

CONTRIBUTIONS FROM THE CUSHMAN
LABORATORY FOR FORAMINIFERAL RESEARCH

107. SOME NEW TERTIARY FORAMINIFERA FROM
TEXAS

By JOSEPH A. CUSHMAN and ALVA C. ELLISOR

The following descriptions are of Tertiary foraminifera from Texas. They include species and varieties from the Lower Oligocene and from the Upper Eocene. Several of these are closely related to other species of the Tertiary, but have definite stratigraphic ranges to which they are restricted. The characters noted here will distinguish them from their near relatives, and make them available for close stratigraphic work.

TEXTULARIA MISSISSIPPIENSIS Cushman, var. *RHOMBOIDEA* Cushman and Ellisor,
n. var.

Plate 7, figures 1 a, b

Variety differing from the typical in the much thinner, flatter form and the generally rhomboid outline.

Holotype of variety (Cushman Coll. No. 15,513) from Upper Eocene, 1/2 mile Southeast of Diboll, on White Oak Creek just below bridge on Club Road, Angelina County, Texas.

This Upper Eocene variety is usually easily distinguished from the Lower Oligocene one in its outline and very much compressed characters of the test.

TEXTULARIA WARRENI Cushman and Ellisor, n. sp.

Plate 7, figures 2 a, b

Test much compressed, broad, periphery subacute, median line somewhat raised, outline generally rhomboid; chambers distinct,

fairly numerous, low and broad; sutures distinct, slightly raised, meeting in a definite, raised area along the middle, slightly curved, the inner portion forming an angle from 20-25° with the median line, slightly more curved toward the periphery; wall distinctly arenaceous with considerable proportion of cement, and rather smoothly finished; aperture small, in the median line at the base of the last-formed chamber. Length up to 1.20 mm.; breadth 0.60-0.95 mm.; thickness 0.25 mm.

Holotype (Cushman Coll. No. 15,514) from the Lower Oligocene, Vicksburg, from core sample, Humble Oil and Refining Company's Well No. 73 Sims Smith, at 5,795-5,801 feet, Goose Creek, Harris County, Texas.

This is a very distinctive species in the Lower Oligocene material. The general form in appearance is well shown in the illustration, and the species should be an easily distinguished one.

TROCHAMMINA TEASI Cushman and Ellisor, n. sp.

Plate 7, figures 3 a-c

Test trochoid, low, the periphery rounded; chambers distinct, about four making up the last-formed whorl in the adult, but in the younger stages 5 or 6 making up a whorl; sutures fairly distinct, oblique on the dorsal side, nearly radial on the ventral, slightly depressed; wall finely arenaceous, slightly roughened on the surface; aperture a low elongate slit on the ventral side between the umbilicus and the periphery. Diameter 0.45 mm.; height 0.07-0.10 mm.

Holotype (Cushman Coll. No. 15,515) from Upper Eocene, core sample from Humble Oil and Refining Company's No. 12 Thompson, 3,313-3,320 feet, Raccoon Bend, Austin County, Texas.

This seems to be a well characterized species which has the number of chambers in a whorl distinctly decreasing with the development of the test.

NONION LAEVIS (d'Orbigny), var. *MARGINATUM* Cushman and Ellisor, n. var.

Plate 7, figures 5 a, b

Variety differing from the typical in the very distinct, somewhat thickened, marginal keel and the subacute to acute periphery.

Holotype of variety (Cushman Coll. No. 15,516) from Upper Eocene, Dubois Ranch, on Sandies Creek, East of Sample, Gonzales County, Texas.

This form which is often common in the Upper Eocene of the general Coastal Plain region, may be distinguished by the very distinct keel. In its general characteristics it is nearest to d'Orbigny's species which was described from the Tertiary of the Paris Basin. It is close to *Nonion advenum* (Cushman) of the Lower Oligocene.

ELPHIDIUM EOCENICUM Cushman and Ellisor, n. sp.
Plate 7, figures 6 a, b

Test small, biconvex, periphery broadly rounded, the umbilical region slightly depressed; chambers distinct, somewhat inflated, typically eight in the last-formed coil, of rather uniform size and shape; sutures distinct, depressed, very slightly curved, retral processes distinct, usually 9 or 10 visible along each suture in side view; wall smooth, finely perforate; aperture consisting of several small pores along the base of the apertural face. Diameter 0.30 mm.; thickness 0.10-0.12 mm.

Holotype (Cushman Coll. No. 15,517) from the Upper Eocene, Northeast Corner of Survey No. 27, Jurisdiction of Mier, Starr County, Texas.

This species is probably nearest to *Elphidium minutum* (Reuss) described from the Later Tertiary of Europe, but seems to be distinct from that species. It has invariably fewer chambers than *E. texanum* (Cushman and Applin), and the retral processes are much more distinct and well developed.

MASSILINA PRATTI Cushman and Ellisor, n. sp.
Plate 7, figures 4 a-c

Massilina sp(?) CUSHMAN and APPLIN, Bull. Amer. Assoc. Petr. Geol., vol. 10, 1926, p. 185, pl. 10, figs. 25-27.

Test slightly longer than broad, much compressed, periphery distinctly keeled; chambers distinct, projecting at both ends so that the apertural end has a short cylindrical neck, usually six chambers visible on each side in the adult, each chamber inflated in the middle, and compressed toward the sides; sutures distinct, slightly depressed; wall smooth; aperture subcircular with a simple tooth. Length 0.60-0.80 mm.; breadth 0.45-0.50 mm.; thickness 0.10 mm.

Holotype (Cushman Coll. No. 15,518) from Upper Eocene, core sample from Humble Oil and Refining Company's No. 12 Thompson, at 3,313-3,320 feet, Raccoon Bend, Austin County, Texas.

This is a rather widely distributed species in the Upper Eocene of the general Coastal Plain region. It is unornamented, and the general form of the chambers well distinguished.

UVIGERINA VICKSBURGENSIS Cushman and Ellisor, n. sp.

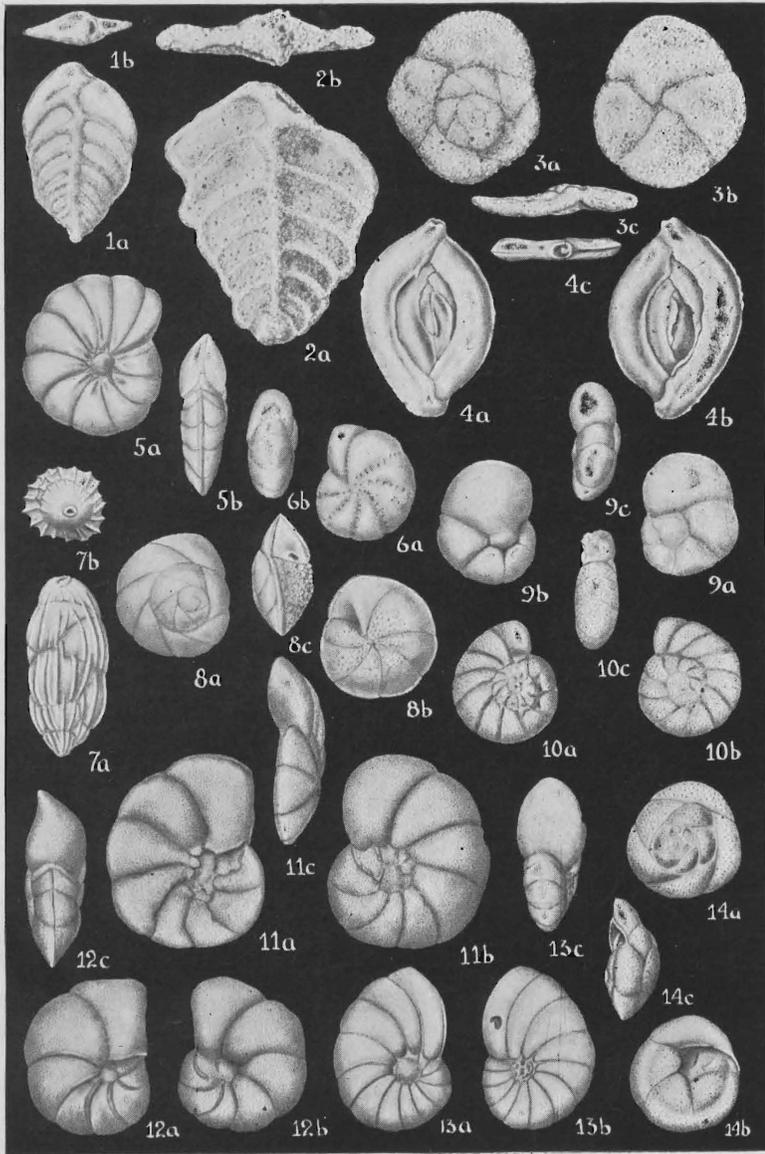
Plate 7, figures 7 a, b

Test elongate, 2-2½ times as long as broad, nearly circular in end view; chambers numerous, fairly distinct, only slightly inflated; sutures fairly distinct, slightly depressed; wall orna-

EXPLANATION OF PLATE 7

- FIGS. 1 a, b. *Textularia mississippiensis* Cushman, var. *rhomboidea* Cushman and Ellisor, n. var. × 40. a, front view; b, apertural view.
- FIGS. 2 a, b. *Textularia warreni* Cushman and Ellisor, n. sp. × 35. a, front view; b, apertural view.
- FIGS. 3 a-c. *Trochammina teasi* Cushman and Ellisor, n. sp. × 60. a, dorsal view; b, ventral view; c, peripheral view.
- FIGS. 4 a-c. *Massilina pratti* Cushman and Ellisor, n. sp. × 40. a, b, opposite sides; c, apertural view.
- FIGS. 5 a, b. *Nonion laevis* (d'Orbigny), var. *marginatum* Cushman and Ellisor, n. var. × 60. a, side view; b, peripheral view.
- FIGS. 6 a, b. *Elphidium eocenicum* Cushman and Ellisor, n. sp. × 60. a, side view; b, peripheral view.
- FIGS. 7 a, b. *Uvigerina vicksburgensis* Cushman and Ellisor, n. sp. × 40. a, side view; b, apertural view.
- FIGS. 8 a-c. *Eponides vicksburgensis* Cushman and Ellisor, n. sp. × 60. a, dorsal view; b, ventral view; c, peripheral view.
- FIGS. 9 a-c. *Valvulineria texana* Cushman and Ellisor, n. sp. × 60. a, dorsal view; b, ventral view; c, peripheral view.
- FIGS. 10 a-c. *Anomalina barrowi* Cushman and Ellisor, n. sp. × 60. a, dorsal view; b, ventral view; c, peripheral view.
- FIGS. 11 a-c. *Anomalina jacksonensis* (Cushman and Applin), var. *limbosa* Cushman and Ellisor, n. var. × 60. a, dorsal view; b, ventral view; c, peripheral view.
- FIGS. 12 a-c. *Cibicides yazoensis* Cushman, n. sp. × 60. a, dorsal view; b, ventral view; c, peripheral view.
- FIGS. 13 a-c. *Nonionella hantkeni* (Cushman and Applin), var. *spissa* Cushman, n. var. × 50. a, dorsal view; b, ventral view; c, peripheral view.
- FIGS. 14 a-c. *Discorbis hemisphaerica* Cushman, n. sp. × 60. a, dorsal view; b, ventral view; c, peripheral view.

Figures drawn by Margaret S. Moore



mented by numerous, slightly raised, longitudinal costae, usually broken at the sutures, but a few of them extending across adjacent chambers; aperture with a very short neck. Length 0.60-0.70 mm.; diameter 0.30 mm.

Holotype (Cushman Coll. No. 15,519) from Lower Oligocene, Vicksburg, from core sample from Humble Oil and Refining Company's No. 73 Sims Smith at 6,174 feet, Goose Creek, Harris County, Texas.

This species has usually been referred to as "*Uvigerina pygmaea* d'Orbigny", but it is very different from that species, the typical form of which has been recently figured in these "Contributions" (Vol. 6, 1930, pp. 62, 63, pl. 9, figs. 14-20). Our species has fewer costae, the sides nearly parallel for most of the length, and there is no tendency to develop the spinose last chamber, and a very elongate neck is characteristic of typical *U. pygmaea*.

VALVULINERIA TEXANA Cushman and Ellisor, n. sp.

Plate 7, figures 9 a-c

Test small, slightly longer than broad, periphery broadly rounded; chambers comparatively few, usually five making up the last-formed whorl in the adult, inflated on the ventral side with a distinct prolongation forming a semicircular lip, and extending out over the aperture; sutures distinct, depressed, on the dorsal side very slightly curved, on the ventral side radial; wall smooth, very finely perforate; aperture an elongate slit below the projecting lip in the umbilical region of the ventral side. Length 0.30 mm.; breadth 0.25 mm.; thickness 0.12 mm.

Holotype (Cushman Coll. No. 15,520) from Upper Eocene, core sample from Humble Oil and Refining Company's No. 6 Mueller, from 3,165-3,177 feet, Raccoon Bend, Austin County, Texas.

This is a very small but distinctive species with its few strongly inflated chambers and very distinct umbilical projection. It is not likely to be confused with any of the other American species in the Upper Eocene.

EPONIDES VICKSBURGENSIS Cushman and Ellisor, n. sp.

Plate 7, figures 8 a-c

Test small, strongly biconvex, ventral side somewhat more convex than the dorsal, periphery acute with a distinct keel in the

early portion; chambers distinct, not inflated, of uniform shape, increasing only slightly in size as added, about seven usually making up the last-formed whorl in the adult; sutures distinct, slightly limbate, not depressed, strongly oblique on the dorsal side, slightly curved on the ventral; wall finely perforate, smooth except on the ventral side which has numerous small papillae, especially on the inner end of the chambers; aperture a short, curved opening on the ventral side at the base of the chamber, midway between the umbilicus and the periphery. Diameter 0.30 mm.; height 0.15-0.18 mm.

Holotype (Cushman Coll. No. 15,521) from Lower Oligocene, Vicksburg, core sample from Humble Oil and Refining Company's No. 73 Sims Smith, from 6,174 feet, Goose Creek, Harris County, Texas.

This is a very small but distinct species in the Lower Oligocene, easily overlooked because of its small size. It has however very distinct characteristics, and should not be confused with any other species in this formation.

ANOMALINA BARROWI Cushman and Ellisor, n. sp.

Plate 7, figures 10 a-c

Test small, almost equally biconvex, periphery broadly rounded, the early portion of the coils often showing from both sides; chambers distinct, numerous, 10-12 making up the last-formed coil in the adult, not inflated; sutures distinct, strongly limbate, those of the early portion on the dorsal side somewhat raised, the remainder flush with the surface, strongly oblique, but very slightly curved; wall distinctly and coarsely perforate, otherwise smooth; aperture a narrow opening at the peripheral margin at the base of the last-formed chamber. Diameter 0.30 mm.; thickness 0.12 mm.

Holotype (Cushman Coll. No. 15,522) from Upper Eocene, core sample from Humble Oil and Refining Company's No. 12, Thompson, from 3,048-3,060 feet, Raccoon Bend, Austin County, Texas.

This species resembles several of the other Upper Eocene species of this genus, but a comparison of the type figures with these given here will show that the differences are sufficient so that this new species may be used for definite correlation purposes. The characters are often somewhat more obscure than shown in the figures, but the general characters are held throughout any considerable series of specimens.

ANOMALINA JACKSONENSIS (Cushman and Applin), var. *LIMBOSA* Cushman and Ellisor, n. var.

Plate 7, figures 11 a-c

Variety differing from the typical, especially in the less curved sutures which are often strongly limbate, and occasionally tend to become beaded.

Holotype of variety (Cushman Coll. No. 15,523) from Upper Eocene, core sample from Humble Oil and Refining Company's No. 6 Mueller, from 3,165-3,177 feet, Raccoon Bend, Austin County, Texas.

This variety is very close to var. *dibollensis*, but the umbonal boss is much less pronounced, and the sutures are less curved. It seems to have a very short vertical range, and should be an excellent variety for correlation purposes.

108. THREE NEW UPPER EOCENE FORAMINIFERA*

By JOSEPH A. CUSHMAN

The following three foraminifera from the Upper Eocene of the Coastal Plain region of the United States are here described and figured in order that they may be available for use in another paper while awaiting the publication of a large manuscript on the "Upper Eocene Foraminifera of the Coastal Plain of the United States" soon to be published by the U. S. Geological Survey.

NONIONELLA HANTKENI (Cushman and Applin), var. *SPISSA* Cushman, n. var.

Plate 7, figures 13 a-c

Variety differing from the typical in the much thicker test and the usually smaller number of chambers.

Some of the broader specimens are close to the typical in outline, but there is a very considerable amount of variation in any large series of specimens. The typical form occurs in the Eocene of Texas, but the material from regions to the eastward seems all to belong to the variety.

Holotype of variety from the Upper Eocene, Cooper marl, pit on U. S. Highway No. 17, about one mile South of Moncks Corner, Berkeley County, South Carolina.

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DISCORBIS HEMISPHERICA Cushman, n. sp.
Plate 7, figures 14 a-c

Test small, typically plano-convex, convex, the dorsal side strongly convex, the base flattened or very slightly convex, periphery subacute to slightly rounded; chambers few, slightly more than four making up the adult coil, somewhat inflated; sutures distinct, very strongly oblique on the dorsal side, slightly tangential on the ventral, very slightly depressed, sutures in the earlier portion limbate; wall smooth, very distinctly perforate; aperture ventral, opening into an umbilical cavity with a slight lip running from the periphery to the umbilicus. Diameter 0.30 mm.; height 0.15 mm.

Holotype from the Upper Eocene of Jackson, Mississippi.

This is a very distinct little species with the dorsal side very convex, and a very few chambers making up the very last-formed coil. The limbate sutures of the early portion are also a characteristic feature of this species. This is widely distributed in the Upper Eocene of the Gulf Coastal Plain of the United States.

CIBICIDES YAZOOENSIS Cushman, n. sp.
Plate 7, figures 12 a-c

Test slightly longer than broad, compressed, periphery angled, slightly lobulate, ventral side convex, dorsal side flattened or slightly convex, nearly involute on both sides; chambers distinct, usually eight in the last-formed coil; sutures distinct, curved, very strongly limbate and somewhat raised, increasing in thickness toward the inner end; wall distinctly, but finely, perforate with a clouding of the surface except at the sutures which are clear and transparent; aperture a curved, somewhat arched opening near the periphery on the ventral side. Length 0.60 mm.; breadth 0.50 mm.; thickness 0.25 mm.

Holotype from U. S. G. S. station 6473, Jackson formation, 1½ miles East of Yazoo City, Mississippi.

This species is widely distributed in the Upper Eocene from Alabama to Texas.

109. A NEW PLECTOFRONDICULARIA FROM FLORIDA

By JOSEPH A. CUSHMAN and GERALD M. PONTON

During recent investigations in the Miocene of Florida, a new species of *Plectofrondicularia* has been discovered which is quite distinct from *P. floridana* Cushman. The description of this and the differences between it and *P. floridana* follow:

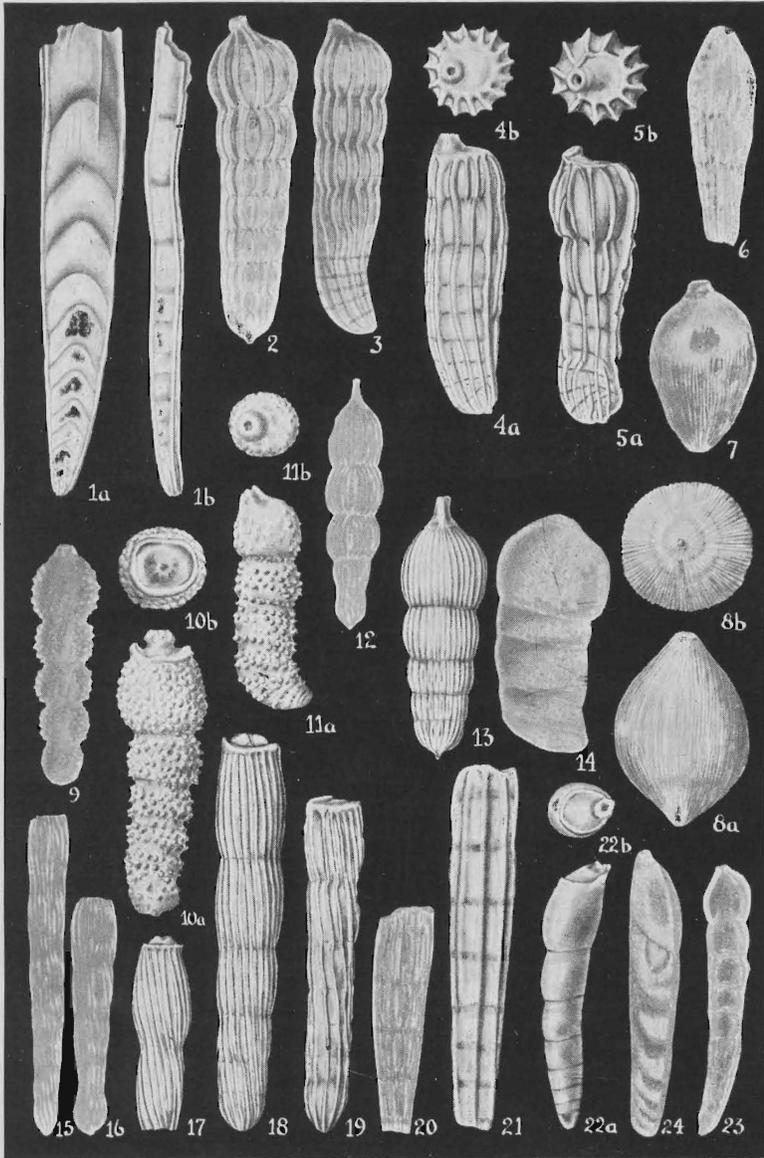
PLECTOFRONDICULARIA MANSFIELDI Cushman and Ponton, n. sp.

Plate 8, figures 1 a, b

Test very much compressed, much elongated, very slightly tapering, the later portion with the sides nearly parallel, sides sharply truncate or slightly concave with distinct keels, giving a narrow rectangular shape in end view; chambers numerous, the earliest ones biserial, soon becoming uniserial, and increasing

EXPLANATION OF PLATE 8

- FIGS. 1 a, b. *Plectofrondicularia mansfieldi* Cushman and Ponton, n. sp. $\times 50$. a, front view; b, side view.
- FIGS. 2-5. *Marginulina costatus* (Batsch). Figs. 2, 3, (After Batsch). Figs. 4, 5, Recent specimens from Rimini. a, a, side views; b, b, apertural views. Figs. 2, 4, Megalospheric form. Figs. 3, 5, Microspheric form.
- FIG. 6. *Pseudoglandulina comata* (Batsch). (After Batsch.)
- FIGS. 7, 8. *Pseudoglandulina glans* (d'Orbigny). Fig. 7, (After Batsch). Fig. 8, Recent specimen from Rimini, a, side view; b, basal view. $\times 35$.
- FIGS. 9-11. *Marginulina murex* (Batsch). Fig. 9, Megalospheric form, (After Batsch). Figs. 10, 11, Recent specimens from Rimini. $\times 30$. a, a, side views; b, b, apertural views. Fig. 10, Megalospheric form. Fig. 11, Microspheric form.
- FIGS. 12, 13. *Nodosaria scalaris* (Batsch). Fig. 12, (After Batsch). Fig. 13, Recent specimen from Rimini. $\times 35$.
- FIG. 14. "*Nautilus* (*O.*) *vaginaeformis* Batsch." (After Batsch.)
- FIGS. 15-19. *Nodosaria obliquata* (Batsch). Figs. 15, 16, (After Batsch). Figs. 17-19, Recent specimens from Rimini. $\times 30$.
- FIGS. 20, 21. *Dentalina vertebralis* (Batsch). Fig. 20, (After Batsch). Fig. 21, Recent specimen from Rimini. $\times 25$.
- FIGS. 22, 23. *Dentalina communis* d'Orbigny. Fig. 22, Recent specimen from Rimini. $\times 25$. a, side view; b, apertural view. Fig. 23, (After Batsch).
- FIG. 24. *Vaginulina leguminiformis* (Batsch). (After Batsch.)



rather rapidly in height toward the apertural end, somewhat inflated; sutures very distinct, slightly depressed especially in the later portion, usually not distinctly limbate, convexly curved; wall mostly smooth, but the basal end with 1 or 2 very short costae, and in the adult the later chambers occasionally with fine costae; aperture not shown. Length up to 1.50 mm.; maximum breadth 0.25 mm.; thickness 0.12 mm.

Holotype (Cushman Coll. No. 15,483) from the Miocene of Old Frazier Farm N.W. $\frac{1}{4}$ of S.E. $\frac{1}{4}$ Sec. 18. T. 2 N., R. 19 S., Florida.

This species is a very distinct one from *Plectofrondicularia floridana* in the sides which in this species are distinctly truncate and concave, while in *P. floridana* there is a distinct high median keel in addition to the two keels at either side. The sutures also in this species are much more curved, not limbate, and much compressed, all characters very distinct from those of *P. floridana*. The chambers also in our species are much higher than those of *P. floridana*.

110. NOTES ON THE FORAMINIFERA DESCRIBED BY BATSCH IN 1791

By JOSEPH A. CUSHMAN

In reviewing the older literature on the foraminifera, the first work which has a definite place in determining definite names for the foraminifera after those of Linné and Gmelin is that of Batsch. His work entitled: "Sechs Kupfertafeln mit Conchylien des Seesandes" published in 1791, contains six plates with short descriptions of the species figured. These figures are excellently drawn, and there is very little doubt about the species which they represent. As this work of Batsch was published before that of Fichtel and Moll, Lamarck, DeFrance, and d'Orbigny, it is very necessary to fix definitely just what these species of Batsch really are. Unfortunately he gives no data in regard to the source of his material, but from a comparison of faunas, it is very probable that his material came from either Rimini or some other locality on the Adriatic, and is of Recent origin. Most of his species can be found in the shore collections from Rimini, which was the most prolific source of Recent material described by many of the earlier authors.

In 1865, Parker, Jones and Brady devoted one of their series of articles: "On the Nomenclature of the Foraminifera. XI. The Species Enumerated by Batsch in 1791" to a review of this work. They give descriptions in English translated from the originals of Batsch, and make numerous notes as to their understanding of the species. Like much of the work reviewed by these authors, it is to be suspected that it is based more on a review of the literature than upon a comparative study of specimens from various type localities. In this present work, the descriptions given by Parker, Jones and Brady are here copied, and notes are given as to what seem to be the characters of Batsch's species from a study of material collected by the author in Rimini on the Adriatic in 1927.

Fornasini has published in his series of papers, many notes on the foraminiferal fauna of Rimini. He also published a series of papers on the "Planches Inedites" of d'Orbigny. Many of the species of d'Orbigny's 1826 work are based on material from Rimini, as are also some earlier species of DeFrance and Fichtel and Moll. Most of these authors paid little attention to the works which had preceded theirs, and the work of Batsch was very little recognized by any of them. This is probably due to the rarity of his published work. As a result, many of his species are later given different names by subsequent authors. These short notes are however intended more to supply many of the younger workers with an idea of what these species of Batsch really are rather than to go into the detailed synonymy of these species. However, reference is made to some later names, especially to those of d'Orbigny, which have been applied to them. The work of Soldani, while not in itself binomial, was referred to by d'Orbigny in his 1826 work. Many of Soldani's figures are of Recent material from Rimini and elsewhere, and as a result in this way d'Orbigny gave names to certain of the species which had already been described by Batsch.

In order to give an idea of these species, photographic copies of those which he described are here given, but only selected ones of his somewhat larger series. These are supplemented by drawings of typical specimens from Rimini which seem to be identical with Batsch's species. The various forms are taken up in the order that they appear in the original of 1791, which is the same order in which they were taken up by Parker, Jones and Brady.

The first name that appears under each number is that given

by Batsch, and the following is the accepted name in the present classification. As already noted, the translation in quotation marks is copied from Parker, Jones and Brady, but the notes given are our own.

1. *Nautilus (Orthoceras) costatus* Batsch. [*Marginulina costatus* (Batsch).]

"The chambers or joints are round, bullet-shaped, and separated from one another, and are bound by strong ribs, which extend without interruption over the whole of the shell, and have for the most part smooth edges. The forms differ both in contour and colour, which here, less than in other natural objects, determine the general character. Fig. 1 is ground down to show the construction of the interior. In Plates 1 and 2 the small horizontal lines show the natural sizes."

This is one of the most abundant species in the shore sands of Rimini. It is a very variable species as the microspheric and megalospheric forms are quite different in their early development. Two of these are shown in the drawings as well as in the figures given from Batsch. The test is marked by heavy longitudinal ribs, and the aperture is excentric. d'Orbigny gave the name "*Marginulina bifurcata*" to an identical form which he notes is from the Adriatic (Ann. Sci. Nat., vol. 7, 1826, p. 258; Fornasini, Mem. Accad. Sci. Bologna, ser. 5^a, vol. 10, 1902, p. 38, fig. 30 [in text]). d'Orbigny's model No. 6, which he called "*Marginulina Raphanus*" is very much like Batsch's species. However, Linné's species was based upon figures given by Plancus and Gualtieri, both of which show costate nodosarian forms with no sign of either an excentric aperture or of any coiling. It seems therefore that on the evidence, d'Orbigny's species may be the same as that of Batsch, but is not the same as the earlier "*Nautilus Raphanus* Linné".

Of those species named by d'Orbigny and based on the figures of Soldani, the one referred to "*Marginulina Raphanus* Linné" is again Batsch's species, and not that of Linné. It is a megalospheric form. The other species called by d'Orbigny "*Marginulina subtilius*" and based upon Soldani's figure is a microspheric form very similar to the microspheric form which we have figured here.

2. *Nautilus (O.) comatus* Batsch. [*Pseudoglandulina comata* (Batsch) + *P. glans* (d'Orbigny).]

"The cylindrical joints run more together, and the whole is cov-

ered with riblets, which are continuous, except over the end portions of the terminal chamber. Probably fig. 7 *b* (on plate 3) is simply a variety. Both specimens are ground away."

Two distinct species are figured by Batsch. One of these is much more elongate and more coarsely costate than the other. Both show evidences of overlapping of the chambers. The usual use of Batsch's name is to apply it to the short, delicately costate form following Brady's designation in the *Challenger* Report. However, Parker, Jones and Brady in their 1865 review of Batsch's work definitely assign the name "*comata*" to the more elongate form, and designate figures 2 *a*, and 2 *b*. To the short stout form they assign d'Orbigny's name of "*Glandulina glans*" represented by his Model No. 51. According to the Rules of Nomenclature, this very definitely disposes of this species. We have found the shorter, finely costate form in our Rimini collections, but not the more elongate typical form.

3. *Nautilus* (*O.*) *murex* Batsch. [*Marginulina murex* (Batsch).]

"The chambers are round and bullet-shaped, covered with warts, and separated by smooth belts. The specimen ground down is curved."

Specimens of this species occur at Rimini, but are not common. Both microspheric and megalospheric forms are figured here. Batsch's figured form was a megalospheric one.

4. *Nautilus* (*O.*) *scalaris* Batsch. [*Nodosaria scalaris* (Batsch).]

"The round, bullet-shaped chambers are provided with delicate ribs, running perpendicularly and joining where the chambers meet."

This is a very definite species at Rimini with its spinose, initial end, few chambers, with numerous costae and the elongate, slender neck. As suggested by Parker, Jones and Brady, the species named by d'Orbigny "*Nodosaria longicauda*" and based on Soldani's figures is a synonym of *N. scalaris* (Batsch). It is possible that d'Orbigny's *Nodosaria gibba*, which is from Rimini, may also be a more finely costate form of *N. scalaris*.

5. *Nautilus* (*O.*) *obliquatus* Batsch. [*Nodosaria obliquata* (Batsch).]

"This very much elongated shell has longish chambers, which run almost into one another; and it is provided with string-like ribs, which run in a not quite straight direction down the shell."

This is a fairly common species at Rimini, and several specimens are here figured. All are megalospheric, and none of them has the apertural end complete. Batsch's figured specimens were also lacking in this same respect, showing that there is a decided line of weakness along the sutures in the later chambers.

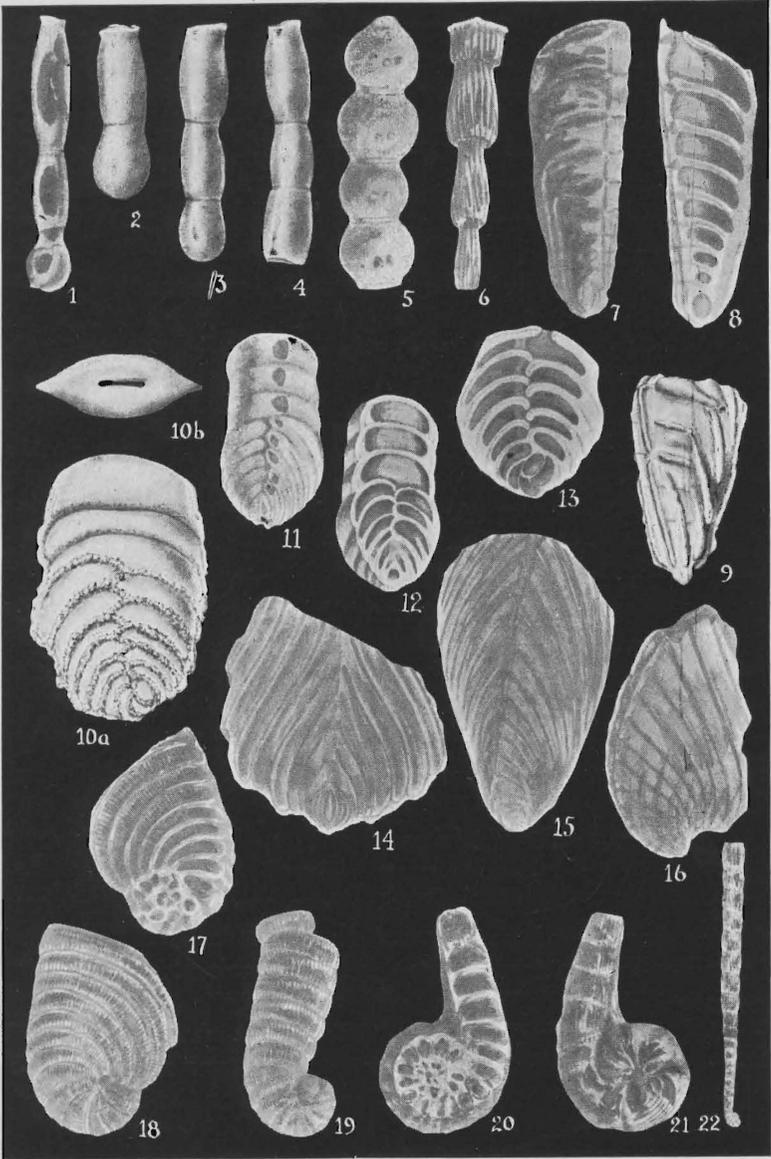
6. *Nautilus (O.) vertebralis* Batsch. [*Dentalina vertebralis* (Batsch).]

"A prolonged almost unjointed shell, which has a few continuous somewhat waved ribs. The partition-walls are broad and transparent."

The name "*Nodosaria vertebralis*" has been very widely used. As usually applied, the species is a *Dentalina*, the microspheric form at least being decidedly arcuate. Batsch's figure which is reproduced here is of a specimen with both ends missing, the sutures marked by clear shell material, and the costae very definitely continued throughout the length of the test. We have searched our Rimini collections without finding complete specimens that could be used to obtain the full characters of this species. Our figured specimen gives little additional information, but it evidently belongs to Batsch's species. Parker, Jones and Brady assign this

EXPLANATION OF PLATE 9

- FIGS. 1-4. *Nodosaria globifera* (Batsch). Fig. 1, (After Batsch). Figs. 2-4, Recent specimens from Rimini. $\times 25$.
- FIG. 5. "*Nautilus (O.) Radicula* Batsch." (Not *N. radicleula* Linné.) (After Batsch.)
- FIG. 6. *Articulina conico-articulata* (Batsch). (After Batsch.)
- FIGS. 7-9. *Vaginulina margaritifera* (Batsch). Figs. 7, 8, (After Batsch). Fig. 8, Section. Fig. 9, Recent specimen from Rimini. $\times 30$.
- FIGS. 10-13. *Vulvulina pennatula* (Batsch). Fig. 10, Recent specimen from Rimini. $\times 30$. a, side view; b, apertural view. Figs. 11-13, (After Batsch). Figs. 12, 13, Sections.
- FIG. 14. *Frondicularia complanata* DeFrance. (After Batsch.)
- FIG. 15. *Flabellina harpa* (Batsch). (After Batsch.)
- FIG. 16. *Planularia auris* (Fichtel and Moll). (After Batsch.)
- FIGS. 17, 18. *Peneroplis planatus* (Fichtel and Moll). (After Batsch.) Fig. 17, Section.
- FIG. 19. *Peneroplis arietinus* (Batsch). (After Batsch.)
- FIGS. 20, 21. *Peneroplis semi-lituus* (Gmelin). (After Batsch.) Fig. 20, Section.
- FIG. 22. *Monalysidium lituus* (Gmelin). (After Batsch.)



species as a synonym of Linné's *Nodosaria fascia*. Linné based his species on a figure given earlier by Gualtieri, which has raised bands at the sutures. This may be due to inaccuracy in the drawing, but it is difficult to put the two together, and *Dentalina vertebralis* (Batsch) should stand until further evidence can be secured as to the real characters of Linné's specimens.

7. *Nautilus* (*O.*) *vaginaeformis* Batsch.

"The shell is broad and flat, with scarcely separated chambers, the broad and blunt under surfaces of which reach far into succeeding chambers."

There are probably two species in the specimens figured by Batsch, and nothing identical with them was found in the Rimini collections. It is possible that 7 *b* is a *Lingulina*, and that 7 *c* and 7 *d* are microspheric forms. We have not been able to solve this problem from our Rimini collections.

8. *Nautilus* (*O.*) *leguminiformis* Batsch. [*Vaginulina leguminiformis* (Batsch) + *Dentalina communis* d'Orbigny.]

"The smooth, almost coincident joints of this elongated shell are nearly cylindrical, and fit into each other like sheaths."

Parker, Jones and Brady have already settled the disposition of these two forms. We have found the *Dentalina communis* form at Rimini, but not the other.

9. *Nautilus* (*O.*) *globifer* Batsch. [*Nodosaria globifera* (Batsch).]

"The chambers are elongated and somewhat distinct; only the last [properly the first], the lowest in the drawing, is bullet-shaped. At the top it is button-shaped."

This species was found in our Rimini collections in some numbers, but no complete specimens. The megalospheric specimens have a very large, globular proloculum as shown in the figures. Parker, Jones and Brady assign to this species that named by d'Orbigny from Soldani's figure as "*Nodosaria ovicula*". Soldani's specimen is from the Pliocene of Siena, and the species he figures seems to be a distinct one from this Recent one of Rimini. The Siena species becomes very elongate, and its variations have been well figured by A. Silvestri in his large work on the Pliocene of the Siena region.

10. *Nautilus* (*O.*) *Radicula* Batsch.

"The chambers are bullet-shaped, very distinct, and unusually strong."

No specimens were found in the collection from Rimini which

exactly fit this form figured by Batsch. As noted by Parker, Jones and Brady, the specific name "*radicula*" had already been used by Linné for a nodosarian form. They unite this Recent form from the Adriatic with the Cretaceous *Nodosaria limbata* d'Orbigny, but they do not seem to be the same.

11. *Nautilus* (*O.*) *conico-articulatus* Batsch. [*Articulina conico-articulata* (Batsch).]

"The chambers are shaped like inverted cones, and the walls are folded into oblique furrows. It was quite impossible to grind away this shell, as it was too brittle."

Various forms have been assigned to this species by later authors. As the early chambers are not shown by Batsch, it is not entirely clear that this belongs to the genus *Articulina*, but it is more probably this than a *Vertebralina*. Such forms occur commonly in the Mediterranean, although none exactly like this were found in the collections from Rimini.

12. *Nautilus* (*O.*) *margaritiferus* Batsch. [*Vaginulina margaritifera* (Batsch).]

"This strong, elongated, and almost unjointed shell is flattened, and has two sharp edges, and has in the middle high and projecting partition-walls, the feeble continuations of which can be seen at one edge."

This form figured by Batsch is evidently rather closely related to *Vaginulina legumen* (Linné), the types of which were from the Adriatic. The form figured by Batsch and also figured here from Rimini is one common in the Adriatic and in the Late Tertiary of Italy. It may prove to be only a varietal form of Linné's species. The early portion has rather definite, longitudinal costae toward the margin of each chamber, and the ornamentation in general is much more marked than in the typical form.

13. *Nautilus* (*O.*) *Pennatula* Batsch. [*Vulvulina pennatula* (Batsch).]

"The partition-walls, which at the beginning of its growth are strangely crowded together, make at the upper end of the shell an altered feather-like portion. Figure *e* represents one of these parts alone."

Our figure of an adult form from Rimini adds somewhat to the characters as given by Batsch. His figures show in section both microspheric and megalospheric forms. The microspheric form has several coiled chambers before the biserial form is taken on. Usually in the microspheric form but 1 or 2 chambers in the adult

show the uniserial chambers. Our figured specimen shows three. The megalospheric form has fewer biserial chambers, and therefore attains the uniserial stage much earlier. The aperture in the biserial portion is similar to that of *Textularia*, to which it is evidently closely related. In the adult, uniserial portion, the aperture becomes elongate, central, and terminal.

d'Orbigny figures a very similar form also from the Adriatic as "*Vulvulina capreolus*", and gives a model of it.

It has been customary for later authors to distinguish between these two species probably based on the figures given by Brady. As the microspheric and megalospheric forms differ so considerably in the number of chambers, and also in the relative shape and size, a careful study of the Recent forms would seem to be desirable before definitely committing oneself to a final statement in regard to the relationship of these two species. It is quite possible that this common form from the Adriatic is not the same as that developed for example in the Western Atlantic, and the much larger and peculiarly shaped forms known from the Philippines.

It may also be noted here that Figure 13 *e* seems to be a specimen of *Textularia carinata*.

14. *Nautilus* (O.) *Harpa* Batsch. [*Flabellina harpa* (Batsch) + *Frondicularia complanata* Defrance + *Planularia auris* (Fichtel and Moll).]

"The shell is quite flat, bright, and smooth. The partition-walls run obliquely, are parallel, and shine through the otherwise opaque shell. In this and in figure 13 may be clearly seen how little nature has made the evident character depend upon either form or colour."

Parker, Jones and Brady have already dealt with the five drawings: 14 *a-e*. They have by selection taken out 14 *a*, as being the same as *Frondicularia complanata* Defrance, and 14 *d* and *e* as *Planularia auris* (Fichtel and Moll). This leaves 14 *b* and *c* as the types of *Flabellina harpa* (Batsch).

At Caen in 1927, I studied, through the kindness of Professor Bigot, the original collections of Defrance, which were preserved in the University of Caen. The types of Defrance's *Frondicularia complanata* are marked as coming from Rimini. There are three specimens on the type slide, and they show that this species is identical with the form figured by Batsch and selected by Parker, Jones and Brady as the same as Defrance's species. The proloculum is strongly costate with a few short, raised ribs, and the

basal margin of the test somewhat notched as the chambers do not all come down to the same level. This species is well characterized, and there seems to be no doubt as to the type form.

In the same collection of DeFrance, is a slide with specimens which he himself identified as the equivalent of Fichtel and Moll's species. *Planularia auris* (Fichtel and Moll) is therefore a well characterized species, the figures of Batsch being even better than the type figures given by Fichtel and Moll. The chambers increase rapidly in length, but fail to continue back entirely to the proloculum on the inner margin. The outer margin is curved, and there are usually two supplementary keels, one at either side of the main one. The early portion of the test has several curved, raised costae running across a number of chambers, and becoming obsolete after a few chambers are developed, continuing longest along the inner margin of the test. Such specimens are fairly common at Rimini, and also occur in the Late Tertiary of Italy.

This leaves then for the types of *Flabellina harpa* (Batsch) the rather anomalous forms figured by Batsch in 14 *b* and 14 *c*. These forms have the early portion somewhat like that of the form already assigned to *Planularia auris* (Fichtel and Moll). The ornamentation is very similar, but instead of the chambers becoming elongate on one side, only in this particular form they are elongate on both sides and become frondicularian. The figured one indicates that this form is megalospheric while those assigned to *Planularia auris* are microspheric. However in several bags of material collected at Rimini, a careful search failed to show any such forms. Therefore the definite relationship of these two forms must be left until more material can be studied that will show whether or not these two forms are definitely related.

15. *Nautilus (Lituus) arietinus* Batsch [*Peneroplis arietinus* (Batsch) + *P. planatus* (Fichtel and Moll) + *P. semi-lituus* (Gmelin).]

"In all the different forms two characters remain quite evident, namely, the strong shell and its numerous folds or wrinkles. It is also much coiled."

The forms given by Batsch, Nos. 15 and 16, all belong to the general *Peneroplis* group. The various forms given by Batsch which belong to the genus *Peneroplis* have been a subject of considerable study by Heron-Allen and Earland in connection with their work on the Recent Foraminifera of the Kerimba Archipelago. They have refigured a number of the early drawings on

which Linné and Gmelin based their species of this group. Very little can be added to their treatment of this subject, except in regard to the definite assignment of the name "*arietinus*". In their review of Batsch's work, Parker, Jones and Brady definitely designated Figure 15 *c* of Batsch as the one to which the name "*arietinus*" should be referred, and left Figures *d*, *e*, and *f* as "*Spirolina Hemprichii* Ehrenberg". Other authors have referred these particular figures to Lamarck's *Spirolina cylindracea*. It is very questionable whether or not these are actually identical with the Eocene species.

16. *Nautilus (Lituus) acicularis* Batsch [*Monalysidium lituus* (Gmelin).]

"This is a linear or awl-shaped shell, extraordinarily delicate, with projecting riblets. The curvature of the top forms a small head, somewhat in the form of a knot."

In spite of the fact that Heron-Allen and Earland have discussed this form at some length, it seems that the original species of Gmelin cannot be ignored according to the Rules of Priority. This species of Gmelin having been very definitely included in genus *Monalysidium*, it would seem that it can hardly be ignored. It is very evidently the same as Batsch's species. Although, as pointed out by Heron-Allen and Earland, *Monalysidium* in some of its species never shows a coiled portion, such a beginning cannot be entirely eliminated, as the specimens break so easily. None of the straight forms show any definite proloculum, and it is therefore to be supposed that the early beginnings in all cases have been broken away.

RECENT LITERATURE ON THE FORAMINIFERA

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

Jaworski, E.

Bibliographia Palaeontologica für die Jahre 1914-1926 by E. Jaworski. Erste Lieferung. Allgemeine Paläontologie. Spezielle Paläozoologie: Protozoa, Coelenterata, Echinodermata, Molluscoidea, Mollusca (ausser Cephalopoda).

(Published by Max Weg, Leipzig, Germany. Price: 18 Marks.)

The part on foraminifera takes up pages 53-77 with papers numbered 781-1152 arranged under various groupings.

Hada, Yoshine.

Report of the Biological Survey of Mutsu Bay. 19. Notes on the Recent Foraminifera from Mutsu Bay.

(Sci. Rep. Tohoku Imperial Univ., Fourth Series, Biology, vol. VI, No. 1, March, 1931, pp. 45-148, text figs. 1-95.) *Sendai*.

Describes 100 species, and figures nearly all. Eleven species new.

Hada, Yoshine.

A Contribution to the Study on the Plankton and the Allied Protozoa in the Northern Waters of Japan. I. A List of the Littoral Foraminifera of Hokkaido.

(Trans. Sapporo Nat. Hist. Soc., vol. XI, pt. I, July, 1929, pp. 9-15, text figs. *a-d*.) *Sapporo*.

Lists 72 species, one new species of *Reophax*.

Le Maitre, D.

Observations sur les Algues et les Foraminifères des calcaires dévoniens.

(Ann. Soc. Géol. du Nord, vol. LV, 1930, pp. 42-50, pl. III.) *Lille*.

A few arenaceous foraminifera are recorded and figured.

Le Maitre, D.

Foraminifères des terrains dévoniens de Bartine (Turquie).

(Ann. Soc. Géol. du Nord, vol. LVI, 1931, pp. 1-8, pl. I.) *Lille*.

Six genera, all arenaceous are recorded, and figures given of photographed sections.

Cushman, Joseph A. and Boris Laiming.

Miocene Foraminifera from Los Sauces Creek, Ventura County, California.

(Journ. Pal., vol. 5, No. 2, June, 1931, pp. 79-120, pls. 9-14, 5 text figs.) *Tulsa*.

Record and figure 68 species, of which 10 species and 6 varieties are described as new.

Cole, W. Storrs.

The Pliocene and Pleistocene Foraminifera of Florida.

(Bull. 6, Florida State Geol. Survey, April, 1931, pp. 1-79, pls. 1-7, table.) *Tallahassee.*

Describes and figures numerous species and varieties, of which 5 are given as new.

Hofker, J.

Resultats Scientifiques du Voyage aux Indes Orientales Neerlandaises. Vol. II, Fasc. 1. Sur Quelques Foraminifères, Dec. 31, 1930, pp. 1-12, pls. I-III. *Brussels.*

Notes and figures are given of 11 tropical species.

Hofker, J.

Die Foraminiferen aus dem Senon Limburgens. XI. Einige Textulariden.

(Nat. Hist. Maandblad, Jaarg. 20, No. 5, May 21, 1931, pp. 74-79, 8 text figs.) *Limburg.*

Notes and figures on several Cretaceous species.

Dryden, A. L., Jr.

Glaucinite in Fossil Foraminiferal Shells.

(Science, vol. 74, No. 1905, July 3, 1931, p. 17.) *Lancaster.*

Gives data for the occurrence of glauconite in Miocene and Eocene foraminifera.

Cushman, Joseph Augustine.

The Foraminifera of the Atlantic Ocean. Part 8. Rotaliidae, Amphisteginidae, Calcarinidae, Cymbaloporettidae, Globorotaliidae, Anomalinidae, Planorbulinidae, Rupertiidae and Homotremidae.

(Bull. 104, U. S. Nat. Mus., pt. 8, 1931, pp. i-ix, 1-179, pls. 1-26.) *Washington.*

The final part of this work with many species and varieties, mostly illustrated and a few new.

J. A. C.