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CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
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159. EORUPERTIA BERMUDEZI, A NEW FORAMINIFER FROM THE MIDDLE EOCENE OF CUBA[1]

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ABSTRACT

Eorupertia bermudezi, a new foraminiferal species, extends the occurrence of this little known genus from Venezuela to Cuba in the Western Hemisphere. The species is represented by relatively rare specimens occurring in the middle Eocene Loma Candela formation at the famous Peñón Quarry locality in Matanzas Province, Cuba. The associated microfauna in the formation suggests a normal saline, shallow marine, warm and clear water depositional environment typical of reef or near-reef conditions.

The Cuban specimens are high-spired forms having a thick test wall built up of laminae of calcium carbonate corresponding to successive chamber additions. The laminae are pierced approximately at right angles by tubules, which extend uninterruptedly from the outer surface inward terminating in a basal mantle. The laminae and perforations are present generally only in that part of the wall structure which is exposed and faces the exterior. A central hollow axis is developed.

INTRODUCTION

During the preparation by the writer of a paper on fragmentary specimens of *Eorupertia* from middle and upper Eocene formations of Venezuela, Dr. Pedro J. Bermúdez kindly donated five specimens of this genus from Cuba for comparison purposes. At the same time he suggested that the writer describe and publish on the Cuban forms. Dr. Bermúdez previously had recognized that these forms represented a new species (Bermúdez, 1950, pp. 243 & 340), but did not describe them. The present study thus is the result of Dr. Bermúdez's generosity and suggestion.

The Cuban specimens of *Eorupertia* are well preserved, free individuals, so that it has been possible to prepare oriented thin sections of them. Unfortunately, through an oversight, two of the five specimens were sectioned before first being described and photographed. However, since the critical morphological features of the genus are recognizable in thin sections, this error has been minimized.

Specimens of *E. bermudezi* were collected by Dr. Bermúdez from the richly foraminiferal strata cropping out at Bermúdez Station No. 110, located at Peñón Hole (Quarry) on Rancho Peñón, 850 meters northwest of the settlement of Peñón and 7 kilometers south of Martí, in Matanzas Province, Cuba.

STRATIGRAPHIC AND ECOLOGIC SIGNIFICANCE

Bermúdez (1950, p. 240) assigns the strata at Peñón Hole to the middle Eocene Loma Candela formation. He correlates the formation with the Plaisance of Haiti and the Dominican Republic, the "Lake City Limestone" of Florida and Georgia, and the Cook Mountain formation of the Claiborne group of the Gulf Coast. Cole and Gravell (1952, pp. 709 & 710), likewise, consider the beds exposed at Peñón Hole to be middle Eocene in age and correlative with the basal Cook Mountain formation. The occurrence of *E. bermudezi* in the middle Eocene of Cuba again emphasizes its value as a guide fossil for the Eocene. The genus has been recorded in the literature in sediments of Eocene age from France, Poland, Bavaria, Austria, Italy, Turkey, Iraq, Japan and Venezuela.

At the Peñón Hole locality, *E. bermudezi* is found together with numerous other Foraminifera, including particularly a species of *Haddonia* and abundant specimens of the families Valvulinidae, Amphisteginidae and Discocyclinidae. Both the genera representing these families at Peñón Hole and the two known Recent species of *Haddonia* are indicative of reef conditions. Because of its faunal association, therefore, *E. bermudezi* is interpreted as preferring an environment of warm actively circulating, shallow, normally saline, marine water. This type of environment apparently is consistent for the habitat of the genus,

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since it occurs commonly in limestones and often with orbitoid Foraminifera in those localities from which it has been previously described.

DESCRIPTION OF SPECIES

Superfamily ROTALIIDEA

Family VICTORIELLIDAE

Genus **Eorupertia** Yabe & Hanzawa, 1925

Eorupertia bermudezi Anisgard, n.sp.

Plate 1, figures 1-10; text figure 1A-C

Eorupertia, n.sp., Bermúdez, 1950, Mem. Soc. Cubana Hist. Nat., vol. 19, no. 3, pp. 243, 340 (lists); middle Eocene, Cuba.

Diagnosis: 1) *Exterior.*—Test nearly conical to nearly oval in side view, circular or nearly so in views from both proximal and distal ends. Sides of test nearly parallel for about two-thirds of test, at initial end tapered to make an acute angle of 48° (average of 5 specimens). Surface of test smooth, almost entirely dotted by numerous perforations; perforations especially visible when wet. Chambers non-lobulate, tightly coiled in high vertical spire, both septal sutures and contacts of whorls indistinct, both nearly flush with surface or only slightly depressed so that chamber outlines and whorls are vaguely defined. Spire composed of 4 to 5 whorls, 2 to 3 chambers in initial whorl, increasing to 3 or 4 chambers per whorl in youngest portion. Chambers enlarging in size regularly and gradually, subcircular to subrectangular in outline, usually nearly twice as high as wide. Septa visible in broken specimens, gently curved backwards, non-perforate, with median "dark" partition. Aperture an arched slit at the base of the inner third of the septal face, bordered by a slightly raised, thin, but distinct lip. Of 5 available specimens all but one are coiled dextrally. Truncated initial portions indicate basal attachment of tests at some time during growth.

Dimensions of figured specimens (in mm.)

	Length	*Maximum Width*	*Length/Width*
Fig. 1	1.83	1.00	1.83
Fig. 2	2.36	1.60	1.48
Fig. 4	2.50	1.52	1.64

2) *Thin sections.—Horizontal* (fig. 8): Cut across early part of specimen above embryonic chamber; nearly circular in outline. 1-1/2 whorls visible, 5 chambers in earlier inner whorl, one chamber in later outer whorl. Chambers enlarging gradually, varying in outline from elliptical, suboval, subtriangular to subrectangular.

Test wall of both inner and outer whorls thick, composed of concentric layers, or lamellae, of fibrous (?) calcite (9 to 10 visible in outer whorl); thickness of lamellae gradually decreasing towards periphery of walls, but concentrically of equal thickness; lamellae generally slightly thicker than interlamellar portions of test wall; entire series of lamellae pierced perpendicularly by numerous fine, linear to gently curved, cylindrical tubules, which extend uninterruptedly inward from periphery of wall and terminate in basal mantle, tubules, being inner prolongations of exterior perforations; tubules neither branching nor bunched, but evenly distributed around curvature of walls; intertubular parts of wall about twice of diameter of tubules; lamellae and tubules combining to give cancellate pattern to wall structure. At contact of inner and outer whorls one-half to nearly two-thirds of wall of inner whorl forms thickness of entire test wall.

Septa non-perforate, gently curved (of three recognizable, two are curved posteriorly, one anteriorly); median "dark" partition visible in one septum. Mantle of space present above basal lamella of test wall but indistinct locally. Hollow central axis present.

Dark brown to black matter in tubules and less commonly in chamber cavities probably represents organic material.

Dimensions of fig. 8 (in mm.)

Maximum diameters	.99 x .93
Chamber no. 1	.13 x .09
Chamber no. 2	.13 x .08
Chamber no. 3	.13 x .10
Chamber no. 4	.28 x .09
Chamber no. 5	.25 x .12
Chamber no. 6	.33 x .08

Thickness wall (chamber nos. 1 & 6) .10 & .18 respectively

Thickness septum (between chambers nos. 3 & 4) .02

Thickness septum (between chambers nos. 4 & 5) .04

Diameter hollow central axis .02

Diameter of tubule & intertubular area (in wall of chamber no. 4) .007 & .015 respectively.

Thickness of inner & outer lamellae (in wall of chamber no. 4) .015 & .007 respectively.

Vertical (figs. 6,9): Cut through centers of two specimens showing vertically coiled spire; nearly elliptical in outline and slightly lobulate due to indentation of wall at contacts of whorls; 4 to 5 dextrally coiled whorls visible. Embryonic apparatus probably unilocular. Chambers enlarging in size gradually, varying in shape from circular to subcircular, oval, elliptical, reniform, rounded triangular to subrectangular, 12 chambers visible in fig. 9, 13 visible in fig. 6.

Test wall thick, thickness decreasing gradually from early to late portion of specimens due to presence of successively lesser number of lamellae; most of test wall, as in horizontal section, composed of parallel layers, or lamellae, of fibrous (?) calcite (at least 8 lamellae visible in proximal part of fig. 9, 12 in fig. 6); longitudinally, lamellae are of equal thickness; thickness of lamellae slightly greater than that of interlamellar portions; lamellae cut at right angles by numerous, rather fine, straight to gently curved, cylindrical tubules, which extend from periphery of wall inward and terminate in basal mantle; tubules represent interior extensions of surface perforations; tubules continuous, neither branching nor bunched, but regularly distributed along wall; intertubular areas nearly twice the diameter of tubules; intersections of lamellae and tubules combining to give cancellate pattern to test wall.

Test wall partly or entirely lacking lamellae and without tubules in those portions which form whorl contacts and so do not face exterior of specimen; absence of lamellae and tubules in intra-whorl areas probably due to progressive plugging up of wall with shell material during growth of animal; lamellae and tubules present in increasing numbers in test wall of successively younger intra-whorl areas. Test wall at base of specimen also partly lacking lamellae and tubules. Nearly all of thickness of test wall in area of

Dimensions (in mm.)

	Figure 6 (section of fig. 2)	*Figure 9*
Length (through center of specimen)	2.36 (broken)	1.60
Maximum width	1.60	1.35
Chamber no. 1	.22 x .22	.21 x .12
Chamber no. 2	.22 x .10	.21 x .09
Chamber no. 3	.38 x .27	.06 x .05
Chamber no. 4	.31 x .08	.25 x .10
Chamber no. 5	.40 x .27	.23 x .16
Chamber no. 6	.46 x .30	36 x .33
Chamber no. 7	.50 x .15	.38 x .35
Chamber no. 8	.53 x .31	.10 x .06
Chamber no. 9	.24 x .20	.17 x .14
Chamber no. 10	.55 x .22	.55 x .44
Chamber no. 11	.35 x .18 (broken)	.62 x .26
Chamber no. 12	.29 x .16 (broken)	
Chamber no. 13	26 x .22	
Thickness of outer wall	Chamber nos. 5 & 10: .28 & .26 respectively	Chamber nos. 4 & 7: .15 x .12 respectively
Thickness of wall	Between chambers nos. 3 & 6: .11	Between chambers nos. 4 & 6: .11
Thickness of septum	Between chamber nos. 6 & 7: .03	Chamber no. 9: .11
Thickness of partition between first and second chamber	.06	.04
Diameter of hollow central axis	Adjacent to chamber nos. 5 & 9: .05 & .09 respectively	Adjacent to chamber nos. 3 & 7: .06 & .07 respectively
Diameter of tubule & intertubular area	In outer wall of chamber no. 6: .007 & .015 respectively	In outer wall of chamber no. 7: .007 & .012 respectively
Thickness of lamella	In wall of chamber no. 6: .01	In wall of chamber no. 6: .007

intra-whorl contact formed by wall of older chamber.

Mantle visible at base of test wall, immediately overlying initial layer of calcium carbonate which encloses chamber cavity; mantle continuing and extending into septum, parallel to but distinct from median "dark" septal partition. Septa non-perforate, curved gently backwards, median "dark" partition present. Central hollow axis present, beginning just above embryonic chamber, extending entire length of specimen and ending in and connecting with aperture of final chamber of last whorl; axis curving with volutions of chambers, increasing slowly in diameter and opening into all chambers except the first and second through apertures.

Dark brown to black matter in tubules, chamber cavities, apertures, and less commonly in interlamellar areas, probably is organic material; in interlamellar areas organic material is more prevalent in wall of final chambers. Truncated initial portions indicate basal attachment of tests at some time during growth.

Holotype.—U.S.N.M. no. P5143; Plate 1, fig. 1.

Paratypes.—U.S.N.M. nos. P5144-P5147 inclusive; Plate 1, figs. 4, 6, 8, 9.

Also available in Bermúdez's private collection.

Type level.—"Lowest 6 inches of strata exposed in an abandoned pit 8 feet deep made to obtain road material." (Cole and Gravell, 1952, p. 708).

Type locality.—See "INTRODUCTION", p. 1.

Remarks.—Except for topotypes of *Eorupertia boninensis* (Yabe and Hanzawa), the genotype, actual type material of the other two previously described species of the genus is not available to the writer for comparison. However, the illustrations and descriptions of these two species readily distinguish them from *E. bermudezi.* From *E. boninensis,* the Cuban species differs externally by the non-lobulate character of its test. Thin sections of *E. bermudezi* have neither the pillars nor the early rotaloid coil present in the sections of *E. boninensis. E. bermudezi* differs from *E. cristata* (Gümbel) in the lack of pillars and bunching of its tubules. *E. bermudezi* also has a much more regularly coiled vertical spire. Hagn's (1955) illustration of *E.* cf. *uhligi* (Leardi) indicates that this species, too, lacks the regular vertical spire of *E. bermudezi.* Both *Eorupertia furcateseptata* Trauth and *E. incrassata* var. *laevis* Grimsdale have been made varieties of *E. cristata* by Hagn and do not possess the vertically spired growth pattern of *E. bermudezi.*

MORPHOLOGICAL INTERPRETATIONS OF EORUPERTIA

Growth Pattern

The excellently preserved, free specimens and the sections of *E. bermudezi* permit some interesting interpretations regarding the growth pattern of the genus, especially the nature and relationship of the lamellae and tubules in the test wall to the basal mantle, the septa, the aperture, and the central, hollow axis around and along which the chambers grow spirally upward.

The first chamber, in vertical thin section, can vary in shape from nearly circular to oval. Under high magnification (Bausch and Lomb binocular microscope, oculars-10x, objectives-43x), both the horizontal and vertical thin sections indicate that the tubules pierce the periphery of the test wall to form the characteristic pores or perforations on the surface of the specimens. Inwardly, however, the tubules do *not* enter directly into the chamber cavity proper. Instead, they terminate in a layer of space parallel and conforming to the shape of the chamber cavity, but separated from the cavity itself by a thin lamina of calcium carbonate. The layer of space can be termed the basal mantle and the thin lamina the basal lining or floor of the mantle. The roof or upper lining of the mantle is formed by the first perforate layer of calcium carbonate.

Because it is not pierced by the tubules and no other micropores are visible with the available magnification, the basal lining apparently seals off the living matter within the chamber cavity from the exterior. For the first chamber, therefore, communication with the outside world must be through the aperture located at the base of the septum. Distally the outer porous lamina becomes imperforate, and the two initial lamellae in this area form the septum. The upper lamina of the older chamber in the septal area represents the median "dark" partition. At the apertural area protoplasmic matter can flow either directly outward from the chamber to the exterior, or into the basal mantle to reach the tubules.

Both the free specimens and the two prepared vertical thin sections indicate that the test wall of the last-formed chamber possesses a single set of double laminae, and that the outer one is pierced by tubules. It is believed, therefore, that the two laminae, which form the floor and roof respectively of the basal mantle, are deposited simultaneously by protoplasmic matter during the life activity of *E. bermudezi.* If each deposit represented a separate stage, one would expect to find specimens of *Eorupertia* in which the last chamber had only the imperforate basal lamina of calcium carbonate preserved in its wall makeup. Such forms are not present in the Cuban material, and previously figured species of the genus also show the wall structure to be both perforate and lamellar to the very end.

Text figure 1A is a vertical section of the first chamber enlarged about 190x, illustrating diagrammatically how an early stage during the growth of a specimen of *E. bermudezi* can occur. Life activity of the protoplasmic matter within the first chamber has resulted in the formation of the initial sealing lamina, and immediately overlying it, its perforate counterpart. Sandwiched between the two laminae is the basal mantle. Distally the two laminae are bent to form the first septum. The septal area is open at its basal inner portion to form the first aperture. Note that in the septum the basal mantle parallels but is distinct from the median "dark" partition. Living matter pervades the chamber cavity, the apertural area, the basal mantle and the tubules.

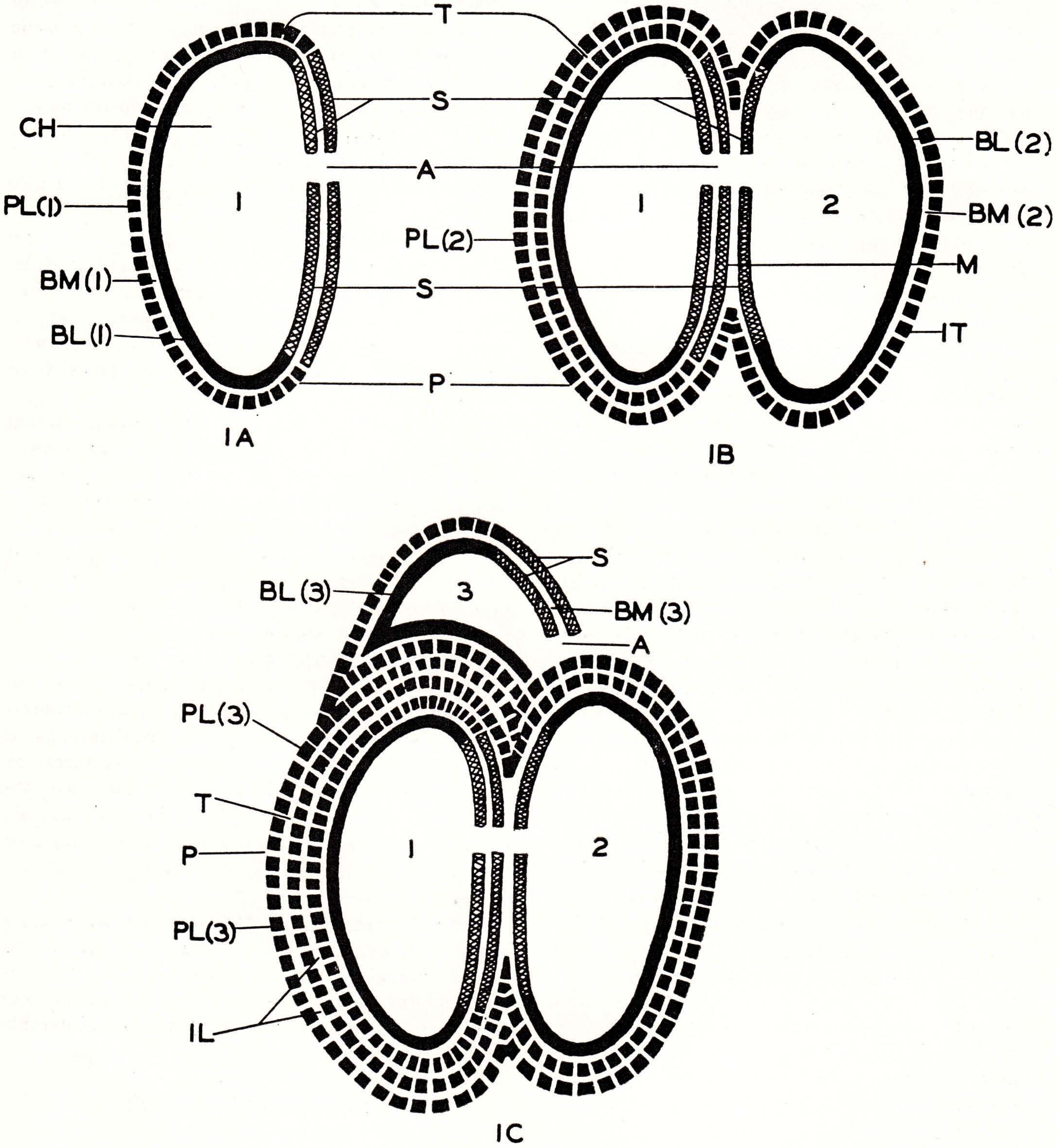
With the continued growth of the animal, the formation of the wall of the second chamber occurs. Again, as with the first chamber, protoplasmic matter performs a dual function in the life process of chamber no. 2, concurrently depositing both a sealing, imperforate, inner lamina and a porous, outer lamina. Between the two new laminae is the basal mantle of the second chamber. In addition to being responsible for constructing the wall of the second chamber, the protoplasmic material continues to be active in the test wall of the first chamber. Here, a second perforate lamella of calcium carbonate is deposited simultaneously with the two lamellae of the second chamber. The second porous lamina adheres closely to the first, but, nevertheless, is separate from it, thus leaving an interlamellar area between the two laminae. Tubules are continuous across the two laminae, and neither branch nor bunch.

Text figure 1B diagrammatically shows a second and later stage during the life of *E. bermudezi.* Chamber no. 2 is enclosed by a doubly laminated wall, the imperforate inner lamina and the perforate outer lamina. Lying between the two laminae is the basal mantle. In the septal area common to the first two chambers, only the inner lamina of the new chamber is imperforate. Over chamber no. 1 a second perforate lamella is now present, and the tubules and lamellae in the wall of this chamber already begin to show the characteristic reticulate pattern. In the illustrated section, the distal septum and aperture of the second chamber are nearly parallel to the plane of the page, and are, therefore, not visible to the reader. However, in the distal septal area, the two laminae are both non-porous, and an aperture is developed at the base of the inner part of the septal face.

As the animal continues to grow, lamellae will be formed and will enclose chambers as described above. Text figure 1C shows a diagrammatic section of *E. bermudezi* with the first three chambers now formed. Only the upper part of the septal face of the third chamber is visible in the section. Note that in the area of the whorl contact between chamber nos. 1 and 3, the illustration indicates that the test wall is composed of the four lamellae belonging to the older chamber and only the first two of the new chamber. This condition results because those parts of the walls of the older chambers can and will continue to be lined by parallel lamellae as long as they are exposed to the exterior and not covered by the wall of a younger chamber.

Except for an initial double set of laminae, the lamellar growth of the chamber walls of *E. bermudezi* is similar to that described so ably for all members of the superfamily Rotaliidea by Smout (1954). The interpretation for the Cuban species that the septa are the continuations of the enveloping laminae and are completely formed in two stages corresponding to the creation of two successive chambers also agrees with Smout's conception of the growth of this part of the test of rotaliid Foraminifera. However, where Smout envisions communication of protoplasm from within the chamber cavity to the exterior directly through fine perforations in the laminae, in *E. bermudezi* the perforations do not penetrate into the chamber cavity. Instead, the protoplasmic matter is considered to flow either directly to the exterior via the aperture, or through the basal mantle of space before reaching the tubules, which are the inner prolongations of the surface perforations.

Hagn's (1955) recent, excellently detailed study and revision of the species of *Eorupertia* also notes the presence of concentric lamellae in the test wall of these Foraminifera. In contrast to the present interpretation of a single stage for the formation of the initial chamber layers and the septum, Hagn postulates (p. 57) two stages of deposition. During the first, the chamber roof and posterior portion ("primary lamella") of the



Text Figure 1

Diagrammatic illustrations showing growth pattern of *E. bermudezi* during the formation of the first three chambers. A-aperture; BL (1), (2), (3)-basal lamina or lamella of first, second, and third chamber respectively; BM (1), (2), (3)-basal mantle of first, second, and third chamber respectively; CH-chamber cavity; IL-interlamellar area; IT-intertubular area; M-median "dark" partition; P-pore or perforation; PL (1), (2), (3)-perforate lamina or lamella corresponding to formation of first, second, and third chamber respectively; S-septum (shaded by cross-hatching); T-tubule. Magnification approximately X190.

septum are formed. During the second stage, the actual test wall is laid down over the chamber roof, and the anterior side ("central lamella") of the septum is deposited. Both the latter deposits are thicker than their previously formed counterparts. One may ask if the alternating thin and thick lamellae coat all of the previous test as new chambers are formed, and if there are specimens of *Eorupertia* examined by Hagn in which the final chamber has only its roof and the anterior portion of the septum developed.

Canals

The Cuban specimens of *E. bermudezi* do not reveal the existence of canals or a canal system as such. It is possible, and very likely, that the basal mantle and the interlamellar portions of the test wall serve as communication areas during the life of the foraminifer, but they cannot be termed "canals" in the true sense of the word. Yabe and Hanzawa (1922) visualize the presence of canals in the test wall between two successive whorls. They claim that the canals open externally along the depressed suture, and believe it is reasonable to suppose that these canals connect with the median "dark" partition of the septal sutures. Hagn interprets a dorso-ventral canal system to be present between the whorls of his specimens of *E. cristata,* but finds that they definitely do not coincide with the septal partition. In *E. bermudezi* the septal portion of the basal mantle also is observed to be distinct from the median "dark" partition. Canals in the test wall between the whorls and opening externally along the sutures have not been observed in the Cuban specimens.

Perforations and Chamber Cavity

Until recently, the nature of the pores and their relationship to the chamber cavity have received little attention in the literature on Foraminifera. Cushman (1948), Galloway (1933), Wood (1949), and Sigal (in Piveteau, 1952) discuss the presence of pores in the walls of Foraminifera, but do not state specifically whether or not they penetrate the chamber cavity. Glaessner (1948, p. 67), referring to Bonte, mentions the presence of an internal chitinous layer in the tests of calcareous perforate Foraminifera. Arnold (1954), in his lucidly written study of living cultures of *"Discorinopsis"* (=*Trichohyalus* Loeblich and Tappan) implies that the pores in the calcareous wall of this genus terminate in a subjacent organic layer, and not in the chamber cavity proper. Two years later Arnold (1956), succinctly reviewing Le Calvez's important contributions to the basic knowledge of Foraminifera, states (p. 9) that "During the same year [1947], Le Calvez published the results of his observations on the nature of the test wall and pore structure in *Discorbis erectus.* This study has shown that thickened extensions of the underlying organic layer ("basale chitinoide") of the test lie at the base of the test perforations, possibly preventing the flow of protoplasm through the pores to the outside. As successive lamellae are added to the test, discoidal structures are deposited at corresponding intervals by the extralocular protoplasmic sheath which extends down into the pores from the outside."

It is quite possible that the sealing lamina interpreted for *E. bermudezi* may correspond to the organic layers described by Arnold and Le Calvez and to the inner chitinous layer or membrane of Hagn (p. 56). The thin sections of the Eocene specimens, however, when examined under crossed nicols, indicate that all parts of the test are composed of calcium carbonate. If an organic layer or chitinous material were present originally in the test wall, it may have been destroyed subsequently by fossilization. It is of interest to observe that the tubules of *E. bermudezi* are consistently continuous and open throughout their length, and that the "discoidal structures" or "dark discs" of Le Calvez have not been observed in the Cuban material. Arnold, likewise, has been unable to find the disc-like structures in his examination of *"Discorinopsis" aguayoi* (Bermúdez).

Most of the thin sections figured by Hagn show the pores of his specimens extending across the entire thickness of the test wall to enter the chamber cavity, although he states (p. 57) merely that the pores penetrate the wall for a considerable distance.

ACKNOWLEDGMENTS

As mentioned previously, Dr. Pedro J. Bermúdez unselfishly donated the material on which this paper is based. He also loaned the writer the topotypes of *E. boninensis.* Were it not for his generosity, the paper could not have been written. The ideas expressed regarding the morphology and growth of *E. bermudezi* have been inspired to a great degree by the discussions with Lee Gibson, A. N. Dusenbury, Jr., and Dr. Virgil D. Winkler, of Creole Petroleum Corporation. The responsibility for the interpretations, however, is entirely the writer's. Lee Gibson gave generously of his time and effort in photographing the material, and Rodolfo Montiel Villasmil drafted the text figures and lettered the plate figures. Sra. Nency J. de Bustos and Filiberto A. Sánchez typed the manuscript, and George J. Gaenslen and Mrs. Anisgard proof-read the manuscript. Lastly, the paper could not have been written without the use of the laboratory and reproduction facilities generously furnished by Creole Petroleum Corporation.

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CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
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160. *ANOMALINOIDES VANBELLENI* TEN DAM AND SIGAL, A SYNONYM OF *ANOMALINOIDES GRANOSA* (HANTKEN, 1875)

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Kirkuk, Iraq.

Ten Dam and Sigal described and figured in 1950 *Anomalinoides vanbelleni* as a new species from the Algerian Dano-Montian.

They mention as the only specific difference from *"Truncatulina" granosa* Hantken 1875 the broadly rounded periphery, apparently absent in the latter. It is indeed correct to say that Hantken's figure 2b shows the periphery to be only slightly rounded. But his figures 2a and 2c suggest without doubt a much broader periphery (R.C. van Bellen, 1946, p. 75).

Through the good offices of Mr. C. D. Ovey the author was able to examine type material, labelled by Hantken himself and available in the British Museum (Nat. Hist.). The correctness of the author's surmise could be established.

A few years later Dr. A. Smout of the Geological Research Centre of the Iraq Petroleum Company in London was good enough to make some photographs of the British Museum specimens. These are published herewith (Pl. 2, figs. 1a-c, 2a-c). They show clearly the broadly rounded periphery already suggested in Hantken's original figures 2a and 2c.

This same rounded periphery also occurs in specimens which the author determined, some years ago, from the Eocene of Dalmatia and the Netherlands. It apparently occurs also in specimens described as *Anomalinoides vanbelleni.* As the latter, in all other details, is identical with *Anomalinoides granosa* (Hantken 1875) there can be no doubt that it is synonymous with Hantken's species.

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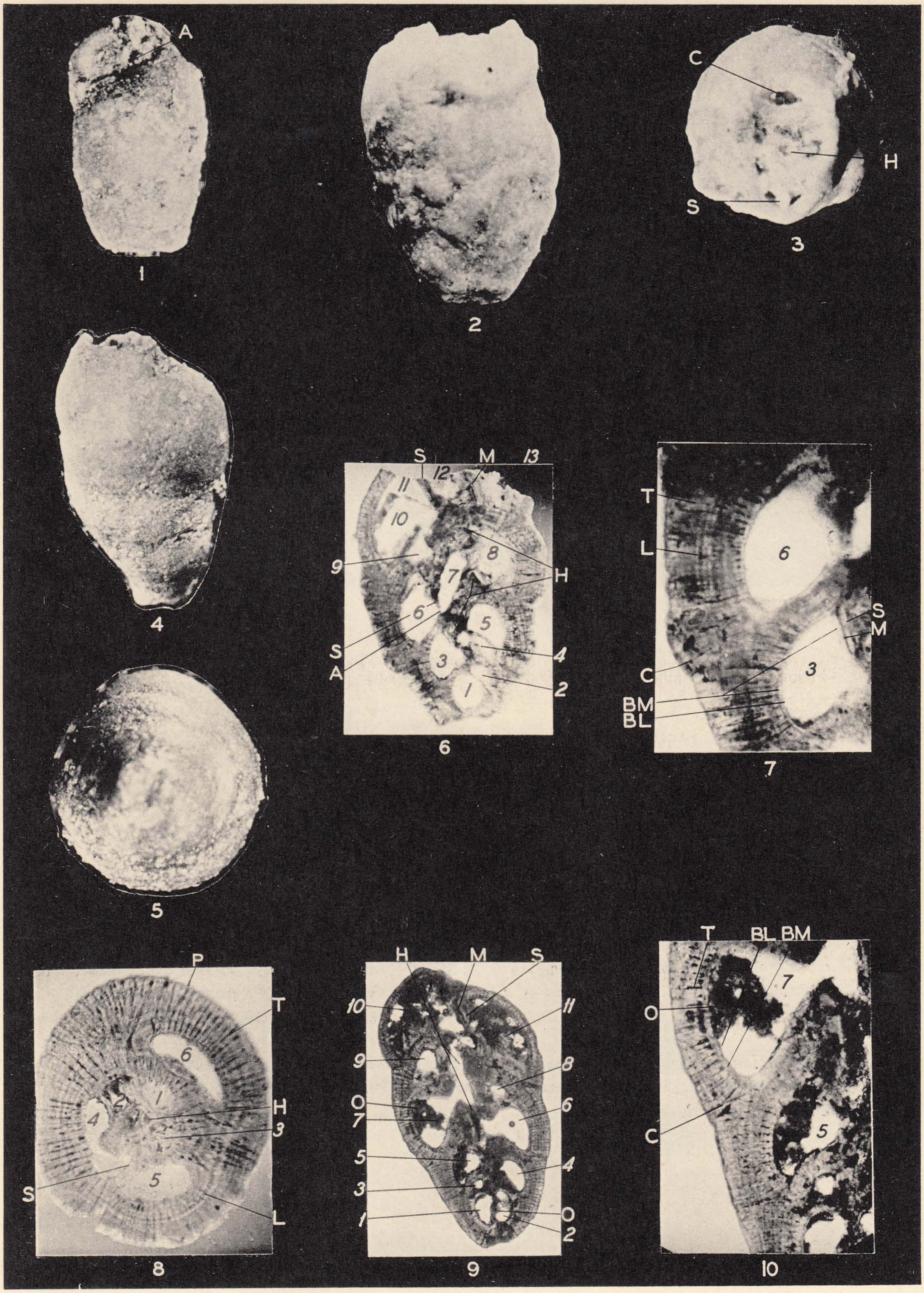
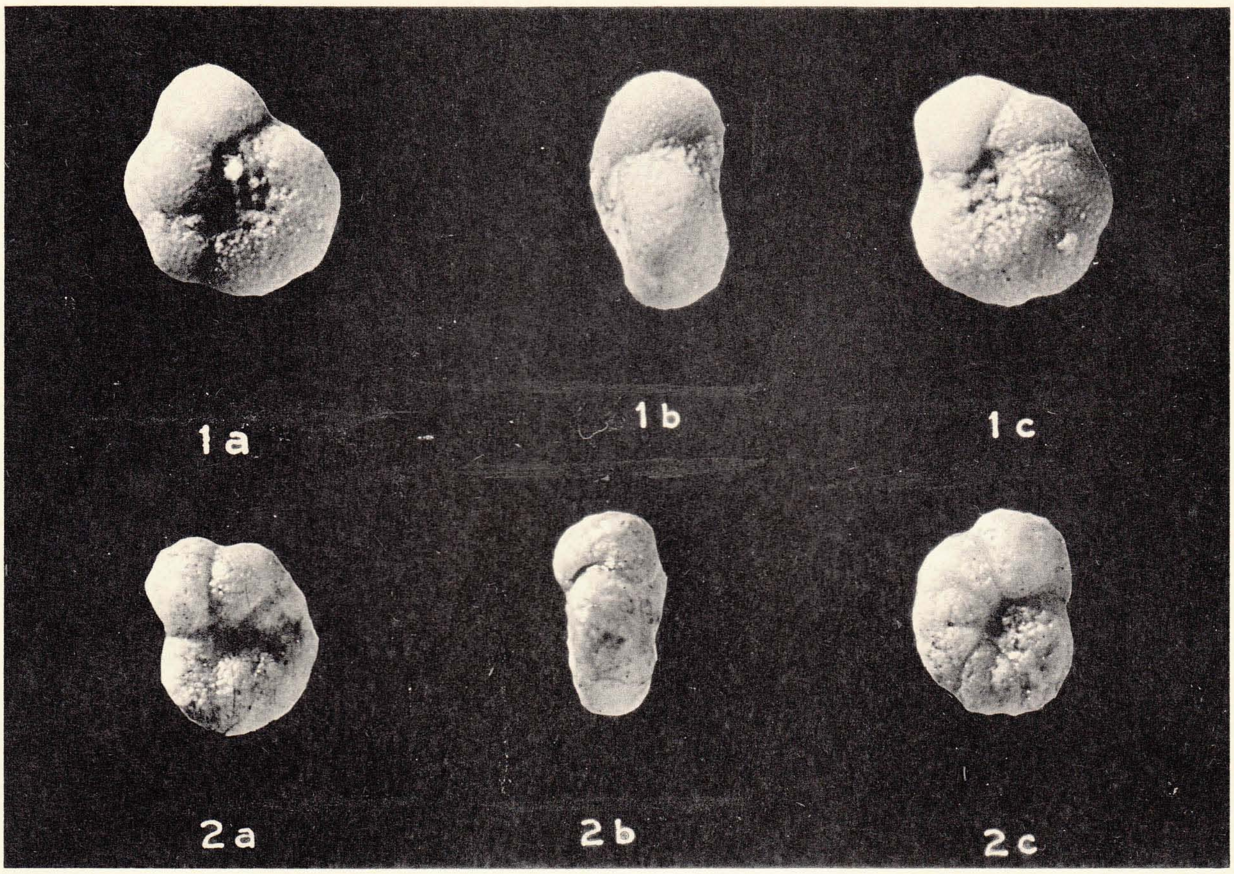
EXPLANATION OF PLATE 1

Figs.		Page
1.	Holotype, U.S.N.M. P5143. Aperture at base of inner portion of septal face indicated by black line. Initial portion truncated. Narrow conical specimen. X19.	2
2.	Larger, nearly oval-shaped specimen. Initial portion truncated. X17.	2
3.	Distal view of above specimen showing chamber cavities, C; septa, S, and central hollow axis, H, in last whorl. X17.	2
4.	Paratype, U. S. N. M. P5144. Specimen with constricted initial portion, expanding rather rapidly after second whorl. Initial portion truncated. X17.	2
5.	Initial view of above specimen showing basal truncation and circular outline. X21.	2
6.	Paratype, U.S.N.M. P5146. Vertical thin section slightly above center, showing lamellae and tubules in test wall continuing to youngest chambers; aperture, A; central hollow axis, H; median "dark" partition, M; imperforate septa, S. Refer to p. 3 for chamber numbers. Initial portion truncated. X18.	3
7.	Enlarged portion of above section illustrating basal lamella, BL; basal mantle, BM, in which tubules, T, terminate; contact of two successive whorls, C; a lamina, L; median "dark" partition, M, in septum, S, parallel to, but distinct from, basal mantle. Note that nearly all of thickness of test wall at contact of whorls consists of wall of older chamber no. 3. X49.	3
8.	Paratype, U.S.N.M. P5145. Horizontal section showing circular outline; central hollow axis, H; lamella, L; pore, P; septum, S; tubule, T. Refer to p. 2 for chamber numbers. X41.	2
9.	Paratype, U.S.N.M. P5147. Centered vertical section showing central hollow axis, H; median "dark" partition, M, in septum, S; organic matter, O. Note lamellae and tubules in youngest chambers (nos. 10 & 11. Initial portion truncated. Refer to p. 3 for chamber numbers. X22.	3
10.	Enlarged portion of above section illustrating basal lamella, BL; basal mantle, BM, in which tubules, T, terminate; contact of two successive whorls, C; organic matter in chamber cavities and tubules, O. Note that at contact of whorls thickness of test wall consists nearly entirely of wall of older chamber no. 5. X51.	3



Anisgard: Eorupertia bermudezi, n.sp. from Cuba



EXPLANATION OF PLATE 2

FIGS. PAGE

1. *Anomalinoides granosa* (Hantken 1875), British Museum (Nat. Hist.), specimen No. P/37565, Ofen, Hungary, Lower *Clavulina szaboi* beds, (a) ventral, (b) peripheral, (c) dorsal. x 25. 9

2. *Anomalinoides granosa* (Hantken 1875), British Museum (Nat. Hist.), specimen No. P/4046, Buda, Hungary, Lower *Clavulina szaboi* beds, (a) ventral, (b) peripheral, (c) dorsal. x 25. 9

van Bellen: Anomalinoides vanbelleni, a synonym of A. granosa

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
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161. THE PALEOECOLOGY OF THE LATE PALEOGENE SEDIMENTS OF THE ISLE OF WIGHT, ENGLAND[1]

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ABSTRACT

The ecological value of selected foraminiferal faunules from the marine Oligocene beds of the Isle of Wight are discussed. The biotopes in which they occurred have been directly interpreted by analogy with Recent species and modern environments. The differences in the foraminiferal faunule of the middle Headon beds of the east and west coast sections of the island are here attributed to variations in the depth and salinity of the water in which these beds were deposited in the two areas. The basal middle Headon beds in the east (Whitecliff Bay area) were deposited in an infraneritic environment (depth range from 20-100 fathoms) which in time was replaced by a near-shore, epineritic environment and finally by the brackish-water conditions. The conditions of deposition of the middle Headon beds of the west coast section appear to have been similar to those pertaining during the deposition of the upper part (*'Venus'* beds) of the Whitecliff Bay section. The foraminiferal fauna of the Bembridge Oyster beds is similar to that of the middle Headon beds of the west coast section, indicating similarity in depositional environments. The Hamstead *Corbula* beds were deposited in a uniform marine environment with depths less than 50 fathoms.

INTRODUCTION

The work described in this paper attempts to elucidate the nature of the environments prevailing during the deposition of the various marine or brackish-water beds of the late Paleogene sediments of the Isle of Wight, based on foraminiferal evidence. The late Paleogene sediments of the island are particularly suitable for depositional and ecological studies. Their lithological associations and contained faunas reflect a varied succession of facies ranging from fresh-water through brackish-water to typically marine conditions.

Although the sediments form a well defined and continuously deposited unit, they are divisible into smaller units, each of which is the product of a cycle of sedimentation and its characteristic alternation of depositional environments (*vide* Stamp, 1921, p. 157). Within each sedimentary cycle, the sediments were deposited in rythmic pattern with usually an alternation of sands and clays. A major thickness of these beds is of fresh-water or fluviatile origin. There are, however, three marine intercalations (often partly brackish) representing marine phases, which contain a sufficient number of Foraminifera for study and are therefore of value in systematic and paleoecological studies. They are, 1) The middle Headon beds, 2) The Bembridge Oyster beds, and 3) The Hamstead *Corbula* beds. The main stratigraphic subdivisions of the late Paleogene sediments and the cycles of sedimentation are represented in Fig. 1.

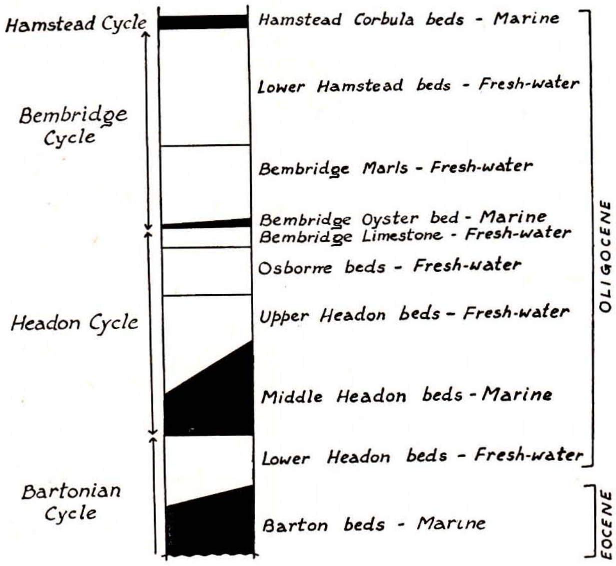

FIGURE 1

Generalized vertical section showing main subdivisions of the late Paleogene sediments of the Isle of Wight and the cycles of sedimentation. Not to scale.

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[1] This paper is a sequel to an earlier paper published by the author (Bhatia, 1955) on the Oligocene Foraminifera from the Isle of Wight, and is abridged from the thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Faculty of Science, University of London, England.

The stratigraphy of these beds and their contained foraminiferal faunas have been described in detail (Bhatia, 1955, pp. 665-693, Tables 1-5). The tables showing the percent distribution of Foraminifera (*loc.cit.*) are reproduced here for easy reference.

Any attempt at a reconstruction of the details of an environmental pattern based on the evidence of Foraminifera must, of necessity, be hypothetical, because Foraminifera are often adapted to a wide range of environment in depth, salinity and to a lesser extent, temperature. Such a reconstruction is, therefore, of little value unless it is substantiated by the occurrence of species of definite ecological value. This work, however, may be further facilitated by the presence of fossil assemblages which change both laterally and vertically. Lateral variations in fossil assemblages often furnish data on the distribution of sedimentary environments or biotopes. Krumbein and Sloss (1951, p. 227) define a biotope as "an area inhabited by a uniform community adapted to its environment." On the other hand, vertical variations in fossil assemblages reflect the continuance or variability of environments through time. It is, therefore, possible to distinguish both lateral and vertical biotopes. The occurrence of both lateral and vertical biotopes may easily be recognised in the middle Headon beds of the east and west coast sections of the Isle of Wight. The faunules characterizing these biotopes are tabulated in Table 6, and will be dealt with in detail in the following pages.

In order to evaluate the evidence furnished by the foraminiferal fauna, ecological data (including bathymetric ranges) were collected for various species found in the British Oligocene material which also occur in the present-day seas. These data are given in Table 7. Species which are very rare in occurrence have been omitted. Average depths have been calculated in cases where it is possible to do so. In calculating these averages, occurrences below 1000 fathoms have been omitted, as most of the species found in the material studied are characteristic shallow water forms and have been recorded in great abundance in depths less than 100 fathoms. The few anomalous occurrences from deep-waters may perhaps be due to these species having been washed from shallow waters. The only exception is *Ammobaculites agglutinans* (d'Orbigny) which is more common in deeper water.

Although a number of older references have been included in Table 7, most of them give only the minimum and maximum depths at which these species are found and are, therefore, of comparatively little help in estimating average depths. With regard to the ecological data given by Brady (1884), Glaessner (1948, p. 184) states—"it should be remembered that they refer to a much wider concept of genera and species than that accepted in modern taxonomy." It must also be remembered that many of the older records of species may be based on misidentifications which cannot be checked as the types are either lost or inaccessible.

THE MIDDLE HEADON BEDS

General

It is generally admitted that the deposition of the middle Headon beds (including the Brockenhurst beds) marked the beginning of the Headon Cycle, distinct from the Bartonian (see Fig. 1). During the period of deposition of the middle Headon beds, marine conditions returned and the sea spread over a considerable area previously only occupied by freshwater lakes. The marine transgression, which may be attributed to the slight subsidence of the area, came from the east via Belgium and Germany (Stamp, 1950, p. 292). This is demonstrated by the facts that the middle Headon beds attain a greater thickness in the east (Whitecliff Bay area) but gradually thin out towards the west (Colwell Bay and Headon Hill areas); and by the presence of the Oligocene species which show distinct affinities with those from Belgium and Germany.

The faunules characterizing the biotopes in the middle Headon beds of the east and west coast sections show certain characteristics and peculiarities (*vide* Table 6; see also Fig. 2). These faunal differences are here attributed to variations in the depth and salinity of the water in which the middle Headon beds were deposited in the two areas. Whether the depth indirectly affected the temperature is difficult to say from the evidence available. As will be shown later, the foraminiferal evidence suggests that these beds were accumulated in shallow marine waters (neritic environment). The vertical changes in the contained assemblages, coupled with the occurrence of a greater thickness in the Whitecliff Bay area indicates that subsidence took place during the deposition of the middle Headon sediments. Scott (1940) on the basis of a study of the paleoecological factors controlling the distribution of Cretaceous ammonoids in the Texas area, subdivided the neritic type of environment into the

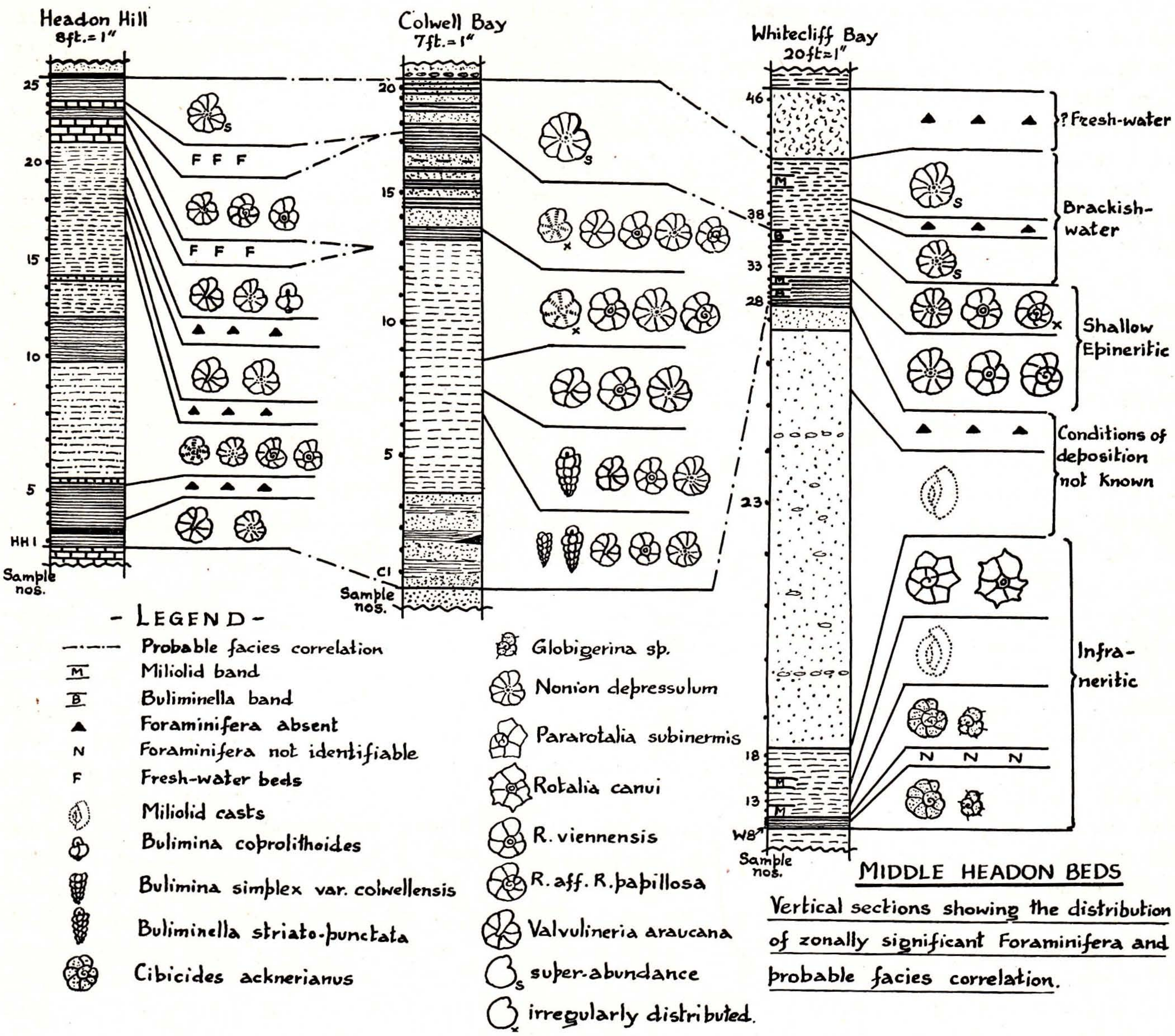
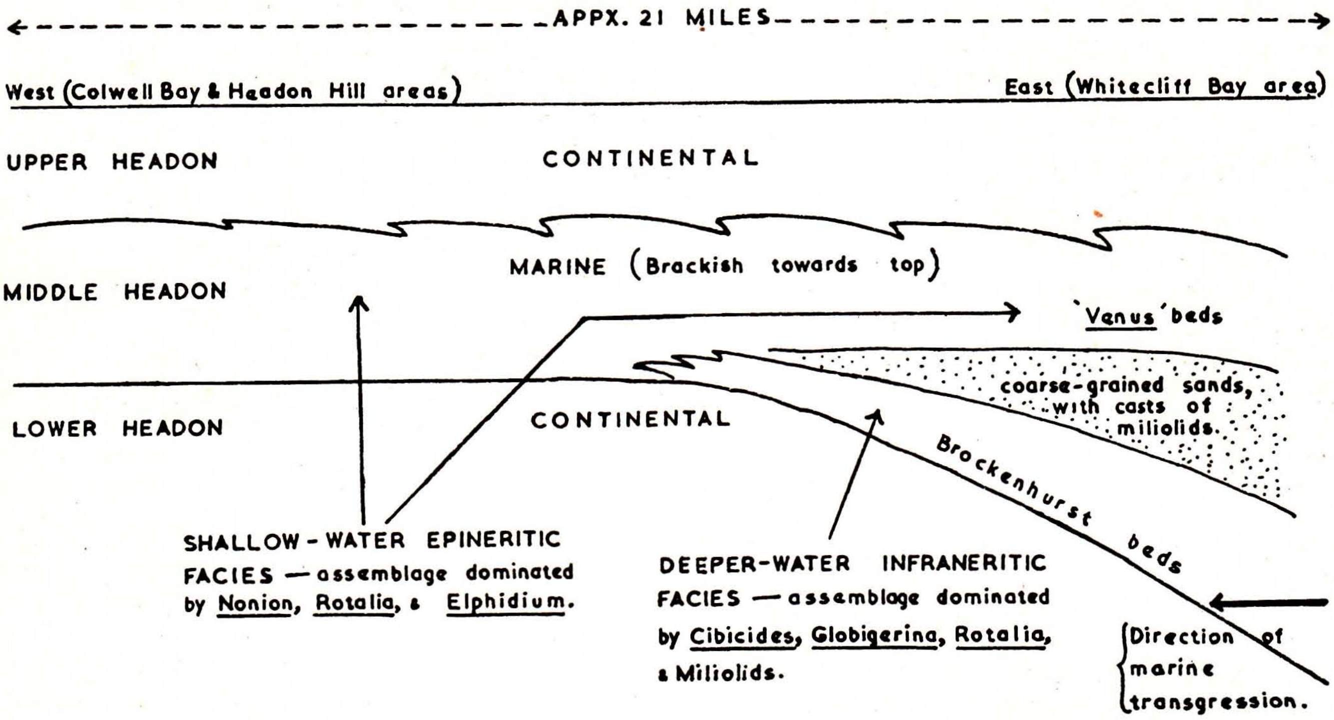


FIGURE 2

epineritic environment, with water depths less than 120 ft. (20 fathoms), and the *infraneritic environment,* with water depths from 120 to 600 ft. (20-100 fathoms). Using this terminology, it is here suggested that the basal middle Headon beds in the east (Whitecliff Bay area) were initially deposited in an infraneritic environment, while those in the west (Colwell Bay and Headon Hill areas) and in the upper part (*'Venus'* beds) of the Whitecliff Bay section, were deposited in a near-shore, epineritic environment. The distribution of the environments during the deposition of the Headon beds is shown in Fig. 3.

A. Whitecliff Bay Section

The Brockenhurst and Roydon Zones.—The Brockenhurst beds, which form the base of the succession in the Whitecliff Bay section, contain the richest and most varied of the foraminiferal faunas (Table 1) to be found in the late Paleogene sediments of the Isle of Wight. They can be subdivided, both lithologically and faunally, into two zones (Keeping and Tawney, 1881, p. 109), a lower or Brockenhurst zone *s.s.,* and an upper or Roydon zone. The former consists of some two feet of chocolate coloured clay dominated by *Cibicides aknerianus, C. refulgens, Globigerina* sp., and *Nonion umbilicatulum;* the latter of some twelve feet of brown sandy clay containing abundant *Pararotalia subinermis* and *Rotalia canui.* The Roydon zone contains two bands in which members of the Miliolidae are concentrated (samples W12 and W15), but with



HYPOTHETICAL CROSS SECTION OF HEADON CYCLICAL DEPOSITIONAL UNIT, SHOWING THE DISTRIBUTION OF BATHYMETRIC BIOFACIES (DURING MIDDLE HEADON TIMES), AS INTERPRETED FROM FORAMINIFERAL DATA (Vertical scale exaggerated).

FIGURE 3

the exception of *Quinqueloculina juleana* and *Triloculina trigonula,* they are not individually abundant. The Polymorphinidae are fairly evenly distributed throughout both zones. Although this family is represented by numerous species, the number of individuals is in no case large. Other families represented are the Buliminidae, Rotaliidae, and the Anomalinidae, several members of which are restricted to the Brockenhurst and Royden zones in the Whitecliff Bay section.

On the whole the Rotaliidae and the Anomalinidae are the dominant families represented in the Brockenhurst and Royden zones. According to Norton (1930), these families do not seem to possess any definite ecological significance. Recent work has shown, however, that consideration of groups of family rank seldom permits the recognition of ecological controls. Since even members of the same genus are liable to show wide differences in degrees of tolerance to depth, temperature, salinity, etc., ecological deductions must be based on considerations of species and varieties if valid conclusions are to be reached.

Although *Cibicides refulgens* and *C. aknerianus* are found in both the Brockenhurst and Roydon zones, they reach their maximum abundance in the former. Of the two, *C. aknerianus* is usually predominant, and near the top of the Brockenhurst zone (sample W10) constitutes some 60.0% of the assemblage. Neither of these species is found in the beds above the Roydon zone in the Whitecliff Bay section, and except for a few rare specimens of *C. refulgens* in the Headon Hill samples (HH10 and HH13) they are unrepresented in the other middle Headon sections examined.

Little is known concerning the bathymetric range of *C. aknerianus,* as the species does not occur in present-day seas. The Recent records by Brady (1884, p. 663) have been discredited (*vide etiam* Thalmann, 1932). However, since the species occurs abundantly with *C. refulgens,* their bathymetric distribution must be similar. *C. refulgens* is a moderately shallow-water form, and occurs commonly round the margins of temperate seas below 20 fathoms. The shape and construction of the tests suggest that both these species lived on the surfaces of broad fronded seaweeds. Since luxuriant algal growth is usually found in the oxygenated waters of the brachyhaline zone (16.5-30‰ salinity, *vide* Hiltermann, 1949), the occurrence of these two species would indicate deposition in waters of almost normal salinity and oxygen content. This is in accordance with the views of Lowman (1949) who states that *Cibicides* is the most abundant genus in the mid-neritic zone.

Further ecological information is furnished by the distribution of *Globigerina* sp. The percentage of this species is at a maximum of 27.1% at the base of the Brockenhurst zone, and disappears just above the base of the Roydon zone. It is not represented in the higher beds of the Whitecliff Bay section, and neither does it appear in the middle Headon beds of Colwell Bay and Headon Hill. *Globigerina* is a pelagic form and its normal habitat is the surface waters of the open sea. It is not normally found in shallow turbid coastal or estuarine waters in the temperate zones, but is liable to be swept into them from the ocean by the action of tides and currents. The occurrence of significant percentages of *Globigerina* in a deposit, therefore, is not necessarily an indication of accumulation at great depth but rather an indication that the area of deposition was in unrestricted communication with the open sea. The occurrence of *Globigerina* in the Brockenhurst and Roydon zones and its absence from the overlying 'Barren' sands and *'Venus'* beds is thus an indication that the area of deposition was becoming progressively cut off from direct communication with the open sea with passage of time; and almost certainly indicates that the Whitecliff Bay area was progressively silting up. The absence of *Globigerina* from the other middle Headon areas similarly indicates that the deeper-water conditions apparent during the deposition of the Brockenhurst and Roydon zones at no time existed in these areas, and supports the hypothesis that the marine Middle Headon transgression came from the east via Whitecliff Bay.

Another ecologically significant species found in the Brockenhurst and Roydon zones is *Nonion umbilicatulum.* This is typically a deeper, cool-water form, and is not normally found in shallow coastal sediments. It occurs abundantly at depths over 50 fathoms, and according to Brady (1884) is found in much deeper water than its ally *N. depressulum.* The abundance of *N. umbilicatulum* in the basal samples of the Brockenhurst and Roydon zones supports the assumption that these beds were laid down in deeper and more saline waters than the succeeding beds.

As had been mentioned previously, the Polymorphinidae are well represented in the Brockenhurst and Roydon zones. Although this family has a wide bathymetric distribution in present-day seas, it is most abundantly represented in both number of species and individuals in the deeper neritic waters. It is not commonly represented in very shallow waters of low salinity and does not appear to tolerate waters of abnormally low oxygen content. The two best known Recent forms that occur in the Isle of Wight material—*Globulina gibba* and *G. inaequalis*—are both typically marine species, and occur most abundantly in the deeper waters of the neritic zone. Members of this family are not found in the middle and upper parts of the *'Venus'* beds, indicating that conditions at the time of deposition of the latter had become unsuitable for their survival. It seems likely that the factors governing their disappearance were the changes in depth and possibly salinity during the silting up of the Middle Headon sea.

Examination of the distribution of *Cibicides refulgens, C. aknerianus, Globigerina* sp., and *Nonion umbilicatulum* in the Whitecliff Bay section (see Table 1) indicates that these forms are most abundant in the clays of the Brockenhurst zone, and that these beds were laid down in slightly deeper, cooler waters than the sandy clays of the succeeding Roydon zone.

Ecological conditions during the deposition of the Roydon zone appear to have been slightly different from those pertaining during the accumulation of the underlying clays. Although the differences between the Roydon and Brockenhurst faunas are to some extent due to a slight shallowing in the depth of the sea (as indicated by the decrease in abundance of *Nonion umbilicatulum, Globigerina* sp., and *Cibicides* spp.) it seems unlikely that this would account for the sudden appearance in abundance of *Rotalia canui* and *Pararotalia subinermis.* Some additional factor is probably involved, and in view of the close correspondence between the faunal and lithological changes, it is suggested that the factor in question is the nature of the substratum supporting the assemblage.

Nothing is known concerning the distribution of *R. canui* and *P. subinermis,* since neither species has survived to Recent times. However, these species show a certain resemblance to several groups of late Tertiary and Recent species, the ecological significance of which is known. The similarities in test construction and constitution (spinosity, thickness of walls, heaviness of ornamentation, etc.) suggest that they probably thrived under similar conditions. Perhaps the commonest of the Recent allied species is *'Rotalia' calcar* d'Orbigny. An examination of the literature suggests that this species is confined to warm tropical marine waters and thrives best on coarser sediments in well oxygenated lime-rich environments. According to Brady (1884, p. 709) it is commonly found in shallow water coral sands in the East and West Indies, and he also records it from the Mediterranean and Red seas, off Mauritius, Ceylon, and the Cape of Good Hope. It has also been recorded by Norton (1930, p. 352) from Murray Island, Australia; he states that "Members of this genus seem to have definite ecologic relations, and are practically confined to shallow warm waters."

These inferences are also supported by recent work on the distribution of *Pararotalia serrata* (ten Dam and Reinhold) in the Pliocene Coralline Crag of East Anglia (D. J. Carter, personal communication). The distribution of this form (which is closely related to *P. subinermis*) has been found to be governed in part by the lithology of the enclosing sediments, and it appears that this species only becomes abundant where a shallow-water current-swept sandbank facies is developed.

If the parallel that has been drawn between *R. canui* and *P. subinermis* on the one hand, and the Recent and Pliocene species on the other is valid, then it is probable that the sudden appearance of the two former species may well be correlated with the change in conditions which initiated the deposition of the coarser sediments of the Roydon zone.

An interesting feature of the Roydon zone is the appearance within it of members of the Miliolidae. These are particularly concentrated at the level of samples W12 and W15 and constitute 31.4% and 14.2% respectively of the contained assemblages. In these two samples, the family is represented by nine species. The dominant form in sample W12 is *Quinqueloculina juleana* which accounts for 26.9% of the total foraminiferal assemblage. *Triloculina trigonula* is the next most abundant species and constitutes 3.8% and 3.3% of the contained assemblages in samples W12 and W15 respectively.

The ecological conditions that governed the distribution of the individual species of the Miliolidae represented in the miliolid bands are not certainly known. The dominant species represented—*Q. juleana-* has not been reported from recent seas. The most detailed and comprehensive ecological data concerns the distribution of *Q. seminulum.* According to Said (1951, pp. 82 and 85), who worked on the Foraminifera of Narragansett Bay, on the coast of Rhode Island, the distribution of this species is dominantly controlled by salinity. He found it to be characteristic of a zone of intermediate salinity representing the transition between Hiltermann's pliohaline and brachyhaline zones (9-16‰ and 16.5-30‰ salinity respectively—*vide* Hiltermann, 1949, pp. 4-8). This distribution coincides with that in Jade Bay, N.W. Germany, described by Bartenstein (1938, p. 339, table 1b). It must be remembered, however, that although *Q. seminulum* is the most abundant in the zone of intermediate salinity, it is by no means restricted to it. In North America and Europe, the species is widely distributed in the shallow temperate coastal waters of normal salinity.

Other Recent Miliolidae which are found in the Roydon miliolid bands are *Miliolinella oblonga, Triloculina trigonula* and *Quinqueloculina bicarinata.* Of the three, *M. oblonga* and *T. trigonula* are perhaps the most widely distributed species. Although *M. oblonga* had a wide bathymetric range, the majority of records are from depths less than 50 fathoms. It has also been reported from very shallow waters of subnormal salinity (Brady, 1870). Natland (1933) records *T. trigonula* at depths ranging from 20.8 to 150 fathoms. No detailed ecological data are available for *Q.bicarinata.*

A survey of the rather limited information concerning the distribution of these species would seem to indicate that the sediments comprising the miliolid bands were laid down in an inner-neritic environment, possibly at depths of less than 50 fathoms. This is in accordance with the information concerning the distribution of the Miliolidae as a whole given by Norton (1930, p. 339), who states that "the most favorable habitat for members of the Miliolidae is in warm shallow waters of tropical and warm temperate seas in depths down to perhaps 50-60 fathoms, where the temperature ranges between 20° and 26°C."

Although the appearance of miliolids in the Roydon zone as a whole may have been dependent on the slight shallowing of the sea (indicated by the distribution of *Cibicides* spp., *Glo-*

bigerina sp., and *Nonion umbilicatulum* in that zone), it seems unlikely that it could account for the fairly high percentage of miliolids in samples W12 and W15. It seems more likely that this high percentage should be ascribed to some sudden ecological change during the deposition of the Roydon zone. A local current change which resulted in the reduction of the salinity of the water may have been responsible for the increase in abundance of the Miliolidae, but it is probable that some other ecological factor hitherto not considered was involved.

Although the Miliolidae are the most abundant Foraminifera in shallow water in coral reef regions, they tend to be somewhat locally distributed within these areas. Cushman and Valentine (1930, p. 5) note that the miliolids are plentiful on one side of the bay but are nearly absent on the other. The findings of Dawson (1870) in the Gulf of St. Lawrence are interesting in this respect, for he states that the Miliolidae, although abundant in the shallow partially landlocked sheltered Gaspe Bay, are characteristically and almost entirely absent from the current swept area outside the bay. In the light of Dawson's remarks on the effect of currents, it is possible that the distribution of the miliolids in the miliolid bands may have been governed by a momentary moderation of current action in the area.

It has been suggested (van Voorthuysen, 1949, p. 67, re *Q.seminulum*) that the abundance of certain miliolids may be largely controlled or affected by food supply. Unfortunately, variations in food supply, except in so far as they are related to changes in lithology and organic content of the substratum, cannot be determined by study of the enclosing sediments; verification of this hypothesis will therefore have to await detailed studies on the distribution of living specimens.

With regards to the composition of the assemblage from samples W12 and W15, it is interesting to note that an increase in the abundance of miliolids is accompanied by a marked reduction in the percentage of *Cibicides aknerianus*. It is therefore probable that the ecological factor which favoured the abundant development of the miliolids was precisely the one which inhibited the development of *C.aknerianus*. Although the ecological factor involved could be a sudden decrease in the depth of water during the accumulation of the enclosing sediments there are many other alternatives. Carter (personal communication) found a similar relationship between the distribution of *Q.seminulum* and *Cibicides* spp., in samples from the Holocene Estuarine clays of Northern Ireland, and suggested that the controlling factor may be variations in the abundance of algal growth.

Although the evidence furnished by the Foraminifera indicates that the Roydon zone was laid down in somewhat shallower water than the underlying Brockenhurst zone, the evidently richer and more varied fauna of these two zones (in contrast to the assemblages of the west coast sections) indicates a comparatively deeper-water, infraneritic to deep epineritic environment for their deposition. An analogy may be drawn from the Gulf Coast region, where Lowman (1949, p. 1956) distinguished several facies-zones, based on the abundance of certain Foraminifera. The inner neritic zone or near-shore area is characterised by the abundance of *Rotalia, Elphidium,* and various members of Miliolidae, whereas the mid-neritic zone is characterised by the abundance of genera and species of Rotaliidae, especially *Cibicides.*

In view of the absence of inland exposures of the Brockenhurst beds in the Isle of Wight, it is not possible to know the exact lateral limit of its infraneritic/deep epineritic depositional environment.

The 'Barren' sands—Soon after the deposition of the Brockenhurst beds, the sea gradually began to retreat eastwards and partial silting up of the area took place. As a result of these changes in physical conditions, beds which succeed the Brockenhurst beds (in the eastern area) consist entirely of coarse-grained greyish-green sands (76 ft.) with occasional bands of ironstone nodules. They are unfossiliferous, except for some obscure casts of miliolids (probably *Q.seminulum*) and casts and corroded fragments of marine mollusks.

The miliolid casts are made up of minute spherules of black iron pyrites. Myers (1942, p. 34) states, concerning the black pyrites of iron (found in foraminiferal tests in certain regions off Plymouth, England)—"It is presumed that this mineral is produced in subsurface sediments when anaerobic bacteria utilize sulphates as a source of oxygen and release hydrogen sulphide which in turn produces the pyrites from soluble iron salts. The occurrence of the pyritized tests may be related to the bacterial decomposition of the protoplasm of the Foraminifera that had died as a result of being buried during periods of turbulence or when the bottom was disturbed by strong currents." It is possible that the pyritized miliolid casts in the 'Barren' sands were also produced under the same conditions as those outlined by Myers.

It is interesting to note that in the 'Barren' sands and in the Roydon zone (samples W13 and W14), miliolids are the only fossils that are found in the form of casts in pyrite. If Myers' surmise concerning the method of formation of pyrites casts is correct, this would suggest that the Miliolidae are particularly liable to be buried during the periods of turbulence or current action, possibly through inability of the protoplasm to disengage itself from enclosing sediments.

The absence of foraminiferal remains other than miliolid casts in the 'Barren' sands should not be construed as an indication that the environment during the deposition of these beds was inimicable to foraminiferal life. It is more probable that the absence of organic remains is secondary and is due to the lithology and structural attitude of the sediments. The 'Barren' sands consist entirely of coarse-grained sands and consequently offer no hindrance to the passage of percolating water. They occur in a succession consisting largely of clays and sands, and the whole succession in Whitecliff Bay has been sharply folded, so that it dips at an angle of 75°. Any water percolating downwards would have been canalised through the sandy beds leading to the decalcification of the contained fossils.

In the absence of foraminiferal remains other than the miliolid casts, it is impossible to deduce the ecological conditions during the deposition of the 'Barren' sands. In view of the decalcification subsequent to deposition, too much emphasis must not be placed on the occurrence of the miliolid casts. The heavy fractions of some samples from the Roydon zone usually contain similar miliolid casts, and if these beds had suffered complete decalcification the remaining organic content would closely resemble that of the 'Barren' sands. Similarly the scarcity or absence of foraminiferal remains at the top of the Brockenhurst zone (sample W11) and the middle part of the Roydon zone (samples W13, W14) does not indicate that environmental conditions during the deposition of these layers was inimical to foraminiferal life. The frequent occurrence in these samples of dehydrated selenite crystals points to subsequent destruction of the calcareous contents by acidified waters.

The 'Venus' beds.—The *'Venus'* beds in the Whitecliff Bay section are divisible into three lithologically distinct portions. At the base is the 4 ft. bed of stiff blue clay containing abundant molluscan remains. This is overlain by 20 ft. of bluish-green sandy clay containing *Cordiopsis incrassata.* The topmost bed consists of sandy loam (12 ft.), devoid of organic remains except for a few indistinct molluscan casts. As in the Brockenhurst and Roydon zones, the contained foraminiferal faunas appear to be largely controlled by the lithology of the enclosing sediments, so that the boundaries between the faunal zones coincide with those between the three lithological subdivisions.

The stiff blue clay at the base of the *'Venus'* beds marks the disappearance of the characteristic deeper-water marine species found in the lower beds, the first appearance in the succession of *Rotalia viennensis,* and the first appearance in marked abundance of *Rotalia* aff. *R.papillosa* and *Nonion depressulum.* An interesting feature of this clay bed is the appearance within it of two bands containing concentrations of foraminiferal species (*Q. seminulum* and *Buliminella carteri* respectively) not found in abundance elsewhere.

Of the above species, *N. depressulum* is the most widely distributed in recent seas. From the Table 7, it will be seen that this species is usually frequent at depths less than 150 fathoms. This, in fact, is true of most of the records of the species from around the British Isles. *N. depressulum* is also remarkable in that it exhibits a very high degree of tolerance to waters of low salinity (Brady, 1865, 1870, 1884, 1887; Hada, 1936). *N. depressulum* associated with *Elphidium excavatum* (Terquem) (=*Polystomella striatopunctata auctorum*) has actually been reported from grassy fresh-water pools receiving land drainage (Brady, 1870, p. 278). This euryhaline species is also a very important constituent of assemblages living in waters of extremely low oxygen content, and is common in Holocene stagnant-water clays of the Netherlands (van Voorthuysen, 1951, Diagrams nos. 1 & 2). In stagnant waters of very low salinity, however, it is usually accompanied by *Trochammina* and *Haplophragmoides,* which are not represented in the Isle of Wight assemblages.

Little is known concerning the ecology of *Rotalia* aff. *R. papillosa* and *R. viennensis* which do not occur in the present-day seas. Hantken (1867) records *R. viennensis* from Oligocene brackish-water deposits of Hungary. Since this record is without any figure or description, the identification might be taken as doubtful. From the type locality in the Vienna Basin, the species is frequent in the Sarmatian (upper Miocene) sediments. Marks (1951, p. 33) states—"The Tortonian passes upwards into the Sarmatian sediments of shallow to brackish water facies, containing Cerithiae, *Tapes,* etc. The almost exclusive occurrence of various species of *Elphidium* and *Rotalia* clearly indicates a shallow water depositional environment."

The disappearance or marked decrease in abundance of many forms in the lower *'Venus'* beds appears to indicate that conditions during deposition had become less favourable to the development of a rich and varied foraminiferal fauna. Such conditions are usually to be found in epineritic, very shallow pliohaline coastal waters, where the decrease in salinity due to dilution of the sea water by land drainage is becoming appreciable. Assemblages subsisting under these conditions typically contain a small number of species represented by a large number of individuals, and are usually dominated by *Nonion,* and *Rotalia.*

A notable feature of the *'Venus'* bed clay is the occurrence within it of a band containing a very high percentage of *Buliminella carteri* (88.0%). Unfortunately this species is not represented in recent seas, and no information is available concerning the factors governing its distribution. Although the genus is typically a shallow-water form, its species inhabit too wide a range of environments to allow accurate deductions based solely on the occurrence of the genus to be made. However, it is interesting to note that the conditions which favoured the increase in abundance of *B. carteri* caused a marked reduction in the abundance of *N. depressulum* and *R. viennensis.* It is therefore possible that a localized increase in depth (or more probably salinity) may be responsible. In view of the recurrence of a very similar assemblage at one level in the more brackish-water overlying sandy clays it seems more likely that some factor other than salinity or depth is responsible.

In sample W32 from the top of the clay, the percentage of *N. depressulum* decreases very markedly concurrently with the sudden appearance of *Quinqueloculina seminulum* and *Q. impressa* var. *cognata.* In this sample *N. depressulum* constitutes over 50% of the assemblage. The conditions which govern the distribution of *Q. seminulum* have already been discussed. The misconception that *Q. seminulum* is a species which thrives in waters of very low salt content appears to rest on a misidentification in "The Ostracoda and Foraminifera of Tidal rivers", Pt. 11 (Brady, 1870). In this publication certain thin-shelled forms approaching *Miliolinella subrotunda* (Montagu) in appearance, found in association with *Miliammina fusca* (Brady), a typical brackish-water form, were erroneously included in *Q. seminulum, s.s.* If the remarks concerning these forms are eliminated, Brady's statement (*op.cit.,* p. 285) on the distribution of *Q. seminulum* becomes 'typically shallow marine' and thus more closely in accordance with present-day information. It has already been pointed out, however, that another factor independent of salinity may be involved, and in view of a recurrence of a very similar assemblage in more brackish-water higher beds this seems to be a more likely explanation.

The bluish-green sandy clays with *Cordiopsis incrassata* contain a very restricted fauna, and a study of the foraminiferal assemblages reveals a sudden progressive reduction in the salinity of the water during the deposition of the upper beds. Other faunal changes occurring at the boundary between the underlying clays and the sandy clays may be correlated with a sudden decrease in salinity and/or oxygen content of the water or with the change in lithology.

The assemblages in the sandy clays are dominated by the two species—*Rotalia viennensis* and *Nonion depressulum.* In the lower parts of the section the former is the most abundant, but it disappears about 4 ft. above the base. In the upper part of the section *N. depressulum* is the dominant form and at some levels (samples W37, W38, and W42) the assemblages become monospecific. This would seem to indicate that not only was the water becoming more brackish with the passage of time but it was also tending to become stagnant. Such conditions are commonly found in shallow turbid estuarine areas where abundant plant remains and organic refuse tend to reduce the oxygen content of the water. In coastal brackish-water lagoons characterised by sluggish or non-existent water circulation, and water of very low oxygen content, *Nonion/Trochammina/Haplophragmoides* assemblages would be produced.

The progressive decrease in salinity during the deposition of the upper sandy clay *'Venus'* beds (as indicated by the increase in percentage of *N. depressulum*) is in accordance with the views of Stamp (1950, p. 292) that the initial marine invasion during the Oligocene in English and French regions was followed by a considerable period during which brackish-water and eventually fresh-water conditions prevailed.

A significant feature of the sandy clays is the occurrence in them of assemblages rich in *Buliminella carteri* and *Quinqueloculina seminulum.* The former was found in the mid-portion of the sandy clay succession, and the latter near its top. These assemblages are closely similar to those found in the underlying blue clays, and it is noteworthy that the assemblages occupy a similar spatial position relative to the base of the individual bed in which they occur. The conditions which gave rise to them probably tended to recur in the same order in each lithological phase, and are to some extent oscillatory.

The green sandy loams overlying the sandy clays appear to be totally devoid of foraminiferal remains. The heavy fraction of sample W43 was found to contain pyrites, but this was not in the form of foraminiferal casts. The occurrence in these beds of fragmentary corroded molluscan remains and obscure molluscan casts indicate that organic remains were present in the beds at the time of deposition and have been subsequently removed by percolating water. If, however, the trend away from marine conditions during the deposition of the underlying beds was continued, the sandy loams would probably have been laid down in almost fresh water. In such an environment Foraminifera are usually not found, and it is therefore possible that these deposits did not originally contain them.

B. Colwell Bay and Headon Hill Sections

The foraminiferal faunas of the middle Headon beds of the Colwell Bay and Headon Hill sections (*vide* Tables 2 and 3), though limited in the number of species, consist of abundant specimens of *Nonion depressulum, Rotalia viennensis, Rotalia* aff. *R.papillosa,* and *Elphidium minutum.* The first two species together usually constitute over 60% of the total assemblage in different samples. *Valvulineria araucana* is virtually restricted to the Colwell Bay and Headon Hill sections, where it attains abundance in a few basal samples. Other species are too rare to be of any significance. *V. araucana* is reported from 150-1000 fathoms (Natland, 1930). According to Brady (1884) however, it is a shallow water species. Excepting two samples (C3 and HH2), the percentage of this species does not exceed that of *N. depressulum* or *R. viennensis.* It is therefore probable that *V. araucana* occupied the same ecological niche as that occupied by *N. depressulum* and *R. viennensis.*

As in the Whitecliff Bay section, the percentage of *N. depressulum* increases markedly in the upper samples, both in the Colwell Bay and Headon Hill sections (samples C17-C20 and HH24, HH25 respectively). In the Colwell Bay samples, it is over 96% and at Headon Hill, over 86.7%. Further, the same samples contain abundant specimens of the gastropod *Theodoxus concavus* (J. Sowerby), which lives in brackish- and fresh-waters (Davies, 1935, p. 228; Wood, 1947, p. 283).

The foraminiferal evidence (as well as molluscan), therefore, suggests that the middle Headon beds in the western areas (Colwell Bay and Headon Hill) were initially deposited under shallow marine conditions at depths less than 50 fathoms. During the deposition of the upper part of the middle Headon beds, however, the rapidly shallowing sea gave place to lagoonal or brackish-water conditions, as shown by the abundance of brackish-water fossils.

The middle Headon beds pass imperceptibly into the overlying freshwater upper Headon beds, indicating the gradual retreat of the sea and the establishment of freshwater conditions. The Osborne beds and the Bembridge Limestone also belong to the freshwater phase and are complementary to the marine phase of the middle Headon beds.

THE BEMBRIDGE OYSTER BEDS

The Bembridge Oyster beds were deposited during the second marine cycle, under the same environmental conditions that prevailed during the deposition of the middle Headon beds in the western area, i.e. a near-shore, epineritic environment. This marine transgression, however, was of shorter duration than the previous one, and continental conditions were soon re-established. The foraminiferal fauna (*vide* Table 4) is similar to that of the middle Headon beds of Headon Hill and Colwell Bay sections. Some species which are rare in the middle Headon beds, however, become abundant here. These are *Miliolinella oblonga, Buliminella elegantissima* and *B. striatopunctata. Nonion depressulum* is again the dominant species, and occurs in most of the samples in super-abundance. *M. oblonga,* though having a wide bathymetric range, is very common in shallow waters with depths less than 50 fathoms. Natland (1933) recorded both *M. oblonga* and *B. elegantissima* in abundance from zone II, with a depth range from 2 to 20 fathoms, which is virtually the range of the epineritic environment, as suggested by Scott (1940). Most of the other records of *B. elegantissima* from around the British Isles, off the coast of Belgium, and the eastern coasts of North and South America are from depths less than 50 fathoms. According to Hada (1936), the species can also live in brackish-waters.

The continental Bembridge beds comprise a great thickness of clays and grey-blue marls, the Bembridge marls. Within this phase may also be included the lower, middle and upper Estuarine and Freshwater Hamstead beds, which are merely a continuation of the Bembridge marls and differ from them mainly in lithology—sandy beds and shales replacing the marls and clays.

THE HAMSTEAD *CORBULA* BEDS

The uppermost 20 feet or so of the Hamstead series—the Hamstead *Corbula* beds—represent the third and the last important marine phase of the late Paleogene sedimentation.

Of the Recent species found in the Hamstead *Corbula* beds, the dominant forms are *Ammobaculites agglutinans, Miliolinella oblonga, Nonion depressulum, Nonionella auricula, Buliminella elegantissima, Bulimina pupoides, Bolivina variabilis* and *Virgulina schreibersiana* (*vide* Table 5).

A. agglutinans is rather abundant in the two basal samples (63.6% and 84.1%). Though the species has a wide bathymetric range, the deeper-water records are more numerous than those from shallow waters. Around the British Isles, however, the species occurs in shallow waters, at depths less than 50 fathoms (Brady, 1887). According to Heron-Allen and Earland (1910, p. 422), it cannot be described as a common British species. Hada (1936) records the species in great abundance from brackish-water lakes in Japan, with salinity ranging from 12.0 to 33.5%o. Lowman (1949, p. 1953) states "The foraminiferal genus *Ammobaculites* is the dominant genus in what may be classed as weakly brackish environments in the range from 100 to 5000 parts per million chloride". It seems highly unlikely that the basal Hamstead *Corbula* beds were deposited in very deep waters, as the associated faunule contains no other deeper-water species. The possibility of a brackish-water environment, however, cannot be ruled out completely. The state of preservation of this species indicates a shallow-water depositional environment. The shells are very fragile, and out of over 600 specimens that were found, only 3 have the uniserial portion intact. Heron-Allen and Earland (*op.cit.*, p. 424) state concerning *Ammobaculites* (*Haplophragmium*) *agglutinans*—"The shell is constructed with a peculiarly perishable cement which conduces to its disintegration under the action of waves upon the shore and the process of drying and floating". Since the specimens of this species occur in a very fragmentary state, it appears probable that the basal Hamstead *Corbula* beds were deposited in very shallow marine waters, where, due to the action of the waves, the fragile shells were partially disintegrated. The exact or even an approximate estimate of the depth is of little importance, because the species inhabits a wide range of ecological conditions.

The Buliminidae are abundantly represented in these beds, both by the number of species and the number of individuals. According to Norton (1930, p. 348) the members of the family "are not restricted as regards conditions of depth and temperature". However, two species seem to be of ecological value. These are *Buliminella elegantissima* and *Bolivina variabilis.* The former species, as already remarked, occurs abundantly at depths less than 50 fathoms, the optimum range being 2.3-20.8 fathoms. *B. variabilis* is typically developed and abundant around the British Isles (the types were from off the south coast of England). Except for deeper-water records by Cushman (1942) from the Pacific 'Albatross' collection at depths ranging from 613 to 1135 fathoms, all the other records are from depths less than 85 fathoms. Off the Belgian coast, the species occurs commonly at depths less than 28 fathoms (Cushman, 1949). *Bulimina elongata* and *Virgulina schreibersiana,* though somewhat abundant in some samples, have bathymetric ranges too wide to be of any ecological value.

In the upper samples, *Nonionella auricula* occurs commonly. Though there are few records of the species, it appears to be restricted to, and abundant in, shallow waters. Heron-Allen and Earland (1930) record the species from off Plymouth, England, at a depth of 30 fathoms. Cushman (1949) records it from several stations in the Atlantic Ocean, off the New England coast, at depths ranging from 6-13 fathoms.

Thus the foraminiferal evidence suggests a relatively shallow marine environment (with depths less than 50 fathoms) for the deposition of the Hamstead *Corbula* beds.

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TABLE 1.—PER CENT DISTRIBUTION OF FORAMINIFERA, MIDDLE HEADON BEDS, WHITECLIFF BAY

TABLE 1—*Continued*

	Brockenhurst Zone				Roydon Zone							Barren Sands												"Venus" Beds																
Sample Nos. Foraminiferal Species	W 8	W 9	W 10	■ W 11	W 12	● W 13	● W 14	W 15	W 16	W 17	W 18	● W 19	● W 20	● W 21	● W 22	● W 23	● W 24	● W 25	▲ W 26	▲ W 27	W 28	W 29	W 30	W 30	W 31	W 32	W 33	W 34	W 35	W 36	W 37	W 38	▲ W 39	W 40	W 41	W 42	▲ W 43	▲ W 44	▲ W 45	▲ W 46
Clavulina angularis d'Orbigny	0.2								0.2																															
Miliolinella oblonga (Montagu)								2.1																																
Quinqueloculina bicarinata d'Orbigny								1.5																																
Quinqueloculina impressa var. *cognata* (Borne.)								2.8																		0.8	3.3													
Quinqueloculina pertusa Terquem								1.3																																
Quinqueloculina juleana d'Orbigny					26.9																																			
Quinqueloculina seminulum (Linné)					0.7			2.6																	0.1	15.9	3.3							1.0	19.8					
Quinqueloculina simplex Terquem								0.1																			7.1								3.1					
Spiroloculina obscura Cushman & Todd								0.5																																
Triloculina trigonula (Lamarck)					3.8			3.3			0.9																													
Glandulina laevigata d'Orbigny											0.9																													
Globulina ampulla (Jones)		0.7																																						
Globulina gibba d'Orbigny	0.8				0.7			0.1		1.2																														
Globulina gibba var. *tuberculata* (d'Orb.)	0.2																																							
Globulina inaequalis Reuss	1.9	2.8			0.7			1.1																																
Globulina cf. *G. minuta* (Roemer)	0.4	0.2						0.1														0.8																		
Guttulina bulloides (Reuss)					0.3																																			
Guttulina irregularis (d'Orbigny)	1.0	1.4																				0.2																		
Pyrulina sp. indet.																					3.8																			
Sigmomorphina sp. indet.		0.7			0.3																																			
Nonion depressulum (Walker & Jacob)	6.5	4.9	10.0		2.9																13.7	18.0	8.0	8.0	82.4	63.9	7.4	12.5	56.7	78.2	100	100		98.0	75.9	100				
Nonion laeve var. [illegible], [redacted] Bhatia	0.8	3.9	20.0		1.8																																			
Nonion umbilicatulum (Walker & Jacob)	17.0	1.4			1.4			1.1																																
Elphidium minutum (Reuss)	2.7	2.8			3.2																				0.5															
Buliminella carteri, [redacted] Bhatia																						0.3	88.0	88.0					4.3	15.0										
Bulimina coprolithoides Andreae																						0.2													0.1					
Entosolenia laevigata (Reuss)	1.0	4.9			0.7																																			
Bitubulogenerina reticulata Cushman	1.9	4.9	10.0		4.8			0.5		1.2	5.6																													
Bolivina fastigia Cushman	1.2				1.0																																			
Bolivina variabilis (Williamson)	3.2				2.1																																			
Valvulineria araucana (d'Orbigny)																							2.0	2.0																
Valvulineria subconica (Terquem)	0.4							1.5	2.5	4.8																														
Eponides cf. *E. pygmeus* (Hantken)	1.9	5.2																																						
Pararotalia subinermis, [redacted] Bhatia								71.3	69.5	70.7	15.4																													
Rotalia aff. *R. papillosa* d'Orbigny	2.9	2.8			1.0			0.8		1.2											31.0	19.5			8.5	10.8			8.6	3.4										
Rotalia canui Cushman					3.2			7.7	15.3	21.9	71.6																													
Rotalia viennensis (d'Orbigny)																					37.9	60.3	2.0	2.0	8.5	8.6	78.5	87.5	30.4	3.4				1.0	1.1					
Asterigerina sp. indet.	0.6				1.4			0.1			0.9										6.8	0.5																		
Pullenia sp. indet.	0.4	5.2			1.4																6.8																			
Globigerina sp. indet.	27.1	26.3			22.2																																			
Cibicides ahnerianus (d'Orbigny)	27.5	29.8	60.0		37.5			1.5	12.5		1.8																													
Cibicides refulgens Montfort	10.6	2.1									2.9																													

■ Foraminifera not identifiable. ● Only miliolid casts present. ▲ Foraminifera absent.

TABLE 2.—PER CENT DISTRIBUTION OF FORAMINIFERA, MIDDLE HEADON BEDS, HEADON HILL

Sample Nos. / Foraminiferal Species	HH 1	HH 2	▲ HH 3	▲ HH 4	▲ HH 5	HH 6	HH 7	HH 8	HH 9	HH 10	HH 11	HH 12	HH 13	HH 14	HH 15	HH 16	▲ HH 17	HH 18	▲ HH 19	HH 20	▲ HH 21	HH 22	▲ HH 23	HH 24	HH 25
Miliolinella oblonga (Montagu)											1.0							0.7							
Lagena sulcata (Walker & Jacob)											0.2														
Guttulina bulloides (Reuss)								0.2																	
Nonion depressulum (Walker & Jacob)	56.6	0.6				50.6	55.8	56.9	40.5	49.3	36.6	40.8	55.8	44.0	55.0	59.7		86.9		33.4		33.4		98.1	92.4
Elphidium minutum (Reuss)						7.5	8.7	3.5	6.0	5.0	3.6	1.7	7.5	6.6	5.5	1.7									
Buliminella carteri, [redacted] Bhatia						0.5	0.5	0.7	0.2				0.3			0.5		0.1							
Buliminella elegantissima (d'Orbigny)													0.1												
Bulimina coprolithoides Andreae						2.3	0.5	0.2	0.3	0.3	0.2	0.3	0.5	0.4	0.2	1.7		0.7		33.3				1.6	
Discorbis cf. *D. rugosa* (d'Orbigny)		0.5																							
Valvulineria araucana (d'Orbigny)	43.4	98.4																11.5		33.3					
Rotalia aff. *R. papillosa* d'Orbigny						13.8	10.3	11.2	10.6	8.5	8.4	16.3	8.2	5.5	16.3	3.0		0.1				33.3		0.3	
Rotalia viennensis (d'Orbigny)		0.5				25.3	24.2	27.3	42.4	36.8	50.0	40.9	27.3	43.5	23.0	33.4						33.3			7.6
Cibicides refulgens Montfort										0.1			0.3												

▲ Foraminifera absent.

TABLE 3.—PER CENT DISTRIBUTION OF FORAMINIFERA, MIDDLE HEADON BEDS, COLWELL BAY

Sample Nos. / Foraminiferal Species	C 1	C 2	C 3	C 4	C 5	C 6	C 7	C 8	C 9	C 10	C 11	C 12	C 13	C 14	C 15	C 16	C 17	C 18	C 19	C 20
Miliolinella oblonga (Montagu)	0.5	2.9																		
Quinqueloculina seminulum (Linné)		0.9	1.2	8.6	2.8	0.1			0.8											
Quinqueloculina simplex Terquem																1.1				
Nonion depressulum (Walker & Jacob)	62.2	76.6	30.4	41.8	52.5	32.8	50.8	34.0	22.9	25.6	26.9	25.7	16.5	66.1	96.1	83.5	98.3	100	96.1	99.0
Elphidium minutum (Reuss)				2.1		2.7		5.0	2.0	0.8	0.8	1.4	0.1	1.2		1.6	0.9		3.0	
Buliminella carteri, [redacted] Bhatia					1.8	4.9	3.0			0.3		0.3	0.1			0.1	0.3			1.0
Buliminella striatopunctata (Terquem)	3.0	1.4	5.4	4.3	3.9	1.1	3.0													
Bulimina coprolithoides Andreae		0.4		2.1					0.2		0.8	0.1	0.2		0.2	0.7	0.3		0.3	
Bulimina simplex var. *colwellensis*, [redacted] Bhatia	3.7	0.9	2.0	4.3	1.9	0.1														
Valvulineria araucana (d'Orbigny)	10.5	7.0	48.2	8.6	14.2	1.7	12.3	5.0						0.1	0.7	3.7				
Rotalia aff. *R. papillosa* d'Orbigny	1.8	0.9		2.1			1.6	1.6	3.5	6.2	5.5	5.1	3.6	10.1	0.2	1.9	0.2		0.6	
Rotalia viennensis (d'Orbigny)	18.3	9.0	12.8	26.1	22.9	56.6	29.3	54.4	70.6	67.1	66.0	67.4	79.5	22.5	2.8	7.4				

TABLE 4.—PER CENT DISTRIBUTION OF FORAMINIFERA, BEMBRIDGE OYSTER BEDS, WHITECLIFF BAY

Sample Nos. / Foraminiferal Species	B 1	B 2	B 3	B 4	B 5	B 6
Miliolinella oblonga (Montagu)	12.0	1.5	5.5	44.9	4.4	0.3
Triloculina cf. *T. consorbina* (d'Orbigny)	2.1	0.2		8.1		
Nonion depressulum (Walker & Jacob)	54.1	86.3	94.5	30.8	72.8	83.5
Buliminella carteri, [redacted] Bhatia						2.9
Buliminella elegantissima (d'Orbigny)	0.9	1.6			1.0	0.2
Buliminella striatopunctata (Terquem)	29.0	5.3		8.1	5 2	11.6
Bulimina coprolithoides Andreae	0.3	1.0		8.1	1.0	0.2
Bulimina pupoides d'Orbigny	0.3	1.0				0.6
Discorbis bembridgensis, [redacted]. Bhatia	0.3	0.1			11.5	
Rotalia sp. indet.	1.0	3.0			4.1	0.7

TABLE 5.—PER CENT DISTRIBUTION OF FORAMINIFERA, HAMSTEAD *CORBULA* BEDS, HAMSTEAD HILL

Sample Nos. / Foraminiferal Species	HA 1	HA 2	HA 3	HA 4	HA 5	HA 6	HA 7	▲ HA 8	HA 9	▲ HA 10	▲ HA 11	▲ HA 12
Ammobaculites agglutinans (d'Orbigny)	84.1	63.6			6.5							
Miliolinella oblonga (Montagu)	5.9		4.3		4.3		0.2		0.5			
Quinqueloculina sp. indet.			3.9									
Quinqueloculina seminulum (Linné)		5.1	2.4				0.2					
Quinqueloculina simplex Terquem			1.4									
Guttulina austriaca d'Orbigny							0.1					
Nonion scaphum (Fichtel & Moll)						0.6	0.6					
Nonion depressulum (Walker & Jacob)		10.1	27.3			0.3	4.5		10.1			
Nonionella auricula Heron-Allen & Earland						2.1	3.0		9.0			
Buliminella carteri, [redacted] Bhatia	0.6	1.6		33.3	4.3	12.0	6.3		4.6			
Buliminella elegantissima (d'Orbigny)		0.8	0.3		8.6	0.6	0.9		1.6			
Bulimina coprolithoides Andreae	1.0	10.0	1.2		19.4	18.4	15.2		5.9			
Bulimina elongata d'Orbigny		1.7	0.1		3.0	4.2	1.9		0.8			
Bulimina pupoides d'Orbigny							0.8					
Entosolenia laevigata (Reuss)		0.3	1.2									
Bolivina beyrichi var. *bituminosa* Spandel					18.2	2.1	1.6		1.0			
Bolivina fastigia Cushman			0.7		8.6	17.6	13.8		38.3			
Bolivina variabilis (Williamson)	5.8	1.6	6.2	33.4	20.2	18.7	14.6		10.9			
Virgulina schreibersiana Czjzek						0.6	2.3		2.9			
Angulogerina aff. *A. oligocaenica* var. *globosa* (Stoltz)							0.1					
Angulogerina tenuistriata (Reuss)							4.4		1.0			
Valvulineria aarucana (d'Orbigny)	2.6		1.2									
Pseudoparrella oveyi, [redacted] Bhatia		3.2					1.0		2.0			
Pullenia sp. indet.		2.0	49.8	33.3	6.9	22.8	35.2		10.6			
(Embryonic polymorphs)							0.3		0.8			

▲ Foraminifera absent

TABLE 6.—SHOWING THE CHARACTERISTICS IN THE FORAMINIFERAL ASSEMBLAGES OF THE MIDDLE HEADON BEDS OF THE EAST AND WEST COAST SECTIONS

Colwell Bay and Headon Hill sections (west coast)	Whitecliff Bay section (east coast)
'Venus' Beds:—Assemblage dominated by *Nonion depressulum* (Walker and Jacob), *Rotalia viennensis* (d'Orb.), *Rotalia* aff. *R. papillosa* d'Orb., and *Elphidium minutum* (Reuss). *Valvulineria araucana* (d'Orb.) is restricted in both the sections to the basal and upper parts.	*'Venus' Beds*:—Assemblage dominated by *Nonion depressulum* (Walker and Jacob), *Rotalia viennensis* (d'Orb.), *Rotalia* aff. *R. papillosa* d'Orb., with occasional bands of miliolids.
'Barren' sands are unrepresented in the west coast sections.	*'Barren' Sands*:—Only miliolid casts present.
The characteristic Brockenhurst fauna is represented by only a few exotic forms.	*Brockenhurst Beds*:—Assemblage dominated by *Cibicides aknerianus* (d'Orb.), *C. refulgens* Montfort, *Globigerina* sp. indet., *Pararotalia subinermis* Bhatia, and *Rotalia canui* Cushman. Occasional bands with miliolids.

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	BALKWILL & WRIGHT –	BRADY –				BRADY, PARKER & JONES –	CHASTER –	CUSHMAN –					CUSHMAN & PARKER –	DAWSON –	EARLAND –		HADA –	HERON-ALLEN & EARLAND –				NATLAND –	NORTON
	1885	1865	1870	1884	1887	1888	1892	1918 - 1931	1927	1932, -33, -42	1944	1949	1931	1870	1933	1934	1936	1914-15	1916a	1916b	1922	1933	1930
aculites agglutinans (d'Orbigny)	VR <50 fms.	–	–	2-3125 fms. C in deep water	0-50 fms.	–	R at 23 fms.	553 fms. (av.)	–	–	–	–	–	–	703 fms. (av.)	>310 fms.	brackish-water, salinity 12·0 –33·5 ‰.	5-8 fms.	–	–	>1000 fms.	–	–
lla oblonga (Montagu)	R <50 fms.	C, ndg.	moderately common in brackish-waters	all depths	GD, ndg.	31-940 fms.	R 14-23 fms.	ndg.	–	C at 3-80 fms., 189-1385 fms.	–	<28 fms.	–	–	173 fms. (av.)	<122 fms.	–	6-85 fms.	35-40 fms.	30 fms.	129 fms. (av.)	A 2·3-20·8 fms.	all depths
loculina seminulum (Linnaeus)	A <50 fms.	C, ndg.	F in brackish-waters	0-3000 fms.	GD, ndg.	31-940 fms.	C <23 fms.	F in shallow waters	–	–	ndg.	<28 fms.	–	C 10-16 fms. R 200, 3132 fms.	95 fms. (av.)	80-540 fms.	brackish & marine	5-20 fms.	–	A 3-5 fms.	179 fms. (av.)	A <150 fms.	deeper wat
lina trigonula (Lamarck)	R <50 fms.	A, ndg.	R, sometimes well grown in brackish-waters	C <100 fms.	GD, ndg.	–	F at 23 fms.	ndg.	–	12 fms.	VR 239 fms.	<28 fms	–	–	–	–	–	5-85 fms.	shore sand	A 10-30 fms.	224 fms. (av.)	A 20·8-150 fms.	warm shallow water
depressulum (Walker & Jacob)	A <50 fms.	C in brackish-waters	A in brackish-waters	C <50 fms. & brackish-waters	C in brackish-waters	R 260 fms.	C <23 fms.	ndg.	–	–	–	A <28 fms.	–	–	102 fms. (av.)	A <150 fms.	brackish & marine	A <22 fms.	GD in shallow water	A at 18 fms.	118 fms. (av.)	–	wide depth range
scaphum (Fichtel & Moll)	VR <50 fms.	R 40-48 fms.	–	0-1375 fms.	C 40-120 fms.	40-260 fms.	R at 23 fms.	ndg.	–	–	–	R <28 fms.	–	C in shallow waters	116 fms. (av.)	R, ndg.	–	ndg.	–	VR, ndg.	–	A 2·3 – 20·8 fms.	<60 fms.
umbilicatulum (Walker & Jacob)	–	R 40-48 fms.	–	30-3125 fms.	C in deeper water	31-940 fms.	VR <23 fms.	ndg.	321 fms. (av.)	–	–	–	–	–	623 fms. (av.)	207 fms. (av.)	–	R at 6 fms.	–	ndg.	361 fms. (av.)	A >1000 fms.	wide depth range
lla auricula Heron-Allen & Earland	–	–	–	–	–	–	–	–	–	–	C 6-13 fms.	–	–	–	–	–	–	–	–	–	–	–	–
lla elegantissima (d'Orbigny)	R <50 fms.	VR, ndg.	R in brackish-waters	2-610 fms.	R, ndg.	–	F <23 fms.	–	–	–	6 fms.	C <28 fms.	VA <15 fms.	C 18-20 fms.	53 fms.	–	brackish & marine	C, exposed coral reefs.	35-40 fms.	12-25 fms.	261 fms. (av.)	A 2·3-20·8 fms.	–
a elongata d'Orbigny	–	–	–	630-1425 fms.	–	–	VR <23 fms.	ndg.	–	–	–	R <28 fms.	–	–	–	VR >88 fms.	–	–	VR 35-40 fms.	12-30 fms.	–	–	–
a pupoides d'Orbigny	C <50 fms.	R, ndg.	–	0-1000 fms.	R, ndg.	R 40 fms.	F <23 fms.	787 fms. (av.)	–	–	–	–	–	–	–	VR >152 fms.	–	C 5-8 fms.	GD, ndg.	A <20 fms.	185 fms. (av.)	–	–
enia laevigata (Reuss)	C 40-50 fms.	–	–	2-3125 fms	C, ndg.	F 260 fms.	R <23 fms.	ndg.	–	–	10-18 fms.	–	–	–	–	–	–	–	–	A 12 30 fms.	deeper water	–	–
variabilis (Williamson)		R, ndg.	VR in brackish-waters	–	–	–	R <23 fms.	ndg.	–	613, & >1000 fms. R 40-50 fms.	ndg.	C <28 fms.	–	–	–	–	–	5-85 fms.	GD, ndg.	C <60 fms.	R 11-20, 100, 750 fms.	–	–
na schreibersiana Czjzek	R <50 fms.	VR, ndg.	–	10-3000 fms.	GD, ndg.	R 940 fms.	–	834 fms. (av.)	–	–	–	VR 28 fms.	–	–	286 fms. (av.)	189 fms. (av.)	–	ndg.	35-40 fms.	12-25 fms.	–	150-1000 fms.	687 fms.
eria araucana (d'Orbigny)	–	–	–	shallow water	–	–	–	ndg.	377 fms. (av.)	–	–	–	–	–	–	–	–	ndg.	–	–	–	150-1000 fms.	–
es refulgens Montfort	–	R 30-40 fms.	–	45-2400 fms.	C >20 fms.	–	–	159 fms.	–	–	–	<28 fms.	–	–	244 fms. (av.)	C 175 fms.	–	R <85 fms.	GD, ndg.	<60 fms	142 fms. (av.)	–	<100 fms

LEGEND

VR – VERY RARE.
R – RARE.
F – FREQUENT.
C – COMMON.
A – ABUNDANT.
VA – VERY ABUNDANT.

fms. — FATHOMS.
ndg. — NO DATA GIVEN
GD — GENERALLY DISTRIBUTED
av. — AVERAGE

TABLE 7

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CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH

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162. FORAMINIFERA OF THE BURAS-SCOFIELD BAYOU REGION, SOUTHEAST LOUISIANA

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ABSTRACT

Recent Foraminifera from twenty-two samples collected in the Buras-Scofield Bayou Region of Louisiana are recorded in a systematic list. There are sixty-five species listed of which ten are new species. All of the new species are characteristic marsh or brackish water forms.

INTRODUCTION

The Buras-Scofield Bayou Region lies within Plaquemines Parish, Louisiana, and extends from the town of Buras on the Mississippi River southward to the Gulf of Mexico. This is a fairly typical area of the Louisiana coastal marshlands consisting of a system of shallow lakes and connecting tidal channels surrounded by marsh. However, it is unique in that the lakes, of which there are seven, are concentrated within an area of only thirty-six square miles.

The lakes are small and shallow, none having a natural depth of more than five feet. They are polyhaline varying from slightly brackish to very brackish, approaching the comparatively constant salinity of the nearshore Gulf of Mexico which averages about 31 parts per thousand throughout the year. As would be expected, salinity values tend to decrease away from the Gulf of Mexico and increase toward it. All of the enclosed water bodies of the region have soft mud bottoms rich in plant remains and containing a small percentage of silt and some shells. The very topmost layer of the bottoms is a dark gel-like ooze varying in thickness up to six inches or more. Deposition of sand, excluding the Gulf of Mexico and the beach, seems to be restricted to bar deposits in the three mouths of Scofield Bayou. Even the single bottom sample from the Gulf of Mexico consisted of silty, sandy mud.

The region has no natural source of fresh water influx other than rainfall due to the artificial levee which flanks the Mississippi River as far downstream as Venice. Tidal channels permit easy access to the area for saline waters from the Gulf of Mexico. There is only one apparent tidal cycle every twenty-four hours and although the average tidal range is only about one foot, tidal currents often attain appreciable velocities in the tidal channels.

The marsh throughout the area is fairly firm and can be traversed on foot most of the time, It is generally slightly above water level except when persistent winds from the south cause water levels along the coast to rise and flood the marsh. There is a gradation seaward from polyhaline marsh inland to saline marsh adjacent to the coast. This is comparable to a similar gradation in salinity of the water bodies toward the coast.

Marsh and bottom samples consisting of one pint of sediment were collected by G. W. Grant and A. D. Warren on October 22, 1953. Sample locations are plotted in Figure 1. More detailed sample locality descriptions as well as records of salinity, pH values and temperature for these locations are on record at the Geological Museum, Louisiana State University, Baton Rouge, Louisiana.

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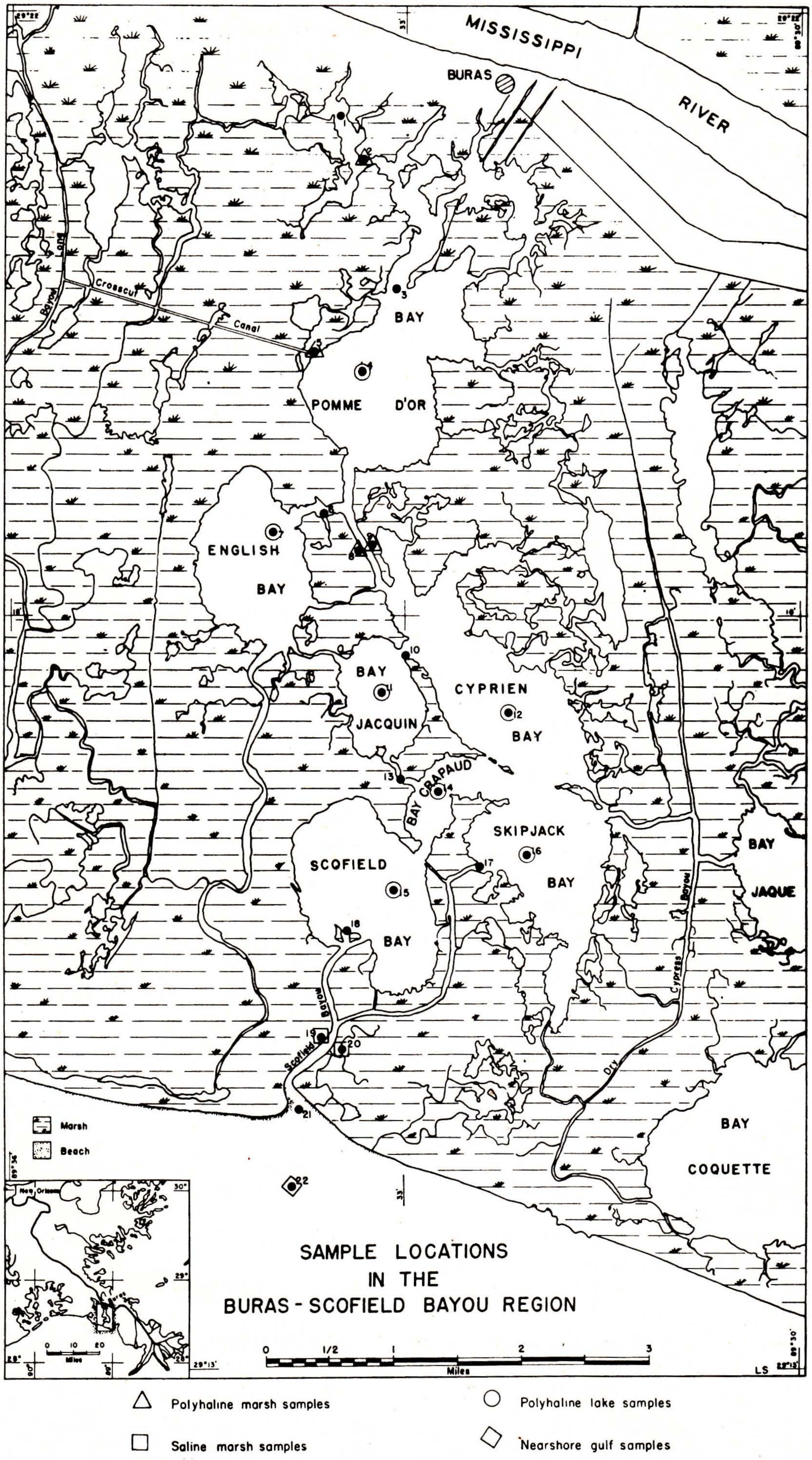

FIGURE I

Map of the Buras-Scofield Bayou Region

TREATMENT OF SAMPLES

Each pint sample was thoroughly washed through a 65 mesh and a 150 mesh screen using only a water spray to wash away the very fine material, thereby providing a coarse and a fine fraction. All sample residues contained a high percentage of fine organic debris such as rootlets and plant stems. This debris was removed in the following manner. A washed residue was placed in a wide mouthed jar filled with water and the mixture was stirred rather briskly for a few seconds. The water and temporarily suspended plant remains were then decanted slowly and only a small portion at a time onto a 150 mesh screen. More water was added, stirred and decanted until practically all of the debris had been removed. An examination of the decanted portion of the residue under a binocular microscope revealed almost no loss of essential material. By means of this process it was possible to obtain a sample residue consisting almost entirely of foraminiferal tests. Since many of the foraminiferal tests were very delicate, the residues were dried by adding alcohol to the wet sample. It was found that with this method there was much less tendency for the foraminiferal tests to break or adhere to one another.

FAUNAL SUMMARY

This paper represents only the taxonomic phase of a larger study of the ecology of Foraminifera of the Buras-Scofield Bayou Region. Therefore, no attempt has been made here to show any characteristic distribution of species or populations.

More than seventy species of Foraminifera were found during the course of this study. Of these, only sixty-five species including ten new species are listed or described. Those not listed were excluded by reason of extreme rarity, indefinite classification or because they appeared to be reworked fossil types. There were two of the last mentioned forms which were quite similar to certain Cretaceous and Tertiary species; they were a *Gümbelina* sp. and a *Nonion* sp. cf. *N. micrum* Cole.

It is interesting to note that the geographical ranges of seven species have been extended and even more interesting that they were all described from the same locality in Trinidad, British West Indies (Cushman and Bronnimann, 1948). The seven species are *Ammotium pseudocassis, Trochamminita irregularis, Cribroelphidium kugleri, Cribroelphidium limosum, Cribroelphidium salsum, Cribroelphidium trinitatensis* and *Cribroelphidium vadescens.* During the past few years other species described from Trinidad by the same authors have been reported from the San Antonio Bay Area of Texas (Parker, Phleger and Peirson, 1953) and also from the Mississippi Sound Area of Mississippi and Alabama (Phleger, 1954).

Holotypes and paratypes of new species are deposited in the Geological Museum, Louisiana State University, Baton Rouge, Louisiana.

SYSTEMATIC LIST OF SPECIES AND DESCRIPTIONS OF NEW SPECIES

Order FORAMINIFERA

Family REOPHACIDAE

Genus **Sulcophax** Rhumbler, 1931

Sulcophax palustris Warren, n.sp.

Plate 3, Figures 1-4

Description.—Test rigid and fragile consisting of nine to fifteen uniserial chambers increasing in length slowly at first and then rapidly; sutures in early portion distinct, slightly depressed in later portion; periphery lobulate in last few chambers; test finely arenaceous, well cemented, rather smoothly finished. Aperture an elongate slit at the terminal end of the test. Length: 0.35-0.70 mm. Thickness: 0.08-0.11 mm.

Occurrence.—Holotype from Sample 5; wet marsh on the northeast side of Crosscut Canal at Bay Pomme d'Or (L. S. U. Geol. Museum Locality No. 2009). Specimens were also present in Sample 20.

Remarks.—This is apparently a rather rare marsh species. It differs from *Reophax mariae* Acosta in the larger size, more numerous chambers and the slit-like aperture.

Family LITUOLIDAE

Genus **Haplophragmoides** Cushman, 1910

Haplophragmoides manilaensis Andersen

Haplophragmoides manilaensis Andersen, 1953, Contr. Cushman Found. Foram. Res., vol. IX, pt. 1, p. 22, pl. 4, figs. 8a, b.

Specimens are typical and are found in Samples 4, 11, 13, 14, 15, 16 and 22.

Haplophragmoides wilberti Andersen

Haplophragmoides wilberti Andersen, 1953, Contr. Cushman Found. Foram. Res., vol. IV, pt. 1, p. 21, pl. 4, figs. 7a, b.

Specimens are typical and present in all except Samples 3, 9, 16 and 20.

Genus **Ammoastuta** Cushman and Bronnimann. 1948

Ammoastuta salsa Cushman and Bronnimann

Ammoastuta salsa Cushman and Bronnimann, 1948, Contr. Cushman Lab. Foram. Res., vol. 24, pt. 1, p. 17, pl. 3, figs. 14-16.

Specimens are typical and present in all except Samples 5, 8, 9 and 14.

Genus **Ammobaculites** Cushman, 1910

Ammobaculites crassus Warren, n.sp.

Plate 3, figures 5-7

Description.—Test large; initial coil with an umbonal recess, slightly evolute, having a tendency to become trochoid; later portion uniserial; chambers distinct, inflated, from two to six making up the uniserial portion of the test in adult specimens; sutures distinct, depressed, usually slightly curved; test very coarsely arenaceous, well cemented; aperture large, round, terminal, with a slight neck. Length: 0.40-0.90 mm. Thickness: 0.18-0.30 mm. Width of the uniserial portion: 0.20-0.40 mm.

Occurrence.—Holotype from Sample 3; center of lagoon mouth at northwest end of Bay Pomme d'Or (L.S.U. Geol. Museum Locality No. 2008). Specimens were also present in Samples 1, 4, 6 and 7.

Remarks.—This species seems to prefer the less brackish lake bottoms. It was also found in abundance in lakes of lower salinity north of Barataria Bay in another series of samples. It differs from *Ammobaculites exilis* Cushman and Bronnimann in the less compressed test and large round aperture; it differs from *Ammotium salsum* (Cushman and Bronnimann) in the less compressed test and the tendency toward a trochoid coiled portion.

Ammobaculites dilatatus Cushman and Bronnimann

Ammobaculites dilatatus Cushman and Bronnimann, 1948, Contr. Cushman Lab. Foram. Res., vol. 24, pt. 2, p. 39, pl. 7, figs. 10, 11.

Specimens are typical and present in all samples with the exception of the ones from the marsh. Specimens could not be found in Samples 2, 5, 8, 9, 19 and 20.

Ammobaculites subcatenulatus Warren, n.sp.

Plate 3, figures 11-13

Description.—Test medium size; initial coil with umbonal depression, usually evolute, later portion uncoiled and uniserial; chambers of uniserial portion distinct, inflated, round or slightly flattened and three to five in number; sutures depressed, straight or oblique; test coarsely arenaceous, well cemented, exterior roughly finished; aperture round, terminal, with a very slight neck. Length: 0.25-0.70 mm. Width of uniserial portion: 0.10-0.18 mm.

Occurrence.—Holotype from Sample 6; center of pass between Bayou Auguste and English Bay (L.S.U. Geol. Museum Locality No. 2008). Specimens were also present in Samples 1, 3, 4, 7 and 10-18.

Remarks.—This species is more abundant in waters of lowered salinity. It differs from *Ammobaculites catenulatus* Cushman and McCulloch in the distinct chambers and evolute coil.

Genus **Ammotium** Loeblich and Tappan, 1953

Ammotium fragile Warren, n.sp.

Plate 3, figures 14, 15

Description.—Test medium size, very much compressed; early portion close coiled, slightly evolute and tending to be trochoid; later portion becoming uncoiled, but with chambers reaching backward toward the coil at the inner margin; periphery of inner margin lobulate; chambers fairly distinct, depressed, overlapping; test very fragile, finely arenaceous, poorly cemented; aperture round or oval, terminal, with a neck. Length: 0.30-0.85 mm. Thickness: 0.70-0.10 mm. Width: 0.12-0.25 mm.

Occurrence.—Holotype from Sample 6; center of pass between Bayou Auguste and English Bay (L.S.U. Geol. Museum Locality No. 2008). Specimens were also present in all samples except 5, 8, 9, 15, 18, 21 and 22.

Remarks.—Specimens of this foraminifer were more abundant in the less brackish waters bottoms;

rare specimens were found in only one of the polyhaline marsh samples. This species differs from *Ammobaculites pseudospirale* (Williamson) var. *gracilis* Lacroix in the large evolute coil, more parallel sides, and the more distinct sutures.

Ammotium multiloculatum Warren, n.sp.

Plate 4, figures 1, 2

Description.—Test large, very much compressed; close coiled and evolute; later chambers tending to uncoil, but reaching backward toward the coil at the inner margin; periphery lobulate; chambers fairly distinct and overlapping giving them an imbricate appearance; sutures distinct and depressed; wall very finely arenaceous and fragile, poorly cemented; aperture terminal at the dorsal angle, large, rounded to oval in shape. Width: 0.25-0.55 mm. Thickness: 0.07-0.10 mm.

Occurrence.—Holotype from Sample 3; center of lagoon mouth at the northwest end of Bay Pomme d'Or (L. S. U. Geol. Museum Locality No. 2008). Specimens were present in Samples 1, 3, 10, 11 and 14.

Remarks.—This species appears to be characteristic of the polyhaline lakes. It differs from *Ammobaculites bargmanni* Earland in the smaller size of the test and more numerous chambers.

Ammotium palustre Warren, n.sp.

Plate 3, figures 8-10

Description.—Test medium size, compressed; early portion close coiled; involute; later portion uncoiling; periphery usually smooth, rounded; chambers indistinct, usually three making up the uncoiled portion of adult specimens; sutures indistinct, oblique and curving backward toward the coil at the inner margin; test finely arenaceous, well cemented; aperture oval, terminal, with a slight neck. Length: 0.18-0.46 mm. Width: 0.12-0.22 mm. Thickness: 0.08-0.14 mm.

Occurrence.—Holotype is from Sample 5; wet marsh on northeast side of Crosscut Canal at Bay Pomme d'Or (L. S. U. Geol. Museum Locality No. 2009). Specimens were present in Samples 2, 5, 8, 9, 19, 20 and 22.

Remarks.—This species is apparently a very characteristic marsh type. Although one or two specimens were found in the nearshore Gulf sample, they were probably not indigenous to that environment. It differs from *Ammobaculites howelli* Acosta in the finely arenaceous and rather smoothly finished test and in the presence of a slight apertural neck.

Ammotium pseudocassis (Cushman and Bronnimann)

Ammobaculites pseudocassis Cushman and Bronnimann, 1948, Contr. Cushman Lab. Foram. Res., vol. 24, pt. 2, p. 39, pl. 7, figs. 12a, b.

Specimens are typical and are present in Samples 2, 5, 6, 17 and 19.

Ammotium salsum (Cushman and Bronnimann)

Ammobaculites salsus Cushman and Bronnimann, 1948, Contr. Cushman Lab. Foram. Res., vol. 24, pt. 1, p. 16, pl. 3, figs. 7-9.

Specimens seem to be typical and are present in all samples except 8, 19 and 20.

Ammotium subdirectum Warren, n.sp.

Plate 4, figures 6-8

Description.—Test small, compressed; early coiled portion small, becoming uncoiled very quickly; chambers of uniserial portion reaching toward the coil along the inner margin and along the outer margin as well in the last few chambers of some adult specimens; periphery rounded, slightly lobulate; chambers usually distinct with five to ten comprising the uniserial stage in adult specimens, last chamber of larger specimens inflated; sutures usually distinct; wall thin, finely arenaceous, well cemented, exterior rather smoothly finished; aperture narrowly elliptical, terminal. Length: 0.30-0.55 mm. Width: 0.11-0.15 mm. Thickness: 0.07-0.10 mm.

Occurrence.—Holotype is from Sample 5; wet marsh on the northeast side of Crosscut Canal at Bay Pomme d'Or (L. S. U. Geol. Museum Locality No. 2009). Specimens were also present in Samples 5, 19, 20 and 22.

Remarks.—Specimens were rare wherever found except in one of the polyhaline marsh samples where they represented approximately 30% of the fine fraction residue. This species differs from *Ammobaculites directus* Cushman and Bronnimann in the more numerous uniseral chambers which reach backward toward the coil at the inner margin and in the distinct sutures.

Family TEXTULARIIDAE

Genus **Bigenerina** d'Orbigny, 1826

Bigenerina sp. cf. **B. irregularis** Phleger and Parker

Bigenerina irregularis Phleger and Parker, 1951, Geol. Soc. Amer. Mem. 46, pt. 2, p. 4, pl. 1, figs. 16-21.

Specimens present in Samples 15, 18, 21 and 22.

Genus **Textularia** Defrance, 1824

Textularia sp. cf. **T. mayori** Cushman

Textularia mayori Cushman, 1922, Publ. 311, Carnegie Inst. Wash., p. 23, pl. 2, fig. 3.

Specimens present in Samples 21 and 22.

Textularia palustris Warren, n.sp.

Plate 4, figures 3-5

Description.—Test small, elongate, straight or slightly curved, tapering gradually to oral extremity which is thickest portion of test; periphery rounded and lobulate; chambers slightly inflated having up to fourteen biserial pairs; sutures distinct, depressed; aperture a curved slit on inner edge of terminal chamber; test finely arenaceous, well cemented. Length: 0.28-0.68 mm. Width: 0.11-0.20 mm. Thickness: 0.08-0.18 mm.

Occurrence.—Holotype is from Sample 5; wet marsh on the northeast side of Crosscut Canal at Bay Pomme d'Or (L. S. U. Geol. Museum Locality No. 2009). Specimens were found only in Sample 5.

Remarks.—This species is apparently not widely distributed in the area. It may possibly be a marsh type since specimens were common in the polyhaline marsh sample in which they occurred. It differs from *Textularia gracillima* Höglund in the lobulate periphery and from *Textularia elegans* Lacroix in the absence of any spiral arrangement in the early portion of the test.

Family VERNEUILINIDAE

Genus **Gaudryina** d'Orbigny, 1839

Gaudryina sp. cf. **G. exilis** Cushman and Bronnimann

Gaudryina exilis Cushman and Bronnimann, 1948, Contr. Cushman Lab. Foram. Res., vol. 24, pt. 2, p. 40, pl. 7, figs. 15a, b, 16.

Specimens present in Samples 10, 12, 13, 15-18, 21 and 22.

EXPLANATION OF PLATE 3

Figs.		Page
1- 4.	*Sulcophax palustris* Warren, n. sp. X 100. 1, Side view of holotype; 2, side view of a paratype; 3, 4, apertural and side views of a paratype	31
5- 7.	*Ammobaculites crassus* Warren, n. sp. X 100. 5, Side view of holotype 6, 7, apertural and side views of a paratype	33
8-10.	*Ammotium palustre* Warren, n. sp. X 100. 8, Side view of holotype; 9, 10, inclined apertural and side views of a paratype	33
11-13.	*Ammobaculites subcatenulatus* Warren, n. sp. X 100. 11, Side view of holotype; 12, 13, inclined apertural and side views of a paratype	32
14-15.	*Ammotium fragile* Warren, n. sp. X 100. 14, Side view of holotype; 15, side view of paratype	32

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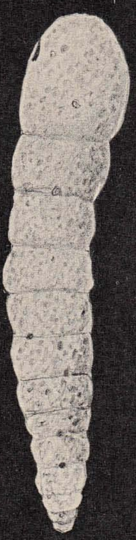

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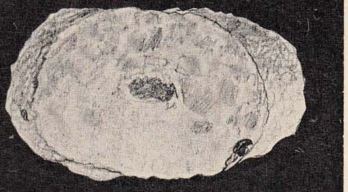

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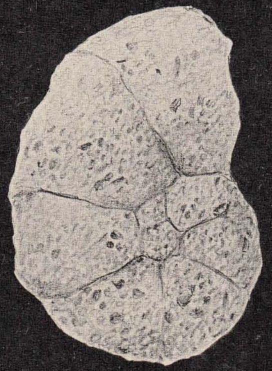

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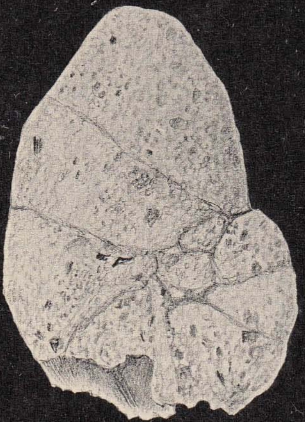

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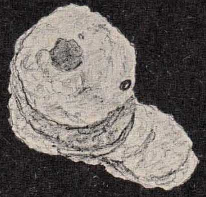

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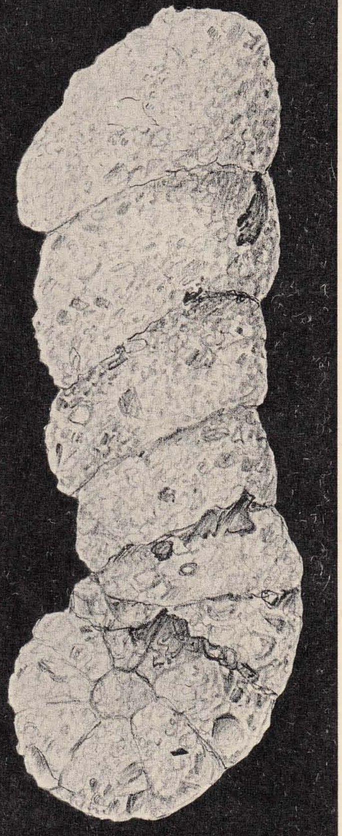

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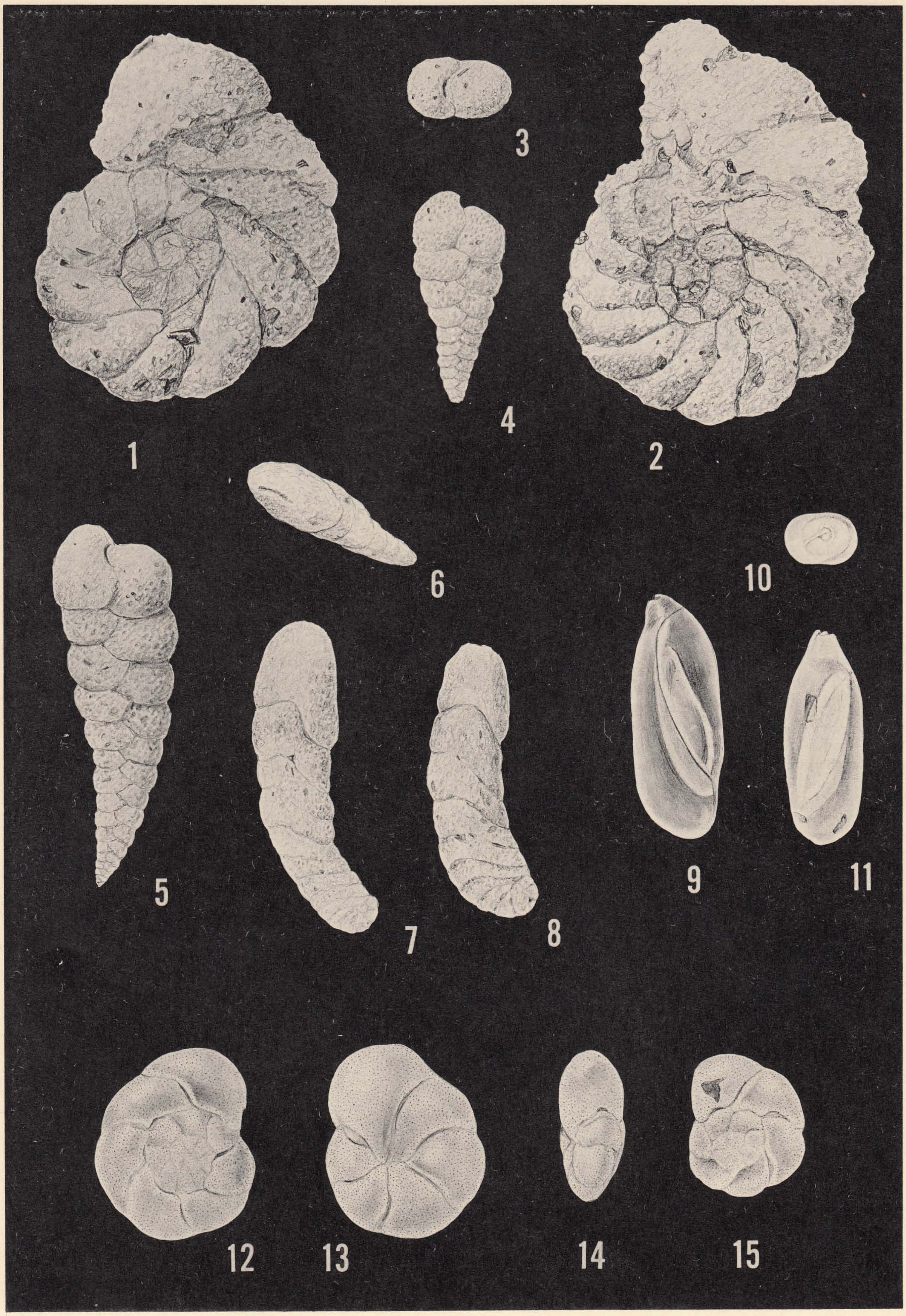
Warren: Recent Foraminifera off Louisiana



Warren: Recent Foraminifera off Louisiana

Genus **Pseudoclavulina** Cushman, 1936

Pseudoclavulina sp. cf. **P. gracilis** Cushman and Bronnimann

Pseudoclavulina gracilis Cushman and Bronnimann, 1948, Contr. Cushman Lab. Foram. Res., vol. 24, pt. 2, p. 40, pl. 7, figs. 17, 18.

Specimens present only in Sample 2.

Family SILICINIDAE

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

Miliammina fusca (H. B. Brady)

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

Specimens are found in all samples with the exception of Sample 21.

Family MILIOLIDAE

Genus **Miliolinella** Weisner, 1931

Miliolinella microstoma Warren, n.sp.

Plate 4, figures 9-11

Description.—Test small, calcareous imperforate, triloculine, elongate, ovate, round or oval in transverse section; last formed chamber broadest at initial end, longer than preceding ones; sutures fairly distinct, arcuate; wall smooth, shiny, translucent in most specimens; aperture small, "keyhole" shaped, lying completely within the last chamber and filled with a circular tooth which stems from the next to last chamber. Length: 0.28-0.40 mm. Thickness: 0.09-0.12 mm.

Occurrence.—Holotype is from Sample 19; wet marsh on the west side of Scofield Bayou (L. S. U. Geol. Museum Locality No. 2009). Specimens were also present in Samples 5, 13, 19 and 20.

Remarks.—This species was common in only one of the saline marsh samples. It differs from *Triloculinella obliquinoda* Ricco in the smaller size and in the small "key hole" shaped aperture.

Genus **Triloculina** d'Orbigny, 1826

Triloculina sp. cf. **T. oblonga** (Montagu)

Vermiculum oblongum Montagu, Test. Brit., p. 522, pl. 14, fig. 9.

EXPLANATION OF PLATE 4

Figs.		Page
1, 2.	*Ammotium multiloculatum* Warren, n. sp. X 150. 1, Side view of holotype; 2, side view of paratype	33
3- 5.	*Textularia palustris* Warren, n. sp. X 100. 3, 4, Apertural and side views of a paratype; 5, side view of holotype	34
6- 8.	*Ammotium subdirectum* Warren, n. sp. X 100. 6, 7, Inclined apertural and side views of a paratype; 8, side view of holotype	33
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12-15.	*Pseudoeponides anderseni* Warren, n. sp. X 100. 12, 13, Dorsal and ventral views of holotype; 14, 15, apertural and dorsal views of a paratype	39

————Fleming, 1882, Mem. Wernerian Nat. Hist. Soc., vol. 4, p. 565, pl. 15, fig. 4.

Specimens are present in all but marsh samples 2, 5, 8, 9, 19 and 20.

Family OPHTHALMIDIIDAE

Genus **Cornuspira** Schultze, 1854

Cornuspira sp. cf. **C. planorbis** Schultze

Cornuspira planorbis Schultze, 1854, Organismus Polythal., p. 40, pl. 2, fig. 21.

Specimens were very rare and occurred only in Sample 19.

Family TROCHAMMINIDAE

Genus **Arenoparrella** Andersen, 1951

Arenoparrella mexicana (Kornfeld)

Trochammina inflata (Montagu) var. *mexicana* Kornfeld, 1931, Contr. Stanford Geol. Dept., vol. 1, no. 3, p. 86.

Specimens are typical and are present in all samples.

Genus **Trochammina** Parker and Jones, 1859

Trochammina comprimata Cushman and Bronnimann

Trochammina comprimata Cushman and Bronnimann, 1948, Contr. Cushman Lab. Foram. Res., vol. 24, pt. 2, p. 41, pl. 8, figs. 1-3.

Specimens are typical and are found in all samples with the exception of Sample 18.

Trochammina inflata (Montagu)

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

Specimens are typical and present in all samples.

Trochammina lobata Cushman

Trochammina lobata Cushman, 1944, Cushman Lab. Foram. Res. Spec. Publ. no. 12, p. 18, pl. 2, figs. 10a, b, c.

Specimens seem typical and are present in Samples 14, 15, 17, 19, 21 and 22, but are common only in the Gulf sample.

Trochammina macrescens H. B. Brady

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

Specimens were found in Samples 2-6, 8-11, 13-16 and 18.

Genus **Trochamminita** Cushman and Bronnimann, 1948

Trochamminita irregularis Cushman and Bronnimann

Trochamminita irregularis Cushman and Bronnimann, 1948, Contr. Cushman Lab. Foram. Res., vol. 24, pt. 1, p. 17, pl. 4, figs. 1-3.

Specimens were found in Samples 1, 7 and 19.

Family LAGENIDAE

Genus **Nodosaria** Lamarck, 1812

Nodosaria sp. cf. **N. catesbyi** d'Orbigny

Nodosaria catesbyi d'Orbigny, 1839, in de la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminifères", p. 16, pl. 11, figs. 8-10.

Specimens were found in Samples 18 and 22.

Family NONIONIDAE

Genus **Bisaccium** Andersen, 1951

Bisaccium imbricatum Andersen

Bisaccium imbricatum Andersen, 1951, Journ. Pal., vol. 25, no. 1, p. 32, figs. 2a-e.

Specimens are typical, but are present only in Sample 19.

Genus **Nonionella** Cushman, 1926

Nonionella atlantica Cushman

Nonionella atlantica Cushman, 1947, Contr. Cushman Lab. Foram. Res., vol. 23, pt. 4, p. 90, pl. 20, figs. 4, 5.

Specimens are present in Samples 15-18, 21 and 22.

Nonionella sp. cf. **N. auris** (d'Orbigny)

Valvulina auris d'Orbigny, 1839, Voyage dans l'Amérique méridionale, vol. 5, pt. 5, Foraminifères, p. 47, pl. 2, figs. 15-17.

Specimens are present in Samples 13-18, 21 and 22.

Family ELPHIDIIDAE

Genus **Elphidium** Montfort, 1808

Elphidium sp. cf. **E. advena** (Cushman)

Polystomella advena Cushman, 1922, Publ. 311, Carnegie Inst. Wash., p. 56, pl. 9, figs. 11, 12.

Specimens are present in Samples 16, 18, 21 and 22.

Elphidium discoidale (d'Orbigny)

Polystomella discoidalis d'Orbigny, 1839, in de la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminifères", p. 56, pl. 6, figs. 23, 24.

Specimens are typical and present in Samples 13, 15, 17, 18, 21 and 22.

Elphidium gunteri Cole

Elphidium gunteri Cole, 1931, Fla. State Geol. Surv. Bull. 6, p. 34, pl. 4, figs. 9, 10.

Specimens are typical. For occurrence see remarks under *Cribroelphidium trinitatensis* Cushman and Bronnimann which follows.

Elphidium incertum mexicanum Kornfeld

Elphidium incertum (Williamson) var. *mexicanum* Kornfeld, 1931, Contr. Stanford Geol. Dept., vol. 1, no. 3, p. 89, pl. 16, figs. 1a-2b.

Specimens are typical and present in Samples 2-4, 12-15, 17, 18, 21 and 22.

Elphidium matagordanum (Kornfeld)

Nonion depressula (Walker and Jacob) var. *matagordana* Kornfeld, 1931, Contr. Stanford Geol. Dept., vol. 1, no. 3, p. 87, pl. 13, figs. 2a, b.

Specimens are typical and present in all but marsh Samples 2, 5, 8, 9, 19 and 20.

Elphidium sp. cf. **E. poeyanum** (d'Orbigny)

Polystomella poeyana d'Orbigny, 1839, in de la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminifères", p. 55, pl. 6, figs. 25, 26.

Specimens seem typical and are present in Samples 2, 6, 10, 12-18, 21 and 22.

Genus **Cribroelphidium** Cushman and Bronnimann, 1948

Cribroelphidium kugleri Cushman and Bronnimann

Cribroelphidium kugleri Cushman and Bronnimann, 1948, Contr. Cushman Lab. Foram. Res., vol. 24, pt. 1, p. 18, pl. 4, figs. 4a, b.

Specimens are typical and present in Samples 1, 4, 6, 10-18 21 and 22.

Cribroelphidium limosum Cushman and Bronnimann

Cribroelphidium limosum Cushman and Bronnimann, 1948, Contr. Cushman Lab. Foram. Res., vol. 24, pt. 1, p. 19, pl. 4, figs. 7a, b.

Specimens are typical and present in all but marsh Samples 2, 5, 8, 9, 19 and 20.

Cribroelphidium salsum Cushman and Bronnimann

Cribroelphidium salsum Cushman and Bronnimann, 1948, Contr. Cushman Lab. Foram. Res., vol. 24, pt. 1, p. 19, pl. 4, figs. 6a, b.

Specimens seem typical. For occurrence see remarks under *Cribroelphidium trinitatensis* Cushman and Bronnimann which follows.

Cribroelphidium trinitatensis Cushman and Bronnimann

Cribroelphidium trinitatensis Cushman and Bronnimann, 1948, Contr. Cushman Lab. Foram. Res., vol. 24, pt. 1, p. 20, pl. 4, figs. 8a, b.

Specimens which seem identical with this species have been recorded from Recent deposits of the Gulf Coast as a variant of *Elphidium gunteri* Cole. Unfortunately, when statistical population counts were being done, this species and *Cribroelphidium salsum* Cushman and Bronnimann were grouped together with typical specimens of *Elphidium gunteri* Cole, so there is no complete record of occurrence for these three species. However, it was ascertained that specimens of *Elphidium gunteri* Cole were present at least in Samples 21 and 22 and that specimens of the *Cribroelphidium* spp. were present in at least some of the samples from the polyhaline lakes.

Cribroelphidium vadescens Cushman and Bronnimann

Cribroelphidium vadescens Cushman and Bronnimann, 1948, Contr. Cushman Lab. Foram. Res., vol. 24, pt. 1, p. 18, pl. 4, figs. 5a, b.

Specimens are typical and present in all but samples 2, 5, 8, 9, 19, 20 and 21.

Family BULIMINIDAE

Genus **Bolivina** d'Orbigny, 1839

Bolivina lowmani Phleger and Parker

Bolivina lowmani Phleger and Parker, 1951, Geol. Soc. Amer. Mem. 46, pt. 2, p. 13, pl. 6, figs. 20a, b, c.

Specimens are typical and present only in Sample 22.

Bolivina striatula Cushman

Bolivina striatula Cushman, 1922, Publ. 311, Carnegie Inst. Wash., p. 27, pl. 3, fig. 10.

Specimens are typical and present in Samples 12, 14, 16, 17, 18, 21 and 22.

Bolivina striatula spinata Cushman

Bolivina striatula Cushman var. *spinata* Cushman, 1936, Cushman Lab. Foram. Res., Spec. Publ. no. 6, p. 59, pl. 8, figs. 9a, b.

Specimens are typical and present only in Sample 22.

Genus **Bulimina** d'Orbigny, 1826

Bulimina marginata d'Orbigny

Bulimina marginata d'Orbigny, 1826, Ann. Sci. Nat., Ser. 1, tome 7, p. 269, pl. 12, figs. 10-12.

Specimens are typical and present only in Sample 22.

Genus **Buliminella** Cushman, 1911

Buliminella sp. cf. **B. bassendorfensis** Cushman and Parker

Buliminella bassendorfensis Cushman and Parker, 1937, Contr. Cushman Lab. Foram. Res., vol. 13, pt. 1, p. 40, pl. 4, figs. 13a, b.

Specimens are present in Samples 14, 16, 18, 21 and 22.

Genus **Rectobolivina** Cushman, 1927

Rectobolivina advena (Cushman)

Siphogenerina advena Cushman, 1922, Publ. 311, Carnegie Inst. Wash., p. 35, pl. 5, fig. 2.

Specimens are typical and are present in Samples 14 and 22.

Genus **Reussella** Galloway, 1933

Reussella atlantica Cushman

Reussella spinulosa (Reuss) var. *atlantica* Cushman, 1947, Contr. Cushman Lab. Foram. Res., vol. 23, pt. 4, p. 91, pl. 20, figs. 6, 7.

Specimens are typical and present in Samples 16, 21 and 22.

Genus **Uvigerina** d'Orbigny, 1826

Uvigerina sp. cf. **U. peregrina** Cushman

Uvigerina peregrina Cushman, 1923, Bull. 104, U. S. Nat. Mus., pt. 4, p. 166, pl. 42, figs. 7-10.

Specimens are present only in Sample 22.

Genus **Virgulina** d'Orbigny, 1826

Virgulina pontoni Cushman

Virgulina pontoni Cushman, 1932, Contr. Cushman Lab. Foram. Res., vol. 8, pt. 1, p. 17, pl. 3, fig. 7.

Specimens seem typical and are present in Samples 12, 13, 15, 16, 18, 21 and 22.

Family ROTALIIDAE

Genus **Buccella** Andersen, 1952

Buccella hannai (Phleger and Parker)

Eponides hannai Phleger and Parker, 1951, Geol. Soc. Amer. Mem. 46, pt. 2, p. 21, pl. 10, figs. 11-14.

Specimens are typical and present only in Sample 22.

Genus **Cancris** Montfort, 1808

Cancris sp. cf. sagra (d'Orbigny)

Rotalina sagra d'Orbigny, 1839, in de la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 77.

Specimens are present in Samples 13, 15, 17, 21 and 22.

Genus **Discorbis** Lamarck, 1804

Discorbis floridana Cushman

Discorbis floridana Cushman, 1922, Publ. 311, Carnegie Inst. Wash., p. 39, pl. 5, figs. 11, 12.

Specimens are typical and present in Samples 15, 17, 18, 21 and 22.

Genus **Epistominella** Husezima and Maruhasi, 1944

Epistominella vitrea Parker

Epistominella vitrea Parker, 1953, in Parker, Phleger and Peirson, Cushman Found. Foram. Res., Spec. Publ. no. 2, p. 9, pl. 4, figs. 34-36, 40, 41.

Specimens are typical and present only in Sample 22.

Genus **Pseudoeponides** Uchio, 1950

Pseudoeponides anderseni Warren, n.sp.

Plate 4, figures 12-15

Description.—Test small, trochoid, close coiled biconvex; umbilical area closed by a lobe-like extension of the last chamber; six or seven chambers in the last whorl; sutures sigmoid in shape dorsally, ventrally curved, deeply incised on both sides; wall calcareous, finely perforate, thin; primary aperture two small openings at the base of the apertural face; supplementary apertures usually occur within the deeply incised sutures dorsally near the junction of spiral and septal sutures and ventrally within the incised sutures near their mid point. Width: 0.20-0.30 mm. Thickness: 0.07-0.11 mm.

Occurrence.—Holotype from Sample 5; wet marsh on the northeast side of Crosscut Canal at Bay Pomme d'Or (L. S. U. Geol. Museum Locality No. 2009). Specimens were also found in Samples 2, 5, 10, 13, 15, 19 and 22.

Remarks.—This species occurred commonly in two of the marsh samples; it was very rare in all other samples where found. It differs from *Pseudoeponides nakazatoensis* (Kuwano) in its smaller size, more sinuous sutures and in having the supplementary apertures more or less concealed within the incised sutures.

Genus **Eponidella** Cushman and Hedberg, 1935

Eponidella gardenislandensis Akers

Eponidella gardenislandensis Akers, 1952, Journ. Pal., vol. 26, no. 4, p. 645, figs. 2a, b, c.

Specimens are typical and present in all samples with the exception of Samples 2, 5, 8, 9, 19, 20 and 21.

Genus **Rotalia** Lamarck, 1804

"Rotalia" beccarii parkinsoniana (d'Orbigny)

Rosalina parkinsoniana d'Orbigny, 1839, in de la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 99, pl. 4, figs. 25-27.

Specimens are typical and present in all samples with the exception of Samples 2, 5, 8 and 9.

"Rotalia" beccarii tepida Cushman

Rotalia beccarii (Linné) var. *tepida* Cushman, 1926, Publ. 311, Carnegie Inst. Wash., p. 79, pl. 1.

Specimens are typical and present in all but Samples 2, 5, 8 and 9.

"Rotalia" pauciloculata Phleger and Parker

"Rotalia" pauciloculata Phleger and Parker, 1951, Geol. Soc. Amer. Mem. 46, pt. 2, p. 23, pl. 12, figs. 8a-9b.

Specimens are typical and present only in Sample 22.

"Rotalia" rolshauseni Cushman and Bermudez

Rotalia rolshauseni Cushman and Bermudez, 1946, Contr. Cushman Lab. Foram. Res., vol. 22, pt. 4, p. 119, pl. 19, figs. 11-13.

Specimens are typical and present in Samples 17, 18, 21 and 22.

Family GLOBIGERINIDAE

Genus **Globigerina** d'Orbigny, 1826

Globigerina bulloides d'Orbigny

Globigerina bulloides d'Orbigny, 1826, Ann. Sci. Nat., Ser. 1, tome 7, p. 227.

Specimens are typical and present in Samples 15, 16, 21 and 22.

Genus **Globigerinoides** Cushman, 1927

Globigerinoides sacculifera (Brady)

Globigerina sacculifera Brady, 1877, Geol. Mag., decade 2, vol. 4, p. 535.

Specimens are typical and present in Samples 21 and 22.

Family ANOMALINIDAE

Genus **Cibicidina** Bandy, 1949

Cibicidina strattoni (Applin)

Truncatulina americana Cushman var. *strattoni* Applin, 1925, in Applin, Ellisor and Kniker, Amer. Assoc. Petr. Geol. Bull., vol. 9, no. 1, p. 99, pl. 3, fig. 3.

Specimens are typical and present in Samples 11, 15, 16, 18, 21 and 22.

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Cushman, J. A. and Bronnimann, P., 1948, Some new genera and species of Foraminifera from brackish water of Trinidad, Contr. Cushman Lab. Foram. Res., vol. 24, pt. 1, pp. 15-20.

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Kornfeld, M. M., 1931, Recent littoral Foramini fera from Texas and Louisiana, Contr. Dept Geol., Stanford University, vol. 1, no. 3, pp 77-101.

Loeblich, A. R. and Tappan, Helen, 1953, Studies of Arctic Foraminifera, Smithsonian Misc. Collections, vol. 121, no. 7, pp. 1-150.

Lowman, S. W., 1949, Sedimentary facies in Gulf Coast, Bull. Amer. Assoc. Petr. Geol., vol. 33, no. 12, pp. 1950-1963.

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Phleger, F. B and Walton, W. R., 1950, Ecology of marsh and bay Foraminifera, Barnstable, Mass., Am. Journ. Sci., vol. 248, pp. 274-294.

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CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH

VOLUME VIII, PART 1, JANUARY, 1957

RECENT LITERATURE ON THE FORAMINIFERA

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

AMSDEN, THOMAS W. Catalog of fossils from the Hunton Group, Oklahoma.—Oklahoma Geol. Survey, Circ. 38. June 1956, p. 1-63.—Numerous Foraminifera are listed from three formations of Silurian and Devonian age.

BARNARD, TOM. Some Lingulinae from the Lias of England.—Micropaleontology, v. 2, No. 3, July 1956, p. 271-282, pls. 1-3.—A complete succession through the Lias yielded material in which numerous variants of the species **Lingulina tenera** were observed to have zonal significance. The **tenera** plexus is discussed and illustrated, and four other species are briefly described and illustrated.

An unusual worm tube from the lower Lias.—Journ. Pal., v. 30, No. 5, Sept. 1956, p. 1273, 1274, text fig. 3.—The inner lining of the tube is almost exclusively made up of tests of three elongate species of Foraminifera, in parallel orientation.

BRÖNNIMANN, PAUL, and BROWN, NOEL K., JR. Taxonomy of the Globotruncanidae.—Eclogae geol. Helvetiae, v. 48, No. 2, 1955 (June 1, 1956), p. 503-561, pls. 20-24, text figs. 1-24.—An important study of trends in morphologic characters and of lineages in this group of planktonic forms in which are included the most common and widespread Cretaceous Foraminifera. Twelve genera, four new, are recognized and grouped in four principal lineages. Twenty-two species, five new, are described and illustrated. **Hedbergina** n. gen. (genotype **Globigerina seminolensis** Harlton), **Rugotruncana** n. gen. (genotype **R. tilevi** n. sp.), **Kuglerina** n. gen. (genotype **Rugoglobigerina rugosa rotundata** Bronnimann), and **Bucherina** n. gen. (genotype **B. sandidgei**, n. sp.).

CHANG, LI SHO. On the correlation of the Neogene formations in western Taiwan and some diagnostic species of smaller Foraminifera.—Mem. Nat. Taiwan Univ., Commem. 10th Anniv., March 1956, p. 1-9, pls. 1-5, map, tables 1, 2.—Numerous species and varieties (two new) are illustrated. Stratigraphic ranges of many species are shown.

CILEK, VACLAV. Neue Erkenntnisse über die Geologie des Ausseralpinen Beckens zwischen Kromeriz und Prerov (with Russian and German summaries).—Cesk. Akad. Ved, Prague, Rozpravy, roc. 65, ses. 4, 1955, p. 1-48, tables, maps, sections.—Numerous Foraminifera are listed from several borings.

CITA, M. B. Il Daniano in Italia.—Istit. Geol., Pal. e Geogr. Fis., Univ. Milano, ser. G, Pubb. No. 85, 1955, p. 201-207, text figs. 1, 2.

The Cretaceous-Eocene boundary in Italy.—Istit. Geol., Pal. e Geogr. Fis. Univ. Milano, ser. G. Pubb. No. 69, 1955, p. 427-452, text fig. 1 (map), 8 columnar sections.—Sketches and discussion of pelagic species and genera available for recognition of strata belonging to upper Maestrichtian, Danian, Paleocene, and Eocene. Faunistic changes within the Danian are rapid, without transition, and not connected with environmental change.

CRESPIN, IRENE. Stratigraphy and micropaleontology of the marine Tertiary rocks between Adelaide and Aldinga, South Australia.—Australia Bureau of Mineral Resources, Rept. No. 12, 1954, p. 1-65, pls. 1-7, tables 1, 2.—Strata of upper Eocene, lower Miocene ("f."), and lower Pliocene age are studied. Numerous Foraminifera are listed. Notes are included on 32 species, most of which are illustrated.

Migration of Foraminifera in Tertiary Times in Australia.—Australia Bureau of Mineral Resources. Rept. No. 25, 1956, p. 1-15.—Many species are discussed with regard to their source and time of origin and extinction.

Changes in ideas of age of certain beds in the Australian Tertiaries.—Australia Bureau of Mineral Resources. Rept. No. 25, 1956, p. 16-25.—**Hantkenina** and **Victoriella plecte** provide means for recognition of upper Eocene. Oligocene was a time of prolonged denudation.

Fossiliferous rocks from the Nullarbor Plains.—Australia Bureau of Mineral Resources, Rept. No. 25, 1956, p. 26-42, pls. 1, 2 (maps).—Many species of Foraminifera are listed from lower Miocene (f_{1-2}) and upper Eocene (b) rocks.

Notes on a **Lepidocyclina**-bearing rock from Cebu, Philippines.—Australia Bureau of Mineral Resources, Rept. No. 25, 1956, p. 43-46.—Discovery of the large paper-thin species **Lepidocyclina (Eulepidina) badjirraensis** in strata assigned to the upper part of Tertiary e. Associated smaller Foraminifera are listed.

CUMMINGS, ROBERT H. Revision of the Upper Palaeozoic textulariid Foraminifera.—Micropaleontology, c. 2, o. 3, July 1956, p. 201-242, pl. 1, text figs. 1-24.—This exhaustive review of all Upper Paleozoic textulariids questions the presence of wholly agglutinated forms (Textulariidae in the superfamily Lituolidea) while all remaining textulariids are placed in the new family Palaeotextulariidae (of the superfamily Endothyridea) which is distinguished from the Textulariidae by having a secreted granular calcareous wall, often with an inner fibrous calcareous layer and/or an external coating of agglutinated material. Two genera in the Textulariidae and eight in the Palaeotextulariidae are discussed with stratigraphic distribution and abundance indicated. Thirteen species, eleven new, are described from the palaeotextulariid genera. **Palaeotextularia, Cribrostomum, Climacammina,** and **Deckerella.** Probable origins of and evolutionary relationships in the Palaeotextulariidae, as indicated by chamber arrangement and type of aperture, are suggested.

TEN DAM, A. Stratigraphy and sedimentation of the Lower Tertiary and Mesozoic in the Foredeep Basin of S.E. Turkey.—Bull. Geol. Soc. Turkey, v. 6. No. 1, Oct. 1955, p. 135-155.—Numerous Foraminifera are mentioned.

DESIO, ARDITO, and CITA, MARIA BIANCA. Nuovi ritrovamenti di calcari fossiliferi del Paleozoico superiore nel bacino del Baltoro (Himalaya-Karakorum). Istit. Geol., Pal. e Geogr. Fis., Univ. Milano, ser. G, Pubb. No. 86, 1955, p. 587-598, text figs. 1-4.—Fusulinids and miliolids.

DIZER, ATIFE. Les Foraminifères de l'Eocène Inférieur de l'Ouest de Ravin de Filyos.—Rev. Fac. Sci. Univ. Istanbul, ser. B, Sci. Nat., Tome 21, fasc. 1, 2, Jan.-April 1956, p. 1-8, pls. 1, 2.—Six **nummulites** described and figured, one new.

DUSZYNSKA, STANISLAWA. Foraminifers from the Middle Devonian of the Holy Cross Mountains.—Acta Palaeont. Polonica, v. 1, No. 1, 1956, p. 23-34, pls. 1, 2, text figs. 1-3.—Three species, none new, two known also from America.

EMILIANI, CESARE. Pleistocene temperature variations in the Mediterranean.—Quaternaria, v. 2, 1955, p. 87-98, text fig. 1, tables 1, 2.—Oxygen isotopic analysis of **Globigerina dubia, G. inflata,** and **Globigerinoides rubra** revealed ten glacial stages in a core 8.43 m. long.

Oligocene and Miocene temperatures of the equatorial and subtropical Atlantic Ocean.—Journ. Geol., v. 64, No. 3, May 1956, p. 281-288, text figs. 1-3, tables 1-6.—Isotopic temperatures determined from **Globigerinoides sacculifera** indicate uniform temperatures similar to modern ones for one Oligocene core and lower than modern for two Miocene cores.

ERICSON, DAVID B., and WOLLIN, GOESTA. Micropaleontological and isotopic determinations of Pleistocene climates.—Micropaleontology, v. 2, No. 3, July 1956, p. 257-270, text figs. 1-7, tables

1-5.—In the upper parts of the cores correlation is good between oxygen-isotope paleotemperature curves and curves drawn on relative numbers of cold- and warm-water species and on frequency variations of **Globorotalia menardii**, as represented by ratio of number of specimens to weight of the $>74\ \mu$ fraction. Correlation fails below the levels interpreted as the beginning of the last glacial stage.

FUJIMOTO, HARUYOSHI. A new species of **Parafusulina** from the Kitakami Massif, Japan.—Trans-Proc. Pal. Soc. Japan, n. ser., No. 21, April 15, 1956, p. 157-160, pl. 25.—An elongate cylindrical Permian species, **Parafusulina matsubaishi.**

FUJITA, YUKINORI. On some species of the genera **Elphidium, Elphidiella,** and **Cribroelphidium**—Variation of Japanese **Elphidium crispum**—Sci. Repts. Tokyo Kyoiku Daigaku, v. 4, sec. C, March 20, 1956, p. 219-233, pls. 7, 8, text figs. 1-6, table 1.—Statistical study of **E. crispum** from four Recent and three fossil (Pleistocene to Pliocene) localities as to number of chambers and retral processes, size of chambers, and shape of test. Six species, two new, and two varieties, one new, are described and illustrated.

GANSS, O., and KNIPSCHEER, H. C. G. Nochmals: Zur Altersstellung der Nierentaler Schichten.—Neues Jb. Geol. Pal., Mh., v. 6, June 1956, p. 290-297.

GLAESSNER, M. F., and WADE, M. J. The foraminiferal genus **Lepidocyclina** in South Australia.—Australian Journ. Sci., v. 18, No. 6, June 1956, p. 200.—An important marker for lower Miocene.

GUILLAUME, HENRI. Une nouvelle espèce crétacée du genre **Dictyoconus** Blanckenhorn.—Eclogae Geol. Helvetiae, v. 49, No. 1, 1956, p. 141-146, pl. 1, text fig. 1.—**Dictyoconus reicheli.**

HARRIS, R. W., and JOBE, THOMAS C. Chester Foraminifera and Ostracoda from the Ringwood Pool of Oklahoma.—Oklahoma Geol. Survey, Circ. 39, July 1956, p. 1-41, pls. 1-4.—Three Foraminifera, none new, from the Upper Mississippian.

HARRIS, R. W., and McNULTY, C. L., JR. Notes concerning a Senonian valvulinerian.—Journ. Pal., v. 30, No. 4, July 1956, p. 865-868, pl. 97.—**Valvulineria cretacea** (Carsey) and **V. depressa** (Alth) included as synonyms of **V. lenticula** (Reuss).

HIGUCHI, YU. Fossil Foraminifera from the North-Miura Peninsula, Kanagawa Prefecture, Japan (in Japanese with English abstract).—Journ. Geol. Soc. Japan, v. 62, No. 725, Febr. 1956, p. 49-60, text figs. 1-7, distrib. table.—Quantitative study of 225 species in five Pliocene and Pleistocene formations. **Cassidulinoides miuraensis** n. sp. described.

HILTERMANN, HEINRICH. Ten rules concerning the nomenclature and classification of the Foraminifera.—Micropaleontology, v. 2, No. 3, July 1956, p. 296-298.

Biostratigraphie der Oberkreide auf Grund von Mikrofossilien.—Paläont. Zeitschr., Band 30, Aug. 1956, p. 19-32, text figs. 1-6.—Includes stratigraphic range charts for many species.

HILTERMANN, HEINRICH, and KOCH, WILHELM. Mikropaläontologische Feinhorizontierung von Santon-Profilen durch das Erzlager Lengede-Broistedt.—Paläont. Zeitschr., Band 30, August 1956, p. 33-44, pls. 1-3, text figs. 1-5.—Stratigraphic ranges are indicated for 12 diagnostic Foraminifera: eight species (one new) and four subspecies, by which the Santonian is divided into seven horizons.

HOFKER, J. Foraminifera Dentata, Foraminifera of Santa Cruz and Thatch Island, Virgin Archipelago, West Indies.—Univ. Zool. Museum, Kobenhavn XV, 1956, p. 1-237, pls. 1-35, 21 diagrams (graphs).—A detailed illustrated catalog of about 118 species, 12 new, placed in about 60 genera, two new and 22 families, one new (Hyalovirgulinidae. New genera are **Stainforthia** (genotype **Virgulina concava** Höglund) and **Virgulinopsis** (genotype **Bolivina cubana** Bermudez). Mostly based on two Recent West Indian samples.

Foraminifera from the Cretaceous of southern Limburg, Netherlands. XIV. The genus **Orbignyna.**—Natuurhist. Maandblad, 45e Jrg., No. 1-2, Febr. 29, 1956, p. 16-19, text figs. 1-4, range chart.—Illustrations and range chart of four species.

Foraminifera from the Cretaceous of southern Limburg, Netherlands. XV. **Dictyopsella tenuissima** (Reuss). XVI. **Bolivinoides polonica** Pozaryska. XVII. **Lagena acuticosta** Reuss. XVIII. **Eponides toulmini** (Brotzen).—Natuurhist. Maandblad, 45e Jrg, No. 3-4, April 27, 1956, p. 28-33, pls. 1-4.

Foraminifera from the Cretaceous of southern Limburg, Netherlands. XIX. Planctonic Foraminifera of the Chalk Tuff of Maestricht and environments.—Natuurhist. Maandblad, 45e Jrg., No. 5-6, June 29, 1956, p. 51-57, text figs. 1-24, range chart.—Illustrations and ranges given for 19 species.

Die Globotruncanen von Nordwest-Deutschland und Holland.—Neues Jb. Geol. Pal., Abh., Band 103, July 1956, p. 312-340, text figs. 1-26.—Twelve species, six new, placed in three genera, one new, as follows: **Marginotruncana** n. gen. (genotype **Rosalina marginata** Reuss).

Tertiary Foraminifera of coastal Ecuador: Part II, additional notes on the Eocene species.—Journ. Pal., v. 30, No. 4, July 1956, p. 891-958, text figs. 1-101.—A revised list is presented containing 147 named species of which 29 are newly discovered and 39 re-determined. Three new families: Gavelinellidae, Globobuliminidae, and Parrelloididae; three new genera: **Spirobolivina** (genotype **Bolivinopsis pulchella** Cushman and Stainforth), **Stainforthia** (genotype **Virgulina concava** Höglund), and **Parrelloides** (genotype **Cibicides hyalinus** Hofker): 16 new species and three new names. Numerous sketches and diagrams illustrate the 86 species that are discussed.

Die **Pseudotextularia**-zone der Bohrung Maasbüll I und ihre Foraminiferen-Fauna.—Paläont. Zeitschr., Band 30, August 1956, p. 59-79, pls. 5-10, text fig. 1.—Seventy-one species (nine new) and one new subspecies are illustrated and discussed.

HOMOLA, VLADIMIR, and HANZLIKOVA, EVA. Biostratigraphical, tectonical and lithological studies in the Tesin District.—Ustredniho Ustavu Geologickeho, Sbornik, v. 21, 1954, ser. paleo., p. 317-502, pls. 1-11 (English summary p. 472-502).—One hundred eighteen species and varieties, four new, are recorded and some illustrated from 15 zones in strata ranging from Paleocene to Oligocene(?).

IGO, HISAYOSHI. Notes on the Osobudani Conglomerate and some Lower Permian Fusulinids contained in its Limestone Pebbles. Part II (On a new type of the wall structure of fusulinids).—Sci. Repts. Tokyo Kyoiku Daigaku, v. 4, sec. C, March 20, 1956, p. 293-302, pls. 18, 19, text fig. 1.—A new species of **Pseudofusulina** is described.

IRELAND, H. A. Upper Pennsylvanian arenaceous Foraminifera from Kansas.—Journ. Pal., v. 30, No. 4, July 1956, p. 831-864, text figs. 1-7 (map, stratigraphic column, and 5 pls.), table 1.—Fifty-one species (26 new and one indeterminate) in 17 genera (two new) are identified and illustrated from insoluble residues of limestones. A table showing distribution and abundance in 27 formations and members is included. **Saccammminoides** n. gen. (type **S. multicellus** n. sp.) and **Ammodiscella** n. gen. (type **A. virgilensis** n. sp.).

JANACEK, JOSEF, and HORCIC, KAREL. Beitrag zur Paleographie und Tektonik der Neogenen ausfullungen im Inneralpinen Wienerbecken (with Russian and German summaries.)—Cesk. Akad. Ved, Prague, Rozpravy, roc. 65, ses. 2, 1955, p. 1-27, tables.

JONES, DANIEL J. Introduction to Microfossils.—Harper and Brothers, New York, 1950, 406 p., illus.—An invaluable textbook. In the chapter on Foraminifera (29 p. and 23 pls.), an abbreviated classification of superfamilies and families, mostly following Glaessner, is included and illustrated by representative species.

KANE, JULIAN. North Atlantic planktonic Foraminifera as Pleistocene temperature-indicators.—Micropaleontology, v. 2, No. 3, July 1956, p. 287-293, text fig. 1, tables 1-5.—Twenty-six species are combined into groups to indicate 20°C or higher surface-water temperature: Group A when common or abundant, Group B only when abundant, and Group C non-reliable temperature indicators. Correlation of Pleistocene temperature fluctuations in three deep-sea cores is demonstrated.

KICINSKI, F. M. Note on the occurrence of some Tertiary Larger Foraminifera on Bougainville Isl. (Solomon Islands).—Australia Bureau of Mineral Resources. Rept. No. 25, 1956, p. 76, 77.—Species listed from Tertiary e and lower Tertiary f.

KICINSKI, F. M., and BELFORD, D. J. Note on the Tertiary succession and Foraminifera of Manus Island.—Australia Bureau of Mineral Resources, Rept. No. 25, 1956, p. 71-75, map.—Numerous species are listed.

KNIGHT, RAYMOND L. Permian Fusulines from Nevada.—Journ. Pal., v. 30. No. 4, July 1956, p. 773-792, pls. 83-88, text figs. 1-3.—Nineteen species (ten new) and four varieties (one new) are described and illustrated and their stratigraphic ranges indicated.

KNIPSCHEER, H. C. G. Biostratigraphie in der Oberkriede mit Hilfe der Globotruncanen.—Paläont. Zeitschr., Band 30, Aug. 1956, p. 50-56, pl. 4, text figs. 1-4.—**Globotruncana elevata elevata, G. elevata stuartiformis, G. stuarti,** and **G. falsostuarti** are used.

KOCHANSKY-DEVIDE, V. in RAMOVS. A. **Palaeofusulina nana** Licharew aus den Bellerophonschichten von Volaka und ein Vergleich mit den Mikrofossilien anderer Fundorte Sloweniens (with German summary).—Slovenska Akad. Znan, Umet., Class. IV, Hist. Nat., Razprave, Dissertationes, v. II, 1954, p. 329-340, pl. 1.

KOCHANSKY-DEVIDE, V., in RAMOVS, A. Die Neoschwagerinenschichten und ihre Fusuliniden-fauna bei Bohinjska Bela und Bled (Julische Alpen, Slowenien, NW Jugoslawien) (with German summary).—Slovenska Akad. Znan. Umet., Class. IV, Hist. Nat., Razprave, Dissertationes, v. 3, 1955, p. 359-424, pls. 1-8, maps, chart, tables.—Sixteen species and subspecies, three species and two subspecies new and four species indeterminate are recorded and illustrated. **Kahlerina** n. gen. (genotype **K. pachytheca** n. sp.) is erected from the Middle Permian, upper Word.

KSIAZKIEWICZ, M. The Jurassic and Cretaceous of Bachowice (western Carpathians) (in Polish with English summary).—Ann. Soc. Geol. Pologne, v. 24, fasc. 2-3, Année 1954 (1956), p. 121-405, pls. 11-32.—Twenty-one species and subspecies of **Globotruncana** are discussed and illustrated.

LANGE, WOLFGANG. Grundproben aus Skagerrak und Kattegat, mikrofaunistisch und sedimentpetrographisch untersucht.—Meyniana (Kiel) Band 5, May 1956, p. 51-86, pls. 9, 10, text figs. 1-3. tables 1-5.—Quantitative data on occurrences of species, in 13 submarine cores, presumed to be a result of climatic fluctuations and other ecologic changes. Ninety-two species of Foraminifera, none new, are recorded.

LEWIS, G. EDWARD, and STRACZEK, JOHN A. Geology of South-central Oriente, Cuba.—U. S. Geol. Survey Bull. 975-D, 1955 (Febr. 1956), p. 171-336, pls. 19-22 (maps, sections), text figs. 20-44, tables 1-3.—Includes lists of larger and smaller Foraminifera.

LOEBLICH, ALFRED R., JR. The types of Lamarck's genera of Foraminifera as selected by J. G. Children in 1823.—Micropaleontology, v. 2, No. 3, July 1956, p. 303-304.

LUDBROOK, N. H. Microfossils from Pleistocene to Recent deposits, Lake Eyre, South Australia.—Trans Royal Soc. So. Australia, v. 79, May 1956, p. 37-45, pl. 1, distrib. table.—**Rotalia beccarii** var. **tepida** abundant in estuarine or shallow saline lake deposits of late Pleistocene age.

MARPLE, MILDRED FISHER. Small Foraminifera of the Pottsville formation in Ohio.—Ohio Journ. Sci., v. 55, No. 2, March 1955, p. 81-89, 2 pls., table 1.—Sixteen species and one variety, none new, are described and illustrated from marine members of this Pennsylvanian formation.

MASLAKOVA, N. I. Stratigrafia I Fauna Melkikh Foraminifer Paleogenovykh Otlozhenii Vostochnykh Karpat (in Russian) in "Materials on biostratigraphy of western regions of Ukraine". —Russia Minister. geol. okhrany nedr., 1955, p. 5-131, pls. 1-17. text figs. 1-11.—Seventy-six species and varieties, of which 17 are new.

McLEAN, JAMES D. JR. The Foraminifera of the Yorktown formation in the York-James Peninsula of Virginia, with notes on the associated mollusks. —Bull. Amer. Paleontology v. 36, No. 160, Sept. 26, 1956, p. 261-394, pls. 35-53, text figs. 1-7, tables 1-3.—One hundred and six species and two subspecies are recorded and illustrated, 29 new and 25 indeterminate. Many specimens are illustrated in duplicate (photographs and drawings). Descriptions are quoted from earlier authors. **Rectocibicidella** n. gen. (type species **R. robertsi** n. sp.) is erected for a **Cibicides** with elongate uniserial stage.

NEMKOV, G. I. Nummulity I Orbitoidy Pokutsko-Marmarosh-skikh Karpat I Severnoi Bukoviny (in Russian) in "Materials on biostratigraphy of western regions of Ukraine".—Russia Minister geol. okhrany nedr., 1955, p. 133-259, pls. 1-15, text figs. 1-10, 1 table.—Twenty-eight species, none new, are illustrated and discussed.

OMARA, S. New Foraminifera from the Cenomanian of Sinai, Egypt.—Journ. Pal., v. 30, No. 4, July 1956, p. 883-890, pls. 101, 102, text figs. 1-6.—A new genus, five new species, and emendation of **Thomasinella** Schlumberger, 1893. **Nezzazata** n. gen (genotype **N. simplex** n. sp.).

PAPP, A. Orbitoiden aus dem Oberkreideflysch des Wienerwaldes.—Verhandl. Austria Geol. Bundes., Heft 2, 1956, p. 133-143, text fig. 1 (pl.), tables 1, 2.

PATERSON, S. J. and KICINSKI, F. M. An account of the geology and petroleum prospects of the Cape Vogel Basin, Papua.—Australia Bureau of Mineral Resources, Rept. No. 25, 1956, p. 47-70, pls. 1, 2, tables 1-3.—Larger Foraminifera are listed.

REICHEL, MANFRED. Sur une **Trocholina** du Valanginien d'Arzier.—Eclogae geol. Helvetiae, v. 48, No. 2, 1955 (1956), p. 396-408, pls. 14-16, text figs. 1-5.—**Trocholina** is restudied and **Neotrocholina** n. gen. (genotype **N. valdensis** n. sp.) is distinguished from it on the basis of its hyaline radiate calcareous test.

SEROVA, M. I. Stratigrafiia I Fauna Foraminifera Miotseno-Vykh Otlozhenii Predkarpatia (in Russian) in "Materials on biostratigraphy of western regions of Ukraine".—Russia Minister. geol. okhrany nedr., 1955, p. 261-458, pls. 1-29 text figs. 1-18.—One hundred species and varieties of which 41 are new.

SMITTER, Y. H. Foraminifera from the Upper Cretaceous beds occurring near the Itongazi River, Natal.—Palaeontologia Africana. v. 3. 1955, p. 103-107, text fig. 38 [plate].—A small Maestrichtian fauna including nine species (one new).

A foraminiferal fauna from the Tertiary sediments of southern Mocambique.—Palaeontologia Africana. v. 3, 1955, p. 109-118, text figs. 39, 40 [plates]. —Twenty-nine species (three new) and two varieties (one new) from beds of probable upper Miocene age.

STACH, E. Eine Foraminifere im Brandschiefer des Ruhrflözes Wellington.—Zeitschr. Deutsch. Geol. Gesellschaft, Band 107, 1955 (June 1956), p. 116-119, pls. 7, 8.—**Calcituba wellingtonensis** Stach from bituminous shale.

SULIMSKI, ANDRZEJ. Miliolidea Tortoniens et Saramatiques de Suchowola (in Polish with French and Russian résumés).—Acta Palaeont. Polonica, v. 1, No. 1, 1956, p. 69-101, pls. 1-4, tables A, B.—Thirteen species and two varieties, none new, are discussed and illustrated and their local ranges graphed.

THOMPSON, M. L., VERVILLE, G. J., and LOKKE, D. H. Fusulinids of the Desmoinesian—Missourian contact.—Journ. Pal., v. 30, No. 4, July 1956, p. 793-810, pls. 89-93, text fig. 1.—Six species, all but one new, are described and illustrated.

TINOCO, IVAN DE MEDEIROS. Foraminíferos Recentes de Cabo Frio, Estado do Rio de Janeiro.—Div. Geol. Min., Rio de Janeiro, Bol. No. 159. 1955, p. 1-42, pls. 1-4.—Thirty-eight species (four new and eight indeterminate) and two varieties are described and illustrated from this open-ocean beach deposit. A new miliolid genus. **Erichsenella** (genotype **E. kegeli** n. sp.) is erected.

TURNOVSKY, K. Notiz über Peneroplidenvorkommen in Ostanatolien.—Bull. Geol. Soc. Turkey, v. 6, No. 1, Oct. 1955, p. 160, 161, 1 pl.

UJIIE, HIROSHI. **Pseudocibicidoides,** n. gen., from the Sea Coast of Katase, Kanagawa Prefecture, Japan.—Sci. Repts., Tokyo Kyoiku Daigaku, v. 4, sec. C, March 20, 1956, p. 263-265, pl. 13.—**Pseudocibicidoides** n. gen. (genotype **P. katasensis** n. sp.).

The internal structures of some Elphidiidae.—Sci. Repts., Tokyo Kyoiku Daigaku. v. 4, sec. C, March 20, 1956, p. 267-282, pls. 14, 15, text figs. 1, 2.—Eleven species, one new, and two subspecies (in **Elphidium, Cribroelphidium,** and **Elphidiella**) are studied in thin section.

WEYNSCHENK, ROBERT. Some rare Jurassic index Foraminifera.—Micropaleontology, v. 2, No. 3, July 1956, p. 283-286, pl. 1, text figs. 1-3, table 1.—Thin section photographs of five already described species.

WICHER, C. A. Die Gosau-Schichten im Becken von Gams (Österreich) und die Foraminiferengliederung der höheren Oberkreide in der Tethys (with paleontological section by F. BETTENSTAEDT). Paläont. Zeitschr., Band 30, August 1956, p. 87-136, pls. 12, 13, text figs. 1-7.—Eight microfaunal zones are recognized from upper Campanian to lower Eocene. The same sequence of zones is present in Mexico, Israel, Egypt, and northern Italy, each with different missing parts. Stratigraphic ranges in the boreal and Tethys provinces are shown for about 25 species and subspecies. **Aragonia daniensis** n. sp. is described, and several other diagnostic species are illustrated.

YOSHIDA SABURO. Paleogene Foraminifera from the Sitakara Formation near Kusiro, Eastern Hokkaido.—Journ. Hokkaido Gakugei Univ., v. 6, No. 2, Dec. 1955, p. 1-8, pls. 1, 2, text fig. 1 (chart).—Seventeen species, ten indeterminate and five others doubtfully identified, are illustrated and briefly described from beds assigned to middle or lower Oligocene.

Foraminifera from the Ikusina Formation, Kusiro Coal-Field, Hokkaido.—Journ. Hokkaido Gakugei Univ., v. 6, No. 2, Dec. 1955, p. 9-16, pl. 1, text figs. 1-4, table 1.—Ten species, five indeterminate and three others doubtfully identified, are illustrated and briefly described from a lower Pliocene formation.

RUTH TODD

ERRATA

The following corrections should be made in the explanation of plate 16, vol. 7, pt. 3, of these Contributions:

Figures 5-5e=*Nonionella robusta* Plummer var. *perdita* Haynes, n. var. X50

6-6a=*Nonionella* aff. *austinana* Cushman. X50

11-11e-the words "megalospheric specimen" should be substituted for "holotype".