CONTRIBUTIONS
FROM THE
CUSHMAN FOUNDATION
FOR
FORAMINIFERAL RESEARCH

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WASHINGTON, D. C., U. S. A.
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CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH

Editor
Alfred R. Loeblich, Jr.

The CONTRIBUTIONS, the official organ of the Cushman Foundation for Foraminiferal Research, publishes original papers on any phase of foraminiferal study and short reviews of recent literature. The CONTRIBUTIONS will be issued quarterly.

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18. NORTHERN ALASKA INDEX FORAMINIFERA[1]

HELEN TAPPAN[2]
U. S. Geological Survey, Washington, D. C.

In the course of investigations by the U. S. Geological Survey in northern Alaska, Foraminifera have been found in beds ranging in age from Triassic to Pleistocene. These faunas are being described and illustrated by the writer for publication in the near future, the taxonomy to be accompanied by discussions of the paleoecology and correlations. However, 17 "index species" of northern Alaska are here named and described in order to validate the 10 new specific names for use in advance of publication of the comprehensive faunal descriptions. Seven previously described species are also discussed. These Alaskan faunas include the first Triassic Foraminifera and the first Lower Jurassic Foraminifera to be recorded from the western hemisphere.

The writer gratefully acknowledges the assistance and information supplied by geologists of the Navy Oil Unit, U. S. Geological Survey, as well as the assistance of the laboratory staff of the Navy Oil Unit in Fairbanks, Alaska, who prepared and picked many of the microfossil samples. Illustrations are shaded camera-lucida drawings by the writer.

Triassic species

Nodosaria shublikensis Tappan, n. sp.

Plate 1, figures 1a-b

Test free, elongate, rectilinear, subcylindrical; chambers numerous, increasing very little in size from the rounded base, slightly tapering at the apertural end; sutures somewhat obscure, straight; wall calcareous, hyaline, surface smooth, ornamented by eight low longitudinal costae crossing the sutures; aperture terminal, rounded. Length of holotype 0.60 mm; greatest diameter 0.21 mm.

Remarks—This species resembles *Nodosaria orthopleura* Reuss in the elongate test, high ribs and obscure sutures, but differs in having a more cylindrical test, and rounded instead of tapering base.

Types and occurrence—Holotype (U. S. N. M. no. 106114) and figured paratype (U.S.N.M. no. 106115) from the Shublik formation (Upper Triassic), from a 150-foot zone, beginning about 350 feet below the top of the formation, in the banks of a south-flowing tributary which enters the Sadlerochit River at approximately lat. 69° 34′ 30″ N., long. 145° 03′ W., on the south slope of the Sadlerochit Mountains, northeastern Alaska. Collected by Edward G. Sable, 1948. Figured paratype (U.S.N.M. no. 106116) from the Upper Triassic, from a core at 6,316 to 6,334 feet in Simpson Test Well No. 1, west of Cape Simpson, northern Alaska.

Lingulina alaskensis Tappan, n. sp.

Plate 1, figures 2a-b

Test free, elongate, flattened, robust, margins subacute; early chambers increasing rapidly in breadth from the rounded proloculus, later chambers increasing very little in size so that the sides of the test are parallel; sutures distinct, not depressed, slightly arched centrally; wall calcareous, hyaline, surface smooth, ornamented only by a central longitudinal furrow, bordered on each side by a low rib; aperture terminal, simple. Length of holotype 0.52 mm, greatest breadth 0.21 mm, thickness through center 0.13 mm. Other specimens are from 0.29 to 0.57 mm in length.

Remarks—This species resembles *Lingulina testudinaria* Franke, from the Lias of Germany, in the broad low chambers and central lengthwise groove. In *L. testudinaria* the groove is bordered by much stronger costae, and the sutures are limbate. The Alaskan species is also shorter and narrower.

Types and occurrence—Holotype (U.S.N.M. no. 106117) and paratypes (U.S.N.M. no. 106118) from the Upper Triassic, from a core at 6,304 to 6,314 feet, in Simpson Test Well no. 1, west of Cape Simpson, northern Alaska. Paratypes (U.S.N.M. no. 106119) from the Upper Triassic Shublik formation, 150 feet below the top, in the banks of a south-flowing tributary which enters the Sadlerochit River at approximately lat. 69° 34′ 30″ N., long. 145° 03′ W., on the south slope of the Sadlerochit Mountains, northeastern Alaska. Collected by Edward G. Sable, 1948.

Jurassic species

Haplophragmoides ? barrowensis Tappan, n. sp.

Plate 1, figures 5a-b

Test free, discoid, planispiral and evolute, periphery bluntly rounded; chambers numerous, increasing rapidly in size as added, usually forming about 2½ whorls, with nine to 12 chambers in the final whorl; sutures radial, straight or slightly curved, those of earliest whorls indistinct, those of the final whorl somewhat constricted and slightly thickened; wall arenaceous, with large grains in a ground mass of finer material, surface rough; aperture obscure, but apparently at the base of the final chamber. Greatest diameter of holotype 1.01 mm, least diameter 0.70 mm, greatest thickness 0.26 mm. Other specimens range from 0.47 to 1.04 mm in greatest diameter.

1. Published by permission of the Director, U. S. Geological Survey.
2. Mrs. Alfred R. Loeblich, Jr.

Remarks—This species is similar to the Recent *Labrospira jeffreysi* (Williamson) but differs in being approximately twice as large, more evolute, more compressed, and in possessing more chambers in the final whorl. Due to the preservation, the exact character of the aperture of the present species cannot be determined, and it is thus referred questionably to *Haplophragmoides*. The aperture of *Labrospira* is in the face of the final chamber, and that of *Haplophragmoides* is at the base of the final chamber.

Types and occurrence—Holotype (U.S.N.M. no. 106477) and unfigured paratypes (U.S.N.M. no. 106478) from the Lower Jurassic (Upper Pliensbachian) Kingak formation, from a core at 2,109 to 2,119 feet, and unfigured paratypes (U.S.N.M. no. 106479) from a core at 2,099 to 2,109 feet, all from South Barrow Test Well no. 3, south of Point Barrow, northern Alaska. Unfigured paratypes (U.S.N.M. no. 106480) from the Lower Jurassic in a core at 5,866 to 5,874 feet in Simpson Test Well no. 1, west of Cape Simpson, northern Alaska.

Frondicularia lustrata Tappan, n. sp.

Plate 1, figures 3-4b

Test free, narrow, elongate, compressed, rectilinear, periphery carinate; chambers numerous, proloculus with an elongate apical spine which is usually broken, but may be preserved on perfect specimens, equitant chambers increasing gradually in size from the proloculus in the megalospheric form, flaring more rapidly in the microspheric form; sutures distinct, sharply angled at the center of the test; wall calcareous, hyaline, surface smooth, ornamented by strong lengthwise costae, with two prominent and parallel ribs at either side of a central longitudinal furrow, and two to three less prominent ones at either side of these, which tend to parallel the margins of the test; aperture terminal, radiate, on a distinct neck. Length of holotype 1.43 mm, breadth 0.34 mm, thickness 0.21 mm. Other complete specimens range in length from 0.39 to 1.43 mm, and in breadth from 0.18 to 0.42 mm.

Remarks—This species somewhat resembles *Frondicularia terquemi* var. *bicostata* d'Orbigny, which occurs in the Liassic of France, England and Germany, but differs in having much more prominent ribs and an apical spine, and in having a central longitudinal depression.

Types and occurrence—Holotype (U.S.N.M. no. 106481) and unfigured paratypes (U.S.N.M. no. 106482) from the Lower Jurassic (upper Pliensbachian) Kingak formation, from a core at 2,150 to 2,160 feet, figured paratype (U.S.N.M. no. 106483) from a core at 2,130 to 2,140 feet, unfigured paratypes (U.S. N.M. no. 106484) from a core at 2,109 to 2,119 feet and unfigured paratypes (U.S.N.M. no. 106485) from a core at 2,170 to 2,179 feet, all from South Barrow Test Well no. 3, south of Point Barrow, northern Alaska.

Lower Cretaceous species

Gaudryina nanushukensis Tappan, n. sp.

Plate 1, figures 8a-11

Test free, elongate, robust, early triserial portion flaring from the pointed base, with the third angle somewhat lower than the other two, many tests developing only the triserial stage, later portion of mature specimens biserial, with the loss of the series of chambers forming the lowest of the three angles of the triserial stage, angles rounded, sides slightly excavated; chambers numerous, low and broad, final chambers comparatively somewhat higher; sutures distinct, very slightly depressed, straight across the angles; wall arenaceous, with considerable cement, surface rather smoothly finished; aperture a low arch at the base of the apertural face of the final chamber. Length of holotype 0.91 mm, greatest breadth 0.36 mm, thickness through triserial portion 0.26 mm, thickness through biserial portion 0.17 mm. Other specimens range between 0.39 and 1.12 mm in length.

Remarks—This species is similar in appearance to *Gaudryina alexanderi* Cushman, from the Lower Cretaceous of Texas, but is somewhat smaller, has less excavated sides and more rounded angles, and the biserial stage is not as well developed.

Types and occurrence—Holotype (U.S.N.M. no. 106120) and figured paratypes (U.S.N.M. nos. 106124a-b) from the upper Tuktu member of the Umiat formation, Nanushuk group, from cuttings at 2,720 to 2,730 feet and figured paratype (U.S.N.M. no. 106121) from cuttings at 2,400 to 2,410 feet, all from Umiat Test Well no. 2, north of Umiat, in the northern foothills of the Brooks Range, northern Alaska. Unfigured paratype (U.S.N.M. no. 106122) from a core at 2,000 to 2,010 feet in South Barrow Test Well no. 2, south of Point Barrow, northern Alaska. Unfigured paratypes (U.S.N.M. no. 106123) from the Torok formation, Nanushuk group, on Birthday Creek which flows south into the Awuna River, on the north flank of the Awuna anticline, at approximately lat. 69° 09′ N., long. 156° 32′ 30″ W., northern Alaska. Collected by Charles L. Whittington, 1947.

Marginulinopsis umiatensis Tappan, n. sp.

Plate 1, figures 6-7b

Test free, small, robust, slightly longer than broad, thickness as great as breadth, early portion close coiled, later chambers becoming uniserial, periphery broadly rounded; four to six inflated chambers in the coiled portion, increasing rapidly in size, uniserial development poor, in most specimens being represented by a single terminal chamber; sutures distinct, depressed, straight; wall calcareous, hyaline, ornamented by numerous fine costae, about eight visible in side view, costae disappearing at about the midline of the final chamber, the terminal portion of the chamber being smooth; aperture terminal, rounded. Length of holotype 0.31 mm, greatest breadth of coil 0.29 mm, greatest thickness 0.23 mm. Other specimens are up to 0.49 mm in length.

Remarks—This species is very similar to *Marginulina trinitatensis* Cushman, from the Upper Cretaceous of Trinidad, but is about one half as large, the test is comparatively thicker and lacks the peripheral keel, sutures are more depressed in the early portion and the costae are less elevated, and the terminal neck is lacking.

Types and occurrence—Holotype (U.S.N.M. no. 106125) from the upper Tuktu member of the Umiat formation, Nanushuk group, in a core at 2,408 to 2,418 feet, and figured paratype (U.S.N.M. no. 106126) from the Tuktu member in cuttings at 2,530 to 2,540 feet, both from Umiat Test Well no. 2, north of Umiat, in the northern foothills of the Brooks Range, northern Alaska.

Ammobaculites tyrrelli Nauss

Plate 1, figures 12-14

Ammobaculites coprolithiforme (Schwager) CUSHMAN, 1927, Roy. Soc. Canada, Trans. 3rd ser., vol. 21, sec. 4, p. 130, pl. 1, figs. 6-7; CUSHMAN and JARVIS, 1932, U. S. Nat. Mus. Proc., vol. 80, art. 14, p. 13, pl. 3, figs. 4-5.

Ammobaculites coprolithiformis (Schwager) WICKENDEN, 1932, Jour. Paleon., vol. 6, no. 2, p. 204, pl. 29, fig. 2; CUSHMAN, 1946, U. S. Geol. Survey Prof. Paper 206, p. 22, pl. 3, figs. 7-9.

Ammobaculites tyrrelli NAUSS, 1947, Jour. Paleon., vol. 21, no. 4, p. 333, pl. 48, fig. 2.

Test free, elongate, slightly compressed, early portion close-coiled, with five to seven chambers in the coil and a large umbilicus, later portion uniserial with nearly parallel sides, uniserial portion of less breadth than coiled portion, periphery broadly rounded; chambers numerous, inflated in the coiled portion, ranging from subround to low and broad in the uniserial portion, uniserial chambers increasing very little in size as added; sutures distinct, depressed, straight; wall arenaceous, with considerable cement, rather smoothly finished; aperture terminal, rounded, at the end of a short neck, which is sometimes broken. Length of hypotype in fig. 12, 1.27 mm, greatest breadth of coil 0.47 mm, greatest breadth of uniserial portion 0.52 mm, thickness 0.26 mm. Other specimens range between 0.47 and 1.27 mm in length.

Remarks—This species was described by Nauss from his Lloydminster shale of the Vermilion area of Alberta, Canada. It is apparently the same as that referred by Cushman to *A. coprolithiformis* (Schwager), but differs from Schwager's species in having nearly parallel sides in the uniserial portion; the chambers increase very little in height as added and the earliest uniserial portion is of nearly the same breadth as the coil. In *A. coprolithiformis* the earliest uniserial chambers are much narrower than the coil, the later uniserial portion flares rapidly and the chambers also increase rapidly in height.

Types and occurrence—Figured hypotypes (U.S. N.M. nos. 106127a-b) and unfigured hypotype (U.S. N.M. no. 106128) from the upper Topagoruk member (Lower ? Cretaceous) of the Umiat formation, Nanushuk group, in a core at 532 to 547 feet in Umiat Core Test no. 1, north of Umiat, in the northern foothills of the Brooks Range, northern Alaska. Figured hypotype (U.S.N.M. no. 106129) from cuttings at 3,570 to 3,580 feet in Umiat Test Well no. 1, west of Umiat, and unfigured hypotypes (U.S.N.M. no. 106130) from the Topagoruk member of the Umiat formation, Nanushuk group, from a core at 990 to 992 feet in Umiat Test Well no. 2, north of Umiat, in the northern foothills of the Brooks Range, northern Alaska. Unfigured hypotypes (U.S.N.M. no. 106486) from the upper Topagoruk member of the Umiat formation, Nanushuk group, from a core at 1,080 to 1,087 feet in Simpson Test Well no. 1, west of Cape Simpson, northern Alaska. Unfigured hypotypes (U.S.N.M. no. 106487) from the upper Topagoruk member of the Umiat formation, Nanushuk group, from cuttings at 250 to 260 feet in Simpson Core Hole no. 8, west of Cape Simpson, northern Alaska. Unfigured hypotypes (U.S.N.M. no. 106488) from the upper Topagoruk member of the Umiat formation, Nanushuk group, from a core at 558 to 568 feet in Point Barrow Core Test no. 1, north-northeast of Barrow village, northern Alaska.

Tritaxia manitobensis Wickenden

Plate 1, figures 15-17

Tritaxia manitobensis WICKENDEN, 1932, Trans. Roy. Soc. Canada, ser. 3, vol. 26, sec. 4, p. 87, pl. 1, fig. 10; CUSHMAN, 1937, Cushman Lab. Foram. Research, Spec. Publ. 7, p. 27, pl. 4, fig. 7; CUSHMAN, 1946, U. S. Geol. Survey Prof. Paper 206, p. 31, pl. 7, fig. 8.

Test free, robust, loosely triserial; chambers few in number, distinct, rounded, inflated, increasing rapidly in size; sutures distinct, depressed; wall finely arenaceous, surface smoothly finished; aperture terminal, rounded, at the end of a distinct neck. Length ranges between 0.29 and 0.81 mm, breadth varies between 0.23 and 0.47 mm.

Remarks—This species apparently had a chitinous base to the arenaceous test, for the specimens are almost invariably crushed, compressed and distorted in various ways, although other species in the same beds are undistorted. The necklike extension of the final chamber, the rounded aperture and large irregular chambers serve to make this species one of the most easily recognized in the Cretaceous section.

Tritaxia manitobensis was described from the upper shale member of the Ashville formation of Kirk, in Manitoba. In northern Alaska, it is found in the Tuktu and Topagoruk members of the Umiat formation.

Types and occurrence—Figured hypotypes (U.S. N.M. nos. 106489a-b) from the Lower Cretaceous Tuktu member of the Umiat formation, Nanushuk group, from an outcrop about 4.75 miles airline, upstream from the mouth of Fossil Creek, a small northflowing tributary to the Colville River, at approximately lat. 69° 19′ 20″ N., long. 152° 28′ W., southwest of Umiat, in the northern foothills of the Brooks range, northern Alaska, collected by R. L. Detterman, 1947. Figured hypotype (U.S.N.M. no. 106490) from the upper Topagoruk member of Lower ? Cretaceous age, in the Umiat formation, Nanushuk group, from a core at 1,080 to 1,087 feet, unfigured hypotype (U.S.N.M. no. 106491) from a core at 733 to 743 feet and unfigured hypotype (U.S.N.M. no. 106492) from cuttings at 3,350 to 3,360 feet, all from Simpson Test Well no. 1, west of Cape Simpson, northern Alaska.

Unfigured hypotypes (U.S.N.M. no. 106493) from the upper Topagoruk member of the Umiat formation, Nanushuk group, from cuttings at 1,150 to 1,160 feet, and unfigured hypotypes (U.S.N.M. no. 106494) from cuttings at 1,830 to 1,840 feet, all from South Barrow Test Well no. 1, southwest of Point Barrow, northern Alaska. Unfigured hypotypes (U.S.N.M. no. 106495) from the upper Topagoruk member of the Umiat formation, Nanushuk group, from a core at 459 to 469 feet, in South Barrow Test Well no. 2, south of Point Barrow, northern Alaska. Unfigured hypotype (U.S. N.M. no. 106496) from the upper Topagoruk member of the Umiat formation, from cuttings at 892 to 902 feet in Point Barrow Core Test no. 1, southwest of Point Barrow, northern Alaska. Unfigured hypotypes (U.S.N.M. no. 106497) from the upper Topagoruk member of the Umiat formation, from a core at 256 to 264 feet in Skull Cliff Core Test no. 1, just southeast of Skull Cliff, at about lat. 70° 55′ N., and long. 157° 30′ W., on the northeast coast of Alaska.

Discorbis stictata Tappan, n. sp.

Plate 1, figures 18a-c

Test free, large, biconvex, trochoid, umbilicate, periphery subacute; all chambers of the 2½ whorls visible dorsally, only the six to eight of the final whorl visible from the ventral side, chambers increasing gradually in size as added; sutures distinct, thickened, especially at the umbilicus on the ventral side, flush or slightly depressed, oblique and reaching backwards at the periphery on the dorsal side, gently curved and more radiate ventrally; wall calcareous, very coarsely perforate, generally with a distinctive brownish color; aperture an arch at the base of the final chamber, near the periphery on the ventral side. Greatest diameter of holotype 0.47 mm, least diameter 0.39 mm, greatest thickness 0.16 mm. Other specimens range between 0.31 and 0.73 mm in diameter.

Remarks—This species resembles *Discorbis rosacea* (d'Orbigny) in general appearance, large umbilicus, oblique dorsal sutures, and radiate ventral sutures but differs in the lower spire, fewer whorls, slightly more numerous chambers in the final whorl, and large aperture. It resembles *Discorbis ciperensis* Cushman and Stainforth in the low spire, number of chambers, wide umbilicus and coarsely perforate wall, but differs in the somewhat more acute periphery, more rapid increase in the size of the chambers, more oblique sutures dorsally, and the much larger arched aperture.

Types and occurrence—Holotype (U.S.N.M. no. 560385) and paratypes (U.S.N.M. no. 560386) from the upper Topagoruk member of Lower ? Cretaceous age, in the Umiat formation, Nanushuk group, from a core at 1,010 to 1,020 feet in Simpson Test Well no. 1, west of Cape Simpson, northern Alaska. Paratypes (U.S.N.M. no. 560387) from a core at 293 to 303 feet, and paratypes (U.S.N.M. no. 560388) from a core at 1,030 to 1,040 feet from the same well, all from the upper Topagoruk member of the Umiat formation. Paratypes (U.S.N.M. no. 560389) from the upper Topagoruk member of the Umiat formation, Nanushuk group, in a core at 466 to 476 feet in Skull Cliff Core Test no. 1, just southeast of Skull Cliff, at about lat. 70° 55′ N., long. 157° 30′ W., on the coast of northern Alaska. Paratypes (U.S.N.M. no. 560390) from the same member, in a core at 236 to 246 feet in Point Barrow Core Test no. 1, southwest of Point Barrow, northern Alaska. Paratype (U.S.N.M. no. 560391) from well cuttings at 3,090 to 3,100 feet in South Barrow Test Well no. 2, southwest of Point Barrow, northern Alaska.

Upper Cretaceous species

Globigerina loetterlei Nauss

Plate 1, figures 19a-c

Globigerina loetterlei NAUSS, 1947, Jour. Paleon., vol. 21, no. 4, p. 336, pl. 49, figs. 11a-c.

Test free, small, coiled in a low trochoid spire; about six globular chambers in the final whorl, increasing rapidly in size in the early stages, later chambers increasing very little in size; sutures distinct, depressed; wall calcareous, hyaline, distinctly perforate; aperture an arch at the base of the final chamber, extending from near the periphery almost to the large umbilicus. This species ranges in greatest diameter from 0.18 to 0.29 mm and in thickness from 0.10 to 0.16 mm.

Remarks—According to Nauss, " 'Floods' of this species are characteristic of the central part of the Lloydminster shale where the species is associated with a few specimens of *Gümbelina globulosa* (Ehrenberg). It has been encountered in this zone in wells in the Vermilion area, in southern Alberta and in an outcrop at Green Lake 112 miles northeast of Lloydminster." In northern Alaska, *Globigerina loetterlei* occurs in the Seabee and Tuluga members of the Schrader Bluff formation, Colville group, but is most characteristic of the Seabee member, where it is also associated with *Gümbelina*. Both genera are rare elsewhere in the Alaskan Upper Cretaceous, and are present in abundance only locally in the Seabee member.

Types and occurrence—Figured hypotype (U.S.N.M. no. 106498) and unfigured hypotypes (U.S.N.M. no. 106499) from the Seabee member of the Schrader Bluff formation, Colville group, from a core at 655 feet in Simpson Core Test no. 13, at Cape Simpson, northern Alaska. Unfigured hypotypes (U.S.N.M. no. 106500) from about 340 feet above the base of the Tuluga member of the Schrader Bluff formation, Colville group, from an exposure on the Nanushuk River, about 17 miles upstream from its confluence with the Anaktuvuk River, in the northern foothills of the Brooks Range, northern Alaska, collected by E. J. Webber, 1947.

Spiroplectammina mordenensis Wickenden

Plate 1, figures 20a-b

Spiroplectammina mordenensis WICKENDEN, 1932, Trans. Roy. Soc. Canada, ser. 3, vol. 26, sec. 4, p. 86, pl. 1, figs. 4a-b; CUSHMAN, 1946, U. S. Geol. Survey Prof. Paper 206, p. 28, pl. 6, fig. 4.

Test free, small, with early planispiral portion comparatively large, comprising one-third to one-fourth the length of the test and of diameter equal to or greater than the breadth of the biserial portion which follows, biserial portion gradually increasing in breadth, periphery rounded; chambers distinct, about six in the coil, followed by six to eight closely appressed, biserially arranged chambers, the final pair of chambers being much higher than the preceding ones; sutures straight, flush with the surface in the planispiral portion, distinct, straight and slightly depressed in the biserial portion; wall finely arenaceous, with considerable cement, surface smoothly finished; aperture at the base of the inner margin of the final chamber. Length of figured hypotype 0.31 mm, greatest breadth of coil 0.16 mm, greatest breadth of biserial portion 0.18 mm, greatest thickness 0.13 mm. Other specimens range from 0.31 to 0.47 mm in length.

Remarks—Wickenden described this species from the Morden member of the Vermilion River formation of Manitoba. In northern Alaska it is found in the Tuluga member of the Upper Cretaceous Schrader Bluff formation of the Colville group.

Types and occurrence—Figured hypotype (U.S.N.M. no. 106501) from the Tuluga member of the Schrader Bluff formation, Colville group, from a seismograph shot hole, Umiat Shot Point 15, at a depth of 20 feet, at lat. 69° 25′ N., long. 150° 05′ 30″ W., about 7 miles north-northeast of Umiat in the northern foothills of the Brooks range, northern Alaska.

Neobulimina canadensis Cushman and Wickenden

Plate 1, figures 21a-b

Neobulimina canadensis CUSHMAN and WICKENDEN, 1928, Cushman Lab. Foram. Research, Contr., vol. 4, p. 13, pl. 1, figs. 1-2; CUSHMAN, 1946, U. S. Geol. Survey Prof. Paper 206, p. 125, pl. 52, figs. 11, 12; CUSHMAN and PARKER, 1947, U. S. Geol. Survey Prof. Paper 210-D, p. 132, pl. 29, figs. 32, 33; NAUSS, 1947, Jour. Paleon., vol. 21, no. 4, p. 340, pl. 48, figs. 5a-b.

Test free, tiny, elongate, narrow, early portion triserial, later biserial; chambers inflated, subglobular; sutures distinct, depressed; wall calcareous, hyaline, surface smooth; aperture loop-shaped, extending from the base of the final chamber about one-half the height of the chamber. Length ranges from 0.18 to 0.31 mm, greatest breadth is between 0.08 and 0.13 mm.

Remarks—Although this species has been recorded from beds varying in age from Eagle Ford through Navarro in the Gulf Coastal Region of the United States, it seems to have a much more restricted occurrence in the type area in Canada, where Nauss (1947, p. 340) states that it ranges from 200 feet below the top to 200 feet above the base of the Lea Park formation. In northern Alaska, it is restricted to the Tuluga member of the Schrader Bluff formation, Colville group. It is probable that in other areas more than one species has been referred to this name, and the synonomy given above does not include many records which might be thus questioned.

Types and occurrence—Figured hypotype (U.S.N.M. no. 106504) and unfigured hypotypes (U.S.N.M. no. 106505) from the Tuluga member of the Schrader Bluff formation, Colville group, from a seismograph shot hole, Umiat Shot Point 15, at a depth of 20 feet, at lat. 69° 25′ N., long 150° 05′ 30″ W., about 7 miles north-northeast of Umiat, in the northern foothills of the Brooks Range, northern Alaska. Unfigured hypotypes from Simpson Core Hole no. 11, at 280 to 290 feet (U.S.N.M. no. 106506), at 290 to 300 feet (U.S. N.M. no. 106507), and at 390 to 400 feet (U.S.N.M. no. 106508), west of Cape Simpson, northern Alaska, all from the Tuluga member of the Schrader Bluff formation, Colville group.

Bulimina venusae Nauss

Plate 1, figures 23-26

Bulimina venusae Nauss, 1947, Jour. Paleon., vol. 21, no. 4, p. 334, pl. 48, fig. 10.

Test free, tiny, triserial; early chambers low, those of the last two whorls inflated and increasing rapidly in height; sutures distinct, depressed; wall calcareous, hyaline, distinctly perforate, surface smooth; aperture loop-shaped, at the base of the final chamber. Length ranges from 0.13 to 0.31 mm, greatest breadth between 0.10 and 0.16 mm.

Remarks—Nauss records this species as common in the marine clay shales of the Vanesti tongue of the Belly River, and in the upper part of the Lea Park shale. It occurs in the Tuluga member of the Schrader Bluff formation in northern Alaska.

Types and occurrence—Figured hypotype (U.S.N.M. no. 106509) and unfigured hypotypes (U.S.N.M. no. 106510) from the Tuluga member, Schrader Bluff formation, Colville group, from cuttings at 280 to 290 feet, in Simpson Core Hole no. 11, west of Cape Simpson, northern Alaska. Figured hypotypes (U.S.N.M. no. 106511) and unfigured hypotypes (U.S.N.M. no. 106512) from the Tuluga member of the Schrader Bluff formation, Colville group, from a cut bank 2.8 miles airline distance upstream from the mouth of Prince Creek, where it flows into the Colville River, at about lat. 69° 24′ 30″ N., long. 152° 34′ W., in the northern foothills of the Brooks Range, northern Alaska, collected by R. L. Detterman, 1947. Figured hypotype (U.S.N.M. no. 106513) from the Tuluga member of the Schrader Bluff formation, in an exposure where an east-flowing tributary enters the Kuparuk River, at lat. 69° 30′ N., long. 149° 15′ 30″ W., northern Alaska, collected by George Gryc, 1946. Unfigured hypotypes (U.S.N.M. no. 106514) from the Tuluga member of the Schrader Bluff formation, from a seismograph shot hole, Umiat Shot Point 15, at a depth of 20 feet, at lat. 69° 25′ N., long. 150° 05′ 30″ W., about 7 miles north-northeast of Umiat, in the northern foothills of the Brooks Range, northern Alaska.

Eoeponidella strombodes Tappan, n. sp.

Plate 1, figures 22a-c

Test free, small, biconvex, trochoid, dorsally convex, ventrally umbilicate, periphery subacute; all whorls visible dorsally, only the eight chambers of the final whorl visible ventrally, chambers of approximately equal breadth and height, stellar chambers of the ventral side somewhat inflated, small, reaching slightly more than half the distance from the center to the periphery, and alternating in position with the larger dorsal chambers, outer margin of the stellar chambers angular, each chamber forming an acute angle; sutures distinct, slightly curved backwards at the periphery on the dorsal side, straight and radiate ventrally, sutures of the stellate portion slightly depressed; wall calcareous, with rather large perforations, surface smooth; aperture an arch at the ventral side of the final chamber, adjacent to the preceding stellar chamber. Greatest diameter of holotype 0.36 mm, least diameter 0.29 mm, greatest thickness 0.10 mm. Other specimens are between 0.16 and 0.39 mm in diameter.

Remarks—This species differs from *Eoeponidella linki* Wickenden in being more lenticular in shape and in having more numerous chambers in the last whorl; it has 7 to 8 regular chambers visible dorsally, instead of only 5 to 6, and the supplementary ventral chambers have a more stellate arrangement, appearing to alternate with the regular chambers instead of paralleling them. The Alaskan species is also about one-third larger. *Eoeponidella linki* occurs in the upper part of the Lea Park and in the Grizzly Bear member of the Belly River in Canada, while *E. strombodes* occurs throughout only 200 feet of section, from 800 to 1000 feet above the base of the Sentinel Hill member of the Schrader Bluff formation in northern Alaska.

Types and occurrence—Holotype (U.S.N.M. no. 560392) and paratypes (U.S.N.M. no. 560393) from the Sentinel Hill member of the Schrader Bluff formation, Colville group, from a core at 719 to 724 feet in Sentinel Hill Core Test no. 1, on the Colville River, south of Sentinel Hill, northern Alaska. Paratypes (U.S.N.M. no. 560394) from the Sentinel Hill member of the Schrader Bluff formation, on the west side of the Colville River, about 2.7 miles southwest of the confluence with the Anaktuvuk River, northern Alaska, collected by Karl Stefansson, 1947.

Pleistocene species

Cribroelphidium arcticum Tappan, n. sp.

Plate 1, figures 27a-28b

Test free, robust, planispiral, involute, umbilicate, periphery broadly rounded; chambers numerous, 8 to 9 in the final whorl, broad, thick and inflated but closely appressed, increasing very gradually in size as added; sutures distinct, depressed ,with numerous short retral processes; wall calcareous, distinctly perforate, surface smooth; aperture consisting of a row of very small openings at the peripheral margin of the last-formed chamber, and several small rounded openings in the middle of the apertural face. Greatest diameter of holotype 0.81 mm, least diameter 0.65 mm, greatest thickness 0.44 mm. Other specimens are between 0.47 and 0.81 mm in diameter.

Remarks—This species is similar to *Elphidium bartletti* Cushman in many respects, but is of greater thickness, has fewer and more inflated chambers in the final whorl, and possesses the multiple aperture typical of the genus *Cribroelphidium.*

Types and occurrence—Holotype (U.S.N.M. no. 560395) and unfigured paratypes (U.S.N.M. no. 560396) from the Gubik formation, at a depth of 15 to 20 feet in Simpson Core Hole no. 5, west of Cape Simpson, northern Alaska. Figured paratype (U.S. N.M. no. 560483) from a seismograph shot hole, Party 47, Line 14A-48, Shot point 43, at a depth of 40 to 50 feet, at about lat. 71° 16′ 47″ N., long. 156° 45′ W., southwest of Point Barrow, northern Alaska. Unfigured paratype (U.S.N.M. no. 560397) from a depth of 40 to 50 feet, paratypes (U.S.N.M. no. 560398) from 70 to 75 feet, paratype (U.S.N.M. no. 560399) from 110 to 115 feet, paratypes (U.S.N.M. no. 560400) from 120 to 125 feet, all from Simpson Core Hole no. 5; paratypes (U.S.N.M. no. 560401) from 65 to 70 feet in Simpson Core Hole no. 2, and paratypes (U.S.N.M. no. 560402) from 0 to 5 feet in Simpson Core Hole no. 4, all from the Gubik formation, and west of Cape Simpson, northern Alaska.

Elphidiella sibirica (Goës)

Plate 1, figures 29a-b

Polystomella sibirica Goës, 1894, Kongl. Svensk. Vet-Akad. Handl., Stockholm, N. F. Bd. 25, no. 9, (1892), p. 100, pl. 17, fig. 814; Cushman, 1914, U. S. Nat. Mus. Bull. 71, pt. 4, p. 34, pl. 19, figs. 1a, b.

Elphidium sibiricum (Goës) Cushman, 1930, U. S. Nat. Mus. Bull. 104, pt. 7, p. 29, pl. 11, figs. 7a, b.

Elphidiella sibirica (Goës) Cushman, 1939, U. S. Geol. Survey Prof. Paper 191, p. 66, pl. 19, fig. 4.

Elphidium oregonense Cushman and Grant, Cushman, 1941, Contr. Cushman Lab. Foram. Research, vol. 17, pt. 2, p. 34, pl. 9, figs. 7-9 (not *Elphidium oregonense* Cushman and Grant, 1927).

Test free, large, lenticular, planispiral, involute, with a large umbonal boss of clear shell material which contains numerous pores and slits, periphery subacute; chambers numerous, about 14 in the last whorl in small specimens, 20 to 22 in the final whorl of large specimens, chambers increasing very little in height as added, increasing slightly in thickness, low and broad; sutures curved, distinct, thickened and slightly depressed, two rows of septal pores along the sutures, with the thickened area between the openings; wall calcareous, coarsely perforate; aperture consisting of a row of small pores at the base of the apertural face of the final chamber and numerous small pores scattered irregularly over the entire apertural face. Greatest diameter of figured hypotype 3.2 mm, least diameter 2.65 mm, greatest thickness of test through a line across the middle of the apertural face 0.91 mm, thickness through umbo 0.83 mm. Other specimens are up to 4.16 mm in maximum diameter.

Remarks—This species somewhat resembles *Elphidium oregonense* Cushman and Grant, but differs in being more than twice as large, and in lacking the strongly inflated umbonal region. *E. oregonense* is thickest through the umbo, while the present species is as thick or thicker through the center of the later chambers. The sutures of *Elphidiella sibirica* are more strongly curved and the septal pores are smaller and generally rounded instead of elongate or slitlike. *E. sibirica* was originally described from the Nova Zemlya, in the Siberian Arctic Ocean, and was recorded by Cushman from the Bering Sea.

Types and occurrence—Figured hypotype (U.S.N.M. no. 560403) and unfigured hypotypes (U.S.N.M. no. 560404) from the Gubik formation, from 125 to 130 feet in Simpson Core Hole no. 5, west of Cape Simpson, northern Alaska. Hypotype (U.S.N.M. no. 560405) from 80 to 85 feet and hypotype (U.S.N.M. no. 560406) from 95 to 100 feet, both in Simpson Core Hole no. 5. Hypotype (U.S.N.M. no. 560407) from cuttings at 35 to 45 feet and hypotype (U.S.N.M. no. 560408) from cuttings at 65 to 70 feet, both from Simpson Test Well no. 1, west of Cape Simpson, northern Alaska.

Cassidulina teretis Tappan, n. sp.

Plate 1, figures 30a-c

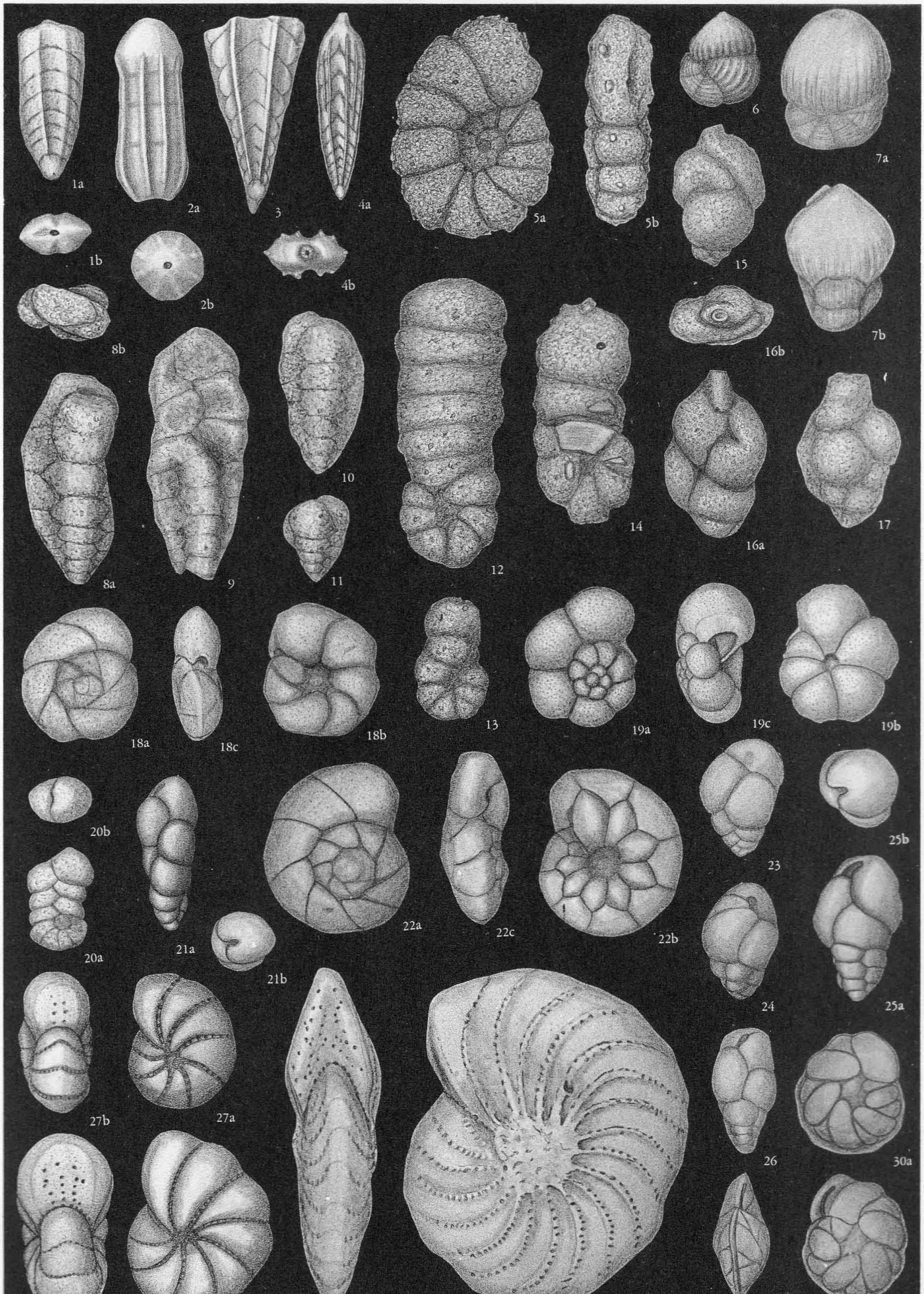
Test free, lenticular, with an umbilical boss on each side, composed of clear shell material; coiled and biserially arranged chambers alternating on the two sides of the peripheral keel, about 8 to 10 chambers visible along the periphery, chambers extending from the umbilical boss on one side, across the peripheral keel and about halfway to the umbilical boss of the opposite side, chambers appearing ovate in outline on the side where they reach the umbo, with the small subtriangular portion extending on the opposite side between the two adjacent ovate-appearing chambers of that side; sutures distinct and thickened, but flush with the surface, gently curved; wall calcareous, with rather large perforations, surface smooth; aperture elongate, extending from the base of the final chamber in a crescent paralleling the anterior margin of the chamber, reaching nearly three-fourths the distance from the base of the chamber to the peripheral keel. Greatest diameter of holotype 0.55 mm, least diameter 0.49 mm, greatest thickness 0.23 mm. Other specimens are between 0.36 and 0.55 mm in greatest diameter.

Remarks—This species resembles *Cassidulina limbata* Cushman and Hughes in general appearance and relative proportions of the lenticular test and in the presence of a peripheral keel, but it differs in having wider chambers which are ovate in outline as seen in side view, rather than narrow and bandlike, and in having a more elongate slitlike aperture.

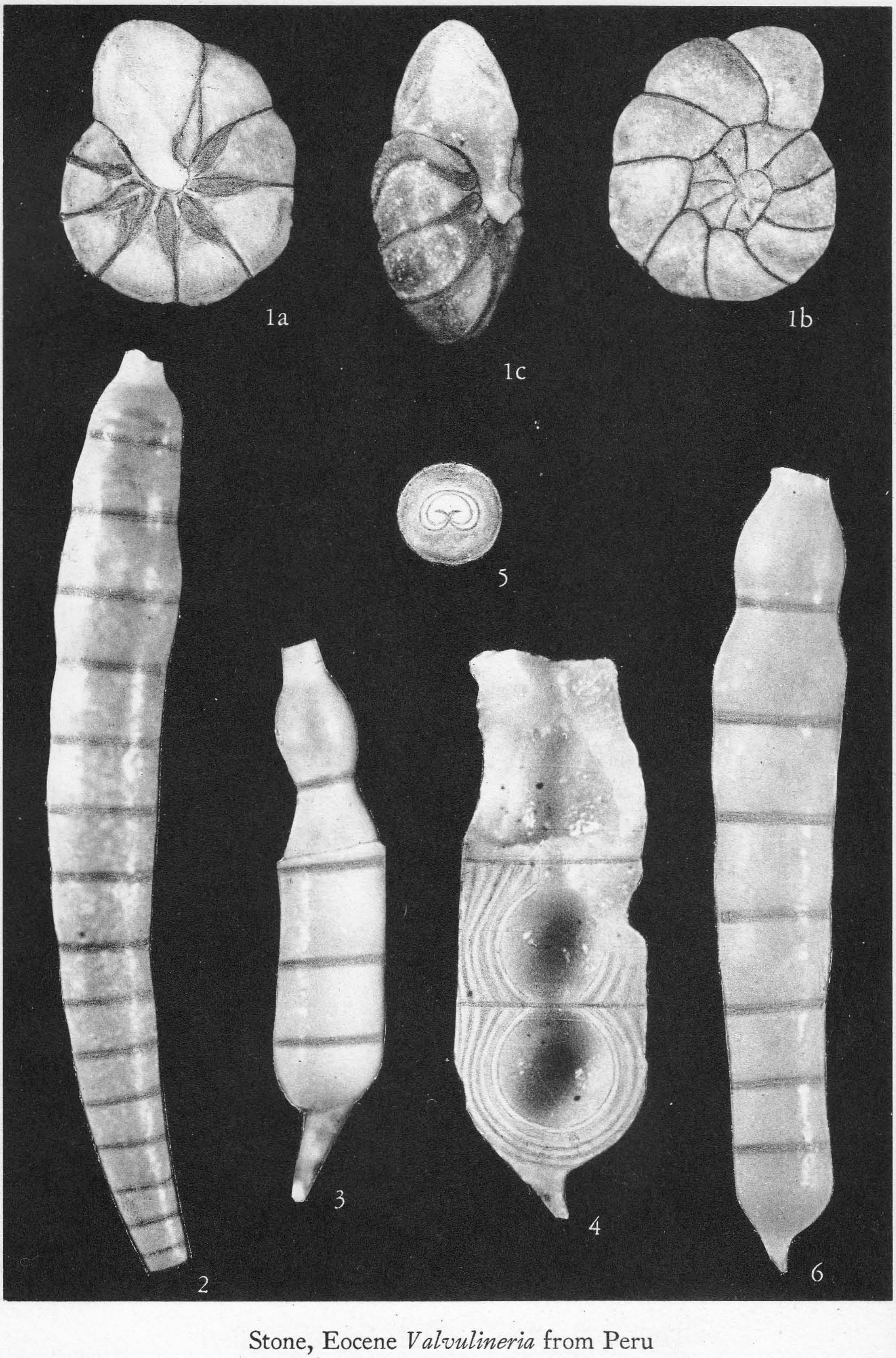
Types and occurrence—Holotype (U.S.N.M. no. 560409) and paratypes (U.S.N.M. no. 560410) from the Gubik formation, in a core at 100 to 105 feet in Point Barrow Core Test no. 1, north-northeast of Barrow village, northern Alaska. Paratypes (U.S.N.M. no. 560411) from 60 to 65 feet in Simpson Core Hole no. 2, paratypes (U.S.N.M. no. 560412) from 70 to 75 feet in Simpson Core Hole no. 2, paratypes (U.S. N.M. no. 560413) from a core at 121 to 123½ feet in Simpson Core Hole no. 4, paratypes (U.S.N.M. no. 560414) from 55 to 60 feet in Simpson Core Hole no. 5, paratypes (U.S.N.M. no. 560415) from 65 to 70 feet and (U.S.N.M. no. 560416) from 70 to 75 feet in Simpson Core Hole no. 5, all from the Gubik formation, from west of Cape Simpson, northern Alaska.

EXPLANATION OF PLATE 1

FIGS.		PAGE
Triassic species		
1a, b.	*Nodosaria shublikensis* Tappan, n. sp. 1a, Side view of holotype (U.S.N.M. no. 106114); 1b, top view. × 48.	1
2a, b.	*Lingulina alaskensis* Tappan, n. sp. 2a, Side view of holotype (U.S.N.M. no. 106117); 2b, top view. × 48.	1
Jurassic species		
3-4b.	*Frondicularia lustrata* Tappan, n. sp. 3, Side view of microspheric paratype (U.S.N.M. no. 106483), showing apical spine and flaring test, × 48; 4a, Side view of megalospheric holotype (U.S.N.M. no. 106481), × 20; 4b, top view, showing ribs and central groove, × 36.	2
5a, b.	*Haplophragmoides ? barrowensis* Tappan, n. sp. 5a, Side view of holotype (U.S.N.M. no. 106477); 5b, edge view. × 36.	1
Cretaceous species		
6-7b.	*Marginulinopsis umiatensis* Tappan, n. sp. 6, Side view of holotype (U.S.N.M. no. 106125); 7a, side view of paratype (U.S.N.M. no. 106126); 7b, edge view. × 48.	2
8a-11.	*Gaudryina nanushukensis* Tappan, n. sp. 8a, Side view of holotype (U.S.N.M. no. 106120); 8b, top view; 9, side view of large paratype (U.S.N.M. no. 106121), showing unusually well developed biserial stage; 10, side view of paratype (U.S.N.M. no. 106124a); 11, side view of paratype U.S.N.M. no. 106124b), showing more common form, with only the triserial stage. × 36.	2
12-14.	*Ammobaculites tyrrelli* Nauss. 12, Side view of large hypotype (U.S.N.M. no. 106127a); 13, side view of small hypotype (U.S.N.M. no. 106127b); 14, side view of hypotype (U.S.N.M. no. 106129). × 36.	3
15-17.	*Tritaxia manitobensis* Wickenden. 15, Side view of hypotype (U.S.N.M. no. 106489a), showing loosely triserial character and apertural neck, × 36; 16a, side view of hypotype (U.S.N.M. no. 106490); 16b, top view, showing rounded terminal aperture, × 48; 17, side view of hypotype (U.S.N.M. no. 106489b), × 36.	3
18a-c.	*Discorbis stictata* Tappan, n. sp. 18a, Dorsal view of holotype (U.S.N.M. no. 560385), showing coarsely punctate surface; 18b, ventral view; 18c, edge view, showing large aperture. × 48.	4
19a-c.	*Globigerina loetterlei* Nauss. 19a, Dorsal view of hypotype (U.S.N.M. no. 106498), showing globular chambers; 19b, ventral view, showing open umbilicus; 19c, edge view, showing large aperture. The final chamber was broken from this specimen, and its contact with the last remaining chamber is shown by an arched scar above and encircling the apertural margin. × 80.	4
20a, b.	*Spiroplectammina mordenensis* Wickenden. 20a, Side view of hypotype (U.S.N.M. no. 106501), showing large coil, and few low biserial chambers; 20b, top view. × 48.	5
21a, b.	*Neobulimina canadensis* Cushman and Wickenden. 21a, Side view of hypotype (U.S.N.M. no. 106504); 21b, top view. × 80.	5
22a-c.	*Eoeponidella strombodes* Tappan, n. sp. 22a, Dorsal view of holotype (U.S.N.M. no. 560392); 22b, ventral view, showing characteristic stellate supplementary chambers alternating with the regular series; 22c, edge view, showing position of the low arched aperture. × 80.	6
23-26.	*Bulimina venusae* Nauss. 23, Side view of hypotype (U.S.N.M. no. 106509), × 110; 24, side view of hypotype (U.S.N.M. no. 106513), × 80; 25a, side view of hypotype (U.S.N.M. no. 106511a); 25b, top view, × 80; 26, side view of hypotype (U.S.N.M. no. 106511b), × 80.	6
Pleistocene species		
27a-28b.	*Cribroelphidium arcticum* Tappan, n. sp. 27a, Side view of paratype (U.S.N.M. no. 560483); 27b, edge view; 28a, side view of holotype (U.S.N.M. no. 560395); 28b, edge view, showing well developed multiple aperture. × 36.	6
29a, b.	*Elphidiella sibirica* Goës. 29a, Side view of hypotype (U.S.N.M. no. 560403), showing raised and curved sutures and septal pores; 29b, edge view, showing multiple aperture. × 16.	7
30a-c.	*Cassidulina teretis* Tappan, n. sp. 30a, Side view of holotype (U.S.N.M. no. 560409), showing alternating chambers; 30b, opposite side, showing narrow and elongate aperture; 30c, edge view, showing lenticular character of test and slight keel. × 36.	7



Tappan, Northern Alaska Index Foraminifera



Stone, Eocene *Valvulineria* from Peru
Crouch, Pliocene *Nodosarella* from California

19. A NEW SPECIES OF FORAMINIFERA FROM PERU

BENTON STONE
S. V. P. M., Palembang, Sumatra

In a recent paper Cushman and Stone (1949) described the foraminiferal fauna of the Middle Eocene Chacra formation in northwestern Peru. Unfortunately the drawings of one species which should have been included were lost. As this form is the most abundant one found in the Chacra fauna, and is a very reliable species for the identification of the formation it is described below.

Valvulineria compressa Stone, n. sp.

Plate 2, figures 1a-c

Test large, height slightly greater than the breadth, compressed, biconvex, coiled in a very flat trochoid spire, dorsal side evolute, ventral side involute, about three whorls making up the entire test, periphery rounded; chambers distinct, inflated, increasing rapidly in size as added, inner margin of the final chamber terminating in a rather flat, lobular plate which covers the open umbilical area, nine chambers in the final whorl; sutures on the ventral side distinct, raised and very strongly thickened at the umbilicus where they form coarse, short, digitate protuberances extending into the umbilical area, tapering rapidly toward the periphery where they are weakly raised, gently curved, depressed between the final three chambers; dorsal sutures distinct, thickened and raised, gently curved; spiral sutures distinct, depressed; wall calcareous, finely perforate; aperture ventral, a low elongate, arched opening at the base of the apertural face of the final chamber, toward the umbilical area.

Dimensions of holotype, from I.P.C. well No. 4145 at 1470 feet: height 0.76 mm, breadth 0.61 mm, thickness 0.36 mm.

This species occurs very abundantly throughout the lower and middle parts of the Chacra shale. It somewhat resembles *Valvulineria samanica* (W. Berry) but differs in having thickened and raised sutures, a thinner periphery and a more strongly inflated final chamber with a smaller apertural face.

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20. *NODOSARELLA VERNEUILI* (D'ORBIGNY) FROM THE PLIOCENE OF THE LOS ANGELES BASIN

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Nodosarella verneuili (d'Orbigny)

Plate 2, figures 2-6

Dentalina verneuili D'ORBIGNY, 1846, Foram. Foss. Bass. Tert. Vienne, p. 48, pl. 2, figs. 7, 8.

Nodosarella camerani GALLOWAY and MORREY (not Dervieux), 1929, Bull. Amer. Pal., vol. 15, no. 55, p. 41, pl. 6.

Ellipsonodosaria verneuili (d'Orbigny) CUSHMAN, 1929, Contr. Cushman Lab. Foram. Res., vol. 5, p. 96, pl. 14, figs. 1-3; CUSHMAN and JARVIS, 1930, Jour. Paleontology, vol. 4, p. 364, pl. 33, fig. 12; PALMER and BERMUDEZ, 1936, Mem. Soc. Cubana Hist. Nat., vol. 10, p. 295, pl. 18, figs. 1, 2, 14-16.

Nodosarella verneuili (d'Orbigny) GALLOWAY and HEMINWAY, 1941, New York Acad. Sci., vol. 111, pt. 4, p. 440, pl. 35, figs. 10a, b.

Dr. Bramlette of the University of California at Los Angeles kindly loaned to the author specimens of *Nodosarella verneuili* (d'Orbigny) from the Miocene of Venezuela and Ecuador. These specimens were from the original material used by Galloway and Morrey (1929) from Manta, Ecuador and by Cushman (1929) from Venezuela.

The author's specimens are from the Lower Pliocene sediments of the Los Angeles Basin, located on the west side of the Newport Lagoon, Orange County, California, at approximately Lat. 33° 38′ 26″ N., Long. 117° 53′ 25″ W. The material was collected by Sam Stewart of the Richfield Oil Corporation.

EXPLANATION OF PLATE 2

FIGS.		PAGE
1.	*Valvulineria compressa* Stone, n. sp. 1a, ventral view of holotype; 1b, dorsal view; 1c, edge view. Middle Eocene Chacra formation of northwestern Peru.	9
2-6.	*Nodosarella verneuili* (d'Orbigny). 2, microspheric form (U.S.N.M. 547454), × 30; 3, megalospheric form (U.S.N.M. 547452) showing concentric rings broken away from internal chambers, × 64; 4, longitudinal section through a megalospheric specimen (U.S.N.M. 547456), showing concentric rings, × 88; 5, apertural view (U.S.N.M. 547455), × 47; 6, megalospheric form (U.S.N.M. 547453), × 47. Pliocene of the Los Angeles Basin, California.	9

The species *Nodosarella verneuili* (d'Orbigny) has been previously identified and reported by many authors, from the Miocene of Vienna, Ecuador, Venezuela, Trinidad, Jamaica and the Oligocene of Cuba and Porto Rico. Le Roy (1941, Jour. Paleontology, vol. 15, no. 6, p. 623) mentioned this species in a list in his paper describing *Cibicides repettoensis*. *Cibicides repettoensis* Le Roy and *Nodosarella verneuili* (d'Orbigny) have both been found in the Lower Pliocene of the Newport Lagoon, Orange County, California. A form very close to *Cibicides repettoensis* Le Roy was also observed by the author in the samples from Venezuela and Ecuador. At the Newport Lagoon locality, *Nodosarella verneuili* appears about 200 feet above the commonly accepted Miocene contact. Near the center of the Los Angeles Basin, it appears about 1500 feet above the accepted Miocene boundary. It is not known from the Pliocene of the Ventura Basin, Ventura, California, and has not been found in the Miocene of California.

Optimum conditions must have existed for *Nodosarella verneuili* in the Newport Lagoon area since it is extremely abundant, and some specimens have attained a length of 5½ mm. More megalospheric forms were found than microspheric. Broken specimens show that the tests are composed of concentric layers as reported by Galloway and Morrey (1929) for their species *Nodosarella paucistriata* from Ecuador. This concentric layering is much thicker in the microspheric specimens than in the megalospheric forms. The thickness is also greater near the initial chamber and gradually thins until the globose chambers below the layers are nude. The length of covering is extremely variable, from almost complete cover to entirely nude. The layers, however, may be chipped or broken off and it is difficult to say whether all forms have this concentric layering. In some zones where *Nodosarella verneuili* is found in the Lower Pliocene of the Los Angeles Basin, this layering is not observed. These specimens, in general, are very small, and it may be that certain conditions may have been necessary for this species to form the concentric layers. The megalospheric form always has one or more spines on the initial chamber. One spine seems to be normal, but as many as three spines have been observed. When the species has only one spine, it is generally on the same side or in line with the tooth in the kidney-shaped aperture.

The chambers making up the test of both the microspheric and megalospheric forms vary greatly in shape. Some tests are much more constricted at the sutures than others, especially the last few chambers of the adult test, giving these chambers a more globose appearance.

The following Foraminifera were found associated with this species. An asterisk (*) indicates identical species also found in the Venezuela Miocene. Forms not found living off the southern California coast are represented by a (§). Based on studies of Recent Foraminifera off the coast of southern California, the living assemblage is indicative of water temperatures of 3° C. or less and a minimum depth requirement of about 4,000 feet in the open ocean.

	Angulogerina angulosa (Williamson)	Rare
	Bolivina argentea Cushman	Few
§*	*B. piscaformis* Galloway and Morrey	Common
§	*B. sinuata* Galloway and Wissler	Common
	B. spissa Cushman	Few
§	*B. subadvena* Cushman var. *sulphurensis* Cushman and Adams	Common
§	*Bulimina denudata* Cushman and Parker	Few
	B. spinifera Cushman	Few
	B. subacuminata Cushman and R. E. Stewart	Rare
§	*B. subcalva* Cushman and K. C. Stewart	Common
	Buliminella subfusiformis Cushman	Few
*	*Cassidulina delicata* Cushman	Abundant
	C. laevigata d'Orbigny	Few
	C. translucens Cushman and Hughes	Rare
	Cibicides cf. *basilobus* Cushman	Rare
	C. mckannai Galloway and Wissler	Few
§*	*C. repettoensis* Le Roy	Few
	C. spiralis Natland	Few
*	*Eponides umbonatus* (Reuss)	Few
	Frondicularia advena Cushman	Rare
*	*Glandulina laevigata* d'Orbigny	Common
*	*Gyroidina soldanii* d'Orbigny	Few
§	*Karreriella milleri* Natland	Few
§	*Nodogenerina advena* Cushman and Laiming	Few
§	*N. lepidula* (Schwager)	Few
§*	*Nodosarella verneuili* (d'Orbigny)	Abundant
§*	*Nodosaria longiscata* d'Orbigny	Few
§	*N.* cf. *tosta* Schwager	Few
	Nonion barleeanum (Williamson)	Few
*	*N. pompilioides* (Fichtel and Moll)	Common
	Orbulina universa d'Orbigny	Rare
§*	*Plectofrondicularia californica* Cushman and R. E. Stewart	Few
	Pseudoparrella smithi (R. E. and K. C. Stewart)	Few
	P. subperuviana (Cushman)	Common
	Pullenia bulloides (d'Orbigny)	Common
§*	*Robulus calcar* (Linné)	Few
	R. cushmani Galloway and Wissler	Rare
*	*Sphaeroidina chilostomata* Galloway and Morrey	Few
§*	*Uvigerina* cf. *beccarii* Fornasini	Common
	U. peregrina Cushman	Few
	U. proboscidea Schwager var. *vadescens* Cushman	Few
	U. senticosa Cushman	Few
*	*Virgulina bramletti* Galloway and Morrey	Rare
	V. nodosa R. E. and K. C. Stewart	Rare

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21. PRELIMINARY NOTE ON THE SPECTROSCOPIC DISTRIBUTION OF ELEMENTS IN THE SHELLS OF SOME RECENT CALCAREOUS FORAMINIFERA*

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ABSTRACT—Results are given of the spectrochemical analyses of the shells of some Recent calcareous Foraminifera. Seventeen elements are recorded of which silicon, strontium and sodium are present in unusually high quantities. The structure of the shell does not seem to be a constant character determined solely by genetic factors, but rather one which is controlled by the environment and the physiological activity of the organism.

Very little work has been done on the detailed structure of the foraminiferal shell. Clarke and Wheeler in their pioneer work (1922) published the results of their micro-chemical analyses of the tests of seven species of calcareous Foraminifera. They found that these tests accumulate silica in quantities ranging from 0.022 to 15.33%, alumina from 0.022 to 3.98%, $MgCO_3$ from 1.79 to 11.08% and $Ca_3P_2O_8$ was recorded as a trace in two species and questionably present in the remaining five species. These two authors noted that the environment plays an important role in the amount of magnesium concentrated by the shell, there being more in warmer waters than in colder waters.

More recently Wood (1949) studied the structure of the foraminiferal test as observed in polarized light. This author attempted to find a cause for the brown color shown by Recent porcellaneous Foraminifera when observed in transmitted light. He made spectroscopic analyses of some Recent and fossil forms and concluded that the brown color of the Recent forms is probably due to the presence of traces of lead, some of the compounds of which are deeply colored. He recorded the presence in the shells of Foraminifera of calcium, magnesium, iron and lead, as well as other elements not listed.

The following work is an attempt to determine the detailed structure of the shells of some Recent calcareous Foraminifera. The material that forms the basis for this study is from the Red Sea (sample No. 22 of the Mabaheth Expedition, 1934-35)[1], and the Bikini Lagoon. From the Bikini sample were picked approximately one hundred specimens each of *Amphistegina radiata* d'Orbigny and *Calcarina defrancii* d'Orbigny. About one hundred specimens of both *Amphistegina radiata* and *Amphisorus hemprichii* Ehrenberg were obtained from the Red Sea sample. The four lots of specimens were washed with boiling water, ground into fine powder and mixed with equal weights of pure graphite.

* Contribution No. 541 from the Woods Hole Oceanographic Institution.

1 For further information regarding this sample, see Said (1950).

The spectrochemical analyses of these four lots were made by Dr. H. C. Harrison of the Rhode Island State College, for whose generous help the author is grateful. Spectrograms of each sample were taken, covering the spectrum range from approximately 2300 A to 4800 A. Since the sensitive spectral lines of such elements as potassium, rubidium and cesium, as well as bands of fluorine compounds, occur in the range above 4800A, these elements were not sought, or were reported with regard to the upper limit of concentration that could be present in the sample.

The results of these analyses as submitted by Dr. Harrison are given in the table on page 12.

Only seventeen elements are recorded. The alkaline earth metals, calcium, strontium and barium constitute a large percentage, of which calcium is by far the most dominant element, while strontium occurs in sizable quantities (1 - 5%). With the exception of the Radiolaria which build their skeleton entirely of strontium sulfate, these values are the highest yet recorded in marine invertebrates. Barium occurs in small quantities ranging from 0.003 to 0.007%. This percentage is higher than Engelhardt's figure (1936) for barium in *Globigerina* ooze which he recorded as 0.0002%. This could be attributed to the fact that my material is a concentrated shell matter rather than an ooze, or to the fact that barium is accumulated in larger quantities in benthonic species.

Of the alkali metals, lithium, sodium, potassium, rubidium and cesium, it is noted that potassium occurs in unusually small quantities (potassium was not recorded quantitatively, but its values were less than 0.01% in all samples). Lithium is completely absent, although this element has been reported to be present as a variable micro-constituent in some organisms (Rankama and Sahama, 1950) and in spite of the fact that Foraminifera assimilate an unusually large number of elements in their shells. Sodium is recorded in rather high quantities (0.5 - 7%). It is seen to be appreciably lower in the Pacific material than in the Red Sea. This observation could be attributed to higher salinities in the latter area.

Silicon is observed in quantities ranging from 1 to 5%. The foraminiferal test seems to accumulate more silicon than any other calcareous invertebrate test, with the exception of certain corals and echinoderms (compare for example Clarke and Wheeler's data [1922]). Magnesium is recorded in rather large quantities. Although no attempt was made to test Clarke

	Amphistegina radiata (Red Sea)	Amphistegina radiata (Bikini)	Calcarina defrancii	Amphisorus hemprichii		Amphistegina radiata (Red Sea)	Amphistegina radiata (Bikini)	Calcarina defrancii	Amphisorus hemprichii		Amphistegina radiata (Red Sea)	Amphistegina radiata (Bikini)	Calcarina defrancii	Amphisorus hemprichii
Si	B—	C+	C+	B—	Cu	E—	E—	E—	E—	As	×	×	×	×
Al	C—	D	D—	D—	Ag	E	F	F+	F	Sb	×	×	×	×
Fe	D+	D—	E+	E+	Au	×	×	×	×	Bi	×	×	×	×
Mg	B—	B—	B+	B+	Ba	E	E	E	E	B	E—	E—	E	E—
Ca	A	A	A	A	Be	×	×	×	×	Ce	×	×	×	×
Na	B—	C+	B—	B+	Li	×	×	×	×	Y	×	×	×	×
K	All less than 0.1%				Sr	B—	B—	B—	B—	Nd	×	×	×	×
Mn	D—	E	E	E+	Rb	Not Determined				La	×	×	×	×
Re	×	×	×	×	Cs	Not Determined				Gd	×	×	×	×
Ti	E	E	E	E	Hg	×	×	×	×	Pr	×	×	×	×
Zr	×	×	×	×	Zn	×	×	×	×	Sc	×	×	×	×
Hf	×	×	×	×	Cd	×	×	×	×	Ho	×	×	×	×
Th	×	×	×	×	Ga	×	×	×	×	Dy	×	×	×	×
Pb	E+	F+	F+	F+	In	×	×	×	×	Yb	×	×	×	×
Sn	E	×	×	×	Tl	×	×	×	×	Er	×	×	×	×
Ge	×	×	×	×	Co	×	×	×	×	Eu	×	×	×	×
Cr	E—	E—	F+	E—	Ni	×	×	×	×	Tb	×	×	×	×
Mo	×	×	×	×	Pt	×	×	×	×	Lu	×	×	×	×
W	×	×	×	×	Ir	×	×	×	×	Tm	×	×	×	×
U	×	×	×	×	Os	×	×	×	×	Sm	×	×	×	×
V	E—	E—	E—	E—	Pd	×	×	×	×	S	Not Determined			
Cb	×	×	×	×	Rh	×	×	×	×	P	All less than 0.01%			
Ta	×	×	×	×	Ru	×	×	×	×	F	Not Determined			
										Te	Not Determined			

	A (over 10%)	B (10 - 1%)	C (1 - 0.1%)	D (0.1 - 0.01%)	E (0.01-0.001%)	F (under 0.001%)
1	Ca	Si, Mg, Na, Sr	Al	Mn, Fe	Ti, Pb, Sn Cr, V, Cu, Ag Ba, B	
2	Ca	Mg, Sr	Si, Na	Al, Fe	Mn. Ti, Cr V, Cu, Ba, B	Pb, Ag
3	Ca	Mg, Na, Sr	Si	Al	Mn, Ti, V, Cu Ba, Fe, B	Pb, Ag, Cr
4	Ca	Si, Mg, Sr, Na		Al	Mn, Ti, Cr, V Cu, Fe, Ba, B	Pg, Ag

(+) means higher end of concentration range
(—) means lower end of concentration range
(×) means sought but not found

(1) Amphistegina radiata (Red Sea)
(2) Amphistegina radiata (Bikini)
(3) Calcarina defrancii (Bikini)
(4) Amphisorus hemprichii (Red Sea)

and Wheeler's theory that magnesium increases with temperature, it was noted that the amount of magnesium varies considerably with little range in temperature.

Boron is recorded in the foraminiferal shell for the first time. It occurs in minor quantities (0.001 - 0.003%). These quantities, however, are higher than the amount of boron recorded by Goldschmidt and Peters (1932) in some corals.

Aluminum, iron, vanadium, lead and silver are common micro-constituents of foraminiferal shells and are invariably recorded with little changes irrespective of locality.

Cobalt, zinc and molybdenum are absent, although it is unusual for calcareous tests not to accumulate these elements.

Summary and conclusions—The detailed spectrochemical analyses of four samples of foraminiferal shells gave the following interesting results:

1. Only seventeen elements were found to be present in the foraminiferal shell. Sixteen of these are common, and tin is erratically recorded in one sample.
2. Foraminifera have a great affinity for strontium, sodium and silicon which occur in their shells in greater quantities than in most other calcareous marine invertebrate shells.
3. One species was found to have a different shell composition in two separate localities, both in regard to the chemical elements present and the quantities of these. It was found that the specimens of *Amphistegina radiata* collected from the Red Sea possess higher percentages of practically all the rarer elements recorded than those collected from the Pacific. This could be attributed to higher salinities of the Red Sea. It is also noted that the Red Sea specimens of *Amphistegina radiata* have incorporated tin, while those from the Pacific have not. It is therefore concluded that the selection of elements for shell building and the amounts of these elements used are not controlled solely by genetic factors, but are probably due to environmental conditions.

It must be remembered, however, that the shells of two species collected from the same area did not have the same composition. It is likely that although certain genetic limitations control the selection of elements somewhat and the environment plays an important role, probably the physiological conditions and the metabolic activity of the organism are also of importance.

4. The chemical composition of the test cannot be used in classifying Foraminifera or in tracing their evolutionary lines. It is interesting to note that Wood (1949) has attempted to use the optical properties of the calcite crystals of the wall of Foraminifera as a basis for classification with some degree of success.
5. Wood's theory (1949) that the presence of minor quantities of lead might cause the brown color of some Recent porcellaneous Foraminifera when seen in transmitted light, cannot be substantiated. Lead in minor quantities occurs in both porcellaneous and hyaline forms.

Due to the small number of analyses made, some of the conclusions presented in this preliminary note are tentative and remain subject to revision when more data become available. It must be emphasized, however, that the field of spectrochemical investigation of the foraminiferal shell is enormous, and that the intention of this preliminary note is to provoke research along this hitherto neglected line.

This work was undertaken at the Woods Hole Oceanographic Institution during the summer of 1950.

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22. THE GENUS SIPHOGENERINA SCHLUMBERGER

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Numerous species of the genus *Siphogenerina* Schlumberger, have long been very useful indices of many horizons of the middle Miocene of California, so much so that the generic name has become a familiar byword to a great many people, both in paleontology and in the oil industry. In view of the well-established name of this genus, it is with considerable regret that we find that nomenclatural studies indicate that the name does not fit the existing concept.

In 1945, Mathews published an analysis of the genus *Siphogenerina* in which he indicated that *S. costata* Schlumberger, which he considered to be the genotype of *Siphogenerina*, was biserial in the neanic portion and uniserial in the adult stages; hence, Mathews created a new genus, *Rectuvigerina* for those forms which have triserial chamber arrangement in the early part followed by a uniserial adult stage with or without an intermediate biserial stage. (1945, p. 590). He selected *S. multicostata* Cushman and Jarvis as the genotype. Miss Ruth Todd of the U. S. Geological Survey has kindly re-examined the types of *Rectuvigerina* (*S. multicostata* Cushman and Jarvis) and indicates that they show a triserial to uniserial mode of development (Todd, 1950). Dr. P. Bronniman of the Trinidad Leaseholds, Ltd., Trinidad, has also furnished a suite of about 60 specimens from the vicinity of the type area and these specimens exhibit the same development. A sufficient range of specimens was examined to indicate that mega- and micro-spheric individuals follow the same pattern of growth.

There has been considerable reluctance on the part of professional paleontologists to recognize *Rectuvigerina* of Mathews and of course such a situation invites close scrutiny on the part of other paleontologists. The correct solution may be found in Schlumberger's work. In 1882, Schlumberger established the genus *Siphogenerina* without mention of species. (1882, p. 51). Freely translated, this original description reads, "close to *Bigenerina*, but differs in having a siphon which unites the suture planes of the upper chambers." It is significant here that Schlumberger compared his new genus with an arenaceous isomorph, *Bigenerina* d'Orbigny (1826, p. 261) which has an early biserial stage followed by a uniserial chamber arrangement in the adult part of the test. In the next publication (1883, p. 117, 118) concerning *Siphogenerina*, Schlumberger placed three species in the genus in the following order: *S. glabra, S. costata* and *S. ocracea*. Many authors in addition to Mathews have assumed that *S. costata* was the first-mentioned specific name published in connection with this genus and as such should be designated as the genotype. Actually this assumption is incorrect and, as indicated above, *S. glabra* was the first-mentioned species. According to opinion 46 of the Rules of Zoological Nomenclature, ". . . if . . . it is not evident from the original publication of the genus how many or what species are involved, the genus contains all the species of the world which would come under the generic description as originally published and the first species published in connection with the genus . . . becomes *ipso facto* the type." Hence, *Siphogenerina glabra Schlumberger* (1883, p. 118), is the type of the genus.

Subsequent designation of genotypes by Cushman (1913, p. 104; 1927, p. 190) are invalid in view of the status of *S. glabra*. An examination of the original figure of *S. glabra* shows that the chambers of the lower half of the test are biserially arranged and those of the upper half or adult portion are uniserial and possess an internal siphon. The existing popular concept of *Siphogenerina,* conversely, considers the genus to be triserial in the early portion followed by a uniserial adult stage. The new name recently proposed by Mathews for this form is then proper. Clearly, there are some cases of dimorphism in highly accelerated species wherein there is a small triserial early stage in the microspheric generation of an otherwise biserial to uniserial species. These are probably better assigned to *Siphogenerina* if the usual forms encountered are of the biserial to uniserial type.

The correct diagnosis of *Siphogenerina* as predicated on the type (*S. glabra* Schlumberger), is similar to that of *Rectobolivina* Cushman (1927, p. 68). Both forms have internal siphons and similar chamber arrangement; however, *Siphogenerina* is round in cross section whereas *Rectobolivina* has a flattened or compressed cross section. This basis for separation seems to be a valid one. *Bifarina* Parker and Jones (1872, p. 198), is also very similar to *Siphogenerina* as correctly interpreted. *Bifarina* differs from *Siphogenerina* and *Rectobolivina* in lacking the internal siphon.

KEY TO SIPHOGENERINA AND RELATED GENERA

With internal tube aligned with aperture
- Chambers triserial plus uniserial
  - *Rectuvigerina* Mathews, 1945
- Chambers biserial plus uniserial
  - Round in cross section
    - *Siphogenerina* Schlumberger, 1882
  - Compressed in cross section
    - *Rectobolivina* Cushman, 1927

With internal tube partially offset from aperture
- *Siphogenerinoides* Cushman, 1927 (see Stone, 1946)

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23. REMARKS ON THE AGE OF THE LIZARD SPRINGS FORMATION OF TRINIDAD, B. W. I.

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In his recent publication entitled, "The direction of coiling in the evolution of some Globorotaliidae" (Contr. Cushman Found. Foram. Res. Vol. 1, Pts. 3 and 4, (1950) pp. 85-86) Hans Bolli mentions the occurrence in the Lizard Springs formation (Trinidad) of *Globorotalia aragonensis* Nuttall, *G. crassata* (Cushman) var. *aequa* Cushman and Renz and *G. wilcoxensis* Cushman and Ponton var. *acuta* Toulmin, none of which were mentioned in the monographs by Cushman and Jarvis (Proc. U. S. Nat. Mus. Vol. 80, Art. 14, 1932) and Cushman and Renz (Cushman Lab. Foram. Res. Spec. Publ. No. 18, 1946). These latter publications did mention *Globorotalia velascoensis* (Cushman) and *Globorotalia lacerti* Cushman and Renz. This discrepancy is difficult to understand and may lead to future confusion in the age assignment of the various Upper Cretaceous - Early Tertiary formations of Trinidad.

Globorotalia aragonensis Nuttall occurs in Trinidad in the Navet formation (Cushman Lab. Foram. Res. Spec. Publ. No. 24 (1948), p. 40) but does not in our opinion, occur in the Lizard Springs formation. There are good reasons to believe that Bolli's *G. aragonensis* is actually *G. velascoensis* (Cushman) which is very abundant in the Lizard Springs formation but was not even mentioned by Bolli in his study. In this respect Bolli's statement "*Globorotalia aragonensis* Nuttall is described by Cushman and Jarvis (loc. cit.) under the name of *Globotruncana arca* (Cushman)" is significant as there can be scarcely any doubt that Cushman and Jarvis' species belongs to *G. velascoensis* (Cushman). Bolli assumes, moreover, that Cushman and Renz (loc. cit.) included *G. aragonensis* Nuttall under the name *G. lacerti* Cushman and Renz. This is unlikely considering the marked differences between the two species; however, Bolli may have been misled by the error which occurred in figuring the holotype of *G. lacerti* Cushman and Renz.

Another form mentioned by Bolli from the Lizard Springs formation is *Globorotalia crassata* (Cushman) var. *aequa* Cushman and Renz. This variety was originally described from the Upper Midway Soldado formation of Soldado Rock (Contr. Cushman Lab. Foram. Res. Vol. 18, Pt. 1 (1942), p. 12). During a recent check through the Lizard Springs type material, the writer failed to find *G. crassata aequa* Cushman and Renz but the close similarity of this form to *G. lacerti* Cushman and Renz leaves the possibility that Bolli's form should be referred to *G. lacerti* Cushman and Renz. This species can be distinguished from *G. crassata aequa* by its coarser spinose ornamentation and by its indistinct sutures on the dorsal side, which are however rather well pronounced in *G. crassata aequa*. *G. lacerti* may be an ancestral form of *G. crassata aequa*.

A third *Globorotalia* mentioned by Bolli from the Lizard Springs formation is *G. wilcoxensis* Cushman and Ponton var. *acuta* Toulmin which also occurs in the Midway Soldado formation of Soldado Rock (loc. cit. p. 12). No typical representatives of this variety have been found by the writer in the Lizard Springs formation. Judging from the high frequency of this form in Bolli's Table I (138 specimens) it appears probable that it may belong to some, as yet undescribed variety of *Globorotalia velascoensis* (Cushman).

Bolli states "A Paleocene age for the Lizard Springs, as suggested by Grimsdale (Jour. Pal. Vol. 21, No. 6 (1947), p. 586), is favored today by Trinidad paleontologists" but the evidence put forward by Bolli is not entirely convincing. It is surprising to note that Bolli did not even mention the only definitely established Paleocene formation in Trinidad, namely the

Soldado formation, with its characteristic foraminiferal fauna which is essentially absent in the Lizard Springs formation.

Grimsdale (loc. cit.) criticized Cushman for placing the Velasco shale and Lizard Springs formation in the Upper Cretaceous without, however, presenting evidence for their Paleocene age. Cushman (Jour. Pal. Vol. 21, No. 6 (1947), p. 587) in his reply to this criticism gives good faunistic reasons for considering the Velasco and Lizard Springs as late Cretaceous and not as Paleocene. Reference is also made to the discussion by Cushman and Renz (loc. cit. p. 4, 5, 11) on the age of the Lizard Springs formation which stresses the predominantly Cretaceous aspect of the foraminiferal fauna. Further paleontological evidence for a late Cretaceous age of the Lizard Springs formation is indirectly supplied, as mentioned elsewhere by the occurrence of the Upper Cretaceous genus *Orbignyana* Hagenow within the range of the Lizard Springs faunas in the upper part of the Vidoño formation of Eastern Venezuela.

Although the faunistic boundary between the Cretaceous and Tertiary has not as yet satisfactorily been settled in the Western Hemisphere, some light is thrown on this question in the interesting publication by F. Brotzen entitled "The Swedish Paleocene and its foraminiferal fauna" (Sver. Geol. Unders. Ser. C. No. 493 (1948), pp. 32-33). Brotzen reaches the conclusion based on faunistic grounds, that the lower Midway of the Gulf States most probably correlates with the upper Danian of Europe and the upper Midway with the European lower Paleocene. During a visit to Caracas in 1948, Brotzen was shown the foraminiferal assemblages of the Trinidad Lizard Springs formation and he expressed the opinion that they are of predominantly Danian age.

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24. *GLOBIGERINITA NAPARIMAENSIS* N. GEN., N. SP., FROM THE MIOCENE OF TRINIDAD, B. W. I.

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In a recent paper on *Globigerinatella insueta* Cushman and Stainforth from the Oligocene of Trinidad, B.W.I. (Bronnimann, 1950) reference was made (p. 82, pl. 14, fig. 11) to a small trochoidal *Globigerina* which in the adult stage is three chambered with a single, irregularly shaped supplementary chamber covering the umbilical portion of the test. This form had been included in the genus *Globigerinatella* as *G.* aff. *insueta,* but reservation was made as to its true *Globigerinatella*-character (p. 82). The ontogeny of this "*Globigerina*" has since been investigated in some detail, although the structure and the mode of communi-

EXPLANATION OF TEXT FIGURES 1-14

Figs.

1-14. *Globigerinita naparimaensis* Bronnimann, n. gen., n. sp. All figures × 170. Cruse formation (Miocene) of Naparima area, Trinidad, B.W.I. Cushman Coll. Nos. 64182-64187.

1, 2. Holotype.—Sample T. L. L. Cat. No. 161214. 1, umbilical view; 2, dorsal view. *Globorotalia menardii* zone, Lengua Beds. The supplementary chamber is transparent and shows the last-formed *Globigerina* chamber with single large aperture. Two small semicircular openings are visible at the suture of the supplementary chamber.

3. 4, 8. Sample T. L. L. Cat. No. 161016. *Globorotalia menardii* zone, Lower Cruse—Lengua Beds. Umbilical views of small trochoid specimens, showing supplementary chambers.

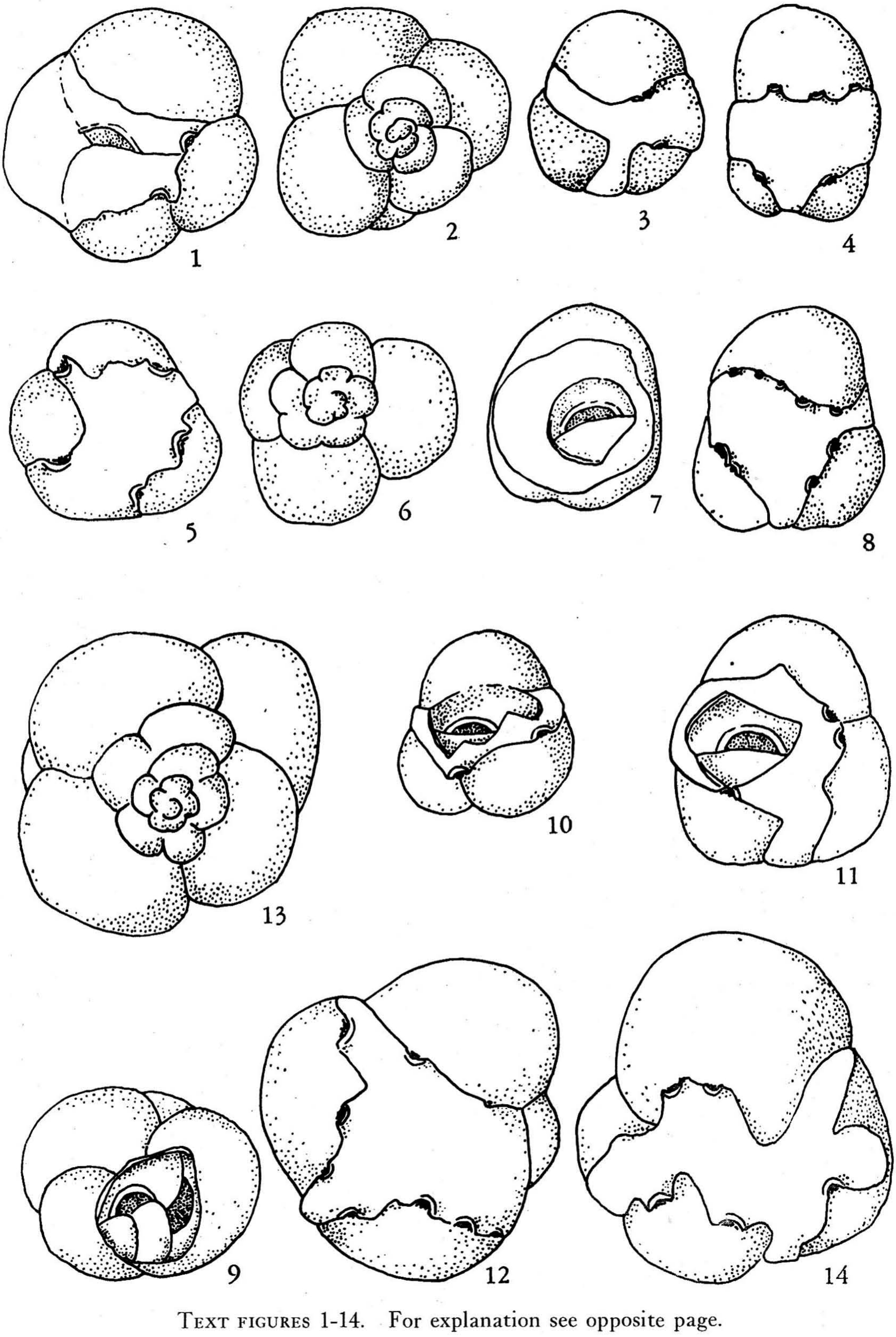
5, 6. Sample T. L. L. Cat. No. 161342. *Globorotalia mayeri* zone, Lengua Beds. 5, umbilical view; 6, dorsal view.

7, 10, 11. Sample T. L. L. Cat. No. 161212. *Globorotalia menardii* zone, Lengua Beds. The supplementary chamber of small trochoid specimens have been opened and show the large, semicircular aperture of the last-formed *Globigerina* chamber.

9. Sample T. L. L. Cat. No. 161212. *Globorotalia menardii* zone, Lengua Beds. The last-formed *Globigerina* chamber has been opened and shows the large semicircular apertures of the *Globigerina* chambers.

12, 13. Sample T. L. L. Cat. No. 161342. *Globorotalia mayeri* zone, Lengua Beds. 12, umbilical view; 13, dorsal view.

14. Sample T. L. L. Cat. No. 91939. *Globorotalia menardii* zone, Lengua Beds. Umbilical side with branching supplementary chamber.



TEXT FIGURES 1-14. For explanation see opposite page.

cation of the innermost chambers are still unknown. However, the features of the adult chambers formed prior to the development of the supplementary chamber-like growth, clearly indicate a new genus only superficially resembling *Globigerinatella.*

The following definition of the new genus *Globigerinita* and the description of the new species *G. naparimaensis* are based on material from the lower Miocene of Trinidad.

Genus **Globigerinita** Bronnimann, n. gen.

Genotype.—*Globigerinita naparimaensis* Bronnimann, n. sp., Lengua Beds, Cruse formation, lower Miocene, Naparima area, Trinidad, B. W. I.

Diagnosis.—Test distinctly trochoidal; chambers subglobular, increasing gradually in size, non-enveloping in the adult. Umbilical portion covered with single, irregularly shaped, frequently inflated, supplementary chamber. Aperture multiple in the adult, consisting of small semicircular openings along the sutures of supplementary chamber. These openings are arched with minute lips. Apertures of chambers formed prior to the supplementary chamber are single, large, broad, semicircular openings with minute lips. Wall variable in thickness, finely perforate.

Remarks.—The monotypic genus *Globigerinita* is characterized by the distinctly trochoidal test, the single irregularly shaped supplementary chamber, the large semicircular apertures connecting the *Globigerina* chambers and the multiple aperture along the suture of the supplementary chamber. Its essential difference from the morphologically similar genus *Globigerinatella* are the non-enveloping adult *Globigerina* chambers and the single apertures connecting the late *Globigerina* chambers. The ancester of *Globigerinita* apparently is a small trochoidal *Globigerina* with single, large aperture similar to that of the early ontogenetic stage of *Globigerinatella* (*Globigerina* stage with single aperture).

Occurrence.—Lower Miocene, possibly also upper Oligocene of Trinidad, B. W. I.

Globigerinita naparimaensis Bronnimann, n. sp.

Text figures 1-14.

Test rather small, distinctly trochoidal, spire with two to three whorls. Chambers subglobular, gradually increasing in size, non-enveloping. Adult with three to four usually fairly large and well separated subglobular chambers. Initial chamber very small and normally not visible. Umbilical region of adult covered with a single, irregularly shaped and frequently inflated supplementary chamber, branching out into the sutural grooves. Multiple aperture of the adult consists of small semicircular openings, with minute lips, along the sutures of the supplementary chamber. Openings frequently at the end of short, lateral processes as in some types of *Globigerinatella insueta* (1950, pl. 14, fig. 9). *Globigerina* chambers formed prior to the supplementary growth possess single, large, broad semicircular apertures, with minute lips. No multiple apertures are developed as in the final *Globigerina* stage of *Globigerinatella insueta.* Walls are finely perforate and vary somewhat in thickness. Wall of supplementary chamber may be very thin, glass-like and transparent, but in general it is of much the same texture as that of the adult *Globigerina* chambers.

Dimensions.—The largest diameters measured across the umbilical side range from 157μ to 330μ.

Holotype.—*Globigerinita naparimaensis* Bronnimann, n. sp. Text figs. 1, 2. T. L. L. Cat. No. 161214, Lengua Beds, lower Miocene, Naparima area, South Trinidad, B. W. I. Deposited in Cushman Collection, U. S. National Museum, (Cushman Cat. No. 64182), Washington, D. C.

Occurrence.—*Globigerinita naparimaensis* occurs in the *Globorotalia menardii* zone and *Globorotalia mayeri* zone, Lengua Beds, Cruse formation, lower Miocene, Naparima area, South Trinidad, B. W. I.

REFERENCES

BRONNIMANN, P., 1950, Occurrence and Ontogeny of *Globigerinatella insueta* Cushman and Stainforth from the Oligocene of Trinidad, B. W. I.: Contr. Cushman Foundation, Vol. 1, parts 3-4, pp. 80-82, pls. 13, 14.

CUSHMAN, J. A. and STAINFORTH, R. M., 1945, The Foraminifera of the Cipero Marl Formation of Trinidad, British West Indies: Cushman Lab. Foram. Research, Spec. Publ. 14.

STAINFORTH, R. M., 1948, Description, correlation and paleoecology of Tertiary Cipero Marl formation, Trinidad, B. W. I.: Bull. Amer. Assoc. Petr. Geol., Vol. 32, no. 7, pp. 1292-1330.

Manuscript received October 30, 1950

25. SOME VARIATIONS WITHIN A SPECIES AS SHOWN BY *LOXOSTOMUM GEMMUM*

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During a study of the foraminiferal fauna in the Arkadelphia marl from the vicinity of Hope, Arkansas, some very bizarre specimens of the genus *Loxostomum* were observed. Although our immediate reaction was that they represented a new species, search for additional specimens showed many variations of that which was first found. After we had collected a number of specimens, we arranged them in a sequence (Figs. 4-11 respectively) ranging from very conservative forms on one hand (Figs. 4-7) to the extremely bizarre gerontic forms on the other (Figs. 8-11). The conservative forms were identified as *Loxostomum gemmum* (Cushman). We were able to find no definite separation between the typical *L. gemmum* and the bizarre forms, but a complete gradation or series of steps occurs, no one form being sufficiently different from that on either side to warrant dividing the sequence into distinct units. Nor could we find a sufficiently large separation even to warrant setting up the end form (Fig. 11) as a variety of the species. We are submitting herewith a series of figures to illustrate the close relationship of the different stages of development, and which will also show the great difference in appearance of the end members. The primary purpose of this note is to again focus attention on the amount of variation which can occur within a species, and to thus discourage the all-too-frequent splitting into varieties, species, and in some cases even genera, of forms that actually are simple end members of a trend developing within a species. We would also like to submit this series of specimens as another proof that the concept of a *species* needs to be reexamined in the light of present day knowledge. A single specimen in many cases cannot adequately serve as the basis for a specific description, and a diagnosis based solely on the holotype limits the description to too narrow a range, resulting in undue and unjustified splitting of species.

REFERENCE

CUSHMAN, J. A., 1946, *Upper Cretaceous Foraminifera of the Gulf Coastal Region of the United States and Adjacent Areas:* U. S. G. S. Prof. Paper No. 206, pp. 129-130, pl. 54, figs. 1-3.

Manuscript received January 11, 1951

26. TWO LOWER CLAIBORNE INDEX FOSSILS

KEITH M. HUSSEY
Iowa State College

Genus **Gyroidina** d'Orbigny, 1826

Gyroidina limbata Hussey

Gyroidina limbata HUSSEY, 1949, Jour. Paleon., vol. 23, no. 2, p. 136, pl. 28, figs. 6, 7.

This species has been reliably reported as being a very good lower Claiborne index fossil. In the Texas section it is very common in the Reklaw and Queen City, and rare in the Weches but extends upward into the Sparta in the marine down-dip facies of that formation.

Specimens from Texas subsurface material recently examined were found to have much more raised and limbate sutures than those of the type specimen from Louisiana.

Genus **Asterigerina** d'Orbigny, 1839

Asterigerina tatumi Hussey, n. sp.

Plate 3, figures 1-3

Test calcareous, finely perforate, of average size for the genus, bi-convex with greater convexity on dorsal side, composed of about three and one-half whorls, chambers numerous, ten to twelve in last formed whorl; chambers of dorsal side hidden in central area by smooth translucent boss, spiral suture featured by retention of crenulations of peripheral keel; ventral side typical of genus with papillate area varying from restricted to the apertural area to covering most of the early chambers, chambers somewhat inflated, development of secondary suture produces a stellate pattern of chambers, sutures range from distinct (Figs. 2, 3) to obscure (Fig. 1), slightly depressed; aperture ventral, a low slit at the base of the chamber margin; periphery with moderately developed thin, crenulate keel.

Dimensions of holotype from the "Lower Lisbon" in the No. 1 James well, Clark Co. Alabama: diameter 0.65 mm; thickness 0.33 mm. Dimensions of paratype from same locality: diameter 0.78 mm; thickness 0.35 mm. Types deposited in R. H. Smith Memorial Collection, Geology Dept., Iowa State College, Ames, Iowa.

Mr. E. P. Tatum, Humble Oil and Refining Company, Houston, Texas, reports *A. tatumi* as occurring typically in Lower Claiborne, sandy siltstones and glauconitic silty clay stones and marls. It has been noted in the subsurface from western Florida westward through Alabama, Mississippi, Louisiana, and into east Texas.

The new species somewhat resembles *A. texana* but distinctly differs in the development of a thin crenulate, peripheral keel.

The species is named in honor of Mr. E. P. Tatum of Houston, Texas, whose work has led to the establishment of this species as an excellent index fossil, and who furnished the material and information on which this description is based.

Manuscript received January 11, 1951

27. PALEOCENE FORAMINIFERA FROM THE ATLANTIC COASTAL PLAIN

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During investigations on the Foraminifera from the Atlantic Coastal Plain of the United States, the author has encountered faunas of undoubted Paleocene (Midway) age. Some work (Richards, 1945, p. 891) has been done on the New Jersey Paleocene and extensive studies have been made of the Maryland Paleocene, notably by Miss Elaine Shifflett (1948). Aside from these works, only sporadic indications of Paleocene species have been noted for the eastern United States.

The present paper describes new species from the Paleocene of New Jersey and North Carolina, and notes occurrences elsewhere in this general region of established Paleocene species. No attempt is made to review previous work, but only to supplement it with evidence gathered by the author.

ACKNOWLEDGMENTS

The writer wishes to acknowledge his indebtedness to the following people whose collective aid has made this paper possible: Horace G. Richards of the Academy of Natural Sciences of Philadelphia, D. J. Cederstrom, of the U. S. Geological Survey; and Paul Schweitzer, President of the Layne Atlantic Company, Norfolk, Virginia, who generously donated materials for study.

Miss Ruth Todd of the U. S. Geological Survey, while at the Cushman Laboratory, kindly checked preliminary foraminiferal identifications from the Point Pleasant well and has since aided the writer on several points of identification; A. R. Loeblich, Jr. of the U. S. National Museum allowed access to Museum specimens and otherwise advised and aided in the completion of this paper.

Illustrations on plate 4 were prepared by Mrs. Gilbert B. Loomis, Jr.

NEW OCCURRENCES OF PALEOCENE SPECIES IN THE ATLANTIC REGION

The species and localities of Foraminifera listed below are original with this paper, the species not having been found previously at the areas noted here, with the exception of some species reported by Jennings (1936) from the "Rancocas group." Species found in the present study quite definitely indicate a correlation with many previously described United States Paleocene localities. In addition, certain species seem to strengthen the relationship of the "Hornerstown" faunas with Brotzen's Swedish Paleocene. The faunas described below are far from complete and contain only those species easily identified with existing facilities and those species which are both new and apparently useful in stratigraphic correlation. Previously figured species which are readily available in foraminiferal literature have not been illustrated here, but the synonymy will show where appropriate figures and descriptions may be found.

New species described in this paper are deposited in the U. S. National Museum.

PALEOCENE SPECIES FROM NEW JERSEY

Locality 1. Hightstown, Mercer County, New Jersey. (Well samples donated by H. G. Richards).

at 120 feet:

Nodosaria affinis Reuss, specimens worn and eroded (Redeposited?)

Locality 2. Small tributary (locally known as Shingle Run) flowing into the west side of Crosswicks Creek, 1 mile north of New Egypt, Ocean County, New Jersey. Both Hornerstown and Vincentown formations are present in the exposure. The sample studied was said to be taken from the Vincentown formation.

Nodosaria affinis Reuss
Robulus midwayensis (?) (Plummer)
Robulus cf. *klagshamnensis* Brotzen
Planularia crosswicksana McLean, n. sp.
Robulus jerseyanus McLean, n. sp.
Polymorphina subrhombica Reuss
Vaginulina loeblichi McLean, n. sp.
Frondicularia richardsi McLean, n. sp.

Locality 3. Banks of small tributary flowing into east side of Crosswicks Creek, 1.8 miles north of New Egypt, Ocean County, New Jersey. Sample reported to be from the Hornerstown formation.

Vaginulinopsis rancocasensis (Jennings)
Nodosaria affinis Reuss
Robulus midwayensis (Plummer)
Cibicidoides cf. *C. mortoni* (Reuss)
Cibicidoides cederstromi McLean, n. sp.
Palmula cf. *P. budensis* (Hantken)
Frondicularia naheolensis Cushman and Todd

Locality 4. 1.75 miles southwest of Harrisonville, Salem County, New Jersey, on the south branch of Oldmans Creek at the crossing of the Harrisonville-Woodstown Road. Sample reported as coming from the Hornerstown formation.

Vaginulinopsis rancocasensis (Jennings)
Nodosaria cf. *N. affinis* Reuss
Vaginulina loeblichi McLean, n. sp.
Robulus jerseyanus McLean, n. sp.

Locality 5. Samples from a well at Van Hiseville, Ocean County, New Jersey (samples donated by H. G. Richards).

at 90 to 94 feet:
Vaginulinopsis tuberculata (Plummer)
Nodosaria affinis Reuss

at 164 to 184 feet:
Polymorphina subrhombica Reuss
Robulus jerseyanus McLean, n. sp.
Dentalina annloomisae McLean, n. sp.
Vaginulinopsis rancocasensis (Jennings)
Nodosaria affinis Reuss
Darbyella n. sp. ?
Vaginulina longiforma (Plummer)
Anomalina cf. *midwayensis* (Plummer)
Pseudoglandulina manifesta (Reuss)

Locality 6. Samples from well at Point Pleasant, Ocean County, New Jersey (samples donated by H. G. Richards).

at 260 feet:
Robulus pseudomamilligerus (Plummer), abundant

at 320 to 390 feet:
Robulus midwayensis (Plummer)
Nodosaria affinis Reuss
Vaginulinopsis tuberculata (Plummer)
Robulus midwayensis var. *virginianus* Shifflett
Nodosaria cf. *N. longiscata* (d'Orbigny)

at 400 feet:
Vaginulinopsis tuberculata (Plummer)
Nodosaria affinis Reuss
Globigerina cf. *G. triloculinoides* Plummer

at 420 to 430 feet:
Ceratobulimina perplexa (Plummer), large specimens
Sigmoidella plummerae Cushman and Ozawa
Robulus piluliferus Cushman, (small specimen)
Robulus midwayensis (Plummer)

at 500 feet:
Vaginulinopsis rancocasensis (Jennings)

at 524 feet:
Polymorphina cushmani Plummer, (juvenile)
Robulus pseudomamilligerus (Plummer)

Locality 7. Pine Valley, Camden County, New Jersey; (Samples from Horace G. Richards).

at 175 feet:
Ellipsonodosaria midwayensis Cushman and Todd
Vaginulinopsis tuberculata (Plummer), abundant
Eponides lunata Brotzen
Globigerina triloculinoides Plummer
Nodosaria affinis Reuss
Nodosaria cf. *N. longiscata* d'Orbigny

at 225 feet:
Vaginulinopsis tuberculata (Plummer)
Nodosaria affinis Reuss
Globigerina triloculinoides Plummer

at 250 to 302 feet:
Pseudoglandulina manifesta (Reuss)
Nodosaria affinis Reuss, large specimens

In the 250-302 foot interval in the Pine Valley Well, the faunas are sparse and largely indeterminate so far as presently known guide species are concerned. This interval is thought to be of Paleocene age inasmuch as the lithology is similar to "Hornerstown" lithology and the foraminifera are similar to those of the Hornerstown, although only *Nodosaria affinis* and an unnamed *Robulus* can be definitely used for correlation at present. Many Paleocene species are also found in the Cretaceous, however, and without established guides this 250-302 foot interval cannot be definitely termed Paleocene on a faunal basis.

The interval from which the upper faunas (at 175 and 225 feet) were taken from the Pine Valley well is lithologically identical with the Paleocene interval at Crisfield, Maryland, as reported by McLean (1950).

PALEOCENE SPECIES FROM DELAWARE

Locality 8. Pits along Noxonton Pond about 1 mile ENE of Townsend, New Castle County, Delaware, on the east side of the pond. The pits are reported to be abandoned and possibly covered by water. Sample was reported to be from an undifferentiated Eocene exposure of either Vincentown or Hornerstown age.

Vaginulina loeblichi McLean, n. sp.
Nodosaria affinis Reuss
Gyroidina subangulata (Plummer)
Guttulina problema (d'Orbigny)
Robulus cf. *midwayensis* (Plummer)
Robulus turbinatus (Plummer)
Marginulina cf. *M. hamata* (Franke)
Oolina cf. *O. crumenata* (Cushman)
Dentalina mucronata Neugeboren
Globigerina cf. *G. triloculinoides* Plummer
Lagena acuticosta Reuss

PALEOCENE SPECIES FROM MARYLAND

Species of Paleocene Foraminifera from Maryland have already been extensively noted in Maryland Survey publications. In addition to species previously reported from the Crisfield well (McLean 1950), *Vaginulinopsis rancocasensis* (Jennings) was found at 802 to 860 feet.

PALEOCENE SPECIES FROM VIRGINIA

Works by Cederstrom (1945, 1950) indicate the presence of possible Paleocene species in strata from the Coastal Plain of Virginia. The writer has failed to identify Paleocene guide species from the Layne-Atlantic Franklin Well No. 4, although Cederstrom (1945, p. 260) reports "Naheola" species in a well at Franklin and noted *Robulus midwayensis* (Plummer) in this interval. The writer found a single specimen of *Robulus midwayensis* var. *virginianus* Shifflett in the Layne well, but this species is not a guide for the Paleocene, having been found higher in the column.

Cederstrom (1950) mentions a possible thin Paleocene stratum from a well at Washington's Birthplace, Virginia, but no specimens from here have been seen by the writer. The only other possible Paleocene occurrence thus far noted from Virginia, consists of several specimens of *Nodosaria affinis* from wells in the York Peninsula, and more definitively, several specimens of *Vaginulinopsis rancocasensis* from a well at Fort Eustis in the York peninsular area. These are considered by the author to be either redeposited in younger sediments or to be the earliest beginning of a Paleocene stratum at the well base.

PALEOCENE SPECIES FROM NORTH CAROLINA

Two wells were drilled in the Washington, North Carolina area, both of which contain a definite Paleocene fauna. There is good correlation between the Washington, North Carolina, Paleocene and the New Jersey "Hornerstown" Paleocene.

Locality 9. Layne-Atlantic well drilled at Washington, North Carolina in 1947 (samples donated by Paul Schweitzer).

at 101 to 134 feet:
- *Robulus midwayensis* (Plummer)
- *Vaginulina loeblichi* McLean, n. sp.

at 134 to 148 feet:
- *Vaginulinopsis rancocasensis* (Jennings)
- *Nodosaria affinis* Reuss, especially abundant at 148 to 152 feet
- *Robulus midwayensis* (Plummer), abundant
- *Vaginulina loeblichi* McLean, n. sp., abundant
- *Cibicidoides* cf. *C. mortoni* (Reuss)
- *Dentalina annloomisae* McLean, n. sp.
- *Frondicularia richardsi* McLean, n. sp.
- *Pseudoglandulina pygmaea* (Reuss)
- *Robulus discus* Brotzen
- *Vaginulina longiforma* (Plummer)

Locality 10. Well at Washington Air Port, 5 miles northeast of Washington, North Carolina. Samples from this well were very small and the Foraminifera were thus not so abundant as in the case of other samples studied.

at 155 to 200 feet:
- *Vaginulina loeblichi* McLean, n. sp.
- other forms

at 200 to 215 feet:
- *Nodosaria affinis* Reuss
- *Vaginulina loeblichi* McLean, n. sp.
- *Robulus klagshamnensis* Brotzen

The formations to which the exposures listed in this paper have been ascribed by others are apparently in some error so far as present correlations would indicate. The Vincentown formation in particular has uniformly been considered as Eocene in age; whereas the Hornerstown formation has only partly been ascribed to a Paleocene (Midway) age. In the light of the foraminiferal species found and here described, the listed samples must be considered, paleontologically at least, to be equivalent to the Midway (Paleocene) developed elsewhere in the United States. If not of Midway age, these samples must be placed in an older stratigraphic position, inasmuch as they are found below established Midwayan guide species in well sections.

DESCRIPTION OF SPECIES

Family LAGENIDAE

Subfamily NODOSARIINAE

Genus **Robulus** Montfort, 1808

Robulus discus Brotzen

Plate 4, figure 1

Robulus discus Brotzen, 1948, Sveriges Geol. Undersoknings, Arsbok 42, No. 2, pp. 42-43, pl. 7, figs. 3-5, text fig. 7.

"Test large, diameter up to 4 mm, convex in the young, strongly compressed in the adult. Peripheral margin acute or slightly keeled, generally lobated at the last sutures. Umbo distinctly elevated, small. Chambers 6-9 in the last whorl. Sutures distinct, curved, transparent, not or only very slightly depressed, rarely finely costated. Aperture long, radiate at the upper end. Wall smooth, rarely with solitary ridges crossing the sutures." Diameter of figured hypotype: 1.95 mm.

Remarks.—According to Brotzen this species is quite variable in several characteristics. Our figured specimen differs in some respects from Brotzen's type, but seems close enough to be referred to this species, most closly resembling Brotzen's fig. 4, pl. 7. A single specimen of the species was found in North Carolina.

Types and Occurrences.—Figured hypotype (U.S.N.M. No. 547467) from the Layne-Atlantic well at 141 to 148 feet, Washington, North Carolina.

Robulus jerseyanus McLean, n. sp.
Plate 4, figure 2

Robulus cf. *R. piluliferus* SHIFFLETT, 1948, Md. Bd. Nat. Res., Dept. Geol., Mines, and Water Resources, Bull. 3, p. 23, pl. 5, fig. 11.

Test of medium size for the genus, somewhat longer than broad, closely coiled, quite thick through the umbonal region, round; periphery angular, with a thick flange or blunt keel; 9 or more chambers in the holotype, chambers increasing only slightly in size as added; sutures represented by heavy raised ridges, irregularly but distinctly curved, merging into umbo and flange, occasionally connected by a crosswise ridge of equal thickness, sometimes merging into each other before reaching the prominent raised irregular umbo; wall thick, calcareous, smooth; aperture broken in all observed specimens. Length of holotype 1.56 mm; breadth 1.20 mm; thickness 0.78 mm.

Remarks.—This species, although based on incomplete specimens, nevertheless seems to be distinctive and its apparently restricted occurrence in closely correlative beds in New Jersey makes it worthy of record as a possible guide species.

Specimens obtained show considerable variation, especially in sutural details, but the thick test with its peculiarly irregular sutures and thick flange is easily identified. This species may be identical with the "*Robulus* cf. *R. piluliferus*" of Shifflett, although it is more irregular than Shifflett's figured specimen.

Types and Occurrences.—Figured holotype (U.S. N.M. No. 547468) from Locality No. 4, a sample near Harrisonville, Salem County, New Jersey, Horace G. Richards location; unfigured paratype from Locality No. 5, from 164 to 184 feet in depth in well near Van Hiseville, Ocean County, New Jersey. Unfigured paratype from Locality 2, outcrop sample from Shingle Run, tributary of Crosswicks Creek, 1 mile N. of New Egypt, Ocean County, New Jersey, Horace G. Richards location.

Robulus klagshamnensis Brotzen

Robulus klagshamnensis BROTZEN, 1948, Sveriges Geol. Undersoknings, Arsbok 42, No. 2, pp. 41-42, Pl. 7, fig. 1, 2.

Apparently typical specimens of Brotzen's species were found at localities 2, and 10 of this paper, at Washington, N. C., Airport well and the Shingle Run, New Jersey locality. Specimens found were either immature or too badly broken to warrant illustration as typical specimens, and the reader is referred to Brotzen's description.

Robulus midwayensis (Plummer) Cushman

Cristellaria midwayensis PLUMMER, (1926) 1927, Univ. Texas Bull. 2644, p. 95, Pl. 13, figs. 5a-c.

Robulus midwayensis CUSHMAN and TODD, 1946, Contr. Cushman Lab. Foram. Res., vol. 22, p. 47, pl. 7, fig. 7.

Typical specimens of this Paleocene species are found in most of the localities listed in this paper and in some places it occurs in considerable numbers. Although reported from Eocene beds, the species appears to be highly diagnostic for the Paleocene, and reported later occurrences should be checked for the possibility that they should be referred to *Robulus midwayensis* var. *virginianus* Shifflett.

Robulus virginianus Shifflett

Robulus midwayensis var. *virginianus* SHIFFLETT, 1948, Md. Bd. Nat. Res., Dept. Geol., Mines, and Water Resources, Bull. 3, p. 48, pl. 1, figs. 15, 16.

This species was found at Franklin, Virginia in a well sample donated by Layne-Atlantic Company of Norfolk. It was first described from the Virginia Aquia formation of Eocene Age and is not diagnostic for the Paleocene. The species is here recorded as being possibly the same as *Robulus midwayensis* of Cederstrom. The variety is herewith elevated to specific rank. *Robulus virginianus* is very similar to *Robulus midwayensis* (from which it doubtless evolved) and requires careful separation.

Robulus piluliferus Cushman

Robulus piluliferus CUSHMAN, 1947, Contr. Cushman Lab. Foram. Res., vol. 23, p. 83, pl. 18, fig. 4.

Small specimens of this species were noted in material from the Point Pleasant, New Jersey, well at 420 to 430 feet and identified by Miss Ruth Todd, as apparently typical although small. *Robulus jerseyanus* McLean, n. sp. seems similar to Shifflett's figured "*Robulus* cf. *R. piluliferus*" but *R. jerseyanus* is not similar to the type of *R. piluliferus*.

Cushman's description further eliminates *R. jerseyanus* from possible confusion with *R. piluliferus* in that *R. jerseyanus* does not at all resemble *R. midwayensis*, while *R. piluliferus* apparently does resemble it to some degree.

Robulus pseudomamilligerus (Plummer)

Cristellaria pseudo-mamilligera PLUMMER, 1926 (1927), Univ. Texas Bull. 2644, p. 98, pl. 7, fig. 11.

Robulus pseudo-mamilligerus CUSHMAN and TODD, 1946, Contr. Cushman Lab. Foram. Res., vol. 22, p. 47, pl. 7, fig. 10.

Typical specimens of this species, described by Mrs. Plummer from the Texas Midway formation, occur in some abundance at several levels in the Point Pleasant, N. J., well.

Robulus turbinatus (Plummer)

Cristellaria turbinata PLUMMER, 1926 (1927), Univ. Texas Bull. 2644, p. 93, pl. 7, fig. 4; pl. 13, fig. 2.
Robulus turbinatus CUSHMAN and TODD, 1946, Contr. Cushman Lab. Foram. Res., vol. 22, p. 47, pl. 7, fig. 11.

One quite typical speciman was found at Noxonton Pond, Delaware. Specimens from other locations may also eventually be referred to this species, but require further study.

Genus **Darbyella** Howe and Wallace, 1933

Darbyella n. sp. ?

A single specimen of this genus was found at locality 5, at 164 to 184 feet in the well at Van Hiseville. Until additional specimens are obtained it seems inadvisable to describe it as a new species.

Genus **Planularia** Defrance, 1824

Planularia crosswicksana McLean, n. sp.

Plate 4, figure 3

Test large, much compressed, longer than broad, involute, periphery keeled except possibly in the later portion, keel thin, periphery lobate in later portion; about 9 chambers in the last whorl, generally rapidly increasing in size as added; sutures distinct, depressed in the later portion, with raised ridges in the early portion, rather strongly curved; wall smooth, white; apertural face narrow, with raised ridges outlining edge; aperture a narrow, elongate, radiate opening situated on the outer peripheral angle of the last chamber, protruding. Length of holotype 2.63 mm; width 2.03 mm; thickness 0.65 mm.

Remarks.—This species seems distinctive although yet represented by only a single specimen. *Planularia crosswicksana* seems to superficially resemble specimens of *Robulus klagshamnensis* Brotzen, which also occurs at this locality, but the similarity is only in the generally large size and the compression of the test. *P. crosswicksana* differs from Brotzen's species in being even more compressed and in not showing the keel in the coil as it enters the test, and in lacking the umbo of *R. klagshamnensis.*

Types and Occurrences.—Figured holotype (U.S. N.M. No. 547469) from outcrop on Shingle Run, tributary of Crosswicks Creek, 1 mile north of New Egypt, Ocean County, New Jersey, Horace G. Richards locality.

Genus **Marginulina** d'Orbigny, 1826

Marginulina cf. **M. hamata** (Franke)

Marginulina cf. *M. hamata* CUSHMAN and TODD, 1946, Contr. Cushman Lab. Foram. Res., vol. 22, p. 49, pl. 7, figs. 19, 20.

A specimen was found at Noxonton Pond, Delaware, which seems similar to *Marginulina* cf. *M. hamata* (Franke) as noted by Cushman and Todd.

Genus **Vaginulinopsis** Silvestri, 1904

Vaginulinopsis rancocasensis (Jennings)

Plate 4, figure 10

Hemicristellaria rancocasensis JENNINGS, 1936, Bull. Amer. Paleon., vol. 23, No. 78, p. 17, pl. 2, fig. 2.

"Test elongate, slightly compressed, periphery nearly rounded; early chambers (4 to 5) coiled, compressed, later chambers (6 to 8) evolute; sutures limbate and raised and curved, sutures in the coiled portion almost as large as the chambers; last two or three chambers inflated in the center, the inflation dying out towards the margins, the sutures showing as narrow transverse ridges in the depressed portion between the inflated portions of the chambers; aperture marginal, radiate, produced. Length 1.40 mm; width 0.50 mm; thickness 0.26 mm."

Remarks.—The genus *Hemicristellaria* is invalid as the genotype is rounded in section rather than compressed, rendering it an exact synonym of the genus *Marginulina.* The genotype of *Marginulina,* however, does not have the early coiling of many species since assigned to the genus. *Hemicristellaria-like* or compressed, coiled forms with a later uncoiled portion are best referred to *Vaginulinopsis. Vaginulinopsis rancocasensis* (Jennings) is valuable as a guide for the Paleocene of the Atlantic region, occurring below *Vaginulinopsis tuberculata* (Plummer), a well-known Midwayan guide fossil.

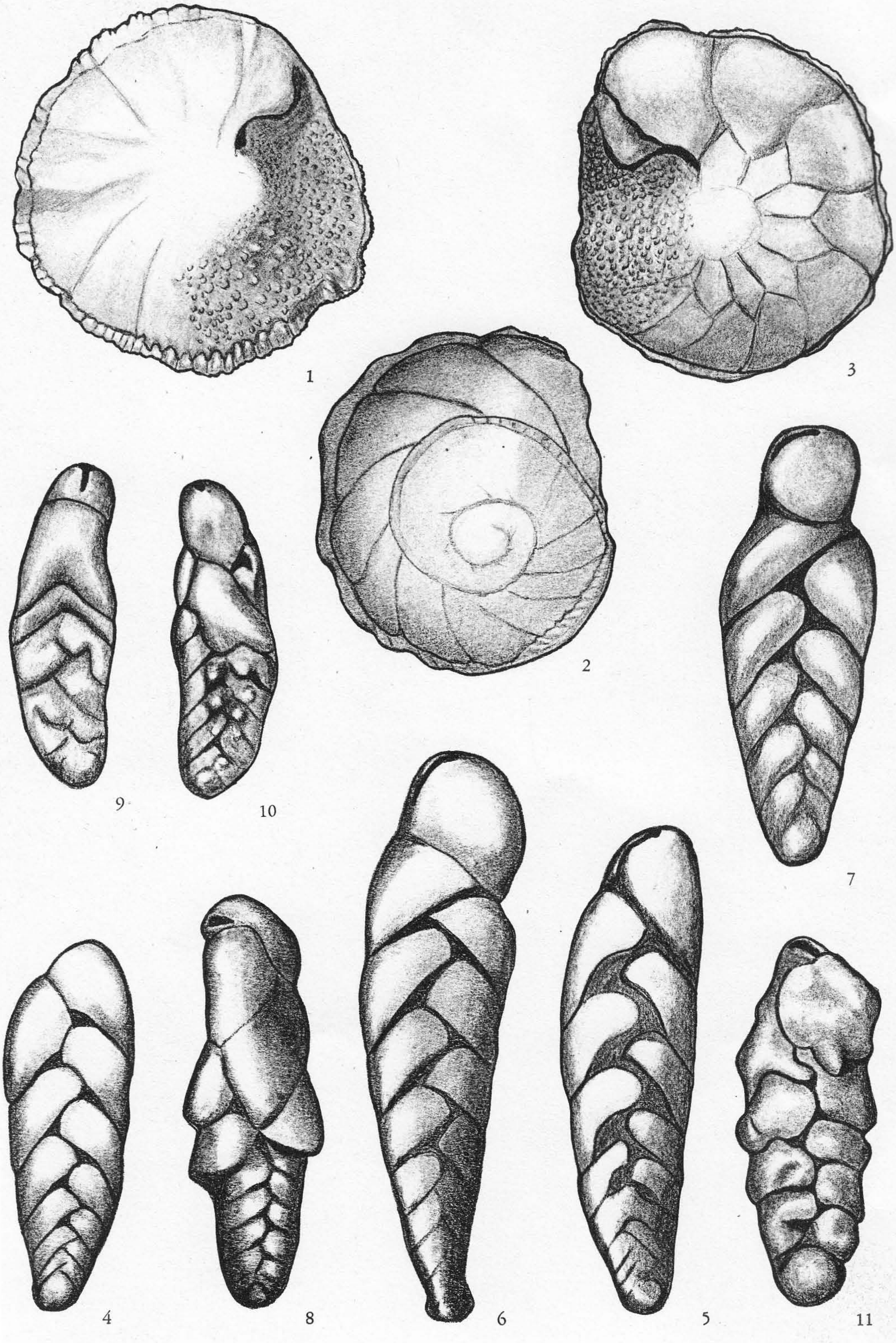
Types and Occurrence.—Figured hypotype (U.S. N.M. No. 547470) from 164 to 184 feet from a well at Van Hiseville, Ocean County, New Jersey. Horace G. Richards locality.

Vaginulinopsis tuberculata (Plummer)

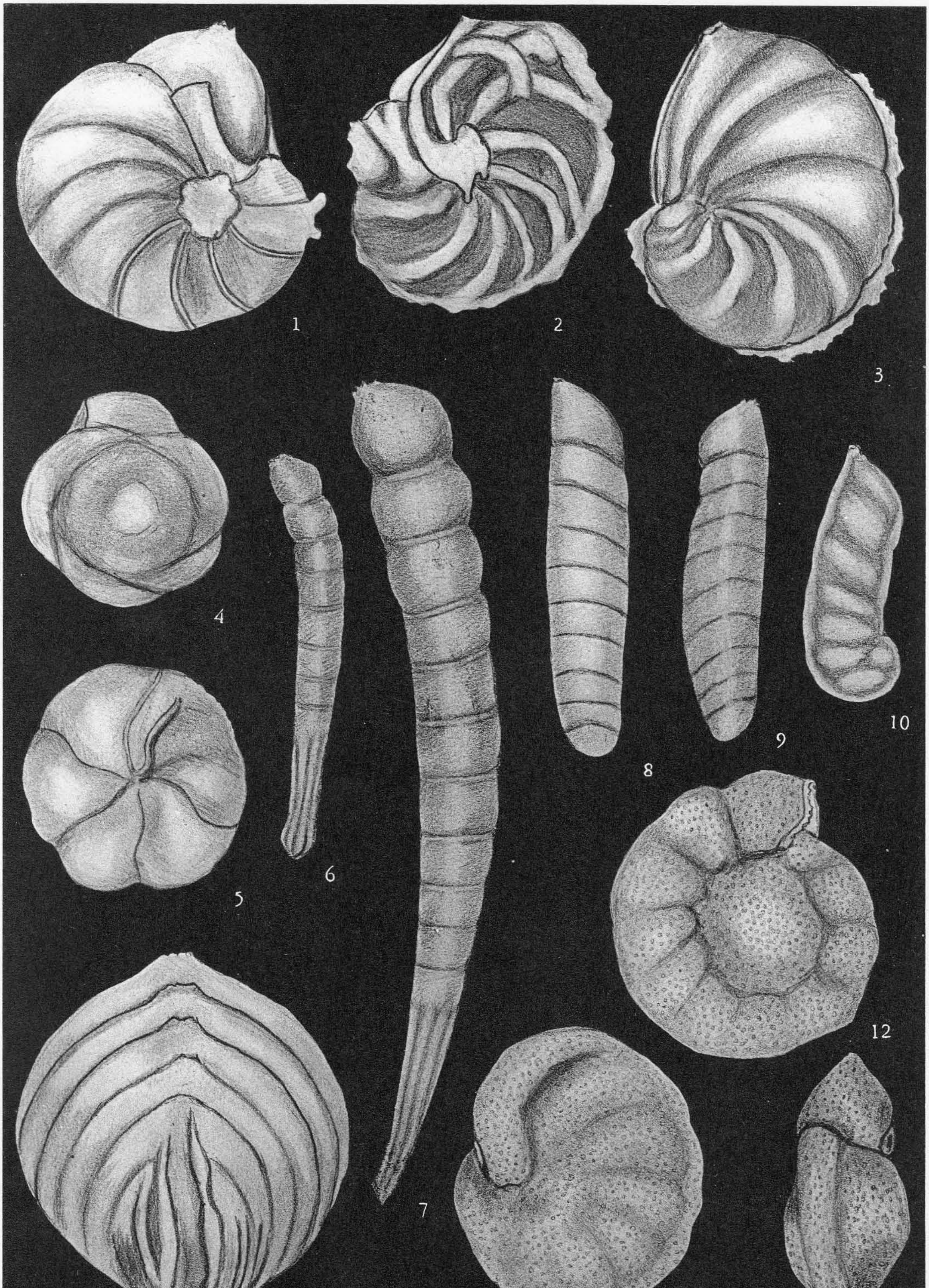
Cristellaria subaculeata var. *tuberculata* PLUMMER, 1926 (1927), Univ. Texas Bull. 2644, p. 101, pl. 7, fig. 2; pl. 14, fig. 1.
Marginulina cf. *M. subaculeata* var. *tuberculata* CUSHMAN, 1948, Md. Bd. Nat. Res., Dept. Geol., Mines and Water Resources, Bull. 2, p. 228, pl. 16, fig. 12.

EXPLANATION OF PLATE 3

FIGS.		PAGE
1-3.	*Asterigerina tatumi* Hussey, n. sp. 1, Paratype, 2-3, Holotype, both from Humble Oil and Refining Co. No. 1 James, Clark Co., Alabama. × 71.	19
4-8.	*Loxostomum gemmum* (Cushman) Cushman. Specimens from U. S. G. S. locality No. 8211, 4.5 miles east of Washington, in creek ½ mile north of Reed's store, Hempstead County, Arkansas. × 77.	19



Hussey, Eocene *Asterigerina* and Cretaceous *Loxostomum*



McLean, Paleocene Foraminifera

Typical specimens of *Vaginulinopsis tuberculata* occur widely in Maryland and New Jersey localities of the uppermost Paleocene, and are associated with *Ellipsonodosaria midwayensis* in at least two well locations. *V. tuberculata* has been a Paleocene (Midway) guide for the Gulf Region since its first description by Mrs. Plummer. Like *Vaginulinopsis rancocasensis,* this species is best referred to the genus *Vaginulinopsis.*

Genus **Dentalina** d'Orbigny, 1826

Dentalina annloomisae McLean, n. sp.

Plate 4, figures 6, 7

Dentalina sp. CUSHMAN, 1940, Contr. Cushman Lab. Foram. Res., vol. 16, p. 58, pl. 10, figs. 20, 21.

Test large, arcuate, with a tapering initial end in the microspheric form, and an enlarged initial chamber with a small indistinct initial spine in the megalospheric form; 11 chambers visible in the microspheric form and 8 in the megalospheric form, early chambers obscured in both generations by the heavy longitudinal ridges of the initial portion of the test; chambers range from almost cylindrical in the early unobscured portion to globular in the later portion; sutures consist of constricted bands of lighter color between the chambers; wall smooth, imperforate, glistening, early portion of test with 8 to 9 heavy longitudinal costae, some of which deviate from the general axis of the test; aperture terminal, slightly produced, radiate.

Length of microspheric holotype 6.24 mm; greatest diameter 0.73 mm, length of megalospheric paratype 3.38 mm; greatest diameter 0.49 mm.

Remarks.—The *Dentalina* sp. illustrated from the Alabama Paleocene by Cushman seems to belong to this species. *Dentalina annloomisae* differs from Mrs. Plummer's *Nodosaria pomuligera* (Stache) in the costate initial portion and in the cylindrical shape of early chambers. Broken portions not showing these characteristic features would be easily mistaken for Plummer's species, however. This new species seems to be remarkably constant in size and other characters, in the two localities where it has been found thus far. The megalospheric form appears to have one more costa than the microspheric form and does not taper as much, even allowing for the swollen initial chamber.

Named for Mrs. Ann McLean Loomis, who illustrated this paper.

Types and Occurrences.—Figured microspheric holotype (U.S.N.M. No. 547471) and megalospheric paratype (U.S.N.M. No. 547472) from sample at 164 to 184 feet in well at Van Hiseville, Ocean County, New Jersey, Horace G. Richards locality. Unfigured paratype from Layne Atlantic well at Washington, N. C., sample from 134 to 148 feet.

Dentalina cf. **D. mucronata** Neugeboren

Dentalina cf. *D. mucronata* CUSHMAN and TODD, 1942, Contr. Cushman Lab. Foram. Res., vol. 18, p. 28, pl. 5, fig. 13.

A specimen comparable to those in the Cushman Collection was found at Noxonton Pond, Delaware.

Genus **Nodosaria** Lamarck, 1812

Nodosaria affinis Reuss

Nodosaria affinis PLUMMER, 1926 (1927), Univ. Texas Bull. 2644, pp. 89-91, pl. 14, figs. 2a-d; CUSHMAN, 1948, U. S. Geol. Surv. Prof. Paper 206, p. 70, pl. 25, figs. 8-23.

Coastal Plain specimens of *Nodosaria affinis* varied from straight to arcuate and were also variable in size and costation. They cannot be separated into distinct species however, and references indicate that *Nodosaria affinis* as now understood is highly variable. Our specimens are closer to those of Mrs. Plummer's than those of Cushman's Professional Paper 206, but differ from Mrs. Plummer's description in that a number of Atlantic Coast specimens are arcuate and perhaps should be referred to *Dentalina* rather than *Nodosaria.* It is obvious that *N. affinis* needs considerable clarification both as to genus and species, but until a more comprehensive study is made, the Atlantic specimens can best be referred to this species, and their presence and frequent abundance in Paleocene sediments is a valuable accessory guide to the age. The writer is convinced that other beds of the Coastal Plain will not

EXPLANATION OF PLATE 4

FIGS.		PAGE
1.	*Robulus discus* Brotzen. Side view of hypotype.	22
2.	*Robulus jerseyanus* McLean, n. sp. Side view of holotype.	23
3.	*Planularia crosswicksana* McLean, n. sp. Side view of holotype.	24
4-5.	*Eponides lunata* Brotzen. 4, Dorsal view of hypotype (U.S.N.M. No. 547477); 5, ventral view of hypotype (U.S.N.M. No. 547476).	28
6-7.	*Dentalina annloomisae* McLean, n. sp. 6, Side view of megalospheric paratype; 7, side view of microspheric holotype.	25
8-9.	*Vaginulina loeblichi* McLean, n. sp. 8, Side view of holotype; 9, side view of paratype.	26
10.	*Vaginulinopsis rancocasensis* (Jennings). Side view of hypotype.	24
11.	*Frondicularia richardsi* McLean, n. sp. Side view of holotype.	26
12-14.	*Cibicidoides cederstromi* McLean, n. sp. 12, dorsal view of paratype (U.S.N.M. No. 547479); 13, ventral view of paratype (U.S.N.M. No. 547480); 14, apertural view of holotype (U.S.N.M. No. 547478).	28

show the development of this species that is evident within the Paleocene, except when reworked.

Nodosaria cf. **N. longiscata** d'Orbigny

Nodosaria longiscata PLUMMER, 1926 (1927), Univ. Texas Bull. 2644, p. 82, pl. IV, figs. 17 a-b.

Specimens possibly identical with Mrs. Plummer's species were found at 320 to 390 feet in the Point Pleasant well and many were also encountered in the Pine Valley well, both in New Jersey.

Genus **Pseudoglandulina** Cushman, 1929

Pseudoglandulina manifesta (Reuss)

Pseudoglandulina manifesta CUSHMAN, 1940, Contr. Cushman Lab. Foram. Res., vol. 16, p. 60, pl. 11, fig. 1.

Typical specimens of this species occur in the Pine Valley, New Jersey, well, and the Van Hiseville, New Jersey, well.

Pseudoglandulina pygmaea (Reuss)

Pseudoglandulina pygmaea CUSHMAN, 1940, Contr. Cushman Lab. Foram. Res., vol. 16, p. 60, pl. 11, fig. 4.

Typical specimens of this species occur at location 9, at 134 to 148 feet in the Washington, North Carolina, well.

Genus **Vaginulina** d'Orbigny, 1826

Vaginulina loeblichi McLean, n. sp.

Plate 4, figures 8, 9

Test elongate, somewhat compressed, sides roughly parallel, dorsal side straight except near the initial portion, where it curves, ventral side usually gently curved, in some specimens lobulate due to unequal development of later chambers, last chamber sharply sloping towards the aperture; initial chamber round, not inflated, later chambers much broader than long, chambers distinct, about 9 in the adult, exclusive of the proloculum; periphery gently rounded, in cross section the test has a flattened ellipsoidal shape; sutures distinct, very slightly if at all depressed, slanting downward from dorsal side, slightly limbate, translucent; wall smooth, white, calcareous, imperforate, unornamented; aperture radiate, slightly protruding from the dorsal angle. Length of holotype 2.03 mm; width of holotype 0.49 mm; thickness of holotype 0.34 mm; length of paratype 2.08 mm; width of paratype 0.55 mm; thickness of paratype 0.44 mm.

Remarks.—This species so far seems to be a good guide fossil for the Paleocene of the Atlantic region, where it has not been observed in higher strata. It is widely distributed and is easily recognized by its compressed, roughly rectangular shaped test and its sloping sutures.

Named for Dr. A. R. Loeblich, Jr., U. S. National Museum.

Types and Occurrences.—Figured holotype (U.S.N.M. No. 547473) from sample at 119-134 feet in well at Washington, North Carolina; figured paratype (U.S.N.M. No. 547474) from outcrop of the Vincentown formation at Shingle Run, New Egypt, New Jersey (Locality 2).

Vaginulina longiforma (Plummer)

Cristellaria longiforma PLUMMER, 1926 (1927), Univ. Texas Bull. 2644, p. 102, pl. 13, figs. 4a-b.

Vaginulina longiforma CUSHMAN and TODD, 1946, Contr. Cushman Lab. Foram. Res., vol. 22, p. 54, pl. 9, figs. 13, 14.

Specimens of this guide form occur at 164 to 184 feet in the Van Hiseville, New Jersey, well, and at 134 to 148 feet in the Washington, North Carolina, well.

Genus **Palmula** Lea, 1833

Palmula cf. **P. budensis** (Hantken)

Palmula budensis CUSHMAN and TODD, 1946, Contr. Cushman Lab. Foram. Res., vol. 22, p. 55, pl. 9, figs. 21, 22.

A single specimen from an outcrop of the Hornerstown formation at locality 3, tributary of Crosswicks Creek, 1.8 miles from New Egypt, New Jersey, is markedly larger than specimens in the Cushman Collection referred to Hantken's species. In all other respects this specimen seems similar.

Genus **Frondicularia** Defrance, 1826

Frondicularia naheolensis Cushman and Todd

Frondicularia naheolensis CUSHMAN and TODD, 1942, Contr. Cushman Lab. Foram. Res., vol. 18, p. 33, pl. 6, figs. 5, 6.

A single specimen from the same locality as *Palmula budensis* above is similar to Cushman and Todd's specimens in the Cushman Collection.

Frondicularia richardsi McLean, n. sp.

Plate 4, figure 11

Test large, flat, decidedly round in outline, except for the initial portion and the protruding aperture, widest at midportion of test, with a large inflated proloculum, periphery truncate, flat; chambers have a very rounded chevron shape, 6 observed in holotype, others obscured by the heavy longitudinal costae, chambers increase in size as added but apparently not in height; sutures distinct except where interrupted by the longitudinal costae, limbate, with the produced aperture clearly outlined between chambers, sutures excavated in later portion of test, slightly raised in the early portion; wall calcareous, porcellaneous, smooth or slightly pitted, but not perforate, wall ornamented in early portion by heavy longitudinal costae of irregular length and thickness, most highly developed on the proloculum, other lesser longitudinal ridges form along the peripheral junction of the chevron chambers, sometimes interrupting the periphery; aperture protruding, truncate, toothed, an elongate slit when viewed from top with the elongation parallel to the compression of the test. Length of holotype 2.70 mm; width of holotype 1.82 mm.

Remarks.—This species is distinct from previously described species, although it seems closest to Brotzen's description of *Palmula robusta* (Brotzen, 1948, Sveriges Geol. Undersokning, Arsbok 42, No. 2, p. 45). However, it does not faintly resemble Brotzen's figure for *P. robusta*. Brotzen's *Palmula robusta* would seem to better fit the genus *Frondicularia*, because of the straight (uncoiled) initial stage in the megalospheric form as illustrated by him.

The species is named in honor of Dr. Horace G. Richards of the Academy of Natural Sciences of Philadelphia.

Types and Occurrences.—Figured holotype (U.S. N.M. No. 547475) from Layne-Atlantic's Washington, North Carolina, well at a depth of 141 to 148 feet. Unfigured specimens from the Vincentown formation, Shingle Run near New Egypt, New Jersey (locality 2).

Subfamily LAGENINAE

Genus **Lagena** Walker and Jacob, 1798

Lagena cf. **L. acuticosta** Reuss

Lagena cf. *acuticosta* CUSHMAN, 1940, Contr. Cushman Lab. Foram. Res., vol. 16, p. 63, pl. 11, fig. 5.

This species was found at Noxonton Pond, Delaware.

Genus **Oolina** d'Orbigny, 1839

Oolina cf. **O. crumenata** (Cushman)

Entosolenia crumenata CUSHMAN and TODD, 1942, Contr. Cushman Lab. Foram. Res., vol. 18, p. 37, pl. 6, fig. 28.

Some specimens questionably assigned to *Oolina crumenata* occur at Noxonton Pond, Delaware. Cushman placed the genus *Oolina* in synonymy with *Lagena*, but it seems that *Oolina* should replace *Entosolenia* on the basis of priority, and because the "Entosolenian tube" seems to be a characteristic of the original *Oolina*. The genus *Oolina* is here placed within the Lageninae as a matter of convenience, until its real placement can be noted.

Family POLYMORPHINIDAE

Subfamily POLYMORPHININAE

Genus **Guttulina** d'Orbigny, 1839

Guttulina problema d'Orbigny

Guttulina problema CUSHMAN and TODD, 1946, Contr. Cushman Lab. Foram. Res., vol. 22, p. 56, pl. 10, fig. 1.

This widely distributed species seems to be present at Noxonton Pond, Delaware.

Genus **Sigmoidella** Cushman and Ozawa, 1928

Sigmoidella plummerae Cushman and Ozawa

Sigmoidella plummerae CUSHMAN and OZAWA, 1930, U. S. Nat. Mus. Proc., vol. 77, Art. 6, p. 142, pl. 39, fig. 3.

This species was found at 420 to 430 feet in the Point Pleasant well in New Jersey.

Genus **Polymorphina** d'Orbigny, 1826

Polymorphina cushmani Plummer

Polymorphina cushmani PLUMMER, 1926 (1927), Univ. Texas Bull. 2644, p. 125, pl. 6, fig. 9; pl. 15, figs. 1a-c.

A single juvenile specimen of this species occurred at 524 feet in the Point Pleasant, New Jersey, well.

Polymorphina subrhombica Reuss

Polymorphina subrhombica JENNINGS, 1936, Bull. Amer. Pal., vol. 23, No. 78, p. 25, pl. 3, fig. 7.

Typical specimens of this species occur at Shingle Run (locality 2), and at 164 to 184 feet in a well at Van Hiseville, New Jersey, (locality 5) and the species may be of some value stratigraphically.

Family ELLIPSOIDINIDAE

Genus **Ellipsonodosaria** A. Silvestri, 1907

Ellipsonodosaria midwayensis Cushman and Todd

Ellipsonodosaria midwayensis CUSHMAN and TODD, 1946, Contr. Cushman Lab. Foram. Res., vol. 22, p. 61, pl. 10, fig. 25.

This species occurs in some abundance in the Pine Valley, New Jersey, well at 175 feet.

Family ROTALIIDAE

Subfamily DISCORBINAE

Genus **Gyroidina** d'Orbigny, 1826

Gyroidina subangulata (Plummer)

Gyroidina subangulata CUSHMAN, 1940, Contr. Cushman Lab. Foram. Res., vol. 16, p. 71, pl. 12, fig. 7.

Specimens apparently referable to this species were found at Noxonton Pond, Delaware.

Subfamily ROTALIINAE

Genus **Eponides** Montfort, 1808

Eponides lunata Brotzen

Plate 4, figures 4, 5

Eponides lunata BROTZEN, 1948, Sveriges Geol. Undersokning, Arsbok 42, No. 2, p. 77, pl. 10, figs. 17, 18.

"Test small, both sides conoidal, spiral side not as high as the umbilical side, with a somewhat more sharply elevated central part. Peripheral margin sharply acute and generally somewhat lobate; chambers 6-7 in the final whorl, on the spiral side crescent-shaped, sutures transparent, the last two or three a little depressed, on the umbilical side chambers slightly inflated, sutures curved, depressed, umbilicus lacking. Aperture under a narrow lip; wall smooth, very finely perforated, diameter up to 0.25 mm."

Remarks.—The figured specimens seem to agree with Brotzen's species very closely, particularly in the sutural characteristics, in which the species differs from *Eponides tenera* (H. B. Brady) which Brotzen notes as a close relative. Nor are the figured specimens as rotund as figured American specimens of *Eponides tenera.* There are only 5 chambers in the final whorl in our figured specimens in contrast to Brotzen's 6-7 for his species, but the other characteristics are so close that it seems best to refer the Pine Valley specimens to this Swedish Paleocene species.

Types and Occurrences.—Figured hypotypes (U.S. N.M. No. 547476 and U.S.N.M. No. 547477) found in a well at Pine Valley, New Jersey, at a depth of 175 feet.

Family CASSIDULINIDAE

Subfamily CERATOBULIMININAE

Genus **Ceratobulimina** Toula, 1915

Ceratobulimina perplexa (Plummer)

Rotalia perplexa PLUMMER, 1926 (1927), Univ. Texas Bull. 2644, p. 156, pl. 12, fig. 2.

Ceratobulimina perplexa CUSHMAN and HARRIS, 1927, Contr. Cushman Lab. Foram. Res., vol. 3, p. 173, pl. 29, fig. 2.

Specimens similar to this Paleocene species in every way but size were found in the Point Pleasant, New Jersey, well at 420 to 430 feet. Point Pleasant specimens are considerably larger than specimens in the Cushman Collection.

Family GLOBIGERINIDAE

Subfamily GLOBIGERININAE

Genus **Globigerina** d'Orbigny, 1826

Globigerina triloculinoides Plummer

Globigerina triloculinoides PLUMMER, 1926 (1927), Univ. Texas Bull. 2644, p. 134, pl. 8, figs. 10a-c.

Specimens apparently similar to Mrs. Plummer's species occur at several Atlantic Coastal Plain localities in this study, but the present state of chaos in this genus makes definite assignment somewhat doubtful.

Family ANOMALINIDAE

Subfamily ANOMALININAE

Genus **Anomalina** d'Orbigny, 1826

Anomalina cf. **A. midwayensis** (Plummer)

Truncatulina midwayensis PLUMMER, 1926 (1927), Univ. Texas Bull. 2644, p. 141, pl. 9, figs. 7a-c; pl. 15, figs. 3a-b.

A single specimen, questionably referred to Mrs. Plummer's species, was found at 164 to 184 feet in the Van Hiseville, New Jersey, well.

Genus **Cibicidoides** Brotzen, 1935

Glaessner notes (1945, p. 148) that Brotzen describes *Cibicidoides* as a subgenus of *Cibicides,* to include biconvex, *Cibicides*-like forms. *Cibicidoides,* in the present author's opinion, should be raised to full generic rank and placed in the subfamily Anomalininae, where it seems to fit best. Furthermore, it should be noted that the genus *Cibicidoides* includes species whose characteristics are similar in some ways to *Anomalina* and in some ways to *Cibicides,* and that the genus *Cibicidoides* is perhaps the evolutionary link between the two forms.

Cibicidoides cederstromi McLean, n. sp.

Plate 4, figures 12-14

Test biconvex, less convex on dorsal side than on ventral; periphery lobate in outline, especially in later portion of test, the periphery a more or less well developed, rounded rim which is sharply incised ventrally, appearing to be a flange when viewed ventrally; chambers of dorsal side number about 11 in last-formed whorl, early chambers obscured by secondary tissue, but dorsal coil is evolute; chambers inflated, especially in later portion; chambers involute on ventral side, slightly inflated, indistinct; sutures of dorsal side limbate and depressed in last portion of final whorl, obscured in early portion, sutures of ventral side gently curved, deeply depressed in later part, indistinct in early part of whorl; umbilicus lacking; wall smooth, calcareous, coarsely perforate; aperture an arched slit extending from dorsal into the ventral side where it terminates at about the peripheral angle of the tumid ventral side, aperture extending along part of the dorsal sutural coil.

Holotype (U.S.N.M. No. 547478): diameter 0.78 mm, thickness 0.39 mm; paratype (U.S.N.M. No. 547479): diameter 0.78 mm, thickness 0.47 mm; paratype (U.S.N.M. No. 547480): diameter 0.81 mm, thickness 0.42 mm.

Remarks.—This species is similar to *Cibicidoides mortoni* (Reuss), but is thicker in proportion to diameter, is not umbilicate, and appears to be more lobate peripherally, as well as having a distinct peripheral rim.

Named in honor of Dr. D. J. Cederstrom, Geologist, U. S. Geological Survey.

Types and Occurrences.—Holotype and paratypes are all from an outcrop of the Vincentown formation, 1.1 miles north of New Egypt, Horace G. Richards locality (locality 2).

Cibicidoides cf. C. mortoni (Reuss)

Cibicides mortoni Jennings, 1936, Bull. Amer. Pal., vol. 23, No. 78, p. 38, pl. 5, figs. 5a-c.

Specimens compared to this species occur at New Egypt, New Jersey, and Washington, North Carolina.

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Richards, Horace G., 1945, Subsurface stratigraphy of Atlantic Coastal Plain between New Jersey and Georgia: Bull. Amer. Assoc. Petrol. Geol., vol. 29, No. 7, pp. 885-955.

Shifflett, Elaine, 1948, Eocene stratigraphy and Foraminifera of the Aquia Formation: Md. Bd. Nat. Res., Dept. Geol., Mines and Water Resources Bull. 3.

Manuscript received November 9, 1950

28. *GLOBOROTALIA LACERTI* CUSHMAN AND RENZ FROM THE LIZARD SPRINGS FORMATION OF TRINIDAD, B. W. I. (A CORRECTION).

H. H. Renz
Mene Grande Oil Company, Caracas, Venezuela

During a recent survey of the genus *Globorotalia* in the Upper Cretaceous and Paleocene of Venezuela and Trinidad, the writer discovered a regrettable error in the publication by Cushman and Renz entitled "The foraminiferal fauna of the Lizard Springs formation of Trinidad, British West Indies" (Cushman Laboratory For Foraminiferal Research, Special Publication No. 18 (1946)).

The species described under the name *Globorotalia lacerti* Cushman and Renz, n. sp. (p. 47) is figured on plate 8, figures 11 and 12 (not 13 and 14), and *Globorotalia velascoensis* (Cushman) (p. 47) refers to figures 13 and 14 (not 11 and 12) of the same plate. In order to verify this error, paratypes of *Globorotalia lacerti* Cushman and Renz have been kindly supplied for study by the Smithsonian Institution of the United States National Museum, and the holotype has been checked by Miss Ruth Todd.

Globorotalia lacerti Cushman and Renz occurs in both the lower and upper Zone of the Lizard Springs formation of Trinidad. In the Rio Querecual section of Eastern Venezuela, the species has recently been found in the upper half of the Vidoño formation (Contr. Cushman Lab. Foram. Vol. 23, Pt. 1, 1947) where it is associated with a foraminiferal assemblage containing most of the species which also occur in the Lizard Springs of Trinidad. This indicates a correlation of the Lizard Springs of Trinidad with the upper part of the Vidoño formation of Eastern Venezuela. At Rio Querecual this assemblage occurs within the range of *Orbignyana pyrei* Cushman (ibid., p. 8) which is further proof for the Cretaceous age of the Vidoño formation and indirectly also of the Lizard Springs formation of Trinidad. This is contrary to the opinion recently expressed by Bolli (Contr. Cushman Foundation Foram. Res. Vol. 1, pts. 3 and 4, Nov. 1950, pp. 85-86), who favors a Paleocene age for the Lizard Springs formation.

Manuscript received January 31, 1951

RECENT LITERATURE ON THE FORAMINIFERA

Below are given some of the more recent works on the foraminifera that have come to hand:

DUNBAR, CARL O. Permian Fusulines from the Karakoram.—Records Geol. Survey India, vol. 75, May 1940, Professional Paper No. 5, 5 pp., 1 pl.—Description of two Parafusulinas, one new, one undeterminable.

MOROSOWA, W. G. Foraminiferen aus Unterkreide-Ablagerungen des Gebietes von Sotschi (West-Kaukasus) (in Russian).—Ber. Moskauer naturforsch. Gesellsch., n. ser., vol. 53, Geol. Abt., vol. 23 (pt. 3), 1948, pp. 23-43, pls. 1, 2, 1 table.—Thirty-four species and one variety, 4 species and one variety new, and one new name, are recorded and a few are figured. Text is in Russian.

SAMSONOWICZ, JAN. Cretaceous Deposits in Bore-Holes in Lodz and the Structure of the Lodz Basin (Central Poland).—Instit. Geol. Pologne, Bull. 50, 1948, pp. 1-47, text figs. 1-6.—**Oligostegina** is found as the chief component in certain beds.

BIEDA, F. Sur quelques Foraminifères nouveaux ou peu connus du Flysch des Karpates Polonaises.—Ann. Soc. Geol. Pologne, vol. 18, Année 1948, 1949, pp. 167-179, pls. 3, 4.—**Grzybowskia** n. gen. (genotype **G. multifida** n. sp.) of the family Camerinidae is described and figured, and a large **Bathysiphon** is discussed and figured.

LISZKA, S. Contribution a la connaissance de la microfauna du Cretace inferieur des environs de Tomaszow Mazowiecki (Pologne Centrale).—L. c., pp. 185-190, pl. 5.—Thirty-five species are recorded, of which 3 are new and are described and illustrated.

HOFKER, JAN. On Foraminifera from the Upper Senonian of South Limburg (Maestrichtian).—Mem. No. 112, Instit. Royal Sci. Nat. Belgique, Aug. 31, 1949, pp. 1-69, text figs. 1-23.—Forty-two species, 3 new, are recorded and many described and illustrated in detail. Numerous species, previously recorded from the upper Senonian, are placed in synonymy or regarded as micro- or megalospheric forms of other species. The author's method of sectioning to study internal structures is briefly described.

SAKAKURA, KATSUHIKO. On Statistic Study of Assemblages of Smaller Foraminifera in Applied Paleontology (English abstract).—Journ. Geol. Soc. Japan, vol. 55, No. 642-643, March-April 1949, pp. 44-48.

"Fossil aggregation"—referring especially to statistical studies of assemblage of smaller foraminifera (Japanese, with English abstract).—L. c., No. 647, August 1949, pp. 90-94.

NAKASEKO, KOJIRO, and KIYOSHI SAWAI. Foraminiferal Fauna of the Nakatsu Formation (Microbiostratigraphic study of the Cainozoic strata of Japan, series 1) (English abstract).—L. c., No. 650-651, Nov.-Dec. 1949, pp. 205-210.—This Pliocene formation is divided into two zones and nine zonules. Conditions of deposition are inferred.

VASICEK, M. Moravian Neogene Representatives of the Species **Vaginulina legumen** (Linnaeus), 1758.—Sbornik Service Geol. Repub. Tchecoslov., vol. 16, fasc. 1, 1949, pp. 329-399, pls. 1-15. (English Summary, pp. 367-382).—An important and well illustrated study of variation in individuals, differences between micro- and megalospheric specimens, ratios of dextral to sinistral specimens, and of the possible causes and the significance of such factors.

REICHEL, MANFRED. Sur un nouvel Orbitoide du Crétacé supérieur hellénique.—Eclogae geol. Helvetiae, vol. 42, No. 2, 1949, pp. 480-485, text figs. 1-10.—**Hellenocyclina** n. gen. (genotype **H. beotica** n. sp.).

Observations sur les **Globotruncana** du gisement de la Breggia (Tessin).—L. c., pp. 596-617, pls. 16, 17, text figs. 1-7.—Based on apertural and umbilical characters, 4 subgenera of **Globotruncana** are recognized: **Globotruncana** s. s., **Rotalipora**, **Thalmanninella**, and **Ticinella** n. subgen. (genotype **Anomalina roberti** Gandolfi). Twelve species and varieties, 1 species and 1 variety new, are described and illustrated.

BETTENSTAEDT, FRANZ. Neues aus der angewandten Mikropaläontologie (X), Nordwestdeutsches Paläozän und Eozän, Methodisches.—Oel und Kohle, vol. 40, 1944, pp. 77-87, text fig. 1, tables 1, 2.—Distribution and abundance of about 25 species of foraminifera are represented graphically in the Paleocene and 5 divisions of the Eocene.

Paläogeographie des nordwestdeutschen Tertiär mit besonderer Berücksichtigung der Mikropaläontologie.—"Erdöl und Tektonik in Nordwestdeutschland," Amt für Bodenforschung, Hannover-Celle, 1949, pp. 143-172, text figs. 1-6, table 1.

VAN DEN ABEELE, D. Lepidocyclinae from Rembang (Java) with description of **L. Wanneri** n. sp.—Kon. Nederl. Akad. Wetenschappen, Proc., vol. 52, No. 7, 1949, pp. 760-765, pl. 1, text figs. 1-4.

RUSCELLI, MARIA. Foraminiferi di due saggi di fondo del mar ligure.—Istit. Geol. Paleont. Geogr. Fis., Univ. Milano, ser. P, No. 62, 1949, pp. 1-31, pls. 1, 2. —Two bottom samples from the Ligurian Sea at 50 and 500 meters are studied and compared, the species from each listed and some figured. Comparisons are also made with the various faunas of the Mediterranean and the Italian Pleistocene.

MARTINIS, BRUNO. La microfauna dell' affioramento pliocenico di Casanova Lanza (Como).—L. c., No. 61, 1950, pp. 1-10, pl. 5.—Twenty-six species and one variety, none new, are recorded. Five species are figured.

CITA, M. B. L'Eocene della sponda occidentale del Lago di Garda.—Riv. Ital. Pal. Stratig., vol. 56, No. 3, 1950, pp. 81-113, pls. 6-9. Forty-eight species and varieties are described and figured, of which three are new.

LIPPARINI, T. "**Globotruncana Stuarti**" (De Lapp.) nel livello fosfatico Campaniano-Maestrichtiano della Tripolitania orientale.—Boll. Ufficio Geol. Italia, vol. 70, Ann. 1945-46 (1950), pp. 171-173, text figs. 1, 2.

MANFREDINI, M. and S. MOTTA. Affioramenti cretacei a Globotruncane nella regione del Monte Soratte.—L. c., pp. 183-191, 1 map.

KSIAZKIEWICZ, M. W sprawie wieku pstrych margli we fliszu Karpat Zachodnich (On the age of variegated marls in the Flysch of the Western Carpathians).—Ann. Soc. Geol. Pologne, vol. 19, fasc. 2, 1949 (1950), pp. 315-358, pl. 3, table 1.—The planktonic fauna in the marls are used to distinguish them; species of **Globotruncana** are mainly used to distinguish between the Cretaceous marls in the Flysch, while several species of **Globigerina** are mainly used in the Eocene marls.

AVNIMELECH, M. Sur les discontinuités dans le Crétacé supérieur de la Shephélâ (Palestine centrale).—C. R. S. Séances de la Soc. Géol. France, 1950, No. 2, séance du 23 janvier 1950, pp. 13-16.—Foraminifera are mentioned.

MURAOUR, P. Observations sur le Dellysien (Oligocène) d'Algérie.—L. c., No. 10, séance du 22 mai 1950, pp. 166-168.—Foraminifera are mentioned.

NEUMANN, M. and J. CUVILLIER. Sur la présence de **Hellenocyclina beotica** Reichel en Aquitaine occidentale.—L. C., No. 12, seance du 19 juin 1950, pp. 208, 209.

BATALLER, J. R. A propos de **Queraltina**, nouveau genre de Foraminifères de l'Eocène pyrénéen.—L. c., No. 14, séance du 20 novembre 1950, pp. 251, 252.—Correction of locality data.

COLOM, GUILLERMO. Estudio de los Foraminiferos de muestras de fondo recogidas entre los Cabos Juby y Bojador.—Bol. Instit. Espanol Oceanografia, No. 28, March 14, 1950, pp. 1-45, pls. 1-10, distribution table.—Over a hundred species and varieties, none new, are recorded and many figured from numerous bottom samples from 9 to 878 meters from off the west coast of Africa east of the Canary Islands. Distribution and abundance shown in a table, with the samples grouped into 3 zones.

FRIZZELL, DON L. and I. J. ANDERSON. Diastems in the Pecan Gap chalk of Travis County, Texas.—Journ. Sedimentary Petrology, vol. 20, No. 1, April 1950, pp. 55-59, text figs. 1-6.—Encrusting foraminifera on casts of mollusks are evidence for the presence of diastems.

KHAN, M. H. Note on the depth and temperature of the Gault Sea as indicated by Foraminifera.—Geol. Mag., vol. 87, No. 3, May-June 1950, pp. 175-180, table 1.—The author reinterprets available data to suggest a temperate and fairly shallow marine environment.

KUWANO, YUKIO. New Species of Foraminifera from the Pliocene Formations of Tama Hills in the Vicinity of Tokyo.—Journ. Geol. Soc. Japan, vol. 56, No. 657, June 1950, pp. 311-322, text figs. 1-13.—Six new species and one new subspecies are described and figured, and **Epistomariella**, new subgenus (genotype **Epistomaria (E.) miurensis** n. sp.) is erected. Frequency ratios of five forms of **Rotalia** are studied in connection with lateral facies changes in the Pliocene Miura group.

MINATO, MASAO. New Discovery of Lower Carboniferous **Millerella** (Fusulinid Foraminifera in Manchuria).—L. c., No. 658, July 1950, pp. 379-382, text figs. 1-5. (English abstract).—One indeterminate species is figured and described.

BARTENSTEIN, H. and E. BRAND. Die Foraminiferen-Gattung **Tribrachia** Schubert, 1912, in der deutschen Kreide (For.).—Senckenbergiana, vol. 31, No. 1/2, July 15, 1950, pp. 121-126, pl. 1.—Six species, 4 new, are described and figured.

BENSON, W. N. and H. J. FINLAY. A Post-Tertiary Micro-fauna in a Concretion Containing **Cancer novaezealandiae.**—Trans. Proc. Royal Soc. New Zealand, vol. 78, pts. 2 and 3, August 1950, pp. 269, 270.—A few foraminifera and other microfossils are used to indicate the age of matrix of a wrongly labelled fossil and thus determine the probable origin of the fossil crab.

FEYLING-HANSEN, R. W. Foraminiferer og foraminifer-forskning.—Naturen, 74 Argang, Nr. 9, Sept. 1950, pp. 271-279, text figs. 1, 2.

FRIZZELL, DON L. and ELY SCHWARTZ. A new lituolid foraminiferal genus from the Cretaceous, with an emendation of **Cribrostomoides** Cushman.—Bull. School of Mines and Metallurgy, Tech. Ser., No. 76, Sept. 1950, pp. 1-12, pl. 1, text fig. 1, table 1.—An emendation of **Cribrostomoides** to include **Labrospira** as a synonym, and the erection of **Barkerina** n. gen. (genotype **B. barkerensis** n. sp.). Two previously described genera are placed in the new genus.

NAKKADY, S. E. A new foraminiferal fauna from the Esna shales and Upper Cretaceous Chalk of Egypt.—Journ. Pal., vol. 24, No. 6, November 1950, pp. 675-692, pls. 89, 90, text figs. 1-4 [map and columnar sections].—A rich fauna of 167 species and varieties, 19 species and 16 varieties new, is recorded from the transitional Esna shales and the underlying Upper Cretaceous and overlying Eocene beds. Only the new forms are described and figured.

CROFT, W. N. A parallel grinding instrument for the investigation of fossils by serial sections.—L. c., pp. 693-698, text figs. 1-5.

THALMANN, HANS E. Bibliography and index to new genera, species and varieties of Foraminifera for the year 1949.—L. c., pp. 699-745.—A continuation of the invaluable Thalmann series.

Review of "Foraminifera from the Tertiary of the Dominican Republic," by Pedro J. Bermudez.—Bull. Amer. Assoc. Petr. Geol., vol. 34, no. 11, Nov. 1950, pp. 2227-2229.—Introduces one new name: **Globorotalia dominicana** for **G. lobata** Bermudez (not Brotzen).

HANZAWA, SHOSHIRO. On the Occurrence of the Foraminiferal Genera, **Eoverbeekina, Nankinella,** and **Sphaerulina** from Japan.—Short Papers from the Institute of Geology and Paleontology, Tôhoku Univ., Sendai, No. 2, December 15, 1950, pp. 1-12, pls. 1, 2, geologic map.—One species of each genus is described and illustrated from Permian beds.

Tertiary Paleogeography of North Japan.—L. c., pp. 74-98, 4 paleogeographic maps.—Larger foraminifera are mentioned.

ASANO, K. Cretaceous Foraminifera from Teshio, Hokkaido.—L. c., pp. 13-22, pl. 3, table 1.—Seventeen species and varieties, 7 new, are recorded and figured.

TOKAYANAGI, YOKICHI. Pliocene Smaller Foraminifera from Western Sendai.—L. c., pp. 23-28, text figs. 1-4.—Quantitative analyses of the foraminifera from 6 zones are represented graphically. A new species and a new variety of **Elphidium** are described and illustrated.

PHLEGER, FRED B and FRANCES L. PARKER. Gulf of Mexico Foraminifera.—Scripps Instit. Oceanography, Submarine Geology Report No. 16 from the Marine

Foraminifera Laboratory, December 1950, pp. 1-6, text figs. 1-8.—The depth distribution of 132 species and varieties, of which 32 are **nomina nuda**, is represented graphically and another graph shows 6 depth facies using 16 species as markers.

LE CALVEZ, YOLANDE. Révision des Foraminifères Lutétiens du Bassin de Paris, III. Polymorphinidae, Buliminidae, Nonionidae. Mémoires pour servir à l'explication de la carte géologique détaillée de la France, Paris, 1950, pp. 1-64, pls. 1-4.—A continuation of Parts I (1947) and II (1949). Sixty-nine species and varieties, of which 4 are new and 2 are new names, are noted and many are described and figured.

TEN DAM, A. Les Foraminifères de l'Albien des Pays-bas.—Mém. Soc. Géol. France, n. ser., vol. 29, fasc. 4, Mém. No. 63, 1950, pp. 1-66, pls. 8-11, text figs. 1-8.—One hundred twenty-six species and varieties, 14 new and 6 with new names, are described and figured.

VAN DER SLUIS, J. P. Geology of East Seran.—In L. Rutten and W. Hotz, Geological, Petrographical and Palaeontological Results of Explorations, carried out from September 1917 till June 1919 in the island of Ceram, 3rd ser., Geol., No. 3, 1950, pp. 166, pls. 1, 2, map, table, section.—Smaller Foraminifera from Upper Cretaceous, Eogene, and Young Neogene are listed; 56, of which 6 are new, listed from the Upper Cretaceous; about 50 from the Eogene; and 58 from the Young Neogene. Eighteen species, the 6 new ones and 12 indeterminate ones, are described and illustrated.

KEYZER, F. G. Foraminifera, in C. Beets, On probably young Miocene fossils from the coal concession Batoe Panggal, near Tenggarong (Samarinda), Eastern Borneo.—Leidse Geologische Mededelingen, deel 15, 1950, pp. 274-276, 280.—Twenty-two species are listed from Tertiary f.

RUTTEN, M. G. Comparison of **Lepidocyclina zeijlmansi** Tan from Borneo with **Lepidocyclina birmanica** Rao from Burmah—Kon. Nederl. Akad. Wetenschappen, Proc., vol. 53, No. 2, 1950, pp. 196-198, text figs. 1, 2. —Study of the two species shows them to be distinct.

SIGAL, J. Les genres **Queraltina** et **Almaena** (Foraminifères), leur importance stratigraphique et paléontologique.—Bull. Soc. géol. France, ser. 5, vol. 20, fasc. 1-2-3, 1950, pp. 63-71, 1 text pl.—**Pseudoplanulinella** n. gen. (genotype **P. hieroglyphica** n. sp.) is erected with one species and one variety, both new, described and figured. Several other forms in related genera are also discussed and illustrated.

MARIE P. **Queraltina**, nouveau genre de Foraminifère de l'Éocène pyrénéen.—L. c., pp. 73-80, text figs. 1-9.—**Queraltina** n. gen. (genotype **Q. epistominoides** n. sp.) belongs in the Anomalinidae and seems to be ancestral to **Keliphystoma** and **Planulinella**. Four species, all new, are described and figured.

HAGN, HERBERT. Granat als Bestandteil von Sandschalergehäusen (Foraminiferen).—Neuen Jahrb. Geol. Pal., Monats., Jahrg. 1950, Heft 10, pp. 305-307.

WEYNSCHENCK, R. Die Jura-Mikrofauna und -flora des Sonnwendgebirges (Tirol).—Schlern-Schriften, 83, 1950, pp. 1-32, pls. 1-3, text figs. 1-5, table 1.—Two new genera in the Dogger, **Protopeneroplis**, n. gen. (genotype **P. striata** n. sp.) in the Peneroplidae, and **Ventrolamina** n. gen. (genotype **V. cribrans** n. sp.) in the Ventrolaminidae n. family, are erected and a third new genus, unnamed, of the Ophthalmidiidae is described and illustrated. Several other species are recorded, charted, and illustrated in section from Lias and Dogger beds.

SCHOTT, WOLFGANG. Die flächenhafte Verteilung der Meeressedimente im Atlantischen Ozean.—Deutschen Hydrograph. Zeitschrift, vol. 3, pts. 1/2, 1950, pp. 89-93, map, table 1.

FRIZZELL, DON L. The genotype and systematic position of **Sporadogenerina** Cushman (Foraminifera, Polymorphinidae).—Studies Honoring Trevor Kincaid, Univ. Wash. Press, 1950, pp. 41-43.—Evidence for synonymity of **S. flintii** Cushman with **S. proteiformis** (Flint), described as **Ramulina**, and transfer of the genus to the Polymorphinidae.

McLEAN, JAMES D., JR. McLean Card Catalogue of American Foraminifera (copyright 1950, 1951).—A set of 5x8″ cards reproducing illustrations, descriptions, and remarks about selected American foraminifera.

Comparison Microscope—a tool with unique possibility. —Bull. Amer. Assoc. Petr. Geol., vol. 35, No. 1, Jan. 1951, pp. 96-101, text figs. 1-4.

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