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216. A VINDICATION OF THE *ORBULINA* TIME SURFACE IN CALIFORNIA[1]

ALFRED R. LOEBLICH, JR. and HELEN TAPPAN
California Research Corporation, La Habra, California
and University of California at Los Angeles, California

The writers are indebted to R. Stanley Beck, consultant, Bakersfield, California, and Zach Arnold, University of California at Berkeley, for the loan of specimens identified as **Orbulina** by Beck from Washington and by Mallory from California. Clifford C. Church, Tidewater Oil Company, and Max B. Payne, Norris Oil Company, gave valuable advice and assistance in collecting field samples, and Max A. Furrer and Huon Walton, California Research Corporation, La Habra, California, also assisted in the collection of material.

During the last 15 to 20 years, numerous publications have cited the evidence for a world-wide "time surface" based upon the first appearance of the planktonic foraminiferal genus *Orbulina*. Most specialists on this group of Foraminifera are convinced of the validity of the *Orbulina* time surface.

Nevertheless, a few records of pre-Miocene *Orbulina* continue to appear, usually in general faunal studies which include the planktonic species as a minor element of the fauna. These articles have ignored the large body of evidence that such records are certainly to be considered suspect. One such recent "occurrence" supplied the impetus for the present discussion.

The references to pre-Miocene *Orbulina* [Matthew 1895, p. 110 (Cambrian); de Gregorio 1930, p. 49 (Permian); Majzon 1954, p. 244 (Triassic); Terquem 1862, p. 432, 1864, p. 377, Kubler and Zwingli 1866, p. 10, Karrer 1867, p. 368, Haeusler 1890, p. 120, Terquem 1883, pp. 343-344, 1886, p. 5, 1877, p. 481, Zalessky 1926, pp. 87-88 (Jurassic); Coryell *in* Sheppard 1937, p. 107, Williams-Mitchell 1948, pp. 99, 101, 102, 105, 107 (Cretaceous); Sherborn and Chapman 1886, p. 756, Halkyard 1919, p. 104, Beck 1943, p. 609, Bowen 1954, p. 141, and Mallory 1959, p. 251 (Eocene)] are based on misidentifications and represent various other foraminifers, holothurian sclerites, *Oligostegina, Pithonella,* inorganic bodies, etc. Some of these citations have been corrected by later workers, as mentioned below.

Tromp (1941) was one of the first to note the disappearance downward of *Orbulina* in the thick Miocene marl sections of Turkey, in spite of the continued favorable facies for the planktonic species. In 1949 (p. 14), Tromp added that "if the first abundance of *Orbulina* is taken as a stratigraphic boundary, the exact Oligocene-Miocene boundary may have to be placed 260 feet higher in the section."

Glaessner (1948, p. 149) also commented on the restricted geologic range of this genus, stating that, "Most of the records of pre-Miocene occurrences of the genus are erroneous, some of them refer to *Oligostegina,* or to radiolaria, others are doubtful."

Finlay (1947, pp. 337-340) critically discussed the occurrence and reported occurrences of *Orbulina* in numerous areas, in Japan, the west coast of North America, in the Caribbean, Venezuela, Ecuador, and New Zealand. He stated (p. 340) that "The sudden and widespread occurrence of *Orbulina* in New Zealand is so marked that it was observed and used (though the full implications were not realized, and the beds were wrongly classified) as early as 1933. . ." He also stated that on the basis of the orbitoid association *Orbulina* first appeared in New Zealand in the upper part of the lower Miocene.

Le Roy (1948) gave further examples of the world-wide first occurrence of *Orbulina,* concluding (p. 502) that *"points of lowest stratigraphic occurrence of Orbulina in a continuously deposited, open sea, deep-water globigerine facies sequence, fall on or in close proximity to an equivalent time horizon within the Middle Tertiary sections in tropical and subtropical zones of the world."* He proposed the term *"Orbulina surface"* for this time datum. Locally this could be modified by interrupted deposition, near-shore facies or lack of open sea connections.

Brönnimann (1951, p. 134) discussed this proposed *"Orbulina* surface," in view of the reported occurrences of *Orbulina* in the upper Oligocene of the Caribbean, and stated that it would "not be suitable to use *Orbulina* for a middle Tertiary world-wide datum line. . . , if it should be established that the first appearance of *Orbulina* occurred at different times in different localities within the same region." These Caribbean deposits are now considered to be of Miocene age by many workers. In Trinidad, for example, *Orbulina* was stated by Brönnimann to appear in the lower part of the "Oligocene" *Globorotalia fohsi* zone (a zone later placed in the Miocene by Bolli, 1957, p. 99).

Le Roy (1952) discussed the *Orbulina* surface in central Sumatra, and numerous additional records. In a chart (fig. 4) showing the lowest stratigraphic position of *Orbulina* in various areas, he noted that these points "may prove to possess inter-regional time significance irrespective of their present allocated chronologic position in terms of European terminology." Thus,

1 Manuscript received July 13, 1960

as has proved to be the case, Le Roy suggested that some of the earlier assigned age designations might well be modified in view of the evidence of the planktonic species.

Bowen (1954, p. 141) noted that although Le Roy and others regarded *Orbulina* as first appearing in the mid-Tertiary, other writers had reported it as occurring in Cretaceous and early Tertiary strata. Bowen considered that it ranged throughout the Tertiary, and recorded four specimens of *Orbulina universa* d'Orbigny from the London clay, although he did not figure these. Further study of the pre-Miocene *"Orbulina"* record resulted in reassignment of the London clay forms by Bowen (1955, p. 163). He also stated at that time that "It is now generally agreed that all pre-Eocene specimens are globoid objects, incorrectly assigned to this genus. . . ." The Cretaceous Chalk specimens were regarded with little doubt as being inorganic in nature.

Beck (1943, p. 609) recorded *Orbulina universa* d'Orbigny from the Eocene of Washington. Bowen (1955, p. 164) restudied these specimens and stated that one broken specimen lacked any internal structure. Others were sectioned and stated to be "thin-walled, but without the inner *Globigerina* chambers characteristic of the genus" (*Orbulina*). All specimens were stated to be approximately 0.3 mm. in diameter. Bowen concluded "The author is of the opinion that none can be assigned to the genus *Orbulina*." Through the courtesy of R. Stanley Beck, the writers examined some of his original material from the Eocene of Washington. The specimens referred to *Orbulina universa* are small (0.29 mm. in diameter) as noted by Bowen. Although no additional sections were made because of scarcity of type material, the specimens do not have the distinctly and coarsely perforate wall characteristic of *Orbulina*. The somewhat granular appearing brownish surface, without distinct perforations, suggests the possibility that these specimens are not Foraminifera.

Bowen also re-examined all Paleogene specimens of *Orbulina* in the British Museum (Natural History), representing the London clay and Bracklesham beds of England, the Calcaire Grossier (Lutetian) of France, the Wemmelian (Bartonian) of Belgium, and the Tertiary of Poland. Some of these proved to be solid spheres of calcite, others far too small to belong to the present genus, and still others ovoidal, irregular in shape, etc. Bowen commented that "none of these specimens possesses the diagnostic characters of the genus *Orbulina*, and all have been misidentified. As a result of this investigation, the author is convinced that the genus does not occur in pre-Oligocene rocks." He divided the pre-Miocene (Oligocene) records into two categories, those based upon misidentifications of the genus, and those recorded from strata whose ages were erroneously assigned. The Caribbean Oligocene was given as an example of the latter.

In a revision of the classification of the planktonic genera, Bolli, Loeblich, and Tappan (1957, p. 23) showed *Orbulina* to have a range of upper Miocene to Recent. In the same bulletin, Bolli (1957, p. 99) recorded *Orbulina* as occurring in Trinidad from the upper part of the *Globigerinatella insueta* zone of the Cipero formation through the top of the Cipero and Lengua formations. The Cipero had been previously regarded by some authors as wholly Oligocene and it was here divided into 11 planktonic zones, four of which were Oligocene, the remainder Miocene. *Orbulina* thus was restricted to a Miocene to Recent range in this part of the Caribbean region.

Eames, Banner, Blow and Clarke (1960, p. 448) stated that the Caribbean zones of *Globorotalia fohsi fohsi*, *G. fohsi lobata* and *G. fohsi robusta* were equivalent to the European Burdigalian. The Cipero zones below the *G. fohsi fohsi* zone (including the *G. fohsi barisanensis* and *Globigerinatella insueta* zones, where Bolli recorded *Orbulina*) were regarded as Aquitanian (as was the equivalent Vicksburgian). They added "The evolution of *Orbulina*, known to occur in the upper part of the *Globigerinatella insueta* zone of the Caribbean, also occurs in the highest Aquitanian of the Mediterranean and Australia; this correlates with the first appearance of *Orbulina* in the upper "e" stage of the Far East."

Carter (1958) cited 13 "events," consisting of first appearances of various planktonic species in the Tertiary of Victoria, Australia, and showed that these coincided with the sequence in New Zealand, and was almost identical to the sequences of first appearances of these same species in Europe, North America, the Caribbean region and in Saipan. The minor discrepancies were probably due to incomplete records from certain of the other regions. Carter also stated that his work supported "the contention that some, at least, of the events affecting pelagic foraminifera were world wide and contemporaneous."

In this regard, the criticism is occasionally voiced that no time for migration is allowed by the specialist on the planktonic Foraminifera, in regarding these ranges as world wide and simultaneous. This criticism may be valid for benthonic forms, where possibly a greater time would be needed for dispersal. However, the planktonic forms are invariably extremely abundant, as witnessed by the Recent deposits of *Orbulina* and *Globigerina* ooze, and the fossil "oozes" from which the planktonic sequences have been described. In recent studies of ocean currents sealed bottles have been traced to circle the globe in a matter of a few years. These bottles have been numbered perhaps in the hundreds, yet the planktonic Foraminifera may occur in astronomical quantities, a single gram of the ooze containing thousands of specimens. Similar current-borne migrations of planktonic Foraminifera would require no greater time than that needed by the sealed bottles, and five to ten years is certainly to be regarded as instantaneous, geologically speaking.

The great body of evidence that has been accumulating for some 20 years thus now seems agreed that *Orbulina* does not occur in pre-Lower Miocene strata. It is therefore somewhat surprising that *Orbulina* has again been reported in Eocene strata of California (Mallory, 1959, p. 251), without comment as to the unusual character of this record. It is reported from the Kreyenhagen shale (upper Narizian), questionably for the Canoas siltstone and Lodo formation (p. 68) of Ulatisian age, and in fact from the lower Ulatisian to upper Narizian (Mallory, 1959, p. 88). The reference of Beck (1943, p. 609) of *Orbulina* in the Eocene of Washington was given in the synonymy, although this had been shown by Bowen (1955) to be an erroneous assignment.

Israelsky (1959, p. 1122) in reviewing Mallory's publication stated "The apparent early appearance of *Orbulina universa* in Eocene rocks deserves checking."

As the present writers do not believe that foraminiferal genera have different ranges in California, many of the localities from which Mallory reported *Orbulina* were recollected in detail, but a thorough search failed to yield specimens applicable to that genus. Re-examination of the specimen figured by Mallory showed it to be very similar to those of Beck from the Eocene of Washington. Brownish in color, it has a somewhat more granular surface, resulting in an almost knobby appearance, and also lacks the distinct perforations characteristic of *Orbulina* and other planktonic Foraminifera. We have no hesitancy in excluding it from *Orbulina*.

Extreme caution should be used in recording planktonic Foraminifera far outside their normal geologic range. The huge quantity of literature on the planktonic species, and the number of specialists that have studied them, suggests that their general ranges are already known, only minor zone refinements being needed in many cases. A study of these exotic "occurrences" serves only to validate their already known geologic ranges.

Orbulina does not appear in California in any Eocene strata observed and it is regarded as highly unlikely that any true examples of the genus will be found in pre-Miocene strata either in California or elsewhere.

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217. NEAR-SHORE FORAMINIFERA OF MARTHA'S VINEYARD ISLAND, MASSACHUSETTS[1]

RUTH TODD and DORIS LOW
U. S. Geological Survey, Washington 25, D. C.

ABSTRACT

Foraminifera were studied from 102 samples collected from beaches and shallow water around the island of Martha's Vineyard, Mass. Forty-two species, none new, were identified from several ecologic groupings and most of the specimens were living where collected. One species, **Streblus beccarii** (Linné), is represented by its typical form only along the ocean beaches and by its smaller and delicate subspecies **tepida** elsewhere around the island. Most abundant and nearly ubiquitous around the island are **Quinqueloculina lata** Terquem, **Rosalina columbiensis** (Cushman), and **Streblus beccarii tepida** (Cushman). Abundant but environmentally restricted are **Elphidium margaritaceum** Cushman, **E. galvestonense** Kornfeld, **Protelphidium tisburyense** (Butcher), **Trochammina inflata** (Montagu), **T. macrescens** Brady, **Quinqueloculina seminulum** (Linné), and **Q. subrotunda** (Montagu).

Major faunal distinctions exist between ocean-facing beaches, sound-facing beaches, protected bays, brackish ponds, stream entrances, and surfaces of submerged bogs. Foraminifera appear to thrive best in association with seaweed and algae and in organic-rich sediments. Clean sand beaches are virtually barren.

INTRODUCTION

The island of Martha's Vineyard, off the southern coast of New England, is ideally situated for study and comparison of a number of sharply differentiated environments. Its southern shore facing the Atlantic Ocean ranges from low barrier beaches composed of clean sand to cliff-backed and boulder-strewn beaches with an abundance of organic life. Its northern shores, facing Vineyard Sound on the northwest and Nantucket Sound on the northeast, likewise include a variety of bottom types. The island is deeply indented with inlets and ponds (see text fig. 1; also Shimer, 1959, p. 28 [airview of Chappaquiddick Island and the eastern end of Martha's Vineyard]), the various sizes and configurations of which result in many different ecologic facies.

In these environments are included salinities ranging from that of normal sea water down to about 8°/oo, August water temperatures between 19° and 28°C, rapid tidal currents to stagnant conditions, grain size from mud to cobbles, and richness or barrenness of organic growth ranging from clean sand to black or brown slimy mud entangled in roots of marsh plants.

The composition of the Foraminifera fauna of the southern New England coast is well known through the work of Cushman (1944), Parker (1948, 1952b), and Parker and Athearn (1959). The last two papers include much specific information about living places of individual species and the faunal composition of various facies. The local restriction of environments on Martha's Vineyard provides an opportunity of learning more about the faunal restrictions of Foraminifera as controlled or affected by these ecologic differences.

The collections that form the basis of the present study were made by the authors during the months of August, 1957, and August, 1958. Observations on the specific environmental conditions, as well as temperature and salinity readings, were made in conjunction with the taking of the samples. The study was undertaken as a part of the U. S. Geological Survey's long range program of paleoecologic investigations.

Figured specimens are deposited in the U. S. National Museum. All collecting localities, including some not reported on in this paper, have been described and recorded under U. S. Geological Survey localities f11552 through f11609 for the 1957 collections and f11901 through f11954 for the 1958 collections. For the purpose of the present report, individual locality data are not included here. Instead, general descriptions are given under summary of assemblages, and key numbers of the ecologic groupings are added to the distribution table to facilitate finding of any particular sample or location.

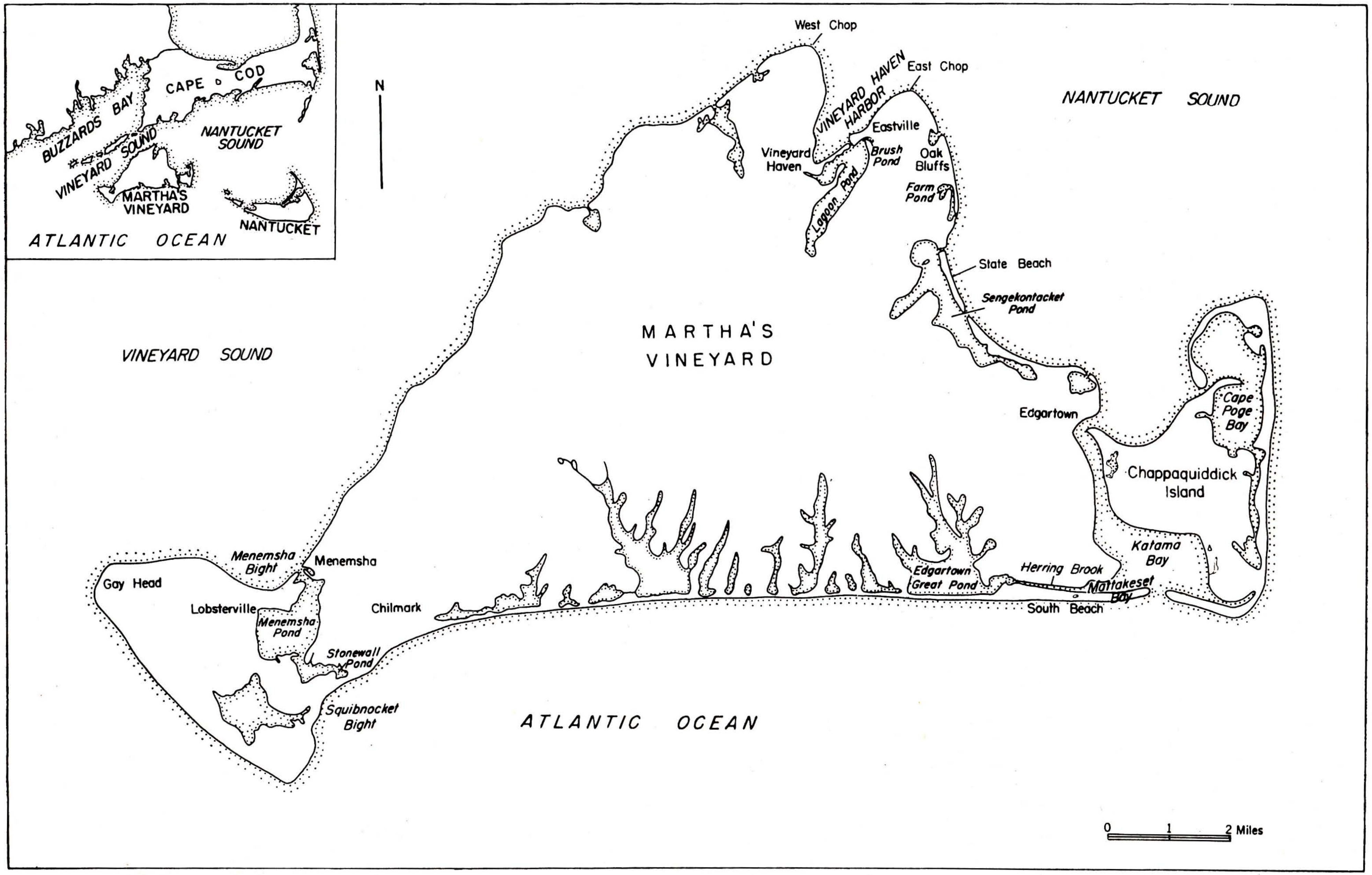
Acknowledgments.—We acknowledge the helpful cooperation of Misses Florence and Irene Larson of Oak Bluffs, Mass., for providing convenient facilities in their home for making on-the-spot examinations of our daily collections and for taking us on the collecting trip to Chappaquiddick Island in 1957.

John T. Hughes, biologist of the Massachusetts Division of Marine Fisheries at the Lobster Hatchery in Oak Bluffs, provided several samples of sediment from the storage and lobster tanks and one from Brush Pond adjoining the hatchery. Dr. and Mrs. J. Gordon Ogden, Jr., also of Oak Bluffs, directed us to several collecting localities.

We are also grateful to Clifford A. Kaye, U. S. Geological Survey, and to Richard Cifelli, U. S. National Museum, for helpful suggestions and for critically reading the manuscript.

Salinities and temperatures were read in the field, using hydrometer, thermometer, and table of corresponding densities and salinities. We are grateful to William D. Athearn, Woods Hole Oceanographic Institution, for verification by the titration method of three of the salinities that had previously been determined by the hydrometer method.

[1] Publication authorized by the Director, U. S. Geological Survey.



TEXT FIGURE 1

GEOGRAPHIC SETTING

Martha's Vineyard is an island about six miles off the southwest shore of Cape Cod. Including Chappaquiddick Island, which is essentially a part of it although actually separated by a narrow channel, Martha's Vineyard is about 21 miles long in an east-west direction and has a maximum north-south width of about 10 miles (text fig. 1). The surface of the island, like Nantucket to the east of it, is covered mainly by glacial debris. The central part of the island is a channelled outwash plain, the southern (seaward) part of which is drowned. The drowning formed rather extensive ponds and bays that are completely or nearly sealed off by sand bars thrown up by the ocean surf along the southern shore of the island. This southern shore, South Beach, extends, with some few and storm-altered breaks, about 15 miles from the eastern edge of Chappaquiddick toward the western end of the island where it is backed by cliffs of varying heights, culminating in the promontory of Gay Head at the westernmost point of the island.

The northern shore of the island is indented by several harbors and protected bays. Being bordered by sounds rather than the ocean—Vineyard Sound on the northwest and Nantucket Sound on the northeast—the northern shore is washed by much less heavy surf than that found on the southern (oceanward) side. As a consequence of the gentler surf, the pebbles, cobbles, and boulders that cover the sea floor in many places are usually found to be coated with algae or other organic matter, providing favorable living places for Foraminifera.

The several quiet bays, called ponds, on the northern side of the island are favorable habitats for Foraminifera. In general the bottom material in the ponds is mud or fine sand, in places interrupted by shell beds or patches of seaweed, and in part bordered by marshes.

The details of the shore line of the island have undergone frequent minor alterations, some as a result of storms or currents, others man-made. Interesting accounts of some of these changes and their effects over the past three centuries may be found in "Martha's Vineyard, a short history and guide" (Mayhew and others, 1956). As a consequence of such changes, the salinity, circulation of water, and hence fauna of the various ponds and inlets are subject to corresponding changes.

SAMPLING METHOD AND TREATMENT OF SAMPLES

Most of the samples were obtained at or near low tide. Mean tide varies between two and three feet, the larger range occuring around the western part of the island and the lesser along the eastern shore. In quiet water material was obtained by skimming off the soft, fine, sometimes flocculent surface material constituting the bottom sediment in water a few inches deep at low tide. This surface sediment was placed in two nested screens, 10- and 200-mesh to the inch, and washed briefly in the sea water from which it was taken. The sediment remaining on the 200-mesh screen was transferred to a jar and neutralized formalin added as soon as practicable, usually within an hour. Some of the samples were processed further during the same or next day. For some, further processing was delayed as much as a year.

In strongly surf-agitated water, samples were collected by holding the two nested screens in such a position that the surf broke into them, bringing the sand and other material stirred up off the bottom into the screens. In less strongly agitated water, material was collected by gathering individual algae-covered pebbles and shells into the screens, scraping the sediment and slime off them, and using the sea water to concentrate the finer material into the lower, finer screen.

All samples were eventually processed with rose Bengal using the method described by Walton (1952). Samples were examined wet and then picked after drying. In most samples the percentage of living to dead shells was high. The only samples in which any significant numbers of empty (dead) shells were found were some of those from the beaches of Vineyard Sound in which were empty shells of the more robust species characteristic of the ocean beaches.

As a consequence of the methods used in collecting the samples, attempts to estimate the absolute abundance of specimens or the percentage of volume of sediment occupied by the Foraminifera would be futile. Even the relative abundance of species in the assemblages could be estimated only roughly.

SUMMARY OF FORAMINIFERA ASSEMBLAGES CHARACTERISTIC OF THE ECOLOGIC GROUPINGS

A-1. From open-sea beaches facing Atlantic Ocean

Major constituents: *Quinqueloculina seminulum* (Linné), *Q. auberiana* d'Orbigny, *Poroeponides lateralis* (Terquem), *Streblus beccarii* (Linné), *Elphidium clavatum* Cushman.

Temperature and salinity: 19° to 23°C; 31.1 to 32.1°/oo.

Study of two ocean beaches form the basis for the above list, namely, the beach southeast of Gay Head (samples 57-MV-46; 58-MV-46, 47, 48, and 51) and Chilmark Town Beach at Squibnocket Bight (samples 58-MV-52 and 53). The former is of fairly fine sand between scattered large glacial erratics and the latter is of boulders, among which are tide pools and a variety of seaweeds. The more varied fauna (see table 1) found near Gay Head may have been a result of more complete sampling. The chief distinction between the faunas of the two beaches is that *Quinqueloculina seminulum* (Linné), the predominant miliolid at Gay Head, is supplanted by *Q. auberiana* d'Orbigny, the predominant miliolid at Squibnocket Bight, and that the attached form *Rosalina columbiensis* (Cushman) is found abundantly in the tidepools at the latter locality.

It is concluded that lack of boulders or erratics on which seaweed can find a foothold accounts for the lack of Foraminifera on South Beach. Even though the Foraminifera found on the ocean beaches are not attached forms, with the exception of *Rosalina columbiensis* (Cushman) and *Cibicides lobatulus* (Walker and Jacob), they apparently flourish only in association with seaweed.

For the greatest part of the extent of South Beach, where it is merely the barrier beach separating the ponds or bays from the ocean, the constantly moving sand is clean and virtually free of algal material. The eastern shore of Chappaquiddick Island is similar to South Beach and no Foraminifera were found in the sand along the ocean sides of the bars at either of these localities. Only at South Beach were very rare specimens found in the strand lines left by the surf breaking on the beach (see sample 57-MV-53 in table 1). These rare strand line occurrences probably had their origin in bottom sediments well out beyond the low tide line.

Where the southern shore of the island becomes the sea-eroded base of Gay Head Cliffs and minor bluffs along the southwestern end of the island, the beach is coarser and includes glacial erratics in places. Such erratics and boulders as are immovable in normal ocean surf have a coating of algae, and some provide a foothold for seaweed. Only in this part of the ocean shore are Foraminifera found in the sands being moved about by the surf.

A-2. From open-sea beaches facing Vineyard Sound

Major constituents: *Rosalina columbiensis* (Cushman), *Elphidium margaritaceum* Cushman, *Quinqueloculina subrotunda* (Montagu), *Q. seminulum* (Linné).

Temperature and salinity: 19° to 20°C; 31.1 to 31.6°/oo.

A-3. From open-sea beaches facing Nantucket Sound

Major constituents: *Quinqueloculina lata* Terquem (especially *Pyrgo* form [Pl. 1, fig. 15]), *Streblus beccarii tepida* (Cushman), *Rosalina columbiensis* (Cushman), *Elphidium margaritaceum* Cushman.

Temperature and salinity: 20° to 24°C; 30.6 to 32.4°/oo.

The open-sea beaches sampled on Vineyard Sound were those immediately north of Gay Head (samples 57-MV-34, 35, 47, 48, and 49) and two areas on Menemsha Bight. Collections in Menemsha Bight were from the beach along the road to Lobsterville (sample 57-MV-52) and from the beach at the foot of the bluffs just northeast of Menemsha Town Beach (samples 58-MV-40, 41, 42, and 43). No other areas on Vineyard Sound between here and Vineyard Haven Harbor were sampled.

Sample 57-MV-52 was from a steeply sloping beach of algae-covered cobbles and pebbles lacking tide pools and large glacial erratics. The other area at the foot of the bluff, however, closely resembled the ocean beach environment southeast of Gay Head. Although many species are in common between this part of Vineyard Sound and the adjoining area of Gay Head, there is a complete difference in the major constituents.

All but three of the samples taken on Nantucket Sound beaches were from the State Beach in Oak Bluffs, between the two channels to Sengekontacket Pond. Several samples were taken along the sides of the numerous jetties which provide erosion protection for the ever changing beach of coarse sand, pebbles, and cobbles, and which accommodate a good growth of algae.

Sample 57-MV-45 was taken from turbulent water driven by a strong northeast wind onto the rocky shore opposite Farm Pond. This is the same location in which samples were taken from a submerged bog. The bog may account for the single specimen of *Trochammina inflata* (Montagu) found in this sample and not found elsewhere in Nantucket Sound samples.

Rock scrapings and coarse grained sediment taken from the riprap along the exposed bluff on East Chop (samples 57-MV-54 and 57-MV-65) contained a smaller fauna than, but similar to, that of State Beach.

The faunas of the beaches facing Vineyard Sound on the northwest side of the island are distinguished from those of the beaches facing Nantucket Sound on the northeast side of the island in two respects: (a) The rare presence on the Vineyard Sound beaches of those species which form the major constituents of the ocean beaches, and (b) the presence as a major constituent on the Nantucket Sound beaches of the small subspecies *Streblus beccarii tepida* (Cushman). On the Vineyard Sound beaches this species is represented only by its typical form which has a larger and more robust test.

B-1, 2, and 3. From harbors and inlets having current action

Major constituents: *Quinqueloculina lata* Terquem, *Rosalina columbiensis* (Cushman), *Elphidium margaritaceum* Cushman, *E. advena* (Cushman), *Rosalina globosa* (Sidebottom).

Temperature and salinity: 20°C and 30.6°/oo near entrance to Sengekontacket Pond; 21°C and 31.6°/oo in Vineyard Haven Harbor; no readings at Menemsha Creek.

The assemblages found in the current-washed areas of the two harbors of Menemsha Creek and Vineyard Haven and one of the narrow inlets to Sengekontacket Pond are in general similar to, although poorer than, those found on the open beaches facing the sounds. Such areas of actively moving water appear to be the favored environment for the minute species *Rosalina globosa* (Sidebottom), as it was found most abundantly here.

Current action at the south entrance to Sengekontacket Pond leaves a bottom of coarse gravel and pebbles with a cobble flat exposed at the base of a steep beach at one point. Sample 58-MV-33, however, was from a wide flat sand bar exposed only at lowest tide on the north edge of the channel and had a much poorer fauna than the samples taken from algal-rich areas with coarser sediments. Bottom sediments were similarly coarse at Vineyard Haven Harbor near the entrance to Lagoon Pond, but the current was less swift. Most of the samples from the Menemsha Creek area were washed from seaweed. In 1958 (sample 58-MV-44), only 3 of the 11 species collected at Menemsha Creek the previous season were obtained.

C-1. From protected bays facing Vineyard Sound and Vineyard Haven Harbor

The three areas included in this category are Lagoon Pond, Menemsha Pond at Lobsterville, and Stonewall Pond (which, with Nashaquitsa Pond, is a southwestern extension of Menemsha Pond).

As the assemblages found in these three areas seem to differ significantly from each other, it is of interest to list their major and minor constituents individually. Also shown are the temperatures and salinity readings for the separate areas.

	Lagoon Pond	Menemsha Pond	Stonewall Pond
Major constituents:			
	Protelphidium tisburyense (Butcher)	*Quinqueloculina lata* Terquem	*Quinqueloculina lata* Terquem
	Trochammina inflata (Montagu)	*Elphidium excavatum* (Terquem)	*Trochammina inflata* (Montagu)
	Elphidium galvestonense Kornfeld		*Elphidium clavatum* Cushman
Minor constituents:			
	Quinqueloculina lata Terquem		
	Buccella frigida (Cushman)		*Buccella frigida* (Cushman)
	Elphidium translucens Natland		*Elphidium translucens* Natland
Rare constituents of restricted distribution:			
	Trochammina ochracea (Williamson)	*Ammobaculites dilatatus* Cushman and Brönnimann	*Quinqueloculina seminulum* (Linné)
Temperature and salinity:			
	22° to 23°C; 24.7 to 31.5°/oo	22° to 27°C; 28.2 to 31.4°/oo	24°C; 29.8°/oo
Sample nos.:			
	57-MV-12; 58-MV-25, 37, 39.	57-MV-36, 37, 41; 58-MV-16	57-MV-42

Within the ponds and protected bays of the island the majority of the Foraminifera seem to live as free individuals without attachment to rocks or seaweed or entanglement in algal material.

The samples from Lagoon Pond, a shell fishing area, were taken on its northeast shore, many near the channel to Brush Pond. The bottom was mostly coarse sand to pebbles with broken shells, patches of algae, and some cobbled areas. The richest sample taken (57-MV-12) was suspended sediment washed up by turbulent water generated by a strong southwest wind. The poorest (58-MV-39) was scraped from a cobbled area with poor circulation of water.

Only the northwest corner of Menemsha Pond at Lobsterville was sampled, near the mouth of a small channel draining an adjoining marsh. Wide flats of coarse reddish brown sand were exposed at low tide with poorly drained areas (sample 57-MV-41) containing slimy flocculent material trapped behind sand bars.

One sample (57-MV-42) was taken from slimy mud bottom at the west edge of Stonewall Pond near where it connects with Nashaquitsa Pond. The faunal differences, especially the presence of *Quinqueloculina seminulum* (Linné) and *Elphidium clavatum* Cushman, probably indicate the influence of ocean breakthroughs from time to time across the sand bar forming the southeastern border of the pond.

C-2. From protected bays facing Nantucket Sound

Major constituents: *Streblus beccarii tepida* (Cushman), *Quinqueloculina lata* Terquem.

Although *Rosalina columbiensis* (Cushman) and several species of *Elphidium* are present in nearly all the samples, they are represented by insignificant amounts.

Temperature and salinity: 21° to 25°C; 32.0 to 32.7°/oo. One additional reading in Sengekontacket Pond was lower at 19°C and 29.0°/oo.

Like Lagoon Pond off Vineyard Haven Harbor, Sengekontacket Pond off Nantucket Sound is used for shell fishing. We sampled a variety of bottom conditions on its eastern shore adjacent to the Oak Bluffs-Edgartown Beach Road. Samples 57-MV-56 and 59 were taken from marsh grass roots, the latter sample from clusters of living mussels exposed only at lowest tide. Samples 57-MV-55 and 57 were washed from empty *Pecten* valves and seaweed while samples 57-MV-8, 58, and 60 were from medium to fine sand covered by flocculent organic matter. The remaining collections (samples 57-MV-17, 18, 19, and 58-MV-54) were from better circulated areas of coarser sand and seaweed near Sengekontacket Inlet at the town line.

One sample (57-MV-24) was taken on the southern edge of Cape Poge Bay, Chappaquiddick Island. General conditions at this locality were similar to those at Sengekontacket, namely an area of still waters, shell fragments, and seaweed patches within 50 feet of marsh grass.

C-3. From protected bays behind South Beach

Major constituents: *Quinqueloculina lata* Terquem, *Streblus beccarii tepida* (Cushman), *Elphidium galvestonense* Kornfeld.

Temperature and salinity: 19° to 24°C; 29.8 to 30.3°/oo.

Katama Bay is situated just behind South Beach and has water from both sound and ocean circulating in it — ocean water from around the end of the easternmost extension of South Beach and sound water through the channel between Edgartown and the island of Chappaquiddick. In Mattakeset Bay, the southwestern extension of Katama Bay, we found rich assemblages in all samples. Likewise in the southeastern extension of Katama Bay along the southern edge of Chappaquiddick Island, Foraminifera were found thriving.

In contrast, several samples taken from Crackatuxet Cove (the southeastern end of Edgartown Great Pond), also just across the sand bar (South Beach) from the ocean, were barren of Foraminifera. The low salinity in Edgartown Great Pond (in our samples ranging from 9.3 to 15.7°/oo), plus the absence of circulation of ocean water, probably accounts for the lack of Foraminifera in this pond which was completely enclosed in August, 1957.

Two areas in Mattakeset Bay were sampled: the south edge of the bay (the north side of the spit forming the easternmost extension of South Beach) and an area near the mouth of Herring Brook. In both places the bottom surface was soft and composed of fine to coarse brown sand with fine seaweed and some flocculent organic matter suspended near the bottom. The latter area was within a few yards of marsh grass.

Although samples 57-MV-64 and 58-MV-1 represent the same area on the south side of the bay, collected in the two consecutive years, there is a striking difference in variety and abundance of their species. In the 1958 sample *Quinqueloculina lata* Terquem exceeded the balance of the fauna (five other species) by a ratio of several hundred to one. Of the 16 species tabulated from the 1957 collection, *Streblus beccarii tepida* (Cushman) and *Elphidium galvestonense* Kornfeld were each about equal to *Quinqueloculina lata* in abundance and the balance of the fauna was also much richer. Of the two samples taken near the mouth of Herring Brook, there is a less startling contrast, but 57-MV-63 is somewhat richer than 58-MV-2 and has a greater variety of species of *Elphidium,* though none are abundant.

Three samples were taken on the southeastern shore of Katama Bay from bottom conditions quite similar to those on Mattakeset Bay. Only sample 57-MV-26 was a bottom sample; samples 57-MV-25 and 29 were taken from the roots of marsh grass. All three samples were taken near a stream outlet draining a small marshy pond.

D. From brackish ponds

The assemblages found in the four brackish ponds that were investigated are rather distinct from each other in their major constituents, although most of the species were found in all four ponds. Major constituents are given for each pond, and temperatures and salinities are covered in the discussion instead of being listed.

D-1. Farm Pond

Major constituents: *Elphidium galvestonense* Kornfeld, *E. gunteri* Cole, *Protelphidium tisburyense* (Butcher), *Quinqueloculina lata* Terquem, *Streblus beccarii tepida* (Cushman).

This assemblage was the richest in specimens, although the most restricted in number of species, of all those found around Martha's Vineyard.

D-2. Brush Pond

Major constituents: *Trochammina inflata* (Montagu), *Miliammina fusca* (Brady).

D-3. Unnamed pond between Beach Road and Brush Pond, near Eastville

Major constituents: *Trochammina inflata* (Montagu), *Protelphidium tisburyense* (Butcher), *Elphidium translucens* Natland (during 1958 only, samples 58-MV-27 and 29).

D-4. Unnamed pond near east end of Herring Brook

Major constituents: *Protelphidium tisburyense* (Butcher), *Elphidium incertum* (Williamson).

Farm Pond, where the richest assemblage occurs—that characterized by abundant *Elphidium galvestonense* Kornfeld—is connected by a narrow half-mile long channel with Nantucket Sound. There seems to be considerable circulation of water within Farm Pond due to the rise and fall of the tide. In 1957 our salinity readings in the pond ranged from 17.9 to 23.3°/oo and the temperature readings were from 19° to 23.5°C. In 1958 salinity readings were from 11.2 to 24.3°/oo with temperatures of 27° or 28°C.

The Farm Pond samples were obtained from three areas. Two samples (57-MV-44 and 58-MV-20) were taken from west of the road to Edgartown on the northeastern shore of the main body of the pond. Most of the other samples came from the east shore of the small extension of the pond between the road to Edgartown and Nantucket Sound. This sandy shore of the pond is, in effect, the inner side of the sand bar separating Farm Pond from Nantucket Sound. Elsewhere the pond is bordered by marsh grass. The floor of Farm Pond at this locality is composed of fine to coarse sand with soft flocculent material suspended above the bottom. Our samples were taken from a series of miniature coves of finer grained sand between low ridges of coarse sand, pebbles, and cobbles derived from the sand bar. Three samples (57-MV-7 and 58-MV-18 and 19) were collected from the channel connecting Farm Pond with Nantucket Sound.

In the small unnamed pond near Eastville, we found the salinity and temperature readings to be similar in 1957 and 1958: 30.1°/oo and 22.5°C in 1957 and 30.4°/oo and 23°C in 1958.

The small unnamed pond near Herring Brook was not sampled in 1957. In 1958 its salinity was 8.2°/oo and its temperature 23°C. Neither of these two unnamed ponds are connected by channels to the adjacent bay waters and what fluctuation of level there is in them seems to be by seepage, rainfall, and evaporation. Consequently the water is stagnant.

Sediments in the two stagnant ponds consist of fine sand and mud associated with dark flocculent material and considerable organic debris. Both ponds were encircled by marsh grass. Under these conditions, the brackish-tolerant species of *Trochammina* appear to thrive and are of normal size and robustness. The miliolids and some of the other calcareous species, however, appear to have unusually fragile walls.

E. From surface of submerged bogs

Major constituents: *Trochammina inflata* (Montagu), *T. macrescens* Brady.

Temperature and salinity: 20° to 24°C; 30.1 to 32.4°/oo.

Slight change in sea level combined with changes in configuration of the shore line has placed some former bogs in positions where they undergo marine erosion. One fairly extensive submerged bog in Oak Bluffs, just across the sand bar from Farm Pond, was sampled. It consists of a broad area of a firm black peaty substance, barely awash at low tide, covered more or less thinly at its inner edge by coarse sand, pebbles, and cobbles, and ending at its outer border as an undercut ledge. As it is on the northeast-facing shore of the island, it is subject to rather active erosion, mainly by breaking off of large pieces of fibrous peat from the outermost part of the ledge.

Collections taken from its surface yielded a fauna consisting largely of the two species of *Trochammina* listed above, occurring in great abundance. Other species found in the bog collections probably were not native to the bog surface but were washed onto the ledge from the adjacent sediments.

Two other small outcrops of former bogs were observed and sampled: one (samples 57-MV-21 and 58-MV-56) at the inner end of the northern channel entrance into Sengekontacket Pond, and the other (sample 57-MV-28) within the unnamed pond near Eastville. On both these bog surfaces, the two species of *Trochammina* were found in abundance.

F. From stream entrances

Major constituents: *Miliammina fusca* (Brady), *Trochammina inflata* (Montagu), *Quinqueloculina lata* Terquem, *Elphidium excavatum* (Terquem), *E. poeyanum* (d'Orbigny).

Three stream channels, in which flow is reversed with rise and fall of tide, are included in this ecologic grouping: 1, stream draining an unnamed pond and marsh on the southwest shore of Chappaquiddick Island; 2, stream draining a marsh at Lobsterville on Menemsha Pond; and 3, stream draining Brush Pond into Lagoon Pond.

Samples 57-MV-27 and 28 on Chappaquiddick were taken 10 and 25 feet respectively upstream from the entrance where the channel was quite shallow and about 6 feet wide. The first sample was from flowing water on a clean sandy bottom without vegetation and the second from still water near plant roots. Both areas had salinity readings of about 30°/oo with temperature readings of 24°C.

The Lobsterville channel gave a high salinity reading of 31.0°/oo (rising tide) and a low of 14.5°/oo (ebbing tide) in 1957 with temperatures of 21° and 22°C. In 1958, at low tide, a still lower salinity reading of 7.2°/oo was obtained with a temperature of 25°C. Samples 57-MV-38 and 40 and 58-MV-15 were taken from the clean channel bottom sand; sample 57-MV-39 was from sediment above water level but still wet; and 57-MV-51 was from the roots of the marsh grass bordering, and in some places overhanging, the deeply incised, narrow (about 2 feet wide) channel.

The Brush Pond-Lagoon Pond channel more closely resembled that of Chappaquiddick Island in its width and depth. Samples 58-MV-26 and 36 were from the channel edge, clean sand near marsh grass. Sample 58-MV-35 was from an exposed flat of medium sand in the middle of the stream bed. Temperature and salinity readings were less variable here than at Lobsterville: 28.5 to 30.6°/oo at temperatures of 22° and 23°C, taken both years.

FORAMINIFERA FOUND IN SEDIMENT FROM LOBSTER HATCHERY

Thanks to John T. Hughes, biologist of the Massachusetts Division of Marine Fisheries, we had the opportunity of examining the fauna found in the sea water storage tank for the Lobster Hatchery at Oak Bluffs.

In the black muddy sediment taken in August, 1957, during the annual cleaning of the storage tank, the following species were found: *Textularia earlandi* Parker, *Eggerella advena* (Cushman), *Miliammina fusca* (Brady), **Quinqueloculina lata* Terquem, *Q.* sp. (angular periphery tending toward spiroloculine form), *Cornuspira planorbis* Schultze, **Trochammina macrescens* Brady, *Bolivina pseudoplicata* Heron-Allen and Earland, *Patellina corrugata* Williamson, **Rosalina columbiensis* (Cushman), **Buccella frigida* (Cushman), **Streblus beccarii tepida* (Cushman), **Elphidium margaritaceum* Cushman, **E. poeyanum* (d'Orbigny), *E.* sp.

All of the species except *Quinqueloculina* sp. and *Elphidium* sp. were found around Martha's Vineyard. Those starred were found in Lagoon Pond, the immediate source of the sea water stored in the tank. Their presence in the artificial environment of the storage tank probably indicates their tolerance of abnormal conditions. All the specimens are small and thin walled; most are smaller than their normal size, but one notable exception is *Cornuspira planorbis* Schultze, specimens of which are larger in the storage tank than in the shore sediments. None of the species restricted to the open-sea beaches were found in the storage tank sediment.

SPECULATIONS AND CONCLUSIONS

The species found living around Martha's Vineyard contribute a negligible amount, in the form of their empty shells, to the actual volume of the sediments being deposited in the bays and ponds and around the island. Their value lies in the light they throw on environmental factors associated with their deposition when the same or similar species are found as fossils.

The following are to be considered as partly speculative and partly factual conclusions based on our observations of the fauna of living Foraminifera around Martha's Vineyard; their application elsewhere is subject to limitation.

(*a*) Because we found few empty (dead) shells, we conclude that a large proportion of empty shells are either destroyed before permanent burial in the near-shore sediments or transported elsewhere (perhaps to off-shore areas).

(*b*) Under turbulent conditions are found species that normally have shells of larger than average size for smaller Foraminifera (such as *Quinqueloculina seminulum*) and/or that have heavier than usual walls (such as *Poroeponides lateralis* and *Elphidium clavatum*).

(*c*) Under conditions of slight turbulence, weak currents, and abundant food supply are found species that normally have thin, translucent tests or that are smaller than average size for smaller Foraminifera.

(*d*) Under severely unfavorable conditions, such as a stagnant pond in which direct communication with the sea is shut off, are found specimens having abnormally small, thin, fragile tests compared with the average for their respective species.

(*e*) Under conditions of strong currents, attached species (such as species of *Rosalina, Cornuspira, Patellina,* and *Cibicides*) may be expected to comprise a larger proportion of an assemblage than elsewhere.

(*f*) Species showing signs of attachment (*i.e.*, a flattened side such as is characteristic of species of *Rosalina* and *Cibicides*) lived in association with seaweed

EXPLANATION OF PLATE 1

[All figures × 62]

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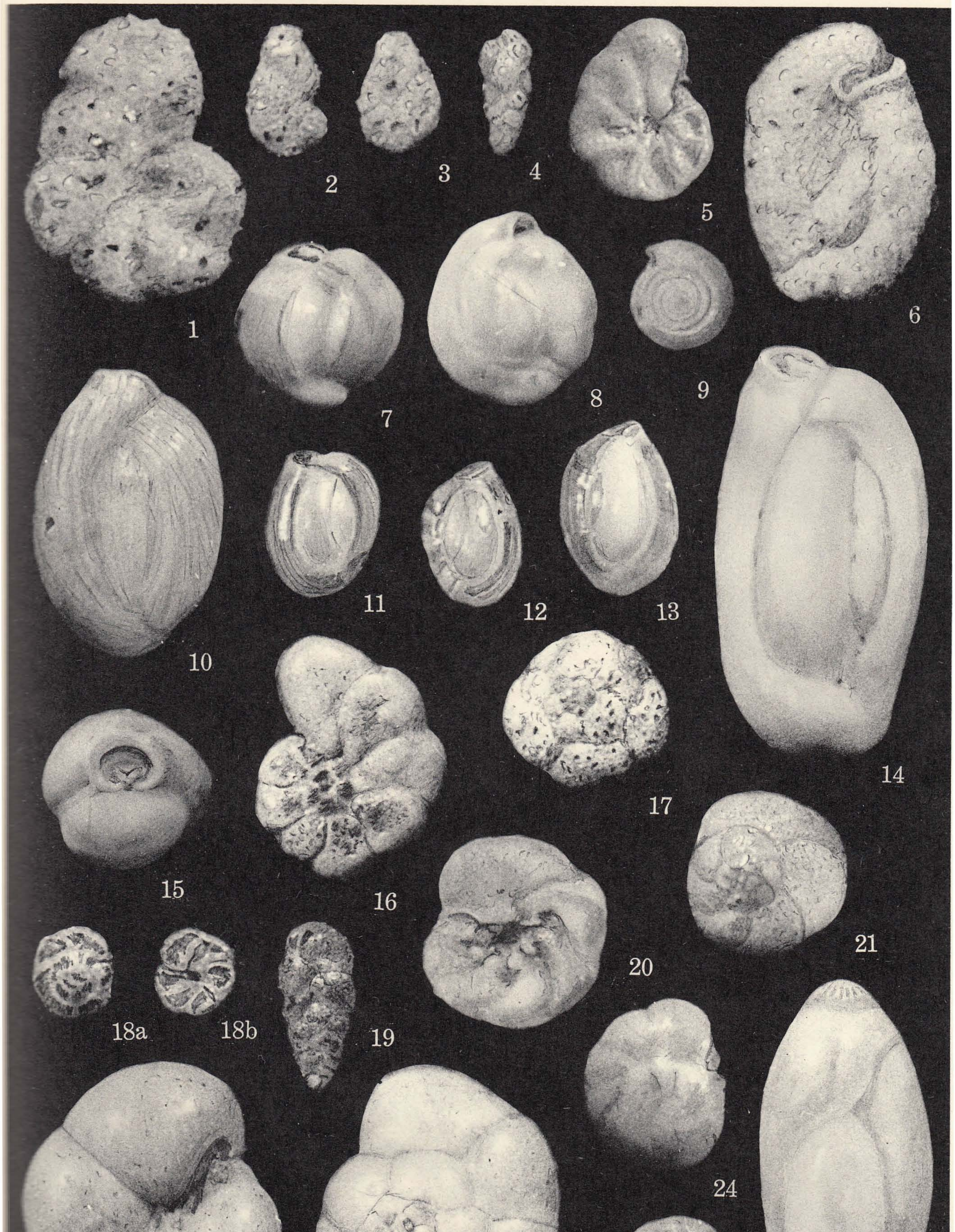
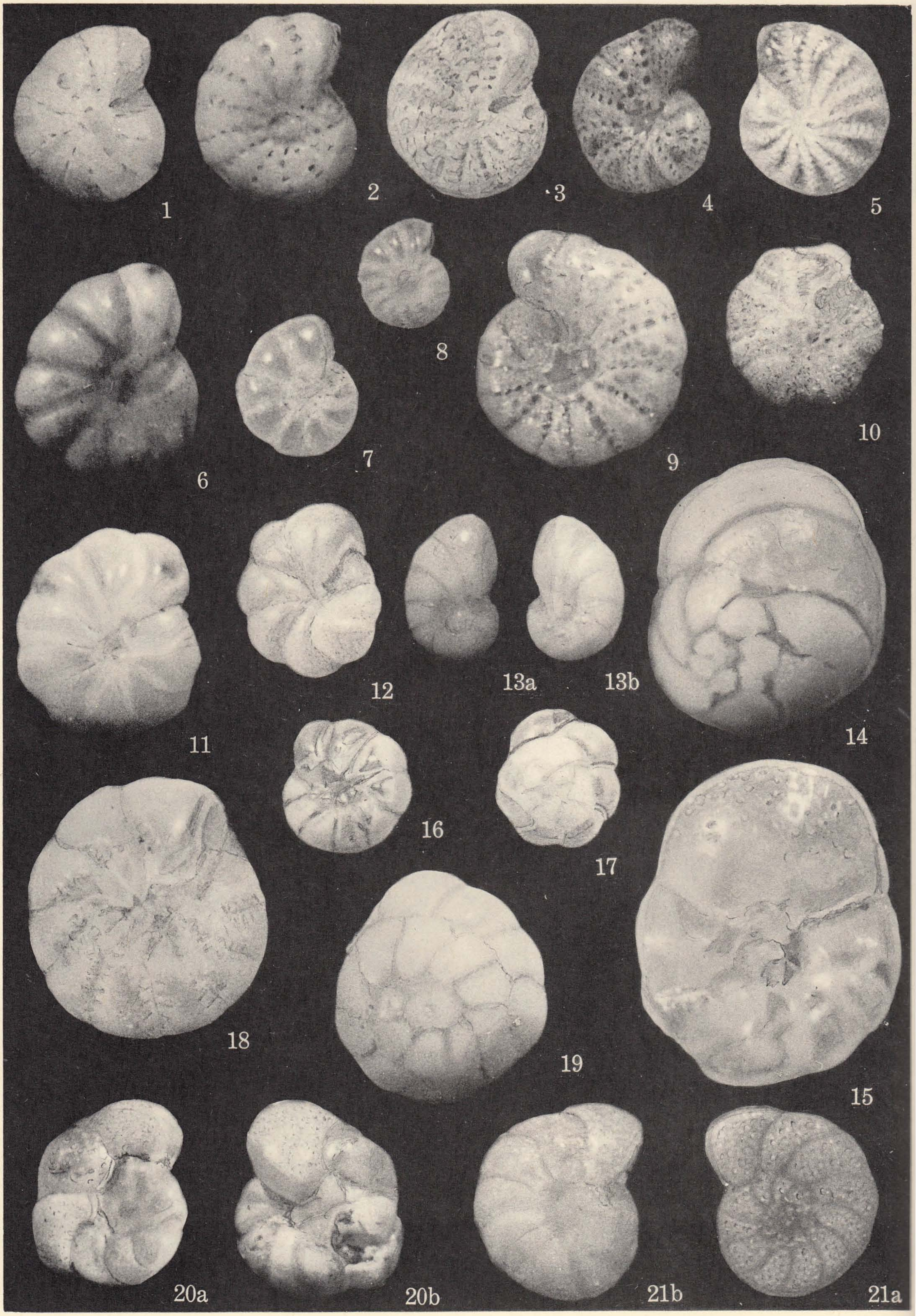


Todd and Low: Foraminifera of Martha's Vineyard



Todd and Low: Foraminifera of Martha's Vineyard or on a bottom where algae-covered rocks were present.

(*g*) Because we found that collections taken from various parts of the same body of water, or in different years from the same locality, differed significantly in richness or composition, we speculate that species of Foraminifera may live in more or less transitory colonies unevenly distributed irrespective of the suitability of individual parts of the area. Thus, it follows that one suitable environment will not necessarily support a fauna similar to that of an equivalent environment. This highly speculative conclusion is open to question because so much remains unknown about what kind of factors constitute optimum or tolerable ecologic conditions for a species. Also, not enough is known about means or speed of dispersal. Perhaps what appeared to be transitory colonies were a result of alteration or destruction by winter storms of the previous year's optimum environment.

(*h*) In the near-shore environment around Martha's Vineyard, salinity ranges, turbulence, currents, food supply, associated biotas, and size of bottom sediments seem to be more effective as determinants of the Foraminifera fauna than does temperature.

(*i*) Most of the species found around Martha's Vineyard have some tolerance of considerable variations in salinity, temperature, and probably other factors which are more stable in an off-shore than in a near-shore environment. As the shore is approached, increasing fluctuations of these factors act as screens against the establishment of the species less tolerant of brackish conditions (such as *Poroeponides lateralis* and *Elphidium margaritaceum*). On the other hand, these increasing fluctuations appear to favor the species more tolerant of brackish conditions. Brackish species, such as *Miliammina fusca,* species of *Trochammina, Haplophragmoides wilberti, Ammobaculites dilatatus, Ammotium salsum,* and *Helenia anderseni,* are useful in recognizing marsh and near-marsh deposits. These observations from the study of local conditions around Martha's Vineyard are compatible with conclusions already reached in nearby or similar areas.

SYSTEMATIC CATALOG OF SPECIES

Family LITUOLIDAE

Genus **Haplophragmoides** Cushman, 1910

Haplophragmoides bonplandi Todd and Brönnimann

Haplophragmoides bonplandi TODD and BRÖNNIMANN, 1957, Cushman Found. Foram. Research, Spec. Publ. 3, p. 23, pl. 2, fig. 2.

Rare specimens of this small species were found in two stream samples at Lobsterville and one tide pool sample from Squibnocket Bight on the ocean. The species was described from mangrove swamps in the Gulf of Paria, Trinidad.

Haplophragmoides wilberti Andersen

Plate 1, figure 5

Haplophragmoides wilberti ANDERSEN, 1953, Cushman Found. Foram. Research Contr., v. 4, p. 21, pl. 4, fig. 7.

The only previous records of this species are from brackish environments along the Louisiana coast and in the eastern Gulf of Paria, Trinidad (Todd and

EXPLANATION OF PLATE 2

[All figures × 62]

FIGS.		PAGE
1.	*Elphidium clavatum* Cushman. USNM 627708. Gay Head (57-MV-46)	18
2.	*Elphidium incertum* (Williamson). USNM 627690. Farm Pond (57-MV-7)	19
3.	*Elphidium margaritaceum* Cushman. USNM 627691. State Beach, Nantucket Sound (57-MV-9)	19
4.	*Elphidium translucens* Natland. USNM 627707. Green specimen with final chamber stained red. Stonewall Pond (57-MV-42)	20
5.	*Elphidium excavatum* (Terquem). USNM 627705. Stream entrance, Katama Bay (57-MV-28)	19
6.	*Elphidium subarcticum* Cushman. USNM 627720. State Beach, Nantucket Sound (58-MV-5)	20
7.	*Elphidium poeyanum* (d'Orbigny). USNM 627692. State Beach, Nantucket Sound (57-MV-9)	20
8.	*Elphidium advena* (Cushman). USNM 627726. Menemsha Bight (58-MV-41)	18
9.	*Elphidium galvestonense* Kornfeld. USNM 627681. Farm Pond (57-MV-3)	19
10.	*Elphidium gunteri* Cole. USNM 627682. Farm Pond (57-MV-3)	19
11.	*Protelphidium orbiculare* (Brady). USNM 627709. Gay Head (57-MV-46)	20
12.	*Protelphidium tisburyense* (Butcher). USNM 627702. Lagoon Pond (57-MV-12)	21
13.	*Pseudononion atlanticum* (Cushman). USNM 627730. Gay Head (58-MV-46)	21
14, 15.	*Poroeponides lateralis* (Terquem). 14, USNM 627710; dorsal view. 15, USNM 627711; ventral view. Gay Head (57-MV-46)	18
16, 17.	*Streblus beccarii tepida* (Cushman). 16, USNM 627700; ventral view. 17, USNM 627701; dorsal view. State Beach, Nantucket Sound (57-MV-9)	18
18, 19.	*Streblus beccarii* (Linné). 18, USNM 627712; ventral view. 19, USNM 627713; dorsal view. Gay Head (57-MV-46)	18
20.	*Cibicides lobatulus* (Walker and Jacob). USNM 627714. *a,* Dorsal view; *b,* ventral view. Gay Head (57-MV-46)	21
21.	*Cibicides pseudoungerianus* (Cushman). USNM 627715. *a,* Dorsal view; *b,* ventral view. Gay Head (57-MV-46)	21

Brönnimann, 1957, p. 23, pl. 1, figs. 28, 29). Its wall surface is similar to that of *Trochammina macrescens* Brady, with which it is associated at Martha's Vineyard, but it is involute on both sides.

Genus **Ammobaculites** Cushman, 1910

Ammobaculites dilatatus Cushman and Brönnimann

Plate 1, figure 1

Ammobaculites dilatatus CUSHMAN and BRÖNNIMANN, 1948, Cushman Lab. Foram. Research Contr., v. 24, p. 39, pl. 7, figs. 10, 11.—PARKER and ATHEARN, 1959, Jour. Paleontology, v. 33, p. 340, pl. 50, figs. 4, 5.

This species and *Ammotium salsum* (Cushman and Brönnimann) occur together around Martha's Vineyard. Such an association seems to be true in the several other regions (Gulf of Paria, southwest Texas, Mississippi Sound, and southern New England) where they have been reported and makes their separation open to doubt. Specimens are easily distinguishable, however, on the basis of size, angle of sutures, size of initial coil, and degree of uncoiling. *Ammobaculites dilatatus* measures between 0.45 and 0.50 mm. across the initial coil and up to 0.75 mm. in height.

If it is found that these two species are related as micro- and megalospheric forms, then it would suggest that the genus *Ammotium,* which is separated on the basis of its incomplete uncoiling, is only a form of *Ammobaculites.*

A. dilatatus was found in samples from protected bays and the brackish Farm Pond.

Genus **Ammotium** Loeblich and Tappan, 1953

Ammotium salsum (Cushman and Brönnimann)

Plate 1, figures 2, 3

Ammobaculites salsus CUSHMAN and BRÖNNIMANN, 1948, Cushman Lab. Foram. Research Contr., v. 24, p. 16, pl. 3, figs. 7-9.—PARKER, PHLEGER, and PEIRSON (part), 1953, Cushman Found. Foram. Research, Spec. Publ. 2, p. 5, pl. 1, figs. 17, 20, 21.—PHLEGER, 1954, Am. Assoc. Petroleum Geologists Bull., v. 38, p. 635, pl. 1, figs. 7, 8.

Ammotium salsum (CUSHMAN and BRÖNNIMANN). PARKER and ATHEARN, 1959, Jour. Paleontology, v. 33, p. 340, pl. 50, figs. 6, 13.

This small species, described from the Gulf of Paria and also known along the Gulf Coast, was found living in typical form in Farm Pond and its connecting channel with Nantucket Sound. Specimens are uniform in size (about 0.35 mm.), with smoothly finished wall, indistinct sutures, and a relatively large protruding aperture.

Family TEXTULARIIDAE

Genus **Textularia** Defrance, 1824

Textularia earlandi Parker

Textularia elegans LACROIX, 1932 (not *Plecanium elegans* HANTKEN, 1868), Inst. Océanographique Monaco Bull. 591, p. 8, figs. 4, 6 (not fig. 5).

Textularia tenuissima EARLAND, 1933 (not HÄUSLER 1881), *Discovery* Repts., v. 7, p. 95, pl. 3, figs. 21-30.

Textularia earlandi PARKER. PHLEGER, 1952, Cushman Found. Foram. Research Contr., v. 3, p. 86, pl. 13, figs. 22, 23.—PARKER, 1954, Mus. Comp. Zool. Bull., v. 111, no. 10, p. 490, pl. 2, fig. 12.

This species was originally described from the Mediterranean. Earland, finding it around South Georgia, renamed it and included information on the forms described earlier from the Mediterranean by Lacroix. Later records from the Antarctic, Falklands, southwest Sweden, and Canadian and Greenland Arctic indicate it to be a cold water form. However, it has also been noted in the northeastern Gulf of Mexico, and forms from the shallow waters of Todos Santos Bay, Baja California (Walton, 1955), and the Gulf of Paria, Trinidad (Todd and Brönnimann, 1957), have been compared with it.

Textularia earlandi Parker occurs only rarely in the Martha's Vineyard material, giving no indication of ecologic or faunal preference.

Family VALVULINIDAE

Genus **Eggerella** Cushman, 1933

Eggerella advena (Cushman)

Plate 1, figure 4

Eggerella advena (CUSHMAN). PARKER, 1952, Mus. Comp. Zool. Bull., v. 106, no. 9, p. 404, pl. 3, figs. 12, 13.

In addition to being well distributed in the shallow waters off the northeast coast of North America, *Eggerella advena* is widely recorded from the colder waters of the Pacific and the Arctic.

It is rare in the present material being found in scrapings off rocks as well as in shallow pond and bay areas.

Family SILICINIDAE

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

Miliammina fusca (Brady)

Plate 1, figure 6

Quinqueloculina fusca BRADY, 1870, Annals and Mag. Nat. History, ser. 4, v. 6, p. 47, pl. 11, figs. 2, 3.

Miliammina fusca (H. B. BRADY). PARKER, 1952, Mus. Comp. Zool. Bull., v. 106, no. 9, p. 404, pl. 3, figs. 15, 16; 1952, *idem,* v. 106, no. 10, p. 452, pl. 2, fig. 6.

This species was found living in abundance in the brackish channels draining marshes and small ponds. The distribution chart (table 1) shows its presence also in areas adjacent to these more brackish environments (especially Menemsha and Sengekontacket Ponds and Katama Bay). Similar ecologic conditions were noted by Parker (1952a, 1952b).

Family MILIOLIDAE

Genus **Quinqueloculina** d'Orbigny, 1826

Quinqueloculina auberiana d'Orbigny

Plate 1, figure 7

Quinqueloculina auberiana D'ORBIGNY, 1839, *in* de la Sagra, Histoire Phys. Politique Nat. Cuba, "Foraminifères," p. 193, pl. 12, figs. 1-3.

This species, described from the West Indies, was found living in Squibnocket Bight on the Atlantic Ocean. A few specimens were also found in one of the Vineyard Sound beach samples.

Quinqueloculina auberiana is smaller than *Q. seminulum*, nearly circular in outline, but with the peripheral edges of the chambers making sharp projecting angles in transverse section. It is characterized by its lack of apertural neck and its simple tooth.

Quinqueloculina lata Terquem

Plate 1, figures 10-13, 15

Quinqueloculina lata TERQUEM, 1876, Essai Class. Anim. Dunkerque, p. 82, pl. 11, fig. 8.—CUSHMAN, 1944, Cushman Lab. Foram. Research, Spec. Publ. 12, p. 14, pl. 2, fig. 16; 1949, Inst. Royal Sci. Nat. Belgique, Mem. 111, p. 10, pl. 2, fig. 11.

The specimens identified as *Quinqueloculina lata* are variable, some being triloculine and a few biloculine (pl. 1, fig. 15). Most specimens are smooth, rounded in transverse section, and straight sided. Others are faintly costate (Pl. 1, fig. 10), in this respect probably grading into the varietal form described as var. *jugosa* of *Q. seminulum* by Cushman (1944, p. 13, pl. 2, fig. 15), and some are slightly rounded top and bottom. The wall is polished and translucent; the small tooth is simple and does not project above the aperture in side view.

This species probably has a wider distribution, reported perhaps under other names, than indicated by the few records noted above—from Dunkerque, where it was described, and from off New England.

It is the best-represented miliolid found in these shallow water samples, being common to abundant in most samples except those from off Gay Head and the exposed beaches of Vineyard Sound in which the more robust miliolids, *Q. seminulum* (Linné) and *Q. subrotunda* (Montagu), appear to replace it.

Quinqueloculina seminulum (Linné)

Plate 1, figure 14

Quinqueloculina seminula (LINNÉ). PARKER, 1952, Mus. Comp. Zool. Bull., v. 106, no. 9, p. 406, pl. 3, figs. 21, 22; pl. 4, figs. 1, 2; 1952, *idem*, v. 106, no. 10, p. 456, pl. 2, fig. 7.

Already recorded as common in waters of this area, *Quinqueloculina seminulum* was most frequent in the Atlantic Ocean and Vineyard Sound samples taken around Gay Head. It was not found in the protected bays and brackish ponds.

Compared with *Q. lata*, this species is larger, thicker walled, more robust, and has an opaque yellowish test instead of a translucent one.

Quinqueloculina subrotunda (Montagu)

Plate 1, figure 8

Quinqueloculina subrotunda (MONTAGU). PARKER, 1952, Mus. Comp. Zool. Bull., v. 106, no. 9, p. 406, pl. 4, fig. 4; 1952, *idem*, v. 106, no. 10, p. 456, pl. 2, figs. 9, 10.

Quinqueloculina disciformis (MACGILLIVRAY). CUSHMAN, 1944, Cushman Lab. Foram. Research, Spec. Publ. 12, p. 15, pl. 2, figs. 17, 18.

This is a flattened, circular species having chambers barely half a coil in length, and consequently no suggestion of apertural neck. Its aperture lacks an internal tooth and is characteristically broader than high. What appears to be an incipient tooth of the *Miliolinella* type, present as a transverse ridge in front of the apertural opening, is probably the thickened rim of the aperture of the penultimate chamber.

From the records this appears to be a cosmopolitan species found in shallow waters. Around Martha's Vineyard it occurs mainly along the beaches facing Vineyard Sound. Parker (1952b, p. 435, text fig. 4) found this species in association with *Quinqueloculina seminulum* in the Long Island Sound-Buzzards Bay area.

Family OPHTHALMIDIIDAE

Genus **Cornuspira** Schultze, 1854

Cornuspira planorbis Schultze

Plate 1, figure 9

Cornuspira planorbis SCHULTZE, 1854, Organismus Polythal., p. 40, pl. 2, fig. 21.—CUSHMAN and TODD, 1947, Cushman Lab. Foram. Research, Spec. Publ. 21, p. 7, pl. 1, fig. 24.

Cornuspira involvens CUSHMAN (not REUSS), 1944, Cushman Lab. Foram. Research, Spec. Publ. 12, p. 17, pl. 2, fig. 26.

Cornuspira planorbis Schultze undoubtedly has a wider range than is indicated by the published records. It is probably a cosmopolitan form in shallow water areas. As discussed by Cushman and Todd (1947, p. 7), similar forms from New England waters were referred to *C. involvens* (Reuss).

This species occurs commonly to rarely in actively moving waters around Martha's Vineyard. Conditions under which it was collected confirm it to be a form attached temporarily to plants washed by currents or tides, a condition noted by Cushman (1944, p. 17).

Family TROCHAMMINIDAE

Genus **Trochammina** Parker and Jones, 1859

Trochammina inflata (Montagu)

Plate 1, figures 22, 23

Nautilus inflatus MONTAGU, 1808, Testacea Britannica, Suppl., p. 81, pl. 18, fig. 3.

Trochammina inflata (MONTAGU). CUSHMAN, 1944, Cushman Lab. Foram. Research, Spec. Publ. 12, p. 18, pl. 2, fig. 10.—PARKER, 1952, Mus. Comp. Zool. Bull., v. 106, no. 10, p. 459, pl. 3, fig. 1.—PARKER and ATHEARN, 1959, Jour. Paleontology, v. 33, no. 2, p. 341, pl. 50, figs. 18-20.

From the majority of the occurrence records, this species appears to be characteristic of both salt marshes and brackish waters (Parker, Phleger, and Peirson, 1953, p. 15). Our greatest abundances were found where the open waters of Nantucket Sound wash over the submerged bog opposite Farm Pond and where salinities of 31.2 to 32.4°/oo are similar to those found in other open-sea localities around the island. In this kind of environment, it would appear that other factors, such as pH and the nutrient elements available on the disintegrating bog, might be the determining influences favoring the existence of *Trochammina,* almost to the exclusion of all other Foraminifera.

Trochammina macrescens Brady

Plate 1, figure 16

Trochammina inflata (MONTAGU) var. *macrescens* H. B. BRADY, 1870, Annals and Mag. Nat. History, ser. 4, v. 6, p. 51, pl. 11, fig. 5.

Trochammina macrescens H. B. BRADY. PARKER, 1952, Mus. Comp. Zool. Bull., v. 106, no. 10, p. 460, pl. 3, fig. 3.—PARKER and ATHEARN, 1959, Jour. Paleontology, v. 33, p. 341, pl. 50, figs. 23-25.

This species occurs in association with, but less abundantly than, *Trochammina inflata* (Montagu). Its test is flexible and is consequently collapsed, flattened, or otherwise deformed in dried samples.

Parker and Athearn (1959, p. 341) suggest the possible identity between this species and *Jadammina polystoma* Bartenstein and Brand. We were unable to find in our material any individuals having supplementary apertures on the apertural face.

Trochammina ochracea (Williamson)

Plate 1, figure 18

Rotalina ochracea WILLIAMSON, 1858, Recent Foram. Great Britain, p. 55, pl. 4, fig. 112; pl. 5, fig. 113.

Trochammina ochracea (WILLIAMSON). CUSHMAN, 1944, Cushman Lab. Foram. Research, Spec. Publ. 12, p. 19, pl. 2, figs. 12, 13.

This species was described from the British Isles and has been widely recorded, but it never seems to occur in abundance. It is a minute (about 0.15 mm.) scale-like form, probably always attached. Unlike the other species of *Trochammina* it was not found on the submerged bog surfaces.

Trochammina rotaliformis J. Wright

Plate 1, figure 17

Trochammina rotaliformis WRIGHT. LOEBLICH and TAPPAN, 1953, Smithsonian Misc. Coll., v. 121, no. 7, p. 51, pl. 8, figs. 6-9.

A few specimens were found in our Martha's Vineyard material. This species is smaller than *Trochammina inflata,* and lacks the polished appearance of that species. It is characteristically irregular in outline, and the grains incorporated in its wall are of irregular size and shape.

Family POLYMORPHINIDAE

Genus **Pseudopolymorphina** Cushman and Ozawa, 1928

Pseudopolymorphina novangliae (Cushman)

Plate 1, figure 26

Polymorphina lactea (WALKER and JACOB) var. *novangliae* CUSHMAN, 1923, U. S. Natl. Mus. Bull. 104, pt. 4, p. 146, pl. 39, figs. 6-8.

Pseudopolymorphina novangliae (CUSHMAN). PARKER, 1952, Mus. Comp. Zool. Bull., v. 106, no. 10, p. 455, pl. 3, figs. 11, 12.

Only two specimens were obtained, one each year from the same area of fast current in Nantucket Sound near the entrance to Sengekontacket Pond.

Parker (1952b, p. 455) reported it from open water facies in the Gardiners Bay and Buzzards Bay areas but not in river facies.

Family BULIMINIDAE

Genus **Bolivina** d'Orbigny, 1839

Bolivina pseudoplicata Heron-Allen and Earland

Plate 1, figure 19

Bolivina pseudoplicata HERON-ALLEN and EARLAND, 1930, Royal Micros. Soc. Jour., v. 50, p. 81, pl. 3, figs. 36-40.—PARKER, 1952, Mus. Comp. Zool. Bull., v. 106, no. 10, p. 444, pl. 4, fig. 11.

Our specimens have been compared with material in the Cushman Collection, U. S. National Museum, received from A. Earland from shore sand of Bognor, Sussex, England (Cushman Coll. no. 64866), and other British localities, and also with Parker's specimens from west of Cuttyhunk and from Portsmouth, N. H. The Martha's Vineyard specimens are mostly shorter and less well defined, but otherwise typical.

Bolivina pseudoplicata was found only in samples from the open beaches and harbor entrances of Vineyard and Nantucket Sounds. Its presence in bog samples is probably due to its being washed up onto the bog from the adjacent bottom sediments of Nantucket Sound.

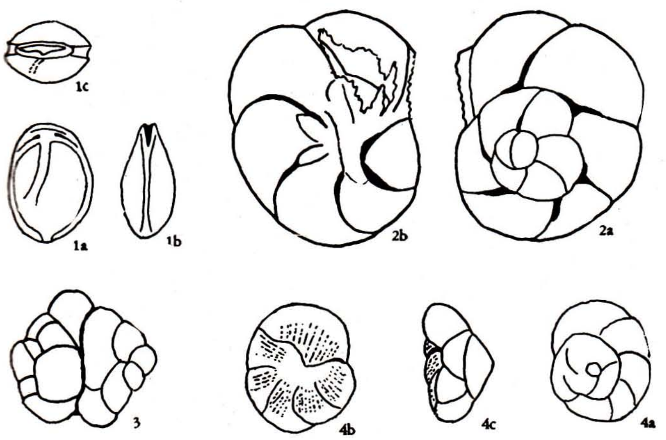
Genus **Fissurina** Reuss, 1850

Fissurina marginata Seguenza

Text figure 2, figure 1

Fissurina marginata SEGUENZA, 1862, Foram. Monotalamici Mioc. Messina, pt. 2, p. 66, pl. 2, figs. 27, 28.

Except for size (0.15 mm. instead of 0.3 mm.), our specimens seem identical with those described from the Miocene of Sicily. They are elongate circular with slightly protruding apertural end but no apertural



TEXT FIGURE 2

[All specimens approximately × 85.]

1. *Fissurina marginata* Seguenza. USNM 627695. *a,* front view; *b,* side view; *c,* top view. Nantucket Sound (57-MV-9). 2. *Helenia anderseni* (Warren). USNM 627703. *a,* dorsal view; *b,* ventral view. Stream entrance, Katama Bay (57-MV-27). 3, 4, *Rosalina globosa* (Sidebottom). 3. USNM 627723. Two specimens attached in plastogamy. Entrance to Sengekontacket Pond (58-MV-32). 4. USNM 627724. *a,* dorsal view; *b,* ventral view; *c,* peripheral view. Entrance to Sengekontacket Pond (58-MV-34).

neck. They have two narrow peripheral flanges and the internal tube, flaring at the free end, is more than half the length of the chamber and curved toward one side.

Similar single-chambered forms have been reported under other specific names and under the genera *Lagena* and *Entosolenia.* They never seem to be found abundantly and seem to have little importance. Both specimens found at Martha's Vineyard came from Nantucket Sound, washed from bright green, soft hair-like seaweed awash at low tide.

Family DISCORBIDAE

Genus **Patellina** Williamson, 1858

Patellina corrugata Williamson

Patellina corrugata WILLIAMSON, 1858, Recent Foram. Great Britain, p. 46, pl. 3, figs. 86-89.—CUSHMAN, 1931, U. S. Natl. Mus. Bull. 104, pt. 8, p. 11, pl. 2, figs. 6, 7.

This widely recorded species occurs only rarely in our material. A single specimen was found in sediments from tide pools among kelp-covered boulders near Menemsha on Vineyard Sound (58-MV-42). It was also found in sediment taken from the Lobster Hatchery tank.

Genus **Rosalina** d'Orbigny, 1826

Rosalina columbiensis (Cushman)

Plate 1, figures 20, 21

Discorbis columbiensis CUSHMAN, 1925, Cushman Lab. Foram. Research Contr., v. 1, pt. 2, p. 43, pl. 6, fig. 13.—PARKER, 1952, Mus. Comp. Zool. Bull., v. 106, no. 10, p. 446, pl. 4, figs. 17-20.

Rosalina columbiensis (Cushman) constitutes a substantial part of the Martha's Vineyard fauna, absent only from Menemsha Pond and the brackish environments of ponds and stream entrances. Without doubt the specimens are loosely attached during life, and most of them were living when collected. Those from open sound waters were largest and most robust. They apparently do not live within the bottom sediments but are attached to rocks, shells, seaweed, or other objects that project above the sea bottom. This was the only species found in scrapings from bridge pilings and boulders in the entrance to Lagoon Pond (58-MV-23), while bottom sediments from the same area included a considerable variety of forms (see grouping B2 on table 1).

Rosalina globosa (Sidebottom)

Text figure 2, figures 3, 4

Pulvinulina globosa SIDEBOTTOM, 1909, Mem. Proc. Manchester Lit. Philos. Soc., v. 53, no. 21, p. 9, pl. 4, fig. 3.

Discorbina globosa (SIDEBOTTOM). HERON-ALLEN and EARLAND, 1915, Zool. Soc. London Trans., v. 20, p. 702, pl. 52, figs. 27-31.

This minute (about 0.15 mm. in diameter) species was found living at several localities on the sound side and in the protected bays of Martha's Vineyard. It was described from shallow water off Delos in the Grecian Archipelago. The only other reported occurrence is from an exposed coral reef at Pekawi Bay in the Kerimba Archipelago, Portuguese East Africa.

Rosalina globosa (Sidebottom) is probably attached by its concave ventral side during life. The final whorl consists of about six chambers. The periphery is rounded and slightly lobulated. The wall is distinctly perforate on the dorsal side and ornamented by fine radial striae on the ventral side. The aperture appears to be a low opening under the free ventral edge of the last-formed chamber extending from the umbilicus out to the periphery.

Several pairs were found attached in plastogamy, a feature of similar species having radial ventral lines, such as "*Discorbina wrightii* Brady" and "*Discorbis ornatissima* Cushman." In our material we found no other species showing this feature.

Genus **Hanzawaia** Asano, 1944

Hanzawaia concentrica (Cushman)

Cibicides concentrica (CUSHMAN). CUSHMAN, 1931, U. S. Natl. Mus. Bull. 104, pt. 8, p. 120, pl. 21, figs. 4, 5; pl. 22, figs. 1, 2.

Cibicides concentricus (CUSHMAN). PARKER, 1952, Mus. Comp. Zool. Bull., v. 106, no. 10, p. 445, pl. 5, fig. 10.

Only two specimens of this species were found, both in samples from Gay Head. This is primarily a southern species, living along the southern coast of the United States and in the West Indian region. Cushman (1944, p. 37) recorded it as abundant from depths of 6-13 fathoms in Vineyard Sound. However, in Long Island Sound and near Block Island, areas that are slightly to the west and less exposed to the influence of the Gulf Stream, Parker (1948, p. 222; 1952b, p. 445) found it only rarely.

Genus **Buccella** Andersen, 1952

Buccella frigida (Cushman)

Plate 1, figures 24, 25

Buccella frigida (CUSHMAN). ANDERSEN, 1952, Washington Acad. Sci. Jour., v. 42, no. 5, p. 144, pl., figs. 4-6.

This species is a minor constituent occurring in scattered samples from all parts of the island and from marine to brackish environments.

Genus **Helenia** Saunders, 1957

Helenia anderseni (Warren)

Text figure 2, figure 2

Pseudoeponides anderseni WARREN, 1957, Cushman Found. Foram. Research Contr., v. 8, p. 39, pl. 4, figs. 12-15.—PARKER and ATHEARN, 1959, Jour. Paleontology, v. 33, p. 341, pl. 50, figs. 28-31.

Helenia anderseni (WARREN). SAUNDERS, 1957, Washington Acad. Sci. Jour., v. 47, p. 374, pl., figs. 1, 2.

Rare specimens of this minute species (maximum diameter about 0.30 mm.) were found in several samples obtained under brackish conditions. Other recorded occurrences of this species are from marshy areas in southeast Louisiana, Trinidad, and Poponesset Bay on the south shore of Cape Cod.

As pointed out by Saunders (1957, p. 374), the species seems generically distinct inasmuch as the dorsal supplementary apertures are situated along the sutures instead of areally on the surface parallel to the sutures as in *Pseudoeponides*.

In our material, specimens may be confused with juvenile specimens of *Streblus beccarii tepida* (Cushman) but are easily distinguishable by the lack of a ventral umbilical plug.

Family ROTALIIDAE

Genus **Poroeponides** Cushman, 1944

Poroeponides lateralis (Terquem)

Plate 2, figures 14, 15

Rosalina lateralis TERQUEM, 1878, Soc. géol. France Mém., sér. 3, v. 1, p. 25, pl. 2 (7), fig. 11.

Poroeponides lateralis (TERQUEM). CUSHMAN, 1944, Cushman Lab. Foram. Research, Spec. Publ. 12, p. 34, pl. 4, fig. 23.—PARKER, 1952, Mus. Comp. Zool. Bull., v. 106, no. 10, p. 453, pl. 5, fig. 6.

Earlmyersia punctulata MANGIN (not RHUMBLER), 1959, Annales Instit. Oceanographique, Paris, v. 37, p. 97, pl. 4 (top), figs. a-c.

Frequently recorded from waters south of Cape Cod, *Poroeponides lateralis* (Terquem) is a striking constituent of samples obtained from the boulder strewn beaches of Gay Head and Vineyard Sound. The species is also recorded from the Gulf of Mexico, Brazil, Oregon, the Philippines, and western India. Specimens illustrated as *Earlmyersia punctulata* (Rhumbler) from the Gulf of Guinea, west coast of Africa, appear to belong to this species.

Genus **Streblus** Fischer, 1817

Streblus beccarii (Linné)

Plate 2, figures 18, 19

Rotalia beccarii (LINNÉ). CUSHMAN, 1928, Cushman Lab. Foram. Research Contr., v. 4, p. 104, pl. 15, figs. 1-7.—PARKER, 1952, Mus. Comp. Zool. Bull., v. 106, no. 10, p. 457, pl. 5, fig. 5.

This species, having world-wide distribution, occurs around Martha's Vineyard but is found in typical form only in samples from the ocean beaches and those facing Vineyard Sound, with scattered occurrences in Nantucket Sound. Specimens of the typical form occur only rarely but are living.

Streblus beccarii tepida (Cushman)

Plate 2, figures 16, 17

Rotalia beccarii (LINNAEUS) var. *tepida* CUSHMAN, 1926, Carnegie Inst. Washington Pub. 344, p. 79, pl. 1.—PARKER, 1952, Mus. Comp. Zool. Bull., v. 106, no. 10, p. 457, pl. 5, fig. 8.

This subspecies occurs abundantly at Martha's Vineyard, making up a predominant part of the Foraminifera population on the sound side and in certain of the protected bays. It does not occur in the fauna of the ocean beaches. Most of the specimens obtained were living.

Family ELPHIDIIDAE

Genus **Elphidium** Montfort, 1808

Elphidium advena (Cushman)

Plate 2, figure 8

Elphidium advenum (CUSHMAN). CUSHMAN, 1930, U. S. Natl. Mus. Bull. 104, pt. 7, p. 25, pl. 10, figs. 1, 2.—PARKER, 1952, Mus. Comp. Zool. Bull., v. 106, no. 10, p. 447, pl. 3, fig. 9.

Specimens of this species are smaller than typical and the narrow peripheral carina is observable only in edge view. In having a glassy boss in the depressed umbilical area and in other respects our specimens compare well with the types. Parker (1952b, p. 447) suggests that southern New England may be the northern limit of the species and that its atypical development here may be a result.

It seems to prefer open sea beaches and other areas of actively moving water. It was not found in the brackish ponds and only rarely in the protected bays.

Elphidium clavatum Cushman

Plate 2, figure 1

Elphidium clavatum CUSHMAN. LOEBLICH and TAPPAN, 1953, Smithsonian Misc. Coll., v. 121, no. 7, p. 98, pl. 19, figs. 8-10.

In the Martha's Vineyard collections this has the most rugged shell of all the species of the genus *Elphidium.* It is thickest through the umbilical region, due to the presence of the slightly elevated umbonal bosses, and the periphery is subacute. The retral processes are few and short, and the sutures are consequently marked by interrupted radial slits.

Most of its occurrences were on the ocean and sound beaches.

Elphidium excavatum (Terquem)

Plate 2, figure 5

Elphidium excavatum (TERQUEM). CUSHMAN, 1930, U. S. Natl. Mus. Bull. 104, pt. 7, p. 21, pl. 8, figs. 1-7.—PARKER, 1952, Mus. Comp. Zool. Bull., v. 106, no. 10, p. 448, pl. 3, fig. 13.

Elphidium excavatum was originally described from off Dunkerque. Specimens from shore sand at Bognor, Sussex, England (Cushman Coll. no. 18830), from Grundare, Iceland (Cushman Coll. no. 37312), and from 2.5 fathoms in Grace Holman Harbor, Norway (Cushman Coll. no. 10201) seem typical and are identical with the New England specimens.

This species appears to favor protected bays and brackish ponds and stream entrances, the best specimens in the present fauna coming from Katama Bay, Chappaquiddick Island. In the Long Island Sound-Buzzards Bay area, Parker (1952b, p. 448) noted it especially in her facies 2 where the salinity ranged about 28-30°/oo (*idem,* p. 437).

It may be distinguished from *Elphidium translucens* Natland by the retral processes being much closer together so that the depressions between them are like elongate slits transverse to the sutures, giving an impression of concentric rings on the surface of the test.

Elphidium galvestonense Kornfeld

Plate 2, figure 9

Elphidium galvestonense KORNFELD. PARKER and ATHEARN, 1959, Jour. Paleontology, v. 33, p. 342, pl. 50, figs. 33-35.

In all our collections from Farm Pond, one of the brackish ponds having direct communication with Nantucket Sound, this species was found to be predominant. Although it was found elsewhere around the island (see table 1), its favored habitat seems to be brackish and marshy areas, as is clearly shown by its recorded occurrences in the Gulf of Mexico and in the marshes of Poponesset Bay on the south shore of Cape Cod.

It occurs in association with *Elphidium gunteri,* from which it is distinguished by its larger size, complanate test, and indistinctly perforate wall. Our Farm Pond specimens are typically green, except the final chamber or two in which the rose Bengal stain indicates the living animal resided. This green color, found characteristically in this species and rarely in other species of *Elphidium,* may be due to algae filling or lining the unused earlier chambers of the tests of Foraminifera. No green chambers were observed to have been stained by rose Bengal, and the green color fades but does not completely disappear from the dry specimens. The smooth green walls and the glassy beaded appearance of the sutures combine to make this a striking species.

Elphidium gunteri Cole

Plate 2, figure 10

Elphidium gunteri COLE. PARKER and ATHEARN, 1959, Jour. Paleontology, v. 33, p. 342, pl. 50, fig. 36.

This species, like *Elphidium galvestonense,* prefers a marshy and brackish habitat. On Martha's Vineyard, as well as in the marshes of Poponesset Bay just across Nantucket Sound, the two species occur together with *E. gunteri* slightly less abundant.

In Farm Pond, *E. gunteri* is slightly orange in color instead of green, is smaller and relatively thicker than *E. galvestonense,* and distinctly perforate. In one of the Farm Pond samples (57-MV-44), taken from the landward extension of Farm Pond where circulation seems to be rather restricted, *E. gunteri* was the only species found. It occurred there in abundance, and we observed an unusual number of abnormal individuals among them.

Elphidium incertum (Williamson)

Plate 2, figure 2

Elphidium incertum (WILLIAMSON). PHLEGER, 1952, Cushman Found. Foram. Research Contr., v. 3, p. 83, pl. 14, fig. 7.

This species is characterized by a depressed umbilical region without an umbonal boss. The sutures are marked by radial slits joining at the depressed umbilicus and interrupted in their outer portions by relatively few retral processes. The periphery is rounded. In our material, this species is best represented in the Farm Pond samples.

Elphidium margaritaceum Cushman

Plate 2, figure 3

Elphidium advenum (CUSHMAN) var. *margaritaceum* CUSHMAN, 1930, U. S. Natl. Mus. Bull. 104, pt. 7, p. 25, pl. 10, fig. 3.—PARKER, 1952, Mus. Comp. Zool. Bull., v. 106, no. 10, p. 447, pl. 3, fig. 10.

Test small for the genus, compressed, periphery subacute, slightly lobulated in some specimens, umbilicus slightly depressed and coarsely granular; chambers indistinct, not inflated, 6 to 10 comprising the adult whorl, early chambers sometimes appearing as narrow ribs between the wide granular sutural areas; sutures indistinct, only slightly depressed, somewhat curved at the outer ends, retral processes indistinct, short, about 7 between umbilicus and periphery; wall calcareous, densely perforate, smooth with a crystalline surface;

aperture consisting of a line of pores along the base of the apertural face. Diameter 0.35-0.45 mm.; thickness 0.10-0.15 mm.

Elphidium margaritaceum was originally described as a variety of *E. advena* (Cushman) from beach sands at Newport, Rhode Island; but it seems specifically distinct. The umbilical area lacks the clear plug found on *E. advena,* and there is no peripheral carina. The densely perforate chamber walls and granular inter-areas result in an overall crystalline appearance which makes this species one of the most striking and easily recognizable ones in our assemblages.

This is the most widely distributed species of *Elphidium* around Martha's Vineyard, apparently preferring the open-sea conditions of both Vineyard and Nantucket Sounds, and the protected bays. It was not found in the brackish ponds.

Elphidium poeyanum (d'Orbigny)

Plate 2, figure 7

Polystomella poeyana D'ORBIGNY, 1839, *in* DE LA SAGRA, Histoire Phys. Politique Nat. Cuba, "Foraminifères," p. 55, pl. 6, figs. 25, 26.

Elphidium poeyanum (D'ORBIGNY). PARKER, PHLEGER, and PEIRSON, 1953, Cushman Found. Foram. Research, Spec. Publ. 2, p. 9, pl. 3, fig. 26.

This species was described from off Cuba and Jamaica and has been reported widely. Comparison with West Indian material indicates the identity of our material with *Elphidium poeyanum,* differing only in slightly smaller size. It is a thin-walled, finely perforate form with depressed umbilicus and slightly inflated chambers, about 9 comprising the adult whorl. The sutures are slightly incised and the retral processes few and short.

The species from Buzzards Bay called *Elphidium selseyense* (Heron-Allen and Earland) (Parker, 1952b, p. 449, pl. 4, fig. 9) appears to be synonymous.

The species was found rarely in samples from all parts of the island except the ocean side.

Elphidium subarcticum Cushman

Plate 2, figure 6

Elphidium subarcticum CUSHMAN, 1944, Cushman Lab. Foram. Research, Spec. Publ. 12, p. 27, pl. 3, figs. 34, 35.—PARKER (part), 1952, Mus. Comp. Zool. Bull., v. 106, no. 10, p. 449, pl. 4, figs. 3-6 (not fig. 8).

Elphidium subarcticum is a complanate form with depressed umbilicus, rounded periphery, and slightly inflated final few chambers. The finely perforate wall is smooth and translucent except for a broad opaque band along each suture.

This species, described from off Eastport, Maine, and also reported from southward along the New England coast, occurs around Martha's Vineyard, but not in the brackish ponds or stream entrances. It is very similar to *E. frigidum* Cushman, previously described from the Arctic, which appears to be distinguishable from it only by the fine, irregular elongate grooves transverse to the sutures, marking especially the later chambers and extending forward from each suture. It seems likely that these two species may prove to be the same.

Another species having opaque sutural bands is *Nonion pauciloculum* Cushman described from Buzzards Bay. It is distinguishable by its deeply incised sutures. Parker (1952a, p. 412), recognizing that it has indistinct retral processes, considered it an ecologic variation of *Elphidium subarcticum.* We did not find any specimens referable to this variant in our Martha's Vineyard collections.

Elphidium translucens Natland

Plate 2, figure 4

Elphidium translucens NATLAND, 1938, Scripps Inst. Oceanography Bull., tech. ser., v. 4, no. 5, p. 144, pl. 5, figs. 3, 4.

Comparison with type specimens indicates the identity of our specimens with this species described from shallow water off southern California. It is distinguished by its rather coarsely and densely perforate wall. It differs from *Elphidium excavatum,* which it otherwise resembles, in the retral processes being less numerous and less closely spaced. Thus, the depressions between the sutural bridges are elongated parallel with the sutures instead of elongated tranverse to them as in *E. excavatum.*

In the Atlantic, *E. translucens* has been reported from southwest Texas, Mississippi Sound, and the Gulf of Paria. Around Martha's Vineyard the species is found mostly in the protected bays, brackish ponds and stream entrances.

Genus **Protelphidium** Haynes, 1956

Protelphidium orbiculare (Brady)

Plate 2, figure 11

Nonionina orbicularis BRADY, 1881, Annals and Mag. Nat. History, ser. 5, v. 8, p. 415, pl. 21, fig. 5.

Nonion orbiculare (BRADY). CUSHMAN, 1948, Cushman Lab. Foram. Research, Spec. Publ. 23, p. 53, pl. 6, fig. 3.

Elphidium orbiculare (BRADY). LOEBLICH and TAPPAN, 1953, Smithsonian Misc. Coll., v. 121, no. 7, p. 102, pl. 19, figs. 1-4.

This common species of the Arctic is found rarely around Martha's Vineyard, mostly on the open-sea beaches. It is similar in appearance to *Protelphidium tisburyense* (Butcher), but differs in having a more opaque wall and in being relatively thicker and more closely coiled. The sutures are frequently excavated toward the umbilicus.

TABLE 1.—Distribution of Foraminifera according to ecol groupings around Martha's Vineyard Island.

	Open-sea beaches			Harbors and inlets having current action				Protected bays		Brackish ponds				Surface of submerged logs			Stream entrances		
	A-1	A-2	A-3	B-1	B-2	B-3	[illegible]	C-2	C-3	D-1	D-2 (Brush Pond)	D-3	D-4	E-1	E-2	E-3	F-1	F-2	F-3
Haplophragmoides bonplandi Todt and Brönnimann	X																	X X	
H. wilberti Andersen								X						X X X X					
Ammobaculites dilatatus Cushman and Brönnimann							X		X	X X X X									
Ammotium salsum (Cushman and Brönnimann)										X X X X X X X			X		X				
Textularia earlandi Parker	X		X					X	X			X						X	
Eggerella advena (Cushman)		X X X	X X			X		X X X X	X	X									
Miliammina fusca (Brady)			X X	X		X	X	X X X X X	X X	X X X X X X X X	X	X X	X	X X X X		X	X	X X X X X	X
Quinqueloculina auberiana d'Orbigny	X X X	X																	
Q. lata Terquem	X X X	X X X	X X X X X X X X X X X X	X X X X	X X	X X	X X X X X X	X X X X X X X X X X X X X	X X X X X X X	X X X X X X X X X	X	X X X	X	X X X X X X X X		X	X X	X X X X X	X
Q. seminulum (Linné)	X X X X	X X X X X X X X X	X X X	X	X		X							X					
Q. subrotunda (Montagu)	X X X	X X X X X X X X X	X X X			X		X						X					
Cornuspira planorbis Schultze		X X	X X X X X X X	X	X X			X X X				X		X X			X		
Trochammina inflata (Montagu)			X	X			X X X X X	X X X X X X	X X X	X X X	X	X X X		X X X X X X X X	X	X	X X	X X X X	X X
T. macrescens Brady							X	X X X	X X		X	X		X X X X X X X	X	X	X X	X X X	
T. ochracea (Williamson)		X					X	X X X X X		X									
T. rotaliformis J. Wright		X					X	X X	X			X X		X X X X			X	X	X
Pseudopolymorphina novangliae (Cushman)			X X																
Bolivina pseudoplicata Heron-Allen and Earland		X X X	X X X X	X	X	X								X X X X					
Fissurina marginata Seguenza			X X																
Patellina corrugata Williamson		X																	
Rosalina columbiensis (Cushman)	X X X X	X X X X X X X X X X	X X X X X X X X X X X X	X X	X X	X X X	X X X	X X X X X X X X X	X X					X X X X X					X
R. globosa (Sidebottom)		X X	X X X X X X X X	X X	X X	X X		X X X X X X	X					X X					X
Buccella frigida (Cushman)	X		X X X X				X X	X X X X				X X X							
Helenia andersoni (Warren)											X	X					X	X X	
Poroeponides lateralis (Terquem)	X X X X X	X X X X X X																	
Streblus beccarii (Linné)	X X X X X X	X X X X X X	X X X X X X	X X X	X			X						X X			X		
S. beccarii tepida (Cushman)			X X X X X X X X X X	X X X X	X	X	X X X X	X X X X X X X X X X X	X X X X X X	X X X X X X X X X		X X X	X	X X X X X			X X		X
Elphidium advena (Cushman)	X X	X X X X	X X X X X X X X	X X X X	X X	X X X		X X X						X X					
E. clavatum Cushman	X X X X X X X X	X X X	X X X X X	X X			X X	X X X X	X	X					X				
E. excavatum (Terquem)		X					X X	X X X X	X X X X X X	X		X X X		X X				X X X X	
E. galvestonense Kornfeld		X					(	X	X X X	X X X X X X X X X			X						
E. gunteri Cole		X		X			(	X	X X	X X X X X X X X X					X				
E. incertum (Williamson)			X	X X			X X X (	X	X X	X X X X X	X						X X	?	
E. margaritaceum Cushman	X X X X X	X X X X X	X X X X X X X X X X	X X	X X	X X X	X X (	X X X X X X X X X X X	X X X X					X X X X X X			X	X	
E. poeyanum (d'Orbigny)		X X	X X X X X X X X	X X X	X		X X	X X X X X X X X X	X X X	X				X X X			X X		
E. subarcticum Cushman	X X X X X		X X X X X X	X	X		(	X X X X						X X					
E. translucens Natland			X X X	X			X (	X X X X X	X	X X X X X X X		X X		X X					X X
Protelphidium orbiculare (Brady)	X X X	X							X X										
P. tisburyense (Butcher)							(	X X	X X X	X X X X X X X X X		X X	X					X X	
Pseudononion atlanticum (Cushman)	X																		
Cibicides lobatulus (Walker and Jacob)	X	X X X	X																
C. pseudoungerianus (Cushman)	X																		
Hanzawaia concentrica (Cushman)	X X																		

A-1 Facing Atlantic Ocean
A-2 Facing Vineyard Sound
A-3 Facing Nantucket Sound

B-1 Entrance to Sengekontacket Pond
B-2 Entrance to Lagoon Pond
B-3 Entrance to Menemsha Pond

C-1 Facing Vineyard Sound and Vineyard Haven Harbor
C-2 Facing Nantucket Sound
C-3 Behind South Beach

-1 Farm Pond
-2 Brush Pond
-3 Unnamed pond near Eastville
-4 Unnamed pond near Herring Brook

E-1 Nantucket Sound
E-2 Unnamed pond near Eastville
E-3 Sengekontacket Pond

F-1 Katama Bay, Chappaquiddick Island
F-2 Menemsha Pond at Lobsterville
F-3 Brush Pond

Protelphidium tisburyense (Butcher)

Plate 2, figure 12

Nonion tisburyensis BUTCHER, 1948, Cushman Lab. Foram. Research Contr., v. 24, p. 22, text figs. 1-3.

Protelphidium tisburyense (BUTCHER). PARKER and ATHEARN, 1959, Jour. Paleontology, v. 33, p. 342, pl. 50, figs. 26, 32.

This species, described from tidal ponds of Martha's Vineyard and Falmouth, Massachusetts, apparently prefers brackish environments (see table 1). Following Parker and Athearn (1959, p. 342), the species is placed in the genus *Protelphidium* Haynes 1956, because of its lack of true retral processes.

Family NONIONIDAE

Genus **Pseudononion** Asano, 1936

Pseudononion atlanticum (Cushman)

Plate 2, figure 13

Nonionella atlantica CUSHMAN, 1947, Cushman Lab. Foram. Research Contr., v. 23, p. 90, pl. 20, figs. 4, 5.—PARKER, 1952, Mus. Comp. Zool. Bull., v. 106, no. 10, p. 453, pl. 3, fig. 15.

A single specimen was found at Gay Head. This species is widely distributed in the Atlantic Ocean and Gulf of Mexico. It is closely related to, but distinguishable from, *Pseudononion auricula* (Heron-Allen and Earland) which seems to be best distributed in the North Atlantic and Arctic. *P. atlanticum* has a thicker test and two or three more chambers in the adult whorl than does *P. auricula,* and also is characterized by the ventral umbonal area being slightly papillate.

Family ANOMALINIDAE

Genus **Cibicides** Montfort, 1808

Cibicides lobatulus (Walker and Jacob)

Plate 2, figure 20

Cibicides lobatula (WALKER and JACOB). CUSHMAN, 1931, U. S. Natl. Mus. Bull. 104, pt. 8, p. 118, pl. 21, fig. 3.—PARKER, 1952, Mus. Comp. Zool. Bull., v. 106, no. 10, p. 446, pl. 5, fig. 11.

This cosmopolitan species occurs rarely around Martha's Vineyard on the shores of the ocean and sounds, but not in the inlets and protected bays. Judging by the shape of the test, specimens were probably attached during life.

Cibicides pseudoungerianus (Cushman)

Plate 2, figure 21

Cibicides pseudoungeriana (CUSHMAN). CUSHMAN, 1931, U. S. Natl. Mus. Bull. 104, pt. 8, p. 123, pl. 22, figs. 3-7.

Although it is flattened on the dorsal (coiled) side, this species does not appear to be an attached form. It was found only in the material from Gay Head, apparently washed in from the deeper waters of Vineyard Sound.

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CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
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218. LOWER CARBONIFEROUS MICROFOSSILS FROM THE SUBSURFACE ROCKS OF THE WESTERN DESERT OF EGYPT

RUSHDI SAID and SAMIR F. ANDRAWIS[1]
Cairo University and the General Petroleum Company, Cairo, Egypt, U. A. R.

ABSTRACT

Foraminifera separated from the subsurface rocks of Faghur well at the western boundary of Northern Egypt suggest the presence of a Lower Carboniferous (Visean) occurrence in this locality. The discovery of this occurrence alters materially current conceptions of the paleogeography of the mobile shelf of Egypt.

INTRODUCTION

This paper describes fifteen species of Foraminifera and other microfossils separated from core no. 8, raised from Faghur exploratory well no. 1, drilled by the Sahara Petroleum Co. in the extreme western part of the northern Western Desert of Egypt (Lat. 30° 29′ 53″ N., Long. 25° 11′ 20″ E.). The dolomitic bed at depth 6046′ includes a rich and large assemblage of brachiopods and trilobites that were, in the absence of literature, determined as belonging to the Lower Permian. This erroneous age assignment of the core appeared on the final log of the Company and was accepted as fact by subsequent workers (Amin, 1959). From this core we have succeeded in separating rare but well-preserved microfossils which would unquestionably date it as of Lower Carboniferous (Visean) age. The fossils described have a world-wide distribution and have been repeatedly recorded from such widely-spaced classic Lower Carboniferous localities as Britain (Brady, 1876; Cummings, 1955a, b, 1956); the USSR, Donetz Basin (Lee, 1937; Reitlinger, 1950); Inner Mongolia, Gobi region (Galloway and Spock, 1932); Japan (Huzimoto, 1936); France (Jodot, 1930); Iran (Möller, 1880) and others. The presence of the megaspore *Triletes triglobatus* Dijkstra and Pierart in abundance in the lower part of this core adds further evidence to the Visean age of this core (Dijkstra and Pierart, 1957).

Other microfossils that have been separated in abundance from this core are the holothuroid sclerites: *Etheridgella porosa* Croneis and *Calcligula* (?) sp. *Calcligula* (?) sp. is a racquet-like sclerite, consisting of a rod (length .65 mm.) and roughly quadrangular disk (breadth .45 mm.) with about 5 to 6 excavations. Specimens referred to *Etheridgella porosa* agree in dimensions and detail with those described from the Pennsylvanian of Texas.

The discovery of this Paleozoic occurrence is of significance for no other Carboniferous fossiliferous and well-dated record of this age has ever been described from west of the famous Gulf of Suez exposures in Wadi Araba and Abu Zeneima. This discovery should, therefore, alter materially our previous conceptions of the paleogeography of the northern part of Egypt (compare for example the paleogeographic reconstructions given by Said and Shukri [1955] for the Carboniferous).

The assignment of a Visean age to this deposit is well worth emphasizing for this would correlate the new Paleozoic locality with the Visean outcropping localities of eastern Egypt and shows that a widespread regional transgression must have occurred over Egypt after a period of uplift.

As far as the authors are aware no Foraminifera have ever been described from pre-Jurassic sediments in Egypt. Except for a mention by Walther (1890) of the presence of *Ammodiscus* sp. from the Wadi Araba (Gulf of Suez) Carboniferous, no attempt has ever been made to describe the Foraminifera of the Egyptian Carboniferous.

Depository.—The types and sectioned specimens described in this paper are housed in the Geology Department, Faculty of Science, Gizeh, Egypt, U.A.R.

The following classification follows that recently proposed by Pokorny (1958).

SYSTEMATIC DESCRIPTIONS

Superfamily ASTRORHIZIDEA

Family ASTRORHIZIDAE

Genus **Earlandia** Plummer, 1930

Earlandia pulchra Cummings

Text figure 1

Earlandia pulchra CUMMINGS, 1955, Micropaleontology, vol. 1, p. 228, pl. 1, figs. 1, 15, 21.

Test free, cylindrical, elongate, circular in cross section, consisting of a tubular non-septate test; aperture broad, circular, at open end of tube; wall smooth, made of a single layer.

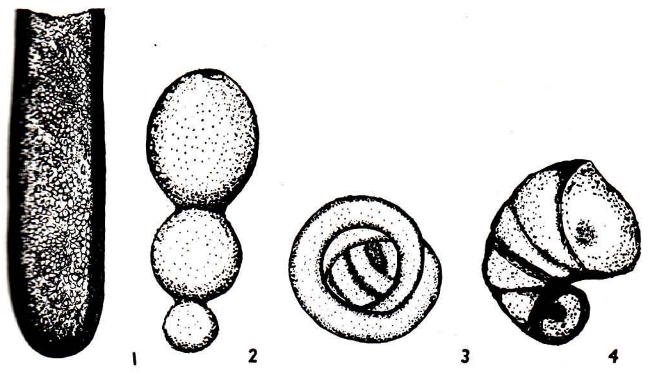
Typical specimens of this Lower Carboniferous Scottish species are found in abundance in the material from Faghur.

Genus **Earlandinella** Cummings, 1955

Earlandinella cf. **E. cylindrica** (Brady)

Earlandinella cylindrica (Brady). CUMMINGS, 1955, Micropaleontology, vol. 1, p. 229, pl. 1, figs. 2, 3, 19.

[1] The senior author carefully checked all paleontologic identifications, prepared the final manuscript and is responsible for all of the taxonomic and geologic conclusions.



TEXT FIGURES 1-4

1. Longitudinal section in *Earlandia pulchra* Cummings, × 50.
2. *Nodosinella* sp., × 75
3. *Glomospira simplex* Harlton, × 50
4. *Ammobaculites* sp., × 30

Test free, large, cylindrical, circular in cross section, consisting of a slightly tapering and partially and irregularly spaced subdivided tube; wall smooth, simple; aperture circular, terminal, at open end of tube.

Specimens differ from the typical ones in having a less tapering test and more irregularly spaced partitions. This is a Lower Carboniferous form.

Family REOPHACIDAE

Genus **Nodosinella** H. B. Brady, 1876

Nodosinella sp.

Text figure 2

Test free, small, straight, tapering, composed of three inflated chambers, arranged in a uniserial pattern increasing gradually in size as added, sutures broad, depressed, distinct, creating a lobulate lateral margin; aperture circular, terminal; wall calcareous, granulate.

Two specimens of this species are found in the samples studied. They seem to belong to a new species.

Family AMMODISCIDAE

Genus **Glomospira** Rzehak, 1888

Glomospira simplex Harlton

Text figure 3

Glomospira simplex Harlton, 1928, Jour. Paleontology, vol. 1, p. 305, pl. 52, figs. 2a-c.

Test free, trochoid, round, peripheral margin broad, with an ovoid proloculum and a long undivided second chamber, winding compactly, irregularly, with five to six convolutions, becoming more or less planispiral in the last convolution; wall finely arenaceous with a large proportion of cement; aperture round, simple, terminal.

A large number of specimens were found in the material studied. This species has been described from the Pennsylvanian rocks of America.

Superfamily LITUOLIDEA

Family LITUOLIDAE

Genus **Ammobaculites** Cushman, 1910

Ammobaculites sp.

Text figure 4

Test small, compressed in its coiled part, rather circular in cross section in the uncoiled part; earlier portion closely coiled, later four chambers uncoiled in a curved series, increasing in diameter largely as added, sutures indistinct in the coiled portion, faintly depressed in the uncoiled portion; wall coarsely arenaceous, rough; aperture terminal, not clear; length: 0.7 mm.

A single specimen of this species has been found in the material studied. It is unlike anything previously recorded. The peculiar trumpet-shaped chambers characterize it.

Family TEXTULARIIDAE

Genus **Palaeotextularia** Schubert, 1920

Palaeotextularia davisella Cummings

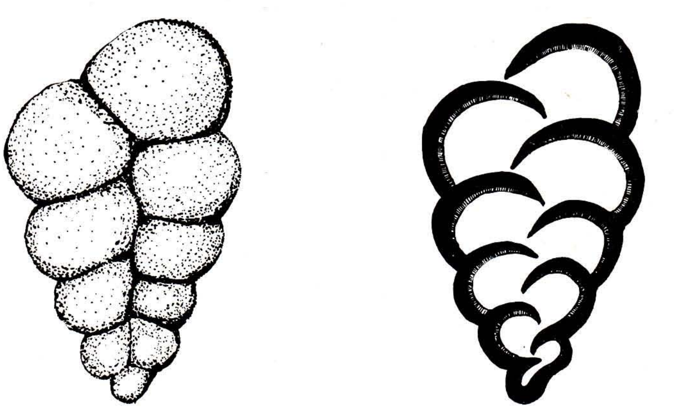
Text figure 5

Textularia gibbosa d'Orbigny. Brady, 1876, Pal. Soc., London, vol. 30, p. 131, pl. 10, fig. 26.

Palaeotextularia davisella Cummings, 1956, Micropaleontology, vol. 2, p. 218.

Test free, strongly tapering, oval in cross section, consisting of six biserial pairs of chambers; sutures indistinct in the earlier part, becoming depressed and less faint in later part; wall thick with two layers, an outer granular, calcareous layer and a thin inner fibrous layer; aperture a slit at the base of the last chamber.

This Lower Carboniferous species is recorded in fair numbers in the Faghur material.



TEXT FIGURE 5

Palaeotextularia davisella Cummings, × 60. Left, whole specimen; right, another sectioned specimen.

Genus **Bigenerina** d'Orbigny, 1926

Bigenerina (?) sp.

Text figure 6

Test small, starting with a spherical proloculum succeeded by a short biserial stage followed by a uniserial stage resulting from the addition of 3 to 4 chambers on one side only. Chambers of the uniserial stage have a circular cross section. They are peculiarly arranged and the aperture is not quite clear. The presence of a single specimen does not permit sectioning for a fuller comprehension of this species which is here assigned questionably to *Bigenerina*.

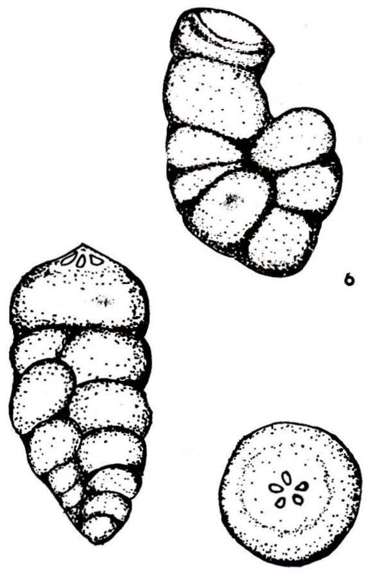
Genus **Climacammina** Brady, 1873

Climacammina ferra Cummings

Text figure 7

Climacammina ferra CUMMINGS, 1956, Micropaleontology, vol. 2, p. 228, pl. 1, figs. 13, 14, text fig. 16.

A few typical specimens identical to those described and figured by Cummings (1956) are found in the Faghur material. Our specimens are slightly larger (1.70 mm. in length). This is a Lower Carboniferous form that was originally described from Scotland.



TEXT FIGURES 6, 7

6. *Bigenerina* (?) sp., × 40.
7. *Climacammina ferra* Cummings, × 20. Left, whole specimen; middle, apertural view; right, another sectioned specimen.

Family TETRATAXIDAE

Genus **Tetrataxis** Ehrenberg, 1843

Tetrataxis conica Ehrenberg

Text figure 8

Tetrataxis conica EHRENBERG, 1843, Berisht K. preuss. Ak. Wiss. Berlin, p. 106; 1854, Microgeologie, pl. 37, pt. 11, fig. 12.—LEHMANN, 1953, Contr. Cushman Found. Foram. Research, vol. 4, p. 72, pl. 12, figs. 1-3.

Test free, trochoidally spiral, conical, composed of long appressed chambers, four to a whorl, with a slightly concave base.

This species, which is repeatedly reported from the Carboniferous rocks of the British Isles, Belgium, Russia, United States and Japan, is here reported in large numbers in Faghur.

Genus **Valvulinella** Schubert, 1907

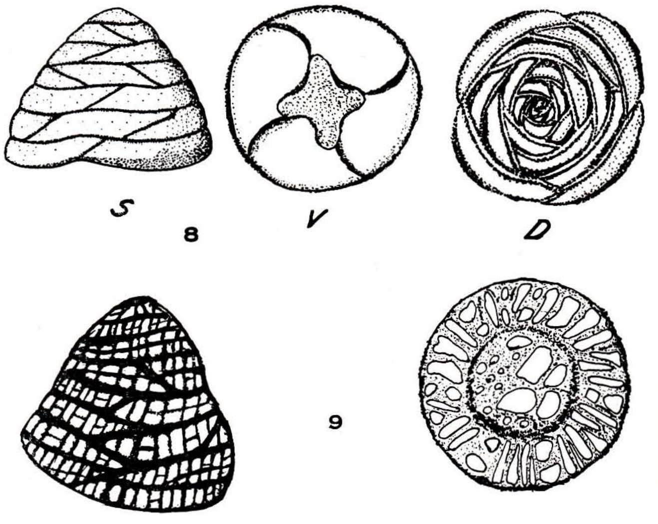
Valvulinella youngi (Brady)

Text figure 9

Valvulina youngi BRADY, 1876, Pal. Soc., London, vol. 30, p. 86, pl. 4, figs. 6, 8, 9.

Test free, conical, round in cross section with a slightly concave base, chambers spirally arranged, four in a whorl, divided by secondary septa in 2 rows of chamberlets; wall calcareous, granular.

Numerous typical specimens of this Carboniferous genus, recorded from many of the classic localities of the world, are found in Faghur.



TEXT FIGURES 8, 9

8. *Tetrataxis conica* Ehrenberg, × 30
9. *Valvulinella youngi* (Brady), × 50

Family ENDOTHYRIDAE

Genus **Endothyranopsis** Cummings, 1955

Endothyranopsis crassa (Brady)

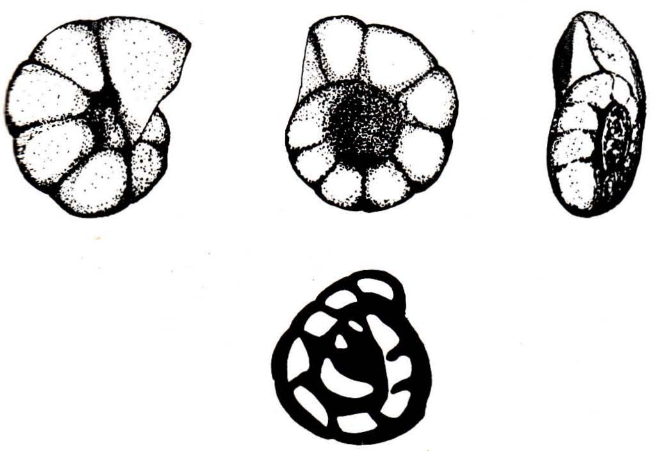
Text figure 10

Endothyra crassa BRADY, 1876, Pal. Soc., London, vol. 30, pl. 5, figs. 15-17.

Endothyranopsis crassus (Brady). CUMMINGS, 1955, Jour. Washington Acad. Sci., vol. 45, p. 3, figs. 5, A-C.

Test free, relatively large, involute, discoidal, slightly assymetrical, umbilicate and slightly evolute on one side, totally involute on the other; three whorls present, increasing moderately in height as added, nine chambers in the final whorl; sutures slightly depressed, radial, losing identity towards the umbilical part; peripheral margin broad and rounded with faint lobulation; wall granular, smooth; apertural face broad, convex, lunate in outline.

This form is found frequently in the samples studied. This species is recorded from the British Lower Carboniferous, being confined to the lower part of the lower limestone group in Scotland.



TEXT FIGURE 10
Endothyranopsis crassa (Brady), × 40

Superfamily NODOSARIIDEA
Family POLYMORPHINIDAE
Genus **Ramulina** R. Jones, 1875
Ramulina cf. **R. ornata** Cushman

Ramulina ornata CUSHMAN, 1938, Contr. Cushman Lab. Foram. Research, vol. 14, p. 44, pl. 7, fig. 15.

Test consisting of a globular chamber with four radiating tubular processes, slightly tapering. This species differs from *R. ornata* Cushman in having only four processes radiating from the globular central chamber which is usually smooth.

Numerous specimens of this species are found in the material studied.

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MOLLER, V. V., 1880, Ueber einige Foraminiferenfuhrende Gesteine Persian's: Jahrb. Geol. Reichsanst., Wien, vol. 30, pt. 4, pp. 573-586.

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SAID, R. and SHUKRI, N. M., 1955, Ancient shore-lines of Egypt; the Paleozoic: Bull. Soc. Géogr. Egypte, vol. 28, pp. 41-49.

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CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME XII, PART 1, JANUARY, 1961

219. *ENDOTHYRA SCITULA*, NEW NAME FOR *E. SYMMETRICA* ZELLER, PREOCCUPIED

DONALD F. TOOMEY
Shell Development Company, Houston, Texas

In compiling a Late Paleozoic nonfusulinid foraminiferal index, it was discovered that *Endothyra symmetrica* Zeller, 1957 (Mississippian endothyroid Foraminifera from the Cordilleran geosyncline: Jour. Paleontology, v. 31, no. 4, p. 701-702, pl. 75, fig. 14, 18, 19; pl. 78, fig. 8, 9; pl. 80, fig. 6) is preoccupied by *E. symmetrica* Morozova, 1949 (Representatives of the families Lituolidae and Textulariidae from the Upper Carboniferous and Artinskian deposits of the Bashkirian pre-Ural: Akad. Nauk S.S.S.R., Trudy, Inst. Geol. Nauk, v. 105 [Geol. Ser. No. 35], p. 247-248, pl. 1, fig. 8, 13-15).

A letter to Zeller dated August, 1957, enclosing a photostat copy of the above Russian article has failed to draw any action. In addition, two articles published since Zeller's have unfortunately perpetuated the error. These are: (1) Okimura, Y., 1958, Biostratigraphical and paleontological studies on the endothyroid Foraminifera from the Atetsu limestone plateau, Okayama prefecture, Japan: Jour. Sci. Hiroshima Univ., ser. C, v. 2, no. 3, p. 262-263, pl. 32, fig. 3-4, and (2) Woodland, R. B., 1958, Stratigraphic significance of Mississippian endothyroid Foraminifera in central Utah: Jour. Paleontology, v. 32, no. 5, p. 800, pl. 101, fig. 7, 9, and 10. Inasmuch as Zeller has failed to act, within what is considered a reasonable lapse of time, and since this form is used as a "stratigraphic marker" it is all the more imperative that the correction be made immediately. For these reasons I propose to rename the form *Endothyra scitula*.

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME XII, PART 1, JANUARY, 1961

RECENT LITERATURE ON THE FORAMINIFERA

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

ADAMS, C. G. A note on two important collections of Foraminifera in the British Museum (Natural History). —Micropaleontology, v. 6, No. 4, Oct. 1960, p. 417-418.—The Challenger collection, transferred from Zoological Museum of University of Cambridge between 1939 and 1959, and the Alfred Issler Jurassic collection, purchased in 1910 from Issler.

ALEXANDROWICZ, ZOFIA. Carboniferous Foraminifers from Kozlowa Gora near Bytom (Upper Silesia) (in Polish with English summary).—Poland Instyt. Geol., Kwartalnik Geol., Warsaw, tom 3, 1959, p. 869-881, pls. 1-3, text figs. 1, 2 (map, columnar section).—Seven species of agglutinating Foraminifera.

ALIJULLA, KH. Novye vidy Foraminifer iz Verkhnemelovykh Otlozhenij Vostochnoj Chasti Malogo Kavkaza. —Akad. Nauk Azerbaidzhan. SSR, Baku, No. 1, 1960, p. 63-71, pls. 1-3.—Seven new species and one new variety from the Upper Cretaceous.

ANTONOVA, Z. A. Novye Vidy Foraminifer iz Jurskikh Otlozhenij Bassejna r. Laby.—Vses. neft. nauchno-issl. instit., Trudy, vyp. 4, Geol. Sbornik, 1960, p. 191-198, pls. 1, 2.—Seven new Jurassic species.

K Voprosy o Stratigraficheskom Raschlenenii Paleogenovykh Otlozhenij Skifskoj Platformy po Dannym Micropaleontologicheskikh Issledovanij.—Vses. neft. nauchno-issl. instit., Trudy, vyp. 4, Geol. Sbornik, 1960, p. 209-218.

APPLIN, ESTHER R. A tropical sea in central Georgia in late Oligocene time.—U. S. Geol. Survey Prof. Paper 400-B, Sept. 30, 1960, p. 207-209, text figs. 90.1, 90.2 (map, columnar section).—Northward extension of sea recognized through **Miogypsina antillea** and **M. gunteri** found in a well in Coffee County.

AVNIMELECH, M. Supplementary note on the occurrence of the genus **Bathysiphon** (Foraminifera: Monothalamia) in the lower Eocene of Israel.—Bull. Research Council Israel, sec. G: Geo-Sciences, v. G8, No. 1, May 1959, p. 61.—A regionally useful lower Eocene fossil, indicating rather deep water.

BANDY, ORVILLE L. The geologic significance of coiling ratios in the foraminifer **Globigerina pachyderma** (Ehrenberg).—Jour. Paleontology, v. 34, No. 4, July 1960, p. 671-681, text figs. 1-7, table 1.—Based on studies in radiocarbon-dated cores from southern California offshore basins, dextral coiling predominates during the last 11,000 years and sinistral coiling predominates in earlier sediments. Modern Arctic and Antarctic specimens are predominantly coiled sinistrally, while most temperate and tropical specimens coil dextrally. Thus the sinistral-dextral boundary of **G. pachyderma** may serve as a marker of the Pleistocene-Recent boundary. In Pliocene and Pleistocene strata of southern California sinistrality is consistent in the Pleistocene and middle part of Pliocene and dextrality in the upper and lower Pliocene.

BARKER, R. WRIGHT. Taxonomic notes on the species figured by H. B. Brady in his Report on the Foraminifera dredged by H.M.S. **Challenger** during the years 1873-1876, accompanied by a reproduction of Brady's plates.—Am. Assoc. Petroleum Geologists, Tulsa, October 1960, p. i-xxiv, 1-238, pls. 1-115 (I-CXV).—An invaluable compilation, including history of taxonomic changes made for Brady's names, suggestions for still-needed changes, notations of type species, and localities and depths of Brady's specimens. New names are proposed for 4 species and 37 others are indicated as needing specific or varietal names. All species referred to are indexed.

BARR, K. W. The occurrence of **Choffatella decipiens** in Trinidad.—Micropaleontology, v. 6, No. 3, July 1960, p. 323.—To clarify the stratigraphic relationships of the **Choffatella**-bearing beds, which constitute the upper part of the Tompire formation of probable early Barremian age, and which underlie the Toco formation.

BÉ, ALLAN W. H. Ecology of Recent planktonic Foraminifera: Part 2—Bathymetric and seasonal distributions in the Sargasso Sea off Bermuda.—Micropaleontology, v. 6, No. 4, Oct. 1960, p. 373-392, text figs. 1-19 (maps, graphs), tables 1-6.—Regular seasonal alternations in abundance between four temperate species (**Globorotalia hirsuta, G. truncatulinoides, Globigerina inflata,** and **G. bulloides;** most abundant in winter and spring) and three subtropical species (**Globorotalia menardii, Globigerinoides sacculifer,** and **G. conglobatus;** most abundant during summer and fall) are plotted for certain months in 1929, 1930, 1931, 1955, 1957, and 1958. Specimens are most abundant in the euphotic zone and more abundant in day tows than night tows. Empty tests constitute 35% of total tests in deep tows (700-1000 meters) but less than 0.1% in 0-150 meter tows. All Globorotaliidae and certain species of Globigerinidae are spineless. Color of protoplasm varies with depth and time of day: olive-green near surface and in daytime; yellow-green or whitish in deeper tows and night tows.

BECKMANN, JEAN PIERRE. Distribution of benthonic Foraminifera at the Cretaceous-Tertiary boundary of Trinidad (West Indies).—Internat. Geol. Congress, Rept. 21st Sess. Norden, pt. V, Proc. sec. 5, Copenhagen, 1960, p. 57-69, 1 pl.—Although the major change in the planktonic faunas comes at the top of the Maestrichtian, the benthonic fauna of the Upper Cretaceous continues up into the upper Paleocene after which a new benthonic fauna of Tertiary aspect gradually appears in the lower Eocene. Species and varieties are listed in 3 groups: (a) 123 Upper Cretaceous-Paleocene markers; (b) 24 occurring first in the upper Lizard Springs; and (c) 50 long-lived forms having little stratigraphic value.

BELFORD, D. J. Upper Cretaceous Foraminifera from the Toolonga Calcilutite and Gingin Chalk, Western Australia.—Australia Bureau Min. Resources, Geol., and Geophysics, Bull. No. 57, 1960, p. 1-198, pls. 1-35, text figs. 1-14, range chart.—Illustrated systematic catalog includes 139 species, 31 new. **Haerella** gen. nov. (type species **H. conica** sp. nov.) erected in the Rupertiidae.

BELLONI, S. La serie retica del Monte Rena (Prealpi bergamasche).—Riv. Ital. Pal. Stratig., v. 66, No. 2, 1960, p. 155-172, pl. 15, columnar section.—Nine species of Rhaetian Foraminifera recorded and illustrated.

BERGGREN, WILLIAM A. Biostratigraphy, planktonic Foraminifera and the Cretaceous-Tertiary boundary in Denmark and southern Sweden.—Internat. Geol.

Congress, Rept. 21st Sess. Norden, pt. V, Proc. sec. 5, Copenhagen, 1960, p. 181-192, text figs. 1, 2 (map, range chart).—Planktonic Foraminifera show an abrupt change at the contact between Maestrichtian and Danian. Range, in terms of zones based on belemnites and echinoids, is shown for 12 planktonic species in the Maestrichtian and 6 in the Danian.

BHATIA, S. B. Additional microfossils from the Umaria marine bed, central India.—Jour. Geol. Soc. India, v. 1, 1959, p. 116-125, text figs. 1, 2.—Two species of **Hyperammina** and one of **Nodosinella?** in Permo-Carboniferous rocks.

BOGDANOVICH, A. K. O Novykh i Maloizvestnykh Vidakh Foraminifer iz Miothena Zapadnogo Predkavkaz'ja.—Vses. neft. nauchno-issl. instit., Trudy, vyp. 3, Geol. Sbornik, 1960, p. 241-263, pls. 1-5, text figs. 1-7.—Descriptions and illustrations of 18 species (6 new) and 4 varieties (3 new) from the Miocene of western Kavkaza.

Mikrofauna i Flora iz Spongolitovykh Otlozhenij Srednego Majkopa Kubani i Severnoj Osetii.—Vses. neft. nauchno-issl. instit., Trudy, vyp. 4, Geol. Sbornik, 1960, p. 233-246, pls. 1-3.—Includes descriptions and illustrations of 10 species and varieties, one variety new, from the upper Tertiary.

BOGUSH, O. I. Foraminifery Aravanskikh Sloev Khrebta Kara-Chatyr.—Paleont. Zhurnal, No. 2, 1960, p. 3-16, pl. 1, text figs. 1, 2.—Describes 9 fusulinid species, all but one new.

BOLLI, HANS M., and CITA, MARIA BIANCA. Upper Cretaceous and lower Tertiary planktonic Foraminifera from the Paderno d'Adda section, northern Italy.—Internat. Geol. Congress, Rept. 21st Sess. Norden, pt. V, Proc. sec. 5, Copenhagen, 1960, p. 150-161, range chart.—The zonation based on planktonic Foraminifera that was established in the Americas is applicable in the Paderno d'Adda area. The restricted occurrences of 43 planktonic species are plotted in a section extending from Maestrichtian to Lutetian.

Globigerine e Globorotalie del Paleocene di Paderno d'Adda (Italia).—Riv. Ital. Pal. Stratig., v. 66, No. 3, 1960, p. 1-42, pls. 31-33, text figs. 1, 2 (geol. section, range chart).—Eighteen species (1 new) and 3 subspecies. Five of the Paleocene zones established in Trinidad are recognized in Italy.

BOLTON, THOMAS E. Catalogue of type invertebrate fossils of the Geological Survey of Canada.—Geol. Survey Canada, v. 1, 1960, p. 1-215 [Foraminifera listed on p. 1-7].—Sixty-six species of Foraminifera, all but 3 from Jurassic and Cretaceous, others from Carboniferous and Permian.

BRANN, DORIS C., and KENT, LOIS S. Catalogue of the type and figured specimens in the Paleontological Research Institution.—Bull. Amer. Pal., v. 40, No. 184, July 15, 1960, p. 1-995.

BUCHANAN, JOHN B. On **Jullienella** and **Schizammina**, two genera of arenaceous Foraminifera from the Tropical Atlantic, with a description of a new species. —Jour. Linn. Soc. London, Zool., v. 44, No. 297, July 28, 1960, p. 270-277, pl. 1, text figs. 1-5 (diagrammatic sections, map, graphs).—**Schizammina arborescens** sp. nov., tree-like arenaceous tubes, lives at about 40-50 meters on very fine sand with **Jullienella foetida**. **Schizammina labyrinthica** and **S. furcata** live between 50 and 100 meters and on a coarser sand bottom. All recorded occurrences are off Tropical West Africa.

BUROLLET, P. F., and MAGNIER, PH. Remarques sur la limite Crétacé-Tertiaire en Tunisie et en Libye.—Internat. Geol. Congress, Rept. 21st Sess. Norden, pt. V, Proc. sec. 5, Copenhagen, 1960, p. 136-144, 2 maps. —Assemblages of planktonic and benthonic Foraminifera are listed.

CICHA, IVAN, and ZAPLETALOVA, IRENA. Stratigraphisch-paläontologische Erkenntnisse über einige Vertreter der Gattung **Cibicides** aus dem Neogen des Wiener Beckens, der Karpatischen Vortiefe und des Waagtales.—Sbornik Ustred. ustavu geol., v. 25, ser. paleo., 1958 (1960), p. 7-53, pls. 1-8, text fig. 1, range chart.—Fourteen species (5 new) and 4 subspecies (1 new), with their ranges and abundance indicated.

CITA, MARIA BIANCA, and GELATI, ROMANO. **Globoquadrina langhiana** n. sp. del Langhiano-tipo.—Riv. Ital. Pal. Stratig., v. 66, No. 2, 1960, p. 241-246, pl. 29, text fig. 1.—Proposed as zone marker for lower part of the Langhian stage (lower Miocene).

COLE, W. STORRS. The genus **Camerina.**—Bull. Amer. Pal., v. 41, No. 190, Oct. 7, 1960, p. 185-205, pls. 23-26.—Only 2 valid genera can be recognized in camerinids with undivided chambers: **Miscellanea** of Paleocene age and **Camerina**, ranging from Paleocene to Recent. **Paraspiroclypeus, Planocamerinoides, Operculina, Operculinoides**, and **Ranikothalia** are included as synonyms of **Camerina.** Four distinct lineages are recognized in **Camerina.**

DOUGLASS, RAYMOND C. Revision of the family Orbitolinidae.—Micropaleontology, v. 6, No. 3, July 1960, p. 249-264, pls. 1-6, text figs. 1-3 (maps, phylogeny diagram).—The family consists of 5 genera: **Orbitolina, Dictyoconus, Coskinolinoides, Simplorbitolina,** and **Iraquia.** Other genera are excluded. Six species are described and illustrated. Phylogeny of genera is indicated.

ECHOLS, DOROTHY J., and SCHAEFFER, KATHERINE M. M. Microforaminifera of the Marianna limestone (Oligocene), from Little Stave Creek, Alabama. —Micropaleontology, v. 6, No. 4, Oct. 1960, p. 399-415, pls. 1, 2, table 1.—Quantitative analysis of microforaminifera as compared with normal-sized foraminifera in two samples suggests that microforaminifera may be megalospheric individuals, mostly of species in the Rotaliidae and Anomalinidae, many not sufficiently differentiated to permit specific identification and some not even generic identification. There is no natural size boundary for microforaminifera.

EICHER, DON L. Stratigraphy and micropaleontology of the Thermopolis shale.—Peabody Mus. Nat. Hist., Yale Univ., Bull. 15, 1960, p. 1-126, pls. 1-6, text figs. 1-12 (maps, correl. diagrams, columnar sections, graphs), tables 1, 2.—The Lower Cretaceous Thermopolis of Wyoming is restricted in this paper to the lowest of 3 formations: Thermopolis shale, Muddy sandstone, and Shell Creek shale. The uppermost of 4 units in the Thermopolis contains arenaceous Foraminifera indicating the joining of the seaway from the Gulf with the arm of the boreal sea, making the first interior seaway extending the length of the continent. Foraminifera in the 2 upper formations indicate first an episode of deposition over a large area of brackish shallow environments and, second, a renewed transgression of the arm of the boreal sea. The fauna is limited in variety as a result of low salinity and lack of oxygen on the sea floor in marginal areas. Thirty-three arenaceous species (8 new and 2 indeterminate) are described and illustrated. **Bimonilina** n. gen. (type species **B. variana** n. sp.) is erected in the Textulariidae.

GLAESSNER, M. F. Tertiary stratigraphic correlation in the Indo-Pacific region and Australia.—Jour. Geol. Soc. India, v. 1, 1959, p. 53-67, correl. table.—Critical evaluation in light of recent data on occurrences of

larger Foraminifera and worldwide planktonic foram zones.

West-Pacific stratigraphic correlation.—Nature, v. 186, No. 4730, June 25, 1960, p. 1039-1040.—**Globigerinoides bisphericus** zone on Saipan should have been dated as Tertiary **f** as the overlying assemblage of larger Foraminifera is Tertiary **f**, not **e**, in age.

GRADER, P., REISS, Z., and KLUG, K. Correlation of sub-surface Lower Cretaceous units in the southern coastal plain of Israel.—Israel Geol. Survey Bull. No. 28, Feb. 1960, p. 1-7, text figs. 1-4 (map, correl. chart, range charts).—Thirteen biostratigraphic units set up on about 70 species of Foraminifera that have limited ranges.

GRUNERT, BRIGITTE. Die Foraminiferen des im Tagebau Edderitz/Kreis Köthen aufgeschlossenen Rupeltonprofils unter besonderer Berücksichtigung der ökologischen und faziellen Wechselbeziehungen.—Freiberger Forschungshefte, No. C86, Paläontologie, March 1960, p. 5-49, text figs. 1-42 (graphs), tables 1-5.—Quantitative analysis of 42 species in a middle Oligocene well section of about 20 meters of light- and dark-banded clay. Relation between trace element concentration and number of specimens in 4 selected species is also shown graphically.

HAGN, HERBERT. Die stratigraphischen, paläogeographischen und tektonischen Beziehungen zwischen Molasse und Helvetikum im östlichen Oberbayern.—Geol. Bavarica, No. 44, 1960, p. 1-208, pls. 1-12, text figs. 1-10, table 1.—Microphotographs of assemblages from Campanian-Maestrichtian to Helvetian. **Bulimina truncana jacksonensiformis** n. ssp. is described from upper Lutetian.

HARKER, P., and THORSTEINSSON, R. Permian rocks and faunas of Grinnell Peninsula, Arctic Archipelago. —Geol. Survey Canada, Mem. 309, 1960, p. 1-89, pls. 1-25, text figs. 1-9, tables 1-7.—Part II, Permian fusulinids of Grinnell Peninsula by R. THORSTEINSSON, consists of descriptions and figures of 7 species, 4 new.

HAY, WILLIAM W. The Cretaceous-Tertiary boundary in the Tampico Embayment, Mexico.—Internat. Geol. Congress, Rept. 21st Sess. Norden, pt. V, Proc. sec. 5, Copenhagen, 1960, p. 70-77, text figs. 1-3 (range chart, diagrams).—Mendez-Velasco boundary, distinguishable by microfaunal content, coincides with the Maestrichtian-Paleocene boundary.

HENBEST, LLOYD G. Paleontologic significance of shell composition and diagenesis of certain Late Paleozoic sedentary Foraminifera.—U. S. Geol. Survey Prof. Paper 400-B, Sept. 30, 1960, p. 386-387.—**Serpulopsis** Girty, 1911, and **Apterrinella** Cushman and Waters, 1928, have been studied petrologically. The wall of **Serpulopsis** is composed of cemented detrital grains and the genus is thus a tolypamminid. In well preserved material the wall of **Apterrinella** is porcellaneous and, before alteration, is ornamented with honeycomb-like pits. **Pseudovermiporella** is transferred from the Algae to the family Ophthalmidiidae.

HOFFMANN, KARL, and MARTIN, GERALD P. R. Die Zone des **Dactylioceras tenuicostatum** (Toarcien, Lias) in NW- und SW-Deutschland.—Paläont. Zeitschrift, Band 34, Nr. 2, June 1960, p. 103-149, pls. 8-12, text figs. 1, 2 (chart, maps).—Ammonites are accompanied by well preserved microfaunas. Thirty-two species of Foraminifera, one new, recorded and illustrated.

HOFKER, J. Foraminifera from the Cretaceous of South-Limburg, Netherlands. XLIX. On another foraminifer from the Maestrichtian Tuff Chalk showing evidence of Danian age of that sediment.—Natuurhist. Maandblad, 49^{e} Jrg., Nos. 5-6, June 29, 1960, p. 58-60, text figs. 1-6.—**Alabamina midwayensis** Brotzen.

The taxonomic status of **Praeglobotruncana**, **Planomalina**, **Globigerinella**, and **Biglobigerinella**.—Micropaleontology, v. 6, No. 3, July 1960, p. 315-322, pls. 1, 2, text fig. 1 (diagram).—These genera are artificial concepts, corresponding to developmental stages of biologic units. The various stages of two such units are illustrated: **Globigerina caseyi** in the Albian and **G. aspera** from the Albian to Maestrichtian. A third unit, **G. aequilateralis** gens, began in the Danian and is not fully ended in the Recent.

HONJO, SUSUMU. A study of some primitive **Neoschwagerina** by a new serial section technique.—Jour. Fac. Sci. Hokkaido Univ., ser. 4, Geol. and Min., v. 10, No. 3, March 1960, p. 457-470, pls. 1-3, text figs. 1-8.

HOTTINGER, LUKAS. Über paleocaene und eocaene Alveolinen.—Eclogae Geol. Helvetiae, v. 53, No. 1, 1960, p. 265-283, pls. 1-21, table 1 (illustrated range chart), text figs. 1-3.—Zonation by alveolines. Photographs (thin sections) of many assemblages from middle Paleocene to Biarritzian are included.

JELETZKY, J. A. Youngest marine rocks in Western Interior of North America and the age of the **Triceratops**-beds; with remarks on comparable Dinosaur-bearing beds outside North America.—Internat. Geol. Congress, Rept. 21st Sess. Norden, pt. V, Proc. sec. 5, Copenhagen, 1960, p. 25-40, text figs. 1, 2 (correl. tables).—Planktonic Foraminifera confirm the placing of the Cretaceous/Tertiary boundary beneath the Danian.

JENKINS, D. GRAHAM. Planktonic Foraminifera from the Lakes Entrance oil shaft, Victoria, Australia.—Micropaleontology, v. 6, No. 4, Oct. 1960, p. 345-371, pls. 1-5, text figs. 1-10 (map, range chart, graphs, correlation chart).—Beautifully illustrated specimens from a closely sampled sequence of Miocene rocks provide convincing correlation with the Caribbean sequence. Forty-eight species and subspecies (6 species and 2 subspecies new) are included and form the basis for the establishment of 11 planktonic zones in Australia.

KALCHEVA, K. Calcarinidae of the Mastricht in Bulgaria (English summary).—Acad. Sci. Bulgarie, geol. instit., ser. paleont. v. 1, 1959, p. 107-113, pl. 1.

KECSKEMÉTI, T. Die Discocycliniden des südlichen Bakonygebirges.—Ann. Hist.-Nat. Mus. Nation. Hungarici, tom 51, 1959, p. 31-84, pls. 1-5, text figs. 1-28, map, tables 1, 2.—Twenty-three species, 2 new.

KLAUS, JEAN. Etude biométrique et statistique de quelques espèces de Globotruncanidés. 1. Les espèces du genre **Praeglobotruncana** dans le Cenomanien de la Breggia (Tessin, Suisse meridionale).—Eclogae Geol. Helvetiae, v. 53, No. 1, 1960, p. 285-308, text figs. 1-3.—Three species, including a newly named variety of one of the species.

KLING, STANLEY A. Permian fusulinids from Guatemala.—Jour. Paleontology, v. 34, No. 4, July 1960, p. 637-655, pls. 78-82, text figs. 1-7.—Nine species, 3 new.

KÖHLER, EDUARD. Les Orbitoïdes Crétacés de la zone des Klippes de la Vallée du Vah.—Slovensk. Akad. Vied, Bratislava, Geol. Sbornik, roc. 11, cislo 1, 1960, p. 67-82, pls. 1-4, tables 1-4.—Four species.

KRASHENINNIKOV, V. A. El'fidiidy Miotsenovykh Otlozhenii Podolii.—Akad. Nauk SSSR, Geol. Instit., Trudy, vyp. 21, 1960, p. 1-140, pls. I-IX, pls. 1-11, text figs. 1-24.—In the systematic part 22 species (8 new) of **Elphidium** are described and illustrated. Two

species (1 new) are included in **Canalifera** gen. nov. (type species **Elphidium eichwaldi** Bogdanovich) which is subdivided into the new subgenera **Canalifera** and **Criptocanalifera.** Morphology is illustrated.

KRINSLEY, DAVID. Trace elements in the tests of planktonic Foraminifera.—Micropaleontology, v. 6, No. 3, July 1960, p. 297-300, tables 1, 2.

KUEHN, OTHMAR. Neue Untersuchungen über die Dänische Stufe in Oesterreich.—Internat. Geol. Congress, Rept. 21st Sess. Norden, pt. V, Proc. sec. 5, Copenhagen, 1960, p. 162-169.—Foraminifera listed from the Danian.

KUSNETZOVA, K. I. Rod **Planularia** i ego novye Vidy iz Verkhnej Jury Russkoj Platformy.—Paleont. Zhurnal, No. 2, 1960, p. 17-34, pl. 2, text figs. 1-4, tables 1, 2.—Seven species of **Planularia,** 4 new and 3 new names, from the Upper Jurassic.

KUWANO, YUKIO. A Paleogene foraminiferal faunule from Osumi Peninsula, southern Kyushu, Japan.—Misc. Repts. Tokyo Instit. Nat. Resources, Nos. 52-53, March 15, 1960, p. 136-146, pls. 6-8, text fig. 1 (map), table 1.—A small fauna, mostly arenaceous with some planktonics, indicates an age between lower Paleocene and upper Eocene. Two spcies and one variety are new.

LEISCHNER, WINFRIED. Zur Mikrofazies kalkalpiner Gesteine.—Österreich. Akad. Wissenschaften, Math.-nat. Kl., Sitzungsber., Abt. I, Band 168, heft 8, 9, 1959, p. 839-882, pls. 1-5, text figs. 1-17.—Foraminifera facies in the Dogger and Malm.

LIPINA, O. A. Stratigrafija Turnejskogo Jarusa i Pogranichnykh Sloev Devonskoj i Kamennougol'noj Sistem Vostochnoj Chasti Russkoj Platformy i Zapadnogo sklona Urala.—Akad. Nauk SSSR, Geol. Instit. SSSR, Trudy, vyp. 14, 1960, p. 1-135, pls. 1, 2, text figs. 1-15, tables 1-4.—Includes descriptions of 4 species and 1 variety of **Plectogyra** (all new), 2 species of **Quasiendothyra,** and 2 of **Ammobaculites?** (1 new).

LUCZKOWSKA, EWA. Changes of homonymic names of some Foraminifera from the Polish Tortonian.—Ann. Soc. Geol. Pologne, v. 29, fasc. 4, Année 1959, 1960, p. 317-325, pl. 29, text figs. 1-4.—Three new names, two for varieties here raised to specific rank.

LUTZE, GERHARD F. Zur Stratigraphie und Paläontologie des Callovien und Oxfordien in Nordwest-Deutschland.—Geol. Jahrb., Band 77, July 1960, p. 391-532, pls. 26-46, text figs. 1-20.—About 75 species and subspecies of Foraminifera (2 species and 2 subspecies new) are described or recorded and illustrated. Ranges and abundance in several sections are plotted.

LYS, M. La limite Crétacé-Tertiaire et l'Eocène Inférieur dans le bassin de Majunga (Madagascar).—Internat. Geol. Congress, Rept. 21st Sess. Norden, pt. V, Proc. sec. 5, Copenhagen, 1960, p. 120-130, map.—Already-established zones are recognized in the Upper Cretaceous, Danian, Paleocene, and lower Eocene. Planktonic and benthonic assemblages are listed.

MACAROVICI, N., MARGINEANU, CARMEN, and CEHAN-IONESI, BICA. Distribution des Foraminifères sur la Plate-forme continentale du Nord-ouest de la Mer Noire (French résumé of Rumanian text).—Acad. Republicii Populare Romine, Hidrobiologia, 1, 1958, p. 33-54, tables 1, 2.—Quantitative analysis of 68 bottom samples between 5.5 and 56.5 meters shows a fauna limited to 9 species among which **Rotalia beccarii** and **Discorbis vilardeboana** are predominant.

MANGIN, JEAN-PHILIPPE. Réflexions sur la limite Crétacé-Tertiaire a propos du Domaine Pyrénéen.—Internat. Geol. Congress, Rept. 21st Sess. Norden, pt. V, Proc. sec. 5, Copenhagen, 1960, p. 145-149.—Major faunal changes occur between Maestrichtian and Danian. Little change occurs between planktonic Foraminifera assemblages of Danian and Montian.

MOROZOVA, V. G., and SUDARIKOV, YU. A. Upper Eocene Kerestinsk formation of the Salo-Ergeni Upland and its stratigraphic significance (in English translation).—Doklady Acad. Sci. USSR, v. 125, No. 1, March-April 1959, English translation, AGI, June 1960, p. 223-225, text fig. 1.—Three new species described by Morozova.

MYERS, DONALD A. Stratigraphic distribution of some Pennsylvanian Fusulinidae from Brown and Coleman counties, Texas.—U. S. Geol. Survey Prof. Paper 315-C, 1960, p. 37-53, pls. 15-24, text figs. 9, 10 (map, columnar section), table 1.—Illustrations of species tied in to a columnar section extending from Strawn group undifferentiated (in the **Fusulina** zone) up through Canyon and Cisco groups (in the **Triticites** zone). Correlation may be possible by comparing evolutionary stages.

NAGAPPA, Y. The Cretaceous-Tertiary boundary in the India-Pakistan subcontinent.—Internat. Geol. Congress, Rept. 21st Sess. Norden, pt. V, Proc. sec. 5, Copenhagen, 1960, p. 41-49, text fig. A (map).—A clear faunal change, indicating end of a cycle of deposition, marks the top of Maestrichtian beds. Succeeding beds, equivalent to Danian, contain a new fauna and indicate the beginning of a new cycle of deposition. The dying out and first appearances of several genera and species of Foraminifera, mostly planktonic, take place at the Maestrichtian-Danian boundary. Additional first appearances of some genera of larger Foraminifera occur in the Ranikot beds which are placed in upper Paleocene.

NEMKOV, G. I. The present members of Nummulitidae family and their life history (in Russian).—Biul. Moskov. obshch. ispyt. prirody, nov. ser., tom 65, otdel geol., tom 35, vyp. 1, 1960, p. 79-86, 1 pl.—Variation in **Operculina ammonoides.**

OBREGÓN DE LA PARRA, JORGE. El contacto Cretacico-Terciario y el Paleoceno de la Cuenca Sedimentaria de Tampico-Misantla.—Internat. Geol. Congress, Rept. 21st Sess. Norden, pt. V, Proc. sec. 5, Copenhagen, 1960, p. 78-81, chart, map.—A **Globigerina** assemblage identical with that in the type Danian occurs in the base of the Velasco-Chicontepec group.

PAPP, ALEXANDER. Über das Vorkommen von **Miogypsina** (Foraminifera) in der Südlichen Slovakei (CSR).—Slovensk. Akad. Vied, Bratislava, Geol. Sbornik, roc. 11, cislo 1, 1960, p. 59-66, text fig. 3.

PESSAGNO, EMILE A., JR. Thin-sectioning and photographing smaller Foraminifera.—Micropaleontology, v. 6, No. 4, Oct. 1960, p. 419-422, pls. 1, 2, text figs. 1-3.

PHLEGER, FRED B. Ecology and distribution of Recent Foraminifera.—The Johns Hopkins Press, Baltimore, 1960, 297 p., 11 pls., 83 text figs.—An invaluable textbook integrating the major works in this field.

Sedimentary patterns of microfaunas in northern Gulf of Mexico, in Recent sediments, northwest Gulf of Mexico, a symposium summarizing the results of work carried on in Project 51 of the American Petroleum Institute, 1951-1958.—Am. Assoc. Petroleum Geologists, Tulsa, Sept. 1960, p. 267-301, pls. 1-6, text figs. 1-16 (maps, graph, range chart), tables 1-4.—Cores show an upper (modern) planktonic fauna with low-latitude species and a lower (late glacial) planktonic fauna with mixed mid- and low-latitude species. The distinction between these two faunas forms an important level of reference. Illustrations are included of the Holocene and pre-Holocene planktonic faunas and of Foraminifera assemblages characteristic of marsh, inner lagoon, lower lagoon, beach, fluvial marine, deltaic marine, inner continental shelf, upper continental slope, and lower slope and deep sea.

POKORNY, VLADIMIR. Nové poznatky o mikrostratigrafii tercieru Zdanickeho lesa.—Casopis pro Min. Geol., sv. 5, cis. 3, 1960, p. 296-305, pl. 16, text figs. 1-5.—Eocene Foraminifera.

POZARYSKI, W., and POZARYSKA, K. On the Danian and lower Paleocene sediments in Poland.—Internat. Geol. Congress, Rept. 21st Sess. Norden, pt. V, Proc. sec. 5, Copenhagen, 1960, p. 170-180, text figs. 1, 2 (columnar sections, map).—The uppermost surface of the Maestrichtian shows evidence of an interruption in sedimentation in the form of hard ground overlain by a thin bed in which Danian microfauna is associated with upper Maestrichtian molluscan fauna. No sedimentary discordance is found between Danian and Paleocene.

REISS, Z. Structure of so-called **Eponides** and some other rotaliiform Foraminifera.—Israel Geol. Survey, Bull. No. 29, June 1960, p. 1-29, pls. 1-3, text figs. 1, 2.—**Eponides** is suppressed because (a) its type species, **Nautilus repandus** Fichtel and Moll, is a nomen dubium and (b) **Pulvinulina repanda** Brady 1884 (upon which Cushman's redescription of the genus was based) is congeneric with **Poroeponides.** Species traditionally placed in **Eponides** fall into monolamellid and bilamellid groups. **Eponidopsis** gen. nov. (type species **Eponides lornensis** Finlay), differing from **Poroeponides** in lacking multiple apertures, and **Neoeponides** gen. nov. (type species **Rotalina schreibersii** d'Orbigny) both have bilamellid wall structure. Taxonomic position of other species is discussed. Numerous structural features of Foraminifera tests are defined, illustrated and discussed.

REYMENT, R. A. Notes on some Globigerinidae, Globotruncanidae and Globorotaliidae from the Upper Cretaceous and Lower Tertiary of western Nigeria.—Records Geol. Survey Nigeria, 1957 (1960), p. 68-86, pls. 15-17, text figs. 1, 2 (map, outline drawings).—Thirteen species from the Cretaceous-Tertiary transition.

Notes on the Cretaceous-Tertiary transition in Nigeria.—Internat. Geol. Congress, Rept. 21st Sess. Norden, pt. V, Proc. sec. 5, Copenhagen, 1960, p. 131-135, map.—Strongly defined differences in faunas are noted at the Cretaceous-Tertiary boundary. No Danian is noted.

SAID, RUSHDI. Planktonic Foraminifera from the Thebes formation, Luxor, Egypt.—Micropaleontology, v. 6, No. 3, July 1960, p. 277-286, pl. 1, text fig. 1 (columnar section), tables 1, 2.—Descriptions and illustrations of 14 species (1 new) from the Thebes formation of Ypresian age and the Esna shale of Landenian age.

SARTONI, SAMUELE, and CRESCENTI, Uberto. La zona a **Palaeodasycladus mediterraneus** (Pia) nel Lias dell'Appennino Meridionale.—Giornale Geol., ser. 2, v. 27, 1956 (1960), p. 1-25, pls. 1-3, text figs. 1, 2 (map, columnar sections).—Five species of larger Foraminifera recorded and illustrated in thin section.

SCHAUB, HANS. Über einige Nummuliten und Assilinen der Monographie und der Sammlung d'Archiac.—Eclogae Geol. Helvetiae, v. 53, No. 1, 1960, p. 443-451, pls. 1-4, text fig. 1.—Illustrations and descriptions of additional material of **Nummulites couisensis** and **Assilina leymeriei.**

SCHEIBNEROVA, VIERA. Some notes on the genus **Praeglobotruncana** Bermudez from the Kysuca beds of the Klippen-Belt.—Slovensk. Akad. Vied, Bratislava, Geol. Sbornik, roc. 11, cislo 1, 1960, p. 85-90, text figs. 4, 5.—**Praeglobotruncana oraviensis** n. sp. and **trigona** n. ssp. from the lower Turonian.

SCHELL, W. W., and CLARK, DAVID L. Lower Triassic Foraminifera from Nevada.—Micropaleontology, v. 6, No. 3, July 1960, p. 291-294, pl. 1, text fig. 1 (columnar section).—Five species, 2 new, found in acid residues from limestone.

SEIBOLD, EUGEN, and SEIBOLD, ILSE. Foraminifera in sponge bioherms and bedded limestones of the Malm, south Germany.—Micropaleontology, v. 6, No. 3, July 1960, p. 301-306, text figs. 1-15.—Summary of earlier paper published in Stuttgart.

SHADMON, A. The Bi'na Limestone.—Israel Geol. Survey Bull. No. 24, Dec. 1959, p. 1-4, pl. 1, text figs. 1, 2 (map, range chart with micropaleontological determinations by Z. REISS).—Ranges are indicated for about 20 species of Foraminifera within this 60-meter thick formation of Cenomanian-Turonian age. Microfauna indicates shallow water deposition.

SHIRAI, TAKEHIRO. New genus and species of Foraminifera from the Pliocene formation, southwestern Hokkaido.—Jour. Fac. Sci. Hokkaido Univ., ser. 4, Geol. and Min., v. 10, No. 3, March 1960, p. 537-543, pls. 1, 2.—**Discotruncana** n. gen. (genotype **D. japonica** n. sp.), related to **Planulinoides.** Descriptions and illustrations of 8 new species.

SMITH, PATSY BECKSTEAD. Fossil Foraminifera from the southeastern California deserts.—U. S. Geol. Survey Prof. Paper 400-B, Sept. 30, 1960, p. 278-279.

STANCHEVA, M. **Lenticulina** and **Robulus** of the Cretaceous and Tertiary in north-eastern Bulgaria (English summary).—Acad. Sci. Bulgarie, geol. instit., ser. paleont., v. 1, 1959, p. 115-227, pls. 1-16, text figs. 1-5, table 1.—Descriptions and illustrations of 74 species and varieties, 18 in **Lenticulina** (2 new) and 56 in **Robulus** (10 new). Discussion of nature and significance of apertural distinctions between **Lenticulina** and **Robulus.**

Microfaunistic characteristics of the Tortonian in northwestern Bulgaria (English summary).—Acad. Sci. Bulgarie, geol. instit., ser. paleont., v. 1, 1959, p. 229-319, pls. 1-11, table 1.—Descriptions and illustrations of about 100 species and varieties, none new. Occurrence of about 150 species and varieties noted in four zones which are generally correlative with those of the Vienna Basin.

Eocene Foraminifera of Pleven County (English summary).—Acad. Sci. Bulgarie, geol. instit., ser. paleont., v. 1, 1959, p. 321-359, pls. 1-5, distribution and abundance chart.—Middle Eocene assemblage from the **Globorotalia aragonensis** zone.

UCHIO, TAKAYASU. Planktonic Foraminifera off the coast of Boso Peninsula and Kinkazan, Japan (in Japanese with English abstract).—Jour. Oceanographical Soc. Japan, v. 15, No. 3, Oct. 1959, p. 137-141, text fig. 1 (map), tables 1, 2.—Analysis of 17 plankton tows made in the warm Kuroshio current.

Ecology of shallow-water Foraminifera off the coast of Noboribetsu, southwestern Hokkaido, Japan.—Publ. Seto Marine Biol. Lab., v. 7, No. 3, Dec. 1959, p. 295-302, text figs. 1-3 (maps, graphs), tables 1, 2.—Quantitative analysis of 11 sediment samples between 19 and 80 meters. Thirty-nine species are involved. Four depth assemblages are recognized.

Biological results of the Japanese Antarctic Research Expedition. 11. Planktonic Foraminifera of the Antarctic Ocean.—Spec. Publ. Seto Marine Biol. Lab., May 31, 1960, p. 1-10, pl. 1, text fig. 1 (map).—**Globigerina** sp. cf. **G. bulloides** is found in plankton-net samples. **G. dutertrei** (dominant) and **G. pachyderma** (minor) are found in bottom samples that are dated by C^{14} as about 5,500 years old. **G. dutertrei** of Ovey and Brady (not d'Orbigny) may be the adult form of **G. pachyderma,** and both are only questionably planktonic.

Biological results of the Japanese Antarctic Research Expedition. 12. Benthonic Foraminifera of the Antarctic Ocean.—Spec. Publ. Seto Marine Biol. Lab., May 31, 1960, p. 1-20, pl. 1, text figs. 1-3 (maps, diagrams), tables 1-3.—Quantitative analysis of 11 sediment samples between 350 and 2,480 meters. Nearly 200 species are involved; 11 are found living in one sample. Three depth assemblages are recognized and illustrated.

VAN DER VLERK, I. M. Modification de l'ontogénèse pendant l'evolution des Lépidocyclines (Foraminifères).—Bull. Soc. géol. France, ser. 7, tome 1, 1959, p. 669-673, text figs. 1-4.—Evolution in two lines and migration from America to Europe and northern Africa and thence to Asia, Australia, and southeastern Africa.

WALTON, WILLIAM R. Diagnostic faunal characteristics on and near a barrier island, Horn Island, Mississippi.—Trans. Gulf Coast Assoc. Geol. Soc., v. 10, 1960, p. 7-24, text figs. 1-5 (maps, graphs), tables 1-3.—Quantitative analysis of Foraminifera (about 70 species) from a profile transverse to a barrier island reveals existence of 9 environmental zones that are recognizable through their species composition. Other features also serve to distinguish the zones: faunal diversity, population size, character of the fauna, and faunal dominance. By these features, as well as by close spacing and abruptness of faunal boundaries, nearshore-barrier islands may be recognized in the subsurface.

YANSHIN, A. L. Stratigraphic position of the Danian stage and the problem of the Cretaceous-Paleogene boundary.—Internat. Geol. Congress, Rept. 21st Sess. Norden, pt. V, Proc. sec. 5, Copenhagen, 1960, p. 210-215.—Summary of evidence for and against placing Danian in Paleogene; planktonic Foraminifera favor it while benthonic Foraminifera and many other groups do not.

ZIEGLER, JOSEPH H. Die Assilinen des Eozäns vom Kressenberg in Oberbayern.—Geol. Bavarica, No. 44, 1960, p. 209-231, pls. 1-4, text figs. 1-12 (outline drawings, graphs).—Descriptions and illustrations of nine species.

RUTH TODD