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78. ECOLOGICAL STUDY OF THE FORAMINIFERA OF MASON INLET, NORTH CAROLINA

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ABSTRACT—Mason Inlet, North Carolina, is a lagoonal marsh area with warm-temperate water, the salinity ranging from fresh to salt water. Nine collecting stations comprise an ecological gradient across the environment. Forty-two species of Foraminifera are recorded from the inlet, ranging in their affinities from brackish water to open-sea facies. Several extensions of range are recorded, both northward and southward. Substratum conditions apparently control the distribution of Foraminifera within the inlet. Clean, fine sand provided the largest faunal populations. A depauperate assemblage was found in an organic, argillaceous substratum. The largest population of arenaceous forms was found at the channel through the off-shore bar.

INTRODUCTION

An ecological study of the Foraminifera of Mason Inlet, North Carolina, was undertaken in part as a basis for a paleontological understanding of the assemblages of waters of lowered salinity, and in part to supplement similar studies in Texas and Louisiana (Kornfeld, 1931; Post, 1951), New York Harbor (Shupack, 1934), and Massachusetts (Phleger and Walton, 1950). The area was selected because of its accessibility and the availability of field facilities. The only previous work on this general area (Hadley, 1936), was not of an ecological nature.

Current interest in foraminiferal ecology is evidenced by the increasing number of publications on the subject. Investigations within the past half century have somewhat coordinated previous correlation; however, there is need for additional information from new localities to supplement data from widely scattered areas. Mason Inlet, North Carolina, provides one more point of control along the Atlantic coast through which zonations may be correlated.

Results of ecological studies conducted at Barnstable, Massachusetts (Phleger and Walton, 1950) and along the southern coast of Japan (Hada, 1936, 1937, 1939) compare favorably with this study, in which a complementary foraminiferal assemblage was found under similar ecological conditions. Forty-two species constitute the typical assemblage of Mason Inlet.

The geographical ranges of three species have been extended as follows: *"Ammobaculites" cassis* (Parker), southward from Cape Cod, Massachusetts; *Planulina caribaea* Cushman, northward from Florida; and *Planorbulina mediterranensis* Orbigny, northward from Florida.

One new species is described, *Elphidium frizzelli*, named in honor of Don L. Frizzell. The holotype will be deposited in the collection of the U. S. National Museum, Washington, D. C., as will the other specimens illustrated here.

Acknowledgments.—The project was made possible by a Research Fellowship at the Missouri School of Mines and Metallurgy, Rolla, Missouri, and through the facilities of the Department of Geology of that institution. Sankey L. Blanton, Jr., Southern Methodist University, Dallas, Texas, has given me the advantage of his extensive knowledge of the area, as well as furnishing equipment and field assistance. His initial interest in the fauna of Mason Inlet brought attention to the feasibility of the project. In addition, assistance by Miss Ruth Todd, U. S. National Museum, Washington, D. C., has been greatly appreciated. The study was made under the guidance of Don L. Frizzell.

LOCALITY DESCRIPTIONS

Description of Mason Inlet, North Carolina

Middle Sound is a segment of the system of bars and lagoons that is typical, in its general features, of most of the North Carolina coast (Fig. 1). It includes three inlets, the center of which is Mason Inlet. Three main physiographic features are present: (1) an offshore bar which parallels the coast, (2) a salt marsh, with mud flats and oyster beds, and (3) the shore. Many channels connect the inlets and the interior of the marsh. A dredged Inland Waterway is maintained along the shore, providing the deepest water inside the bar. Small fresh water creeks enter the marsh and provide harbors such as Mason Inlet.

Mason Inlet, the central portion of Middle Sound, is situated 13 miles east of Wilmington, North Carolina, on U. S. Highway 17. It is a salt marsh, approximately 1½ miles long and averaging 1 mile in width, consisting in its upper reaches of the meanders of Page Creek and a shallow elongate bay filled with oyster beds.

The intermediate area between Wilmington and the inlet has a gently rolling surface, sustaining various marsh grasses and reeds in the low lands and tall, straight Southern Pines along the ridges. These low, pine covered ridges, about ten feet high, parallel the existing offshore bars of the coast. S. L. Blanton, Jr. (personal communication), who has studied the bars in detail, regards these ridges as remnants of ancient offshore bars.

The flat land between the highway and the inlet is a fresh water swamp. Small, but deep, water filled de-

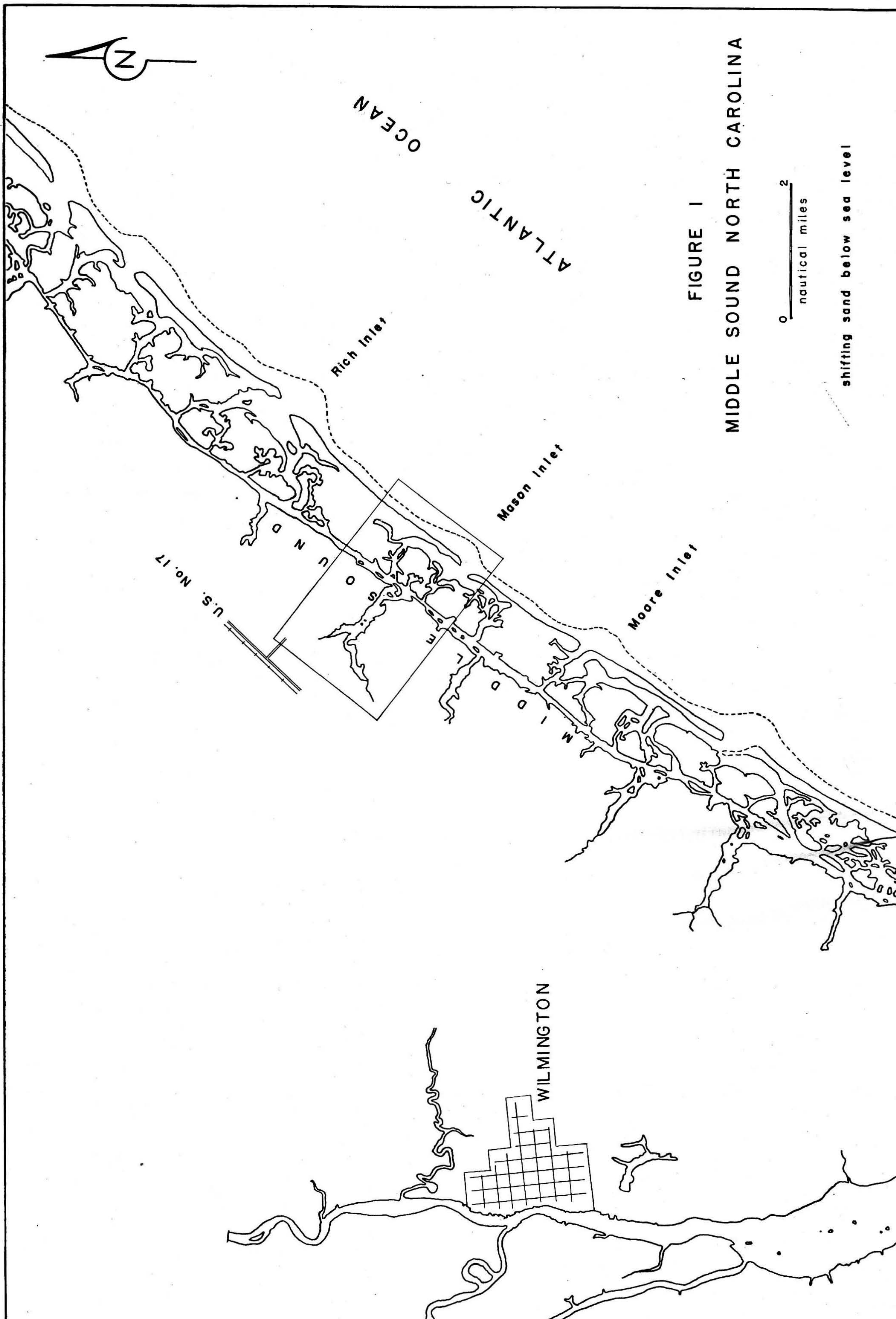


FIGURE I
MIDDLE SOUND NORTH CAROLINA

pressions are surrounded by a mass of vegetation which sustains an abundance of wild life. Salinity is variable in the upper reaches of Page Creek.

The offshore bar in this locality trends northeasterly, and is the outer limit of Mason Inlet. The bar rises about thirty feet above sea level. It consists of wind blown sand dunes, with thick cross-bedded sand showing segregation of the dark minerals into thin stratified bands. Vegetation is sparse and variable, its distribution due primarily to wind action. The seaward side of the bar slopes gently to a beach approximately one hundred yards wide. The landward side of the bar is irregular.

The area between the Inland Waterway and the offshore bar consists of intertidal mud flats and low islands. These islands are predominantly old oyster beds which support thick growths of rough marsh grasses and reeds causing the area to become a swampy jungle in the late summer. Channels between the islands are sporadic, due to filling of the area by shifting sand. Two main channels connect the break in the offshore bar and the waterway. The major channel extends north from the break in the bar along the landward side, then turns west directly to Mason's dock (Station 3). The depth of the water varies in this channel from a few feet to four fathoms and is not suitable for navigation throughout, except by outboard motorboat. The minor channel winds east from the break in the bar and joins the waterway south of Mason's dock. This channel is variable in width and depth, and navigation is hazardous except by small boat. Shifting sands have filled in the previously existing channel and it therefore is called the secondary channel by fishermen.

The shore line of Mason Inlet consists primarily of a low sandy ridge, which rises approximately 15 feet above sea level. Small narrow beaches, 10 to 30 feet in width, extend seaward from the hill in some local areas where erosion is active. The irregular surface of the hill is covered by plant life including; grasses, vines, shrubs, and a variety of large trees. S. L. Blanton, Jr. (personal communication), believes the hill to be the youngest of the ancient offshore bars. Evidence supporting this belief was observed in an investigation of the region by the writer.

The drainage of Middle Sound is variable. Surface water drains through creeks in shallow depressions, and empties into the marsh behind the bar. The major inflow of fresh water into Mason Inlet is from Page Creek. The direction and amount of fresh water penetration into the marsh are functions of seasonal rainfall and channel filling. At the time of sampling (March, 1950), fresh water currents were visible at the surface. These passed east from the mouth of Page Creek to Station 3 (Fig. 2), then south toward Station 5 along the Inland Waterway. This is the normal trend of the fresh water currents (S. L. Blanton, Jr. personal communication).

Since the date of sampling, the writer has been advised by Mr. Blanton of recent current trends which have altered the fresh water passage. Present currents (August, 1950), pass from the mouth of Page Creek toward Station 4, then veer northeast up the Inland Waterway. This change in the direction of flow apparently is due to channel filling south and east of Station 5.

Location and Description of Collecting Stations

Samples were collected on March 16-17, 1950, by Sankey L. Blanton, Jr. and D. N. Miller, Jr. The localities are described as follows:

Sta. 1. Page Creek, 1½ miles upstream from Mason's house, where stream narrows to 100 feet. *Depth*: less than 1 fathom. *Water*: clear, clean. *Salinity*: low. *Substratum*: sandy mud; very fine, well sorted, quartz sand; containing an abundance of brown organic debris, plant remains, large diatoms, ostracods, micro-gastropods and pelecypods. Oyster beds abundant.

Sta. 2. Page Creek, about 350 yards west of Mason's dock, in front of frame house on north shore. *Depth*: less than 1 fathom. *Water*: clear. *Salinity*: low. *Substratum*: sandy mud; predominantly oyster shell fragments and very fine, quartz sand; with an abundance of marine plants and ooze, echinoid spines, ostracods, gastropods, and pelecypods. Oyster beds abundant.

Sta. 3. Beach sand, from the landward side of the lagoon, in front of house owned by S. L. Blanton. *Water*: turbid, quiet, influenced only slightly by channel currents. *Salinity*: subnormal. *Substratum*: sandy mud; very well sorted, silty sand and shell fragments; containing very little plant remains.

Sta. 4. In the center of the intersection of the Inland Waterway and the major inlet channel on the east side. *Depth*: 1 to 2 fathoms. *Water*: clear, clean. *Salinity*: subnormal. *Substratum*: clayey sand; firmly packed, gray to black, highly organic; devoid of visible plant remains and mega-fauna. Intra-tidal currents pass through this channel leaving it with a scoured appearance.

Sta. 5. At the intersection of the secondary channel and the Inland Waterway, on the east side, approximately 300 yards southwest of Blanton's house. *Depth*: 2 to 3 fathoms. *Water*: turbid but quiet. *Salinity*: subnormal. *Substratum*: silty sand; loosely packed, tan, very fine, well sorted, quartz sand; containing only a small amount of organic debris, and supporting an abundance of molluscan forms and ostracods.

Sta. 6. Intersection of the major channel and the main tributary outlet, where the channel turns land-

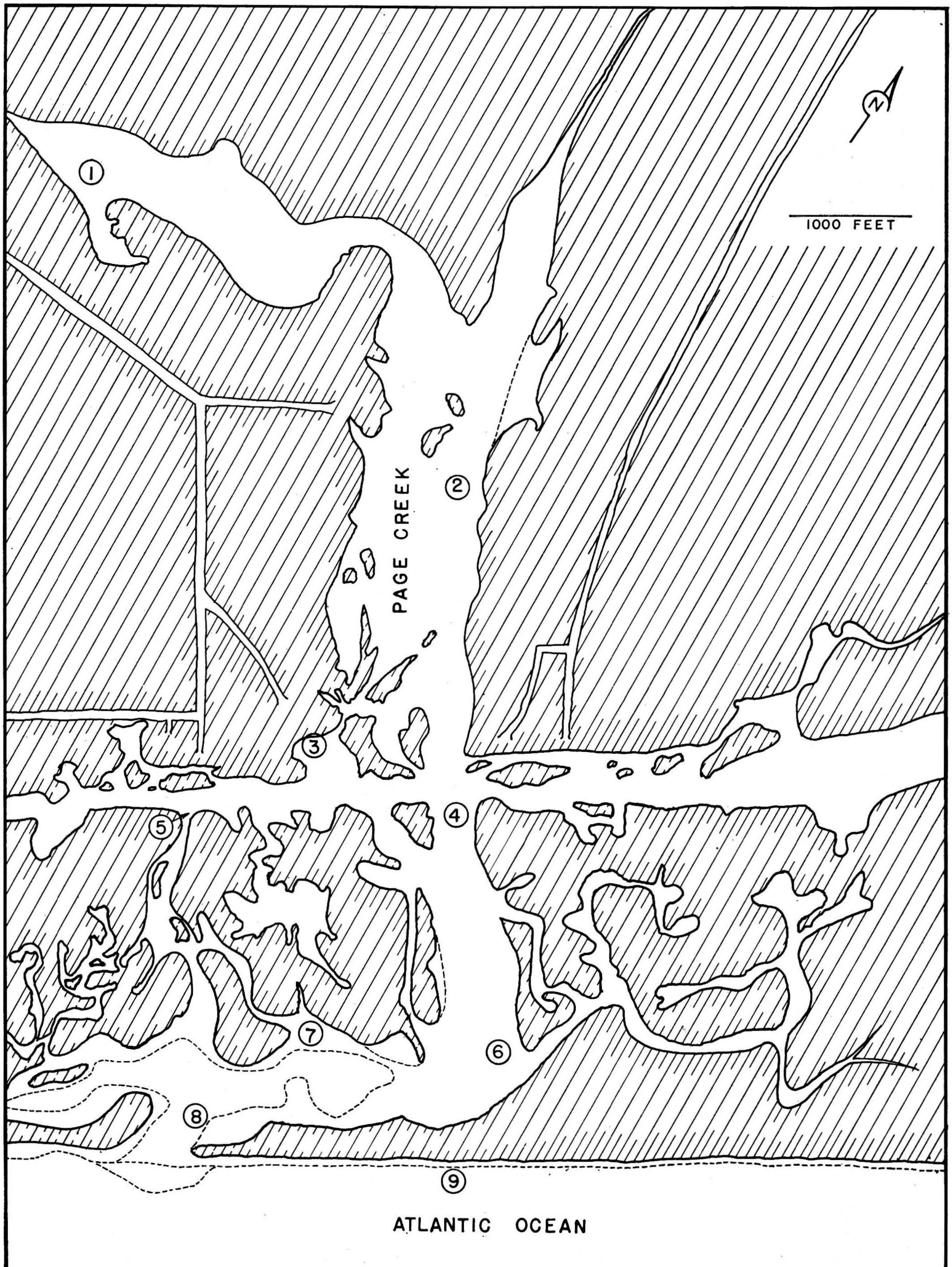


Figure 2. Detailed map of Mason Inlet, North Carolina, showing sample location.

ward from the bar. *Depth*: 2 to 3 fathoms. *Water*: turbid, quiet. *Salinity*: subnormal. *Substratum*: silty sand; gray, well sorted; containing only a minor amount of organic debris and supporting an abundant micro-fauna.

Sta. 7. On the west side of the major channel at the mouth of the creek, approximately 1000 feet north-northeast of the break in the bar. *Depth*: less than 1 fathom. *Water*: clear, clean. *Salinity*: normal. *Substratum*: sand; clean, tan, very well sorted, very fine quartz sand; containing only a small amount of organic debris, but sustaining an abundance of micro-organisms including; diatoms, ostracods, pelecypods, and gastropods.

Sta. 8. Approximately 400 feet landward from the break in the offshore bar. *Depth*: 1 fathom. *Water*: swift during tidal periods, highly turbid. *Salinity*: normal. *Substratum*: sand; firm, gray, fine to medium, quartz sand; containing no visible plant life and only a minor amount of shell fragments.

Sta. 9. Beach sample from the seaward side of the offshore bar, in front of the Army Lookout Station and approximately 2500 feet northeast of the break in the bar. *Water*: turbid. *Salinity*: normal. *Substratum*: sand; a normal beach sand; containing an abundance of shell fragments and well sorted, very fine, quartz sand.

ECOLOGY

Method of Sampling

The area was sampled at the locations described in the preceding and shown in Fig. 2. A dredge (Fig. 3) was used for bottom sampling. Littoral samples were taken at low tide. Salinity was estimated by taste and recorded as low, subnormal, and normal. Chemical analyses of the water were not made because of insufficient time, and no information is available on the salinity of this region.

The dredge consists of three parts: (1) a flanged octagonal lip, made from 8-gauge steel; (2) a piece of iron pipe, 4 inches in diameter and 15 inches long, to which the lip is welded; and (3) a butt plate, made from a thread protector, with 1/16 inch perforations in the backing. The dredge weighs about 15 pounds and the total cost when scrap material is used should not exceed $3.00. Although this dredge was designed independently for the purpose of sampling Mason Inlet,

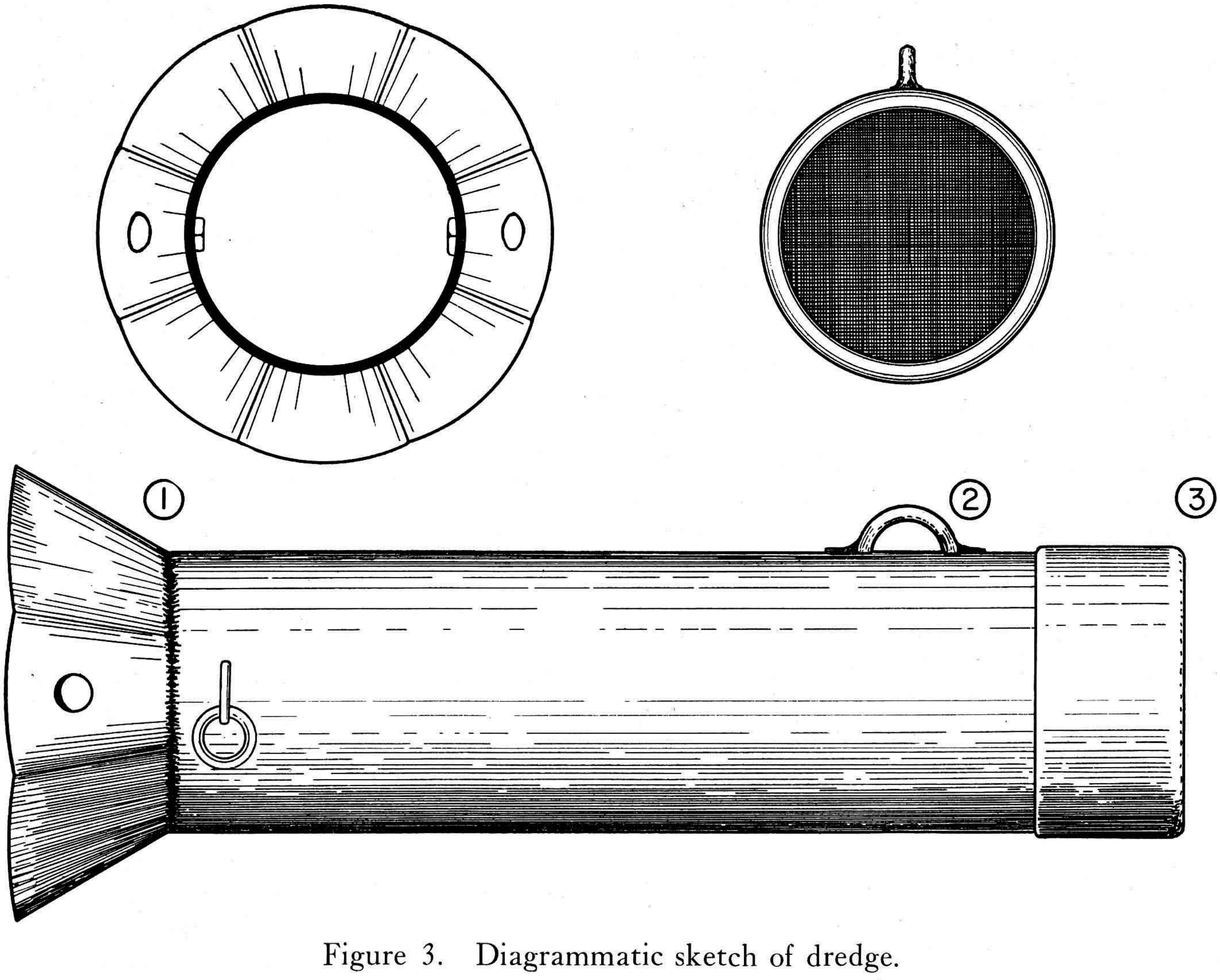


Figure 3. Diagrammatic sketch of dredge.

it is similar to that previously used by Shupack (1934) in sampling western Long Island Sound and New York Harbor.

Treatment of Samples

A sample of approximately 1000 grams, from each station, was air dried and set aside for sedimentary analysis. The remainder was washed and decanted onto a 200 mesh sieve. As a considerable number of foraminifera tended to float, their retention was required. The sample then was dried, and concentrated by carbon tetrachloride flotation. The concentrates were screened and picked, and distribution slides of Foraminifera were prepared.

Nomenclature of Sedimentary Particles

An attempt has been made in the preceding to use terminology that will be readily understood both by geologists and biologists. Sedimentary analysis, however, requires different definition of some grain size units. Terms such as "mud flat" and "sand" have been used to describe ecological conditions, because they convey the most appropriate meaning. The following descriptions and data, however, are based upon Wentworth's definitions and classifications of grain sizes (Wentworth, 1922).

Sedimentary Analysis

The unpicked fraction, 1000 grams, was quartered to a representative sample of 100 grams and sieved on nested screens. Tyler screens, with openings most closely agreeing with Wentworth's classification of grain sizes, were used with the Ro-Tap mechanical shaker. Table 1 shows the various allocated percentages of the material by weight, which was left on the screen after shaking. Care should be exercised in the evaluation of these analyses, on a weight basis, inasmuch as shell fragments constitute nearly 100 per cent of the material coarser than 0.246 mm. In every case, material finer than 0.246 mm. and coarser than 0.124 mm. constitutes a conspicuous modal class. It is the finer material, however, less than 0.124 mm., that is of importance in this study. This material is a very fine sand composed almost entirely of quartz. A microscopic examination of the heavy minerals has shown that tourmaline, zircon, and garnet are common.

Summary of Sedimentary Factors

The accumulated detritus of the lagoon consists of silt, sand, and shell fragments, combinations of which form the "mudflats" and sandy substratum of the marsh. A sandy facies occurs in the channels. At Station 8, the sand is unconsolidated and free to shift with every tidal change. Station 4, unlike the others, contains 5.7% clay size material which acts as a binder in producing a tough, indurated substratum, free from ooze and soft "muds."

Oyster beds within the inlet are abundant and constitute nearly 100% of the island foundations. Protected pools in and about the oyster beds contain silt and very fine sand. Irregular growth of the oyster beds is directly dependent upon the stability of the existing bar. Seasonal variations disrupt deposition throughout the inlet.

The origin of the sediments is diverse. Most of the material is brought in from the mouth of the inlet by wave action; the remainder is derived from the shore. Channel filling, at the break in the offshore bar, is deltaic in structure. The foreset beds, however, face the shore. Accumulated sands have developed a submerged shoal, approximately 250 yards off shore, which parallels the existing bar. The accumulation is visible and has become somewhat enlarged in the past few years. This furnishes the source for the delta-like channel filling.

TABLE 1

Sedimentary analyses of samples from Mason Inlet, showing percentages by weight (100 gram samples; Tyler screens; separation by Ro-Tap).

Screen sizes in mm.	+ 1.980	+ 0.991	+ 0.495	+ 0.246	+ 0.124	+ 0.065	− 0.065
U. S. Series Equivalent No.	10	18	35	60	120	230	− 230
Station							
(1)	0.67	2.27	2.29	16.84	72.57	4.98	0.11
(2)	6.46	6.90	3.25	14.35	59.35	10.02	1.36
(3)	1.72	1.55	3.59	18.60	59.50	11.96	3.04
(4)	0.24	0.11	0.70	19.00	64.88	9.38	5.70
(5)	0.30	0.66	1.34	18.07	77.51	2.05	1.06
(6)	——	0.34	1.37	9.81	72.12	12.35	4.01
(7)	0.39	0.32	0.33	4.94	88.91	4.90	0.21
(8)	0.20	0.23	2.62	19.81	67.73	7.86	1.53
(9)	0.49	0.19	0.40	6.49	88.63	3.37	1.07

Other Environmental Factors

Salinity determination was very crude. Accurate determination of salinity control on foraminiferal populations would be desirable, although similar studies have shown that minor changes in salinity do not influence the populations (Shupack, 1934). The temperature of the water was not measured during this investigation, but the water of the lagoon is warm-temperate. The amount of temperature variation between stations is believed to be negligible. Depth of light penetration was not measured. The turbidity of the water at the surface was recorded, but no conclusions may be made concerning its importance.

Many environmental factors may influence the Foraminifera of Mason Inlet. From available evidence (Table 2), and in the absence of accurate physical-chemical data necessary to evaluate these factors, some conclusions may be drawn: Substratum conditions appear to have the most effect on faunal population. Shifting sands produced the highest arenaceous/calcar-

TABLE 2. ECOLOGIC DATA FROM SAMPLE LOCATIONS

Station	Depth in fathoms	Nature of the water	Salinity	Substratum: Description	Substratum: % finer than 0.124 mm.	Micro-fauna other than foraminifera	Number of foraminiferal species	Flora	Remarks
1	0-1	clear, clean	low	Very fine sandy silt with abundant organic remains	5.09	Large diatoms, ostracods, micro-gastropods, pelecypods	21	Abundant, brown, organic, debris; plant remains	Taken from deltaic deposit of fresh water creek, in hole between oyster beds
2	0-1	clear	low	Fine, sandy, mud with abundant oyster shell fragments	11.38	Echinoid spines, ostracods, gastropods, pelecypods	18	Abundant plant remains ooze, algae	Taken in sandy channel between oyster beds
3	beach	turbid, quiet	subnormal	Sandy, silty, mud with abundant shell fragments	15.00	none	13	Very little plant remains and algae	Littoral beach sand, influenced at high tide by wave action
4	1-2	clear, clean	subnormal	Organic, clayey, sand	15.08	Fragments of pelecypods, and gastropods	22	none	Scoured channel due to intertidal currents, faunas depauperate and dark colored
5	2-3	turbid, quiet	subnormal	Silty sand	3.11	Abundant ostracods, pelecypods, gastropods, echinoids, diatoms	37	Very little plant remains	This station probably influenced by the deep channel of the Inland Waterway
6	2-3	turbid, quiet	subnormal	Silty sand	16.36	Large diatoms, ostracods, gastropods, pelecypods, echinoid spines, sponges	35	Very little plant remains	Basin, influenced by 3 currents; 2 are fresh water, 1 saline
7	0-1	clear, clean	normal	Very fine sand	5.11	Diatoms, ostracods, pelecypods, gastropods	29	Very little plant remains	Taken adjacent to transgressing sandy shoal
8	1-2	turbid, swift	normal	Fine to medium sand	9.33	none	17	none	Taken from channel at the break in the off-shore bar; turbulent during tidal periods
9	beach	violent wave action	normal	Fine sand with abundant shell fragments	4.44	none	13	none	Taken from unconsolidated sandy beach influenced by violent wave action

eous ratio for Foraminifera. Compact, organic, argillaceous sands produced depauperate fauna. Fine, clean sands carried the most abundant populations.

Reworked Foraminifera

A number of reworked fossils have been encountered in the samples, including *Gümbelina* spp. (some striate) and *Eponides frigida* var. *calida* Cushman and Cole. The source of these is not apparent, and they have been ignored in this study.

Summary

Mason Inlet is a brackish water environment, characterized by nearly fresh water in the upper reaches of Page Creek and normal salinity at the bar. At the time of sampling, the tide was approximately 0.84 meters (about the minimum). A maximum tide of 1.05 meters (U. S. Coast and Geod. Surv. Tide Tables, East Coast, 1950) occurred in July, 1950. Seasonal changes affect the area, through changing currents, by alternately filling and scouring the channels.

No sharply defined faunal zones have been shown by this study. However, samples collected at stations with similar ecological conditions contain correlative assemblages. Station 8 (at the break in the offshore bar) stands alone in having a predominance of arenaceous forms and lacking miliolid species. Stations 5 and 6 are similar in all respects except for slight differences in the texture of the substratum. Their assemblages are nearly identical. Station 9 (beach sample, open ocean) compares nearly equally well with a sample from Kure Beach (south of Wilmington).

Samples (Stas. 1, 2, 5 and 6) containing an abundance of diatoms, gastropods, pelecypods, and other micro-organisms contain large foraminiferal populations. Organic ooze and gelatinous muds did not exist to any great extent where large faunal assemblages were found. Clean, loose, fine sand, uncontaminated by organic debris provided the maximum number of specimens. Littoral samples (Stas. 3 and 9) carried smaller assemblages than the others.

Of the nine stations studied in detail, one (Sta. 4) carries abnormally small Foraminifera. The increased current, acting on a compacted substratum of organic, argillaceous sand, provides the conditions under which the population exists. Anerobic conditions in the organic clay (evidenced by a strong smell of hydrogen sulphide) have provided a substratum unsuited to normal growth. Many of the specimens contained pyrite grains which are visible in the transparent chambers. These contrast with specimens collected from other stations, that are for the most part of normal size and devoid of pyrite.

Specimens of *Triloculina brevidentata* collected from Stations 1, 3, 4, 5, 6, and 7 are characteristically small, ranging from 0.40 to 0.43 mm. in length. Normal specimens, reported from other localities, typically range from 1.10 to 1.25 mm. Whether this is complete depauperization of the population or an undescribed variety is not known. Similarly, specimens of *Globigerinoides* cf. *G. ruber* were found (Stas. 1, 2, 4, 5, 6 and 7) less than 0.20 mm. in diameter.

SYSTEMATIC DESCRIPTIONS

References preceded by an asterisk (*) have been seen by the writer.

Family REOPHACIDAE

Genus **Reophax** Montfort, 1808

Conch. Syst., 1:331. Genotype: *Reophax scorpiurus* Montfort.

Reophax sp.

Plate 7, figure 6

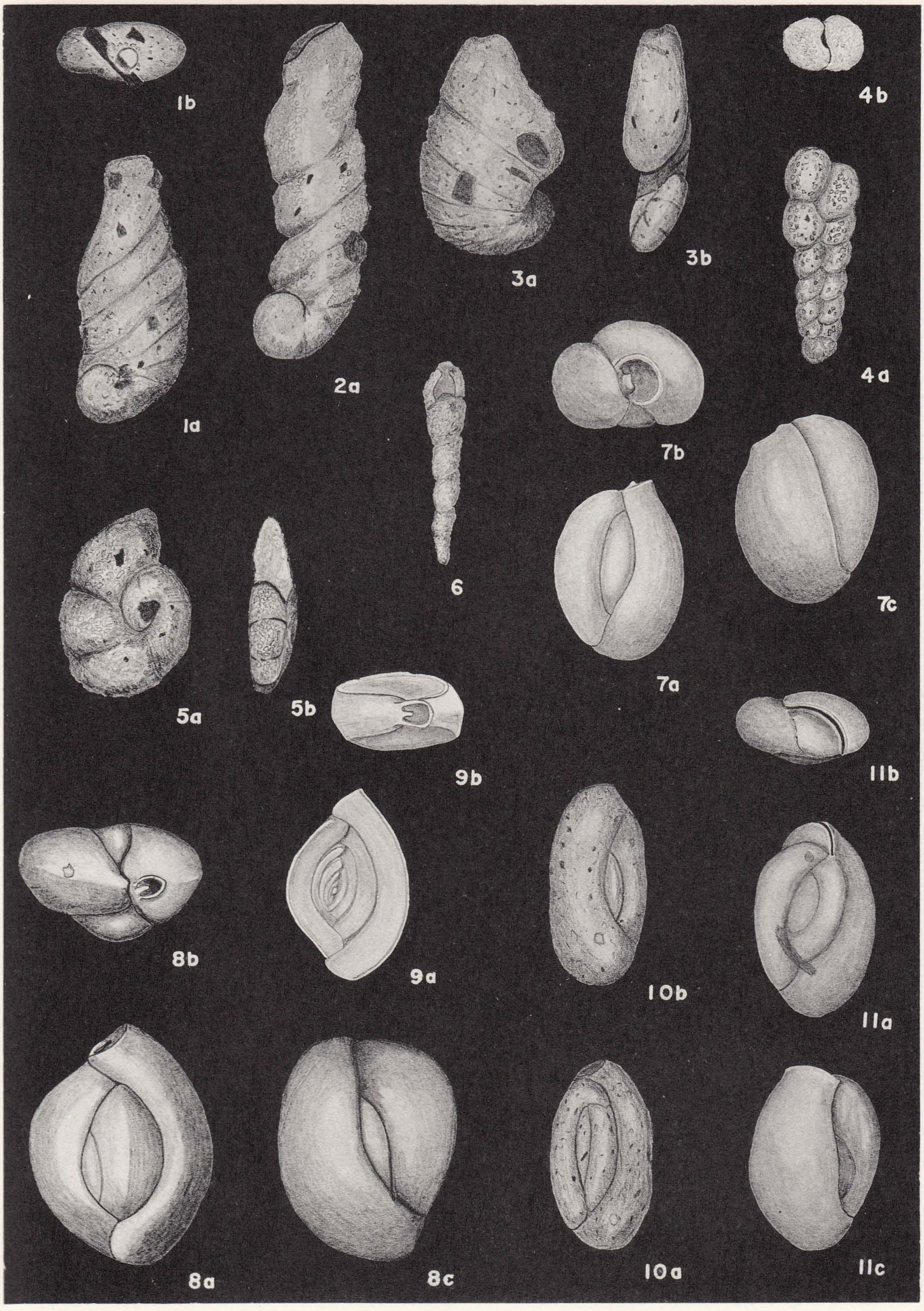
Description.—Test very small (length, 0.34 to 0.39 mm.), free, arenaceous, consisting of about 7 elongate uniserial chambers, increasing very gradually in size. Chambers slightly inflated, circular in cross-section; height of chamber approximately equal to diameter. Sutures distinct in last chambers, evenly curved, slightly oblique, depressed. Septal face evenly rounded. Aperture small, simple, terminal, circular, not produced but with fine rounded rim. Test material fine, well sorted, consisting of quartz sand with occasional darker grains. Color unevenly light to dark tannish gray.

Collecting Stations.—Stas. 4, 6, and 8 (rare).

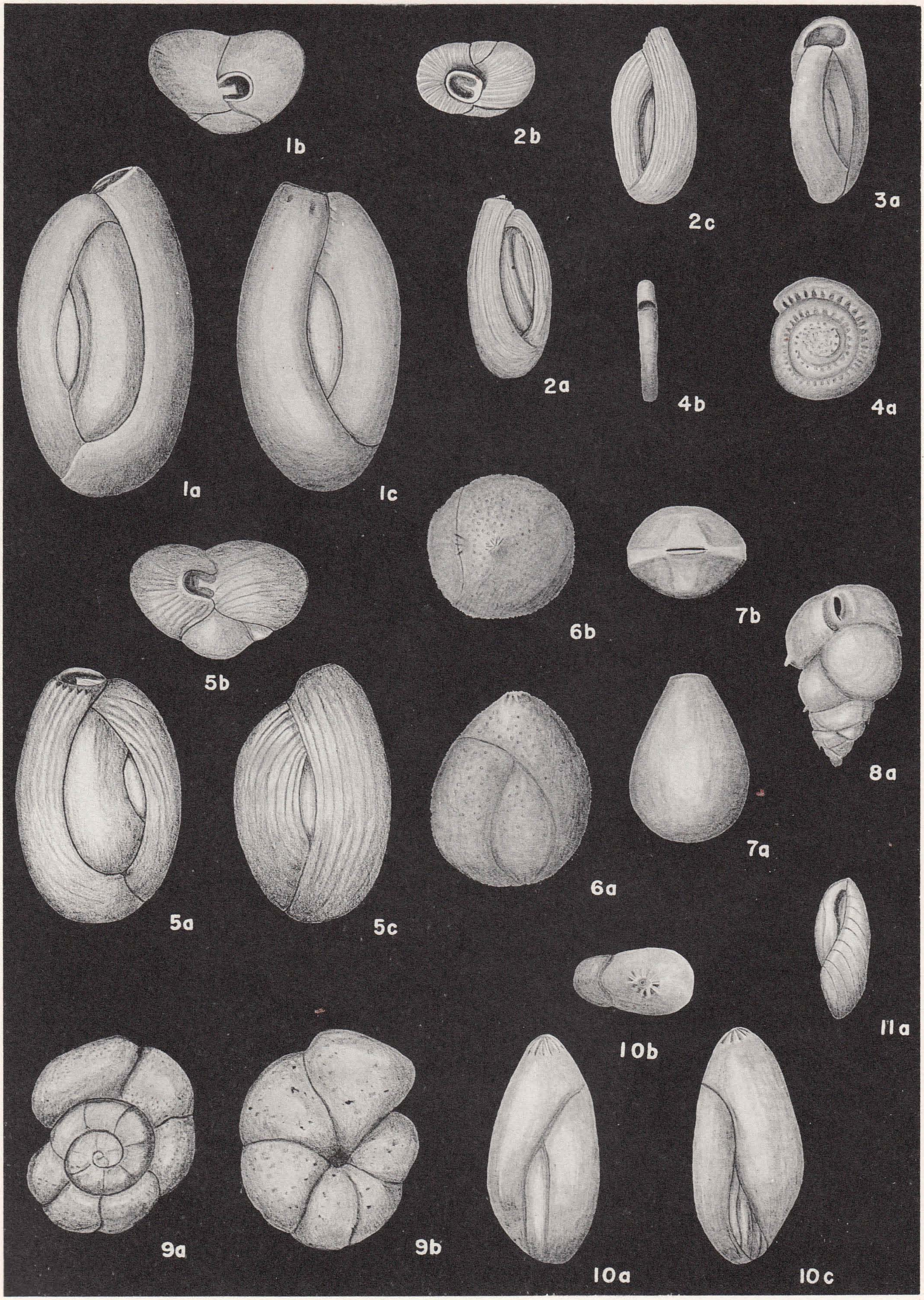
EXPLANATION OF PLATE 7

Recent foraminifera from Mason Inlet, North Carolina. (Magnifications approximate.)

Figs.		Page
1-3.	*"Ammobaculites" cassis* (Parker), Sta. 8; × 48. 1a, 2a, 3a, lateral views. 1b, apertural view. 3b, end view.	49
4.	*Textularia* sp. cf. *T. parvula* Cushman, Sta. 8; × 48. 4a, lateral view. 4b, apertural view.	51
5.	*Haplophragmoides* sp., Sta. 8; × 36. 5a, dorsal view. 5b, apertural view.	49
6.	*Reophax* sp., Sta. 4; × 48. 6a, lateral view.	48
7.	*Triloculina* sp. cf. *T. brevidentata* Cushman, Sta. 5; × 36. 7a, 7c, lateral views. 7b, apertural view.	53
8.	*Quinqueloculina lamarckina* Orbigny, Sta. 7; × 36. 8a, 8c, lateral views. 8b, apertural view.	51
9.	*Spiroloculina planulata* (Lamarck), Sta. 5; × 27. 9a, lateral view. 9b, apertural view.	53
10.	*Milliammina fusca* (Brady), Sta. 8; × 36. 10a, 10b, lateral views.	51
11.	*Miliolinella*? sp., Sta. 7; × 36. 11a, 11c, lateral views. 11b, apertural view.	52



Miller: Foraminifera of Mason Inlet, North Carolina



Miller: Foraminifera of Mason Inlet, North Carolina

Family LITUOLIDAE

Genus **Haplophragmoides** Cushman, 1910

U. S. Nat. Mus., Bull., 71(1):99. Genotype: *Nonionina canariensis* Orbigny.

Haplophragmoides? sp.

Plate 7, figure 5

Description.—Test small (greater diameter, 0.40 to 0.42 mm.), free, arenaceous, depressed trochoid, early whorls indistinct; 5 to 7 chambers in last whorl (typically 6). Chambers of last whorl moderately well defined by arcuate peripheral outlines. Sutures indistinct. Wall entire; composed predominantly of poorly sorted quartz grains, crystals of darker minerals conspicuous. Aperture indistinct, basal, not enclosed by septal face. Color light tan.

Collecting Stations.—Stas. 6, 8, and 9 (rare).

Remarks.—All of the specimens showed chemical decomposition of the cement within a short time. In nearly every case the test collapsed several days after mounting.

Genus **Ammobaculites** Cushman, 1910

U. S. Nat. Mus., Bull. 71(1):99. Genotype: *Spirolina agglutinans* Orbigny.

"Ammobaculites" cassis (Parker)

Plate 7, figures 1, 2, 3; text figure 4

Lituola cassis PARKER, 1870, in *DAWSON, *Canadian Nat.*, n. s., 5:176, fig. 3.

Ammobaculites cassis (PARKER). *CUSHMAN, 1944, Cushman Lab. Foram. Research, Sp. Pub., 12:12, pl. 1, figs. 23-25.—*PHLEGER and WALTON, 1950, Am. Journ. Sci., 248(4):274, pl. 1, figs. 11-14.

Type Locality.—Gaspé Bay, Gulf of the St. Lawrence River, Canada.

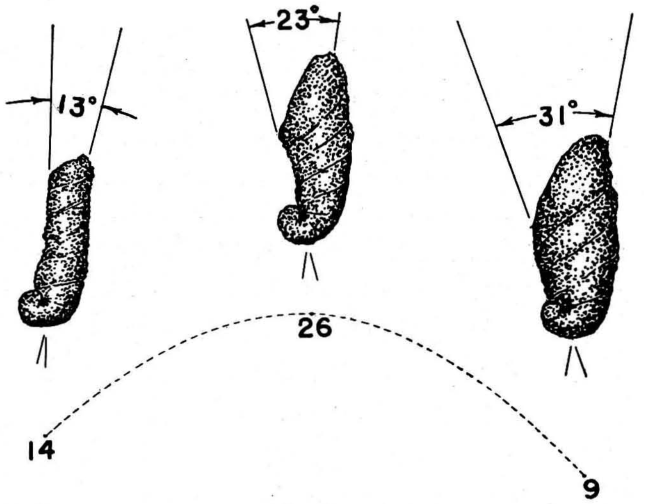


Fig. 4. Variation in the shape of *"Ammobaculites" cassis* (Parker). Figures indicate number of specimens at end points and mode of curve.

Description.—Test of medium size (length, 0.47 to 1.20 mm.), free, arenaceous, elongate, consisting of a very small initial coil followed by an arcuate series of uniserial chambers. Initial coil trochoid, highly compressed, 1 to 1½ whorls; subsequent portion uniserial, slightly arched, consisting of four or five chambers that increase gradually in width; width of uniserial chambers extremely variable; *width/length* ratios, 25% to 70% (typically about 31%). Chambers of uniserial part low (*width/height* ratios about 48%), inclined downward at angle of 12 to 40 degrees (typically 35 degrees), slightly inflated; height of last chamber about one and one third times height of penultimate chamber, septal face arched. Sutures indistinct in initial coil; in later part narrow, impressed, in some cases indistinct. Wall entire; composed of medium to fine, subrounded grains, moderately well sorted; predominantly quartz, with occasional larger grains and crystals of tourmaline, garnet, and zircon; color buff, included crystals conspicuous. Aperture simple, circular, large, terminal, situated near peripheral margin, slightly produced.

EXPLANATION OF PLATE 8

Recent foraminifera from Mason Inlet, North Carolina. (Magnifications approximate.)

FIGS.		PAGE
1.	*Quinqueloculina* sp. cf. *Q. seminulum* (Linné), Sta. 9; × 36. 1a, 1c, lateral views. 1b, apertural view.	52
2.	*Quinqueloculina poeyana* Orbigny, Sta. 5; × 27. 2a, 2c, lateral views. 2b, apertural view.	52
3.	*Planispirina auriculata* Egger, Sta. 1; × 48. 3a, oblique lateral view.	53
4.	*Cornuspira?* sp., Sta. 1; × 48. 4a, dorsal view. 4b, apertural view.	53
5.	*Quinqueloculina seminulum* (Linné) var. *jugosa* Cushman, Sta. 1; × 36. 5a, 5c, lateral views. 5b, apertural view.	52
6.	*Globulina* sp. cf. *G. gibba* Orbigny, Sta. 5; × 36. 6a, lateral view. 6b, apertural view.	54
7.	*Lagena* sp. aff. *"L." laevigata* (Reuss), Sta. 4; × 60. 7a, lateral view. 7b, apertural view.	54
8.	*Bulimina* sp., Sta. 4; × 36. 8a, lateral view.	58
9.	*Trochammina inflata* (Montagu), Sta. 5; × 36. 9a, dorsal view. 9b, ventral view.	54
10.	*Sigmomorphina?* sp. aff. *S. williamsoni* (Terquem), Sta. 6; × 36. 10a, 10c, lateral views. 10b, apertural view.	55
11.	*Buliminella elegantissima* (Orbigny), Sta. 4; × 60 11a, lateral view.	57

TABLE 3. FORAMINIFERAL CHECK LIST

	Station:	1	2	3	4	5	6	7	8	9
1.	*Quinqueloculina poeyana* d'Orbigny	A	—	—	R	MC	A	R	—	—
2.	*Elphidium incertum* (Williamson)	C	C	A	R	—	—	—	—	—
3.	*Quinqueloculina seminulum* (Linné) var. *jugosa* Cushman	C	MC	R	MC	VA	C	C	—	C
4.	*Elphidium* aff. *incertum* (Williamson) var. *mexicanum* Kornfeld	C	R	R	R	MC	A	R	—	—
5.	*Quinqueloculina lamarckina* d'Orbigny	C	—	—	—	R	—	R	—	—
6.	*"Rotalia"* cf. *beccarii* (Linné)	MC	R	MC	A	C	A	C	MC	R
7.	*Globigerinoides* cf. *ruber* d'Orbigny	MC	R	—	MC	C	VA	C	—	—
8.	*Triloculina* cf. *brevidentata* Cushman	MC	—	R	C	R	R	R	—	—
9.	*Bolivina subaenariensis* Cushman	MC	—	—	—	—	MC	—	—	R
10.	*Nonion* sp.	R	C	C	A	R	R	R	A	R
11.	*Quinqueloculina* cf. *seminulum* (Linné)	R	C	—	R	A	—	A	—	A
12.	*Cibicides* cf. *concentrica* (Cushman)	R	—	—	—	MC	R	MC	—	C
13.	*Nonionella* aff. *auricula* Heron-Allen & Earland	R	—	—	—	MC	—	MC	—	C
14.	*Cornuspira*? sp.	R	—	—	R	—	—	R	—	—
15.	*Planispirina auriculata* Egger	R	—	—	R	—	—	—	—	—
16.	*Uvigerina* sp.	R	—	—	—	R	R	—	—	—
17.	*Cibicides floridanus* (Cushman)	R	—	—	—	—	—	—	—	R
18.	*Elphidium* sp.	—	MC	—	—	R	—	—	—	—
19.	*Trochammina inflata* (Montagu)	—	R	C	—	C	C	—	R	—
20.	*Cibicides* cf. *refulgens* Montfort	—	R	—	—	R	R	—	—	—
21.	*Eponides* aff. *wrightii* (H. B. Brady)	—	R	—	—	—	—	R	R	—
22.	*"Ammobaculites" cassis* (Parker)	—	—	R	—	R	—	—	VA	—
23.	*Buliminella elegantissima* (d'Orbigny)	—	—	—	A	—	MC	—	—	—
24.	*Globigerinella* sp.	—	—	—	A	—	—	—	—	—
25.	*Discorbis* sp.	—	—	—	MC	R	—	—	—	—
26.	*Textularia* cf. *parvula* Cushman	—	—	—	MC	—	MC	—	R	—
27.	*Lagena* aff. *laevigata* (Reuss)	—	—	—	MC	—	—	—	—	—
28.	*Reophax* sp.	—	—	—	R	—	R	—	R	—
29.	*Bulimina* sp.	—	—	—	R	—	—	—	—	—
30.	*Poroeponides repanda* (Fichtel & Moll)	—	—	—	—	C	C	MC	—	MC
31.	*Spiroloculina planulata* (Lamarck)	—	—	—	—	MC	R	—	—	—
32.	*Globulina* cf. *gibba* d'Orbigny	—	—	—	—	R	R	—	—	—
33.	*Reussella* sp.	—	—	—	—	R	R	—	—	—
34.	*Sigmomorphina*? aff. *williamsoni* (Terquem)	—	—	—	—	—	MC	—	—	—
35.	*Haplophragmoides*? sp.	—	—	—	—	—	R	—	R	R
36.	*Planorbulina mediterranensis* d'Orbigny	—	—	—	—	—	R	—	—	—
37.	*Planulina caribaea* Cushman	—	—	—	—	—	—	R	—	—
38.	?*Dyocibicides biserialis* Cushman & Valentine	—	—	—	—	—	—	R	—	—
39.	*Miliolinella* sp.	—	—	—	—	—	—	R	—	—
40.	*Elphidium gunteri* Cole var. *galvestonensis* Kornfeld	—	—	—	—	—	—	—	C	—
41.	*Miliammina fusca* (Brady)	—	—	—	—	—	—	—	MC	—
42.	*Elphidium frizzelli* n. sp.	—	—	—	—	—	—	—	R	—

Frequency (number of specimens): R, 1-3; MC, 4-10; C, 11-20; A, 21-35; VA, over 35.

Collecting Stations.—Stas. 8 (very abundant), 3 and 5 (rare).

Geographic Range.—*Ammobaculites cassis* (Parker) has been recorded (Cushman, 1920, 1944; Phleger and Walton, 1950) as a cold water ("Arctic") species. It has been reported as far south as Cape Cod, Massachusetts. An extension of the range approximately 700 miles southward to Mason Inlet, North Carolina, is now placed on record, the species having been found in abundance at one station and rare at two others.

Family TEXTULARIIDAE

Genus **Textularia** Defrance, 1824

Dict. Sci. Nat., 32:177. Genotype: *Textularia sagittula* Defrance.

Textularia sp. cf. **T. parvula** Cushman, 1922

Plate 7, figure 4

?*Textularia parvula* *CUSHMAN, 1922, U. S. Nat. Mus., Bull., 104(3):11, pl. 6, figs. 1, 2.

Type Locality of Textularia parvula: Albatross Station H-79, 821 fathoms, in the eastern part of the Caribbean Sea.

Description.—Test of medium size (length, 0.24 to 0.41 mm.), free, arenaceous, elongate, with tiny initial coil followed by a series of biserial chambers. Chambers of initial coil extremely small, indistinct, approximately 1 whorl; chambers in biserial portion distinct, elliptical in cross-section, 6 to 8 tiers; growth gradual and regular. Sutures impressed, narrow, distinct in biserial portion. Aperture simple, of medium size, curved, median; consisting of an arch at base of septal face. Test material predominantly well sorted, very fine, quartz sand grains, with occasional conspicuous crystals of tourmaline. Color light tan to buff.

Collecting Stations.—Stas. 4 and 6 (moderately common), and 8 (rare).

Geographic Range.—*Textularia parvula* has been recorded by Cushman from several Albatross Stations in the Caribbean Sea. Most occurrences were at depths greater than 60 meters.

Family SILICINIDAE

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

Roy. Micr. Soc., Jour., p. 140. Genotype: *Miliammina oblonga* (Montagu) var. *arenacea* Chapman.

Miliammina fusca (Brady), 1870

Plate 7, figure 10

Quinqueloculina agglutinans ORBIGNY. H. B. BRADY, 1865, Nat. Hist. Trans. Northumberland and Durham, 1:87,95 (misidentification).

Quinqueloculina fusca BRADY, 1870, Ann. Mag. Nat. Hist., Ser. 4, 6:286, pl. 11, fig. 2.—*CUSHMAN, 1929, U. S. Nat. Mus., Bull., 104(6):23, pl. 1, figs. 4a-c.

Miliolina fusca (BRADY). BALKWILL and MILLETT, 1884, Jour. Micr. Nat. Sci., 3:—(19-28, 78-90, pls. 1-4; species apparently not figured).

Miliammina fusca (BRADY). *HADA, 1936, Zool. Mag., 48(8,9,10):852; *1937, 49(10):345 (Japanese).—*PHLEGER and WALTON, 1950, Am. Jour. Sci., 248 (4):280, pl. 1, figs. 19a, b.

Type Locality.—Not designated (see range, below).

Description.—Test of medium size (length, 0.39 to 0.46 mm.), free, arenaceous, elliptical, with rounded periphery, quinqueloculine; chambers arcuate, circular in cross-section; *maximum width/length* ratios, 46% to 48% (typically 48%). Sutures distinct, narrow, impressed. Wall entire, composed of fine to medium, moderately well sorted sand grains; predominantly quartz, with occasional crystals of tourmaline. Aperture large, simple, circular, terminal. Color light to dark tan.

Collecting Stations.—Sta. 8 (moderately common).

Geographic Range.—This species is recorded as common from regions of brackish water along the coast of Great Britain, and the British Isles (Cushman, 1929). It has also been reported by Cushman from Casco Bay, Maine, and by Phleger and Walton (1950) from Cape Cod, Massachusetts. The brackish water of several Japanese estuaries has yielded typical specimens (Hada, 1936, 1937).

Family MILIOLIDAE

Genus **Quinqueloculina** Orbigny, 1826

Ann. Sci. Nat., 7:301. Genotype: *Serpula seminulum* Linné.

Quinqueloculina lamarckiana Orbigny, 1839

Plate 7, figure 8

Quinqueloculina lamarckiana ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Fis. Pol. Nat. Cuba, "Foraminifères," p. 189, pl. 11, figs. 14,15.—CUSHMAN, 1921, U. S. Nat. Mus., Proc., 59:65, pl. 15, figs. 13, 14; *1929, U. S. Nat. Mus., Bull., 104(6):26, pl. 2, figs. 6a-c.—*HADLEY, 1936, Elisha Mitchell Sci. Soc., Jour., 52: 35 (check list only).

Quinqueloculina auberiana ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Fis. Pol. Nat. Cuba, "Foraminifères," p. 193, pl. 12, figs. 1-3.

Quinqueloculina cuvieriana BRADY, 1884, Rep. Voy. Challenger, Zoology, 9:162, pl. 5, figs. 12a-c.

Type Locality.—Not designated (see range below).

Description.—Test of medium size (length, 0.49 to 0.58 mm.), free, calcareous-imperforate, quinqueloculine; *maximum width/length* ratios, 40% to 51%(typically 40%). Lateral axis through final chamber rotated about 120 degrees from axis of preceding chamber. Chambers inflated, arcuate, rounded in cross-section, distinct; with thin, impressed sutures. Aperture large, terminal, elliptical; with a single, large, medium-sized tooth extending nearly half way across opening. Color white.

Collecting Stations.—Stas. 1 and 6 (common), and 5 and 7 (rare).

Geographic Range.—This species has been recorded from shore sands of Cuba, Jamaica, and Martinique by d'Orbigny. It has also been recorded from the Indian Ocean and the British Isles (as *Quinqueloculina auberiana*). Hadley reported the species as common at Beaufort, North Carolina.

Quinqueloculina poeyana Orbigny, 1839
Plate 8, figure 2

Quinqueloculina poeyana ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Fis. Pol. Nat. Cuba, "Foraminifères," p. 191, pl. 11, figs. 25-27.—CUSHMAN, 1921, U. S. Nat. Mus., Proc., 59:67, pl. 16, figs. 7, 8; *1929, U. S. Nat. Mus., Bull., 104(4):31, pl. 5, figs. 2a-c.—*HADLEY, 1936, Elisha Mitchell Sci. Soc., Jour., 52: 35, 37 (check list only).

Type Locality.—Shore sands of Cuba.

Description.—Test of medium size (length, 0.62 to 0.67 mm.), free, calcareous-imperforate, quinqueloculine; *maximum width/length* ratios, 45% to 46% (typically 46%). Chambers elongate, arcuate; nearly circular in cross-section; with distinct, narrow longitudinal costae. Sutures distinct, narrow, curved, impressed. Aperture simple, large, nearly circular, terminal; slightly extended, with smoothly rounded lip and narrow, simple tooth; tooth usually slightly extended above lip. Color white to light tan.

Collecting Stations.—Stas. 1 and 6 (abundant), 5 (moderately common), and 4 and 7 (rare).

Geographic Range.—*Quinqueloculina poeyana* has been recorded from several stations in the West Indies, and has been reported as common near Cuba, Puerto Rico, Jamaica, and the Tortugas.

Quinqueloculina sp. cf. **Q. seminulum** (Linné)
Plate 8, figure 1

?*Serpula seminulum* LINNÉ, 1767, Syst. Nat., ed. 12, p. 1264.

?*Quinqueloculina seminulum* (LINNÉ). ORBIGNY, 1826, Ann. Sci. Nat., 7:303.—*CUSHMAN, 1929, U. S. Nat. Mus., Bull., 104(6):24, pl. 2, figs. 1, 2.—*KORNFELD, 1931, Stanford Univ., Geol. Dept., Contr., 1(3).—*HADLEY, 1936, Elisha Mitchell Sci. Soc., Jour., 52: 35.—*HADA, 1936, Zool. Mag., 48(8,9,10):858; 1937, *Ibid,* 49(10):345.—*PARKER, 1948, Mus. Comp. Zool., Bull., 100(2):214,241.—*PHLEGER and WALTON, 1950, Am. Jour. Sci., 248(4):285, pl. 1, fig. 20.

Type Locality of Quinqueloculina seminulum: Rimini, Italy.

Description.—Test large (length, 0.70 to 0.82 mm.), free, calcareous-imperforate, quinqueloculine; *maximum width/length* ratios, 42% to 49% (typically 48%). Chambers arcuate, inflated, smooth, oval in cross-section. Sutures thin, impressed. Aperture large, terminal, nearly circular; with a large, single tooth extending half way across opening. Color white.

Collecting Stations.—Stas. 1 and 4 (rare), 2 (common), and 5, 7, and 9 (abundant).

Geographical Range.—This species is common at many localities in the western Atlantic Ocean. Cushman has recorded *Quinqueloculina seminulum* as most abundant in the shallow water typical of the northeastern coast of America and Europe. The species is also common in shallow, brackish estuaries of Japan (Hada, 1936, 1937). It is not a typical warm water species, as evidenced by its rare occurrence in the Gulf of Mexico (Texas and Louisiana — Kornfeld, 1931).

Quinqueloculina seminulum (Linné) var. **jugosa** Cushman, 1944
Plate 8, figure 5

Quinqueloculina seminulum (LINNÉ) var. *jugosa* *CUSHMAN, 1944, Cushman Lab. Foram. Research, Sp. Pub., 12:13-14, pl. 2, fig. 15.—*PARKER, 1948, Mus. Comp. Zool., Bull., 100(2):222, pl. 1, fig. 5 (check list and figure only).

Type Locality.—Thirteen fathoms, 1½ miles north of Mnemsha Bight, Vineyard Sound, Massachusetts.

Description.—Test of medium size (length, 0.51 to 0.60 mm.), free, calcareous-imperforate, ellipsoidal, quinqueloculine; *maximum width/length* ratios, 59% to 61% (typically 60%). Chambers arcuate, inflated, with strong, irregular, longitudinal ribs; ribs narrow, with slightly raised ridges. Sutures distinct, impressed. Aperture large, terminal, elliptical, with medium-sized bifurcate tooth. Color white.

Collecting Stations.—Common at Stas. 1, 6, 7, and 9; rare at Sta. 3; moderately common at Stas. 2 and 4; and very abundant at Sta. 5.

Geographic Range.—This variety has been recorded from shallow waters of the Atlantic Ocean south of Cape Cod. It was found in abundance off the end of the pier at Kure Beach, North Carolina.

Genus **Miliolinella** Wiesner, 1931

Deutsche Südpolar-Exped., 20 (Zool.):65. Genotype: *Quinqueloculina lamellidens* Reuss.

Miliolinella? sp.
Plate 7, figure 11

Description.—Test of medium size (length, 0.45 mm.), free, calcareous-perforate, quinqueloculine; nearly elliptical in outline, *maximum width/length* ratio 62%. Chambers inflated, smooth, arcuate, finely perforate; growth regular, distinct. Sutures narrow, slightly impressed. Aperture simple, large, terminal; slightly produced with single, wide tooth extending across the entire width of the final chamber opening. Apertural opening narrow, curved with a smoothly rounded lip. Color translucent to white.

Collecting Stations.—Sta. 7 (rare).

Remarks.—This description is based on a single well preserved specimen.

Genus **Spiroloculina** Orbigny, 1826

Ann. Sci. Nat., 7:298. Genotype: *Spiroloculina depressa* Orbigny.

Spiroloculina planulata (Lamarck)

Plate 7, figure 9

Miliolites planulata LAMARCK, 1804, Ann. Mus., 5(4): 352.

Spiroloculina planulata (LAMARCK). McDONALD, 1857, Ann. Mag. Nat. Hist., ser. 2, 20:153, pl. 6, fig. 28.—HERON-ALLEN and EARLAND, 1922, British Antarctic Exped., Zool., 6:63; 1926, Zool. Soc. London, Trans., 22(1):68, (check list only).—*CUSHMAN, 1929, U. S. Nat. Mus., Bull., 104(6):41-42, pl. 8, figs. 2-5.—*HADLEY, 1936, Elisha Mitchell Sci. Soc., Jour., 52: 35-37.—*HADA, 1934(?), p. 32 (check list; reprint lacking date and title; Japanese, with English summary).

Type Locality.—*Louvres près Paris,* France.

Description.—Test of medium to large size (length, 0.62 to 0.70 mm.), free, calcareous, irregularly elliptical, of angular, arcuate chambers with convex periphery; *maximum width/length* ratios, 54% to 61% (typically 60%). Chambers nearly square in cross-section, edges thickened; 7 to 8 chambers in the adult, initial chambers depressed between larger and wider final chambers, growth distinct, regular. Sutures narrow, incised, curved lines. Aperture large, terminal; nearly circular; with thick, even rim, and a single large tooth. Chambers white with translucent filling along the sutures.

Collecting Stations.—Stas. 5 (moderately common) and 6 (rare).

Geographic Range.—This species is recorded as common from several stations near the European coast and the British Isles. It has been recorded as rare at one station near Beaufort, North Carolina (Hadley, 1936).

Remarks.—References to this species in the western Atlantic Ocean are few. The presence of *Spiroloculina planulata* at Beaufort and Mason Inlet, North Carolina offers evidence of its range as a species of warm-temperate water in the western Atlantic Ocean.

Genus **Triloculina** Orbigny, 1826

Ann. Sci. Nat., 1:299. Genotype: *Miliola trigonula* Lamarck.

Triloculina sp. cf. **T. brevidentata** Cushman, 1944

Plate 7, figure 7

?*Triloculina brevidentata* *CUSHMAN, 1944, Cushman Lab. Foram. Research, Sp. Pub., 12:16, pl. 2, fig. 25.

Type Locality of Triloculina brevidentata: Coffins Beach, Annisquam, Massachusetts.

Description.—Test of medium size (length, 0.40 to 0.43 mm.), free, calcareous, smooth, triloculine; *maximum width/length* ratios, 75% to 76% (typically 75%). Chambers inflated, evenly rounded, distinct; slightly narrower at the apertural end. Sutures depressed, narrow, distinct. Aperture large, terminal, nearly circular, prominent; single, wide, bifid tooth prominent; tilted up, away from the center of the aperture. Color white, luster vitreous.

Collecting Stations.—Sta. 1 (moderately common), 4 (common), and 3, 5, 6, and 7 (rare).

Geographic Range.—This species has been recorded by Cushman as common at the type locality and along the coast of Massachusetts and Maine.

Remarks.—If this species is *Triloculina brevidentata,* it is greatly reduced in size. The normal lengths of the type specimens are from 1.10 to 1.25 mm.

Family OPHTHALMIDIIDAE

Genus **Cornuspira** Schultze, 1854

Organismus Polythal., p. 40. Genotype: *Cornuspira planorbis* Schultze.

Cornuspira? sp.

Plate 8, figure 4

Description.—Test small (greater diameter, 0.24 mm.), calcareous-imperforate, circular, flattened, planispiral; *thickness/greater diameter* ratio, 12%. Approximately 3 whorls in the adult, initial coil indistinct. Whorls regular, visible dorsally, overlain by nodes of test material ventrally. Nodes small, well-rounded, irregularly spaced. Periphery unevenly rounded, slightly flattened dorsally. Suture narrow, irregularly limbate, depressed along final whorl; sculptured with regular, small, oval depressions, marginal in initial coil, absent in last ⅓ of final whorl. Surface wrinkled in last ⅓ of final whorl. Aperture large, oval, terminal; includes the entire end of chamber. Color white.

Collecting Stations.—Stas. 1, 4, and 7 (rare).

Remarks.—Three specimens were obtained, all of which have similar characteristics but none of which is entire.

Genus **Planispirina** Seguenza, 1880

R. Accad. Lincei, Atti, ser. 3, 6:310. Genotype: *Planispirina communis* Seguenza.

Planispirina auriculata Egger, 1893

Plate 8, figure 3

Planispirina auriculata EGGER, 1893, Kön. bay. Akad. Wiss. München, Abh., Cl. II, 18:245, pl. 3, figs. 13-15.—HERON-ALLEN and EARLAND, 1915, Zool. Soc. London, Trans., 20:590, pl. 46, figs. 3-7.—*CUSHMAN, 1929, U. S. Nat. Mus., Bull., 104(6):93-94, pl.

22, fig. 3; 1932, *ibid.* 161(1):72, pl. 16, figs. 6a-c.

Type Locality.—Indo-Pacific.

Description.—Test small (length, 0.36 mm.), free, calcareous-imperforate, bluntly elliptical and flattened, with 3 chambers visible on one side and 1 on the other. Final chambers are milioline; earlier chambers form an elongate flattened coil, visible in transmitted light; *maximum width/length* ratio 41%. Apertural end bluntly rounded, flattened. Sutures distinct, curved, fine lines, slightly impressed. Aperture large, hemispherical, simple; includes entire side of final chamber that extends above penultimate chamber. Test material curved about the sides and top of aperture, thickened. Color translucent to white.

Collecting Stations.—Stas. 1 and 4 (rare).

Geographical Range.—This species has previously been recorded from the Indo-Pacific. Its rare occurrence in the Tortugas indicates this to be a warm water species. Several specimens have been found as far north as Beaufort, North Carolina (Cushman 1929).

Family TROCHAMMINIDAE

Genus **Trochammina** Parker and Jones, 1859

Ann. Mag. Nat. Hist., ser. 3, 4:347. Genotype: *Nautilus inflatus* Montagu.

Trochammina inflata (Montagu)

Plate 8, figure 9

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

Rotalina inflata (MONTAGU). WILLIAMSON, 1858, Rec. Foram. Great Britain, p. 50, pl. 4, figs. 93, 94.

Trochammina inflata (MONTAGU). *CARPENTER, PARKER and JONES, 1862, Intro. Foram., p. 141, pl. 11, fig. 5.—HERON-ALLEN and EARLAND, 1909, Roy. Micr. Soc., Jour., p. 324; 1913, Roy. Irish Acad., Proc., 31(64):52.—*CUSHMAN, 1920, U. S. Nat. Mus., Bull., 104(2):73.—*PHLEGER and WALTON, 1950, Am. Jour. Sci., 248(4):280, pl. 2, figs. 1-3.

Type Locality.—Unknown.

Description.—Test of medium size (greater diameter, 0.42 to 0.45 mm.), free, arenaceous, depressed trochoid. Typically 2½ whorls in the adult, consisting of an initial coil of depressed chambers and a final whorl of 6 large, well-rounded chambers inflated ventrally. Chambers distinct with peripheral margin well rounded. Umbilicus deep, irregular. Sutures distinct, impressed. Septal face rounded, smooth. Wall composed of moderately well sorted, fine quartz grains, with occasional larger grains conspicuous; surface smooth with a predominance of cement. Aperture of medium size; a simple, curved slit situated ventrally at the base of the septal face. Color buff to light tan.

Collecting Stations.—Common at Stas. 3, 5, and 6, rare at Stas. 2 and 8.

Geographic Range.—This widely ranging shallow water species is recorded from both sides of the Atlantic Ocean. It is recorded from the bay at Barnstable, Massachusetts (Phleger and Walton 1950).

Remarks.—Excellent specimens were collected. Many of them, however, showed collapsed chambers several days after mounting, and chemical decomposition near the aperture.

Specimens that have decomposed slightly and whose chambers have deflated are very similar to *Trochammina rotaliformis* (J. Wright) as illustrated by Cushman (1920, p. 77, pl. 16, fig. 1, *not* fig. 2).

Family LAGENIDAE

Genus **Lagena** Walker and Jacob, 1798

In Kanmacher's ed. of Adams' Essays Micr., p. 634. Genotype: *Serpula (Lagena) sulcata* Walker and Jacob.

Lagena sp. aff. **"L." laevigata** (Reuss)

Plate 8, figure 7

?*Fissurina laevigata* REUSS, 1850, K. Akad. Wiss. Wien, Math.-nat. Cl., Denkschr., 1:366, pl. 46, fig. 1; 1863, Sitz., 46(1):338, Akad. Wiss. Wien, pl. 6, fig. 84.

Lagena laevigata (REUSS). *1923, U. S. Nat. Mus., Bull., 104(4):28, pl. 5, fig. 1, 2.

Description.—Test very small (length less than 0.20 mm.), free, calcareous-perforate, smooth, subglobose, ellipsoidal in cross-section. Unilocular chamber, bilaterally convex, with slightly flattened ends. Chamber oval in outline, truncated at apertural end. Aperture a simple slit; small, narrow, elongate, terminal. Color translucent to white.

Collecting Stations.—Sta. 4 (moderately common).

Geographic Range.—This species has not previously been recorded from the western Atlantic Ocean. Previously, *Lagena laevigata* (Reuss) has been found in abundance off the coast of the British Isles.

Family POLYMORPHINIDAE

Genus **Globulina** Orbigny, 1839

Ann. Sci. Nat., 7:266. Genotype: *Polymorphina (Globulina) gibba* Orbigny.

Globulina sp. cf. **G. gibba** Orbigny

Plate 8, figure 6

?*Globulina gibba* ORBIGNY, Ann. Sci. Nat., 1826, 7(10): 266, Modèles No. 63.—JONES and CHAPMAN, 1896, Linn. Soc. Zool., Jour., 25:509-515, figs. 6, 7, 40.—CUSHMAN and OZAWA, 1930, U. S. Nat. Mus., Proc., 77(6):60 (with complete synonymy).—*CUSHMAN, 1944, Cushman Lab. Foram. Research, Sp. Pub., 12: 22, pl. 3, figs. 18, 19.

?*Polymorphina gibba* (ORBIGNY). BRADY, PARKER, and JONES, 1870, Trans. Linn. Soc., 27:216, pl. 39, figs. 2a-b.—CUSHMAN, 1918, U. S. Geol. Surv., Bull., 676: 10, 52, pl. 2, fig. 4; pl. 11, fig. 5; 1922, Prof. Paper, 129-F, pp. 93, 94, pl. 17, fig. 3; pl. 18, figs. 3a-b.—

PLUMMER, 1927, Univ. Texas, Bull., 2644:122, pl. 6, figs. 8a-b.

Type Locality.—Unknown.

Description.—Test of medium size (length, 0.32 to 0.45 mm.), free calcareous-perforate, subglobular, with distinct, radiate aperture. Test nearly circular in transverse-section; *width/length* ratio 83%. Chambers few, distinct, in nearly triserial growth plan, coarsely perforate. Sutures narrow, curved, slightly depressed from well-rounded chamber walls, distinct. Aperture small, radiate, central, slightly extended by thickening of radiate protrusions. Color translucent to white.

Collecting Stations.—Stas. 5 and 6 (rare).

Geographic Range.—This species has a wide geographical distribution but is usually recorded as rare. It has been reported from many stations throughout the Atlantic and Mediterranean Oceans. The many supposed varieties and synonyms of *Globulina gibba* Orbigny confuse the true range of the species. Recent specimens have been found near Ireland and in the Mediterranean Ocean (Cushman and Ozawa 1930).

Stratigraphic Range.—This species has been recorded from Eocene and younger strata of Europe and the United States.

Genus **Sigmomorphina** Cushman and Ozawa, 1928

Cushman Lab. Foram. Research, Contr., 4:17. Genotype: *Sigmomorphina yokoyamai* Cushman and Ozawa.

Sigmomorphina? sp. aff. **S. williamsoni** (Terquem)
Plate 8, figure 10

?*Sigmomorphina williamsoni* (TERQUEM). CUSHMAN, 1944, Cushman Lab. Foram. Research, Sp. Pub., 12: 23, pl. 3, fig. 21.

Description.—Test of medium size (length, 0.38 to 0.52 mm.), free, calcareous-perforate, with inflated chambers revolved less than 180 degrees. Initial chambers obscured, succeeding chambers elongate, final chambers inflated, smooth, with fine perforations. Sutures narrow, depressed, irregularly curved, distinct. Aperture radiate, small, terminal; very distinct crenulated grooves surrounding the aperture extend ⅛ of the way down the final chamber. Color translucent.

Collecting Stations.—Sta. 6 (moderately common).

Family NONIONIDAE

Genus **Nonion** Montfort, 1808

Conch. Syst., 1:211. Genotype: *Nautilus incrassatus* Fichtel and Moll.

Nonion sp.
Plate 9, figure 2

Description.—Test of medium size (greater diameter, 0.34 to 0.36 mm.), free, calcareous-perforate, planispiral; with inflated chambers and well rounded periphery. Chambers 7 to 10 in final whorl, very finely perforate, walls nearly translucent. Final chambers elliptical in cross-section and more inflated than preceding chambers. Umbo slightly raised, circular, surrounded by depressed, irregular chamber-wall material which joins the sutures. Sutures of medium width, impressed, curved, and distinct. Septal face curved, strongly depressed just above aperture. Aperture of medium size, simple, elongate, curved slit; median, at base of septal face. Color white.

Collecting Stations.—Abundant at Stas. 4 and 8, common at Stas. 2 and 3, and rare at Stas. 1, 5, 6, 7, and 9.

Genus **Nonionella** Cushman, 1926

Cushman Lab. Foram. Research., Contr., 2:64. Genotype: *Nonionella miocenica* Cushman.

Nonionella sp. aff. **N. auricula**
Heron-Allen and Earland, 1930
Plate 9, figure 1

?*Nonionella auricula* HERON-ALLEN and EARLAND. CUSHMAN, 1944, Cushman Lab. Foram. Research, Sp. Pub., 12:25, pl. 3, figs. 26, 27.

Description.—Test of medium size (greater diameter, 0.20 to 0.65 mm.), free, calcareous-perforate, very depressed trochoid with 11 to 13 chambers in the final whorl, and rounded periphery. Chambers numerous, at least two whorls visible dorsally, only final whorl visible ventrally. Average *width/height* ratio of final chamber 34%. Chambers narrow, regular, slightly arcuate, ellipsoidal in cross-section, perforations fine, abundant. Sutures narrow, curved, slightly impressed or flush with the chamber wall. Umbilical region depressed, with irregular umbilical plug. Apertural face slightly arched, perforate, framed with thickened calcareous rim of the chamber walls. Aperture simple, small, narrow slit situated ventrally, at the base of the apertural face. Color light to dark gray.

Collecting Stations.—Sta. 9 (common), Stas. 5 and 7 (moderately common), and Sta. 1 (rare).

Genus **Elphidium** Montfort, 1808

Conch. Syst. 1:15. Genotype: *Nautilus macellus* Fichtel and Moll.

Elphidium gunteri Cole
var. **galvestonensis** Kornfeld, 1931
Plate 9, figure 7

Polystomella galvestonensis APPLIN (*nomen nudum*), 1925, Am. Assoc. Petr. Geol., Bull., 9(1):84.

Elphidium gunteri COLE var. *galvestonensis* *KORNFELD, 1931, Stanford Univ., Geol. Dept., Contr., 1: 87, pl. 15, figs. 2-3 (not fig. 1).

Type Locality.—Leland Stanford Junior University Locality No. 900; eastern end of Galveston Island at junction of pier with island, Galveston, Texas.

Description.—Test of medium size (greater diameter, 0.32 to 0.41 mm.), free, calcareous-perforate, planispiral, peripheral margin well rounded. Chambers slightly inflated, regular, distinct; 10 to 12 chambers in last whorl (typically 10); chamber walls finely perforate. Sutures impressed, slightly curved, with deep interprocess pits; retral processes thin, numerous. Umbo raised, rounded, prominent. Septal face evenly rounded from periphery to umbo. Aperture multiple, of medium size; situated at the base of the septal face. Color white.

Collecting Stations.—Sta. 8 (common).

Geographic Range.—This species has been reported as common in the shallow, warm waters of the Gulf of Mexico along the coast of Texas and Louisiana (Kornfeld 1931).

Stratigraphic Range.—This species has been recorded from the Tertiary sediments of Texas and Louisiana.

Remarks.—These specimens have a rough, strong appearance due to the irregularity of the surface and its structural reinforcement in the retral processes.

Elphidium incertum (Williamson)

Plate 9, figure 4

Polystomella umbilicatula var. *incerta* WILLIAMSON, 1858, Rec. Foram. Gt. Britain, p. 44, pl. 3, figs. 82-82a.

Polystomella striato-punctata var. *incerta* WILLIAMSON. KIAER, 1900, Norwegian Fish. Mar. Invest., Rept., 1(7):51.—CUSHMAN, 1913, Canadian Arctic Exped. Rept., pt. M, p. 10.

Elphidium incertum (WILLIAMSON). *CUSHMAN, 1930, U. S. Nat. Mus., Bull., 104(7):18, pl. 7, figs. 4-9.—*HADLEY, 1936, Elisha Mitchell Sci. Soc., Jour.. 52: 35.—*CUSHMAN, 1939, U. S. Geol. Surv., Prof. Paper, 191:57, pl. 15, figs. 21-24; *1944, Cushman Lab. Foram. Research, Sp. Pub. 12:25, pl. 3, figs. 28-31.

Description.—Test of medium size (greater diameter, 0.23 to 0.31 mm.), free, calcareous-perforate, with planispiral growth plan. Last whorl composed of 7 to 9 chambers (typically 8); slightly inflated, perforate, with peripheral margin well rounded. Umbo small, irregular, frequently with nodes. Sutures narrow, impressed, curved; retral processes numerous, indistinct, interprocess pits deep, indistinct. Septal face rounded, perforate, impressed just above the base. Aperture multiple, of small, circular, irregular openings. Color white.

Collecting Stations.—Abundant at Sta. 5, common at Stas. 1, and 2, and rare at Sta. 4.

Geographic Range.—This is a widely ranging species, having been reported from both sides of the Atlantic Ocean. Hadley reported it as rare to common at Beaufort, North Carolina.

Elphidium sp. aff. **E. incertum** (Williamson) var. **mexicanum Kornfeld,** 1931

Plate 9, figure 3

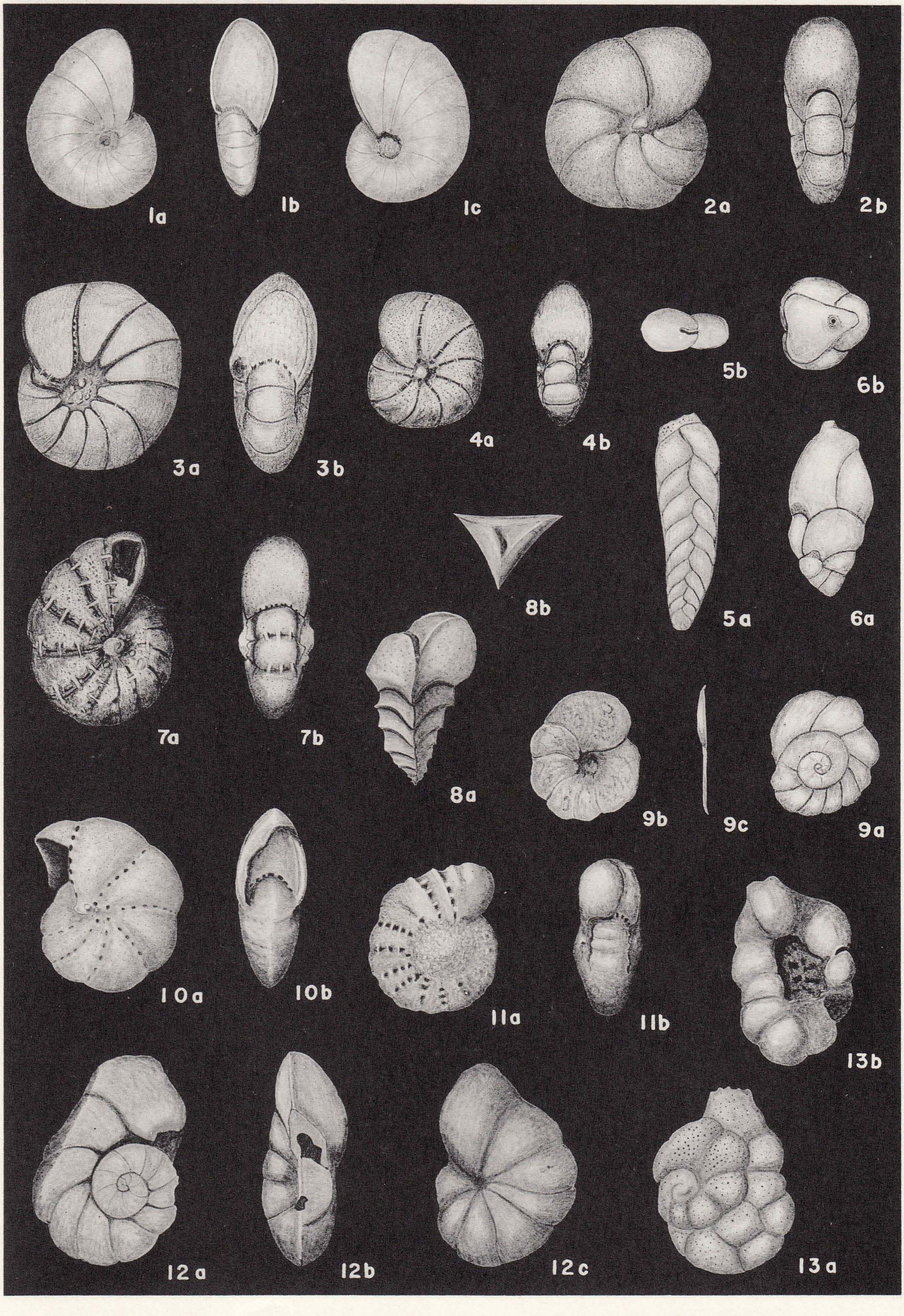
?*Elphidium incertum* (WILLIAMSON) var. *mexicanum* *KORNFELD, 1931, Stanford Univ., Geol. Dept., Contr., 1(3):89, pl. 16, figs. 1-2.

Description.—Test small (greater diameter, 0.32 to 0.40 mm.), free, calcareous-perforate, flattened planispiral with acute, rounded, peripheral margin. Last whorl composed of 10 to 11 inflated, perforate, distinct chambers; regular, with final chamber slightly larger than preceding chamber. Umbo depressed, irregularly filled with small nodes of test material. Sutures narrow, curved and impressed join umbo at depressed level. Retral processes narrow, irregular; prominent in some cases; interprocess pits on final suture hemispherical, deep and numerous, indistinct on preceding sutures. Septal face curved, perforate, thinner than chamber

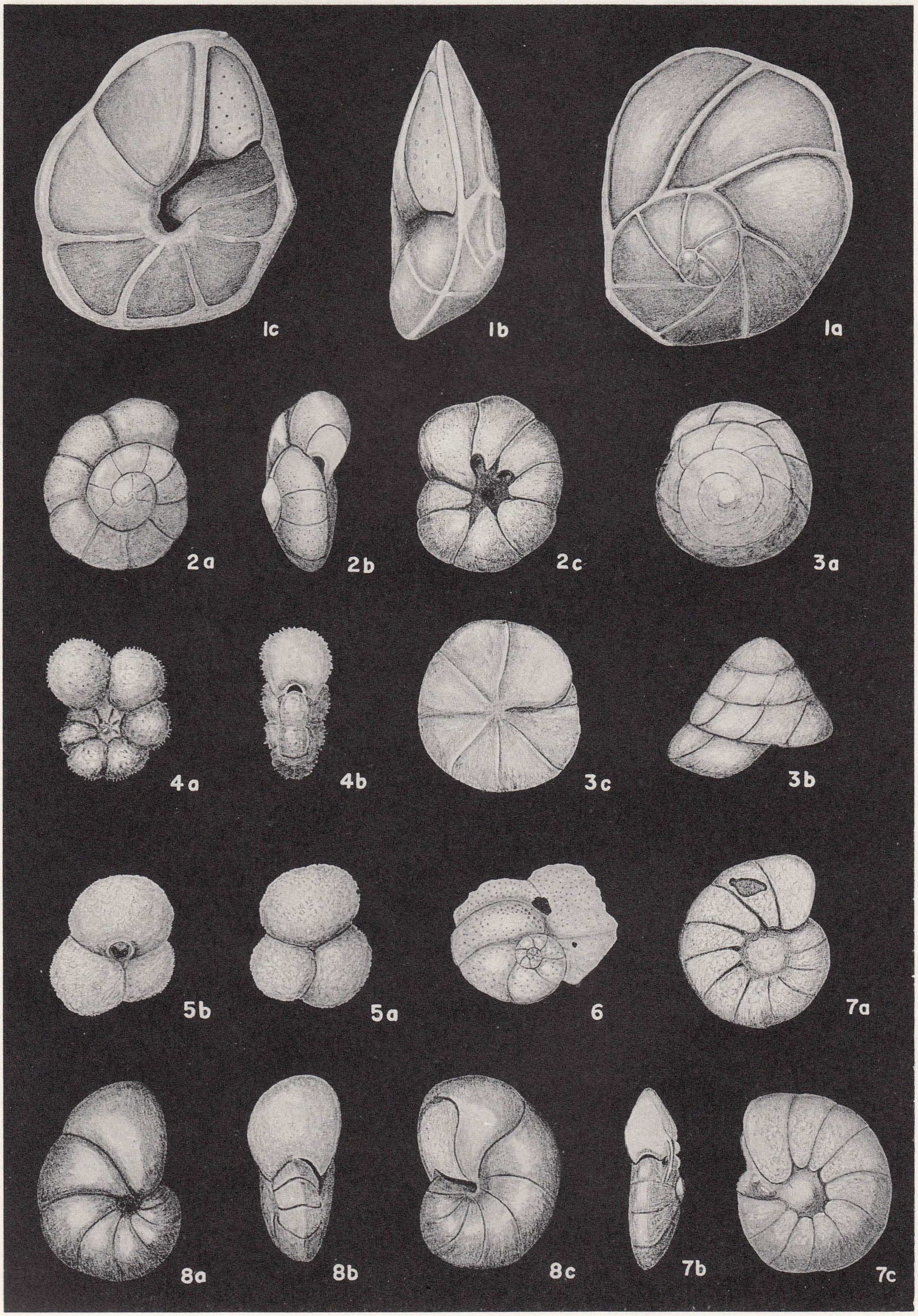
EXPLANATION OF PLATE 9

Recent foraminifera from Mason Inlet, North Carolina. (Magnifications approximate.)

FIGS.		PAGE
1.	*Nonionella* sp. aff. *N. auricula* Heron-Allen and Earland, Sta. 9; × 27. 1a, dorsal view. 1b, apertural view. 1c, ventral view.	55
2.	*Nonion* sp., Sta. 8; × 48. 2a, lateral view. 2b, apertural view.	55
3.	*Elphidium* sp. aff. *E. incertum* (Williamson) var. *mexicanum* Kornfeld, Sta. 5; × 48. 3a, lateral view. 3b, apertural view.	56
4.	*Elphidium incertum* (Williamson), Sta. 4; × 48. 4a, lateral view. 4b, apertural view.	56
5.	*Bolivina subaenariensis* Cushman, Sta. 6; × 48. 5a, lateral view. 5b, apertural view.	58
6.	*Uvigerina* sp., Sta. 6; × 60. 6a, lateral view. 6b, apertural view.	58
7.	*Elphidium gunteri* Cole var. *galvestonensis* Kornfeld, Sta. 8; × 60. 7a, lateral view. 7b, apertural view.	55
8.	*Reussella* sp., Sta. 6; × 48. 8a, lateral view. 8b, apertural view.	58
9.	*Discorbis* sp., Sta. 5; × 36. 9a, dorsal view. 9b, ventral view. 9c, end view.	59
10.	*Elphidium* sp., Sta. 2; × 48. 10a, lateral view. 10b, apertural view.	57
11.	*Elphidium frizzelli* Miller, new species, Sta. 8; × 27. 11a, lateral view. 11b, apertural view.	57
12.	*Cibicides* sp. cf. *C. refulgens* Montfort, Sta. 5; × 36. 12a, dorsal view. 12b, end view. 12c, ventral view.	61
13.	*Planorbulina mediterranensis* Orbigny, Sta. 6; × 48. 13a, dorsal view. 13b, ventral view.	62



Miller: Foraminifera of Mason Inlet, North Carolina



Miller: Foraminifera of Mason Inlet, North Carolina

wall, slightly impressed above aperture. Aperture small, multiple and basal; consisting of about 6 elliptical openings, evenly spaced at the base of the septal face. Color white.

Collecting Stations.—Abundant at Sta. 6, common at Sta. 1, moderately common at Sta. 5, and rare at Stas. 2, 3, 4, and 7.

Remarks.—Identification of this form has proved extremely difficult due to its variability. The characters of the specimen illustrated are similar to *Elphidium articulatum* (Orbigny) var. *rugulosum* Cushman and Wickenden 1929, and *Elphidium incertum.*

Elphidium sp.

Plate 9, figure 10

Description.—Test of medium size (greater diameter, 0.32 to 0.42 mm.), free, calcareous-perforate, planispiral; *thickness/greater diameter* ratio, 31%. Chambers distinct, slightly inflated, with acute periphery; 6 to 7 chambers in the final whorl. Sutures narrow, curved, slightly impressed with distinct, wide, retral processes; inter-process pits circular, deep, numerous. Umbo small, irregular, flush with chamber wall. Aperture small, multiple, 7 to 10 circular openings, basal. Color white.

Collecting Stations.—Sta. 2 (moderately common) and Sta. 5 (rare).

Elphidium frizzelli Miller, new species

Plate 9, figure 11

Elphidium gunteri Cole var. *galvestonensis* Kornfeld (in part), 1931, Stanford Univ., Dept. Geol., Contr., 1:87, pl. 15, figs. 1a-b (not figs. 2a-b, 3a-b).

Description.—Test of medium size (greater diameter, 0.58 mm.), free, calcareous-perforate, nearly circular, planispiral; the *thickness/greater diameter* ratio 40%. Chambers of final whorl numerous, 13, slightly irregular, inflated, well-rounded periphery; perforations small, numerous, closely spaced. Sutures narrow, impressed; distinct retral processes, about 10 per chamber; inter-process pits large, oval, deep. Umbo large, prominently raised with irregular small nodes, covers lower ⅓ of chamber walls. Septal face evenly rounded, perforate. Aperture multiple, small, basal; consisting of 4 or 5 elliptically shaped openings, evenly spaced. Color white.

Range.—Sta. 8 (rare); Texas (Kornfeld).

Comparison.—*Elphidium gunteri* Cole var. *galvestonensis* Kornfeld is the closest allied species. Kornfeld has confused the new species and included it with *E. galvestonensis* (Kornfeld, 1931, pl. 15, figs. 1-3). This form was tacitly excluded from *E. galvestonensis* by Cushman (1939, p. 60, pl. 16, fig. 25). Specimens of *galvestonensis* have a maximum greater diameter of 0.41 mm. This specimen is larger (0.58 mm.). *E. galvestonensis* has a *thickness/greater diameter* ratio of 42%, while this specimen shows a similar ratio of 40%. The umbonal boss of *E. galvestonensis* is multiple and slightly convex. This specimen has a distinct umbonal boss, large and strongly convex, which extends laterally over the lower ⅓ of the chamber walls.

Remarks.—The species is named for Don L. Frizzell, Missouri School of Mines and Metallurgy, Rolla, Missouri.

Disposition of Type.—The holotype will be placed in the collection of the U. S. National Museum, Washington, D. C.

Family BULIMINIDAE

Genus **Buliminella** Cushman, 1911

U. S. Nat. Mus., Bull., 71(2):88. Genotype: *Bulimina elegantissima* Orbigny.

Buliminella elegantissima (Orbigny)

Plate 8, figure 11

Buliminella elegantissima Orbigny, 1839, Voyage dans l'Amérique méridionale, Foraminifères, 5(5):51, pl. 7, figs. 13, 14.—Cushman, 1919, U. S. Nat. Mus., Proc., 56:606; *1944, Cushman Lab. Foram. Research, Sp. Pub., 12:27, pl. 3, figs. 43, 44; *U. S. Geol. Surv., Prof. Paper, 210-D:67-68, pl. 17, figs. 10-12, (with complete synonymy).

Type Localities.—Paita, Peru; Cobija, "Bolivia" (Peru? or Chile?); Valparaiso, Chile.

EXPLANATION OF PLATE 10

Recent foraminifera from Mason Inlet, North Carolina. (Magnifications approximate.)

Figs.		Page
1.	*Poroeponides repanda* (Fichtel and Moll), Sta. 9; × 27. 1a, dorsal view. 1b, end view. 1c, ventral view.	59
2.	*"Rotalia"* sp. cf. *R. beccarii* (Linné), Sta. 8; × 48. 2a, dorsal view. 2b, apertural end view. 2c, ventral view.	59
3.	*Eponides* sp. aff. *E. wrightii* (Brady), Sta. 8; × 60. 3a, dorsal view. 3b, end view. 3c, ventral view.	59
4.	*Globigerinella* sp., Sta. 4; × 60. 4a, lateral view. 4b, apertural view.	60
5.	*Globigerinoides* sp. cf. *G. ruber* Orbigny, Sta. 5; × 36. 5a, lateral view. 5b, apertural view.	60
6.	*Planulina caribaea* Cushman, Sta. 7; × 36. 6a, dorsal view.	60
7.	*Cibicides floridanus* (Cushman), Sta. 9; × 27. 7a, dorsal view. 7b, slightly oblique end view. 7c, ventral view.	61
8.	*Cibicides* sp. cf. *C. concentricus* (Cushman), Sta. 9; × 27. 8a, dorsal view. 8b, end view. 8c, ventral view.	61

Description.—Test very small (length, 0.23 to 0.40 mm.), free, calcareous, elliptical in outline, fusiform; consisting of about 2 whorls with 9 to 11 chambers in the last whorl. *Width/length* ratio 38% to 43% (typically 42%). Chambers of last whorl elongate, rounded, arcuate, regular, and distinct, with final chamber slightly larger than penultimate chamber, chamber wall slightly perforate. Sutures narrow, slightly impressed, curved. Septal face depressed and elongate, extending ⅓ length of test. Aperture small, simple, narrow slit at the top of the apertural face. Color white to light tan, typically translucent.

Collecting Stations.—Stas. 4 (abundant) and 6 (moderately common) .

Geographic Range.—This species occurs in both fossil and Recent material. It was described from Recent material at Paita, Peru, Cobija, in Chile or Peru, and Valparaiso, Chile. It has been described from fossil material in the Eocene, Wilcox Group, of Alabama, the Jackson Group of Texas and Louisiana, and the Pliocene of Florida.

Remarks.—The occurrence of *Buliminella elegantissima* (Orbigny) in Mason Inlet is important ecologically. Previously, it has been recorded from Florida and the New England coast. In New England it has been recorded from Nonamesset Island and Vineyard Sound, Massachusetts. Further studies of brackish water foraminifera will undoubtedly complete this range along the western Atlantic coast.

Genus **Bulimina** Orbigny, 1826

Ann. Sci. Nat., 7:269. Genotype: *Bulimina marginata* Orbigny.

Bulimina sp.

Plate 8, figure 8

Description.—Test of medium size (length, 0.40 to 0.42 mm.), free, calcareous-perforate, elongate, nearly triserial. Chambers inflated, well rounded, smooth, with thickened, short, protruding spines, pointing away from the aperture; *maximum width/length* ratio 65%. Sutures distinct, narrow, impressed, curved. Apertural face depressed, smooth trough with angular periphery at the chamber wall. Aperture of medium size, simple, loop shaped; depressed from the base of the apertural trough. Color translucent to white.

Collecting Stations. Sta. 4 (rare).

Genus **Bolivina** Orbigny, 1839

Voy. Amér. Mérid., 5(5):61. Genotype: *Bolivina plicata* Orbigny.

Bolivina subaenariensis Cushman, 1922

Plate 9, figure 5

Bolivina subaenariensis *CUSHMAN, 1922, U. S. Nat. Mus., Bull., 104(3):46, pl. 7, fig. 6; *1944, Cushman Lab. Foram. Research, Sp. Pub., 12:29-30, pl. 4, fig. 6.—*PARKER, 1948, Mus. Comp. Zool., Bull., 100(2): 237, pl. 5, fig. 17.

Type Locality.—Off coast of Nantucket in 250 fathoms.

Description.—Test of medium size (length, 0.29 to 0.44 mm.), free, calcareous-perforate with biserial growth plan throughout. Chambers slightly inflated, well-rounded periphery, with marginal edge thickened and well-rounded, peripheral edge pointed away from the aperture. Angle between suture and lateral axis about 50 degrees. Sutures narrow, depressed, slightly curved, regular. Aperture of medium size; a slightly curved slit, centrally situated and upright on the final chamber, extending downward to the top of the preceding chamber. Basal ⅓ of test ornate with fine striae. Color translucent to light tan.

Collecting Stations.—Stas. 1, 6 (moderately common), Sta. 9 (rare).

Geographic Range.—This species has been found along the coast of Nantucket, usually in the deeper water. A specimen was found in shallow water off the coast of Trials Island, Eastport, Maine.

Genus **Reussella** Galloway, 1933

Man. Foram., p. 360. Genotype: *Verneuilina spinulosa* Reuss.

Reussella sp.

Plate 9, figure 8

Description.—Test small (length, 0.22 to 0.34 mm.), free, calcareous-perforate, with triangular-shaped chambers arranged in a triserial growth plan. Chambers regular, triangular in cross-section with sides slightly concave, periphery acute; arranged in 6 to 7 whorls or tiers with each tier overlapping the previous one with sharp barbs. Chamber walls concave, smooth, with medium sized pores throughout. Final whorl overlaps penultimate whorl by ⅔ the chamber height. Sutures impressed, narrow, distinct. Aperture an irregular slit at the margin of the last chamber, hidden by broken lip or protrusion. One specimen ornate with short spinose protrusions at the periphery. Color translucent tan.

Collecting Stations.—Stas. 5 and 6 (rare).

Genus **Uvigerina** Orbigny, 1826

Ann. Sci. Nat., 7:268. Genotype: *Uvigerina pigmea* Orbigny.

Uvigerina sp.

Plate 9, figure 6

Description.—Test very small (length, 0.31 to 0.39 mm.), free, calcareous-perforate, elongate, *width/length* ratios 45% to 47% (typically 45%). Chambers slightly inflated, elongate, triserial, nearly circular in cross-section; final chamber somewhat triangular in cross-section, slightly concave at the periphery. Sutures distinct, thin, impressed. Aperture small, terminal, circular and produced at the apex of the last chamber. Color white.

Collecting Stations.—Stas. 1, 5, and 6 (rare).

Family ROTALIIDAE

Genus **Discorbis** Lamarck, 1804

Ann. Mus., 5:183. Genotype: *Discorbis vesicularis* Lamarck.

Discorbis sp.

Plate 9, figure 9

Description.—Test small (greater diameter, 0.27 to 0.29 mm.), apparently attached, calcareous-perforate, extremely depressed trochoid, consisting of about 2¼ whorls of plano-convex chambers, rounded dorsally. Initial coil barely discernible, last whorl with 8 chambers. Chambers flattened, slightly enlarged, rounded dorsally, flat to concave ventrally; final chamber twice as large as succeeding chamber; perforations fine, numerous. Sutures oblique, limbate or depressed irregularly, typically thin, slightly curved. Umbilicus large, depressed, prominent. Septal face basally rounded at the margin, just above thin fold. Aperture simple, small, narrow slit; ventrally situated at the base of the last chamber. Color light tan to brown.

Collecting Stations.—Sta. 4 (moderately common), and Sta. 5 (rare).

Genus **Eponides** Montfort, 1808

Conch. Syst., 1:127. Genotype: *Nautilus repandus* Fichtel and Moll.

Eponides sp. aff. **E. wrightii** (Brady)

Plate 10, figure 3

Eponides wrightii (Brady). *Cushman, 1931, U. S. Nat. Mus., Bull., 104(8):56, pl. 11, figs. 7, 8.

Description.—Test small (greater diameter, 0.21 to 0.27 mm.), free, calcareous-perforate, high-spired trochoid. *Greater diameter/height* ratio 87% to 93% (typically 92%). Consisting of about 3¼ whorls, with initial coil indistinct; 7 to 9 chambers in last whorl; very finely perforate. Peripheral margin acutely rounded. Umbilicus filled by chamber extensions from the last whorl. Sutures thin, slightly curved and impressed. Septal face rounded, smooth. Aperture a small, thin, curved slit at base of apertural face, ventral. Color white.

Collecting Stations.—Stas. 2, 7, and 8 (rare).

Remarks.—This specimen differs from *Eponides wrightii* (H. B. Brady) in having neither an umbilical plug nor beads in radial lines along the ventral sutures.

Genus **Poroeponides** Cushman, 1944

Cushman Lab. Foram. Research, Sp. Pub., 12:34. Genotype: *Rosalina lateralis* Terquem.

Poroeponides repandus (Fichtel & Moll)

Plate 10, figure 1

Nautilus repandus Fichtel and Moll, 1798, Test. Micro., p. 35, pl. 3, figs. a-d.

Eponides repandus Montfort, 1808, Conch. Syst., 1: 127, 32^e genre.

Pulvinulina repanda (Fichtel and Moll). *Carpenter, Parker, and Jones, 1862, Intro. Foram., p. 210. —*Cushman, 1925, Cushman Lab., Foram. Research, Contr., 1(2):43.—Hanzawa, 1925, 1926, Jour. Geol. Pal., 4:44.

Rotalia repanda (Fichtel and Moll). *Shupack, 1934, Am. Mus. Novit., 737:7.

Eponides repanda (Fichtel and Moll). *Cushman, 1931, U. S. Nat. Mus., Bull., 104(8):49, pl. 10, figs. 7a-c.

Type Locality.—Unknown.

Description.—Test large (greater diameter, 0.67 to 1.05 mm.), free, calcareous-perforate, depressed trochoid, unevenly biconvex. Initial coil well defined, flat; subsequent chambers distinct and regular, usually about 1¾ whorls in the adult; last whorl with 7 chambers, nearly triangular in cross-section, very finely perforate. Deep umbilical cavity along base of last 2 or 3 chambers and into base of septal face. Septal face only slightly curved and offset about 30 degrees from longitudinal axis; large pores, possibly secondary apertures, are scattered over the septal face. Sutures wide, distinct, raised, slightly curved, join the heavy keel without interruption. The clear keel follows the curved outline of the youngest chambers, but is angular and thickened in the first 1½ whorls. Aperture a simple, curved slit at the base of the septal face, widening toward the periphery and terminating against the inside margin of the keel. Wall white, distinct from translucent sutures.

Collecting Stations.—Stas. 5 and 6 (common), and 7 and 9 (moderately common).

Geographic Range.—*Poroeponides repandus* has a wide range throughout the warm water zones of the Atlantic Ocean. It is abundant in the open sea at Kure Beach, south of Wilmington.

Remarks.—This species is the largest calcareous foraminifer found in the Mason Inlet region.

Genus **Rotalia** Lamarck, 1804

Ann. Mus., 5:184. Genotype: *Rotalia trochidiformis* Lamarck.

"Rotalia" sp. cf. **"R." beccarii** (Linné)

Plate 10, figure 2

?*Nautilus beccarii* Linné, 1767, Syst. Nat., ed. 12, p. 1162; ed. 13 (Cmelin's) 1788, p. 3370.

?*Streblus beccarii* (Linné). Fischer de Waldheim, 1819, Advers. Zool., fasc. 2, p. 75.

?*Discorbula ariminensis* Lamarck, 1816, Tabl. Encycl. Méth., pl. 466, figs. 6a, b.

?*Rotalina beccarii* (Linné). Williamson, 1858, Rec. Foram. Gt. Britain, p. 48, pl. 4, figs. 90-92.

Rotalia beccarii (Linné). *Cushman, 1931, U. S. Nat. Mus., Bull., 104(8):58, pl. 13, figs. 1a-c; *1944, Cushman Lab. Foram. Research, Sp. Pub., 12:35, pl. 4, figs. 22a, b.

Type Locality of Rotalia beccarii: Rimini, Italy.

Description.—Test of medium size (greater diameter, 0.28 to 0.48 mm.), free, calcareous-perforate, depressed trochoid, with inflated chambers, unevenly biconvex, and well rounded periphery. Typically 3¼ to 3¾ whorls in the adult, consisting of a distinct initial whorl, usually of 8 chambers, and a last whorl of 7 to 8 chambers. Chambers inflated, distinct, unevenly biconvex, intensely perforate. Umbilical region irregular, typically hollow but frequently modified by extensions of the chamber wall. Sutures narrow, impressed, curved, slightly inclined. Septal face rounded, perforate, ventral; slightly raised and produced at the base forming an apertural lip. Aperture of medium size; a simple, curved slit, ventrally situated at the base of the septal face. Color light tan.

Collecting Stations.—Abundant at Stas. 4 and 6, common at 5 and 7, moderately common at Stas. 1, 3, and 8, and rare at Stas. 2 and 9.

Geographical Range.—This is a very common species, having been recorded from nearly the entire Atlantic Ocean. It has been recorded as a shallow water species along the New England coast by Cushman, and in New York Harbor by Shupack. The varieties *tepida* and *parkinsoniana* of this species have also been found by Hadley at Beaufort, North Carolina.

Remarks.—Due to the presumed variation in "*Rotalia*" *beccarii,* no attempt was made to separate these specimens according to described varieties.

Family GLOBIGERINIDAE

Genus **Globigerinoides** Cushman, 1927

Cushman Lab. Foram. Research, Contr., 3:87. Genotype: *Globigerina rubra* Orbigny.

Globigerinoides sp. cf. **G. ruber** (Orbigny), 1839

Plate 10, figure 5

?*Globigerina rubra* Orbigny, 1839, *in* de la Sagra, Hist. Fis. Pol. Nat. Cuba. "Foraminifères," p. 94, pl. 4, figs. 12-14.—H. B. Brady, Parker, and Jones, 1888, Zool. Soc. London, Trans., 12:225, pl. 45, fig. 12.—Cushman, 1914, U. S. Nat. Mus., Bull., 71(4):9, pl. 3, figs. 6-9; *1924, *ibid.,* 104(5):15, pl. 3, figs. 4-7.

Type Locality of Globigerina rubra: West Indian Ocean.

Description.—Test of medium size (greater diameter, 0.20 to 0.45 mm.), free, calcareous-perforate, depressed trochoid with final chambers nearly spherical. Initial coil indistinct, typically 3 chambers in the last whorl. Final chambers rounded, oval with coarse perforations numerous; depressions from remnant spine sockets distinct, large in comparison to the test. Sutures narrow, depressed, distinct on final chambers. Aperture large, simple; highly arched at the inner margin of the chamber, with a thin, smooth lip circumventing the opening. Color very light tan, translucent. These specimens were tinted pink and tan, when first observed, one week after collection.

Collecting Stations.—Very abundant at Sta. 6, common at Stas. 5 and 7, moderately common at Stas. 1 and 4, and rare at Sta. 2.

Geographic Range.—This pelagic species is recorded from both sides of the Atlantic Ocean, the West Indian Ocean and the Caribbean Sea in abundance. The warm Gulf Stream of the Gulf of Mexico frequently produces specimens with bright colored tests.

Remarks.—Some of the specimens appear to be reworked material. Station 4 has yielded specimens less than 0.2 mm. in their greater diameter.

Genus **Globigerinella** sp. Cushman, 1927

Cushman Lab. Foram. Research, Contr., 3:87. Genotype: *Globigerina aequilateralis* Brady.

Globigerinella sp.

Plate 10, figure 4

Description.—Test small (greater diameter, 0.24 to 0.31 mm.), free, calcareous-perforate, with planispiral growth plan of inflated, spheroidal chambers. Adult test of 2 whorls with 5 to 7 chambers in the final whorl. Chambers of medium size, globular, regular, distinct; chamber wall ornate with numerous, short, thin spines. Sutures distinct, narrow, impressed, nearly straight. Apertural face rounded, spine free; slight protrusions near base of septal face. Aperture simple, medium sized, basal, central, highly arched opening completely overlain by apertural lip. Color white, light tan and brownish red.

Collecting Stations.—Sta. 4 (abundant).

Family ANOMALINIDAE

Genus **Planulina** Orbigny, 1826

Ann. Sci. Nat., 7:280. Genotype: *Planulina ariminensis* Orbigny.

Planulina caribaea Cushman, 1931

Plate 10, figure 6

Planulina caribaea *Cushman, 1931, U. S. Nat. Mus., Bull., 104(8):112, pl. 20, figs. 1a-c.

Type Locality.—Montego Bay, Jamaica, West Indies.

Description.—Test of medium size (greater diameter, 0.38 mm.), free, calcareous-perforate, very depressed trochoid initially, with youngest chambers expanded irregularly and flattened. Initial coil of 7 chambers visible dorsally, final whorl of 6 to 7 chambers. About 2½ whorls in the adult, with final whorl incomplete in regular trochoid pattern due to expansion of last three chambers. Chambers slightly inflated, coarsely perforate, regular in first two whorls. Sutures thin, curved, impressed, and oblique. Peripheral margin acute with slight keel. Aperture simple, curved, narrow, ventral slit at base of final chamber. Color tan to white.

Collecting Stations.—Sta. 7 (rare).

Geographic Range.—This species has been recorded from many regions of the West Indies, especially near Jamaica. It has also been reported in the eastern Atlantic Ocean.

Remarks.—The description of this species given by Cushman (1931) states that the initial whorls are planispiral. This specimen, although nearly planispiral, is a very depressed trochoid in which the umbilicus is comparable to the ventral depression discussed by Cushman. This is the northernmost occurrence of the species in the western Atlantic Ocean and represents a northern extension in the geographic range.

Genus **Cibicides** Montfort, 1808

Conch. Syst., 1:123. Genotype: *Cibicides refulgens* Montfort.

Cibicides sp. cf. **C. concentricus** (Cushman)

Plate 10, figure 8

?*Truncatulina concentrica* CUSHMAN, 1918, U. S. Geol. Surv., Bull., 676:64, pl. 21, fig. 3.

Cibicides concentrica (CUSHMAN). CUSHMAN, 1931, U. S. Nat. Mus., Bull., 104(8):120, pl. 21, figs. 4, 5; pl. 22, figs. 1, 2.—*PARKER, 1948, Mus. Comp. Zool., Bull., 100(2):287, pl. 1, figs. 16a, b (check list and figure only).

Type Locality of Truncatulina concentrica: One mile south of Red Bay, Florida.

Description.—Test of medium size (greater diameter, 0.68 to 0.70 mm.), free, calcareous-perforate, trochoid of highly inflated chambers unevenly biconvex with well rounded periphery. Initial coil hidden by subsequent whorls, 7 to 8 chambers in the final whorl of meglospheric form. Sutures narrow and nearly straight dorsally, curved ventrally, slightly impressed. Septal face slightly curved, framed by thin perforate lens of test material, thinner than walls. Aperture simple, medium, curved slit at base of septal face, slightly dorsal, nearly hidden under depressed septal face. Color light gray to tan.

Collecting Stations.—Sta. 9 (common), Stas. 5 and 7 (moderately common), and Stas. 1 and 6 (rare).

Geographic Range.—This is a common warm water species along the coast of Florida and nearby areas.

Stratigraphic Range.—This species has been recorded from the Miocene of Florida, in the Choctawhatchee marl.

Remarks.—Many of these specimens are discolored and show abrasion. These may be fossil specimens. However, several of the specimens, including the one figured, are not discolored and do not show wear.

Cibicides floridanus (Cushman)

Plate 10, figure 7

Truncatulina floridana CUSHMAN, 1918, U. S. Geol. Surv., Bull., 676:62, pl. 19, figs. 2a-c.—NUTTALL, 1928, Geol. Soc. London, Quart. Jour., 84:98, pl. 7, figs. 14, 16.

Cibicides floridana (CUSHMAN). CUSHMAN, 1930, Fla. Geol. Surv., Bull., 4:61, pl. 12, figs. 3a-c; *1931, U. S. Nat. Mus., Bull., 104(8):122, pl. 23, figs. 3-5.

Type Locality.—One mile south of Red Bay, Florida; Choctawhatchee marl (Miocene).

Description.—Test of medium size (greater diameter, 0.65 mm.), free, calcareous-perforate, depressed trochoid; rounded ventrally, flattened dorsally, with peripheral margin acute and rounded. About 2½ whorls in the adult, consisting of 11 to 12 chambers in the last whorl, very finely perforate, inflated ventrally and evenly rounded from margin to umbilical plug; chamber walls roughened by wrinkled surface of small rounded nodes, wrinkled surface also present internally. Umbilical plug large, smooth, and rounded. Sutures thin, impressed, curved, regular but not pronounced ventrally; curved, impressed, pronounced dorsally. Aperture medium sized, simple, arched slit; situated centrally at the base of the septal face, ventral. Color light tan.

Collecting Stations.—Stas. 1 and 9 (rare).

Geographic Range.—This species has been recorded by Cushman as common along the coast of Florida.

Stratigraphic Range.—*Cibicides floridanus* has been reported from the Miocene beds of the Choctawhatchee marl of Florida and from the Miocene of the Vienna Basin.

Cibicides sp. cf. **C. refulgens** Montfort, 1808

Plate 9, figure 12

?*Cibicides refulgens* MONTFORT, 1808, Conch. Syst., 1: 122.—*F. L. PARKER, 1948, Mus. Comp. Zool., Bull., 100, no. 2, pl. 6, figs. 10a, b.

?*Truncatulina refulgens* (MONTFORT). ORBIGNY, 1826, Ann. Sci. Nat., 7:279, pl. 13, figs. 8-11.—HERON-ALLEN and EARLAND, 1930, Roy. Micr. Soc., Jour., p. 187.

Type Locality.—Not designated.

Description.—Test of medium size (greater diameter, 0.32 to 0.47 mm.), apparently attached, calcareous-perforate, depressed trochoid, plano-convex, flattened dorsally, peripheral margin acute. About 2½ whorls in the adult, 6 chambers in the initial whorl, 9 chambers in the second whorl, and 9 in the final whorl. Chambers slightly inflated, regular in the first two whorls, slightly irregular in the final whorl; final chamber 1¼ times as high as preceding chamber. Perforations coarse, very closely spaced, numerous. Sutures thin, curved, impressed, and inclined dorsally, inclined to a lesser degree ventrally. Umbilical region filled by inner margin of chambers in the last whorl. Septal face smoothly rounded and perforate. Aperture broken. Color light tan.

Collecting Stations. Stas. 2, 5, and 6 (rare).

Geographic Range.—This is a widely ranging species which has been reported from many stations in the Atlantic Ocean.

Stratigraphic Range.—*Cibicides refulgens* has been reported as fossil from Tertiary strata of the United States.

Genus **Dyocibicides** Cushman and Valentine, 1930

Stanford Univ., Geol. Dept., Contr., 1(1):30. Genotype: *Dyocibicides biserialis* Cushman and Valentine.

?**Dyocibicides biserialis** Cushman and Valentine

Description.—Test of medium size (length, 0.42 mm.), free, calcareous-perforate; consisting of an initial trochoid coil of about 1¾ whorls and a final whorl with irregular chamber growth. Chambers distinct and regular in initial whorl; later chambers inflated, coarsely-perforate, arcuate. Peripheral margin variable; rounded in early whorls, acute in final chambers. Irregular chambers without definite shape, coarsely-perforate and situated ventrally at the periphery of the final whorl. Sutures of early whorls narrow, strongly curved, impressed, distinct, variable in irregular chambers. Major portion of irregular growth ventral. Aperture simple slit, of medium size, situated ventrally at the base of final chamber. Color light tan to translucent.

Collecting Stations.—Sta. 7 (rare).

Remarks.—A single specimen has been found of a *Cibicides*-like form that may be identical with that referred by Hadley (1936) to *Dyocibicides biserialis.* The specimen is almost certainly teratological, and may belong to one of the species of *Cibicides.*

Family PLANORBULINIDAE

Genus **Planorbulina** Orbigny, 1826

Ann. Sci. Nat., 7:280. Genotype: *Planorbulina mediterranensis* Orbigny.

Planorbulina mediterranensis Orbigny, 1826

Plate 9, figure 13

Planorbulina mediterranensis ORBIGNY, 1826, Ann. Sci. Nat., 7:280, no. 2, pl. 14, figs. 4-6.—BRADY, 1884, Rep. Voy. Challenger, Zool., 9:656, pl. 92, figs. 1-3. —HERON-ALLEN and EARLAND, 1930, Roy. Micr. Soc., Jour., p. 186.—*CUSHMAN, 1931, U. S. Nat. Mus., Bull., 104(8):129, 130, pl. 24, figs. 5-8.

Type Locality.—Mediterranean Sea.

Description.—Test of small size (length, 0.32 to 0.37 mm.), apparently attached, calcareous-perforate, with initial coil of at least 2 whorls, depressed; final chambers irregularly situated, flattened. Chambers of spiral medium sized, slightly inflated, rounded and regular, dorsally; obscure ventrally. Succeeding chambers similar but irregularly situated about the periphery of the spiral. All chambers visible dorsally, irregular chambers visible in part ventrally. Perforations large and numerous. Umbilical region depressed. Sutures narrow, depressed, well defined dorsally, partially obscured ventrally. Aperture medium size, 1 visible, situated on the periphery, extending dorsally and ventrally, overlain by narrow, curved, protruding lip. Color light tan in the inner whorl, white otherwise.

Collecting Stations.—Sta. 6 (rare).

Geographic Range.—This species is widely distributed in the eastern Atlantic Ocean from Norway to Spain and in the Mediterranean and Indo-Pacific Oceans. In the western Atlantic the species has been recorded from the coast of Florida, the West Indies, and Brazil.

Remarks.—This seems to be the first occurrence of the species, on the western Atlantic coast, north of Florida. The presence of *Planorbulina mediterranensis* Orbigny in Mason Inlet extends its geographic range approximately 300 miles north.

REFERENCES

(Exclusive of synonymic entries)

CUSHMAN, J. A., 1920, The Foraminifera of the Atlantic Ocean. Part 2, Trochamminidae. U. S. Nat. Mus., Bull., 104(2):1-111, pls. 1-18.

———, 1939, A Monograph of the Foraminiferal Family Nonionidae, U. S. Geol. Surv., Prof. Paper, 191:1-10, pls. 1-20.

———, 1944, Foraminifera from the Shallow Water of the New England Coast. Cushman Lab. Foram. Research, Sp. Pub., 12:1-37, pls. 1-4.

HADA, Y., 1936, Studies on the Foraminifera of Brackish Waters. I, Hijirippu and Mochirippu Lakes. Zool. Mag., 48(8-10):847-860, text figs. 1-12, tables 1-4, maps 1-3 (Japanese with English summary).

———, 1937, Studies on the Foraminifera of Brackish Waters. II, Hachiro-Gata III. Koyama-Ike. Zool. Mag., 49(10):341-347, text figs. 1-7, tables 1-2 (Japanese with English summary).

———, 1939, Studies on the Foraminifera of Brackish Waters. IV. The Foraminifera of Nakanouzi. Zool. Mag., 51(3):135-140, text fig. 1, tables 1-5 (Japanese with English summary).

HADLEY, W. H., 1936, Recent Foraminifera from near Beaufort, North Carolina. Elisha Mitchell Sci. Soc., Jour. 52:35-37, text fig.

KORNFELD, M. M., 1931, Recent Littoral Foraminifera from Texas and Louisiana. Stanford Univ., Dept. Geol., Contr., 1(3):77-93, pls. 13-16.

PHLEGER, F. B., and WALTON, W. R., 1950, Ecology of Marsh and Bay Foraminifera. Am. Jour. Sci., 248(4):274-294, pls. 1-2, text figs. 1-2, tables 1-3.

POST, R. J., 1951, Foraminifera of the South Texas Coast. Inst. Marine Sci., Publ., 2(1):165-176, pl. 1. table 1.

SHUPACK, B., 1934, Some Foraminifera from Western Long Island and New York Harbor. Am. Mus. Novitates, 737:1-12, plate, text-figures.

WENTWORTH, C. K., 1922, A scale of grade and class terms for clastic sediments. Jour. Geol., 30:377-392.

79. THE NAME AND DIMORPHISM OF *ENDOTHYRA BOWMANI* PHILLIPS 1846[1]

LLOYD G. HENBEST[2]

ABSTRACT—The term **Endothyra bowmani** Phillips, 1846, as emended by Brady, 1876, is one of the most widely used names of Foraminifera in geologic and paleontologic literature and was accepted as representing skew-coiled endothyrids. Discovery that Brown applied the name **E. bowmani** to what seems to be a planispiral endothyrid in a publication prior to Phillips led Zeller (1950) to apply the law of priority and to erect the new generic name **Plectogyra** for skew-coiled endothyrids.

This paper constitutes a recommendation to conserve the name **Endothyra bowmani** Phillips em. Brady because of (1) the long and extensive use of the term in the literature, (2) the types are lost, (3) the revision leaves the nature of the original specimens as obscure as before, and (4) the proposition, offered in this paper, that the planispiral and skew-coiled forms represent alternate generations and not different genera. If dimorphism is ultimately demonstrated the skew-coiled forms would have to be reassigned to **Endothyra.** Conservation of the name would stabilize the usage prior to 1950 and would avoid necessity of a second name shift if alternation of generations is verified.

HISTORY OF THE PROBLEM

In 1846 Phillips (p. 277) introduced *Endothyra bowmani* as a new genus and species of the protozoan order Foraminifera. The specimen that Phillips described belonged to Mr. J. E. Bowman and was collected from rocks of Mississippian age in England. The species was illustrated by a rough outline sketch (see Fig. 1) and was described as follows:

". . . commencing with the Mountain limestone . . I distinguish a beautiful concamerated shell, most probably a foraminifer, with a large opening in each septum, on the interior edge. Formerly I saw in the possession of Mr. John E. Bowman a specimen of this kind, visible to the naked eye, and named it Endothyra Bowmanni. The volutions are swollen externally between the septa."

The species was named after Mr. J. E. Bowman. Through some error the term was spelled *"Bowmanni"* by Phillips. Brady (1876, p. 92) discussed and corrected the spelling to read *"bowmani."* The corrected spelling has prevailed.

The description, sketch, and stratigraphic source indicate but do not verify that the form Phillips described was *probably* one of two endothyrids that are now known to have existed in Mississippian time, but it is not possible to determine which one because the type specimen seems to have been lost. In summary the generic identity of Phillips's specimen cannot be positively determined.

In 1876 Brady (pp. 92-94) redescribed and refigured *E. bowmani* Phillips with new collections. He explicitly attempted to establish what he regarded as the form that Phillips originally described. This constituted a formal revision and apparently the first one. In the century that followed Phillips's publication, the definition of *Endothyra* that Brady established as representing the skew-coiled, endothyrid genus, which has a wandering or revolving axis of coiling (like *E. baileyi* (Hall), for example) has prevailed. In Brady's sense the term *Endothyra* has become one of the most widely used names of Foraminifera in specialized paleontologic and stratigraphic literature and in textbooks of geology and paleontology.

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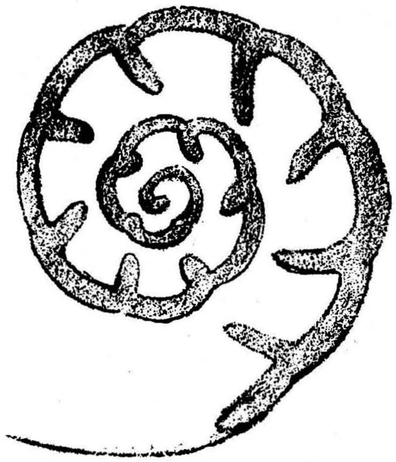

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Fig. 1. Original figure of *Endothyra bowmani* Phillips, 1846, reproduced original size.

Fig. 2. Original figure of *Endothyra bowmani* Brown, 1843, reproduced original size. A 10-mm scale is added for checking the exact size of both original figures.

In 1950, however, Zellar (pp. 2-4) challenged both the validity of Phillips's authorship and the concept of the character of *Endothyra bowmani* that was established by Brady. Zellar's reason was that in 1843, Brown published the name *"Endothyra bowmani* Phillips" three years before Phillips published the name, making Brown, not Phillips, the technical author of the name. Brown's description (1843, p. 17) follows:

> "Genus XI. — ENDOTHYRA." — *Phillips.*
>
> "Generic character.—Shell involute, discoidal, internally concamerated, the chambers communicating by a large perforation; the septa arranged in stellated order; their emarginations on the inner part of their disk; destitute of any shelly siphuncle. Form of the septal edge unknown. Size, one fiftieth of an inch."
>
> *Endothyra bowmani.* Plate VI., fig. 2. Found in the Mountain limestone of Westmoreland."

Brown's figure (fig. 2) is more definitive and his description less so than Phillips's. There is little resemblance between Brown's and Phillips's figures. Brown's drawing represents a planispiral form but as the figure is diagrammatic, circumstantial evidence (none of which is without ambiguity or possible error) is the ultimate basis for determining that the form is an endothyrid. Zeller reasoned that technically Brown was the prior author, and therefore that the planispiral form, which Brown appears to have represented, is legally the true *Endothyra.* Zeller (pp. 3-4) made this revision and applied the new name *Plectogyra* to the skew-coiled, endothyrid genus of Brady and other authors with *Plectogyra plectogyra* n. sp. as the genotype.

From existing evidence, the chances seem better than even that the specimen figured by Brown was a planispiral endothyrid, but this question remains a matter of conjecture. The type specimens are not known to exist. The exact source of the original sample was not indicated and topotypes—whatever they would be worth as evidence — are not obtainable. Brown's figure is idealized but to what extent is not determinable. The morphology represented by Brown's figure differs in one or more significant features from any genus so far recorded from the Mississippian. No one genus possesses the combination of coiling habit, radius vector, number or spacing of septa, length of septa, and degree of subordination of chamber form to the architecture of the shell that his figure illustrates. Actually, Brown's figure looks suspiciously like the equatorial section of a Pennsylvanian fusulinid. The more probable explanation of the inconsistencies in Brown's figure is that the drawing represents a composite of his understanding of foraminiferal morphology and of the actual structure of a specimen. Inasmuch as planispiral growth in Foraminifera appeared before the Mississippian (for example, *Nanicella* Henbest) and as knowledge of Mississippian foraminiferal faunas is still fragmentary, the evidence that Brown described and figured a planispiral endothyrid or actually any kind of endothyrid is not finally determinable. The identity of Phillips specimen suffers from equal uncertainties; so the recognition of Brown instead of Phillips as the technical author of the name, replaced one uncertainty with another. For so little gain, application of the law of priority certainly exacts a heavy toll.

DIMORPHISM AS A FACTOR IN THE TAXONOMY OF ENDOTHYRA

The taxonomic nomenclature of *Endothyra* is threatened with an additional kind of complication. Several lines of evidence indicate that the skew-coiled and the planispiral modes of growth in endothyrids represent alternation of generations instead of separate generic stocks.

So far the problem of dimorphism in *Endothyra* has not been fully examined, but a preliminary outline of the evidence is germane to our problem of nomenclature. The structure and composition of the walls and the low degree of subordination of chamber form to the architecture of the shell is alike in the skew-coiled and the planispiral forms. Both forms seem to possess the peculiar secondary, levee-like mounds and the "hooks" described by Zeller inside the chambers. The significance of this morphologic correlation is increased by the peculiarity of the endothyrids among the Foraminifera of the time. A brief survey of a few hundred specimens of *Endothyra baileyi* (Hall) from Indiana shows that roughly one individual in a hundred has a skew-coiled first volution that is followed by planispiral growth. Various degrees of intergradation from skew to planispiral growth may be seen in the Osage and subsequent species of endothyrids that are illustrated by Zeller (1950, pls. 2-6). The difference in external size and in size of the proloculus of the two forms is not great, but the proloculus of the planispiral form seems to be larger. The skew-coiled form is regarded as the microspheric generation because that mode of growth appears to be more primitive in the Foraminifera.

At this stage of study, the evidence for dimorphism in *Endothyra* must be regarded as inconclusive. Nevertheless the probability that the skew and the planispiral forms represent dimorphism is sufficiently great to add a material factor in the issue of conserving the name *Endothyra* Phillips. If the name *Endothyra* Phillips is preserved, the generic assignment of all but one new endothyrid species will remain undisturbed regardless of whether alternation of generations is demonstarted or is disproved. On the contrary, if the law of priority is rigidly applied as proposed by Zeller and if alternation of generations is demonstrated at some future date, the species of *Plectogyra* will have to be reassigned to *Endothyra* Brown, thereby doubling the confusion of the names.

SUMMARY OF REASONS FOR CONSERVING THE NAME

Four objections may be raised against this instance of the literal application of the law of priority:

1. The exact generic identity of the specimen or specimens figured by Brown and by Phillips is not determinable. Either they figured different specimens or one of them took far more interpretative liberties than the other. The two figures have little in common. The point here is that the rigid application of the law of priority adds little or nothing to solving the basic dilemma as to what the type specimen or specimens of *Endothyra bowmani* actually were.

2. The second objection depends for value on the status of Brady (1876, p. 92-94) as the first reviser. Brady in his revision dealt with *Endothyra bowmani* Phillips and gave no indication that he was aware of what we now regard as Brown's technical priority. Brady's treatment of *Endothyra* leaves no question of its representing the kind of endothyrid that has a wandering or rotating axis of coiling.

3. The third objection is that the term *Endothyra* Phillips 1846, em. Brady 1876, is one of the most widely used names of Foraminifera. Its use is so extensive in paleontologic, stratigraphic, and textbook literature that a change at this date will create confusion and will gain little or nothing in taxonomic precision. Regardless of the other considerations enumerated above, this fourth objection alone is sufficient cause to stay the rigid application of the law of priority that was proposed by Zeller (1950).

4. The fourth objection rests on the possibility that the planispiral endothyrid is but the megalospheric generation of *Endothyra*. If this should prove to be true, another major name shift would be mandatory because most of the species of *Endothyra* are involved in the name shift that is required by rigid application of the law of priority. On the contrary, if the name *E. bowmani* Phillips em. Brady is conserved, future proof or disproof of dimorphism will not affect the stability of the species of *Endothyra* and literature thereon before 1950.

PETITION

For the reasons described above, a formal petition is being submitted to the International Commission on Zoological Nomenclature, under suspension of the rules (a) to suppress *Endothyra* Brown, 1843; (2) to conserve the name *Endothyra* Phillips, 1846, as emended by Brady, 1876 (pp. 92-94); (3) to validate Brady's correction of the spelling of the trivial name of the genotypic species as *bowmani* instead of "Bowmanni"; and (4) to add *Endothyra* Phillips, 1846, em. Brady, 1876, to the Official List of Generic Names in Zoology.

REFERENCES

Brady, H. B., 1876, A monograph of Carboniferous and Permian Foraminifera (The genus Fusulina excepted): Paleontographical Society, vol. for 1876, 166 pp., 12 pls.

Brown, T., 1843, The elements of fossil conchology: Haulston and Stoneman, London, Edinburgh, p. 17, pl. 6, fig. 2.

Phillips, J., 1844-45 [1846], On the remains of microscopic animals in the rocks of Yorkshire: Geol. and Polytechnical Soc. West Riding, Yorkshire, Proc. Leeds, vol. 2, p. 277.

Zeller, E. J., 1950, Stratigraphic significance of Mississippian endothyroid Foraminifera: Univ. Kansas, Paleontological Contrib., Protozoa, art. 4, 23 pp., 6 pls.

80. AN ABNORMAL UVIGERINA FROM THE UPPER EOCENE, MISSISSIPPI

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A single specimen of *Uvigerina cocoaensis* Cushman (1925, p. 68, pl. 10, fig. 12) possessing two necks and two apertures on the terminal chamber, (Text fig. 1), was found by T. J. Keating, geology student at the University of Texas. The specimen was obtained from a sample collected by S. P. Ellison, Jr., in June 1950 from the Shubuta member of the Yazoo clay (Upper Eocene) about 700 feet east of the Shubuta bridge over the Chickasawhay River in a ravine north of Highway 45 along the north line of the NW¼ of sec. 10, T. 10 N., R. 7W, east of Shubuta, Clarke County, Mississippi. This is the type locality for the Shubuta member (Murray, 1947, p. 1839) which here is a light blue-gray fossiliferous clay. Boiled and decanted samples of the clay yield only a residue of fossils, mainly Foraminifera. The unusual specimen illustrated here occurred in the "*Lenticulina*" beds of Monsour (1937, p. 91).

Both necks are slightly divergent in direction of growth and both possess a phialine lip around the terminal aperture. A fortunate broken part of the last chamber allows inspection of the necks (now siphons or internal tubes) of the next to last chamber. These tubes are relatively close together and are welded into a common elliptical tube at their bases. This suggests that if the siphons of all of the chambers could be examined, it would be seen that the anomalous condition of two necks may occur only on the last two chambers. Various common techniques of examining the specimen in transmitted light failed to give a clear picture of the internal structure beyond the last two chambers.

At least two other instances of a double-apertured *Uvigerina* are recorded in the literature. *Uvigerina canariensis* Orbigny forma *distoma* De Amicis (1895, p. 29, pl. 2, fig. 5) from the Lower Pliocene of Sicily is described and illustrated with two terminal chambers each with a neck and a phialine lip around the aperture. De Amicis had only one specimen and considered it an abnormal growth. It differs from the *Uvigerina cocoaensis* Cushman illustrated here (Text fig. 1) in that each of the two necks emerged from different chambers. *Uvigerina curta* Cushman and Jarvis (1929, p. 13, pl. 3, fig. 13) from the Eocene of Trinidad, B. W. I., is illustrated and described with both single and double apertures. Only one double apertured specimen was pictured, but the descriptive text indicates several specimens with two apertures had been observed. This species is like *Uvigerina cocoaensis* Cushman in that the two necks emerge from a single terminal chamber.

Speculation would suggest that the development of

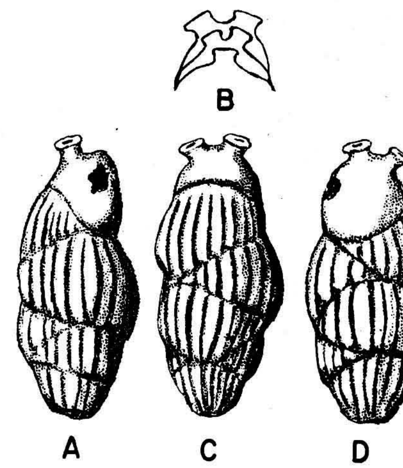

FIGURE I

EXPLANATION OF FIGURE 1

A, C, D — *Uvigerina cocoaensis* Cushman, lateral views of an abnormal specimen, UT 1001, Shubuta member, Yazoo clay, Upper Eocene, Clarke County, Mississippi. × 53.

B — Diagrammatic cross section showing internal arrangement of siphons. × 53.

the two necks may have been a response to an injury, disease, or mutation. If the development was connected with the growth of twins more evidence of twinning should be found in the early chambers.

The double-necked *Uvigerina* is a problem to the taxonomist because the genus and subfamily, according to Cushman (1948, p. 273), or family, according to Galloway (1933, pp. 370-373), are defined as possessing a single terminal neck. A double-necked category has not been recognized. The rarity of specimens with two necks inhibits the temptation to establish a new genus. Furthermore, zoological nomenclatural practice does not commonly emend generic, subfamily, or family definitions so as to include abnormal forms.

The figured specimen is UT 1001 in the University of Texas Department of Geology micropaleontological collections.

REFERENCES

AMICIS, G. A. DE, 1895, Sopra alcune forme nuove di foraminiferi del Pliocene inferiore: Soc. Toscana Sci. Nat. Pisa, Atti, Mem., vol. 14, p. 29, pl. 2, fig. 5.

CUSHMAN, J. A., 1925, Eocene foraminifera from the Cocoa sand of Alabama: Contr. Cushman Lab. Foram. Res., vol. 1, pp. 65-68.

———, 1948, Foraminifera, their classification and economic use: Cambridge, Mass., (Fourth edition) p. 273.

Cushman, J. A., and Jarvis, P. W., 1929, New Foraminifera from Trinidad: Contr. Cushman Lab. Foram. Res., vol. 5, pp. 6-17.

Galloway, J. J., 1933, A Manual of Foraminifera: Bloomington, Ind., pp. 370-373.

Monsour, Emil, 1937, Micro-paleontologic analysis of Jackson Eocene of eastern Mississippi: Am. Assoc. Petroleum Geologists, Bull., vol. 21, p. 80-86.

Murray, G. E., 1947, Cenozoic deposits of central Gulf Coastal plain: *ibid.*, Bull., vol. 31, pp. 1825-1850.

81. A CORRECTION TO "REVISION OF TUBULAR MONOTHALAMIA"

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In my paper "Revision of tubular Monothalamia," published in the "Contrib. Cushm. Foundat. Foramin. Research" vol. III, pt. 2 (June, 1952) a regrettable mistake has occurred, obscuring the reasons for creating the name *Psammosiphonella coalingensis*.

According to the new generic definitions, the species *Bathysiphon eocenica* Cushman and Hanna, 1927, should be placed in the genus *Psammosiphonella* Avnimelech.

Since another species with the trivial name *"eocenica," Rhabdammina eocenica* Cushman and Hanna, 1927, has been placed by me also in the genus *Psammosiphonella,* it was necessary to rename one of the two species with the trivial name "eocenica." The new name *Psammosiphonella coalingensis* for *Rhabdammina cocenica* Cushman and Hanna is, therefore, entirely justified. Unfortunately, I overlooked the transfer of *Bathysiphon eocenica* to the genus *Psammosiphonella.*

In conclusion, *Psammosiphonella ("Bathysiphon") eocenica* Cushman and Hanna, 1927, should be included in the list of *Psammosiphonella* given in my paper and cancelled from the list of *Bathysiphon* in the same paper.

82. FORAMINIFERA FROM THE GLEN EYRIE SHALE OF CENTRAL COLORADO

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ABSTRACT—The Glen Eyrie shale of Pennsylvanian age has a microfauna consisting of ostracods, conodonts, bryozoans, and foraminifers. This paper describes and illustrates seven genera consisting of nine species of Foraminifera.

This fauna was found at one locality of the Glen Eyrie shale along Black Canyon road northwest of Colorado Springs, Colorado.

The foraminiferal assemblage seems to indicate a lower Pennsylvanian age for the Glen Eyrie shale, but in the light of our present knowledge of the stratigraphic ranges of Pennsylvanian Foraminifera, this microfauna is not characteristic of any particular lower Pennsylvanian horizon.

INTRODUCTION

Purpose.—The description and illustration of the microfauna of the Glen Eyrie shale of central Colorado was undertaken primarily for the purpose of contributing to the knowledge of the occurrence and distribution of Foraminifera in the Pennsylvanian system. By comparing this microfauna with others described from the Pennsylvanian of the Midcontinent region the writer also hoped to establish a reliable emplacement of the Glen Eyrie shale in the standard Pennsylvanian section of the Midcontinent region.

Stratigraphy.—The Glen Eyrie shale member of the Fountain formation was named the Gleneyrie sandstone formation by Finlay (1907, pp. 588-589), named for exposures along Glen Eyrie creek on the Glen Eyrie estate. Finlay (1916, p. 6) made the first use of the name Glen Eyrie shale member, and this name is recognized today by the United States Geological Survey (U.S.G.S. Bull. 896, p. 827).

Stratigraphically the Glen Eyrie is considered to be a member of the Fountain formation. It is noteworthy that the Glen Eyrie differs from the Fountain formation considerably in lithology as well as in its areal extent. The Fountain formation is an arkosic, gritty sandstone conglomerate, whereas the Glen Eyrie is a silty to sandy shale. The Fountain formation is widespread along the foothills of the Colorado Rockies, whereas the Glen Eyrie shale member occurs at the surface over a limited area of approximately an eighth of a mile in width and two miles in length.

The Glen Eyrie shale unconformably overlies the Madison limestone which is generally considered to be Osagean (upper Lower Mississippian) in age. In turn, it seemingly is unconformably overlapped by the upper part of the Fountain formation.

The best exposure and thickest section of the Glen Eyrie examined is a 38 foot exposure in the bed and cut banks of a stream in the NW¼, SE¼, section 32, T.13S., R.67W., El Paso County, Colorado. Neither the base nor the top of the Glen Eyrie are exposed at this locality. The lower two feet of this exposure is a black "coaly" shale. This is succeeded by eight to nine feet of a fine-grained tan to buff standstone. The remainder of the section is composed of alternating beds of fine-grained sandstone and sandy or silty cemented shale with occasional seams or lenses of highly carbonaceous black shales. The shale horizons are abundant in this exposure.

Several exposures of the Glen Eyrie shale west of Colorado Springs were visited, described, and extensively sampled. After a careful examination, the exposure near the center of the NW¼, SW¼, section 28, T.13S., R.67W. on the east side of the Rampart Range road just north of the Black Canyon loop turn off was found to be the only one which contained a significant microfauna. Although the contact with the overlying Fountain formation was not observable at this locality, field evidence indicated that the fossiliferous zone of this exposure is approximately fifty feet below the top of the Glen Eyrie shale. All specimens described and illustrated in this report are from samples that were collected at this locality.

Acknowledgments.—To M. L. Thompson are due thanks for suggesting this problem, and for guidance, supervision, and constructive criticism throughout the preparation of this report.

Thanks are also due to my fellow graduate students at the University of Wisconsin for many encouragements and helpful suggestions in the preparation of the illustrations.

My collection of specimens from the Black Canyon loop turn off locality were supplemented by collections which M. L. Thompson of the University of Wisconsin and W. A. Fischer of Colorado College kindly made available.

PALEONTOLOGIC SUMMARY

Foraminifera.—The foraminifera are represented by nine species of seven genera, all of which are described and illustrated.

Plectogyra [*Endothyra*] *rothrocki* (Harlton) is fairly abundant in the Glen Eyrie shale. It is known to range from the Morrowan to the Atokan in Oklahoma, and possibly is restricted to rocks of these ages.

Endothyranella armstrongi Plummer is rare. It is known to range from the Marble Falls limestone through the Canyon of Texas. With a known stratigraphic range of such great length, this species is of little value as a stratigraphic marker.

Textularia grahamensis Cushman and Waters is scarce in the Glen Eyrie shale. This form has been described previously only from the Graham formation (lower Virgilian) of Texas.

Climacammina cylindrica Cushman and Waters is abundant in the Glen Eyrie shale, although complete adult specimens are infrequent. The adult forms usually have the uniserial portion of the test crushed. This form was described from the Graham formation of Texas.

Two species of *Tetrataxis, T. conica* Ehrenberg and *T. corona* Cushman and Waters are found in the Glen Eyrie shale. *T. conica* ranges from Morrowan to the lower Virgilian, and *T. corona* from the Atokan to the Virgilian. The species of this genus in the Glen Eyrie shale are therefore of no value for detailed correlation within the system.

Two species of *Globivalvulina, G. biserialis* Cushman and Waters and *G. ovata* Cushman and Waters, are described and illustrated. The more abundant of these, *G. biserialis,* although still rare, is long ranging, was described from the Atokan of Oklahoma and the Graham formation of Texas. *G. ovata* is rare in the Glen Eyrie. It was described from the Graham formation of Texas. Little more is known concerning its stratigraphic range.

Millerella marblensis Thompson is the only fusulinid in the Glen Eyrie shale. *M. marblensis*, as here described, is given considerable latitude. It is known to occur in rocks of Morrowan to Atokan ages. Specimens in the Glen Eyrie shale seem to be more highly advanced than the type specimens illustrated (Thompson, 1942) from the Marble Falls limestone. They are not as evolute in the fourth and fifth volutions as is the holotype specimen. The Glen Eyrie probably is younger than the Marble Falls limestone.

SYSTEMATIC PALEONTOLOGY

Family LITUOLIDAE

Subfamily ENDOTHYRINAE

Genus **Plectogyra** Zeller, 1950

In 1950, Edward J. Zeller proposed the name *Plectogyra* for those endothyroid forms which are not planispiral (Zeller, 1950, p. 3) leaving the truly planispiral endothyroids in the genus *Endothyra. Plectogyra plectogyra* Zeller from the St. Louis limestone, Meramecian (Mississippian) at St. Louis, Missouri is the type species (Zeller, 1950, Pl. 3, fig. 2) by original designation. The generic character of *Plectogyra* as given by Zeller follows: "The shell is discoidal and probably umbilicate on one side only. It is involute, having a broadly rounded keel, chambers swollen between the sutures, and the apertural face asymmetrical during most stages of growth. The aperture, which is low and slitlike, is situated at the center of the base of the apertural face and reflects its asymmetry. A tunnel or low passage extends back through the entire coil to the proloculus and is secondarily enlarged by resorption, the height of the tunnel commonly being a little greater than the height of the aperture.

The coiling is particularly distinctive in being logarithmic in character, but the spiral is twisted along an axis so a three-dimension spiral is produced. This type of spiral has been defined (Scott, Zeller and Zeller, 1947, p. 558) as endothyroid, but now it seems desirable to call it a plectogyroid spiral.

The wall of *Plectogyra* is calcareous. There are two distinct layers, a less distinct third layer, and well de-developed secondary deposits."

Plectogyra [Endothyra] rothrocki (Harlton), 1928

Plate 11, figures 1-3

Endothyra rothrocki Harlton, 1928, Jour. Paleontology, vol. 1, p. 306, pl. 52, fig. 3a, b.—Galloway and Ryniker, 1930, Oklahoma Geol. Survey Circ. 21, p. 12, pl. 2, figs. 1-3.—Warthin, 1930, Okla. Geol. Survey Bull. 53, p. 19, pl. 1, figs. 9a, b.

Test free, discoidal, involute; with rounded keel, lobulate periphery, unequal umbilici, may be absent on one side; coiled in a three-dimensional manner (plectogyroid), consequently one or more of previous whorls are partially visible at center of test; chambers inflated, usually nine in number; sutures distinct, depressed, especially at periphery, limbate, slightly curved; wall calcareous, smoothly finished; aperture low arched slit at center of base of apertural face of last chamber, reflecting asymmetry of shell.

Measurements of *Plectogyra rothrocki* in millimeters:

Specimen	1	2	3	4	5	6	7
Length	0.365	0.515	0.348	0.313	0.348	0.453	0.552
Width	0.435	0.452	0.435	0.400	0.435	0.556	0.574
Thickness	0.167	0.167	0.161	0.127	0.132	0.174	——
Chambers in last coil	9	9	9	9	9	9	9

Discussion.—Endothyra rothrocki Harlton is referred to *Plectogyra* because of the former's plectogyroid coiling which is faintly suggested by Harlton's illustration of the species (Harlton, 1928, pl. 52, fig. 3b). In the description of the species Harlton does not say the coiling is planispiral, neither does he say that it is not planispiral, although he describes the species as follows: "Test free, nautiloid, nearly symmetrically bilateral, periphery rounded, umbilici depressed; chambers numerous, usually nine; sutures distinct, limbate, slightly depressed, wall calcareous, smooth; aperture a curved small slit at the base of the apertural face."

Although Harlton describes the species as "nautiloid," implying planispiral coiling to this writer, he also states the test is "nearly symmetrically bilateral," which suggests a non-planispiral coiling of the test. In view of the nature of coiling illustrated by Harlton previously referred to, and his statement "nearly symmetrically bilateral," the logical conclusion is that the species does not coil in a planispiral manner, and, therefore, is a member of genus *Plectogyra* as defined by Zeller in 1950.

The specimen of the species illustrated by Harlton (1928, pl. 52, figs. 3a, b) is closely similar to the Glen Eyrie specimens, although the later do have the plectogyroid coiling more pronounced. This difference in degree of plectogyroid coiling may well be due to the fact that Harlton's illustrations are artist's interpretations of the form of the specimen.

Species from the Glen Eyrie shale vary considerably in size, indicating that the fauna is probably indigenous.

Occurrence.—Plectogyra rothrocki is relatively abundant in the Glen Eyrie shale. The form was described as *Endothyra rothrocki* from the Atoka and Holdenville formations of Oklahoma.

Genus Endothyranella Galloway and Harlton, 1930

Genoholotype, *Endothyranella powersi* (Harlton) = *Ammobaculites powersi* Harlton, Journ. Pal., vol. 1, no. 1, 1927, p. 21, pl. 3, fig. 3. (Lower Pennsylvanian, Dornick Hills formation, Love Co., Okla.).

Galloway and Harlton in 1930 proposed the name *Endothyranella* for those Carboniferous endothyroid Foraminifera that are coiled in the early stages like *Endothyra* and rectilinear in the later stages. Early workers on the Foraminifera referred species of this genus to either *Haplophragmium* or *Ammobaculites*. That this disposition is untenable is evidenced by the differences in character of shell material, nature of coiling, and type of aperture. Concerning this, Galloway and Harlton (1928, p. 25) state as follows: "*Haplophragmium* and *Ammobaculites,* which occur typically developed from Cretaceous to Recent, both have plainly arenaceous walls.

The coil of *Endothyranella* is composed of whorls which are added in a rotating plane, and are not planispiral, as has been in specific descriptions, whereas the coil of *Haplophragmium* is irregular, and that of *Ammobaculites* is planispiral. The aperture of *Endothyranella* is single, whereas that of *Haplophragmium* is multiple."

It might be significant to point out that the coiled endothyroid form which the youthful stages of *Endothyranella* resemble (Galloway and Harlton, 1928, p. 28), are not similar to *Endothyra* as Galloway and Harlton suggested, but similar to the more recently established genus *Plectogyra.*

The genus *Endothyranella* is known to range from the Upper Mississippian to the Upper Pennsylvanian (Galloway and Harlton, 1928, p. 28), and *Plectogyra* from the Mississippian Kinderhookian to the Pennsylvanian Desmoinesian (Zeller, 1950, pl. 6). Although Zeller in his consideration of the phylogenetic trends of the endothyroids does not consider *Endothyranella* as genetically related to *Plectogyra,* it seems logcial that *Endothyranella* developed during the Mississippian (prior to the upper Mississippian) from a *Plectogyra* which developed the adult rectilinear chambers characteristic of the genus *Endothyranella.*

Endothyranella armstrongi Plummer, 1930
Plate 11, figures 4-6

Endothyranella armstrongi PLUMMER, H. J., 1930, Univ. of Texas Bull. 3019, pp. 18-19, pl. 1, figs. 9-15.

Test free, crosier-shaped, nearly planispiral in its early portion, followed by straight succession of chambers in full maturity, slightly unsymmetrical, series of rectilinear chambers tangent to coil; periphery broadly rounded, lobulate in later part of coil; chambers eight to nine in last whorl of coiled portion, slowly increasing in size, slightly inflated; sutures radiate, depressed, showing as a thick dark band between chambers; wall calcareous, rather smoothly finished; aperture typically endothrine in coiled test, terminal and round on final chamber of straight series.

Measurements of *Endothyranella armstrongi* in millimeters:

Diameter of coil — 0.2784.

Discussion.—The specimens of this species are smaller than the holotype and paratype specimens of Plummer, but the arrangement of the chambers in the coiled stage is closely similar to them, and the number of chambers is the same. No young plectogyroid coiled Endothyranellas were identifiable among the specimens in the Glen Eyrie shale. The central part of the test of some of my specimens are obscured along the junction of adjacent whorls.

Occurrence.—Only several specimens of *Endothyranella armstrongi* occur in the Glen Eyrie shale. It has been recorded from the Marble Falls limestone and the Graford formation of Texas.

Family TEXTULARIIDAE
Subfamily TEXTULARIINAE
Genus **Textularia** Defrance, 1824

Type species: *Textularia sagittula* Defrance, 1824. Monotypic.

In 1824, Defrance described one species of arenaceous foraminifer for which he proposed the generic name *Textularia.* In his description of the genus Defrance does not mention the locality or the geologic horizon from which the specimen(s) came nor does he illustrate the specimen(s). Following is this writer's translation from the French of Defrance's (1824, p. 177) generic description:

"*Textularia* — Shell submicroscopic, pyramidal, with the apex pointed and the base rounded, presenting on the exterior of each side, some angular sinuous lines, running from the apex to the base, about which fall obliquely a few grooves, marks from the walls which partition the cavity into quite numerous chambers, stacked on two rows, the one on top of the other, no trace of the aperture exteriorly.

This genus, strongly similar to the former (*Saracenaria* Defrance), comprises, however, only one single species."

Since Defrance's description of *Textularia* many species of Foraminifera have been referred to it and today is probably one of the best known Paleozoic foraminifers.

Later workers have emended the generic diagnosis of *Textularia* Defrance with the recognition of its arenaceous wall, biserial arrangement (implied by Defrance), coiled juvenile stage of the microspheric form, external aperture as an elongate slit at the base of the apertural face.

Textularia grahamensis Cushman and Waters, 1927
Plate 11, figures 7-9

Textularia grahamensis CUSHMAN and WATERS, 1927, Cushman Contributions, vol. 3, p. 151, pl. 27, figs. 3a, b.—CUSHMAN and WATERS, 1930, Univ. of Texas Bull. 3019, p. 54, pl. 12, figs. 1a, b.

Paleotextularia grahamensis GALLOWAY and RYNIKER, 1930, Oklahoma Geol. Surv. Circ. 21, p. 21, pl. 4, figs. 13-14.

Test free, elongate, about twice as long as wide; periphery well rounded, biserial throughout, possibly planispiral in early stage, tapering strongly in both front and side views; usually of 13 to 15 chambers; about twice as broad as high in early stage, becoming relatively higher and more inflated in adult stage; sutures distinct, horizontal, strongly depressed in later portion of test; wall arenaceous, imperforate; aperture arched slit at base of inner margin of last chamber.

Measurements of specimens of *Textularia grhamensis* in millimeters:

Specimen	1	2	3	4
Length	1.131	1.131	0.991	1.392
Width	0.696	0.783	0.696	0.870
Thickness	0.522	0.556	0.696	——

Discussion.—According to Cushman and Waters (1927, p. 152), this is the largest and stoutest of any species of the genus. The strong tapering of the test in front and side views. also serves to distinguish this species from others of the genus. Only a few specimens from the Glen Eyrie shale could be identified as belonging to this species.

Occurrence.—*Textularia grahamensis* is not abundant in the Glen Eyrie shale. It was described from the Graham formation of Texas.

Genus **Climacammina** H. B. Brady, 1873

Type species: *Climacammina antiqua* (Brady) = *Textularia antiqua* Brady, 1871. Monotypic.

In 1873 H. B. Brady erected the genus *Climacammina.* At that time he (Brady, 1873, appendix 3, p.

94) stated as follows: "... *Climacammina* is adopted provisionally for some very irregular forms closely allied to *Haplophragmium irregulare* Reuss. It may possibly be found desirable to associate them with Reuss's genus."

Considering *Climacammina* in 1876 Brady wrote as follows: "Test free, consisting of many segments of irregular contour and unevenly combined; typically biserial or subserial in the earlier, uniserial in the later stages of growth. Texture finely arenaceous. Interior more or less labyrinthic. Aperture irregular or cribriform. Septation obscure."

The genus *Cribrostomum* was established by Möller in 1879 for the textularid Foraminifera which possess numerous scattered circular apertures of uniform size in the biserial as well as uniserial stages. Many of Möller's species of this genus are longitudinally costate and some do not seem to develop the uniserial stage. He included *Climacammina* Brady as a synonym under his *Cribrostomum*.

Cushman and Waters (1928, pp. 119-130) studied *Climacammina* and associated forms from the Pennsylvanian of Texas. As a result of this study, a third genus, *Deckerella* Cushman and Waters closely related to *Climacammina* and *Cribrostomum*, was erected. Following is the generic description of *Deckerella* Cushman and Waters (1928, p. 129): "Test elongate, the early stages biserial, textularian, later chambers uniserial; wall with an inner, clear, perforate layer, and an outer, opaque arenaceous layer; aperture in the early biserial chambers simple, textularian, at the inner edge of the chamber, later pushing into the apertural face finally cutting off two distinct, elongate elliptical apertures with a narrow partition between and this character continuing throughout the adult."

Deckerella may be distinguished from *Climacammina* and *Cribrostomum* by the presence in *Deckerella* of two distinct, elongate elliptical apertures with a thin partition which develops late in the biserial stage and continues throughout the uniserial stage.

The textularid aperture throughout the biserial stage and the elongate, irregularly lobed, numerous openings in the apertural face of the final adult chamber of the uniserial stage of *Climacammina* as compared to the multiple circular apertures that develop in the late biserial stage and continue through the uniserial stage (if present) of *Cribrostomum* serves to distinguish the two genera.

Climacammina cylindrica Cushman and Waters, 1928

Plate 11, figures 10-15

Climacammina cylindrica CUSHMAN and WATERS, 1928, The development of *Climacammina* and its Allies in the Pennsylvanian of Texas: Jour. Paleontology, vol. 2, no. 2, pp. 119-130, pls. 17-20.—CUSHMAN and WATERS, 1930, Univ. of Texas Bull. 3019, pp. 22-80, pls. 2-12.

Test free, elongate, about four times as long as wide, subcylindrical, slightly curved in early biserial stage, with broadly rounded periphery, chambers uniserial in adult stage; chambers usually 16 in number in biserial stage, chambers increasing rapidly in height early in biserial stage, uniserial chambers may be as many as four, some specimens have but one uniserial chamber, others have no uniserial development whatever; sutures nearly horizontal, indistinct in early part of test, become strongly depressed in later part of biserial stage; wall granular, apparently arenaceous, imperforate; aperture textularian in biserial chambers, in final stage of uniserial stage many, irregular elongate openings in apertural face of last chamber.

Measurements of specimens of *Climacammina cylindrica* in millimeters:

Specimen	1	2	3	4
Length	2.436	2.175	2.088	1.800
Width	0.696	0.696	0.696	0.609
Breadth	0.696	0.740	0.870	0.783

The last three of these specimens have the biserial stage only. The first one has three partially crushed uniserial chambers.

Discussion.—Thin sections of several specimens of *Climacammina cylindrica* revealed that the wall is basically composed of two layers; an inner, clear, fibrous, perforate (?) calcareous layer, and an outer denser, more opaque layer of arenaceous material in calcareous cement.

Apparently no entirely complete specimen of *Climacammina cylindrica* occurs in the Glen Eyrie shale. Although the specimen illustrated by figure 10, Plate 11 is fragmentary and somewhat distorted, it clearly exhibits the numerous, irregular, elongate openings in the apertural face of the last chamber of the uniserial chambers.

The specimens illustrated by figures 14, 15, Plate 11 show a unique development of the biserial stage of *Climacammina cylindrica*. The last three chambers of the biserial stage are added in a plane 90° to the plane of earlier chambers. The last part of the test is uniserial. This unusual development of *C. cylindrica* is thought to be a freak development of the test, for only two specimens in the Glen Eyrie shale illustrated this character. This freak development is not intended to be construed as characteristic of the species described.

Occurrence.—Specimens of *Climacammina cylindrica* are common in the Glen Eyrie shale, although, as a rule, they are crushed or incomplete. *Climacammina cylindrica* was described from the Graham formation of the Cisco in Texas.

Family TROCHAMMINIDAE

Subfamily TETRATAXINAE

Genus **Tetrataxis** Ehrenberg, 1854

Type species: *Tetrataxis conica* Ehrenberg, 1854. Monotypic.

C. G. Ehrenberg in 1843 introduced the name *Tetrataxis conica* which was invalid under the International Rules of Zoological Nomenclature. Although Ehrenberg followed the principle of binominal nomenclature (International Rules of Zoological Nomenclature, art. 25), he did not accompany the published name with an indication, definition, or description and hence the name was a *nom. nud.*

In 1854 Ehrenberg published the name *Tetrataxis conica* again and accompanied it with a figure (Ehrenberg, 1854, pl. 37 (group 11), fig. 12, ×32), thus establishing the species and genus as valid under the rules, although no type description was given. According to the International Rules of Zoological Nomenclature the genus and species in question are valid and date from the time of publication with an indication, definition or description, so *Tetrataxis conica* Ehrenberg does not date from 1843 as several American workers (Harlton, 1927, and Cushman and Waters, 1930) have indicated, but from 1854, the date of publication with an indication (in this case a figure).

Ehrenberg's type specimen(s) came from the Kohlen-formation of Tula, U. S. S. R.

Tetrataxis conica Ehrenberg, 1854

Plate 12, figures 1-3

Tetrataxis conica EHRENBERG, 1854, Mikrogeologie Leipzig, Deutschland, p. 24.—HARLTON, 1927, Jour. Paleontology, vol. 1, p. 22, pl. 4, figs. 5a, d.—CUSHMAN and WATERS, 1930, Univ. of Texas Bull. 3019, p. 75, pl. 7, figs. 2a, b, 4, 5a, b.

Test free, highly conical, with moderately depressed base, forming equilateral triangle in lateral view; chambers numerous, poorly defined, indistinct in early part of shell, developing four series characteristic of the genus in outer part of shell; sutures indistinct, slightly depressed; wall arenaceous, calcareous cement; aperture on ventral side, elongate, at margin of umbilical border of last chamber.

Measurements of specimen of *Tetrataxis conica* in millimeters:

Diameter - 0.43 Height - 0.34

Discussion.—*Tetrataxis conica* may be distinguished from other species of the genus by its sharp spire and straight lateral slopes. The spire is approximately as high as the test is wide.

Occurrence.—*Tetrataxis conica* has been recorded from the Kohlen formation of Tula, U.S.S.R., the Graham formation of Texas, and the Glenn formation of Oklahoma. It is not abundant in the Glen Eyrie shale.

Tetrataxis corona Cushman and Waters, 1928

Plate 12, figures 4-6

Tetrataxis corona CUSHMAN and WATERS, 1928, Cushman Contributions, vol. 4, p. 65, pl. 8, figs. 10a, b.—CUSHMAN and WATERS, 1930, Univ. of Texas Bull. 3019, pp. 75-76, pl. 7, figs. 3, 8.—GALLOWAY and RYNIKER, 1930, Okla. Geol. Surv. Circ. 21, pp. 17-18, pl. 3, fig. 5.—PLUMMER, 1930, Univ. of Texas Bull. 3019, p. 21.—WARTHIN, 1930, Oklahoma Geol. Surv. Bull. 35, p. 26, pl. 1, figs. 19a, b.

Test free, central part rounded, conical, later part spreading, lateral slopes concave, ventrum depressed; chambers indistinct, especially in early stages; sutures distinct in later chambers, slightly depressed, almost indiscernible in early stages; wall coarsely arenaceous, especially in part of shell; aperture apparently along umbilical depression on ventral side.

Measurements of specimens of *Tetrataxis corona* in millimeters:

Specimen	1	2
Width	0.522	0.609
Height	0.190	0.208

Discussion.—*Tetrataxis corona* differs from other species of the genus in that it possesses a low rounded spire and has concave lateral slopes.

Occurrence.—Only two specimens of *Tetrataxis corona* were found in the Glen Eyrie shale. It has been

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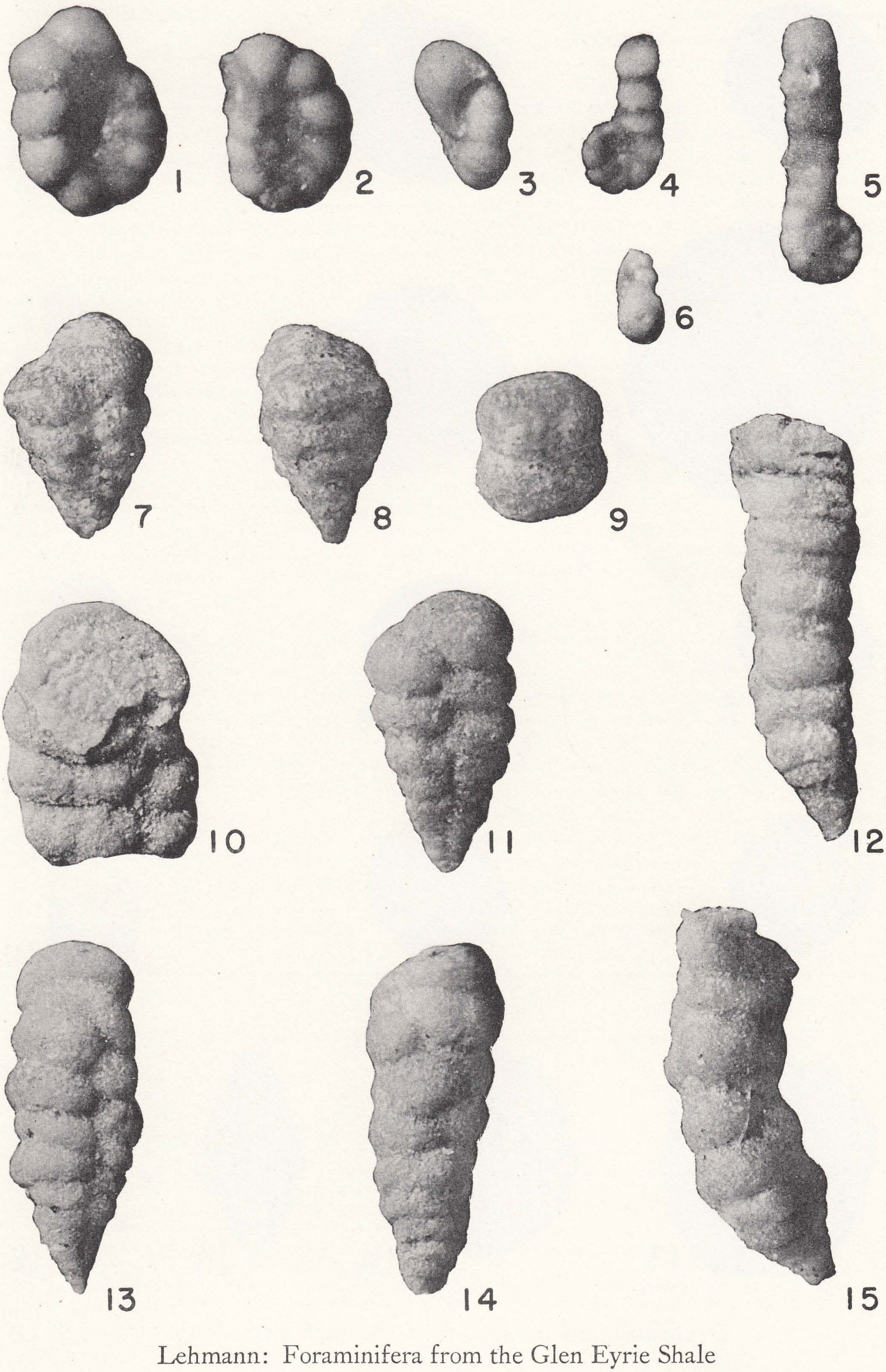
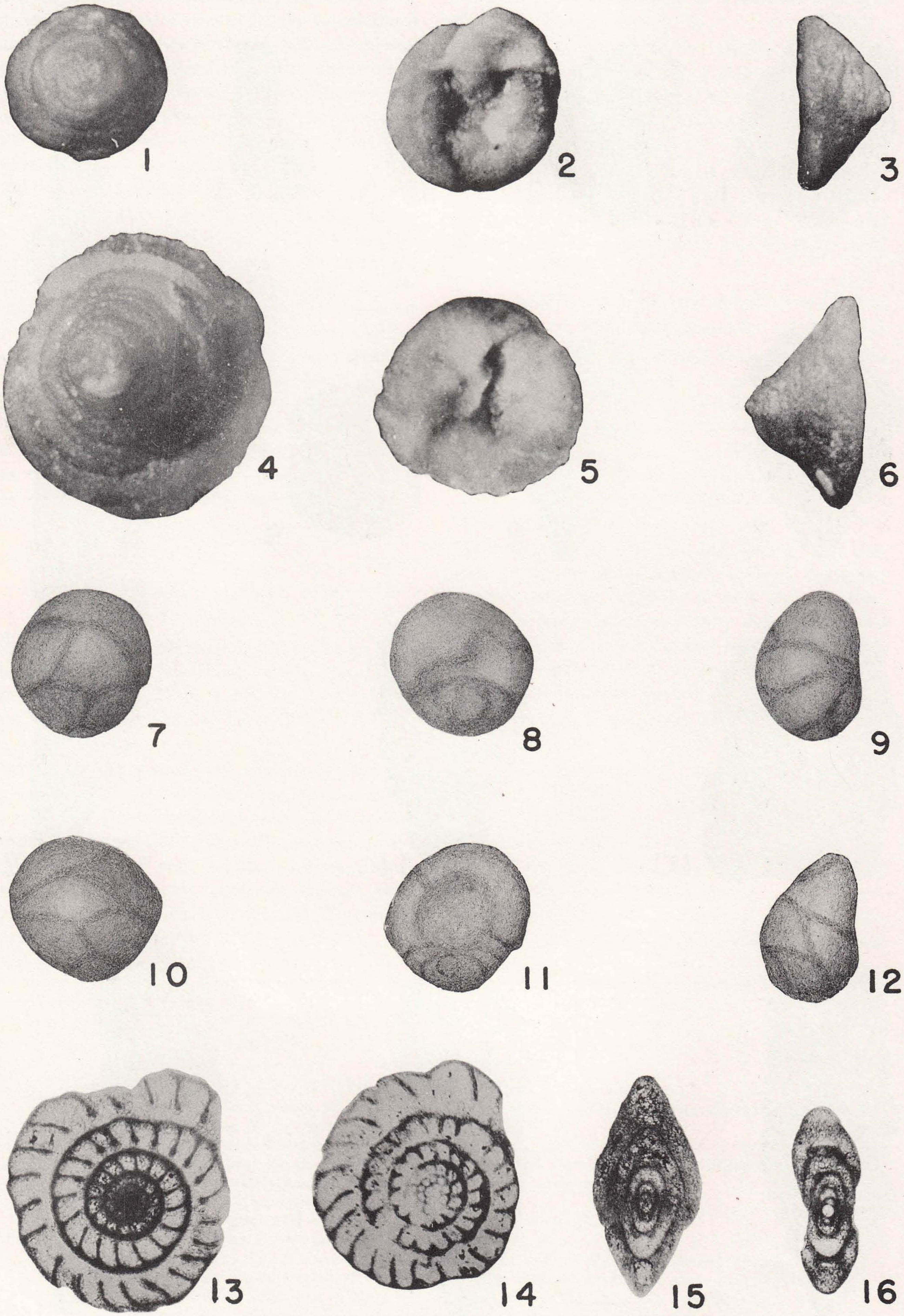
EXPLANATION OF PLATE 11

All illustrations on this plate are unretouched photographs.

FIGS.		PAGE
1-3.	*Plectogyra* [*Endothyra*] *rothrocki* (Harlton)	69
	Lateral and peripheral views × 50. Figure 3, apertural view showing the characteristic plectogyroid coiling of the genus.	
4-6.	*Endothyranella armstrongi* Plummer	70
	Lateral and apertural views × 50. Figure 6, apertural view of specimen illustrated in figure 4, showing the terminal position of the simple aperture.	
7-9.	*Textularia grahamensis* Cushman and Waters	70
	Lateral, side, and apertural views of the same specimen × 25.	
10-15.	*Climacammina cylindrica* Cushman and Waters	71
	Magnification is × 25. Figure 12, side view of specimen having 3 uniserial chambers. Figure 10, an incomplete crushed specimen showing well the numerous elongate irregular apertures of the last chamber. Figure 11, a specimen having only the biserial stages of the test developed. Figures 14 and 15, side views of specimens showing the unique 90° rotation of the plane of biserial arrangement late in the biserial stage.	



Lehmann: Foraminifera from the Glen Eyrie Shale



Lehmann: Foraminifera from the Glen Eyrie Shale recorded from the Graham formation of Texas and the Atoka and Holdenville formations of Oklahoma.

Genus **Globivalvulina** Schubert, 1920

Genoholotype: *Globivalvulina bulloides* (Brady) = *Valvulina bulloides* Brady, 1876.

In 1920 Schubert erected the genus *Globivalvulina* with *Valvulina bulloides* Brady, 1876 as the genoholotype. Following is this writer's translation from the German of Schubert's description of the genus (Schubert, 1920, p. 153): ". . . . they are not *Globigerina,* but *"Valvulina" bulloides,* for which I propose the name *Globivalvulina,* forms with arenaceous agglutinated, partly perforated tests; accordingly the supposition is also justified, that even the casts of the remaining Paleozoic foraminifers are not traceable to *Globigerina,* but to *Globivalvulina.* One becomes strengthed in this supposition based upon this, that the casts of many Jurassic forms (*Gl. lobata* and *"bulloides," Orb.* of Terquem) possess a remarkably rough surface.

The change of *Globivalvulina* into *Globigerina* must have taken place in the early Mesozoic; the first true *Globigerina* is from the upper Triassic of the Alps occurring already in a large number of individuals, dominating in pelagic sediments of every formation until the present."

Globivalvulina biserialis Cushman and Waters, 1928
Plate 12, figures 10-12

Globivalvulina biserialis CUSHMAN and WATERS, 1928, Cushman Contributions, vol. 4, p. 64, pl. 8, figs. 7a-c. —CUSHMAN and WATERS, 1930, Univ. of Texas Bull. 3019, p. 70, pl. 8, figs. 1-5.—GALLOWAY and RYNIKER, 1930, Okla. Geol. Surv. Circ. 21, p. 16, pl. 3, fig. 2.

Test free, hemispherical; six chambers visible in dorsal view, three visible in ventral view; chambers increase in size rapidly, elongate, elliptical in plan view, due to overlapping of chambers, chambers added on either side of an elongate axis producing a biserial arrangement on dorsum; sutures distinct, depressed; wall calcareous, finely punctate to smooth; aperture on inner edge of last chamber on concave ventral surface.

Measurements of a specimen of *Globivalvulina biserialis* in millimeters:

Length - 0.296, width - 0.287, height - 0.209

Discussion.—This species may be distinguished by the braided appearance of the test caused by the biserial arrangement of all chambers along a nearly straight axis. Warthin (1930) placed *Globivalvulina biserialis* in synonymy with *G. gaptankensis,* but this writer cannot agree with his decision. The difference between the two species seem to me distinct. The form illustrated by Harlton as *G. gaptankensis* does not have the biserial character of the test as found in *G. biserialis.*

G. biserialis differs from *G. ovata* in that the form of the latter has the final chamber extending nearly across the periphery, thus breaking the biserial series of the shell. The chambers are more elongate in *G. biserialis* than they are in *G. ovata* due to the greater amount of overlap of the successive chambers in the former.

Occurrence.—Globivalvulina biserialis is rare in the Glen Eyrie shale. It has been recorded from the Graham formation of Texas and from the Atoka formation of Oklahoma.

Globivalvulina ovata Cushman and Waters, 1928
Plate 12, figures 7-9

Globivalvulina ovata CUSHMAN and WATERS, 1928, Cushman Contributions, vol. 4, p. 65, pl. 8, figs. 8a-c.—CUSHMAN and WATERS, 1930, Univ. of Texas Bull. 3019, p. 71, pl. 8, figs. 6-11.

Test free, ovate, hemispherical in lateral view; chambers slightly elliptical in outline, arranged biserially along an elongate axis, last chamber extending across periphery, breaking biserial arrangement; sutures distinct, slightly depressed; wall appears calcareous, slightly punctate; aperture in broad depression on ventrum, with a small valvular projection.

EXPLANATION OF PLATE 12

All illustrations on this plate are unretouched photographs unless otherwise indicated.

FIGS.		PAGE
1-3.	*Tetrataxis conica* Ehrenberg Dorsal, ventral, and lateral views × 50. Figure 3, lateral view of a specimen showing the equilaterally triangular outline of the test.	72
4-6.	*Tetrataxis corona* Cushman and Waters Dorsal, ventral, and lateral views. × 50. Figure 6, lateral view of a specimen showing the rounded spire and concave lateral slopes typical of the species.	72
7-9.	*Globivalvulina ovata* Cushman and Waters Highly retouched photographs of dorsal, ventral, and lateral views × 75.	73
10-12.	*Globivalvulina biserialis* Cushman and Waters Highly retouched photographs of dorsal, ventral, and lateral views × 75.	73
13-16.	*Millerella marblensis* Thompson Sagittal and axial section × 100. Figure 15, axial section showing the subacute periphery of the last volution as compared to the rounded periphery of the early volutions.	74

Measurements of *Globivalvulina ovata* in millimeters:

Length - 0.243, width - 0.243, height - 0.156

Discussion.—*Globivalvulina ovata* may be distinguished from other species of the genus by its ovate outline. It can be distinguished from *G. bulloides* in that the form of the latter has much more rounded chambers and more highly depressed sutures. The final chamber extends further across the periphery and the chambers are more broadly exposed in *G. ovata* than in *G. biserialis.*

Occurrence.—Specimens of *Globivalvulina ovata* are rare in the Glen Eyrie shale. It has been recorded from the Graham formation of Texas.

Family FUSULINIDAE Möller
Subfamily OZAWAINELLINAE Thompson and Foster
Genus **Millerella** Thompson, 1942

Type species: *Millerella marblensis* Thompson.

In 1942 M. L. Thompson (1942, pp. 403-420) reported on a detailed study of the fusulinid faunas and stratigraphy of the Pennsylvanian of New Mexico and adjacent areas. In this report he erected several new genera of fusulinids among which is the genus *Millerella.* The type specimens came from the Marble Falls limestone, Marble Falls, Texas. Following is the generic diagnosis of *Millerella* Thompson (1942, p. 404): "Shell minute, discoidal, with short axis of coiling and narrowly rounded to sub-angular periphery; planispiral throughout growth. The inner three to four volutions are involute but the outer one or two volutions of mature specimens become partially evolute and they only reach approximately one-half the distance to the poles of the preceding volution. Polar regions of mature specimens are depressed (umbilicate). Mature specimens consist of four to seven volutions and measure about 0.3 to 0.6 mm. in width and less than 0.3 mm. in axial length. Spirotheca very thin, consisting of a thin middle layer (tectum and diaphanotheca?) and very thin upper and lower layers which may be tectoria. However, the middle layer is the only layer which can be recognized in all specimens. The rate of expansion of the shell is essentially uniform. Septa are very thin and numerous, and they show a prominent curving in well oriented sagittal sections. Proloculum minute; tunnel low and narrow and bounded by low, narrow chomata."

The short axis of coiling, narrowly rounded to subacute periphery (of last volutions), decidedly curved septa, and the evolute nature of the last volutions of *Millerella* serve to distinguish this genus from most other fusulinid genera. The closely allied genus *Staffella* is distinguished from *Millerella* in that the former is umbilicate with broadly rounded periphery of the last volutions. Exteriorly *Pseudostaffella* may resemble *Millerella,* but the inner volutions are generally coiled at large angles to the outer volutions of the former. The smaller size, less angular periphery, and evolute outer volutions separates representatives of *Millerella* from those of *Ozawainella.*

Millerella can be distinguished from *Paramillerella* Thompson by the more nearly spherical shell of the latter. In mature specimens of *Millerella* the last volution is uncoiled or slightly embraces the earlier volutions.

Millerella marblensis Thompson, 1942
Plate 12, figures 13-16

Millerella marblensis Thompson, 1942, Am. Jour. Sci., vol. 240, pp. 405-407, pl. 1, figs. 3-14.—1944, Kansas Geol. Survey, Bull. 52, p. 420-423, pl. 1, figs. 1-9, pl. 2, figs. 1-15, 24.—1945, Kansas Geol. Survey, Bull. 60, p. 43.—1948, Univ. of Kansas Paleontological Contributions, Protozoa, Art. 1, p. 76, pl. 23, figs. 1-12, 16-31, pl. 24, figs. 1-9.

Test free, minute subdiscoidal, planispiral; with short axis of coiling; rounded periphery in early volutions becoming subacute in fifth to sixth volutions; inner volutions involute, becoming somewhat evolute in fourth or fifth volution; contains as many as six volutions; possibly becoming slightly umbilicate in mature stage; proloculus small, spherical; shell expands uniformly throughout growth; increase of height of chambers accelerates at a uniform rate; septa of inner volutions essentially normal to spirotheca, in later volutions they extend anteriorly at about 15 to 20 degrees, becoming slightly convex anteriorly, free ends of septa considerably thicker than near top of septa; spirotheca relatively thin, composed of thin tectum and thicker less dense, upper and lower layers, outer layer absent on last volution; septa essentially of same construction as spirotheca; tunnel low, bordered by chomata, steepest slope of chomata toward tunnel, more gentle slope poleward.

Specimens of *Millerella marblensis* in the Glen Eyrie range from 0.11 to 0.26 mm. in length of axis and from 0.436 to 0.696 mm. in width. The average form ratio of the six specimens measured is 1:0.31. In the only thin section showing the proloculus clearly the outside diameter of the proloculus measures 0.021 mm.

Table of measurements of *Millerella marblensis* in millimeters:

Specimen	Length	Width	Ratio	Diameter of proloculus
1	0.245	0.592	1:0.40	0.02134
2	0.170	0.487	1:0.55	—
3	0.157	0.460	1:0.34	—
4	0.266	0.533	1:0.49	—
5	0.111	0.436	1:0.25	—
6	0.260	0.696	1:0.37	—

	Height of volutions					Septal count				
	1	2	3	4	5	2	3	4	5	6
1	0.020	0.030	0.053	0.085	0.121	10	15	19	21	—
2	—	0.031	0.048	0.097	—	—	—	—	—	—
3	—	0.024	0.053	0.072	—	—	—	—	—	—
4	—	0.024	0.041	0.097	0.121	—	—	—	—	—
5	—	—	—	—	—	—	13	17	20	26

	Thickness of spirotheca					
	1	2	3	4	5	6
1	0.006	0.009	0.011	0.015	0.017	—
2	—	—	—	0.011	0.017	0.020

Discussion.—*Millerella marblensis* is given considerable latitude in this report. It seems likely that not all the specimens of *Millerella* in the Glen Eyrie are referable to *M. marblensis*. However, they more closely resemble that species than they do any other. Further work may prove that they represent several species of *Millerella*.

Occurrence.—Specimens of *Millerella marblensis* are abundant in the Glen Eyrie shale. It has been reported as ranging from the Morrowan of Arkansas to the middle part of the Middle Pennsylvanian. *M. marblensis* has been described previously from the Bloyd shale of Arkansas, Derryan rocks of New Mexico and Texas, and from rocks of Morrowan age in extreme western Texas. Some forms of *Orobias* described and illustrated by Galloway and Harlton (1928, pp. 338-357) from the Wapanucka limestone of Oklahoma are possibly referable to this species.

REFERENCES

BAILEY, W. P., 1935, Micropaleontology and stratigraphy of the lower Pennsylvanian of central Missouri: Jour. Paleontology, vol. 9, pp. 483-502, pl. 55.

BRADY, H. B., 1873, Mem. Geol. Surv. Scotland, Expl. Sheet 23, p. 94.

———, 1876, A monograph of Carboniferous and Permian foraminifera: Palaeontographical Society, vol. 30, pp. 1-166, pls. 1-12.

CUSHMAN, J. A., 1927, Description of foraminifera: Jour. Paleontology, vol. 1, pp. 13-14.

CUSHMAN, J. A., and WATERS, J. A., 1927, Pennsylvanian foraminifera from Michigan: Cushman Contributions, vol. 3, pt. 2, no. 40, pp. 107-110, pl. 22.

———, 1927, Arenaceous Paleozoic foraminifera from Texas: Cushman Contributions, vol. 3, pt. 3, no. 46, pp. 146-153, pls. 26-27.

———, 1928, The development of *Climacammina* and its allies in the Pennsylvanian of Texas: Jour. Paleontology, vol. 2, pp. 119-130, pls. 17-20.

———, 1928a, Some foraminifera from the Pennsylvanian and Permian of Texas: Cushman Contributions, vol. 4, pt. 2, no. 59, pp. 31-55, pls. 4-7.

———, 1928b, Additional Cisco foraminifera from Texas: Cushman Contributions, vol. 4, pt. 3, no. 61, pp. 62-67, pl. 8.

———, 1930, Foraminifera of the Cisco group of Texas: University of Texas Bull., 3019, pp. 22-80, pls. 2-12.

DEFRANCE, 1824, Dictionnaire des Science Naturelles, Tome XXXII, p. 177.

DUNBAR, C. O., and SKINNER, 1937, The geology of Texas. Volume III. Part 2. Permian Fusulinidae of Texas: Univ. of Texas Bull. 3201, pp. 519-822, pls. 42-81.

EHRENBERG, C. G., 1843, Ber. Preuss. Akad. Wiss., Berlin, p. 106.

FINLAY, G. I., 1907, The Gleneyrie formation and its bearing on the age of the Fountain formation in the Manitou region, Colorado: Jour. Geol., vol. 15, pp. 586-589.

———, 1916, Colorado Springs Folio, Col.: U.S.G.S. Folio No. 203.

GALLOWAY and HARLTON, B. H., 1928, Some Pennsylvanian foraminifera of Oklahoma, with special reference to the genus *Orobias*: Jour. Paleontology, vol. 2, pp. 338-357, pls. 45-46.

GALLOWAY and HARLTON, B. H., 1930, *Endothyranella*, a genus of carboniferous foraminifera: Jour. Paleontology, vol. 4, pp. 24-28.

GALLOWAY, J. J., and RYNIKER, C., 1930, Foraminifera from the Atoka formation of Oklahoma: Oklahoma Geol. Surv., Circ. no. 21, pp. 1-37, pls. 1-5.

GIRTY, G. H., 1915, The fauna of the Wewoka formation of Oklahoma: U.S.G.S. Bull. 544.

HARLTON, B. H., 1927, Some Pennsylvanian foraminifera of the Glenn formation of southern Oklahoma: Jour. Paleontology, vol. 1, pp. 15-27, pls. 1-5.

———, 1928, Pennsylvanian foraminifera of Oklahoma and Texas: Jour. Paleontology, vol. 1, pp. 305-310, pls. 52-53.

———, 1929, Some Pennsylvanian ostracods and foraminifera from southern Oklahoma: Jour. Paleontology, vol. 3, p. 308.

MÖLLER, 1879, Acad. Imp. Sci., St. Petersborg, Russie ser. 7, tome 27, no. 5, pp. 1-131, pls. 1-7.

PHILLIPS, 1849, Proc. of the Yorkshire Geol. and Polytechnic Soc., 1842-48, vol. 2, p. 277, pl. VII, fig. 1.

PLUMMER, H. J., 1930, Calcareous foraminifera in the Brownwood shale near Bridgeport, Texas: Univ. of Texas Bull. no. 3019, pp. 5-21, pl. 1.

———, 1944, Smaller foraminifera in the Marble Falls, Smithwick, and Lower Strawn strata around the Llano uplift in Texas: Univ. of Texas Bull. no. 4401, pp. 21-271, pls. 15-17.

ROTH, R. and SKINNER, J., 1930, The fauna of the Mc-

Coy formation, Pennsylvanian, of Colorado: Jour. Paleontology, vol. 4, pp. 332-352, pls. 28-31.

SCHUBERT, R., 1921, Palaeontologische Daten zur Stammesgeschichte der Protozoen: Palaeontol. Zeitschrift, vol. 3, pp. 129-188.

SCOTT, H. W., ZELLER, E. J., and ZELLER, D. E., 1947, The genus *Endothyra*: Jour. Paleontology, vol. 21, no. 6, pp. 557-562, pls. 1-2.

THOMPSON, M. L., 1935, The fusulinid genus *Staffela* in America: Jour. Paleontology, vol. 9, pp. 114-130, pl. 13.

———, 1942, New genera of Pennsylvanian fusulinids of Kansas: Am. Jour. Sci., vol. 240, pp. 403-420, pls. 1-3.

———, 1944, Pennsylvanian Morrowan rocks and fusulinids of Kansas: Kansas Geol. Survey, Bull. 52, pp. 409-431, pls. 1-2.

———, 1945, Pennsylvanian rocks and fusulinids of east Utah and northwest Colorado correlated with Kansas section: Kansas Geol. Survey, Bull. 60, pp. 17-84, pls. 1-6.

———, 1948, Studies of American fusulinids: University of Kansas Paleontological Contributions, Protozoa, article 1, pp. 1-184, pls. 1-38.

———, 1951, New genera of fusulinid Foraminifera: Cushman Found. Foram. Res., Contr., vol. 2, pp. 115-119, pls. 13, 14.

WARTHIN, A. S., 1930, Micropaleontology of the Wetumka, Wewoka, and Holdenville formations: Okla. Geol. Survey Bull. 53, pp. 1-94, pls. 1-7.

WATERS, J. A., 1928, A group of foraminifera from the Dornick Hills formation of the Ardmore basin: Jour. Paleontology, vol. 1, p. 129, pl. 22.

———, 1928, A group of foraminifera from the Canyon division of the Pennsylvanian formation in Texas: Jour. Paleontology, vol. 1, pp. 271-275, pl. 42.

ZELLER, E. J., 1950, Stratigraphic significance of Mississippian Endothyroid foraminifera: University of Kansas Paleontological Contributions, Protozoa, article 4, pp. 1-23, pls. 1-6.

83. THE GENUS *ASSILINA* IN THE LAKI SERIES (LOWER EOCENE) OF THE KOHAT-POTWAR BASIN, NORTHWEST PAKISTAN

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I. INTRODUCTION

In the course of work on the correlation of Laki beds (Lower Eocene) penetrated by the Attock Oil Company's borings in the Kohat/Potwar basin of Northwest Pakistan, uncertainties arose in the identification of representatives of the genus *Assilina,* particularly from the random sections observed in slices of limestone cores. An attempt was made, therefore, to establish the range of normal variation, and the relative diagnostic value of morphological characters in the genus. The results of this study show the necessity for reassessment of the value of characters previously ascribed to various species, and permit the description of two new species and a new variety. Revised stratigraphical and geographical ranges of several species are recorded and their significance discussed.

The material on which this study is based came from many boreholes and from extensive collections made at surface outcrops. The author is grateful to the Directors of the Attock Oil Company for permission to publish these results.

II. ANALYSIS AND EVALUATION OF THE MORPHOLOGY OF THE GENUS *ASSILINA*

A. *Summary*

The morphological features which can be used for species delineation in the Laki representatives of the genus *Assilina* are assessed in the following order of diagnostic importance:

(i) Degree of envelopment of the spiral sheet.
(ii) Rate of opening of the spire.
(iii) Form of the septa.
(iv) Type and degree of ornamentation.

The following characters previously used in species determination have been found to be of doubtful value due to the wide limits of normal variation in all species:

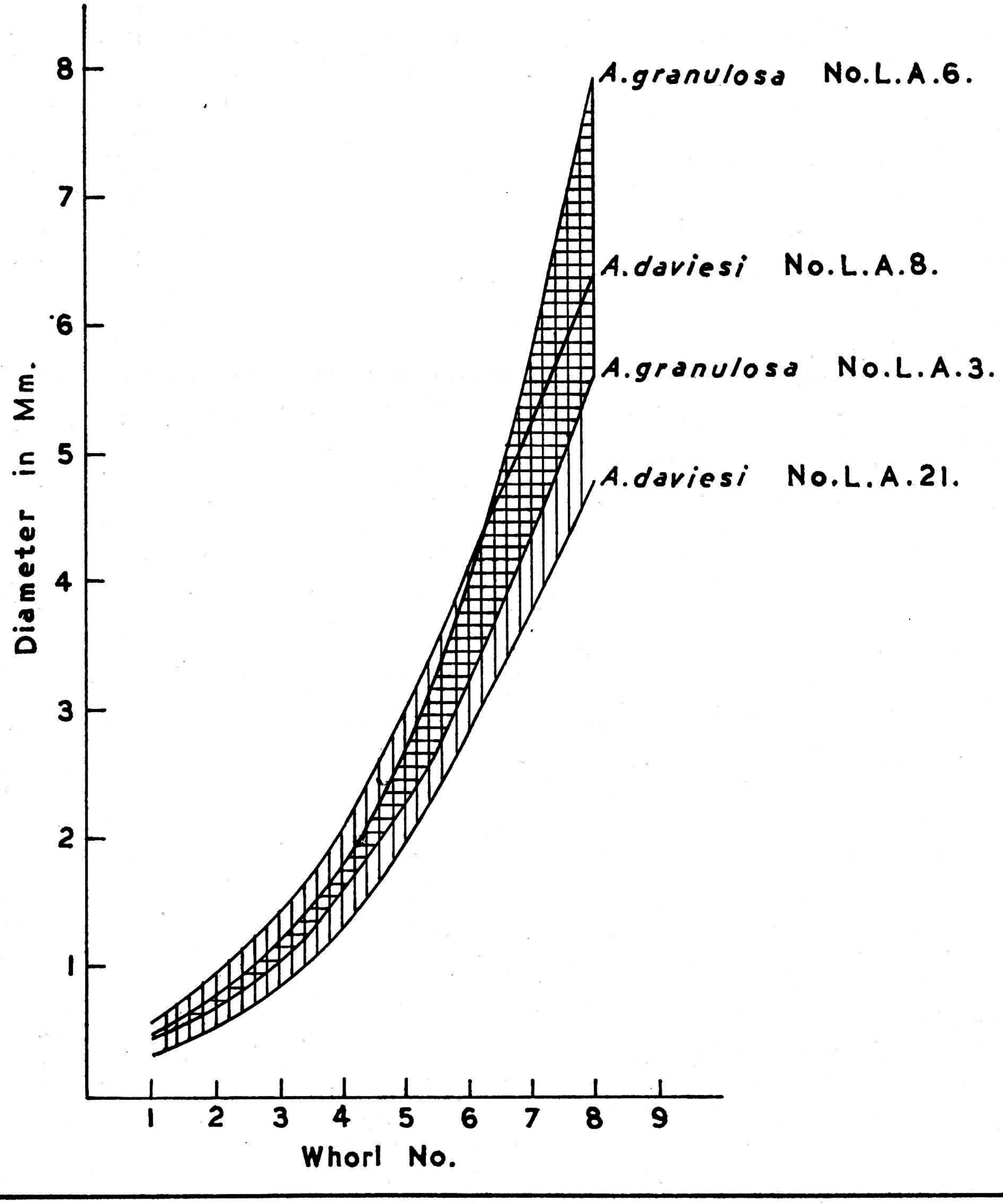
(v) Thickness of the marginal cord and septa.
(vi) Number of septa in a whorl.

B. *Comparative Morphology*

(i) The most simple and probably the most fundamental grouping of Laki *Assilinae* is a threefold one on the basis of the degree of development of the spiral sheet.

TEXT FIG. 1.

Graphs showing range of whorl/diameter dimensions in *Assilina daviesi* and *Assilina granulosa*.



(a) Forms in which the spiral sheet may extend over 1 to 3 of the preceding whorls at the outer margin, but is never seen to be enveloping in the inner whorls. This completely evolute group forms the species *A. daviesi* Cizancourt.

(b) Forms in which the spiral sheet is completely enveloping in the inner whorls, but is never completely enveloping in the outer whorls. This semi-involute group includes the species *A. granulosa* (Archiac) and *A. spinosa* L. M. Davies.

(c) Forms which are completely involute throughout, though the spiral sheet of the outermost whorls may be extremely thin at the poles in some specimens. These constitute the new species *A. laminosa* and *A. sublaminosa.*

(ii) The rate of opening of the spire as observed in equatorial section is a much more difficult character on which to define specific limits, though in spite of variation, it serves to distinguish between *A. granulosa* and *A. daviesi,* and between *A. granulosa* and *A. spinosa.*

Data in the form of measurements are obviously desirable for a sound basis of differentiation. The measurement most commonly quoted is the diameter for a given number of whorls; but the analysis of the measurements of a large number of specimens shows that this is inadequate, failing to differentiate between spires of fundamentally different types whilst, on the other hand, showing great differences between geometrically identical spirals.

In the opinion of the author, the most satisfactory method is to measure the increase in diameter or radius for the addition of each whorl. The first series of measurements to be compared in the present study was the diameter at each whorl. The outer limits of these values for *A. daviesi* and *A. granulosa* are graphed in Text Figure 1.

A large number of specimens of both species fall in the cross-shaded area of the graph where both species can have the same diameter for a given number of whorls. There is, however, in nearly all cases a distinction in the slope of the curve over the later whorls showing *A. granulosa* to have a more rapidly opening spire. The great range of values obtained by these measurements is a serious drawback for comparing the spires, and there is a suspicion that an error may be introduced in the counting of the whorls at the centre. Uncertainty as to the number of the whorl being measured arises from the difficulty of cutting large microspheric forms through the microsphere, and also from the poor preservation of the innermost whorls in many specimens. The following method can be applied to eliminate these uncertainties. The point at which the whorl intersects a fixed radius (in this case a radius of 1.32 mm. proved suitable) is regarded as whorl No. 0. The radius is then measured outwards for whorls 0 + 1, 0 +2, etc., and inwards for whorl 0 — 1, 0 — 2, etc. The average dimensions of 6-10 specimens of all species have been found to give remarkably smooth curves which all pass through a common point, and can be compared as in Text Fig. 2.

A further comparison of spires can be obtained by calculation of the ratio of increase in radius or diameter for the addition of each whorl, though this method tends to emphasize the individual irregularities more than the methods described above. It is interesting to note that the spires are modifications of the *Archimedes* spiral, in that the ratio of increase in radius for the addition of each whorl progressively decreases, in contrast to the Logarithmic spiral in which the ratio remains constant.

Analysis on the above lines has shown that the dimensions of the spire of Laki *Assilinae* are determined by two factors:

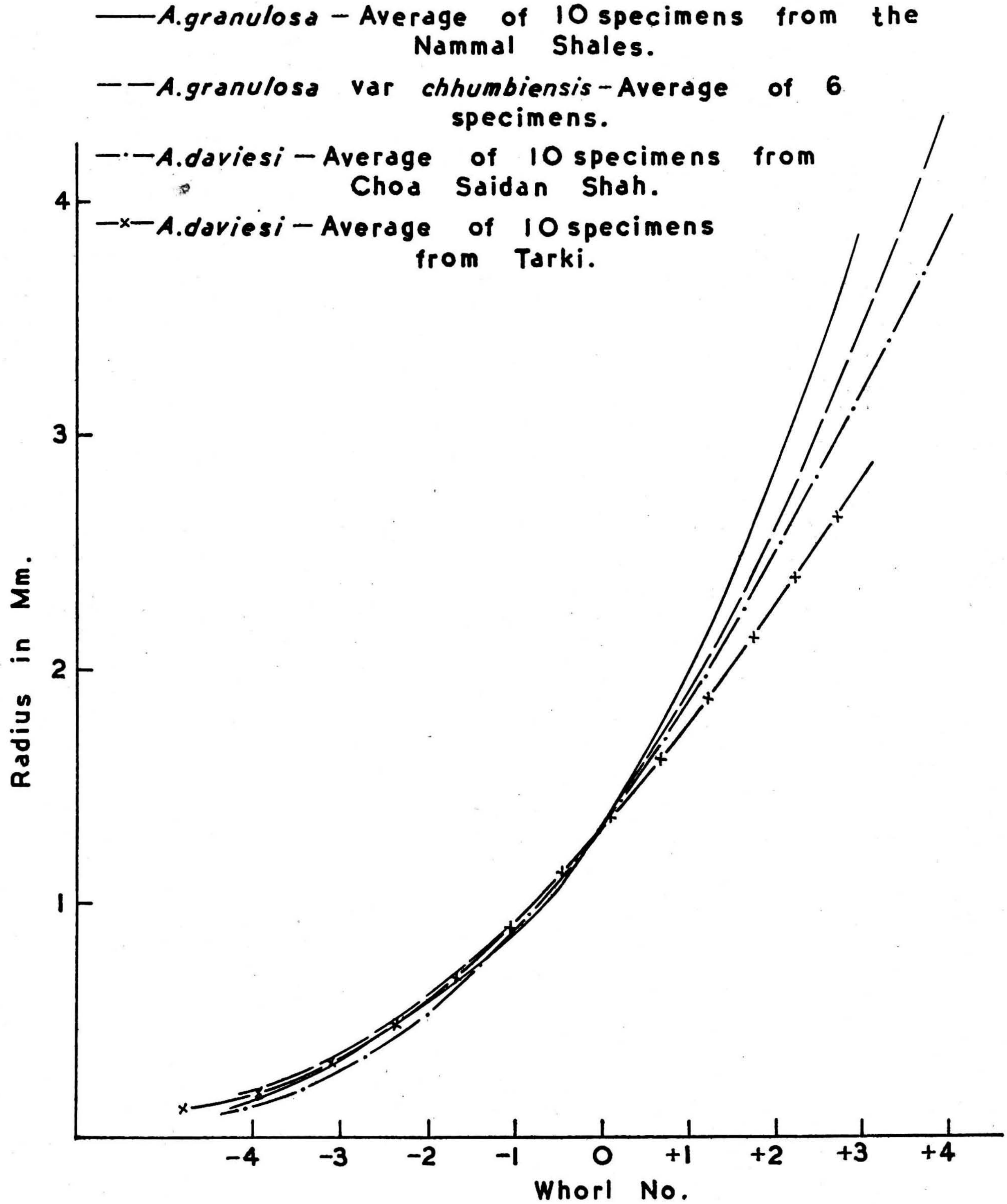
(a) The basic factor is the ratio of increase of radius or diameter for the addition of each whorl, which will be referred to as the ratio factor. This varies considerably and is often irregular in the initial whorls, but becomes more regular and constant in the later whorls.

(b) The ratio factor is complicated by what will be referred to as the origin factor. Owing to variation in the size of the microsphere, or of the first whorl of chambers, or, in certain cases, to an abnormally high ratio factor for one of the early whorls, specimens start their coil on different points of the geometrical spiral. This can be clearly demonstrated in *A. granulosa* in which the origin factor varies more than in any other species. Specimen L. A. 6, Plate 14, fig. 13, appears to have a more rapidly opening spire than specimen L. A. 3 (Fig. 14) from the same locality. The ratio factors of these specimens are, however, identical between whorls 0 —1 and 0 + 3, and it is possible by photographic enlargement of Fig. 14 to prove the geometrical identity of the two spires. In this case it is significant that in L. A. 6 the ratio factor at whorl 0 — 2 is 2.2 compared with the average of 1.6 for the same whorl in 10 specimens from the same locality, giving a considerably greater diameter for the specimen at this whorl than the average. The ratio factor for the succeeding whorls, however, conforms to the average for the species, giving a visibly greater than average height to the later whorls on this specimen.

It is obvious, therefore, that the visual appearance of a spire may be deceptive and the ratio factor should be determined before comparing spires. On the basis of the ratio factor alone, only two species of Laki *Assilinae* can be distinguished with certainty from their equatorial section i. e. *A. daviesi* and *A. granulosa.* Text Fig. 2 shows that the average of 10 specimens of one species from any locality does not encroach on the nearest dimensions of the other. Based on diameters the average ratio factor of *A. daviesi* from all localities

TEXT FIG. 2.

Graph showing variation in opening of the spire in *Assilina daviesi* and *Assilina granulosa*.



is 0.4 - .05 less than the same average for *A. granulosa* for each whorl. The average dimensions for *A. spinosa* and *A. laminosa* fall between the limits of the most tightly coiled *A. granulosa* and the most loosely coiled *A. daviesi,* the former lying towards *A. granulosa* and the latter towards *A. daviesi;* but it is not possible to identify these species on the rate of opening of the spire alone.

(iii) Although variable and less clearly defined in the early whorls, the degree of curvature and inclination of the septa in the later whorls is fairly constant; this factor is almost as important as the opening of the spire in the diagnosis of Laki *Assilinae* from the equatorial section. Details are described under individual species but the grouping can be summarized as follows:

(a) Septa almost invariably straight throughout, and normal to the marginal cord — *A. laminosa.*

(b) Septa leaving the marginal cord at an angle and curved for one-eighth of their length, thereafter being usually straight and with a distinct forward inclination, most marked in the last 3 whorls — *A. daviesi.*

(c) Septa leaving the marginal cord at an angle, with a distinct forward curvature for the first quarter or third of their length, thereafter being straight and normal to the marginal cord — *A. granulosa* and *A. spinosa.*

(iv) The ornamentation of Laki *Assilinae* is in the form of round granules of varying size and degree of prominence, and/or radial bars never exceeding the length of the septa of any whorl. The specimens in the author's collection show a distinct specific grouping as follows:

(a) *A. laminosa.* The microspheric form only rarely shows any ornament, but when this is seen, it is a fainter version of the type common in the megaspheric form — *A. sublaminosa.* This takes the form of radial bars marking the septa. Since the septa are deeply buried beneath the spiral laminae, these bars are continuous pillar structures passing through the laminae from the whorls.

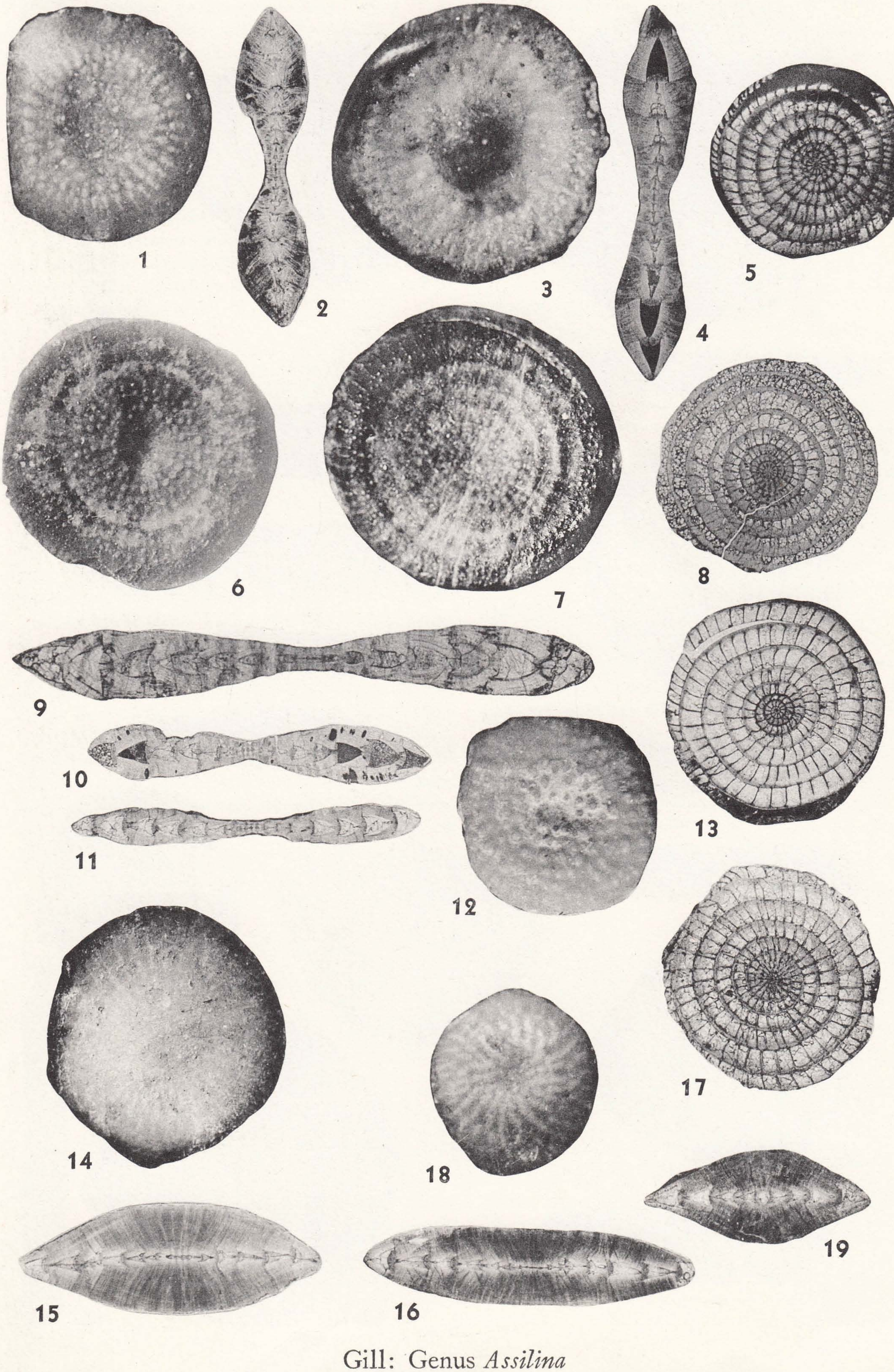
(b) *A. granulosa* and *A. spinosa.* The ornament of the type form of *A. granulosa* from the Nammal Shales of the western Salt Range is not prominent and is not visible in a large number of specimens until etched by acid. It takes the form of granules, mostly along the line of the whorls and septa, though sometimes in between. The radial granules are sometimes so closely packed as to form the bar structures seen in *A. laminosa.* The ornament of *A. spinosa* differs from that of *A. granulosa* only in degree, and may be a normal variation in limestone facies.

(c) *A. daviesi.* This is the most regularly and

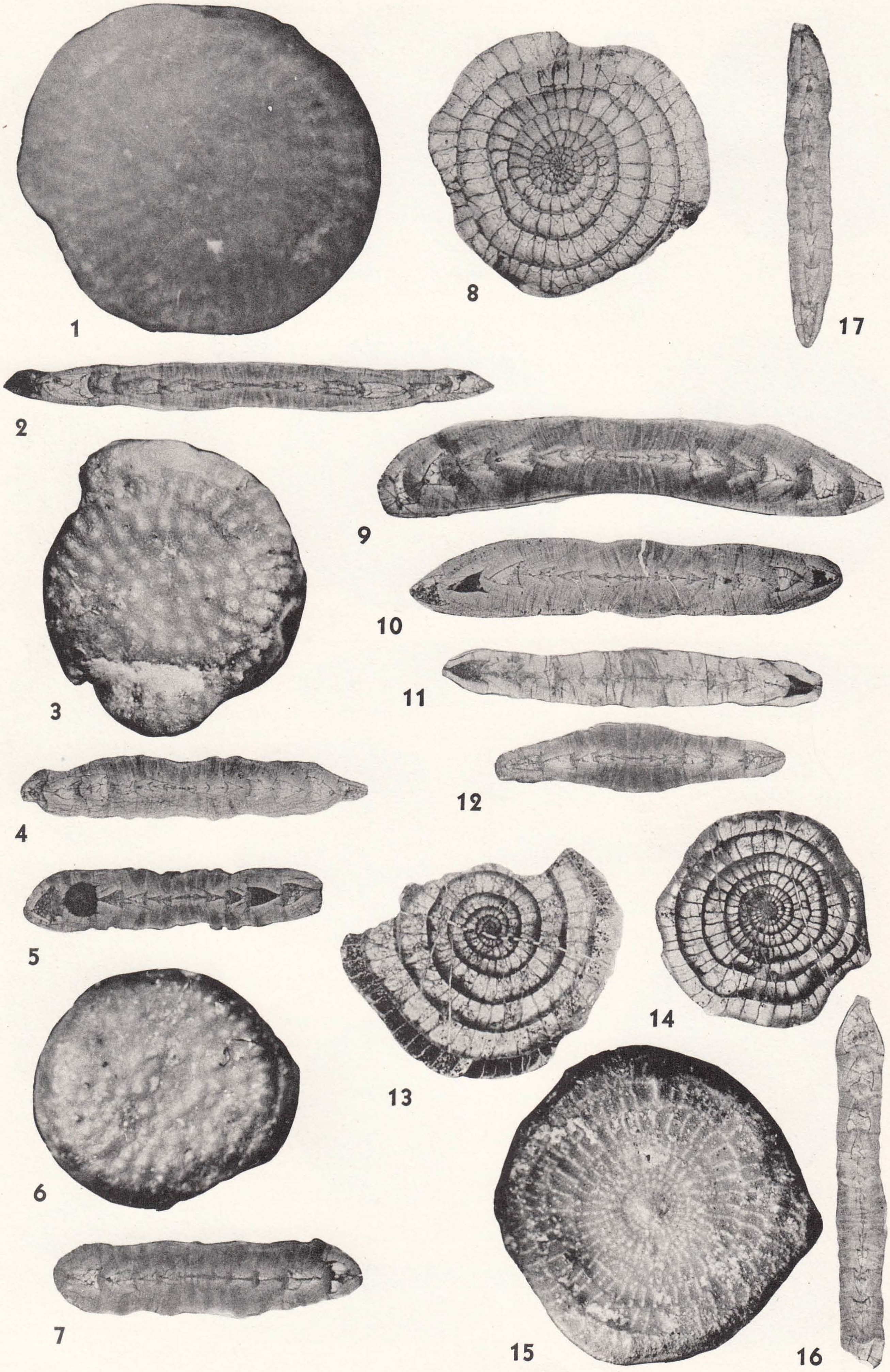
EXPLANATION OF PLATE 13

Figs.		Page
1.	*Assilina daviesi* var. *nammalensis,* var. nov. Nammal Shales, Jaba. × 8. A.O.C.[1] No. L 76c.	82
2.	*Assilina daviesi* var. *nammalensis,* var. nov. Nammal Shales, Jaba. Median section. × 10. A.O.C. No. L 78.	82
3.	*Assilina daviesi* var. *nammalensis,* var. nov. Nammal Shales, Jaba. × 8. A.O.C. No. L 76a.	82
4.	*Assilina daviesi* var. *nammalensis,* var. nov. Nammal Shales, Jaba. Median section. × 12. A.O.C. No. LA 72.	82
5.	*Assilina daviesi* var. *nammalensis,* var. nov. Nammal Shales, Jaba. Equatorial section. × 6. A.O.C. No. LA 21.	82
6.	*Assilina daviesi* Cizancourt. Upper Laki shales, N. of Jhalar, Kala Chitta Range. Typical Salt Range form. × 5. A.O.C. No. A 10.	81
7.	*Assilina daviesi* Cizancourt. Upper Laki shales, N. of Jhalar, Kala Chitta Range. Form showing inflated whorl. × 4.5. A.O.C. No. A. 11.	81
8.	*Assilina daviesi* Cizancourt. Lower Bhadrar Beds, Choa Saidan Shah. Equatorial section. × 5. A.O.C. No. LA 8.	81
9.	*Assilina daviesi* Cizancourt. Laki Shales, N. of Jhalar, Kala Chitta Range. Median section. × 10.6. A.O.C. No. LA 67.	81
10.	*Assilina daviesi* Cizancourt. Lower Bhadrar Beds, Kallar Kahar (Salt Range). Median section showing narrower chambers and sharper keel. × 8. A.O.C. No. L 99.	81
11.	*Assilina daviesi* Cizancourt. Lower Bhadrar Shales, Tarki (Bakrala Ridge). Median section. × 10. A.O.C. No. LA 70.	81
12.	*Assilina daviesi* Cizancourt. Lower Bhadrar Beds, Tarki (Bakrala Ridge). Stunted and heavily granulated form from higher levels. × 7.2. A.O.C. No. A 14.	81
13.	*Assilina daviesi* Cizancourt. Basal Shekhan Limestone, Panoba. Equatorial section. × 6. A.O.C. No. LA 16.	81
14.	*Assilina laminosa* sp. nov. Nammal Shales, Jaba, Salt Range. Cotype. × 8. A.O.C. No. L 39a.	83
15, 16.	*Assilina laminosa* sp. nov. Nammal Shales, Jaba, Salt Range. Median sections. × 9. A.O.C. Nos. L 125, L 126.	83
17.	*Assilina laminosa* sp. nov. Nammal Shales, Jaba, Salt Range. Equatorial section. × 6.5. A.O.C. No. LA 58.	83
18.	*Assilina sublaminosa* sp. nov. Nammal Shales, Jaba, Salt Range. Holotype. × 8. A.O.C. No. L 39d.	83
19.	*Assilina sublaminosa* sp. nov. Nammal Shales, Jaba, Salt Range. Median section. × 13. A.O.C. No. L 130.	83

1 A.O.C.: Attock Oil Company Collection numbers.



Gill: Genus *Assilina*



Gill: Genus *Assilina*

conspicuously granulated of all Laki *Assilinae.* The granules are generally smaller than in *A. spinosa* and are characteristically radially aligned. The bar structures of other species have not been observed, and, however, closely packed, the individual granules are distinct. It is interesting to note that contrary to the evidence in the *A. granulosa - A. spinosa* group, degree of ornament does not appear to reflect facies in the same way, for the most heavily granulated forms are those from the extreme development of shale facies at Tarki at the extreme eastern end of the Salt Range. Despite the heavy granulation, the form from this locality is stunted, possibly reflecting the lack of carbonates.

III. DETAIL OF SPECIES AND OF DISTRIBUTION

Assilina daviesi, Cizancourt

Plate 13, figures 6-13

The type form from the Dalwal-Nurpur area of the Salt Range has been amply figured (5) and only the equatorial section is here figured for comparison with that from other localities (Pl. 13, fig. 8). This large form, with broad chambers and generally with a rounded margin, is the most common form at most localities in the Upper Laki of the Kala Chitta Range and in the Shekhan Limestone of Kohat District (see Pl. 13, figs. 6, 9). Variations in external appearance occur in the Kala Chitta Range. Many forms (Pl. 13, fig. 7) have a very inflated whorl and the spire can be clearly followed by an inter-whorl depression. The inflated form is often lightly granulated and the granules have not the clear radial arrangement of the type form. Other specimens from the same localities have much narrower chambers and are sharply keeled instead of rounded. There is variation in the Salt Range communities in this respect, a narrow chambered and sharper-keeled form being illustrated in Pl. 13, fig. 10.

The most extreme variations from type morphology occur in the upper part of the Laki Shales (Bhadrar Beds) of the Bakrala Ridge — the most northerly of the structural and topographic digitations into which the Salt Range merges at its eastern end. The Foraminifera here occur in thin bands in a shale which is much less calcareous than the marly beds at this horizon in the main part of the Salt Range. The average diameter of *A. daviesi* from these localities is less than 5 mm. and the test proportionately very thin (P. 13, figs. 11 and 12). The stunted aspect would appear to reflect the lack of lime, but on the other hand the form is heavily granulated, almost tuberculated.

The diagnostic features of internal morphology have been described above (pp. 78). The median section is invariably wasp-waisted due to the absence of lateral laminae, and this provides a sure diagnosis of the species. The equatorial section shows a distinctly more tightly coiled spire than in *A. granulosa,* and the septa, which straight for ⅞ of their length, show a distinct forwards inclination of 20-30° in later whorls. There are exceptions to these generalisations, however, for a number of specimens from the Shekhan Limestone in Kohat District (Pl. 14, fig. 13) and from Tarki, lack pronounced inclination of septa. Several specimens from Tarki have curved septa.

Distribution

In a forthcoming paper, submitted to the Journal of Paleontology, the author will demonstrate that in the Laki of Kohat/Potwar Basin this species is to a marked degree restricted both in the stratigraphical and geographical sense to the development of shale facies. It appears to have been capable of rapid migration to areas of favorable ecology. For this reason it is of limited value for other than local correlation of the Eocene succession.

EXPLANATION OF PLATE 14

Figs.		Page
1-7.	Illustrating gradation between *Assilina granulosa* (Archiac), (Figs. 1 and 2), and *Assilina spinosa* Davies (Figs. 3-7). Fig. 2 from the Sakesar Limestone, Jaba, Salt Range. Figs. 3-7 from the Sakesar Limestone, Choa Saidan Shah, Salt Range. Figs. 1-3 and 6 × 8. Figs, 4, 5 and 7 × 10. A.O.C. Nos. LA 110, L 117, LA 112, L 73, L 74, LA 113, L 75.	82
8.	*Assilina granulosa* (Archiac). Nammal shales, Jaba, western Salt Range. Equatorial section × 5. A.O.C. No. LA 2.	82
9-12.	*Assilina granulosa* (Archiac). Median sections showing variations at different localities. All figs. × 8. Figs. 9 and 10 from the Discocyclina (Nammal) Limestone, Panoba, Kohat District. Fig. 11 from the top of the Sakesar Limestone, Tarki, Bakrala Ridge. Fig. 17 from the Sakesar Limestone, Choa Saidan Shah, Salt Range. A.O.C. Nos. LA 145, LA 84, L 113, L 72.	82
13-14.	*Assilina granulosa* (Archiac) showing variation in coiling from the same community in the Discocyclina Limestone, Panoba, Kohat District. Also compare with Fig. 8.	78
15.	*Assilina granulosa* var. nov. Lower Bhadrar shales, Choa Saidan Shah, Salt Range. × 3.2. A.O.C. No. L 104a.	82
16.	Median section of form similar to Fig. 15. From the Lower Bhadrar Beds, Tarki, Bakrala Ridge. × 8. A.O.C. No. L 12.	82
17.	*Assilina leymeriei* (Archiac). Lower Bhadrar Beds, Nurpur, Central Salt Range. Median section. × 11. A.O.C. No. L 81.	83

Assilina daviesi, Cizancourt var. **nammalensis** var. nov.

Plate 13, figures 1-5

Cotypes: A. O. C. Nos. L 76a, L 76c.

The form of *A. daviesi* from the Upper Laki of the Salt Range, and of the Kala Chitta, and from most localities in Kohat District, has almost invariably the broadly arched chambers of the form originally described by Davies. The spiral sheet of this form rarely extends over more than the preceding whorl. From the Nammal Shales at Jaba in the Western Salt Range, and from the Shekhan Limestone at Panoba and Gada Khel in Kohat District, the form is considerably stouter, with a correspondingly deep crater at the poles. This is seen in median section to be due to the development of a spiral sheet extending to 3 or 4 of the outer whorls (Pl. 13, fig. 2). The spiral sheet, however, never extends to the poles and at Jaba there is gradation to a form which is not greatly different from certain specimens from the Bhadrar Beds (compare figs. 4 and 10), though the chambers are narrower and more pointed in median section. The Nammal variety in equatorial section is more tightly coiled than the average form from the Upper Laki, but it is closely similar to the form from Tarki in this respect. Septa are straight and with typical pronounced inclination in the later whorls (Pl. 13, fig. 5).

Distribution

The variety *nammalensis* seems to be restricted to the Lower Laki on the Salt Range, but extends to higher Laki horizons in Kohat District. Gradations towards typical *A. daviesi* occur in the Lower Laki of the Kohat/Potwar basin, and de Cizancourt has recorded typical *A. daviesi* from Lower Laki beds in Afghanistan (2).

Assilina granulosa (Archiac)

Plate 14, figures 1, 2, 8-14

For synonomy see Davies, (5), 1937, pp. 29 and 30.

In a forthcoming paper, to be published in the Journal of Paleontology, the author will comment on the considerable morphological variations of this form in the Laki of the Kohat/Potwar Basin. Nuttall (6) described a similar range of variations from Sinid, regarding them as a single species. Davies (5) ascribed to *A. granulosa* only the large, smooth, relatively thin form common in the Lower Laki of the western Salt Range (Pl. 14, figs. 1 and 2). He separated the heavily granulated, thicker walled, more tightly coiled forms, which are more common in the Sakesar Limestone, as the species *A. spinosa,* though recognising their close affinities with *A. granulosa.* Figs 1-7 on Pl. 14 illustrate a gradational series from one species to the other, which can be collected from the same bed in the lower part of the Sakesar Limestone of the eastern Salt Range. In the author's opinion, the erection of the morphological species *A. spinosa* is of questionable value, since its significance is probably ecological rather than chronological. Strict adherence to the unit characters of the type form would necessitate the erection of numerous species. Thus, whilst the Lower Laki form from the western Salt Range is thin, that from the same horizon on the Tarkhobi/Panoba fold in Kohat District is much stouter, due to the broader chambers and thicker walls (Pl. 14, figs. 9. 10). These two specimens from the same community illustrate also that the relative thickness of the centre compared with that of the outer whorls is a feature of normal variation. One is not justified, therefore, in giving specific recognition to the form with marked thickening at the center (fig. 12) which is common in the higher Laki formations of the eastern Salt Range and the Bakrala Ridge.

The range of variation in the equatorial section has been described above (pp. 78). The rate of opening of the spire appears to vary considerably in specimens from the same community (Pl. 14, figs. 13 and 14), but it has been shown that the apparent differences are due largely to the 'origin factor' and that the spires are geometrically identical. The basic 'ratio factor,' or ratio of increased diameter for the addition of each whorl, varies between much narrower limits, and is distinctly greater than that of *A. daviesi.* The ratio factor for *A. granulosa* rarely falls below 1.35 for Whorl No. 0 + 3 (Whorl 0 at a radius of 1.32 mm.). The average ratio factor for *A. daviesi* for the same Whorls is 1.30.

The form of the septa in *A. granulosa* and *A. spinosa* is distinct from that of other species in the pronounced forward curvature for the first ¼ to ⅓ as they leave the marginal chord; the form of the lower part of the septa is variable. In most specimens the septa become straight and normal to the marginal chord, but in the Sakesar Limestone of the Salt Range, forms towards *A. spinosa* frequently have septa curved throughout their length and/or inclined at angles of 10°-20° from the normal.

Distribution

The revised range charts show that *A. granulosa* and *A. spinosa* occur at all levels of the marine Laki of the Kohat/Potwar basin, though often to mutual exclusion in any particular section. The present evidence suggests that *A. granulosa* dominates the shale facies and *A. spinosa* the limestone facies.

The only morphological variant for which the author has found reasons to separate from the species is a new variety which is to be described elsewhere. This large new variety with granules both on and between the septa and with a raised boss at the poles (Pl. 14, figs. 15, 16), is restricted to the Lower Bhadrar shales of the eastern Salt Range. Although it is contemporaneous with the type form, its similarity to *A. exponens* (Sowerby) of the succeeding Kirthar stage suggests that it may represent a mutation, and not a normal morphological variant.

Assilina leymeriei (Archiac and Haime)

Plate 14, figure 17

This megaspheric form of *A. granulosa* occurs abundantly at many horizons in the Laki of the Kohat/Potwar Basin. Only the smooth form, strictly of type morphology, is figured (Pl 14, fig. 17), but there is a perfect gradational series to *A. subspinosa* L. M. Davies at many horizons.

Assilina laminosa, sp. nov.

Plate 13, figures 14-17

Cotypes: A. O. C. No. L 39a, No. L 39b.

This species is clearly defined by the fact that, excepting in about 10% of specimens in which the spiral sheet of the last whorl may be extremely thin, or occasionally absent, at the poles (possibly due to abrasion in some cases), the form is completely involute, the spiral sheet of each whorl completely enveloping all preceding whorls. The thickness of the spiral sheet at the poles is variable, resulting in a disc shape of varying thickness at the centre. The typical smooth, unornamented, external aspect is shown in Plate 13, fig. 14.

The median section is the best for quick identification (Plate 13, figs. 15 and 16). It shows the thick lateral laminae of the spiral sheet, in which the lamina of each whorl can be followed by growth lines. The median section also shows especially near the poles, numerous pillar structures at the whorl junctions, which are often continuous through succeeding laminae. The chambers in median section are typically narrowly tapering or arrow-headed in shape.

Analysis of the rate of coiling from equatorial sections shows the spire to be very close to that of the more loosely coiled *A. daviesi* from the central Salt Range. The septa, however, provide the diagnostic feature of this section. As illustrated in Pl. 13, fig. 17, they are almost straight throughout and normal to the marginal cord. Many specimens also show a tendency for the ends of the septa to be clubbed, a feature not observed in any other species. The septa appear to be more crowded than in other species, the average of nine specimens having 2 to 3 more septa per whorl than the average for the same number of specimens of *A. granulosa.*

Distribution

A. laminosa was first collected in large numbers from the Nammal Shales at Jaba in the western Salt Range, where it occurs in the same bed with *A. daviesi* var. *nammalensis.* It has subsequently been found in considerable numbers in the lower part of the Sakesar Limestone at several localities in the western Salt Range, and from the same formation in cores from a deep well at Jhatla, about 10 miles north of the central Salt Range. Its most northerly occurrence is from cores in the Dhulian Oilfield about 120 feet below the top of the Marine Laki Limestone. On present evidence it appears to be a zone form of the Lower Laki.

Assilina sublaminosa, sp. nov.

Plate 13, figures 18 and 19

Holotype: A. O. C. No. L 39d.

The megaspheric form of *A. laminosa* is mentioned by Davies (5, p. 29) as a form similar to the Ranikot species *A. dandotica* L. M. Davies occurring in the Nammal Shales, but the lack of sufficiently well preserved specimens precluded detailed description.

As Davies states, the form is larger and more lenticular than the Ranikot species from which it is probably derived. The maximum observed diameter is 3.6 mm., the average of 10 specimens being 2.9 mm. In the majority of specimens the exterior is smooth and opaque as in the microspheric form. In about 30% of specimens, however, the septa are clearly marked at the surface by bars of closely packed granules (ref. Pl. 13, fig. 18). These are continuous pillar structures passing through the lateral laminae from the underlying chambers. No form so far collected shows the degree of granulation common in *A. dandotica.*

In median section (Plate 13, fig. 19), although the base of the chambers is broad, the chambers do not envelop the outermost quarter of the preceding whorl as in *A. dandotica,* and they have straight, tapering sides compared with the broadly arched chambers of the Ranikot species.

The megasphere in all sections prepared is single.

IV. GEOGRAPHICAL INDEX

			Survey of India 1″ Map Sheet
Bhadrar	32° 39′	: 72° 29½′	43 D/6
Choa Saidan Shah	32° 43½′	: 72° 59′	43 D/14
Dalwal	32° 42½′	: 72° 53½′	43 D/14
Dhulian Oilfield	33° 12′	: 72° 20′	43 C/8
Jaba	32° 52′	: 71° 41′	38 P/9
Jhalar R. S.	33° 38′	: 72° 20′	43 C/8
Joya Mair Oilfield	32° 59′	: 72° 50′	43 D/13
Kohat	33° 36′	: 71° 29′	38 O/6
Nurpur	32° 40′	: 72° 35′	43 D/10
Panoba	33° 36½′	: 71° 54′	38 O/14
Potwar	33° 0′	: 72° 0′	
Salt Range	32° 30′	: 72° 0′	
Tarki	33° 04′	: 73° 25½′	43 G/8

V. LIST OF REFERENCES

1. Archiac, E. J. A. d' and Haime, J., 1853-55, Description des animaux fossiles du groupe nummulitique de l'Inde. Paris. Vol. I, 1853; vol. II, 1854; 373 pp., 36 plates.

2. Cizancourt, Mme. H. de, 1938, Contributions à l'Étude des Faunes tertiaires de l'Afghanistan.

Mém. Soc. Géol. France. N. S. Vol. XVII., fasc. 1, Mem. 39. 44 pp.; 5 plates.

3. Davies, L. M., 1940, Correlation of Laki Beds. *Geol. Mag.* vol. lxxvii, pp. 252-3.

4. ———, 1941, Correlation of Laki Beds. *Ibid.*, vol. lxxviii, pp. 151-152.

5. ——— and Pinfold, E. S., 1937, The Eocene Beds of the Punjab Salt Range. *Geol. Surv. India, Mem., Pal. Ind.* N. S. Vol. XXIV, No. 1. 79 pp., 7 plates.

6. Nuttall, W. L. F., 1925, The Stratigraphy of the Laki Series, etc. *Quart. Journ. Geol. Soc. Lond.*, Vol. LXXXI, pp. 417-453, pls. 23-28.

NOTE:

After the manuscript had been set in type, the Editor received a letter from the author, in which he stated that the types and lectotypes of this study will be preserved in the collections of the British Museum (Natural History). Figs. 1-19 of Plate 13, and Figs. 1-17 on Plate 14 should be serially numbered with the British Museum numbers P. 41474 to P. 41509 inclusive.

RECENT LITERATURE ON THE FORAMINIFERA

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

ALLIATA, E. di NAPOLI. Nuove specie di foraminiferi nel Pliocene e nel Pleistocene della zona di Castell' Arquato (Piacenza).—Riv. Ital. Pal. Stratig., vol. 58, No. 3, 1952, pp. 95-110, pl. 5.—Nine new species and one new variety described and illustrated.

ASANO, KIYOSHI. Illustrated catalogue of Japanese Tertiary smaller Foraminifera (compiled and edited by Leo W. Stach).—Tokyo, Japan, Supplement No. 1, July 10, 1952, pp. 1-17, text figs. 1-99.—Forty-nine species, 6 new, are described and illustrated.

BARNARD, TOM. Foraminifera from the upper Oxford clay (Jurassic) of Warboys, Huntingdonshire.—Proc. Geol. Assoc., vol. 63, pt. 4, Dec. 30, 1952, pp. 336-350, text figs. A-C, table 1.—Twenty-two species, 2 new, are described and illustrated and their distribution plotted.

BARTENSTEIN, HELMUT. Stand der Tertiärforschung im süddeutschen Raum.—Erdöl und Kohle, 4. Jahrg., 1951, pp. 679-683, text figs. 1-5.

Faziesbeobachtungen an der Grenze von brackischen zu marinem Valendis des Rehburger Sattels.—Naturhist. Gesellschaft Hannover, Jahresb. 99-101 für die Jahre 1947/48 bis 1949/50, pp. 35-42, text figs. 1-3.—A few Foraminifera enter into the change from fresh to marine facies, as shown on two distribution charts.

Taxonomische Revision und Nomenklator zu Franz E. Hecht "Standard-Gliederung der Nordwest-deutschen Unterkreide nach Foraminiferen" (1938).—Senckenbergiana, vol. 33, No. 1/3, June 15, 1952, pp. 173-183.

BIRKENMAJER, K. La question du Miocène marin de Podhale (Karpates Centrales).—Ann. Soc. Geol. Pologne, vol. 21, fasc. 2, Ann. 1951, Aug. 9, 1952, pp. 235-278.—A few Foraminifera are listed.

BRONNIMANN, PAUL. Trinidad Paleocene and lower Eocene Globigerinidae.—Bull. Amer. Pal., vol. 34, No. 143, Dec. 29, 1952, pp. 1-34, pls. 1-3, table 1.—Thirteen species, 6 new, are described and illustrated.

BURSCH, J. G. **Praeammoastuta**, new foraminiferal genus of the Venezuelan Tertiary, with an emendation of **Ammoastuta** Cushman and Brönnimann.—Journ. Pal., vol. 26, No. 6, Nov. 1952, pp. 915-923, pl. 132, text figs. 1-4.

CIVRIEUX, J. MARC S. de. Apendice micropaleontologico region de Altagracia de Orituco.—Bol. Geol., Venezuela Ministerio de Minas e Hidrocarburos, vol. 1, No. 3, Oct.-Dec. 1951, pp. 260-264.—A few Foraminifera are listed from Cretaceous to Oligo-Miocene beds.

COBBAN, W. A., and REESIDE, J. B. JR. Frontier formation, Wyoming and adjacent areas.—Bull. Amer. Assoc. Petr. Geol., vol. 36, No. 10, Oct. 1952, pp. 1913-1961, text figs. 1-4.—Foraminifera are listed.

COLOM, G. Estudios sobre las microfaunas de algunas cuencas marinas internas Mio-Pliocenas de la cordillera Subbética.—Bol. Real Soc. Española Hist. Nat., sec. Geol., vol. 49, Nos. 1-3, 1951, pp. 157-191, pls. 15-22, text figs. 1-6.—Numerous Foraminifera are illustrated and their abundance shown graphically.

Aquitanian-Burdigalian diatom deposits of the North Betic Strait, Spain.—Journ. Pal., vol. 26, No. 6, Nov. 1952, pp. 867-885, text figs. 1-4, tables 1, 2.—A table is included comparing the ranges of 18 pelagic species and 37 benthonic species of Foraminifera in the Oligocene and Miocene of Central America and Spain.

DROOGER, C. W. and VOUTE, C. Sur la présence d'Inocérames dans un niveau post-Maestrichtian près d'Aïn-Fakroun (Algérie).—Bull. Soc. géol. France, ser. 6, vol. 1, 1951, pp. 313-317.—Twenty-seven species of Foraminifera form the basis for the age determination of the **Inoceramus**-bearing beds.

ELLIOTT, GRAHAM F. Bibliographical note on the Cretaceous Foraminifer **Orbitolina bulgarica** (Boué).—Journ. Soc. Bibliography Nat. Hist., vol. 2, pt. 9, Nov. 1952, pp. 383-385.

EMILIANI, CESARE. Nomenclature and grammar.—Journ. Washington Acad. Sci., vol. 42, No. 5, May 15, 1952, pp. 137-141.

FINLAY, H. J. Microfaunal notes on matrices associated with fossil penguin bones.—New Zealand Geol. Survey Pal. Bull. 20, May 1952, Appendix, pp. 58-64.—Numerous lists of Foraminifera are given, dating several lots of bones from ages ranging from lower Eocene to middle Oligocene.

FRIESE, HEINRICH. Zur Foraminiferen-Fauna der Meeresmolasse des Unteren Inngebietes.—Abhandl. Geol. Dienstes Berlin, n. ser., No. 227, 1951, pp. 1-52, pls. 1-14, 1 map.—A fauna of 86 species from the middle Oligocene Lower Marine Molasse from well borings in the Lower Inn region of Bavaria is described and illustrated. Ranges of variations are well illustrated.

FUSEJIMA, REIKO, MARUBASHI, MASAHO, and KITAZAKI, UMEKA. Correlation between Foraminifera and environment in the Philippine and adjacent seas.

—Bull. Resource Sci. Instit., No. 1, March 1943, pp. 23-40, pls. 1, 2, text figs. 1-5, translation U. S. Geol. Survey, Nov. 1952.—Diagrams, based on data in Cushman's 1921 report on Philippine Foraminifera, representing faunal compositions as they vary with depth and type of bottom. Families, genera, and species are shown.

GLACON, GEORGETTE, and MAGNÉ, JEAN. **Sigmoilina colomi**, nouveau Foraminifère du Miocène algérien.—C.R.S. Soc. Géol. France, No. 3, Feb. 2, 1953, pp. 56-58, text figs. 1-5.

GRIMSDALE, T. F. **Cycloclypeus** (Foraminifera) in the Funafuti boring, and its geological significance.—**Challenger** Soc. Occasional Papers, No. 2, Sept. 1952, pp. 1-11, text figs. 1-3.—Hypothetical discussion and interpretation of evidence.

HAGN, HERBERT. Foraminiferen der subalpinen Molasse, in: Geologischpaläontologische Untersuchungen in der subapinen Molasse des östlichen Oberbayerns zwischen Prien und Sur mit Berücksichtigung des im Süden anschliessenden Helvetikums by Herbert Hagn and Otto Hölzl.—Geologica Bavarica, No. 10, 1952, pp. 121-191, pls. 1-4.—About 250 species and varieties, 10 new, are recorded, and the new ones illustrated.

Zur Kenntnis von Helvetikum und Flysch im Raum von Neubeuern am Inn.—Geologica Bavarica, No. 14, 1952, pp. 69-75, 1 stratigraphic table.

HANZAWA, SHOSHIRO. Notes on the Recent and fossil **Baculogypsinoides spinosus** Yabe and Hanzawa from the Ryukyu Islands and Taiwan (Formosa), with remarks on some spinose Foraminifera.—Short Papers from the Institute of Geology and Paleontology, Tohoku Univ., Sendai, No. 4, June 17, 1952, pp. 1-22, pls. 1, 2, text figs. 1-3.—**B. spinosus** is re-described. Six related genera, 2 new, are discussed. **Silvestriella** n. gen. (genotype **Calcarina tetraëdra** Gümbel) and **Schlumbergerella** n. gen. (genotype **Baculogypsina floresiana** Schlumberger).

ISRAELSKY, M. C. Foraminifera of the Lodo formation, Central California, General Introduction and Part 1, Arenaceous Foraminifera.—U. S. Geol. Survey Prof. Paper 240-A, 1951 (Feb. 28, 1952), pp. 1-29, pls. 1-11, text figs. 1, 2 (maps), stratigraphic distribution chart. —Sixty-six species, varieties, and subspecies are described and illustrated. Thirty-four are new and a new subgenus, **Bramletteia**, of **Silicosigmoilina** is described.

KNIPSCHEER, H. C. G. Die Gliederung der ungefalteten Molasse im östlichen Teil Bayerns auf Grund mikropaläontologischer Untersuchungen.—Geologica Bavarica, No. 14, 1952, pp. 48-68, pl. 1, text figs. 1-4.—Numerous Foraminifera are recorded. Three species of **Cancris**, 1 new, are described. An illustrated range chart is included.

KUGLER, H. G. Resumen de la Historia Geologica de Trinidad.—Bol. Asoc. Venez. Geol., Min. y Petr., vol. 2, No. 1, December 1950, pp. 48-78, map, stratigraphic table.

LeROY, L. W. Biostratigraphy of the Maqfi Section, Egypt.—Mem. 54, Geol. Soc. America, Feb. 27, 1953, 73 pp., 13 pls., 4 text figs., 1 table.—One hundred thirty-two species and varieties, 40 new, are included from one Upper Cretaceous and 4 Lower Tertiary units.

LOEBLICH, ALFRED R. JR., and TAPPAN, HELEN. The foraminiferal genus **Triplasia** Reuss, 1854.—Smithsonian Misc. Coll., vol. 117, No. 15, Sept. 9, 1952, pp. 1-61, pls. 1-8.—Thirty-seven species are included, 9 new.

LYS, M. Etude micropaléontologique, in: Etudes dans le Néogène du Bas-Rhône, by Bonnet, A., Jullian, Yves, Lys, M., and Vatan, André.—Atti VII Conv. Naz. Met. e Petr., April 1952, pp. 1-10, pls. 1-4.—An illustrated table shows stratigraphic distribution of Foraminifera.

MARKS, P. Miocene smaller Foraminifera from the region of Constantine, Algeria.—Geol. Mijnbouw, n. ser., No. 8, 14e Jaarg., August 1952, pp. 282-291, pl. 1, text figs. 1-3 (map and sections).—Thirty-five species and varieties, 2 new, are recorded and many of them illustrated.

MARQUES, J. M. da MOTA. Nota sobre o Calcario Oolitico de Diu.—Bol. Soc. Geol. Portugal, vol. 9, fasc. 3, 1951, pp. 191-194, pls. 1, 2.—A few sections of Foraminifera are illustrated.

NOTH, R. **Plectorecurvoides**, eine neue Foraminiferengattung.—Verhandl. Austria Geol. Bundesanstalt, Heft 3, 1952, pp. 117-119, text figs. 1, 2.—**Plectorecurvoides** n. gen. (genotype **P. alternans** n. sp.).

PARKER, FRANCES L., PHLEGER, FRED B, and PEIRSON, JEAN F. Ecology of Foraminifera from San Antonio Bay and environs, southwest Texas.—Special Publ. No. 2, Cushman Found. Foram. Res., Jan. 29, 1953, pp. 1-75, pls. 1-4, text figs. 1-49, tables 1-7.—An ecologic study based on about 320 samples. Four biofacies and 2 subfacies are recognized. About 75 species and varieties, 2 new and one given a new name, are recorded and illustrated. Areal distribution and abundance of 41 of these are plotted on maps. Factors relating to population patterns are discussed.

RAGGATT, H. G., and CRESPIN, IRENE. Geology of Tertiary rocks between Torquay and Eastern View, Victoria.—Australian Journ. Sci., vol. 14, No. 5, April 1952, pp. 143-147, text figs. 1, 2.—Foraminifera are listed.

REISS, Z. On the Upper Cretaceous and Lower Tertiary microfaunas of Israel.—Bull. Research Council Israel, vol. 2, No. 1, June 1952, pp. 37-50, distribution chart. —Many species of Foraminifera are listed and the stratigraphic ranges of some are shown on a chart.

RUGGIERI, GIULIANO. Foraminiferi del genere **Sakesaria** nel Paleocene della Migiurtinia.—Ann. Mus. Geol. Bologna, ser. 2, vol. 21, 1949 (1950), pp. 94-98, text figs. 1-7.—Three new species and one new variety are described and illustrated.

SCHMIDT, RUTH A. M. Microradiography of microfossils with X-Ray diffraction equipment.—Science, vol. 115, No. 2978, Jan. 25, 1952, pp. 94, 95, text figs. 1-3.

SCHOTT, WOLFGANG. On the sequence of deposits in equatorial Atlantic Ocean.—Medd. Ocean. Instit. Göteborg, 18, 1952, pp. 1-15, text figs. 1-3, 1 table.—The planktonic species are separated into warm water and cool to cold water faunas. Percentage distribution maps for one species from both groups are given. Vertical changes in 3 cores are correlated from one to another, and their significance discussed.

STEPHEN, W. Ein tortoner vulkanischer Brockhorizont in der Oberen Süsswassermolasse Bayerns.—Geologica Bavarica, No. 14, 1952, pp. 76-85, text figs. 1, 2 (section and map).—A few Foraminifera are mentioned.

THALMANN, HANS E. Bibliography and index to new genera, species and varieties of Foraminifera for the year 1951.—Journ. Pal., vol. 26, No. 6, Nov. 1952, pp. 953-992.

TRIEBEL, ERICH. Mikrofossilien und ihre Bedeutung.—Natur unk Volk, vol. 82, Heft 7, July 1952, pp. 201-213, text figs. 1-24.—A few Foraminifera are illustrated.

USBECK, ILSE. Zur Kenntnis von Mikrofauna und Stratigraphie im unteren Lias alpha Schwabens.—Neues Jahrb. für Geol. Pal., Abhandl., vol. 95, Heft. 3, 1952, pp. 371-476, pls. 14-19.—Numerous species and varieties, one new, are recorded, illustrated, and plotted as to distribution and abundance.

VASICEK, MILOSLAV. The representatives of the genus **Stensiöina** from the Moravian Flysch.—Sbornik Geol. Survey Czechoslovakia, vol. 18, Paleontology, 1951, pp. 85-96, pls. 1, 2 (12, 13), range chart.—Two new species are described and illustrated. The generic affinities are reported to be with **Cibicides.** Ranges of all the known species of the genus are plotted.

Preliminary report on the microbiostratigraphy of the earlier Neogene of southern Moravia.—L. c., pp. 97-100, text figs. 1-6.—Zonation based on two undescribed forms: **Bathysiphon** and **Haplophragmoides.**

Representatives of the genus **Hantkenina** in the Paleogene of Moravia.—L. c., pp. 101-128, pls. 1-4.—**H. liebusi** in the upper Eocene.

Origin of pseudoassociations of microfossils.—L. c., pp. 129-144, pls. 1-4 (15-18), text figs. 1, 2 (maps).—Study of effects of water- and wind-transportation and how they may be recognized.

The contemporary state of the microbiostratigraphic research of the Miocene sedimentary deposits in the Out-Carpathian Neogene basin in Moravia.—L. c., pp. 145-196, pls. 1, 2 (19, 20), text figs. 1-7, tables 1-5.—Zonation is established and 14 significant Foraminifera, none new, are described and illustrated.

WRAY, JOHN L. Endothyroid Foraminifera from the Greenbrier series of northern West Virginia.—Journ. Pal., vol. 26, No. 6, Nov. 1952, pp. 946-952, text figs. 1-20.—Several forms, none specifically identifiable, are figured in section.

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