CONTRIBUTIONS

FROM THE

CUSHMAN LABORATORY

FOR

FORAMINIFERAL RESEARCH

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SHARON, MASSACHUSETTS, U. S. A.

CONTENTS

These contributions will be issued quarterly. They will contain short papers with plates, describing new forms and other interesting notes on the general research work on the foraminifera being done on the group by the workers in this laboratory. New literature as it comes to hand will be briefly reviewed.

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Owing to the fact that the Volume date in the previous Volumes did not correspond with the calendar year, a change has been made in the date of publication. Volume 3 will have its parts issued in March, June, September, and December 1927, so that all numbers of the Volume will be dated 1927.

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CONTRIBUTIONS FROM THE CUSHMAN LABORATORY FOR FORAMINIFERAL RESEARCH

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45. NOTES ON THE COLLECTION OF DEFRANCE

The original collection of Defrance is a very important one from the point of view of knowing clearly the species which have become genotypes. I am greatly indebted to Dr. Ferdinand Canu and Dr. Henri Douvillé for the information that this collection is preserved in the Museum of the University at Caen. Doctor Canu kindly accompanied me to Caen for a two day's trip and Professor A. Bigot at Caen gave me every facility for the study of the collection.

The specimens were originally mounted on strips of gray pasteboard with the original labels on the front and on the back are Lamarck's original labels carefully pasted to the strip. Each strip of cardboard is in a large glass tube. Very few of the original specimens on the slides are missing or damaged which is a great credit to those who have had the collection in charge for more than a hundred years.

The first and perhaps the most important part of the Defrance collection is that which was described by Lamarck in 1804 (Annales du Museum, vol. 5 and figured in vol. 8). Nearly all the species described by Lamarck in his paper are given as in "Cabinet de M. Defrance." I have already given some notes on these species (Contrib. Cushman Lab. Foram. Research, Vol. 3, Pt. 2, pp. 123-126). It is now possible to enlarge upon and confirm the points made in that paper.

Discorbis vesicularis Lamarck. There are 17 specimens on the slide all of the same species already well known from the figures of many authors and the same that I have figured (l. c. pl. 24, figs. 1 *a-c)*. This species is then the genotype of *Discorbis* which is a very excellent genus. The species is fairly common at the type locality, Grignon, where I collected excellent material through the kindness of Prof. Courtreur.

Rotalia trochidiformis Lamarck. The type slide from Grignon has 30 specimens all of the same species which is the genotype of *Rotalia*. They are of the same features as the series I have figured (l. c. pl. 24, figs. 5-7) and identical with others which have been figured from the Eocene of France, as by Terquem in 1881, whose figured specimens I examined through the courtesy of Dr. Douvillé and Dr. G. Dollfus.

The types of *Rotalia lenticulina* Lamarck, *R. depressa* Lamarck, and *R. discorbula* Lamarck were also examined. The last is the large strongly biconvex species that occurs at Grignon but is smooth and very different from *R. trochidiformis*. The other two species were not figured by Lamarck, and a study of the published material will be necessary to place them in their correct position. *Rotalia depressa* Lamarck is the *Rosalina parisiensis* of d'Orbigny *Discorbis parisiensis* (d'Orbigny), under which it must be placed as a nomen nudum.

As I have already indicated (l. c. p. 124) *Lenticulina rotulata* Lamarck is the genotype of *Lenticulina*. The type slide has three specimens from the White Chalk of Meudon. The central one of the three is the best preserved, and is a typical keeled *"Cristellaria."* A sketch of this specimen is given here, pl. 28, fig. 7. The aperture is radiate and there is no supplemental median aperture as in *"Robulus"*. The keel is sharp and well marked, the apertural face somewhat thickened at the sides as in so many species of *"Cristellaria"*, the test is umbonate as in the earlier conception of this species by many authors. There can be no question but that Lamarck's *Lenticulina rotulata* is a well characterized species of what has been called *"Cristellaria"* and by the rules of priority must stand for that genus instead of *Cristellaria* Lamarck, 1816 or any of the sixteen generic names proposed by Montfort in 1808. The other two species of the genus not figured by Lamarck are *"Nummulites"*.

Lituola nautiloidea Lamarck is also from Grignon. There are 14 specimens on the slide, one very large, the holotype, figured by Lamarck. The early portion is close coiled and the last three chambers uncoil. The aperture is multiple and terminal in the adult and even in the later portion of the coiled adult the apertures are multiple as shown in the sketches (pl. 28, figs. 8, 9).

As shown by the excellent sections on the slide the aperture in the young is simple, at the base of the apertural face as in *Haplophragmoides*. The test is made of white agglutinated material with a fairly smooth surface, easily eroded and showing the rough character of the structure of the wall. The in-

terior is not labyrinthic and it is probable that *Lituola* will include those Cretaceous species which were referred to *Haplophragmium* by Reuss. *Lituola difformis* also from Meudon has 11 specimens on its type slide, some of which are sections. It is very globular, with 5 or 6 chambers in the coil, the last of which starts to uncoil. The surface is also smoother than in *L. nautiloidea.*

Spirolina cylindracea Lamarck from Grignon is well marked and has already been referred to (l. c. p. 125). The type slide has 29 specimens all of this same species, which has usually been refered to as "*Peneroplis cylindracea.*" Var. β however is represented by a slide with 16 specimens which are *Clavulina. Spirolina depressa* Lamarck is well known at Grignon. There are 26 specimens on the slide and 37 specimens on the slide of the variety unnamed by Lamarck but which is a smaller form starting to uncoil.

Miliola ringens Lamarck is the only one of the series not in the collection. It is the genotype of *Biloculina* d'Orbigny, but which is preoccupied by *Pyrgo* Defrance as will be noted later.

Miliola cor-anguinum Lamarck with 14 specimens from Grignon is a *Triloculina* very close to the following species but more rounded and inflated.

Miliola trigonula Lamarck with 15 specimens and traces of 3 others on the slide is the genotype of *Triloculina.* It has curved sides, the angles rounded and a slightly bifid tooth.

Miliola planulata Lamarck from Louvres has 4 specimens. They are quinqueloculine, the chambers smooth and rounded and the sutures very slightly depressed. It probably belongs under *Quinqueloculina,* although there is a tendency toward *Massilina.* Var. β and γ are other things which will be noted at a later time.

Miliola saxorum Lamarck is from "Mont-Rouge prés Paris, et ailleurs dan les pierres." There is no slide from Mont-Rouge which is evidently in Lamarck's collection. There is however a slide from Grignon on which are two species one of which is the elongate form already referred to (l. c. p. 125) with its ornamentation consisting of pits arranged in longitudinal lines. The aperture in well preserved specimens has a cribrate plate although this is delicate and easily lost.

Miliola opposita Lamarck is from Grignon and has 7 specimens on the slide. The specimens are deeply and strongly costate. The text reads "prés Pontois." A section is necessary to

determine whether this species should be assigned to *Spiroloculina* or *Massilina.*

Miliola birostris Lamarck has a slide with 3 specimens from Chaumont. It was not figured by Lamarck. It is a very elongate, narrow species, smooth or very finely striate.

Renulina opercularia Lamarck has 23 specimens on the type slide from Grignon. The specimens are all typical. This is a rare genus but was splendidly developed in the Lutetian of Grignon.

There are also in the Defrance collection at Caen certain of the species described in 1820 and 1824 by Defrance which are worthy of mention.

Fabularia sphaeroidinalis Defrance from the Lutetian of Chaumont with 9 complete or fragmentary specimens on the slide. Like *F. discolithus* Defrance *(F. ovata* DeRoissy) the test is very similar to *"Biloculina"* with the interior of the chambers labyrinthic. The genus is distinct from *"Biloculina"* and is a specialized one of this part of the Eocene.

Frondicularia complanata Defrance has 3 specimens on the type slide labelled "Rimini", Italy. The middle specimen is very large and is apparently the specimen figured by Defrance. It is megalospheric with a swollen proloculum which is elongate and costate, the border at the base is nearly horizontal, with spinose projections. The other complete specimen has a smaller proloculum, is more angled at the base, and the costae appear on the basal edges of other chambers adjacent to the proloculum. In these evidently megalospheric specimens there is no sign of coiling although it does occur in the microspheric specimens. I obtained this species in my own collecting at Rimini, the type locality. A study of these specimens shows that not all of the forms assigned to *Frondicularia complanata* are the same as Defrance's species.

Planularia auris Defrance is the genotype of *Planularia.* There are 5 specimens on the type slide labelled "Rimini, Italie". The specimens show the characters much more clearly than the figure. The species is a flattened *"Cristellaria"* the chambers extending to the base on one side, the other side a nearly straight line. The dorsal or straight edge is sharply keeled with another keel at either side. On the flattened sides near the base are a few slightly developed costae running across the sutures. The sutures themselves are of clear material and very distinct. *Planularia* may perhaps be used in a subgeneric sense to take those species of *"Cristellaria"* which are much compressed, with

flattened sides and approach *Vaginulina* in the character of having one straight side.

I collected beautiful specimens of this species at the type locality, Rimini, and a study of these with the types shows that there is a rounded aperture below the radiate one at the angle and thus shows its relationship to *Robulina*.

Pyrgo laevis Defrance is the genotype of *Pyrgo*. There are 6 specimens on the slide, one very large one evidently that figured by Defrance. The type slide is marked "Italie". These are all "Biloculinas" with a broad aperture. Specimens very close to the types are in the material I collected both from Rimini and Coroncina. There has been some question in regard to the status of *Pyrgo* as it has been referred by some of the authors to the Pteropods. A study of the type slide is sufficient to show that it is unquestionably a *"Biloculina."*

With this point definitely settled, it seems that there is no alternative under the rules of nomenclature but to substitute the use of *Pyrgo* Defrance 1824 for that of *Biloculina* d'Orbigny 1826. This is somewhat of a pity as the names *Quinqueloculina, Triloculina,* and *Biloculina* are very expressive of the structural characters of these three genera. The two earlier names may be retained however. d'Orbigny uses the specific name *Biloculina laevis* Defrance and places *Pyrgo* as a synonym. The chain of evidence for the use of *Pyrgo* Defrance therefore seems complete.

Saracenaria italica Defrance is the genotype of *Saracenaria*. The type slide has 5 specimens and is marked "Pliocene, Italie." I collected it at Coroncina and also on the coast of the Adriatic at Rimini. It is very evident that not all of the material referred to this species by various authors belongs here.

Textularia sagittula Defrance is the genotype of *Textularia*. Very many things have been referred to this species. It is abundant in the Pliocene of Coroncina, Italy. It is a small species with acute angles and not at all like many of the figures referred to it.

There are a number of other species in the Defrance collection but the notes already given refer to those species which through the work of Lamarck and Defrance based on this collection have become genotypes. The study of these types has shown definitely what these two authors had when they wrote their descriptions and drew their figures. The three localities of Grignon, Rimini, and Coroncina have become classic through their work coupled with that of Soldani and later authors.

46. ARENACEOUS PALAEOZOIC FORAMINIFERA FROM TEXAS

By JOSEPH A. CUSHMAN and JAMES A. WATERS

The foraminiferal fauna of the Pennsylvanian and Permian of Texas, Oklahoma and Kansas is probably richer in species and individuals than formations of the same age in other parts of the world. Conditions at the time of deposition were often changing rapidly and for this reason probably the fauna is more varied and forms are more abundant than in regions where conditions were more uniform over long periods of time.

The fauna almost entirely consists of arenaceous forms, often primitive in character. Some of the species are of unusual interest in the light they throw upon lines of development in the arenaceous foraminifera. A number of genera which were known to be primitive in character have in the last year been recorded from the Pennsylvanian of America and the evidence of the fossil record is added to that of development and morphology. Notes on some of the more interesting species follow:

HYPERAMMINA GLABRA Cushman and Waters, n. sp.
Plate 26, fig. 1

Test elongate, consisting of an oval proloculum and an elongate tubular second chamber, tapering from the narrowest diameter near the proloculum to the greatest width near the apertural end; wall of fine arenaceous material with much cement; aperture formed by the open end of the tube. Length of holotype 1.35 mm.; greatest diameter 0.20 mm.; diameter of proloculum 0.15 mm.

Holotype (Cushman Coll. No. 7003) from 25 feet below the Palopinto limestone near top of Strawn formation, 9 miles E. of Graford, Palopinto Co., Texas.

This species may be distinguished by the somewhat tapering form of the second chamber and the large proportion of cement in the wall of the test. The tapering shape of the test near the aperture in the figured specimen is somewhat accentuated by a slight compression of the test at that point but without this there is a decided tapering of the test toward the aperture.

NODOSINELLA ARENATA Cushman and Waters, n. sp.

Plate 26, figs. 2 *a*, *b*, 3

Test longer than broad, composed of a few, two to four, chambers, each rounded in transverse section, slightly longer than broad, the apertural end tapering; sutures deep; wall of coarsely arenaceous particles but with much cement; apertural end of the chamber produced, with a slight neck, aperture circular, large. Length of holotype 1.25 mm.; breadth 0.80 mm.

Holotype (Cushman Coll. 7004) from the Mineral Wells division of the Upper Strawn formation, 4.5 miles S. W. of Mineral Wells, on Palopinto road, Palopinto Co., Texas.

There is a large amount of cement but on the rounded portions of the test the dark arenaceous fragments show through conspicuously. The aperture is large with an elongation of the chamber. Many of the specimens are crushed, but enough are well preserved to show the full characters of the species.

NODOSINELLA GLABRA Cushman and Waters, n. sp.

Plate 26, figs. 4, 5 *a*, *b*

Test slender, tapering, the initial end occasionally slightly curved, chambers somewhat irregular, numerous, sutures not deeply depressed, indistinct; wall finely arenaceous with a large proportion of cement; apertural end the widest part of the test, aperture small, circular, terminal. Length of holotype 0.75 mm.; breadth 17 mm.

Holotype (Cushman Coll. No. 7006) from 6 inches below Gunsight limestone at Graham, Young Co., Texas.

This is a slender, small, but distinctive species, the sutures not depressed but fairly well shown, the wall very finely arenaceous with much cement. The apertural end is apparently broad but this is probably due to the breaking of the test due to weakness along the suture as in all the specimens examined there is a small circular aperture slightly below the level of the end of the test appearing as though it were the aperture of the previous chamber rather than a final one.

GLOMOSPIRA DUPLEX Cushman and Waters, n. sp.

Plate 26, fig. 6

Test small, compressed, generally planispiral, the early coils slightly overlapping on opposite sides as the coils are made but the resulting test in one plane are flattened on two sides; wall finely arenaceous with much cement; aperture formed by the

open end of the tubular second chamber. Diameter of holotype 0.50 mm.

Holotype (Cushman Coll. No. 7008) from 25 feet below the Palopinto limestone in Upper Strawn formation, 9 miles E. of Graford, Palopinto Co., Texas.

There are a number of specimens of this species from the type locality which show the constancy of the specific characters. The early portion of the test appears as though divided into triangular chambers but a close study shows that these are but overlappings of the coil as it embraces more on one side than the other in its coiling. In the last coils the overlapping becomes equal on the two sides and an appearance similar to *Ammodiscus* results. In some respects this resembles *Glomospira pusilla* (Geinitz) but there is no appreciable thickening in the central portion of the test and the peculiar angled appearance is due to the unequal overlapping rather than an actual change in direction of the coil.

GLOMOSPIRA UMBILICATA Cushman and Waters, n. sp.

Plate 26, figs. 7, 8

Test fairly large for the genus, the elongated second chamber coiling with an angular direction at three points in each coil so that somewhat of a triangular form is produced, the coils not keeping to one plane but slightly twisting about, the early portion thin and appearing as an unbilicate area in the adult; wall finely arenaceous with a very large proportion of cement, rather smoothly finished; aperture at the end of the tubular second chamber. Diameter up to 1 mm.

Holotype (Cushman Coll. No. 7009) from Southwick shale, on Brady-San Saba Road, 3 miles east of Algerita, Texas.

This species is double the size of the preceding, and the make up of the test is very different. In the triangular portion of the test the coil is usually somewhat keeled on the periphery. The convolutions leave an excavated umbilical region that is a feature of the specimens examined. The exterior is somewhat glossy and the tubular chamber is often marked by slight transverse markings.

PSAMMOPHIS INCLUSUS Cushman and Waters, n. sp.

Plate 26, fig. 12

Test attached, basal side flattened, dorsal side convex, consisting of a proloculum and elongate tubular chamber, the latter in

its early stages close coiled planispirally, later the tube swinging back and forth about the early portion and partially embracing it; wall finely arenaceous with much cement and the dorsal surface somewhat roughened; aperture formed by the open end of the tubular chamber. Maximum diameter of holotype 0.85 mm.

Holotype (Cushman Coll. No. 7011) from 1 foot below Gunsight limestone, Graham, Young Co., Texas.

This species differs from *Psammophis inversus* Schellwein in having the embracing character of the chambers and the larger size.

TURRITELLELLA GRANDIS Cushman and Waters, n. sp.

Plate 26, fig. 9

Test elongate, spiral, consisting of a proloculum and elongate tubular second chamber in an elongate close spiral, line between the coils distinct and depressed, wall arenaceous. Length of holotype 1 mm.; maximum breadth 0.40 mm.

Holotype (Cushman Coll. No. 7012) from 25 feet below the Palopinto limestone in Upper Strawn formation, 9 miles E. of Graford, Palopinto Co., Texas.

This is a larger and coarser species than *Turritellella spirans* Cushman and Waters which we have described from the Carboniferous of Michigan.

AMMOBACULITES SPIRANS Cushman and Waters, n. sp.

Plate 26, fig. 10

Test elongate, slender, the early chambers planispirally coiled, later chambers uncoiled but somewhat twisted in their development, so that an irregular biserial form is taken on in some parts of the uncoiled portion; wall arenaceous with a large proportion of cement, surface somewhat roughened; aperture rounded, terminal. Length of holotype 0.70 mm.; breadth 0.15 mm.

Holotype (Cushman Coll. No. 7014) from a sandy shale 5-10 feet above Thurber Coal, near base of Mineral Wells portion of Upper Strawn formation, brick plant at Thurber, Erath Co., Texas.

This species has proved to be fairly common and has some very interesting characters. The early chambers are normally planispiral but the later ones instead of the usual uniserial group become twisted so that two chambers occupy in certain aspects the position of one in the usual species of the genus.

This is especially significant as it may account for the rise of the biserial forms of the Textulariidae from planispiral forms. In typical *Spiroplectammina* (Pl. 27, fig. 11) there is a planispiral young with the remainder of the test composed of chambers arranged biserially. Each of the biserial chambers should be considered as a chamber making 180° of a circle so that two chambers make up a complete volution. The Textulariidae are thus in their biserial forms to be thought of as forms which are coiled about an elongate axis, two succeeding chambers making up a coil. In the Verneuilinidae, three chambers normally make a coil except in the forms such as *Gaudryina* where a return to the simpler form of two chambers to a coil is taken on in the adult after the triserial condition.

From this viewpoint *Ammobaculites spirans* becomes a very interesting species as perhaps indicating the stages that took place in the development of the biserial arenaceous forms.

SPIROPLECTAMMINA CLAVATA Cushman and Waters, n. sp.

Plate 26, fig. 11

Test elongate, somewhat compressed, the sides nearly parallel or slightly increasing in width toward the apertural end, early chambers planispiral, later ones biserial, and about as long as broad; sutures distinct, those of the biserial portion nearly at right angles to the periphery; wall finely arenaceous with occasional coarser fragments but smoothly finished; aperture an elongate opening at the base of the inner margin of the chamber. Length of specimens up to 0.75 mm.; breadth 0.25 mm.

Holotype (Cushman Coll. No. 7017) from Gunsight limestone, Graham, Young Co., Texas.

Some of the specimens have a more swollen apertural end than that figured which gives a decided clavate shape to the test. The thickness in side view also increases toward the apertural end.

TEXTULARIA EXRAYENSIS Cushman and Waters, n. sp.

Plate 27, figs. 2 *a*, *b*

Test compressed, the biserial portion of uniform thickness in side view, in front view rapidly increasing in breadth; periphery rounded; early chambers planispiral at least in the microspheric form, later ones biserial; sutures distinct and depressed, horizontal; wall rather coarsely arenaceous and the surface roughened; aperture narrow, at the base of the inner margin of the

chamber. Length of holotype 0.50 mm.; breadth 0.35 mm.; thickness 0.18 mm.

Holotype (Cushman Coll. No. 7019) from Upper Millsap formation, 100 feet below the coal, 3½ miles west of Exray, Texas.

It is somewhat difficult to determine whether this species should be referred to *Textularia* or to *Spiroplectammina*, but the test is much more biserial than planispiral and the test is flaring like typical *Textularia*.

TEXTULARIA FUSCALIGNENSIS Cushman and Waters, n. sp.

Plate 27, figs. 1 *a-c*

Test small, compressed, periphery rounded, in front view tapering from the initial end to the greatest breadth near the apertural end, in side view with the sides nearly parallel, early chambers planispiral, later ones biserial, about twice as long as high, of rather even proportions throughout, sutures distinct, depressed, oblique, straight or very slightly curved; wall finely arenaceous with a small proportion of cement; aperture a narrow elongate slit at the base of the inner margin of the chamber. Length of holotype 0.55 mm.; breadth 0.25 mm.; thickness 0.13 mm.

Holotype (Cushman Coll. No. 7021) from 35 feet below the Ranger limestone, 5.4 miles S. W. of Brown Wood, Brown Co., Texas.

This is a small but distinct species, and at the locality is common. The oblique sutures and even character of the chambers with the parallel sides will distinguish it from the other American species of the Palaeozoic.

TEXTULARIA GRAHAMENSIS Cushman and Waters, n. sp.

Plate 27, figs. 3 *a*, *b*

Test slightly compressed in the young, rapidly thickening in the adult, tapering strongly in both front and side views, periphery rounded; chambers numerous, in the young with the width nearly double the height but becoming relatively higher in the adult; sutures horizontal, distinct, depressed strongly in the later portion; wall coarsely arenaceous, aperture large and rounded at the base of the inner margin of the chamber. Length of holotype 1.25 mm.; breadth 0.65 mm.; thickness 0.50 mm.

Holotype (Cushman Coll. No. 7023) from Gunsight limestone, Graham, Young Co., Texas.

This is the largest and stoutest of the species described here, and is very distinct from the others. The earliest chambers in the microspheric form are apparently planispiral.

TROCHAMMINA ARENOSA Cushman and Waters, n. sp.
Plate 27, figs. 4 *a-c*

Test trochoid, much compressed, early chambers less compressed, later ones much compressed and spread out, four chambers in a whorl and three to four whorls in the test; sutures on the dorsal side slightly curved, on the ventral side nearly radial; wall rather coarsely arenaceous; aperture ventral, on the inner margin of the chamber. Diameter of holotype 0.65 mm.; thickness 0.18 mm.

Holotype (Cushman Coll. No. 7025) from 35 feet below Ranger limestone, 5.4 miles S. W. of Brown Wood, Brown Co., Texas.

This is a very much flattened and spreading species, the earlier chambers forming a low cone, the wall rather coarsely arenaceous. It is common at the type locality.

AMMOCHILOSTOMA (?) TRILOCULINA Cushman and Waters, n. sp.
Plate 27, figs. 5 *a*, *b*

Test usually with three visible chambers in a planispiral coil; chambers sub-globular, increasing in size as added, sutures very distinct, slightly depressed; wall finely arenaceous, with a large proportion of cement, smoothly finished; aperture slit-like at the base of the chamber in the median line and in the adult apparently two supplementary long slit-like openings at the sides of the chamber. Diameter of holotype 0.50 mm.; thickness 0.35 mm.

Holotype (Cushman Coll. No. 7027) from one foot below Gunsight limestone, Graham, Young Co., Texas.

In some characters this resembles *Bradyina* but in most of its characters it seems to have affinities with *Ammochilostoma*, especially with species as *A. galeata*. The two slit-like openings somewhat resemble those of *Bradyina* but apparently do not have the relationship to the sutures as is usual in species of that genus. The interior shows an irregularly trochoid series of chambers few in number but the adult is planispiral. It is an abundant species at this locality. This is very different from *Bradyina holdenvillensis* Harlton which has five chambers and multiple apertures.

TETRATAXIS MULTILOCULATA Cushman and Waters, n. sp.
Plate 27, figs. 6 *a*, *b*

Test much compressed, the early chambers forming a small low spire, later ones much spread out and toward the edge lobed and divided into numerous smaller chambers, sutures very distinct, slightly limbate; wall finely arenaceous, with a large proportion of cement; ventral side with the chambers only at the periphery, scale-like and overlapping. Diameter of holotype 1.60 mm.

Holotype (Cushman Coll. No. 7029) from Breckenridge limestone, 1 mile south of Breckenridge, Stephens Co., Texas.

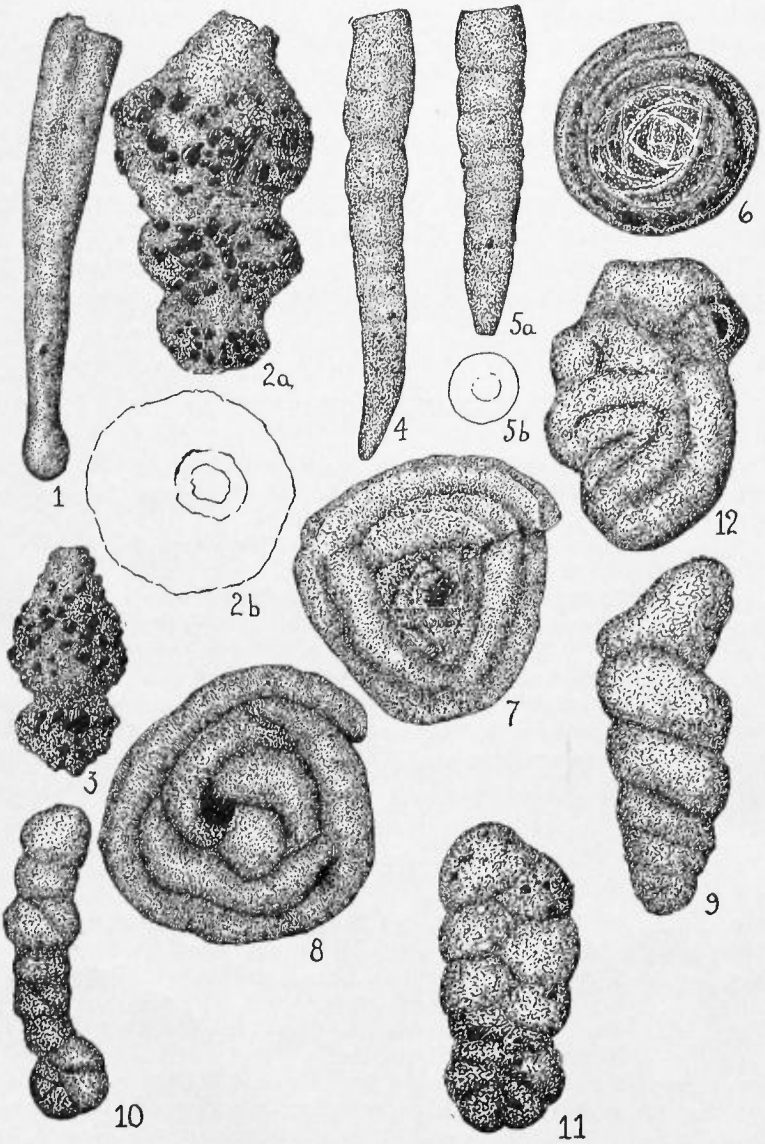
This is a very fine species, the test strongly compressed and the whole very different from the other described species.

EXPLANATION OF PLATE 26

FIG. 1. *Hyperammina glabra* Cushman and Waters, n. sp. × 70.
FIGS. 2, 3. *Nodosinella arenata* Cushman and Waters, n. sp. × 60.
a, front view; *b*, apertural view.
FIGS. 4, 5. *Nodosinella glabra* Cushman and Waters, n. sp. × 125.
a, front view; *b*, apertural view.
FIG. 6. *Glomospira duplex* Cushman and Waters, n. sp. × 90.
FIGS. 7, 8. *Glomospira umbilicata* Cushman and Waters, n. sp. × 60.
Fig. 7, specimen showing the very strongly keeled periphery.
FIG. 9. *Turritellella grandis* Cushman and Waters, n. sp. × 75.
FIG. 10. *Ammobaculites spirans* Cushman and Waters, n. sp. × 100.
FIG. 11. *Spiroplectammina clavata* Cushman and Waters, n. sp. × 90.
FIG. 12. *Psammophis inclusus* Cushman and Waters, n. sp. × 70.

EXPLANATION OF PLATE 27

FIGS. 1 *a–c*. *Textularia fuscalignensis* Cushman and Waters, n. sp. × 100.
a, front view; *b*, side view; *c*, end view.
FIGS. 2 *a*, *b*. *Textularia exrayensis* Cushman and Waters, n. sp. × 100.
a, front view; *b*, side view.
FIGS. 3 *a*, *b*. *Textularia grahamensis* Cushman and Waters, n. sp. × 70.
a, front view; *b*, side view.
FIGS. 4 *a–c*. *Trochammina arenosa* Cushman and Waters, n. sp. × 85.
a, dorsal view; *b*, ventral view; *c*, peripheral view.
FIGS. 5 *a*, *b*. *Ammochilostoma (?) triloculina* Cushman and Waters, n. sp. × 100.
a, side view; *b*, apertural view.
FIGS. 6 *a*, *b*. *Tetrataxis multiloculata* Cushman and Waters, n. sp. × 45.
a, dorsal view; *b*, peripheral view.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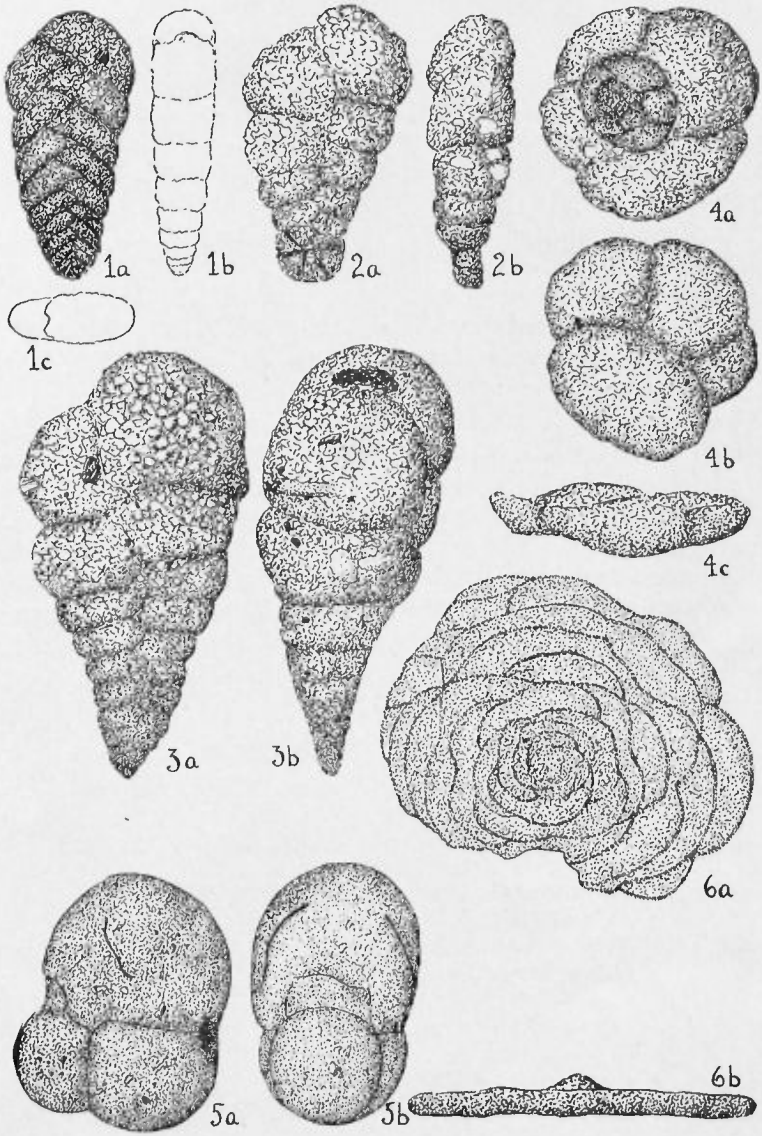

1a
1b
2a
2b
4a
1c
4b
4c
3a
3b
6a
5a
5b
6b

47. ADDITIONAL NOTES ON THE GENUS PLEUROSTOMELLA

By JOSEPH A. CUSHMAN

In the notes on this genus in the previous part of these Contributions, pp. 128-135 a few forms were not figured. I am indebted to Mr. Edward Heron-Allen who has kindly furnished me tracings from Hantken's work and to Dr. W. L. F. Nuttall who has called my attention to two forms omitted in the original paper—

The figures omitted on the previous plate, plate 25, are as follows—

Pleurostomella bellardi Hantken—(see Pl. 28, fig. 1).

Pleurostomella incrassata Hantken—(see Pl. 28, figs. 2, 3).

Pleurostomella tenuis Hantken—(see Pl. 28, fig. 4).

The following were omitted in the original paper:

Pleurostomella acuta Hantken, var. *buliminiformis* Terrigi, Mem. R. Com. Geol. Ital., vol. 4, 1891, pl. 1, fig. 25. This is from the Pleistocene or Pliocene of Italy. (See Pl. 28, fig. 5.)

Pleurostomella rapa Gümbel, var. *recens* Dervieux, Boll. Soc. Geol. Ital., vol. 18, 1899, p. 77. This varietal name is proposed by Dervieux for the recent form figured by Brady in the *Challenger* Report, pl. 51, figs. 21 *a, b*, and which is not the same as Gümbel's species from the Eocene of the Bavarian Alps. Brady's specimen is from off the Ki Islands, Indo-Pacific, *Challenger* Station 192. (See Pl. 28, fig. 6.)

EXPLANATION OF PLATE 28

FIGS. 1 *a, b*. *Pleurostomella bellardi* Hantken (After Hantken).
a, front view; *b*, side view.

FIGS. 2, 3. *Pleurostomella incrassata* Hantken (After Hantken).
a, front view; *b*, side view.

FIGS. 4 *a, b*. *Pleurostomella tenuis* Hantken (After Hantken).
a, front view; *b*, side views.

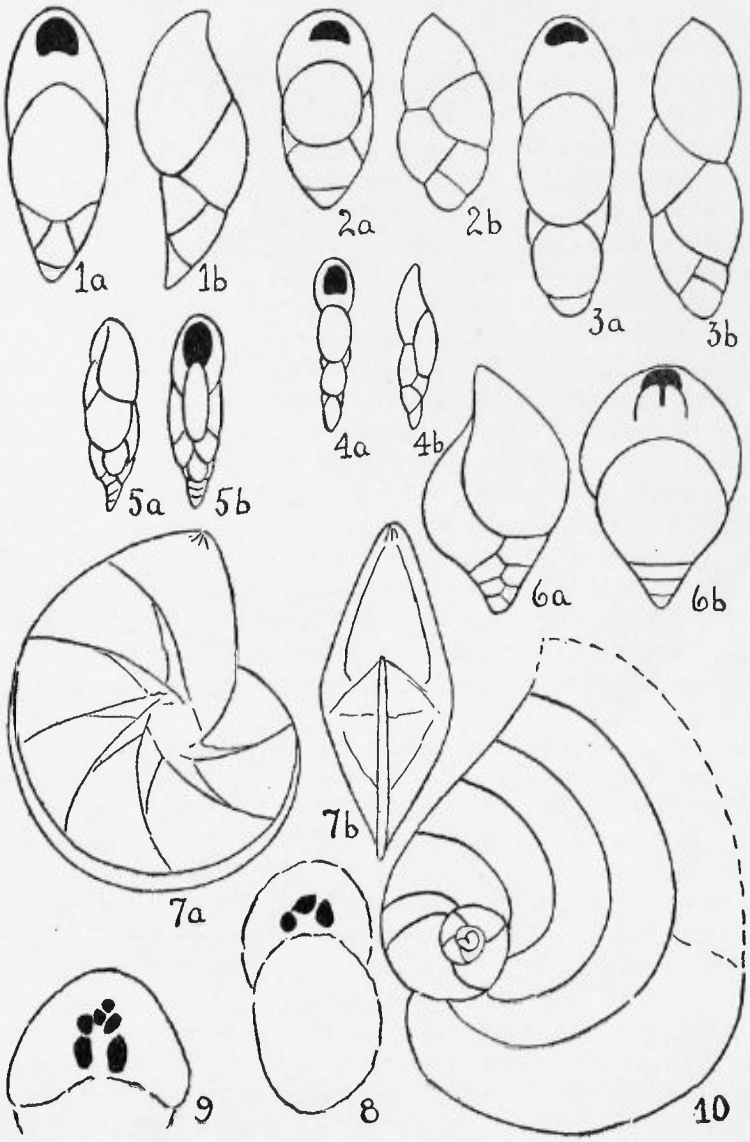
FIGS. 5 *a, b*. *Pleurostomella acuta* Hantken, var. *buliminiformis* Terrigi (After Terrigi).
a, side view; *b*, front view.

FIGS. 6 *a, b*. *Pleurostomella rapa* Gümbel, var. *recens* Dervieux (After H. B. Brady).
a, side view; *b*, front view.

FIGS. 7 *a, b*. *Lenticulina rotulata* Lamarck. (From type specimen.)
a, side view; *b*, apertural view.

FIGS. 8, 9. *Lituola nautiloidea* Lamarck. Showing multiple apertures increasing in number. From specimens on the type slide.

FIG. 10. *Renulina opercularia* Lamarck. Specimen from Grignon showing the developmental stages.


1a
1b
2a
2b
3a
3b
4a
4b
5a
5b
6a
6b
7a
7b
8
9
10

48. THE GENERA RENULINA AND VERTEBRALINA

By JOSEPH A. CUSHMAN

In 1804 Lamarck gave a description of the genus *Renulina* in the following terms (Annales du Museum, vol. 5, 1804, p. 353): "Testa reniformis, complanata, sulcata, polythalamia: loculis linearibus, secundis curvis: ultimis longioribus. Axis marginalis." The type species is *Renulina operculatia* Lamarck, (l. c. p. 354). The type specimens are from the Eocene of the Paris Basin from Grignon. I examined at Caen the type slide in the Defrance collection. This has a large series of beautiful specimens which show the full adult characters. The species is described as follows "semilunaris, planissima; sulcis arcuatis concentricis". In his paragraph of further comment on the species more is given of its characters. It is later figured (l. c. vol. 9, 1807, pl. 17, fig. 6). The specimen figured by Lamarck was evidently an adult and the measurement is given as 3 mm.

In material I have from the type locality there are a number of specimens of this species, but none which show the complete adult characters as shown by Lamarck and by the type specimens, and none of my specimens are as large as the measurement he gives.

A study of this suite of specimens shows an oval proloculum with the second chamber but about a third of a coil in length such as I have figured (Bull. 71, U. S. Nat. Mus., pt. 6, 1917, p. 12, text fig. 10), (see pl. 28, fig. 10). The third chamber makes nearly a complete coil. After this *Cornuspira*-like stage chambers slightly flaring are built, each about a third of a coil in length. After three or four such chambers are built, the following ones are very low and rapidly broaden especially on one side, and finally in the adult reach back on both sides and nearly envelop the earlier test on the periphery. The test is very thin and flat, the wall smooth except in the earliest chambers which are slightly striate longitudinally. One of the important points is that the test is coiled entirely in one plane and not at all involute, all the chambers back to the proloculum being visible from either side. The aperture is very elongate, exactly median, and extending the entire width of the apertural face. This gives a very weak structure, although there are

occasional indications of a trussing across which might strengthen the test somewhat.

Nothing is known of this genus outside the Eocene of the Paris Basin and almost all the later figures are copies of that of Lamarck. Terquem (Mém. Soc. Géol. France, ser. 3, vol. 2, 1882, p. 50, pl. 2 [10], fig. 29 *a, b)* gives a figure of *"Peneroplis opercularis* d'Orbigny" which is probably intended for this species. He indicates that the aperture is filled by a plate with small perforations, a character I have failed to find in any of my specimens. This specimen was from the Eocene of the Paris Basin at Vaudancourt given as "very rare", which may explain my not being able to find it in my material from that locality. This may also be the same as d'Orbigny's *Peneroplis orbicularis* of the 1826 Tableau afterward figured by Fornasini.

There is then in the Paris Basin Eocene a genus which has been placed by Brady and others as a synonym of *Vertebralina.* If the two are synonymous, Lamarck's name is much older. The two, however, seem to be very distinct.

Vertebralina was described by d'Orbigny in 1826 (Ann. Sci. Nat., vol. 7, 1826, p. 282) as follows: "Test très-déprimé; spire se projetant à un certain âge en ligne droite: ouverture en fente, occupant toute la partie supérieure de la derniére loge." There is a single species which simplifies the selection of the type, *V. striata* d'Orbigny illustrated by Modèle No. 81. The localities given are "la Mediterranee, la mer Rouge, et la mer du Sud, a Rawack".

d'Orbigny's Model No. 81 I have before me and a series of Mediterranean specimens which fit it very closely. There can be little doubt as to *Vertebralina striata* d'Orbigny which is a common species of the Mediterranean. The differences between it and *Renulina* are very decided. The most striking of these is the fact that the early chambers are hidden as the chambers are involute. In the earlier portion which is close coiled two chambers make up a coil as a rule, although this is not true in the adults of some species which have several. The chambers in the later development become uniserial in the type species, but show none of the tendency of *Renulina* to extend backward on two sides. The tendency is rather to develop a uniserial test with nearly parallel sides. The aperture also which was entirely median in *Renulina,* in *Vertebralina* has a decidedly different aspect from the two sides. There is an "upper lip" that is broader and an "under lip" that is narrower, the upper completely hiding the lower from the upper side but from the other

side the lower does not cover the upper one. The whole test is really bilateral in most of its other features.

Vertebralina is best developed in the present oceans in warm, shallow water, but is known well back into the Tertiary.

It seems, therefore, that there are two distinct genera, *Renulina* Lamarck and *Vertebralina* d'Orbigny, somewhat closely related but nevertheless very distinct in all their essential characters.

RECENT LITERATURE ON THE FORAMINIFERA

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

Plummer, Helen Jeanne.
Foraminifera of the Midway Formation in Texas.
(Univ. Texas Bull. No. 2,644, Nov. 22, 1926 [April 1927], pp. 1-206, 15 pls., 13 text figs., table.) *Austin.*
An excellent, beautifully illustrated paper on the lowest Eocene. There are 103 species and varieties noted of which 46 are described as new.

Stefanini, Giuseppe.
Sull'esistenza di Dictyoconoides nell'Eocene medio della Somalia settentrionale.
(Atti della Societa dei Naturalisti e Matematici di Modena, ser. 6a, vol. V-VI [57-58], fasc. 2, 1927, pp. 84-86.) *Forli.*
Notes on the occurrence of this peculiar species in Eastern Africa.

Douvillé, H.
Les Orbitoides de la region petrolifere du Mexique.
(Compt. Rend. Somm. Seanc. Soc. Géol. France, 1927, fasc. 4, Feb. 21, 1927, pp. 34, 35, 4 text figs.) *Paris.*
Notes are given on several genera and one new species is figured.

Cushman, Joseph A. and G. Dallas Hanna.
Foraminifera from the Eocene near Coalinga, California.
(Proc. California Acad. Sci., ser. 4, vol. XVI, No. 8, April 22, 1927, pp. 205-229, pls. 13, 14.) *San Francisco.*
There are 33 forms noted of which 9 are described as new.

Cushman, Joseph A. and Marcus A. Hanna.
Foraminifera from the Eocene near San Diego, California.
(Trans. San Diego Soc. Nat. Hist., vol. V, No. 4, March 15, 1927 [May 1927,] pp. 45-64, pls. 4-6.) *San Diego.*
There are 21 forms noted of which 4 are described as new.

Cushman, Joseph A. and U. S. Grant, IV.

Late Tertiary and Quaternary Elphidiums of the West Coast of North America.

(Trans. San Diego Soc. Nat. Hist., vol. V, No. 6, July 28, 1927, pp. 69-82, pls. 7, 8.) *San Diego.*

Five species are noted of which 3 are new.

Franke, A.

Neuere Erfahrungen über die Aufbewahrung und die Sammlung von Mikrofossilien.

(Zeitschr. Deutsch. Geol. Ges. Bd. 79, 1927, pp. 46-48.) *Berlin.*

Franke, A.

Neuere Erfahrungen über die Präparation und Aufbewahrung von Mikrofossilien.

(Pal. Zeitschr., vol. IX, Heft. 1, 1927, pp. 109-111.) *Berlin.*

These two papers describe methods of mounting and storing collections of foraminifera.

Silvestri, A.

Sulla *Conulites cooki* del Carter.

(Riv. Ital. Pal., Ann. XXXIII, 1927, pp. 23-36, pls. 1, 2, 1 text fig.) *Parma.*

The relationships of this form are discussed and figures given as well as those of related forms.

Wengen, W. a

Phylogenetic Considerations of the Nummulinidae.

(Proc. Fourth Dutch East Indian Congress of Natural Science, Weltevreden [Java], Sept. 22 to 26, 1926, Geographic-Geologic Section 1927, pp. 448-466, 3 charts.) *Weltevreden.*

Very interesting discussions are given of relationships with geologic and geographic occurrences in the Nummulite and Orbitoid groups.

Franke, A.

Die Foraminiferen und Ostracoden des Palaeocäns von Rugaard in Jütland und Sundkrogen bei Kopenhagen.

(Danmarks Geol. Unders., II Rackke, Nr. 46, 1927, pp. 1-49, pls. 1-4.) *Kjobenhavn.*

There are 75 species described with many varieties and forms of which 7 are new.

Silvestri, A.

Fossili Esotici nel Paleogene della Brianza.

(Atti Soc. Ital. Sci. Nat. Mus. Civ. Milano, vol. 66, 1927, pp. 105-121, 3 pls., 3 text figs.) *Milano.*

Some good figures of sections of *Lituonella* and other large genera are given.

Cushman, Joseph A.

Description of Foraminifera.

(Journ. Pal., Vol. 1, No. 1, July 1927, pp. 13, 14.) *Chicago.*

Notes relative to descriptive work are given.

Harlton, Bruce H.

Some Pennsylvanian Foraminifera of the Glenn Formation of Southern Oklahoma.

(Journ. Pal., Vol. 1, No. 1, July 1927, pp. 15-27, pls. 1-5.) *Chicago.*

Thirty-one forms are discussed of which 13 are described as new.

Galloway, J. J. and Stanley G. Wissler.

Pleistocene Foraminifera from the Lomita Quarry, Palos Verdes Hills, California.

(Journ. Pal., Vol. 1, No. 1, July 1927, pp. 35-87, pls. 7-12, 2 tables.) *Chicago.*

There are 79 species described and figured, 41 of which are described as new, and one new genus, *Carinina.*

Moreman, W. L.

Fossil Zones of the Eagle Ford of North Texas.

(Journ. Pal., Vol. 1, No. 1, July 1927, pp. 89-101, pls. 13-16, 1 text fig.) *Chicago.*

There are 12 species of foraminifera noted, 2 described as new.

Waters, James A.

A Group of Foraminifera from the Dornick Hills Formation of the Ardmore Basin.

(Journ. Pal., Vol. 1, No. 2, August 1927, pp. 129-133, pl. 22.) *Chicago.*

There are ten forms noted, all described as new.

Thomas, N. L.

The Use of Evolutionary Changes in Geologic Correlation. (Journ. Pal., Vol. 1, No. 2, August 1927, pp. 135-139.) *Chicago.*

The foraminifera are used to show the changes that may be used to advantage in correlation.

Thomas, N. L. and E. M. Rice.

Changing Characters in some Texas Species of Guembelina. (Journ. Pal., Vol. 1, No. 2, August 1927, pp. 141-144, text figs.) *Chicago.*

The changes that took place in the Cretaceous Guembelinas of Texas are discussed.

Cushman, Joseph A.

Some Characteristic Mexican Fossil Foraminifera. (Journ. Pal., Vol. 1, No. 2, August 1927, pp. 147-172, pls. 23-28.) *Chicago.*

Seventy-two of the more striking Cretaceous and Tertiary forms of Mexico are noted, and mostly figured, 6 described as new.

Ikari, Jiro.

A list of *Foraminifera* found in the Bottom-Sand, which was collected at Misaki.

(The Suisangaku Zasshi, No. 30, 1927, pp. 1-8, pls. 1, 2.) *Sapporo.*

Thirty-six species are noted and figured, one of which is new. The plates are excellent.

Cushman, Joseph A.

Recent Foraminifera from off the West Coast of America. (Bull. Scripps Inst. Oceanography, Technical Series, Vol. 1, No. 10, Sept. 1927, pp. 119-188, pls. 1-6.) *Berkeley.*

There are 142 species and varieties noted, of which 21 are described as new.

Cushman, Joseph A.

Phylogenetic Studies of the Foraminifera. Part II. (Amer. Journ. Sci., vol. XIV, Oct. 1927, pp. 317-324, 24 figs.) *New Haven.*

The families Textulariidae, Verneuilinidae and Valvulinidae are discussed.