, fig. 81.

1875. *Polystomella excavata* Terquem, Essai Class. Anim., p. 25, pl. 2, figs. 2 e-f.

1930. *Elphidium excavatum* (Terquem). Cushman, U.S. Nat. Mus., Bull. 104, p. 21, pl. 8. figs. 1-7.

1944. *Elphidium excavatum* Cushman, Cushman Lab. Foram. Res., Spec. Publ., no. 12, p. 26, pl. 3, fig. 40.

This species has been described from the Atlantic Coast of France, Belgium, and the British Isles, as well as from waters off the northern Atlantic coast of the United States. It occurs in Shinnecock Bay, and Oyster Bay Harbor, Long Island, N. Y., Barnegat Bay, New Jersey, and a slightly different variety in Greenwich Cove, Conn.

### **Elphidium frigidum** Cushman

Plate 21, fig. 12

1933. *Elphidium frigidum* Cushman, Smithsonian Inst. Misc. Coll., vol. 89, no. 9, (publ. 3221), pp. 5-6, pl. 1, figs. 8 a-b.

## EXPLANATION OF PLATE 21

All magnifications are linear.

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1948. *Elphidium frigidum* Cushman, Cushman Lab. Foram Res.. Spec. Publ. no. 23, pp. 57-58, pl. 6, figs. 9, 10a-b, 11.

This form seems to be closely allied with some other species of the genera *Nonion* and *Elphidium,* as has been mentioned. It is reported from the Arctic and has also been collected in New England waters. Specimens were found in all localities except Great South Bay, Long Island, N. Y., and Greenwich Cove, Conn.

### **Elphidium gunteri** Cole var. **galvestonense** Kornfeld

Plate 21, fig. 13

1925. *Polystomella galvestonensis* Applin, Amer. Assoc. Petr. Geol., Bull., vol. 9, no. 1, p. 84.

1931. *Elphidium gunteri* Cole var. *galvestonensis* Kornfeld, Stanford Univ. Dept. Geol. Contr., vol. 1, p. 87.

1951. *Elphidium gunteri* Cole var. *galvestonensis* Kornfeld, Phleger and Parker, Geol. Soc. Amer., Mem., no. 46, pt. 2. p. 10, pl. 5, figs. 13-14.

Heretofore, specimens have been reported only from the Gulf of Mexico. The species occurs in Shinnecock Bay and Great South Bay, Long Island, N. Y., and in Barnegat Bay, Great Egg Harbor and Jenkins Sound, New Jersey.

### **Elphidium incertum** (Williamson)

Plate 21, fig. 14

1858. *Polystomella umbilicatula* (Walker) var., *incerta* Williamson, On the Recent foraminifera of Great Britain, p. 44.

1900. *Polystomella striatopunctata* var. *incerta* Kiaer, Rept. Norwegian Fish. Mar. Invest., vol. 1. no. 7, p. 51.

1916. *Polystomella decipiens* Heron-Allen and Earland, Trans. Linn. Soc., ser. 2, vol. 11, p. 282. pl. 43, figs. 20-22.

1930. *Elphidium incertum* (Williamson). Cushman, 1930. U. S. Nat. Mus., Bull. 104, pp. 18-20. pl. 7, figs. 4-9.

1944. *Elphidium incertum* (Williamson). Cushman, Cushman Lab. Foram. Res., Spec. Publ., no. 12, p. 25, pl. 3, figs. 28-31.

In Shinnecock Bay and Great Bay, a different variety of *E. incertum* seems to occur. One sample contains specimens that are characterized by smaller tests, an acute periphery, and in some cases, a cribrate aperture. One sample from Great Bay contains specimens possessing only the smaller tests and the acute periphery. The species is widespread, having been reported from both sides of the Atlantic Ocean. It occurs in all localities with the exception of Napeague Harbor, Long Island, and Greenwich Cove, Conn.

### **Elphidium subarcticum** Cushman

Plate 21, fig. 15

1944. *Elphidium subarcticum* Cushman, Cushman Lab. Foram. Res., Spec. Publ., no. 12, p. 27, pl. 3, figs. 34-35.

This species has been reported from the northern Atlantic Coast of the North American continent. Specimens were found in the Long Island Sound and New Jersey localities.

## Family ROTALIIDAE

### Genus **Bucella** Andersen, 1952

### **Bucella frigida** (Cushman)

Plate 21, fig. 16

1930. *Eponides frigida* (Cushman) var. *calida* Cushman and Cole, Contr., Cushman Lab. Foram. Res., vol. 6, pt. 4, no. 97, p. 93.

1944. *Eponides frigidus* (Cushman) var. *calidus* Cushman and Cole. Cushman, Cushman Lab. Foram. Res., Spec. Publ., no. 12, p. 34, pl. 4, figs. 19, 20.

1952. *Buccella frigida* (Cushman). Andersen, Wash. Acad. Sci., Jour., vol. 42, no. 5, figs. 4a-c, 5, 6a-c.

This species has been described from the shallow waters off the Atlantic coast of the United States. It occurs in all localities with the exception of Great Peconic Bay, Long Island, N. Y., and Great Egg Bay and Jenkins Sound, New Jersey. The genus is separated from *Eponides* on the basis of the pustulose filling of the ventral septa. The species is somewhat variable.

### Genus **Rotalia** Lamarck, 1804

### **Rotalia beccarii** (Linne) var. **tepida** Cushman

Plate 21, fig. 17

1926. *Rotalia beccarii* (Linne) var. *tepida* Cushman, Carnegie Inst. Washington, Publ. no. 344, p. 79.

*Type locality.*—Puerto Rico. This variety has a very wide distribution. It was found in all localities in the brackish waters of the New York Bight.

### Genus **Cribroelphidium** Cushman and Bronnimann, 1948

### **Cribroelphidium** sp.

Some specimens close to *E. incertum* having an acute periphery exhibit a cribrate aperture and are therefore placed under the genus *Cribroelphidium*. However, excepting the cribrate aperture, they are identical in appearance with *E. incertum*.

*Cribroelphidium* has heretofore been reported from Trinidad, Japan and the North Atlantic. The writer has also observed a species of *Cribroelphidum* from a mangrove swamp in Batabano, Cuba. Loeblich and Tappan (1953, pp. 96, 97) consider *Cribroelphidium arcticum* Tappan to be a synonym of *Elphidium bartletti* Cushman.

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Parker, F. L., 1948. Foraminifera of the Continental Shelf from the Gulf of Maine to Maryland. Bull. Mus. Comp. Zool., vol. 100, no. 2, pp. 211-241, pls. 1-7.

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Shupack, B., 1934. Some Foraminifera from western Long Island and New York Harbor. Am. Mus. Novitates, no. 737, pp. 1-12, 1 pl., 2 figs.

Weiss, Lawrence, 1954. Foraminifera and origin of the Gardiners clay (Pleistocene), eastern Long Island, New York. U. S. Geol. Survey Prof. Paper 254-G, pp. 145-163, pls. 32, 33, figs. 14-17.

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME VI, PART 4, OCTOBER, 1955

# RECENT LITERATURE ON THE FORAMINIFERA

Below are given some of the more recent works on the Foraminifera that have come to hand.

ANDEL, TJ. VAN, and POSTMA, H., with the collaboration of others. Recent sediments of the Gulf of Paria. Reports of the Orinoco Shelf Expedition, vol. I.—Verhandl. Kon. Nederland. Akad. Wetenschappen, Afd. Natuurk., Eerste Reeks, Deel 20, No. 5, 1954, pp. 1-245, pls. 1-7, maps 1-4, text figs. 1-78, numerous tables, 2 distribution charts. [Microfauna, by C. KRUIT, pp. 117-134, text figs. 60-64; Foraminifera, by J. KEY, pp. 207-217, pls. 1-3 (pt), distrib. chart on p. 230.]—Thirty-seven species of Foraminifera, none new, are recorded and illustrated. Faunal associations are described and mapped. A summary giving species by species distribution for facies interpretation is included.

ASANO, KIYOSHI. Foraminiferal sequence in the Paleo-Ishikari Sea, Hokkaido, Japan, vol. 60, No. 701, 1954, pp. 43-49, text figs. 1-5, 1 facies diagram.—Two new species described from the upper Eocene Wakkanabe formation.

BARTENSTEIN, HELMUT, and BURRI, FRITZ. Die Jura-Kreide-Grenzschichten im schweizerischen Faltenjura und ihre Stellung im mitteleuropäischen Rahmen.—Eclogae Geol. Helvetiae, vol. 47, No. 2, 1954 (1955), pp. 426-443, pls. 28, 29.— Stratigraphic ranges are plotted for 46 Foraminifera.

BLOW, W. H. Dissection of highly perforate calcareous Foraminifera.—Micropaleontology, vol. 1, No. 2, April 1955, p. 190.

COLOM, GUILLERMO. Jurassic-Cretaceous pelagic sediments of the western Mediterranean zone and the Atlantic area.— Micropaleontology, vol. 1, No. 2, April 1955, pp. 109-124, pls. 1-5.

CRESPIN, IRENE. A bibliography of Australian Foraminifera.— Micropaleontology, vol. 1, No. 2, April 1955, pp. 172-188.

DALBIEZ, F. The genus **Globotruncana** in Tunisia.—Micropaleontology, vol. 1, No. 2, April 1955, pp. 161-171, text figs. 1-10, charts 1, 2.—Species are grouped into 9 evolutionary series, linked by intermediate specimens. Stratigraphic ranges of 26 species and 11 subspecies (3 new) are graphically represented in 5 formations and 11 faunizones from Albian to Maestrichtian in Tunisia.

GLINTZBOECKEL, CHARLES, and MAGNE, JEAN. Sur la répartition stratigraphique de **Globigerinelloides algeriana** Cushman et ten Dam, 1948 (also in English).—Micropaleontology, vol. 1, No. 2. April 1955, pp. 153-155, text figs. 1-3.— A guide fossil for Aptian of North Africa.

HAGN, HERBERT. Fazies und mikrofauna der gesteine der Bayerischen Alpen.—Internat. Sedimentary Petrographical Ser., vol. 1, 1955, pp. 1-174, pls. 1-71, 2 text figs., 8 tables.—Book includes 141 microphotographs illustrating sediment types of the Bavarian Northern Alps. Microfossil contents of the thin sections are described (repeated in English).

Zur Altersfrage der Nierentaler Schichten im Becken von Gosau.—Neues Jb. Geol. Päl., Mh., vol. 1, Jan. 1955. pp. 16-30.

HAYNES. JOHN. Pelagic Foraminifera in the Thanet beds, and the use of Thanetian as a stage name.—Micropaleontology, vol. 1, No. 2, April 1955, p. 189. —Correlation with American upper Midway.

IWASA, SABURO. Biostratigraphy of the Isizawagawa Group in Honjo and its environs, Akita Prefecture. —Jour. Geol. Soc. Japan, vol. 61, No. 712, 1955, pp. 1-18, text figs. 1-5, 1-4; tables 1, 2.—Four zonules and 11 subzonules based on assemblages of smaller Foraminifera in 4 formations of Miocene and Pliocene age. Four new species described.

LINARES RODRIGUEZ, ASUNCION. Contribucion al estudio de la sedimentacion en las cordilleras béticas.—Estudios Geol., Instit. Invest. Geol. "Lucas Mallada." No. 25, 1955, pp. 37-42, pls. 13-16.—Globotruncanas are illustrated in section.

LOEBLICH, ALFRED R. JR., and TAPPAN, HELEN. Revision of some Recent foraminiferal genera.—Smithsonian Misc. Coll., vol. 128, No. 5, July 21, 1955, pp. 1-37, pls. 1-4.— Twenty-four genera are described, of which 3 are suppressed as synonyms (**Proteonina, Trisegmentina,** and **Trochamminella**), 9 are emended, and 4 are new, as follows: **Planctostoma** (type species, **Textularia luculenta** Brady), **Triloculrena** (type species, **Miliammina circularis** Heron-Allen and Earland), **Involvohauerina** (type species, **I. globularis,** n. sp.), and **Alanwoodia** (type species, **Patellina campanaeformis** Brady). One new species is described, one new name proposed (**Miliammina earlandi** for **M. oblonga** Heron-Allen and Earland), and the family Carterinidae erected for forms with tests composed of calcareous spicules secreted by the animal itself.

MAYNC, WOLF. **Reticulophragmium,** n. gen., a new name for **Alveolophragmium** Stschedrina, 1936 (pars).—Journ. Pal., vol. 29, No. 3, May 1955, pp. 557-558.

MONTANARO GALLITELLI, EUGENIA. **Schackoina** from the Upper Cretaceous of the northern Apennines, Italy.—Micropaleontology, vol. 1, No. 2, April 1955, pp. 141-146, pl. 1, table 1.—Two species, one new. A table showing stratigraphic and geographic distribution of all known Schackoinas (11 species and 2 subspecies).

MORENO CARDONA, ILDEFONSO. Nuevas especies de foraminiferos en Sierra Nevada.—Estudios Geol., Instit. Invest. Geol., "Lucas Mallada," No. 25, 1955, pp. 53-56, pl. 19.—**Lingulina melendezi** and **Vaginulina colomi.**

NAPOLI-ALLIATA, E. DI. La limite Plio-Pléistocène dans la coupe de Castell'Arquato (Plaisance).—Congrès Geol. Internat., C. R. 19th Sess. Alger 1952, fasc. 15, 1954, pp. 229-234, text figs. 1, 2 (map section).

A new type of microfaunal diagram.—Micropaleontology, vol. 1, No. 2, April 1955, pp. 133-139, text figs. 1, 2.

SALVATORI, U. Diagnose di forme nuove.— Riv. Ital. Pal. Stratig., vol. 61, No. 1, 1955, pp. 35, 36, text figs. la-e.—**Tritaxilina maxima,** n. sp., from Oligocene of Appennino Vogherese.

SMITH, FOSTER D. JR. Planktonic Foraminifera as indicators of depositional environment.— Micropaleontology, vol. 1, No. 2, April 1955, pp. 147-151, text figs. 1, 2.—In Recent sediments there is significant correlation between depth and per-cent of planktonic tests (in Gulf of Mexico), and between positions inshore from or seaward of island chains and presence of planktonic tests (in Mississippi Sound).

STELCK, C. R., and WALL, J. H. Foraminifera of the Cenomanian Dunveganoceras zone from Peace River area of western Canada.—Research Council of Alberta, Rept. No. 70, 1955, pp. 5-62, pls. 1-3, text figs. 1-6.—Thirty-one species, 18 new, and 9 varieties, all new, are described and illustrated. Several microfaunal zones and subzones are recognized. Ecology and local and regional correlations are discussed.

SWITZER, GEORGE, and BOUCOT, ARTHUR J. The mineral composition of some microfossils.—Journ. Pal., vol. 29, No. 3, May 1955, pp. 525-533, text figs. 1-3, table 1.—Many Foraminifera are studied by x-ray diffraction.

TAI, YOSHIRO. Miocene Foraminifera from the Syôbara Basin, Hiroshima Prefecture.—Journ. Sci. Hiroshima Univ., ser. C, vol. 1, No. 3, Oct. 1953, pp. 1-9, text figs. 1-5, table 1.—Frequency distribution charts show changes by species, genera, and families across 10 horizons. Distribution and abundance table lists 88 species, none new.

Miocene smaller Foraminifera from the Tsuyama Basin, Okayama Prefecture, Japan.—Journ. Sci. Hiroshima Univ., ser. C, vol. 1, No. 4, 1954, pp. 1-24, pl. 1, text figs. 1-7, table 1.— Distribution and abundance table lists 118 species, two new. Frequency distribution charts show changes by species, genera, and families across 6 horizons.

TAKAYANAGI, YOKICHI. Recent Foraminifera from Matsukawa-Ura and its Vicinity.—Contrib. Instit. Geol. Pal. Tohoku Univ., No. 45, March 1955, pp. 18-52, pls. 1, 2, text figs. 1-33, table 1 (in 2 parts).—Two facies (bay and open-sea) and one subfacies (bay-mouth) are recognized on the basis of 38 dominant or critical species. Abundance and distribution, in about 180 samples, of the total fauna (about 155 species) are tabulated. Abundance per sediment weight is plotted on maps for a few species. Five new species are described, and about 60 additional ones are also illustrated.

VILLA, F. Sull'esistenza del Pliocene nel sottosuolo di Venegono inferiore (Varese).—Riv. Ital. Pal. Stratig., vol. 61, No. 1, 1955, pp. 27-34, pl. 6.—A subsurface occurrence of middle lower Pliocene is illustrated.

Ruth Todd

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