CONTRIBUTIONS

FROM THE

CUSHMAN LABORATORY

FOR

FORAMINIFERAL RESEARCH

VOLUME 25, PART 1
March, 1949

Contents

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1949

CUSHMAN LABORATORY FOR FORAMINIFERAL RESEARCH

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CONTRIBUTIONS FROM THE CUSHMAN LABORATORY FOR FORAMINIFERAL RESEARCH

324. UPPER JURASSIC FORAMINIFERA FROM THE NIZNIOW LIMESTONE OF PODOLE, POLAND

By J. A. Cushman and K. Glazewski

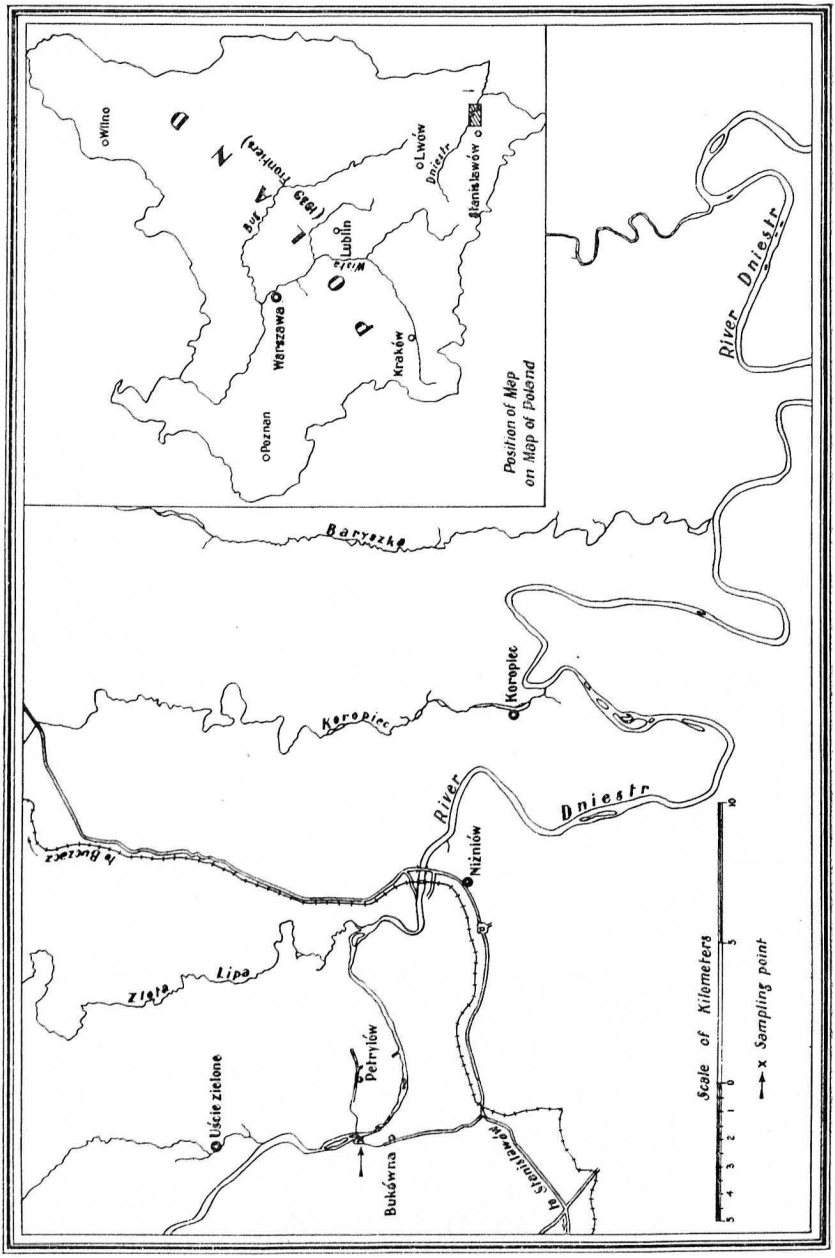
The assemblage of foraminifera described in this paper was collected in 1937 from the Jurassic oolitic limestone underlying the contact with Cenomanian coarse sandstones, in a small ravine on the right bank of the river Dniestr, south of ferry-boat leading from Bukowna to Petrylow in the southeastern portion of Poland called Podole (See accompanying map).

The fauna from Bukowna, described by A. Alth in 1881 (Ref. 1) contained corals, gastropods (mainly Nerineidae), mollusca, a few brachiopods and foraminifera. He considered the age of the formation as Kimmeridgian-Portlandian. Several banks of limestone literally filled with *Corbula inflexa* Rom. were found in 1937 in Zaturzyn (southeast of Nizniow) in the upper portion of this formation, which seems to prove its Portlandian age.

The coauthor of this paper, Mr. K. Glazewski, investigated in detail the whole area of the Jurassic of Podole, which extends mostly along the river Dniestr, from Horodenka (Ref. 3) by Niezwiska, Nizniow up to Uscie Zielone. A few months before the outbreak of war in 1939, he determined the Jurassic limestone with some fauna in the drilling in Bludniki near Halicz, thus extending the known area of Jurassic of Podole for another 25 kilometers farther west. In spite of great care during his field work in the area no foraminifera were found except those in the vicinity of Nizniow.

Alth in his monographic paper (Ref. 1) described only five species of foraminifera found in the same oolitic limestone of Bukowna, namely:

Dimorphina inflexa Alth
Dimorphina tyraica Alth
Haplophragmium podolicum Alth
Dentalina (?) *gigantea* Alth
Nummulites suprajurensis Alth


POLAND
Wilno
Warszawa
Lublin
Lwów
Dniestr
Stanisławów
Kraków
Poznań
Bug
Wisła
Position of Map on Map of Poland
River Dniestr
Barvezka
Koropiec
Karopiec
River Dniestr
Nizniów
Zlota Lipa
Petryliw
Uście zielone
Bukówna
Scale of Kilometers
Sampling point

He mentions also *Textularia* sp. without any detailed description. Of these five forms *Dentalina* (?) *gigantea* Alth seems not to belong to foraminifera at all and *Nummulites suprajurensis* Alth was described and illustrated very incompletely.

The present paper includes only a part of the fauna as a number of species are represented by too few or too poorly preserved specimens to warrant a definite identification, and so were left out. Certain specimens were ground down to the median plane by the junior author which helped much in determining the generic characters.

The types and figured specimens are deposited in the collections of the British Museum (Natural History) and paratypes of the new species are in the collections of the Cushman Laboratory for Foraminiferal Research at Sharon, Massachusetts.

Acknowledgments are due to the Trustees of the British Museum (Natural History) for lending the material and to Mr. C. D. Ovey for his constant and kind help given to Mr. K. Glazewski during his work at the British Museum (Natural History) Foraminiferal Section.

References:

1. Alth, A., 1881, Wapien Nizniowski i jego skamieliny, Akademia Umiejetnosci. Krakow., vol. 6, 1881, pp. 1-160, 12 pls. In German: Die Versteinerungen des Nizniover Kalksteines, Wien Beitr. Pal. Osterreich-Ungarns Orients, vol. 1, 1882, pp. 183-332, 12 pls.
2. Alth, A., and Bieniasz, F., 1887, Atlas geologiczny Galicji, Tekst do zeszytu pierwszego, Krakow. (Textbook to the first volume of Geological Atlas of Galicia)
3. Glazewski, K., 1938, Jura w Horodence i rozmieszczenie jury na Podolu, Krakow. Rocz. Pol. Tow. Geol. tom XIII. (Le Jurassique à Horodenka et la repartition du Jurassique en Podolie, Ann. Soc. Géol. Pologne, Cracovie)

Family AMMODISCIDAE

Genus AMMODISCUS Reuss, 1861

AMMODISCUS cf. ASPER (Terquem) (Pl. 1, fig. 1)

Very rare specimens seem to belong to this species as recorded by Macfadyen (Phil. Trans. Roy. Soc. London, ser. B, Biol. Sci., No. 576, vol. 231, 1941, p. 15, pl. 1, fig. 7). The Polish specimens are very large, reaching 3.75 mm. in diameter, and having but four or five coils. More specimens are really needed to definitely determine this form which may be a new species.

Genus LITUOTUBA Rhumbler, 1895

LITUOTUBA INCERTA Franke (Pl. 1, fig. 2)

Lituotuba incertus FRANKE, Abhandl. Preuss. Geol. Landes., n. ser., vol. 111, 1928, p. 15,

pl. 1, fig. 19.—Bartenstein and Brand, Abhandl. Senck. Nat. Ges., No. 439, 1937, p. 131, pl. 3, fig. 6.—Gandolfi, Riv. Ital. Pal., vol. 48, 1942, Suppl., p. 32.

This species was described from the Upper Cretaceous of Germany and it has been recorded from the Upper Cretaceous of Switzerland and the Liassic of Germany. The specimens also resemble many that have been recorded as *L. lituiformis* (H. B. Brady). Specimens in this Polish material are very rare.

Family LITUOLIDAE

Genus HAPLOPHRAGMOIDES Cushman, 1910

HAPLOPHRAGMOIDES CANUI Cushman (Pl. 1, fig. 3)

Haplophragmoides canui Cushman, Bull. Soc. Linn. Normandie, ser. 8, vol. 2, 1929, p. 133, pl. 4, fig. 1.

Test small, planispiral, almost completely involute, periphery rounded, umbilical region slightly concave; chambers about nine in the final coil, mostly indistinct except the last-formed ones which are slightly inflated; sutures indistinct except the last few which are slightly depressed; wall arenaceous, surface slightly roughened, some specimens nearly smooth; aperture in the early stages at the base of the last-formed chamber and in some adult specimens with the aperture an elongate depression in the apertural face. Diameter 0.65-1.00 mm.

The types of this species are from the Jurassic of France and compared with our Polish specimens they are somewhat smaller and have a more roughened surface. In general, however, the two sets of specimens seem to belong to a single species.

Genus LITUOLA Lamarck, 1804

LITUOLA PODOLICA Cushman and Glazewski, n. sp. (Pl. 1, figs. 4, 5)

Test elongate, slightly compressed, the early portion coiled, later and largest portion uncoiled, periphery rounded; chambers rather indistinct, earlier coiled ones involute and only the last three or four visible, uncoiled portion increasing very slowly in width, but variable, consisting of from five to seven chambers increasing irregularly in size and in the amount of compression; sutures rather indistinct, slightly depressed; wall finely arenaceous, rather smoothly finished, interior labyrinthic; aperture in the adult simple, terminal. Length 2.20-3.50 mm.; diameter of uncoiled portion 0.60-0.80 mm.

This species is named from Podole, the regional name of the southeastern part of Poland from which this material was obtained. The species differs from *Lituola camerata* Lozo from the Lower Cretaceous of Texas in its more regular form, less inflated chambers, obscure sutures, and smooth surface.

LITUOLA SIEMIRADZKII Cushman and Glazewski, n. sp. (Pl. 1, figs. 6, 7)

Test large, elongate, slender, earliest portion close-coiled, much the larger adult portion uncoiled and nearly circular in transverse section; chambers of the early coiled portion rather indistinct, umbilical portion slightly if at all depressed, uncoiled adult portion with usually four, occasionally five, chambers, increasing very little if at all in diameter, usually slightly inflated; sutures rather indistinct in the coiled portion, more depressed and distinct in the uncoiled portion; wall finely arenaceous, rather smoothly finished, labyrinthic; aperture terminal, multiple. Length 3.15-5.00 mm.; diameter of coiled portion 1.50-1.70 mm.; diameter of uncoiled portion 1.05-1.30 mm.

This species is named in honor of Prof. J. Siemiradski, creator of the Paleontological Institute of Lwow University, and a geologist and investigator of the Podole area. The species differs from *L. podolica* n. sp. in the much larger size, more prominent coiled portion and slightly more depressed sutures.

LITUOLA COMPRESSA Cushman and Glazewski, n. sp. (Pl. 1, figs. 8-10)

Test strongly compressed, early portion planispirally coiled, involute, later adult portion uniserial and increasing in diameter as added, chambers obscure throughout, apparently three to six in the uncoiled portion; sutures indistinct; wall finely arenaceous, smoothly finished, labyrinthic; aperture in a depression of the terminal face of the last-formed chamber, apparently somewhat cribrate. Length 2.00-3.25 mm.; breadth of coiled portion 0.90-1.25 mm.; breadth of uniserial portion 0.70-1.05 mm.

This species differs from *L. siemiradzkii* n. sp. in its smaller size, more numerous and lower and broader chambers, and distinctly compressed test.

Genus PSEUDOCYCLAMMINA Yabe and Hanzawa, 1926

PSEUDOCYCLAMMINA BUKOWIENSIS Cushman and Glazewski, n. sp. (Pl. 2, figs. 1, 2)

Test large, close-coiled, except for the last two or three chambers which are uncoiled, periphery broadly rounded, umbilical region somewhat depressed; chambers numerous, more or less indistinct, the coiled ones almost completely involute; sutures rather indistinct, little if at all depressed; wall finely arenaceous, thick, rather smoothly finished, peripheral portion labyrinthic; aperture rather obscure, apparently cribrate. Length of uncoiled forms 3.50-4.75 mm.; breadth 2.50-3.00 mm.

This species is named for Bukowna, the type locality of this material. It differs from *Pseudocyclammina lituus* (Yokoyama) in less definite sutures and chambers not entirely involute, and the fewer uniserial chambers.

PSEUDOCYCLAMMINA ROGALAI Cushman and Glazewski, n. sp. (Pl. 2, figs. 3, 4)

Test large, the early portion coiled, completely involute, periphery broadly rounded, adult portion uncoiled; chambers fairly distinct, slightly inflated, about four visible in the coiled portion and two in the adult uncoiled portion; sutures fairly distinct, somewhat depressed; wall finely arenaceous, distinctly labyrinthic from the exterior; aperture often rather obscure, terminal, and becoming cribrate. Length 2.75-3.75 mm.; breadth 1.50-2.25 mm.

This species is named in honor of Prof. W. Rogala of the Lwow University who has done much investigation in this region. It differs from *P. bukowiensis* n. sp. in the very rough surface, more numerous uniserial chambers and more pointed apertural end.

Family VERNEUILINIDAE

Genus VERNEUILINA d'Orbigny, 1840

VERNEUILINA LIASINA Terquem and Berthelin (Pl. 1, figs. 11, 12)

Verneuilina liasina TERQUEM and BERTHELIN, Mem. Soc. geol. France, ser. 2, vol. 10, pt. 3, 1875, p. 64, pl. 5, fig. 15.—CUSHMAN, Special Publ. 7, Cushman Lab. Foram. Res., 1937, p. 7, pl. 1, fig. 3.

There are specimens in this Polish material that seem identical with the species described by Terquem and Berthelin from the Lower Lias of France.

The test is short and broad, rapidly increasing in width with the greatest width at the final whorl, the angles are very rounded, the wall rather smooth and the aperture a low opening at the inner margin of the last-formed chamber. The specimens vary considerably in size, the largest, the one figured, having a length of 1.12 mm. and a breadth of 0.92 mm. This is considerably larger than the measurements given of the type, but there is considerable variation in size.

VERNEUILINA ANGLICA Cushman (Pl. 1, fig. 13)

Verneuilina anglica CUSHMAN, Special Publ. 6, Cushman Lab. Foram. Res., 1936, p. 1, pl. 1, fig. 1; Special Publ. 7, 1937, p. 7, pl. 1, fig. 4.

"Test triserial, elongate, tapering, greatest breadth formed by the last whorl of chambers, angles prominent, slightly rounded, sides flat or slightly concave; chambers numerous, of rather uniform shape, increasing gradually in size as added, slightly inflated; sutures distinct, slightly depressed, oblique; wall distinctly arenaceous, surface slightly roughened; aperture elongate, low, at inner margin of last-formed chamber. Length 0.80 mm.; breadth 0.45 mm."

The types of this species are from the Jurassic, Kimmeridge clay, of Culham, near Abingdon, England.

Although varying slightly, the series from Poland were compared with the types and seem identical with this species.

VERNEUILINA POLONICA Cushman and Glazewski, n. sp. (Pl. 1, figs. 14, 15)

Test large, triserial throughout, increasing rapidly in breadth from the slightly rounded initial end to the greatest breadth formed by the final whorl, sides flattened or slightly concave, peripheral angles rounded; chambers numerous, fairly distinct, somewhat inflated; sutures fairly distinct, only slightly depressed; wall smooth, finely arenaceous; aperture a comma-shaped opening in the inner face of the last-formed chamber with the larger, rounded portion in the face of the chamber. Length 1.85-2.50 mm.; breadth 1.00-1.25 mm.

This species differs from *V. mauritii* Terquem from the Jurassic of France in the less tapering test and less distinct chambers and sutures.

Genus GAUDRYINA d'Orbigny, 1839

GAUDRYINA VADASZI Cushman and Glazewski, n. sp. (Pl. 2, figs. 5, 6)

Gaudryina textilaroides VADASZ (not HANTKEN), Res. Wiss. Erforsch. Balaton-sees, vol. 1, pt. 1, Anhang. Pal., vol. 1, No. 1, 1911, p. 15, pl. 1, fig. 6.

Test consisting of an initial triserial portion of one or two whorls, then becoming biserial and increasing rapidly in breadth; chambers of the biserial portion distinct, slightly inflated, rapidly increasing in width as added; sutures of the biserial portion distinct, depressed; wall smooth or slightly roughened; aperture a low elongate opening at the base of the inner margin of the last-formed chamber. Length 0.75-0.95 mm.; breadth 0.37-0.55 mm.

This species is apparently the same as the one from the Triassic of Bakony, Austria, referred by Vadasz to Hantken's Eocene species.

GAUDRYINA ALTHI Cushman and Glazewski, n. sp. (Pl. 2, fig. 7)

Test triserial for most of its development but becoming biserial in the last stages, tapering from the initial subacute end to the greatest diameter just below the apertural end, triserial portion smooth or irregular; chambers numerous, increasing in size very regularly in the triserial portion, fairly distinct, slightly inflated; sutures rather indistinct in the early portion, later depressed and distinct; wall very finely arenaceous, surface often somewhat roughened; aperture a rather small, slightly curved opening at the base of the apertural face. Length 0.70-1.10 mm.; breadth 0.37-0.55 mm.

This species is named in honor of Prof. A. Alth from the University of Krakow, who first described this particular formation. This species differs from *Gaudryina hawkinsi* Cushman from the Jurassic, Kimme-

ridge clay, of Culham, near Abingdon, England, which it much resembles, in the much less angular sides and less compressed adult stage.

GAUDRYINA BUKOWIENSIS Cushman and Glazewski, n. sp. (Pl. 2, figs. 10, 11)

Test with the earliest stage triserial, the later adult biserial stage strongly compressed, increasing rapidly in width, the greatest width formed by the last pair of chambers, periphery rounded; chambers rather indistinct, even in the later stages, very slightly if at all inflated; sutures indistinct except in the last-formed portion where they are slightly depressed; wall finely arenaceous, surface smooth; aperture usually obscure, a very narrow elongate opening in the terminal face of the last-formed chamber extending from the basal margin into the apertural face. Length 0.68-0.95 mm.; breadth 0.37-0.45 mm.

This species differs from *Gaudryina rugosa* d'Orbigny in the much less sharply triangular early portion, much smoother surface, and very strongly compressed biserial portion of the test.

GAUDRYINA JURASSICA Cushman and Glazewski, n. sp. (Pl. 2, figs. 8, 9)

Test slender, elongate, early portion increasing in diameter but the adult portion with nearly parallel sides, the final biserial stage often slightly bent to one side, nearly circular in transverse section; chambers fairly distinct, slightly inflated especially in the later portion, increasing little if at all in size after the early stage; sutures fairly distinct in the later portion, slightly depressed; wall smooth; aperture a comma-shaped opening, narrow at the basal margin of the last-formed chamber but expanding into the terminal face. Length 0.82-1.00mm.; breadth 0.25-0.30 mm.

This species differs from *G. bearpawensis* Wickenden from the Cretaceous of Canada in the smoother, more cylindrical form, less distinct chambers and sutures, and the tendency for the final chamber to be distinctly offset from the linear axis.

Family VALVULINIDAE

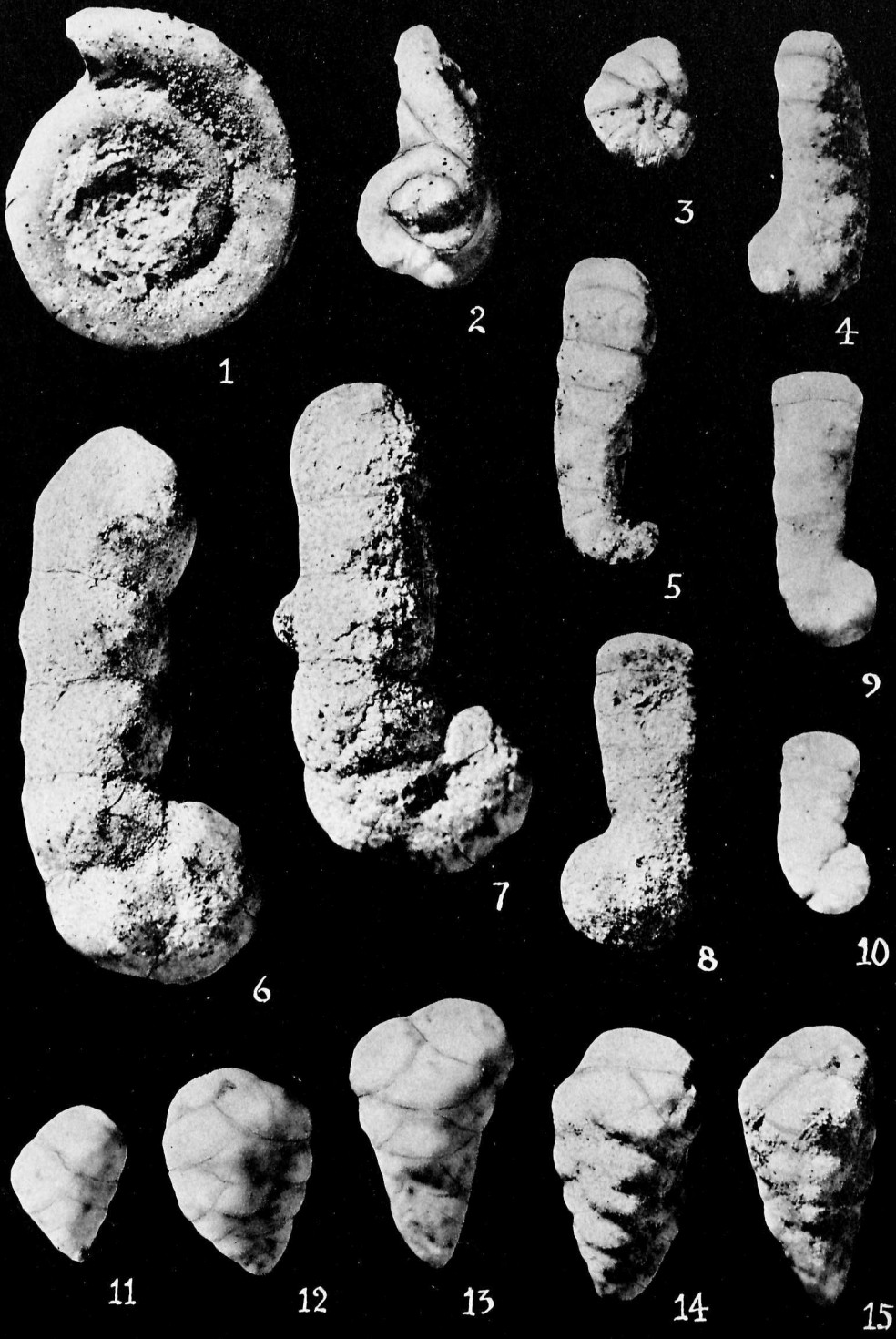
Genus ARENOBULIMINA Cushman, 1927

ARENOBULIMINA JURASSICA Cushman and Glazewski, n. sp. (Pl. 2, figs. 17, 18)

Test low conical, dorsal side raised, ventral side depressed and some-

EXPLANATION OF PLATE 1

FIG. 1. *Ammodiscus* cf. *asper* (Terquem). × 20. 2. *Lituotuba incerta* Franke. × 20. 3. *Haplophragmoides canni* Cushman. × 20. 4, 5. *Lituola podolica* Cushman and Glazewski, n. sp. × 20. 4, Holotype. 5, Paratype. 6, 7. *L. siemiradzkii* Cushman and Glazewski, n. sp. × 20. 6, Holotype. 7, Paratype. 8-10. *L. compressa* Cushman and Glazewski, n. sp. × 20. 8, Holotype. 9, 10, Paratypes. 11, 12. *Verneuilina liasina* Terquem and Berthelin. × 25. 13. *V. anglica* Cushman. × 25. 14, 15. *V. polonica* Cushman and Glazewski, n. sp. × 20. 14, Holotype. 15, Paratype.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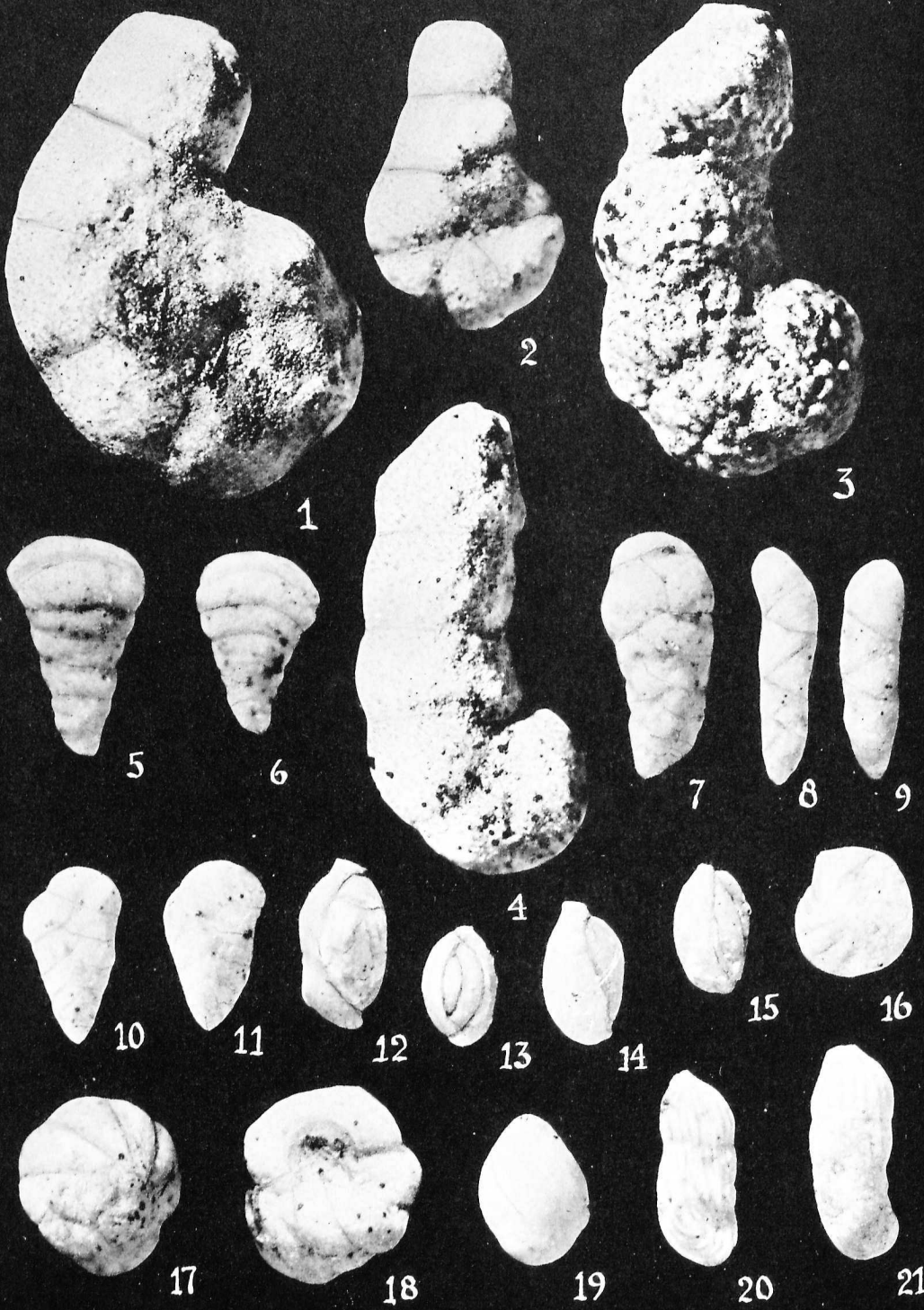
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what umbilicate, periphery rounded; chambers of the early portion rather indistinct, those of the last-formed whorl more inflated and distinct, as many as seven in the adult whorl, increasing very slowly in size as added; sutures of the later portion distinct, depressed, curved; wall finely arenaceous, smooth; aperture a curved opening at the ventral border of the last-formed chamber and extending into the ventral face as a rounded opening with a broad tooth. Height 0.40-0.50 mm.; diameter 0.60-0.75 mm.

This species differs from *A. preslii* (Reuss) in its lower test, larger number of chambers in the adult whorl, more inflated chambers, and deeply umbilicate ventral side.

The genus has not previously been recorded in strata older than Lower Cretaceous. In some respects it suggests *Valvulammina*.

Family MILIOLIDAE

Genus QUINQUELOCULINA d'Orbigny, 1826

QUINQUELOCULINA sp. A (Pl. 2, figs. 12, 13)

There are numerous specimens of *Quinqueloculina* in the Polish material but they are almost all internal casts. A few apparently have the surface present but are not well preserved and cannot be specifically identified. This species A has a rather broad test, tapering toward the ends, the chambers rather narrow, and a projecting apertural neck.

QUINQUELOCULINA sp. B (Pl. 2, figs. 14, 15)

This species seems to be distinct from the preceding in the shorter, more rounded test, and the much broader chambers. They cannot be specifically identified.

Family LAGENIDAE

Genus ROBULUS Montfort, 1808

ROBULUS sp. (Pl. 2, fig. 16)

A few specimens of a smooth form with an acute periphery are present in the Polish material but it is difficult to identify them specifically.

EXPLANATION OF PLATE 2

FIGS. 1, 2. *Pseudocyclammina bukowiensis* Cushman and Glazewski, n. sp. × 20. 1, Holotype. 2, Paratype. 3, 4. *P. rogalai* Cushman and Glazewski, n. sp. × 20. 3, Holotype. 4, Paratype. 5, 6. *Gaudryina vadaszi* Cushman and Glazewski, n. sp. × 40. 5, Holotype. 6, Paratype. 7. *G. althi* Cushman and Glazewski, n. sp. Holotype. 8, 9. *G. jurassica* Cushman and Glazewski, n. sp. × 40. 8, Holotype. 9, Paratype. 10, 11. *G. bukowiensis* Cushman and Glazewski, n. sp. × 40. 10, Holotype. 11, Paratype. 12, 13. *Quinqueloculina* sp. A. × 40. 14, 15. *Quinqueloculina* sp. B. × 40. 16. *Robulus* sp. × 20. 17, 18. *Arenobulimina jurassica* Cushman and Glazewski, n. sp. × 40. 17, Holotype, dorsal view. 18, Paratype, ventral view. 19. *Guttulina* cf. *similis* Terquem and Berthelin. × 40. 20, 21. *Marginulina radiata* Terquem. × 40.

Genus MARGINULINA d'Orbigny, 1826

MARGINULINA RADIATA Terquem (Pl. 2, figs. 20, 21)

Marginulina radiata TERQUEM, Trois. Mem. Foram. Lias, Metz, 1863, p. 200, pl. 9, fig. 10; Six. Mem. Foram. Lias, Metz, 1866, p. 505, pl. 21, figs. 16, 17.—TERQUEM and BERTHELIN, Mem. Soc. geol. France, ser. 2, vol. 10, pt. 3, 1875, p. 57.—BARTENSTEIN and BRAND, Abhandl. Senck. Nat. Ges., No. 439, 1937, p. 161, pl. 1A, fig. 15; pl. 1B, fig. 17; pl. 2A, figs. 12, 13; pl. 2B, fig. 25.

This species was described from the Lias of France and recorded at numerous localities in the Lias of France and Germany. A number of specimens in the Jurassic of Poland seem to belong to this species.

Genus PALMULA Lea, 1833

PALMULA DESLONGCHAMPSI (Terquem) (Pl. 3, figs. 1, 2)

Flabellina deslongchampsi TERQUEM, Trois. Mem. Foram. Lias, Metz, 1863, p. 216, pl. 10, fig. 13.—PAALZOW, Jahr. Ver. vat. Nat. Württemberg, 88 Jahrg., 1932, p. 132, pl. 9, fig. 26.—FRANKE, Abhandl. Preuss. geol. Landes., n. ser., vol. 169, 1936, p. 92, pl. 9, fig. 12.—BARTENSTEIN and BRAND, Abhandl. Senck. Nat. Ges., No. 439, 1937, p. 168, pl. 6, fig. 28; pl. 8, fig. 33; pl. 10, fig. 29; pl. 11A, fig. 9; pl. 11B, fig. 14; pl. 12A, fig. 9.

This species is quite widely distributed in the Jurassic of Europe and, as usual with this group, shows considerable variation. A few specimens in the Polish Jurassic material seem to belong to this species.

Genus DENTALINA d'Orbigny, 1826

DENTALINA sp. (Pl. 3, fig. 3)

The figured specimen is incomplete but is figured here for reference. The longitudinal costae are very definite but the initial part is missing.

Family POLYMORPHINIDAE

Genus GUTTULINA d'Orbigny, 1839

GUTTULINA cf. SIMILIS Terquem and Berthelin (Pl. 2, fig. 19)

A number of specimens from the Polish Jurassic closely resemble this species but the state of preservation is not good enough to be certain of the identification.

Family BULIMINIDAE

Genus VIRGULINA d'Orbigny, 1826

VIRGULINA JURASSICA Cushman and Glazewski, n. sp. (Pl. 3, figs. 4, 5)

Test elongate, initial end acute or subacute, triserial, later portion biserial and with the sides nearly parallel, periphery rounded, apertural end broadly rounded; chambers fairly distinct, especially in the biserial portion where they are slightly inflated, increasing rather rapidly in height in the biserial portion; sutures slightly depressed, fairly distinct in the later portion; wall calcareous, smooth; aperture an elongate opening extending from the inner margin of the last-formed chamber into the apertural face. Length 0.75-1.12 mm.; breadth 0.25-0.30 mm.

This genus has not previously been recorded below the Lower Cretaceous but our specimens seem definitely to belong in this genus. It differs from *V. subcretacea* Cushman in the rather acute initial end, fewer and higher chambers, and less distinct sutures.

Family ROTALIIDAE

Genus DISCORBIS Lamarck, 1804

DISCORBIS cf. DREHERI Bartenstein (Pl. 3, figs. 6, 7)

A few specimens, although not very well preserved, resemble this species described from the Jurassic of Germany (in Bartenstein and Brand, Abhandl. Senck. Nat. Ges., No. 439, 1937, p. 192, pl. 6, fig. 45; pl. 8, fig. 42; pl. 10, fig. 47).

325. THE GENUS *SPHAEROIDINA* AND ITS SPECIES

By Joseph A. Cushman and Ruth Todd

A re-study of material of the genus *Sphaeroidina* shows it to be a less ancient genus than has been believed. The already known species of the genus are reviewed in this paper and four new ones described. Without doubt many additional new ones will be discovered as additional material is studied, and it is hoped that this re-study of the early described species will facilitate the recognition of new species.

Genus SPHAEROIDINA d'Orbigny, 1826

Genotype, *Sphaeroidina bulloides* d'Orbigny

Sphaeroidina d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 267.—Reuss, Denkschr. Akad. Wiss. Wien, vol. 1, 1850, p. 386.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 619.—Chapman, The Foraminifera, 1902, p. 208.—Cushman, Bull. 71, U. S. Nat. Mus., pt. 4, 1914, p. 17; Bull. 104, pt. 5, 1924, p. 36; Foraminifera, 4th Ed., 1948, p. 321.

Sexloculina Czjzek, 1848.

?*Bolbodium* Ehrenberg, 1872.

Test more or less smoothly globular, composed of a few strongly embracing chambers arranged in a spire; wall calcareous, very finely perforate; aperture an arched opening at or near the edge of the last-formed chamber, usually filled with a broad tooth, thus leaving the actual opening a crescent-shaped slit.—Upper Eocene to Recent.

The earliest appearances of the genus seem to be, in America, the Cooper marl of South Carolina (Cushman, U. S. Geol. Survey Prof. Paper 181, 1935, p. 49, pl. 20, fig. 13); in Europe, the Klein Zeller tegel of Neustift b. Ofen, Hungary (Hantken, Mitth. Jahrb. K. Ungar. geol. Anstalt, vol. 4, 1875 (1881), p. 62, pl. 10, fig. 4); and, in the Pacific region, the Kaiatan stage of Ethel Creek, Greymouth District, New

Zealand (Dorreen, Journ. Pal., vol. 22, 1948, p. 298). All of these occurrences are of upper Eocene age. No Sphaeroidinas have been recorded in the lower Eocene or Paleocene.

In the Cretaceous there are numerous records for Sphaeroidinas, but in our material we have found no true Sphaeroidinas earlier than upper Eocene. A single, poorly preserved specimen found in the Velasco shale of Mexico (Cushman, Contr. Cushman Lab. Foram. Res., vol. 12, 1936, p. 78) may have originated from contamination, as the material was from a well sample. Other Cretaceous records are probably to be placed in other genera, such as *Globigerina*. Therefore, the genus may be assumed to have originated in the Eocene, probably from a *Pullenia* ancestor whose later chambers were added rather irregularly and in a way as to embrace much more of the test.

Beginning in the upper Eocene, the genus is more or less common and widespread, though never abundant, in the Oligocene, Miocene, Pliocene, Pleistocene, and Recent.

Ecologically, from its records in the Recent, the genus is always a fairly deep water, probably benthonic form. It may occur in tropical, temperate, or arctic regions, but is not known from shallow, near-shore, or brackish habitats.

In examining Sphaeroidinas, one finds a remarkable irregularity in the structure of the test. Taking d'Orbigny's Model 65 of the genotype as a pattern for the structure of the adult test, one expects to find the test growing by the addition of strongly embracing chambers, each one covering approximately half the previous test and in such a way as to hide the earliest-formed visible chambers. The aperture, in the Model, is in the last-formed chamber at the contact between it and the earliest-formed visible one. Actually, this structure holds good in general but without the almost geometric precision of the Model.

The situation of the aperture in relation to the earliest whorls, and in relation to the sutures, are factors which are variable, and which greatly change the appearance of the individual test, but which may not have any specific importance. There are rare cases in which the position of the aperture is diametrically opposite to its normal position, adjacent to the earliest-formed visible chamber. In these cases, represented by figs. 10, 15, and 17 on pl. 3 and fig. 16 and on pl. 4, the side showing the earliest chambers is opposite to the side on which the aperture is situated, and the structure is somewhat like a rotaliform genus, such as *Baggina*. It was not possible to make certain whether this deviation had held throughout the growth of the individual specimens showing it,

or whether only the last-formed chamber showed it. Its significance is not clear but it does not seem to be of specific importance. Dextral or sinistral coiling also is of no specific importance. Another respect in which specimens deviate from the conventionalized Model is in the position of the aperture as related to the suture. The aperture is usually entirely within the last-formed chamber and is distinctly separated from the suture, although there are exceptions, as fig. 14 on pl. 4. This character does seem to hold true within a species. When the last chamber is broken away, as can be told by the faint rim of the wall left, the previous aperture is often much enlarged by resorption of the wall. This also occurs in *Pullenia* and other genera.

In general, the number of chambers visible on the surface, the inflation of the chambers, the height of the spire, and the nature of the aperture are the characters on which species are separated.

SPHAEROIDINA BULLOIDES d'Orbigny (Pl. 3, figs. 8-11)

Sphaeroidina bulloides D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 267; Modèles No. 65, 1826.—COSTA, Atti Accad. Pont., vol. 7, pt. 2, 1856, p. 318, pl. 25, fig. 1.—SEGUENZA, Atti Accad. Gioenia Sci. Nat., ser. 2, vol. 18, 1862, p. 33.—PARKER and JONES, Philos. Trans., 1865, p. 369, pl. 16, fig. 52.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 29, pl. 2, fig. 58.—TERQUEM, Essai Class. Anim. Dunkerque, pt. 1, 1875, p. 38, pl. 6, fig. 1; Mém. Soc. geol. France, ser. 3, vol. 1, 1878, p. 61.—SIDDALL, Proc. Chester Soc. Nat. Sci., 1878, p. 49.—GOËS, Kongl. Svensk. Vet.-Akad. Handl., vol. 19, 1882, p. 89, pl. 6, figs. 190-193.—FORNASINI, Boll. Soc. Geol. Ital., vol. 2, 1883, p. 6 (list).—H. B. BRADY (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 620, pl. 84, figs. 1, 2 (not figs. 3-7); Journ. Roy. Micr. Soc., 1887, p. 917; Quart. Journ. Geol. Soc., vol. 44, 1888, p. 9 (table).—WRIGHT, Ann. Mag. Nat. Hist., ser. 6, vol. 4, 1889, p. 449 (list).—PEARCEY, Trans. Nat. Hist. Soc. Glasgow, vol. 2, 1890, p. 178 (table).—J. WRIGHT, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 489.—TERRIGI, Mem. Com. Geol. Ital., vol. 4, pt. 1, 1891, p. 104, pl. 4, fig. 6.—SILVESTRI, Mem. Pont. Accad. Nuovi Lincei, vol. 9, 1893, p. 211.—WOODWARD, The Observer, vol. 4, 1893, p. 176.—EGGER, Abhandl. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 375, pl. 13, figs. 48, 49.—FORNASINI, Mem. Accad. Sci. Istit. Bologna, ser. 5, vol. 3, 1893, p. 430, pl. 2, fig. 14.—DE AMICIS, Boll. Soc. Geol. Ital., vol. 12, 1893, p. 151.—GOËS, Kongl. Svensk. Vet.-Akad. Handl., vol. 25, No. 9, 1894, p. 87, pl. 14, fig. 770.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 38.—SILVESTRI, Atti Accad. Sci. Acireale, vol. 7, 1895-1896, p. 76.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 67.—CHAPMAN, Quart. Journ. Geol. Soc., vol. 54, 1898, p. 555.—FLINT (part), Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 325, pl. 71, fig. 1 (part).—SILVESTRI, Mem. Pont. Accad. Nuovi Lincei, vol. 15, 1899, p. 278.—KIAER, Rep't Norwegian Fish.- and Marine-Investigations, vol. 1, No. 7, 1900, p. 49.—SCHUBERT, Sitz. Deutsch. Nat. Med. Ver. Böhmen "Lotos," 1900, p. 97.—FORNASINI, Mem. Accad. Sci. Istit. Bologna, ser. 5, vol. 10, 1902, p. 56.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 692.—EARLAND, Journ. Quekett Micr. Club, ser. 2, vol. 9, 1905, p. 219.—CHAPMAN, Proc. Linn. Soc. New South Wales, 1905, pt. 2, p. 269; Trans. New

Zealand Inst., vol. 38, 1905 (1906), p. 101.—SIDEBOTTOM, Mem. Proc. Manchester Lit. Philos. Soc., vol. 52, No. 13, 1908, p. 5, pl. 1, fig. 11.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 155.—CHAPMAN, Subantarctic Islands of New Zealand, 1909, p. 351; Journ. Linn. Soc., Zool., vol. 30, 1910, p. 418; Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 281.—HERON-ALLEN and EARLAND, Journ. Roy. Micr. Soc., 1910, p. 425.—SCHUBERT, Verh. k. k. geol. Reichs., No. 14, 1910, p. 324; Abhandl. geol. Reichs., vol. 20, 1911, p. 103.—CHAPMAN, Zool. Results *Endeavour,* pt. 3, 1912, p. 311 (list).—TOULA, Jahrb. k. k. geol. Reichs., vol. 64, 1914 (1915), pp. 639, 645, 655, 656, 665.—MARTINOTTI, Boll. Soc. Geol. Ital., vol. 34, 1915, p. 245.—CHAPMAN, Biol. Results *Endeavour,* vol. 3, pt. 1, 1915, p. 27.—SIDEBOTTOM, Journ. Roy. Micr. Soc., 1918, p. 151.—HERON-ALLEN and EARLAND, British Antarctic Exped., Zoology, vol. 6, 1922, p. 194.—MARTINOTTI, Atti Soc. Ital. Sci. Nat., vol. 62, 1923, p. 349.—HERON-ALLEN and EARLAND, Journ. Roy. Micr. Soc., 1924, p. 166.—HANZAWA, Jap. Journ. Geol. Geogr., vol. 4, 1925 (1926), p. 43 (table).—YABE and HANZAWA, l. c., p. 52 (list).—MARTINOTTI, Boll. Ufficio geol. Ital., vol. 51, 1926, p. 3 (list).—KOCH, Ber. Schweiz. Pal. Ges., vol. 19, 1926, p. 727 (list).—KREUZBERG, Neues Jahrb. für Min., vol. 64, 1930, p. 287.—MACFADYEN, Geol. Survey Egypt, 1930 (1931), p. 96.—NUTTALL, Journ. Pal., vol. 6, 1932, p. 29.—CUSHMAN (part), Special Publ. 5, Cushman Lab. Foram. Res., 1933, pl. 33, fig. 22 (not fig. 21).—EARLAND, *Discovery* Reports, vol. 7, 1933, p. 123; vol. 10, 1934, p. 179.—CUSHMAN, Bull. 119, Bernice P. Bishop Mus., 1934, p. 134.—PARR, Trans. Roy. Soc. New Zealand, vol. 65, 1935, p. 79.—EARLAND, *Discovery* Reports, vol. 13, 1936, p. 55.—CUSHMAN, Bull. Geol. Soc. Amer., vol. 47, 1936, p. 425, pl. 4, fig. 1.—COLOM, Bol. Soc. Española Hist. Nat., vol. 36, 1936, p. 220.—PALMER and BERMUDEZ, Mem. Soc. Cubana Hist. Nat., vol. 10, 1936, p. 309.—WOODRING, BRAMLETTE, and KLEINPELL, Bull. Amer. Assoc. Petr. Geol., vol. 20, 1936, pp. 141, 145 (lists).—DI NAPOLI ALLIATA, Boll. Soc. Sci. Nat. Econ. Palermo, vol. 19, 1936-37 (1937), pp. 7, 12; Boll. Soc. Geol. Ital., vol. 56, 1937, pp. 411, 413 (lists).—CHAPMAN and PARR, Australasian Antarctic Exped., ser. C, vol. 1, pt. 2, 1937, p. 110.—HOWCHIN and PARR, Trans. Roy. Soc. So. Australia, vol. 62, 1938, p. 311, pl. 18, fig. 9.—KLEINPELL, Miocene Stratig. Calif., 1938, p. 342.—ELLISOR, Bull. Amer. Assoc. Petr. Geol., vol. 24, No. 3, 1940, pl. 4, fig. 8.—CUSHMAN and HENBEST, U. S. Geol. Survey Prof. Paper 196-A, 1940, pl. 10, fig. 12.—CHAPMAN, Trans. Roy. Soc. So. Australia, vol. 65, 1941, p. 178.—GALLOWAY and HEMINWAY, New York Acad. Sci., Sci. Survey Porto Rico and Virgin Ids., vol. 3, pt. 4, 1941, p. 410, pl. 30, fig. 1.—LEROY, Colorado School Mines Quart., vol. 36, No. 1, 1941, p. 43, pl. 1, figs. 11-13; pt. 2, p. 86, pl. 6, figs. 5, 6.—PALMER, Mem. Soc. Cubana Hist. Nat., vol. 15, 1941, p. 284.—KEIJZER, Proc. Ned. Akad. Wetenschappen, vol. 45, 1942, p. 607 (list).—TEN DAM and REINHOLD, Med. Geol. Stichting, ser. C-V, No. 2, 1942, p. 95, pl. 7, fig. 6.—MARCHESINI, Comm. Pont. Acad. Sci., vol. 6, 1942, p. 752 (list).—PARR, Mining and Geol. Journ., vol. 2, 1942, p. 364 (list).—SILVESTRI and ZANGHERI, Boll. Soc. Geol. Ital., vol. 61, 1942, p. 90.—VAN DER SLUIS and DE VLETTER, Proc. Ned. Akad. Wetenschappen, vol. 45, 1942, p. 1014 (list).—CRESPIN, Bull. 9 (Pal. Ser. No. 4), Commonwealth of Australia, Min. Res. Survey, (mimeographed), 1943, p. 83 (list).—LEROY, Colorado School Mines Quart., vol. 39, No. 3, pt. 1, 1944, p. 38, pl. 4, figs. 49, 50; pt. 2, p. 90, pl. 3, figs. 24, 25.—PARR, Proc. Roy. Soc. Victoria, vol. 56 (n. ser.), pt. 2, 1943 (1945), p. 214.—PALMER, Bull. Amer. Pal., vol. 29, No. 115, 1945, p. 67.—VALK, in RUTTEN and HOTZ, Geol., Petrogr. and Paleont. Results Explor. Island of Ceram, 3rd ser., Geol., No. 1,

1945, p. 26.—CRESPIN, Trans. Roy. Soc. So. Australia, vol. 70, 1946, p. 298 (list).—CUSHMAN, U. S. Geol. Survey Prof. Paper 210-A, 1946, p. 13.—DORREEN, Journ. Pal., vol. 22, 1948, p. 298.

Sphaeroidina austriaca EGGER (not D'ORBIGNY), Jahresb. 16, Nathist. Ver. Passau, 1895, p. 40, pl. 4, fig. 22.

Sphaeroidina variabilis COLOM (not REUSS), Num. 3, Estudios Geologicos, Instit. Invest. Geol., 1946, p. 58, pl. 3, figs. 78, 84.

Test roughly cubic in shape, not much inflated; chambers usually 4, occasionally 5, making up the surface, last one forming approximately half the surface; sutures nearly straight, distinct, not much depressed nor incised; wall smooth, polished; aperture a narrow, slightly rimmed, crescent opening formed by the broad, tooth-like portion of the wall nearly filling the semi-circular arched opening. Diameter 0.35-0.60 mm.

S. bulloides was described from the Adriatic Sea, near Rimini, and fossil near Sienna, Italy, and from Recent material from Mauritius, off Madagascar.

The above synonymy includes most of the records of *S. bulloides*, except those known to belong elsewhere; and the records include most of the Tertiary and the Recent and are very widely distributed over the world. It will undoubtedly be found that not all these records belong to the same species.

In our available material we have specimens referable to *S. bulloides* from Rimini, Italy; 350 fms., South Atlantic (*Challenger* sta. 122); the Pliocene of Castel Arquato, Calabria, and San Rufillo, Italy; the Miocene of Nussdorf, Niederleis, and Loos in the Vienna Basin; and the Oligocene, Balcombian, of Balcomb Bay, Mornington, Victoria, Australia.

S. bulloides seems to be characterized by its roughly cubic, rather than spherical, shape, and its last-formed chamber forming about half the surface of the test.

SPHAEROIDINA AUSTRIACA d'Orbigny (Pl. 3, figs. 12-17)

Sphaeroidina austriaca D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 284, pl. 20, figs. 19-21.—REUSS, Zeitschr. deutsch. geol. Ges., vol. 3, 1851, p. 163.—EGGER, Neues Jahrb. für Min., Jahrg. 1857, p. 273, pl. 6, figs. 19, 20.—REUSS, Sitz. Akad. Wiss. Wien, vol. 42, 1860, p. 368.—SEGUENZA, Atti Accad. Gioenia Sci. Nat., ser. 2, vol. 18, 1862, p. 33.—REUSS, Sitz. Akad. Wiss. Wien, vol. 50, 1864, p. 473; vol. 55, 1867, p. 91.—KARRER, l. c., vol. 58, 1868, p. 175.—TERQUEM, Mem. Soc. Geol. France, ser. 3, vol. 1, 1878, p. 61.—KARRER, in VON DRACHE, Frag. Geol. Insel Luzon, 1878, p. 94.—TERRIGI, Atti Accad. Pont. Nuovi Lincei, vol. 33, 1880, p. 66; vol. 35, 1883, p. 187.—HANTKEN, Mitth. Jahrb. K. Ungar. geol. Anstalt, vol. 4, 1875 (1881), p. 62, pl. 10, fig. 4.—RZEHAK, Verh. Nat. Ver. Brünn, vol. 14, pt. 1, 1885, pp. 87, 92, 102, 110, 111.—HOSIUS, Verh. Nat. Hist. Vereins Pr. Rheinlande, vol. 50, 1893, p. 128.—KRUMPHOLZ, Verh. Nat. Ver. Brünn, vol. 54, 1916, p. 137.—CLODIUS, Archiv. Ver. Freunde Nat.

Mecklenburg, 75 J., 1922, p. 130.—Staesche and Hiltermann, Abhandl. Reichs. Bodenforschung, n. ser., No. 201, 1940, pl. 29, fig. 6; pl. 31, fig. 10; pl. 32, fig. 10; pl. 33, fig. 8; pl. 35, fig. 7; pl. 47, fig. 7.

Sphaeroidina bulloides Chapman, Parr, and Collins (not d'Orbigny), Journ. Linn. Soc., Zool., vol. 38 (No. 262), 1934, p. 568, pl. 10, fig. 31.

Test compact, slightly longer than broad, nearly spherical in shape, or irregularly elongate; chambers usually 5 visible on the surface, last 3 about equal in size, very little if at all inflated; sutures distinct, nearly straight, only slightly depressed; wall smooth, polished; aperture an elongate arched slit in the last-formed chamber just above the edge of the chamber. Length 0.45-0.62 mm.; diameter 0.40-0.50 mm.

S. austriaca was described from the Miocene of Nussdorf in the Vienna Basin, and has been widely recorded in Europe from Eocene to Pliocene, although probably not all the records included in the synonymy belong to the same species. In our material we have specimens from the Eocene of Kiscell, Budapest, Hungary, and Neustift b. Ofen, Hungary; from the Oligocene of Lobsann, Alsace, and Wiesloch, b. Heidelberg, Baden, Germany; from the Oligocene, Balcombian, of Balcomb Bay, Mornington, and lower beds, Muddy Creek, Victoria, Australia; from the Miocene, Janjukian, Green marl, Bird Rock Cliffs, Torquay, Danger Point, Torquay, and Filter Quarries, Batesford, Victoria; from the Miocene of the Vienna Basin at Nussdorf, Perchtoldsdorf, Mollendorf, and Loos; and from Recent material from off Japan (*Albatross* D 4967) and off Romblon, Philippines (*Albatross* D 5178).

S. austriaca is distinguished by its compact, slightly elongate shape and the last chamber forming only about one third of the test.

SPHAEROIDINA HAUERI (Czjzek) (Pl. 4, figs. 1, 2)

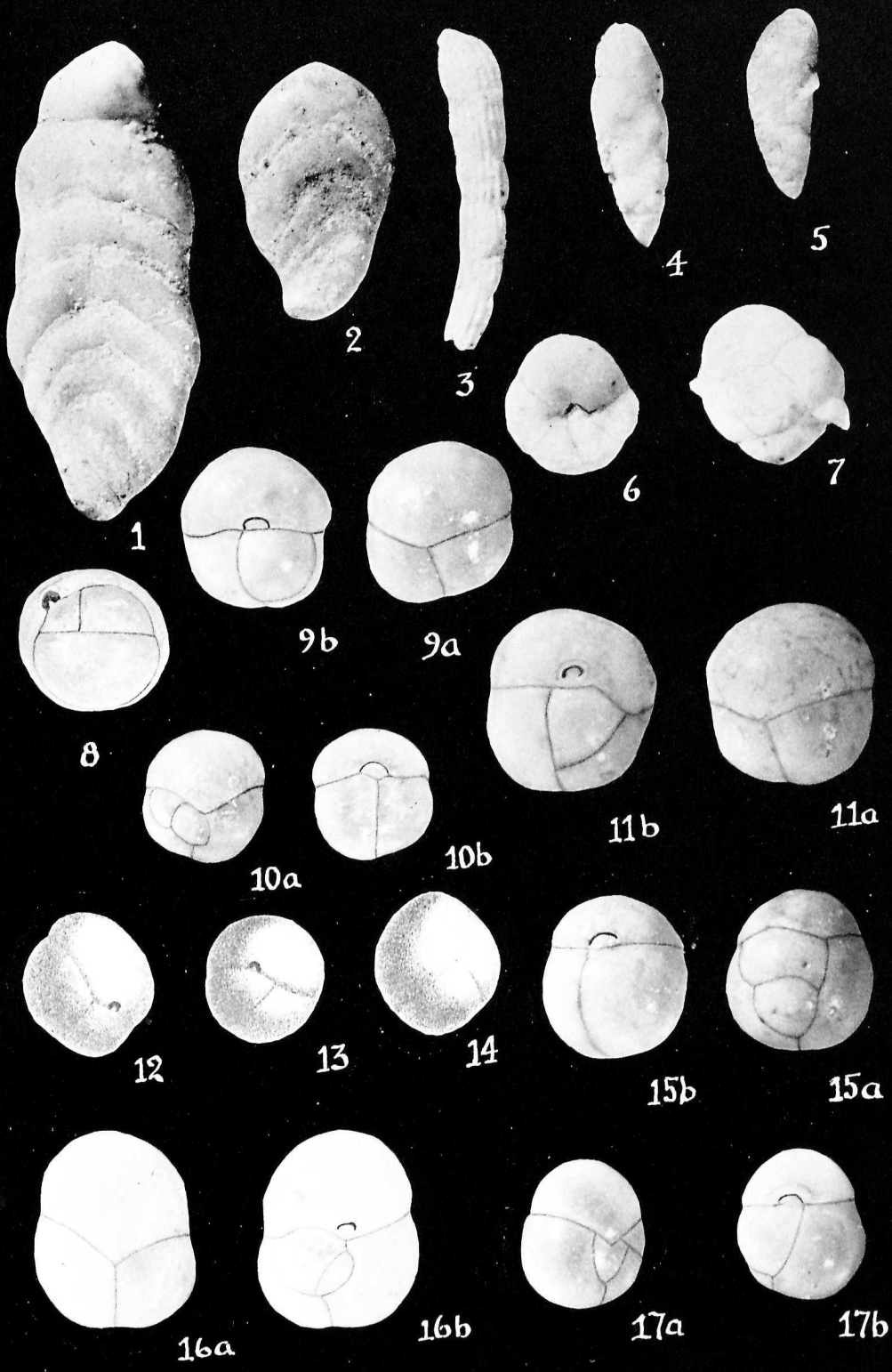
Sexloculina haueri Czjzek, Haidinger's Nat. Abhandl., vol. 2, 1848, p. 149, pl. 13, figs. 35-38.

Test globular, inflated; chambers inflated, usually 6 or occasionally as many as 7 visible on the surface, rapidly increasing in size as added

EXPLANATION OF PLATE 3

Figs. 1, 2. *Palmula deslongchampsi* (Terquem). × 20. 1, Adult with several uniserial chambers. 2, Younger specimen with mostly coiled chambers, the last one being definitely uniserial. 3. *Dentalina* sp. × 40. 4, 5. *Virgulina jurassica* Cushman and Glazewski, n. sp. × 40. 4, Holotype. 5, Paratype. 6, 7. *Discorbis* cf. *dreheri* Bartenstein. × 40. 6, Ventral view. 7, Dorsal view. 8-11. *Sphaeroidina bulloides* d'Orbigny. 8, Photograph of Model. The Model is placed so as to show parts of all the chambers. In order to be viewed from the same angle as figs. 9 and 10 it should be rotated 90° forward and 90° to the right. 9, Topotype, Recent, Rimini, Italy. × 55. 10, Oligocene, Balcomb Bay, Mornington, Victoria, Australia. × 55. 11, Pliocene, Coroncina, Italy. × 55. 12-17. *S. austriaca* d'Orbigny. 12-14, Type figures. (After d'Orbigny). × 65. 15, Miocene, Perchtoldsdorf, Austria. × 55. 16, Recent, off Romblon, Philippines. × 55. 17, Oligocene, lower beds, Muddy Creek, Victoria, Australia. × 55.

(In all cases, *a*, apertural view; *b*, opposite side.)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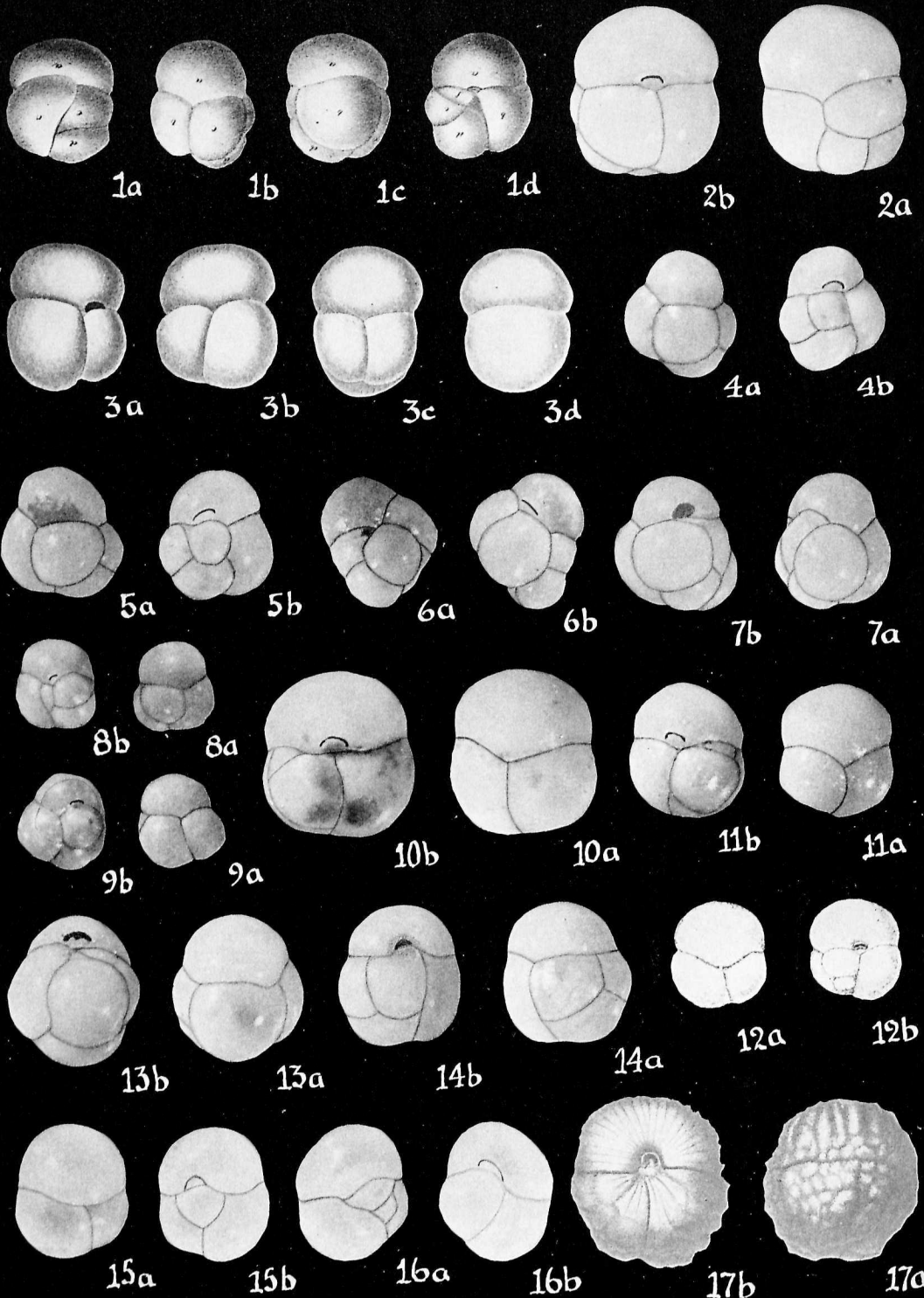
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so that the last one forms about half the surface of the test; sutures distinct, depressed; wall smooth, polished; aperture a narrow, arched, slightly rimmed slit at the edge of the last-formed chamber. Diameter 0.45-0.60 mm.

This species was described from the Miocene of the Vienna Basin at Nussdorf, Baden, and Mollersdorf. It was said to differ generically from *Sphaeroidina* in having six instead of four chambers, but that distinction is not a valid one for genera.

The species occurs in the Miocene of Europe with *S. austriaca* at Baden and Loos in the Vienna Basin and at Lapugy, Hungary. It resembles *S. bulloides* more than *S. austriaca*, differing from the former in greater inflation of the chambers as well as more chambers visible on the surface.

SPHAEROIDINA VARIABILIS Reuss (Pl. 4, figs. 3-9)

Sphaeroidina variabilis Reuss, Zeitschr. deutsch. geol. Ges., vol. 3, 1851, p. 88, pl. 7, figs. 61-64; Sitz. Akad. Wiss. Wien, vol. 48, 1863, p. 68; vol. 50, 1864, p. 474; l. c., Denkschr., vol. 25, 1865, p. 156; l. c., Sitz., vol. 62, 1870, p. 488, in von Schlicht, Foram. Sept. Pietzpuhl, 1870, pl. 22, figs. 24-29.—Andreae, Abhandl. Geol. Special-Karte Elsass-Lothringen, vol. 2, 1884, pp. 121, 141, 163.—Hosius, Nat. Ver. Osnabrück, Jahrb., 1893-94 (1895), p. 178.—Thürach and Herrmann, Mitteil. Badischen Geol. Landes., vol. 4, 1903, p. 546 (list).—ten Dam and Reinhold, Med. Geol. Stichting, ser. C-V, No. 2, 1942, p. 95, pl. 7, fig. 5.

Sphaeroidina austriaca Reuss (not d'Orbigny), Denkschr. Akad. Wiss. Wien, vol. 1, 1850, p. 387, pl. 51, figs. 3-19.—Cushman, U. S. Geol. Survey Prof. Paper 181, 1935, p. 49, pl. 20, fig. 13.

Sphaeroidina bulloides Paalzow (not d'Orbigny), Ber. Offenbach. Ver. Nat., 1912, p. 69, pl. 1, fig. 18.

Test relatively small for the genus, irregular and very variable in shape; chambers rapidly increasing in size as added, usually 5, 6, or 7 visible at the surface, much inflated; sutures distinct, deeply incised, curved; wall smooth, thin; aperture a small, strongly arched slit at the edge of the last-formed chamber, in some cases becoming a large rounded

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EXPLANATION OF PLATE 4

Figs. **1, 2.** *Sphaeroidina haueri* (Czjzek). 1, Type figures. (After Czjzek). × 40. *a-d*, successive views 90° apart with rotation toward the right. 2, Miocene, Baden, Austria. × 55. **3-9.** *S. variabilis* Reuss. 3, Type figures. (After Reuss). 4-7, Oligocene, Septaria clay, Flonheim, Mainz Basin, Germany. × 55. 8, 9, Oligocene, Pietzpuhl, Germany. × 55. **10-12.** *S. chilostomata* Galloway and Morrey. 10, Pliocene, first gully N. of Palos Verdes Hills, Calif. × 55. 11, Topotype, Miocene, on seacoast near Manta, Ecuador. × 55. 12, Type figures. (After Galloway and Morrey). × 40. **13.** *S. nitida* Cushman and Todd, n. sp. Recent, 494 fathoms, Philippines. Holotype. × 25. **14.** *S. compacta* Cushman and Todd, n. sp. Recent, 1002 fathoms, Yucatan Channel. Holotype. × 25. **15, 16.** *S. compressa* Cushman and Todd, n. sp. Recent, 60 fathoms, off "The Poor Knights," New Zealand. × 55. 15, Holotype. 16, Paratype. **17.** *S. ornata* H. B. Brady. Pliocene, Fiji. Type figures. (After Brady). × 45.

opening by the breaking out of the central tooth-like plate. Greatest dimension 0.30-0.42 mm.

S. variabilis was described from the Oligocene of Hermsdorf and Freienwalde near Berlin, Germany. It occurs fairly commonly in our material from the Oligocene of Germany, from Hermsdorf, Pietzpuhl, Flonheim, Sollingen, and Ahnatal b. Cassel. The specimens from the Cooper marl of South Carolina, originally called *S. austriaca,* also seem to belong in this species. No specimens younger than Oligocene were found to be typical of this species in our material.

Reuss described a variety, *conica,* of his species from the Septaria clays of Pietzpuhl and Offenbach (Reuss, Sitz. Akad. Wiss. Wien, vol. 48, pt. 1, 1863, p. 58, pl. 7, fig. 86; vol. 62, pt. 1, 1870, p. 488, in von Schlicht, Foram. Sept. Pietzpuhl, 1870, pl. 23, figs. 22-24) but from our available specimens this conical shape is found in varying degrees wherever *S. variabilis* occurs and may be the microspheric form of the species (See our pl. 4, fig. 6).

SPHAEROIDINA CHILOSTOMATA Galloway and Morrey (Pl. 4, figs. 10-12)

Sphaeroidina bulloides D'ORBIGNY, var. *chilostomata* GALLOWAY and MORREY, Bull. Amer. Pal., vol. 15, No. 55, 1929, p. 32, pl. 5, fig. 1.

Sphaeroidina variabilis CUSHMAN (not REUSS), Contr. Cushman Lab. Foram. Res., vol. 5, 1929, p. 101, pl. 14, fig. 15.—HEDBERG, Journ. Pal., vol. 11, 1937, p. 681, pl. 92, fig. 9.—FRANKLIN, l. c., vol. 18, 1944, p. 317, pl. 48, fig. 3.

Sphaeroidina bulloides CUSHMAN, STEWART, and STEWART (not D'ORBIGNY), Trans. San Diego Soc. Nat. Hist., vol. 6, 1930, p. 76, pl. 7, fig. 2.—CUSHMAN and TODD, Special Publ. 15, Cushman Lab. Foram. Res., 1945, p. 65, pl. 11, fig. 9.—CUSHMAN and RENZ, l. c., Special Publ. 22, 1947, p. 40.—CUSHMAN, STEWART, and STEWART, Bull. 36, Oregon Dept. Geol. and Min. Ind., pt. 1, 1947 (1948), p. 22, pl. 4, figs. 1, 2.

Test roughly cubic in shape; chambers inflated, 5 visible on the surface, very rapidly increasing in size as added so that the last one forms about half the surface, but only a narrow arc of the fifth-from-the-last is visible; sutures nearly straight, distinctly depressed; wall smooth, polished; aperture a distinctly rimmed, arched slit near the edge of the last-formed chamber, directly above the suture. Diameter 0.32-0.50 mm.

This form was described from the Miocene near Manta, Ecuador, as a variety of *S. bulloides,* being said to differ in the character of the aperture. We have topotypes in our collection and they appear to differ in more ways and to be specifically distinct. The species has five rather than four chambers visible on the surface and the chambers are considerably more inflated than in *S. bulloides.*

S. chilostomata is known from the Miocene and upper and lower Oligocene of Venezuela, the upper Oligocene, Ste. Croix formation, of Trin-

idad, the Miocene of Buff Bay, Jamaica, the Pliocene of California, and the Miocene of Oregon. In addition, we have specimens from the Miocene, 2½ km. SW. of deposits in Arroyo Laja at tributary of Rio Chichigara near its head, Isthmus of Tehuantepec, Mexico.

SPHAEROIDINA CIPERANA Cushman and Todd, n. sp.

Sphaeroidina variabilis CUSHMAN and STAINFORTH (not REUSS), Special Publ. 14, Cushman Lab. Foram. Res., 1945, p. 67, pl. 12, fig. 14.

Test large for the genus, compact, roughly cubic in shape; chambers not inflated, last three not much if any increasing in size, 5 to 7 visible at the surface, the earliest ones eccentric and slightly elevated; sutures distinct, limbate, straight, depressed; wall smooth, polished; aperture a high, arched opening at the edge of the last-formed chamber, nearly completely obstructed by a broad tooth which may be broken away leaving a large opening. Diameter 0.75-1.00 mm.

Holotype (Cushman Coll. No. 43942) from the Oligocene, Cipero formation, Zone III, Sample Rz. 425, Cipero Coast, Trinidad, B.W.I. (figured in above reference: figs. 14a, b).

This species differs from *S. variabilis* Reuss in its more compact test and much larger size. It differs from *S. bulloides* d'Orbigny in having more chambers with the earliest ones projecting out from the main test, and in its last chamber comprising proportionately less of the test. It differs from *S. haueri* (Czjzek) in its later chambers not increasing in size as added and its different shaped aperture.

It occurs fairly commonly in Zones II and III (middle and upper) of the Cipero formation but the Sphaeroidinas present in Zone I (lower) are very much smaller and belong to another species not yet described. They do not appear to be the young forms of *S. ciperana* n. sp., as seen in Zones II and III.

SPHAEROIDINA COMPACTA Cushman and Todd, n. sp. (Pl. 4, fig. 14)

Sphaeroidina bulloides CUSHMAN (not D'ORBIGNY), Bull. 71, U. S. Nat. Mus., pt. 4, 1914, p. 18, pl. 12, fig. 1.

Test large for the genus, compact; chambers not inflated, 6 visible at the surface, much embracing, very slightly increasing in size as added, last-formed chamber in the adult normally smaller than preceding ones; sutures distinct, limbate, slightly depressed, little it at all curved; wall thick, smooth and polished except for a slightly roughened, granular area extending outward in all directions from the aperture; aperture a fairly large, arched opening under the edge of the last-formed chamber adjacent to the suture, no tooth has been observed. Diameter 0.75-0.90 mm.

Holotype (Cushman Coll. No. 59404) from 1002 fathoms, Yucatan Channel, between Gulf of Mexico and Caribbean Sea.

This species is distinguished by its large, robust test, the last chamber being somewhat smaller than the previous ones, and the large, open aperture surrounded by a roughening of the surface.

In addition to the type locality, where it is fairly common, the species has been found in the Pacific (*Nero stas.* 990, 1464, and others).

SPHAEROIDINA NITIDA Cushman and Todd, n. sp. (Pl. 4, fig. 13)

Sphaeroidina bulloides CUSHMAN (not D'ORBIGNY), Bull. 100, U. S. Nat. Mus., vol. 4, 1921, p. 297.

Test large for the genus, irregular; chambers slightly inflated, 6 visible at the surface, very slightly increasing in size as added; sutures distinct, depressed, nearly straight; wall thick, smooth and polished; aperture a large arched opening at the edge of the last-formed chamber, surrounded by a slightly inbent area of the chamber and partially filled by an irregular, sometimes bifid, tooth-like process. Diameter 0.75-0.95 mm.

Holotype (Cushman Coll. No. 59407) from 494 fathoms, east coast of Mindanao, Philippines (*Albatross* D 5236).

This species differs from *S. compacta* n. sp. in its greater inflation of chambers and consequently more irregular shape, and its different aperture.

The species, so far as known at present, is confined to the Philippine Seas.

SPHAEROIDINA COMPRESSA Cushman and Todd, n. sp. (Pl. 4, figs. 15, 16)

Sphaeroidina bulloides CUSHMAN (not D'ORBIGNY), Proc. U. S. Nat. Mus., vol. 56, 1919, p. 622.

Test somewhat compressed and rather smoothly oval in shape, chambers not much inflated, 4 or 5 visible on the surface, rapidly increasing in size as added; sutures distinct, depressed, gently curved; wall thin, translucent, smooth, and polished; aperture a very narrow, arched slit near the edge of the last-formed chamber. Diameter 0.37-0.45 mm.

Holotype (Cushman Coll. No. 59409) from 60 fathoms, off "The Poor Knights," New Zealand. It also occurs at 50 fathoms, Oamaru, and 98 fathoms, off the Big King, New Zealand, and at 80 fathoms, 22 miles E. of Nanabeen, New South Wales.

This species differs from *S. bulloides* d'Orbigny in its compressed oval shape and curved sutures, and its very thin, translucent wall.

SPHAEROIDINA ORNATA H. B. Brady (Pl. 4, fig. 17)

Sphaeroidina ornata H. B. BRADY, Quart. Journ. Geol. Soc., vol. 44, 1888, p. 6, pl. 1, fig. 4.

"Test spherical or subspherical, slightly excavated at the umbilicus;

consisting of an involute spire, of which about four chambers are visible externally, the ultimate segment occupying nearly one half of the exterior convolution; surface beset with small, irregular, convex prominences, except in the region of the aperture, which is marked with radiating grooves or furrows; aperture obscure, crescentiform, situated in a depression at the inner margin of the terminal segment. Diameter 1/50 inch (0.5 millim.)."

The types are from the Pliocene of Fiji. The species has apparently not been found elsewhere. If this is a true *Sphaeroidina* it is unique in its surface ornamentation.

The following references to figures of Sphaeroidinas have been ommitted from synonymy as they do not seem to belong to any already described species and further study of additional material is necessary before they can be adequately described:

Sphaeroidina austriaca SCHWAGER (not D'ORBIGNY), *Novara*-Exped., Geol. Theil, vol. 2, 1866, p. 250, pl. 7, fig. 98.

Sphaeroidina bulloides H. B. BRADY (part) (not D'ORBIGNY), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 620, pl. 84, figs. 3, 4; figs. 6, 7.

Sphaeroidina bulloides FLINT (part) (not D'ORBIGNY), Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 325, pl. 71, fig. 1 (lower left figure).

Sphaeroidina bulloides CUSHMAN (not D'ORBIGNY), Bull. 104, U. S. Nat. Mus., pt. 5, 1924, p. 36, pl. 7, figs. 1-5.

Sphaeroidina bulloides PARKER (not D'ORBIGNY), Bull. Mus. Comp. Zoöl., vol. 100, 1948, p. 239 (list), pl. 7, fig. 3.

The following species originally described as *Sphaeroidina* belong in other genera or are indeterminable, as follows:

S. parisiensis EHRENBERG, Mikrogeologie, 1854, pl. 27, figs. 33, 34. (=?)

S. cretacea EHRENBERG, Mikrogeologie, 1854, pl. 28, fig. 30. (=?)

S. gemmula EHRENBERG, Mikrogeologie, 1854, pl. 30, fig. 22. (=?)

S. dehiscens PARKER and JONES, Philos. Trans., 1865, p. 369, pl. 19, fig. 5. (=*Sphaeroidinella*)

S. murrhyna SCHWAGER, *Novara*-Exped., Geol. Theil, vol. 2, 1866, p. 250, pl. 7, fig. 97. (=*Cassidulina*)

S. corticata HERON-ALLEN and EARLAND, Trans. Zool. Soc. London, vol. 20, 1915, p. 681, pl. 51, figs. 14-18. (=*Rugidia*)

?S. sp. HERON-ALLEN and EARLAND, Trans. Linn. Soc. London, ser. 2, vol. 11, 1916, p. 268, pl. 42, figs. 19, 20. (=?)

S. dehiscens PARKER and JONES, var. *immatura* CUSHMAN, Publ. 291, Carnegie Instit. Washington, 1919, p. 40, pl. 14, fig. 2. (=*Sphaeroidinella*)

S. (?) *peruviana* W. BERRY, Eclogae geol. Helvetiae, vol. 25, 1932, p. 29, pl. 2, fig. 4. (=?; the walls are described as coarsely perforate)

RECENT LITERATURE ON THE FORAMINIFERA

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

Reichel, Manfred. Sur un nouveau genre d'Alvéolines du Crétacé supérieur.—Eclogae geol. Helvetiae, vol. 34, No. 2, 1941, pp. 254-260, pl. XV, text figs. 1, 2.—*Cisalveolina* is erected, with the genotype *C. fallax* n. sp. from the Cretaceous of Iran. A second species, *C. lehneri* n. sp., is also described from Iran.

Sur un Miliolidé nouveau du Permien de l'île de Chypre.—Vorhandl. Naturf. Gesell. in Basel, vol. LVI, pt. 2, 1945, pp. 521-530, text figs. 1, 2.—A new genus and species, *Hemigordiopsis renzi,* is described.

Sur quelques foraminifères nouveaux du Permien méditerranéen.—Eclogae geol. Helvetiae, vol. 38, No. 2, 1945, pp. 524-560, pl. XIX, text figs. 1-44.—Several new genera erected: *Lasiodiscus* (genotype *L. granifer* n. sp.); *Lasiotrochus* (genotype *L. tatoiensis* n. sp.); *Robuloides* (genotype *R. lens* n. sp.); *Gourisina* (genotype *G. brönnimanni* n. sp.); *Olympina* (genotype *O. insolita* n. sp.), and numerous new species described.

A propos de *Pyramis parva* Colani.—L. c., vol. 39, No. 2, 1946, pp. 371, 372.

Les Hantkéninidés de la Scaglia et des Couches rouges (Crétacé supérieur).—L. c., vol. 40, No. 2, 1947, pp. 391-409, pl. VIII, text figs. 1-11.—Four new species and two new varieties of *Schackoina* are described.

Multispirina iranensis n. gen. n. sp. Foraminifère nouveau du Crétacé supérieur de l'Iran.—Mém. Suisses de Paléontologie, vol. 65, 1947, pp. 1-13, pls. 1-4, text figs. 1-5.

Hanzawa, Shoshiro. Note on *Lacazina wichmanni* Schlumberger from New Guinea.—Jap. Journ. Geol. Geogr., vol. XX, Nos. 2-4, 1947, pp. 1-4, pl. III.

Notes on some species of *Pseudocyclammina* from Sumatra.—L. c., pp. 5-8, pl. IV.

Note on *Borelis pygmaeus* (Hanzawa) from the Mariana Islands.—L. c., pp. 9-11, pl. V.

Note on an Eocene Foraminiferal Limestone from New Britain.—L. c., pp. 59-61, pls. XIV, XV.—Two new species, *Pellatispira reticularis* and *Acervulina linearis,* are described and figured.

Bartenstein, Helmut. Mikropaläontologische Untersuchungen zur Stratigraphie des westfälischen produktiven Oberkarbons.—Erdöl und Kohle, 1, Jahrg., 1948, pp. 143-146.—Mentions foraminifera.

Untersuchungen zur Systematik und Stratigraphie der *Flabellina*-gestaltigen Foraminiferen.—L. c., pp. 180-184, text figs. 1-14.—Figures numerous species, some new.

de Cizancourt, Maria. Nummulitidae a Orbitoidae Eocénu od Bojnickych Kúpel'ov na Slovensku (Nummulitidae et Orbitoidae de l'Éocène de Bojnice-les-Bains près de Prievidza, Karpathes Slovaques).—Práce Statneho Geologického Ustavu v Bratislave, Sosit 17, 1948, pp. 41-58, pls. VI-IX, 1 text fig.

Sigal, J. Notes sur les genres de Foraminifères *Rotalipora* Brotzen 1942 et *Thalmanninella.* Famille des Globorotaliidae.—Revue Instit. Français Pétrole Ann. Combust.

liquides, vol. III, No. 4, April 1948, pp. 95-103, pls. I, II.—Erects a new genus *Thalmanninella* (genotype *T. brotzeni* n. sp.), and a number of new species and varieties.

ten Dam, A. Les espèces du genre *Epistomina* Terquem 1883.—L. c., No. 6, June 1948, pp. 161-170, pls. I, II.—A number of species and varieties are described and figured, some new.

Lalicker, Cecil G. Dwarfed Protozoan Faunas.—Sedimentary Petrology, Aug. 1948, pp. 51-55, pl. 1, text fig. 1.—Mentions foraminifera.

Thompson, M. L. Studies of American Fusulinids.—Univ. Kansas Pal. Contrib., Protozoa, Art. 1, Oct. 15, 1948, pp. 1-184, pls. 1-38, text figs. 1-7.—A very complete work on the Fusulinidae with many new species.

Henson, Francis Roger Spencer. Larger Imperforate Foraminifera of South-Western Asia, Families Lituolidae, Orbitolinidae and Meandropsinidae.—British Museum (Natural History), 1948, pp. 1-127, 16 pls., 16 text figs.—A very comprehensive work on the three families. The following new genera are erected: *Haurania* (genotype *H. deserta* n. sp.); *Dictyoconella* (genotype *D. complanata* n. sp.); *Lituonelloides* (genotype *L. compressus* n. sp.); *Coskinolinopsis* (genotype *C. primaevus* n. sp.); *Iraqia* (genotype *I. simplex* n. sp.); *Edomia* (genotype *E. reicheli* n. sp.); *Orbitolinella* (genotype *O. depressa* n. sp.); *Broeckinella* (genotype *B. arabica* n. sp.); *Mangashtia* (genotype *M. viennoti* n. sp.); *Zekritia* (genotype *Z. langhami* n. sp.); *Pseudedomia* (genotype *P. multistriata* n. sp.); *Saudia* (genotype *S. discoidea* n. sp.); *Qataria* (genotype *Q. dukhani* n. sp.); *Dohaia* (genotype *D. planata* n. sp.). The family name Meandropsinidae is also new.

Rau, Weldon W. Foraminifera from the Miocene Astoria formation in southwestern Washington.—Journ. Pal., vol. 22, No. 6, November 1948, pp. 774-782, pl. 119.—Several species are recorded and figured, 3 new.

Renz, H. H. Stratigraphy and Fauna of the Agua Salada Group, State of Falcón, Venezuela.—Geol. Soc. Amer., Memoir 32, Dec. 10, 1948, pp. 1-219, pls. I-XII, text figs. 1-15, tables 1-19.—Many species are figured and described, four new. A large table shows the stratigraphic distribution.

Cushman, Joseph A. Foraminifera from the Hammond well.—Bull. 2, Maryland Dept. Geol., Mines and Water Resources, Cretaceous and Tertiary Subsurface Geology, The Stratigraphy, Paleontology, and Sedimentology of Three Deep Test Wells on the Eastern Shore of Maryland, 1948, pp. 213-267, pls. 15-26, figs. 25-27 (charts).—The foraminifera from the Miocene, Eocene, and Upper Cretaceous are noted and many of the species figured, 8 new and 1 new name.

Foraminifera from the Bethards well.—L. c., pp. 267, 268.—Upper Cretaceous foraminifera are listed.

Dorsey, Ann (Mrs. Arthur W. Clapp). Miocene Foraminifera from the Chesapeake Group of Southern Maryland.—L. c., pp. 268-321, pls. 27-39, table 20, figs. 28, 29 (charts), 30 (map).—A comprehensive report on outcrop samples, describing and figuring numerous species, 12 new.

Thompson, M. L., and **A. K. Miller.** Permian fusulinids and cephalopods from the vicinity of the Maracaibo Basin in northern South America.—Journ. Pal., vol. 23, No. 1, Jan. 1949, pp. 1-24, pls. 1-8, text fig. (map) and tables.—Several new species described and figured.

Stone, Benton. New Foraminifera from northwestern Peru.—L. c., pp. 81-83, pl. 21.—Two new genera erected: *Sporobuliminella* (genotype *S. stainforthi* n. sp.) and *Sporobulimina* (genotype *S. perforata* n. sp.).

Frizzell, Don L., and **A. Myra Keen.** On the Nomenclature and generic position of *Nautilus beccarii* Linné (Foraminifera, "Rotaliidae").—L. c., pp. 106-108.

J. A. C.