

CONTRIBUTIONS  
FROM THE  
CUSHMAN LABORATORY  
FOR  
FORAMINIFERAL RESEARCH

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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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# CONTRIBUTIONS FROM THE CUSHMAN LABORATORY FOR FORAMINIFERAL RESEARCH

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## 22. PHOTOGRAPHING FORAMINIFERA

By JOSEPH A. CUSHMAN

The methods of photographic work as developed in this laboratory are now being used with success elsewhere. It is perhaps best to give in some detail the methods used that they may have a wider use as they are of very great service in the study of the foraminifera, especially in economic work where much detailed data should be quickly available in visual form.

Various methods have been tried out for a number of years, but always difficulty was encountered in getting sufficient depth of focus with the desired magnification. Several years ago a method was worked out by the writer, and later put into definite form. It has continued to give excellent results. The main idea has been to obtain a negative of the greatest possible depth of focus regardless of magnification, and then the enlargement from this negative to the desired size. In this way the details are kept with the deep focus.

For the actual photographing a vertical camera is used. The particular camera used in the laboratory is a type "H," Bausch and Lomb, with the camera parts to take 5x7 plates. Kits are used in the plate holders for smaller sizes. Any good compound microscope may be used. For objectives the Micro-Tessars of Bausch and Lomb are used. The 32-millimeter equivalent focus has been found to be of the greatest value although those of greater focal length are excellent for larger specimens. For focusing, the diaphragm should be wide open or nearly so, but for the actual exposure the stop should be cut down at least to 11 of the scale, or even to 22 to get the greatest possible sharpness and depth. An ocular may be used if desired, but much the best results are obtained without it. With the type "H" camera with the bellows extended to full length there is a magnification of the image on the plate to about 18 to 20 diameters.

This will give an excellent depth. By all means a focusing glass of some form should be used, and every change of specimens very carefully refocused. The entire result depends on this point of very exact focus. With the combination of a 32-millimeter, no ocular, and bellows full length all the specimens in a circle of about 5 millimeters may be photographed at once.

For the lighting, one of the regular Bausch and Lomb illuminating outfits with a 6-volt, 108-watt lamp is used. This is placed in the most advantageous position, and then screwed to the table to form a permanent fixture with a table switch. With the microscope and camera fixed, the only thing needed is to get the slide in position. The light from this unit will be found very intense and the shadows it casts very dark. In the laboratory here a counter-light is used. This is a 250-watt, 115-volt "floodlight" bulb in an ordinary pliable gooseneck which can be quickly bent to any desired position.

In actual operation a table was built in across the end of the "exposure room" of the laboratory, the centre of the top removable with a second solid shelf below. In this lower part the camera and microscope are placed, and the counter-light. On the top at the left is the strong light as already noted. This arrangement brings the top of the camera when extended low enough so that focusing can be done from the floor. A medium position is thus obtained obviating stooping to place the slides in position and change the diaphragm, and also standing on a higher level for focusing.

When these factors already mentioned have become fixed a table of variant factors should be worked out. The intensity of the strong light may be varied by focusing, and this will greatly change the time of exposure. The greatest speed can be obtained with the filament just out of focus on the slide. Each new bulb will be found to vary sometimes as much as fifty per cent., and the intensity is apt to decrease with use. This factor must be constantly checked. Specimens will require very different exposures. White foraminifera of tropical reefs containing chalk white Miliolidae will need much less exposure than the gray, dull material of much of the American Cretaceous for example. Length of exposure should be increased rather than opening the iris diaphragm.

The best results will be obtained from fairly slow plates, and any good plate will give excellent results. The normal development time for the plate should be taken as the base and length of exposure, intensity of light, etc., varied until the desired

sharpness of the developed plate results. Tank development is used entirely.

When good negatives are obtained the next step is to get the size best adapted to the purpose desired. In this work an Eastman auto-focus enlarging camera is used. With this camera working in a vertical position no focusing is necessary, and the enlarging paper placed directly on the table in the red light, with a smaller auto-focus enlarger a magnification of  $3\frac{1}{2}$  times may be obtained, making the final print 60 to 75 diameters, a size sufficient for all practical purposes. Where records are desired for filing in the laboratory printing is done on double thick, 4x6 paper, which can then be used as a 4x6 file card with any notes that may be necessary.

By the methods outlined here we have photographed 2,500 specimens of foraminifera in an afternoon on less than a hundred slides, and had the negatives ready for printing in the evening if necessary.

The longest time is spent in mounting the slides for photographing, but if flat slides are used with a black background gummed ready for use, one quickly becomes very expert in placing the specimen in position and arranging a number in the 5-millimeter circle. Specimens of fairly uniform size should of course be mounted together to insure uniform focus.

This method proved by several years of constant usage here in the laboratory will be found a very valuable one wherever numbers of foraminifera are handled, and where permanent records are desired.

## 23. EOUVIGERINA A NEW GENUS FROM THE CRETACEOUS

By JOSEPH A. CUSHMAN

In material from the Taylor Marl of the Upper Cretaceous of Texas, kindly furnished me by Mrs. Helen J. Plummer, there are numerous small forms, which are of especial interest. They are very clearly related to *Sagrina cretacea* Heron-Allen and

Earland and to *S. aspera* Marsson, both of which are known from the Upper Cretaceous of Europe. A study of the developmental stages of the two species from the Taylor Marl shows that they have very interesting relationships with several known genera. The early development seems to be, at least in the microspheric form, a series of coiled chambers such as are found in the microspheric form of *Bolivina* and *Textularia*. Later chambers are biserial, but the last-developed ones in the adult instead of keeping to the biserial form often become triserial and may be compared to *Uvigerina*. The development of a definite neck and phialine lip also makes them resemble *Siphogenerina*, *Uvigerina*, and *Trifarina*. It seems rather clearly indicated that the genus *Uvigerina* may have developed from just such forms as these through the process of acceleration of development, the shoving back of this adult character of a triserial arrangement into the earlier and earlier stages. Such a form would directly result in typical *Uvigerina*. The genus and species are here described after which further discussion of their relationships are given.

**GENUS EOUVIGERINA** Cushman, new genus

Test free, elongate, the early chambers, at least in the microspheric form, coiled, later chambers becoming biserial, final chambers irregularly triserial; aperture circular or rhomboid at the end of a definite neck usually with a phialine lip. (Genotype *Eouvigerina americana* Cushman, n. sp.)

**EOUVIGERINA AMERICANA** Cushman, n. sp.

Plate 1, figs. 1 a-c

Test elongate, tapering, greatest breadth toward the apertural end, composed of numerous chambers, the early ones somewhat compressed, coiled, forming one volution or less in the microspheric form, chambers of the adult mostly biserial but the last-formed ones in fully developed specimens leaving the biserial form and becoming triserial; chambers distinct, polygonal, the upper face flat or slightly convex, the sides concave making a definitely angled chamber with a sharp periphery on the upper edge, the edges of the chamber with a trace of a keel in the adult; sutures distinct and depressed, especially in the later development; wall unornamented; aperture rhomboid, at the end of a short neck with a phialine lip.

Length 0.35 mm.; breadth 0.18 mm.; thickness 0.12 mm.

Holotype (Cushman Coll. No. 4986), from the Upper Cretaceous, Taylor Marl, Clay pit of Dallas Brick Co.,  $\frac{1}{2}$  mile west of Mesquite, Texas, collected by Helen J. Plummer.

This species is most closely related to *Eouvigerina cretacea* (Heron-Allen and Earland) (Journ. Roy. Micr. Soc., 1910, p. 423, pl. 8, figs. 8-10), described from the Chalk of England. The American species, however, differs in the much more angular chambers which are not nearly so convex, and the whole test has the chambers more loosely put together.

**EOUVIGERINA GRACILIS** Cushman, n. sp.

Plate 1, figs. 2 a-c

Test elongate, slender, tapering, greatest width formed by the last 2 chambers, earliest chambers obscure but the test for the most part made up of biserial chambers, those of the adult last formed become triserial and more isolated from one another; chambers nearly round in transverse section, inflated; sutures distinct, much depressed; wall roughened by minute spines; aperture rounded at the end of a short, cylindrical neck with a rather broad phialine lip.

Length 0.35 mm.; breadth 0.13 mm.; thickness 0.10 mm.

Holotype (Cushman Coll. 4988), from the Upper Cretaceous, Taylor Marl, Clay pit of Dallas Brick Co.,  $\frac{1}{2}$  mile west of Mesquite, Texas, collected by Helen J. Plummer.

This is nearest to *Eouvigerina aspera* (Marsson).

As has already been shown elsewhere the genus *Sagrina* being in much doubt from the fact that the type species of the genus, *Sagrina pulchella* d'Orbigny, is probably a *Bolivina* has made *Sagrina* unavailable for use for such forms as these under consideration. They do not belong typically in *Siphogenerina* because there is no tendency to develop a uniserial group of chambers in the adult, but instead, the development of a triserial group much more like that developed as a typical adult character in *Uvigerina*. As it is quite possible that *Uvigerina* may have developed from such forms, the generic name *Eouvigerina* is here given to them. From what has already been noted the genus is evidently widespread in the later Upper Cretaceous, at least of America and Europe. The small size would make them easily overlooked. In this connection it is interesting to note that the one *Uvigerina* described from the American Cretaceous, *U. seligi* Cushman (Contrib. Cushman

Lab. Foram. Res., vol. 1, pt. 1, 1925, p. 1, pl. 4, figs. 1 a-c), described from the Arkadelphia Clay is also very small, being even less in length than either of these species of *Eouvigerina*. The genus *Eouvigerina* is closely related to *Siphogenerina*, *Uvigerina*, and *Trifarina*, and it seems that they should be grouped together under the subfamily Uvigerininae. The *Uvigerina* group has usually been classed with the family Lagenidae. However Silvestri has placed under the subfamily Bulimininae in his family Ellipsoidinidae the genus *Siphogenerina* Schlumberger. The peculiar apertural characters with cylindrical neck and phialine lip are distinctive from the other genera grouped under the subfamily Bulimininae. The internal tube connecting the chambers is present in *Siphogenerina* and in at least some of the species of *Uvigerina*, and occurs in *Trifarina*. This would then take *Uvigerina* and the subfamily Uvigerininae from the family Lagenidae and place it under Silvestri's new family Ellipsoidinidae. The Lagenidae will then be left as a much more definite group, characterized by the glassy type of chamber wall, with a definite radiate aperture except in the group characterized by *Lagena* itself. In this connection it may be noted that the derivation of *Eouvigerina* and the other genera of this group from *Bolivina* is not a very radical step. Most of the Cretaceous Bolivinas are not greatly compressed as is the case in so many of the Tertiary and Recent ones. The development of a cylindrical neck and phialine lip in *Bolivina eocenica* Terquem, as figured by Heron-Allen and Earland (Journ. Roy. Micr. Soc., 1911, pl. 10, figs. 6, 7) would indicate the close relationship of these two groups. Another point which may show that the relationships of *Uvigerina* and the Bulimininae are more closely related than might at first be suspected is shown especially by the Uvigerinas of the Tertiary of our own West Coast where there are developed species in which the apertural characters show a decided deviation from the usual form. Instead of the cylindrical neck there are developed forms with a high "collar," which is open on the side toward the axis of the test. This may in some cases even extend to the wall of the chamber. These forms also instead of having the typical circular aperture have a much elongate one, not unlike that seen in some species of *Bolivina*. As an added feature the aperture frequently develops a decided tooth in which it resembles some forms of *Bolivina*.



## 24. THE GENUS LAMARCKINA AND ITS AMERICAN SPECIES

By JOSEPH A. CUSHMAN

In 1881 Berthelin (C. R. Assoc. Franc. (Reims, 1880) 1881, p. 555) proposed the generic name *Lamarckina* with the type species *Pulvinulina erinacea* Karrer, from the Miocene of Kostež in the Banat region of Hungary. This name has not been used by later authors, but a comparison of specimens of *P. erinacea* Karrer from the type locality with several species of our American Tertiary and elsewhere makes it very advisable to use this generic name *Lamarckina* for the very definite group it includes.

**GENUS LAMARCKINA** Berthelin, 1881

*Lamarckina* BERTHELIN, C. R. Assoc. Franc. (Reims, 1880) 1881, p. 555. [Genotype *Lamarckina erinacea* (Karrer).]

Test evidently attached in life, coiled, composed in the adult of about  $1\frac{1}{2}$  coils, dorsal side with the chambers all visible, ventral side with only those chambers of the last-formed coil visible, dorsal side convex and either smooth or variously ornamented; ventral side flattened or slightly concave, the whole surface very smooth and highly polished or at least such part of it as forms the attachment; chambers distinct on the dorsal side, less so on the ventral; sutures simply curved, slightly depressed or sometimes raised on the dorsal side, on the ventral slightly depressed; wall finely perforate, the ventral side thickened and the perforations less evident; aperture umbilical, large, usually with a projection partially covering the aperture itself; in earlier chambers as covered the aperture is enlarged by resorption.

The attached form is evidenced by the "humping" up of the newly added chambers, and the very smooth polished ventral surface which may be compared in appearance to the highly polished portions of some molluscs.

The type species, *Lamarckina erinacea* (Karrer), as already noted is from the Miocene of the Banat Region of Hungary. The genus is represented by species in the Upper Cretaceous, all the main divisions of the Eocene, and the Lower Oligocene of America, in Eocene and later Tertiary of other regions, and also occurs in the present oceans. The generic characters are closely held from the Upper Cretaceous onward. The descriptions of the American fossil species follow.

**LAMARCKINA RIPLEYENSIS** Cushman, n. sp.

Test longer than broad, dorsal side convex, ventral side flattened, consisting of about  $1\frac{1}{2}$  coils, 8-9 chambers in the last-formed coil; chambers very distinct, only slightly inflated; sutures distinct, limbate, raised, the inner end being more distinct than the peripheral end; periphery carinate, the carina fusing with the raised sutures; surface between, rather coarsely punctate, ventral side smooth and highly polished, umbilicate, the last-formed chamber with a large semicircular lip above the aperture; sutures and chambers hidden by the smooth, secondary thickening of the ventral side.

Length 0.50 mm.; breadth 0.40 mm.; thickness 0.20 mm.

Type specimens (Cushman Coll. No. 5129) from the Cretaceous, Ripley formation, Owl Creek, Mississippi, collected by Helen J. Plummer.

This species kindly furnished me by Mrs. Plummer carries the history of this genus back into the Upper Cretaceous. It may be distinguished from all the other species by the carinate edge combined with very prominently raised sutures and the peculiar, coarsely punctate appearance of the dorsal surface between the sutures. It also differs from other species of the genus in having a large number of chambers in the coil, the average probably being around 7 in other species where this has 8 or 9. Figures of this species will be given in Part 2 of these Contributions.

**LAMARCKINA RUGULOSA** Plummer, MS.

Plate 3, figs. 6 a-c

Test very broadly elliptical to almost round in outline, moderately compressed in average development to nearly globular in extreme old age; convolutions not over  $1\frac{1}{2}$ ; chambers 5-6 in the last-formed whorl, enlarging rapidly, very smooth and glistening on the ventral face, highly granular on the dorsal face; dorsal sutures slightly depressed between last 2 or 3 chambers, but commonly obliterated by the granulations, or rarely marked by faint ridges of smooth shell material; ventral sutures faintly depressed; umbilicus deeply excavated; aperture a low arch on the umbilical edge of the final chamber under a narrow and delicately fringed flap on well-preserved tests.

Maximum length up to 0.50 mm.; maximum breadth 0.40 mm.; thickness 0.30 mm.

Cotypes (Cushman Coll. No. 5111), Lower Eocene, Midway,

from a road-cut south of city reservoir,  $3\frac{1}{2}$  miles S. E. of Corsicana, Texas, collected by Helen J. Plummer.

This species also occurs in the Lower Eocene, Clayton formation, from a bluff on the south side of Owl Creek,  $2\frac{3}{4}$  miles N. E. of Ripley, Tippah Co., Mississippi, collected by C. Wythe Cooke.

*Lamarckina rugulosa*, although one of the smallest of the American species, is very distinct in its rugose dorsal surface and the broadly rounded periphery, as well as the fact that the smooth character of the ventral surface, which extends up onto the dorsal surface at the peripheral end, is seen in the line of coiling on the dorsal surface.

**LAMARCKINA WILCOXENSIS** Cushman, n. sp.

Plate 1, figs. 3 a-c

Test small, thick, slightly longer than broad, periphery sharply angled, slightly lobulate, last-formed coil consisting of about 7 chambers, dorsal side broadly convex, smooth, umbonate; chambers inflated, but the central early chambers forming a distinct umbo; sutures depressed or occasionally limbate; ventral side somewhat convex, strongly umbilicate, smooth and highly polished; aperture with an elongate projecting area from the last-formed chamber.

Length 0.35-0.40 mm.; thickness 0.25 mm.

Type specimens (U. S. N. M. Coll. No. 354035) from Wilcox formation, Woods Bluff, Tombigbee River, Ala., collected by E. A. Smith.

This may be distinguished from all the following species by its smaller size, greater thickness, and smooth dorsal surface.

**LAMARCKINA MARYLANDICA** Cushman, n. sp.

Plate 1, figs. 5 a-c

Test subcircular in outline, periphery lobulate, generally planoconvex, 7 chambers in the last-formed coil, dorsal side broadly and evenly convex, the sutures especially in the earlier portion raised above the otherwise smooth surface and coalescing, ventral side strongly umbilicate, very smooth and highly polished; aperture large, somewhat more oblique than some of the other species.

Diameter 0.75 mm.; thickness 0.45 mm.

Type specimens (U. S. N. M. Coll. No. 354033) from Aquia formation, Upper Marlboro, Maryland.

This is in some ways the handsomest species of the series,

especially in the ornamentation of the dorsal side. The figured specimen shows the last-formed chamber broken away, and the large resorbed lobe of the previous aperture.

It is represented in the Claiborne in the Lisbon formation, by the following variety:

**LAMARCKINA MARYLANDICA** Cushman, n. sp., var. **CLAIBORNENSIS**  
Cushman, n. var.

Variety differing from the typical in the greater involution of the dorsal side, and the greater development of the ornamentation so that the raised costae of the last-formed coil coalesce at the umbo or very near it.

Type of the variety (U. S. N. M. Coll. No. 354034) occurs in the Lisbon formation with *Lamarckina cristellaroides* (Terquem). Branch at bridge  $\frac{1}{2}$  mile N. E. of River Falls, Covington Co., Ala., collected by C. W. Cooke and Julia Gardner.

The variety evidently represents a slightly later and more highly developed form of the typical form of the species.

**LAMARCKINA MARYLANDICA** Cushman, n. sp., var. **YEGUAENSIS**  
Cushman, n. var.

Variety differing from the typical in the sutures, which are slightly limbate but depressed throughout where the typical form of the species has the sutures raised and confluent.

Cotypes (Cushman Coll. No. 5131) from the Yegua formation of Texas, N. of Nixon, Gonzales Co., collected by Esther R. Applin.

**LAMARCKINA CRISTELLAROIDES** (Terquem)

*Rotalina cristellaroides* TERQUEM, Mém. Soc. géol. France, ser. 3, vol. 2, 1882, p. 57, pl. 3 (11), figs. 15 a-c.

Test small, longer than broad, the chambers rapidly increasing in thickness as added, 7 chambers in the last-formed coil, dorsal side strongly convex, smooth and finely perforate, the sutures distinct, flush with the surface, ventral side convex, umbilicate, smooth, and highly polished, the sutures slightly depressed; aperture large, broader than long.

Length 0.40 mm.

Terquem described this species from the Upper Eocene of the Paris Basin. I have in my own collection specimens from localities in the Upper Eocene of the Paris Basin, and they resemble very closely specimens which occur in the Gosport sand member of the Claiborne, Bluff at foot of Gopher Hill, Washington

Co., Ala., collected by T. Wayland Vaughan, and in the Lisbon, branch at bridge  $\frac{1}{2}$  mile N. E. of River Falls, Covington Co., Ala., collected by C. W. Cooke and Julia Gardner.

This species most nearly resembles *Lamarckina glabrata* Cushman, but is smaller, more elongate, the chambers piling up causing a thicker adult, and the dorsal surface is smooth.

**LAMARCKINA OCALANA** Cushman, n. sp.

Plate 1, figs. 4 a-c

Test subcircular in outline, periphery slightly lobulate, thin, slightly biconvex, periphery very thin, slightly keeled, composed of about  $1\frac{1}{2}$  coils, 7 chambers in the last-formed coil; dorsal side smooth and very finely perforate, the sutures barely depressed, not limbate; ventral side flattened or slightly convex, umbilicate, smooth and highly polished, sutures barely depressed; aperture large with a broadly rounded projecting lip.

Diameter about 1 mm.; thickness 0.35 mm.

Type specimens (U. S. N. M. Coll No. 354032) from Ocala Limestone, near Blue Springs, Jackson Co., Fla., collected by C. W. Cooke and Julia Gardner.

This is the largest of the species of the genus, and may be distinguished by its smooth, unornamented dorsal surface, tendency to become keeled, and compressed form.

**LAMARCKINA HALKYARDI** Cushman, new name

*Pulvinulina erinacea* HALKYARD (not Karrer), Mem. Proc. Manchester Lit. Philos. Soc., vol. 62, pt. 2, 1918 (1919), p. 124, pl. 8, fig. 8.

Halkyard figures a species which belongs to this genus from the Eocene of Biarritz, France. It resembles in certain respects *Lamarckina rugulosa*, but differs from that species in the acute periphery as well as the slightly more rounded form. It resembles it, however, in the smooth character of the ventral surface, showing in the line of coiling on the dorsal surface. It is distinct from *Lamarckina erinacea* (Karrer) of the Miocene.

**LAMARCKINA GLABRATA** (Cushman)

Plate 1, figs. 6 a-c

*Pulvinulina glabrata* CUSHMAN, U. S. Geol. Survey, Prof. Paper 129, 1922, pp. 99, 138, pl. 22, figs. 6, 7; Prof. Paper 133, p. 45, pl. 6, figs. 11, 12.

Test biconvex, longer than broad, periphery somewhat lobulate; composed of 2 coils or less, 7 chambers in the last-formed

coil, dorsal side coarsely punctate or somewhat spinose; the sutures depressed, the earlier ones slightly limbate, ventral side strongly umbilicate, smooth and highly polished, the sutures barely depressed; aperture large with a projecting lip from the last-formed chamber.

Length about 0.50 mm.; thickness 0.22 mm.

This species is known from several stations in the Byram Marl and Mint Spring Marl members of the lower Oligocene of Mississippi.

**LAMARCKINA UMBILICATA (Heron-Allen and Earland)**

*Pulvinulina scabra* BRADY, var. *umbilicata* HERON-ALLEN and EARLAND, Journ. Roy. Micr. Soc., 1924, p. 179, pl. 14, figs. 111-113.

Heron-Allen and Earland described this species as a variety of *Pulvinulina scabra* Brady, and specimens were from the Miocene, "Filter Quarry," Victoria, Australia. The species shows a very interesting development of the genus, in which the smooth, polished character of the ventral side extends up onto the periphery, so that as each new chamber is added the smooth character is left showing along the suture lines, as well as along the periphery. The edge of the test is fimbriate, and the surface on the dorsal side between the sutures very coarsely spinose. This forms the most highly developed species of the genus in the character of its ornamentation.

**LAMARCKINA ERINACEA (Karrer)**

*Pulvinulina erinacea* KARRER, Sitz. Akad. Wiss. Wien, vol. 58, pt. 1, 1868, p. 187, pl. 5, fig. 6.

This species described by Karrer is the genotype of the genus *Lamarckina* Berthelin. It is common in the Miocene of the Banat region of Hungary.

**LAMARCKINA VENTRICOSA (H. B. Brady)**

*Discorbina ventricosa* H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 654, pl. 91, figs. 7 a-c.

This species described by Brady in the *Challenger* report and known from the eastern Atlantic evidently belongs to this genus, and is related to such species as *Lamarckina erinacea* Karrer and *L. halkyardi* Cushman, new name.

**LAMARCKINA SCABRA (H. B. Brady)**

*Pulvinulina oblonga* WILLIAMSON, var. *scabra* H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 689, pl. 106, fig. 8.

This species which was referred by Brady as a variety of *Pulvinulina oblonga* probably belongs to the genus *Lamarckina*. There are records for it off Bermuda and west of the Azores, 435 and 1,000 fathoms. The other records are three off the coast of New Guinea, 17-155 fathoms, and off the Philippines, 95 fathoms. There may be two species involved under this name, one possibly identical with *L. ventricosa*.

The following shows the distribution of the American species:  
Lower Oligocene:

Vicksburg ..... *L. glabrata*

Eocene:

Jackson:

Ocala ..... *L. ocalana*

Claiborne ..... *L. cristellaroides*

Yegua ..... *L. marylandica*, var. *yeguaensis*

Lisbon ..... *L. marylandica*, var. *claibornensis*

Aquia ..... *L. marylandica*

Wilcox ..... *L. wilcoxensis*

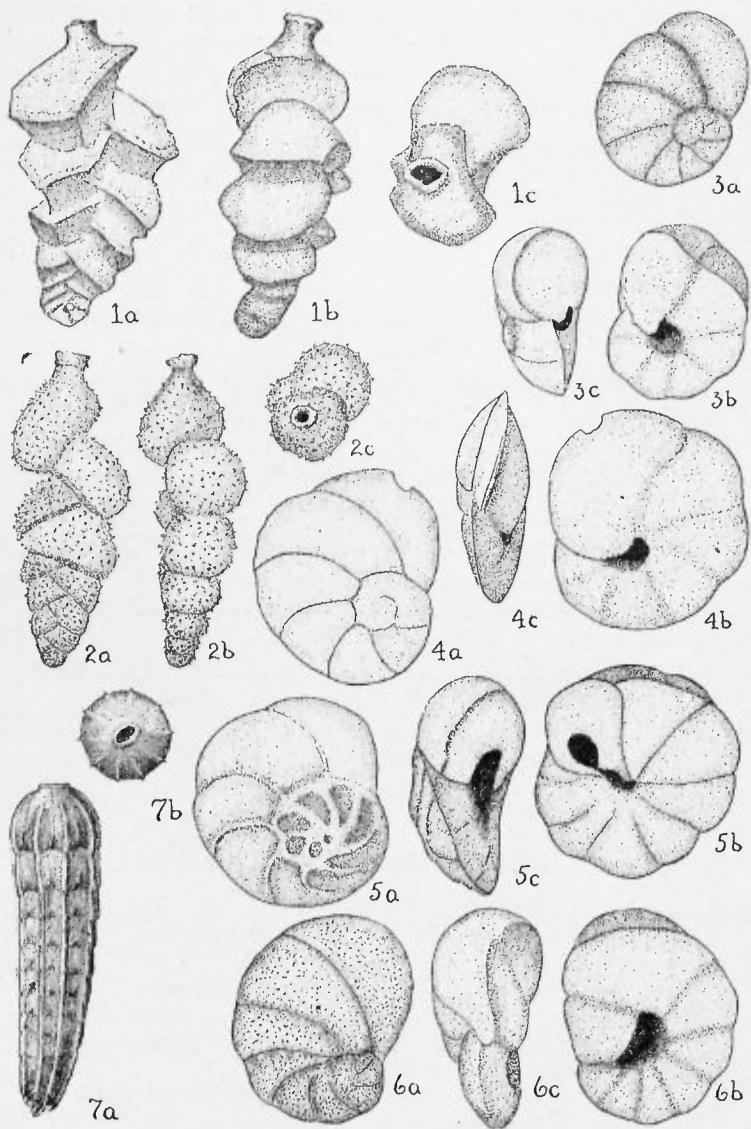
Midway ..... *L. rugulosa*

Cretaceous:

Ripley ..... *L. ripleyensis*

## EXPLANATION OF PLATE 1

- FIGS. 1 *a-c.* *Eouvirgerina americana* Cushman, n. sp. X 125.  
*a*, front view; *b*, side view; *c*, apertural view.
- FIGS. 2 *a-c.* *Eouvirgerina gracilis* Cushman, n. sp. X 125.  
*a*, front view; *b*, side view; *c*, apertural view.
- FIGS. 3 *a-c.* *Lamarckina wilcoxensis* Cushman, n. sp. X 65.  
*a*, dorsal view; *b*, ventral view; *c*, peripheral view.
- FIGS. 4 *a-c.* *Lamarckina ocalana* Cushman, n. sp. X 50.  
*a*, dorsal view; *b*, ventral view; *c*, peripheral view.
- FIGS. 5 *a-c.* *Lamarckina marylandica* Cushman, n. sp. 65.  
*a*, dorsal view; *b*, ventral view; *c*, peripheral view.
- FIGS. 6 *a-c.* *Lamarckina glabrata* (Cushman). X 65.  
*a*, dorsal view; *b*, ventral view; *c*, peripheral view.
- FIGS. 7 *a-b.* *Siphogenerina plummeri* Cushman, n. sp. X 65,  
*a*, front view; *b*, apertural view.





25. SIPHOGENERINA PLUMMERI A SPECIES FROM  
THE UPPER CRETACEOUS OF TEXAS

By JOSEPH A. CUSHMAN

Specimens which can be referred to *Siphogenerina* from the Cretaceous are decidedly rare. It is very interesting, therefore, to find a very distinct though very small species from the Upper Cretaceous of Texas. This has the characters well developed, and occurs in considerable numbers. Specimens of the genus are known from the Lower Eocene onward in many formations, and are now found mainly in the western tropical Atlantic, and in the more shallow waters of the Indo-Pacific region. The genus was exceptionally well developed in the Miocene of our own Pacific coast as well as in Panama, Trinidad, Florida, and Maryland.

**SIPHOGENERINA PLUMMERI** CushmanPlate 1, figs. 7 ~~a-c~~ 6.

*Siphogenerina plummeri* CUSHMAN, Proc. U. S. Nat. Mus., vol. 67, 1926, p. 18.

Test small, elongate,  $3\frac{1}{2}$  to 4 times as long as broad, very slightly tapering, greatest width developed by the last-formed chamber, early chambers biserial, later ones which make the bulk of the test uniserial, circular in transverse section; chambers distinct, slightly inflated; sutures distinct and depressed, especially in the uniserial portion; surface ornamented by about 8 longitudinal costae, sharp, and the posterior angles tending to project slightly in almost spinose angles, the last-formed chambers tending to develop supplementary costae between the primary ones, initial end of the test spinose formed by the ends of the costae; aperture elliptical with a distinct lip and very short neck.

Length up to 0.65 mm.; diameter 0.25-0.30 mm.

Holotype (Cushman Coll. No. 5103), from the Upper Navarro, 10 feet below the Basal Midway Greensand, along Walker Creek about 1 mile west of the main highway, about  $6\frac{1}{2}$  miles north of Cameron, Milam County, Texas, collected by Helen J. Plummer, who kindly furnished the drawings and types.

The species also occurs in the Navarro from  $\frac{1}{2}$  mile south of Kemp, Kaufman County, Texas, collected by Mrs. Plummer.

26. SOME FORAMINIFERA FROM THE MENDEZ SHALE  
OF EASTERN MEXICO

By JOSEPH A. CUSHMAN

The upper portion of the so-called Papagallos shales of the region about Tampico has in it many very characteristic foraminifera, some of which are very widely distributed in both the eastern and western hemispheres. Many of these species are very closely related to or identical with species from the Taylor Marl of the Upper Cretaceous of Texas. The fauna is a considerable one but only a few of the striking species are figured in this present paper. Certain of the species such as *Pseudotextularia varians* Rzehak, *P. acervulinoides* (Egger), *Bolivina incrassata* Reuss, *B. rhomboidea* Cushman, n. sp., and *Pulvinulina arca* Cushman, n. sp., are widely distributed in the upper portion of the Pagagallos shales, which have been given the distinctive name of Mendez from the outcrop near the town of that name (Belt, Bull. Amer. Assoc. Petr. Geol., vol. 9, No. 1, 1925, p. 140). *Pulvinulina arca* is a long-lived species continuing through much of the section, but modified in places so that distinct varieties can be recognized. Only one of these is here noted. Both *Pseudotextularia* and *Guembelina* are genera which mark the upper portion of the Cretaceous both in Europe and America, and which at least in the American section so far as recorded have not been found above the top of the Cretaceous. They therefore are excellent horizon markers. *Ellipsopleurostomella pleurostomelloides* is identical with specimens described by Heron-Allen and Earland from the chalk flints of England, and still further serves to correlate this formation. There are numerous other species which are identical with species found in the Cretaceous of Europe, but these few will serve the purposes of correlation.

**GENUS PSEUDOTEXTULARIA Rzehak, 1886**  
**PSEUDOTEXTULARIA VARIANS Rzehak**

Plate 2, figs. 4 a, b

*Pseudotextularia varians* RZEHAK, Ann. k. k. Nathist. Hofmuseums, vol. 10 pt. 2, 1895, p. 217, pl. 7, figs. 1-3.

*Guembelina fruticosa* EGGER, Abhandl. kön. bay. Akad. Wiss. München, Cl. II, vol. 21, 1899, p. 35, pl. 14, figs. 8, 9.

Test large, in the early stages definitely textularian, alternating series of chambers on either side of an elongate axis after which isolated chambers are formed near the periphery, subglobular in form, resulting in a spiral series about the margin, the central area being somewhat depressed; sutures distinct except in the early portion; wall of the textularian chambers longitudinally costate, later ones irregularly punctate.

Length up to 1½ mm.; breadth about 1 mm.; thickness from 0.40-1 mm.

This is a very variable species, in certain forms apparently the textularian series is held throughout the life history, and the test may become much compressed, in others the globular chambers are developed very early so that they make up most of the test, the end view may be circular or as in the figured specimen elliptical, often specimens which are nearly circular in transverse section in the early stages become more or less compressed in later growth. This is a very characteristic species of the Mendez, and is also found in Europe in the Upper Cretaceous. It does not persist in the Tertiary, at least in America.

Figured specimen (Cushman Coll. No. 5082) from shales near Coco, Hacienda El Limon, San Luis Potosi, Mexico.

**PSEUDOTEXTULARIA ACERVULINOIDES (Egger)**

Plate 2, fig. 5

*Guembelina acervulinoides* EGGER, Abhandl. kön. bay. Akad. Wiss. München, Cl. II, vol. 21, 1899, p. 36, pl. 14, figs. 17, 18, 20-22.

*Pseudotextularia acervulinoides* CUSHMAN, Journ. Wash. Acad. Sci., vol. 15, No. 6, 1925, p. 134.

This species differs from *Pseudotextularia varians* Rzehak in the very greatly reduced textularian development, the isolated, globular chambers developing very early and forming a very much compressed test, which is several times as broad as thick, and in full grown specimens the breadth is greater than the length.

Length up to 0.75 mm.; breadth up to 0.90 mm.

This species originally described by Egger from the Upper Cretaceous of the Bavarian Alps is characteristic of the Mendez shale, and also of certain portions of the Taylor Marl of Texas.

Figured specimen (Cushman Coll. No. 5075) from near Guerrero, San Luis Potosi, Mexico.

**GENUS ELLIPSOPLEUROSTOMELLA Silvestri, 1903**  
**ELLIPSOPLEUROSTOMELLA PLEUROSTOMELLOIDES (Heron-Allen and Earland)**

Plate 2, fig. 6

*Ellipsoidella pleurostomelloides* HERON-ALLEN and EARLAND, Journ. Roy. Micr. Soc., 1910, p. 415, pl. 10, figs. 1-11; 1911, p. 317.

Test elongate, slightly tapering; chambers biserial, inflated, circular in transverse section; sutures slightly depressed, distinct; wall smooth; aperture terminal with an overhanging hoodlike projection, the aperture itself elongate.

Length 0.65 mm.; breadth 0.15 mm.

Figured specimen (Cushman Coll. No. 5087) from Tamuin River, S. E. of Guerrero, San Luis Potosi, Mexico.

This species, which occurs at a number of localities in the Mendez, seems to be identical with a species described from the Chalk of England.

**GENUS PLEUROSTOMELLA Reuss, 1860**  
**PLEUROSTOMELLA TORTA Cushman, n. sp.**

Plate 2, fig. 7

Test large, subcylindrical, composed of few chambers, sides nearly parallel, slightly lobate, circular in transverse section; chambers biserial throughout, the axis of the early portion somewhat twisted; sutures distinct, limbate, slightly depressed; wall smooth; aperture elliptical with a slight lip and a platelike tooth with a central indentation.

Maximum length 2.10 mm.; maximum breadth 0.65 mm.

Holotype (Cushman Coll. No. 5102) from east of Pujal, San Luis Potosi, Mexico.

This is one of the largest species of the genus, and is characterized by the distinctly limbate sutures, and in many of the specimens by the peculiar twisted axis of the early portion.

**GENUS BOLIVINA d'Orbigny, 1839**  
**BOLIVINA INCRASSATA Reuss**

Plate 2, figs. 1 *a, b*

*Bolivina incrassata* REUSS, Haidinger's Nat. Abh. 4, pt. 1, 1851, p. 45, pl. 4, fig. 13.

Test stout, about  $2\frac{1}{2}$  to 3 times as long as broad; chambers fairly numerous, distinct, only slightly inflated; sutures distinct, oblique, slightly depressed; periphery rounded, whole test gently tapering, greatest width toward the apertural end; wall thick, smooth, finely punctate; aperture elongate oval with a very slight lip.

Length up to 1.25 mm.; breadth up to 0.45 mm.; thickness 0.30 mm.

Figured specimen (Cushman Coll. No. 5069) from near Coco, Hacienda El Limon, San Luis Potosi, Mexico.

Reuss originally described this species from the Upper Cretaceous of Europe where it is recorded by many authors.

**BOLIVINA INCRASSATA Reuss, var. LIMONENSIS Cushman, n. var.**

Plate 2, fig. 2

Test differing from the typical in the much longer, more slender form.

Length up to 1.65 mm.; breadth 0.30 mm.; thickness 0.20 mm.

Holotype (Cushman Coll. No. 5068) from near Guerrero, San Luis Potosi, Mexico.

At first it was thought that this might be the microspheric form of *Bolivina incrassata*, but both forms have been found of that species developing the same adult test. The general appearance, the surface, and the obliquity of the sutures of the variety are very close to the typical, but it is much longer and more slender, and can be distinguished at once from the typical form of this species.

**BOLIVINA RHOMBOIDEA Cushman, n. sp.**

Plate 2, figs. 3 *a, b*

Test rhomboid both in front and end views, in front view breadth only slightly less than the length, and the greatest width being an oblique line in almost all specimens, periphery subacute, the apertural end somewhat rounded, initial portion much compressed, rather rapidly increasing in thickness toward

the apertural end; chambers obscured by the surface ornamentation which consists of two nearly parallel median costae, from which oblique costae branch toward the periphery, these again may be connected by short, transverse costae, all ending at the periphery in a raised, smooth surface; aperture elongate, slightly oblique with a trace of a raised lip.

Length 0.50 mm.; breadth 0.40 mm.; thickness 0.20 mm.

Holotype (Cushman Coll. No. 5039) from 5 kilometers S. E. of Guerrero, on the Tamuin River, San Luis Potosi, Mexico.

This is a very distinctly ornamented species, reminding one very slightly of *Bolivina draco* Marsson, which is recorded from the Upper Cretaceous of Europe. This is, however, very distinct in its ornamentation.

**GENUS GUEMBELINA Egger, 1899**  
**GUEMBELINA EXCOLATA Cushman, n. sp.**

Plate 2, fig. 9

Test small, much compressed, broadest near the apertural end, initial end pointed, early portion with the chambers arranged as in *Virgulina*, later chambers biserial; chambers fairly distinct, slightly inflated, increasing in height as added; sutures slightly depressed; wall ornamented with curved, slightly oblique, longitudinal costae, those of separate chambers usually distinct from those of adjacent chambers except in the early portion where the costae may cover more than one chamber; aperture elongate oval.

Length 0.45 mm.; breadth 0.30 mm.; thickness 0.18 mm.

Holotype (Cushman Coll. No. 5071) from the east bank of the Tamuin River, 5 kilometers southeast of Guerrero, San Luis Potosi, Mexico.

This curiously ornamented species of very small size is nevertheless distinct and often occurs in considerable numbers. It is allied with some of the species described from Europe from the Upper Cretaceous, but seems to be distinct from any of these.

**GENUS NODOSARIA Lamarck, 1812**  
**NODOSARIA OBSCURA Reuss**

Plate 2, fig. 8

*Nodosaria obscura* REUSS, Verstein. Böhm. Kreide, 1845-46, pt. 1, p. 26, pl. 13, figs. 7-9.

Test fusiform, circular in transverse section, composed of comparatively few chambers ornamented with 10-12 prominent

longitudinal costae; sutures between the chambers visible between the costae; apertural end somewhat projecting.

Length 0.75 mm.

Figured specimen (Cushman Coll. No. 5073) from the south side of Rancho Nuevo, S. W. of Guerrero, San Luis Potosi, Mexico.

The smallest specimens of this species very much resemble costate forms of *Lagena*, but in the larger ones the sutures become more prominent. The species is known from numerous records from the Upper Cretaceous of Europe.

**GENUS FRONDICULARIA DeFrance, 1824**  
**FRONDICULARIA ARCHIACIANA d'Orbigny**

Plate 3, fig. 4

*Frondicularia archiaciana* D'ORBIGNY, Mém. Soc. Géol. France, vol. 4, 1840, p. 20, pl. 1, figs. 34-36.

Test elongate, sides nearly parallel and truncate, the broader faces nearly parallel, much flattened, composed of few chambers well marked by the raised, limbate sutures which may have between them and on the first-formed chamber additional secondary costae, initial end pointed.

Length 1.25 mm.; breadth 0.35 mm.

Figured specimen (Cushman Coll. No. 5105) from near Huiches, Hacienda El Limon, San Luis Potosi, Mexico.

D'Orbigny originally described this species from the Upper Cretaceous of France, and it has occurred from the records rather widely in this formation in Europe. The original of the species had the area between the raised sutures smooth, but nearly all of the specimens from the Mexican material have the early chamber particularly, with definite costae.

**FRONDICULARIA BAUDOINIANA (d'Orbigny)**

Plate 3, fig. 5

*Frondicularia baudouiniana* D'ORBIGNY, Mém. Soc. Géol. France, ser. 1, vol. 4, 1860, p. 24, pl. 2, figs. 8-11.

Test flattened, oval, initial end broadly rounded, apertural end somewhat pointed, composed of few chambers, the early ones coiled; sutures limbate, raised above the general surface as sharp costae; wall between smooth.

Length 0.85 mm.; breadth 0.45 mm.; thickness 0.23 mm.

Figured specimen (Cushman Coll. No. 5116) from near Las Palmas, Hacienda El Limon, San Luis Potosi, Mexico.

This is the form that has been referred by numerous writers to this species of d'Orbigny, which was described from the Upper Cretaceous of France. It is recorded from the Cretaceous of Central Europe and of England.

**GENUS TRUNCATULINA** d'Orbigny, 1826  
**TRUNCATULINA SPINEA** Cushman, n. sp.

Plate 2, figs. 10 a-c

Test small, planoconvex, the dorsal side flat or often slightly concave, ventral side very strongly convex, periphery acute, marked by a series of spines, one for each chamber, either simple or with secondary small spinose projections at the base, about 7 chambers in the last-formed coil, indistinct; sutures indistinct except on the ventral side where they may be slightly depressed; aperture ventral, elongate.

Diameter 0.35 mm.; thickness 0.18 mm.

Holotype (Cushman Coll. No. 5083) from shale on the Guerrero-Taninul Road, San Luis Potosi, Mexico.

This is a very small species but is very distinct in its characters, and has a wide distribution in the Mexican Mendez shales, although the vertical distribution seems not to be great.

**TRUNCATULINA EXCOLATA** Cushman, n. sp.

Plate 3, figs. 2 a, b

Test planoconvex, dorsal side flattened, vertical side broadly convex, periphery angled, dorsal side curiously ornamented with irregular costae along the suture lines but variously twisted, the intermediate area often roughened, the ventral side smooth, 9 or 10 chambers in the last-formed coil; sutures on the ventral side indistinct; aperture elongate at the base of the last-formed chamber on the ventral side.

Diameter 0.50 mm.; thickness 0.25 mm.

Holotype (Cushman Coll. No. 5104) from shale along the railroad near Coco, Hacienda El Limon, San Luis Potosi, Mexico.

This is a curiously ornamented species and like *Truncatulina spinea* Cushman has a wide geographic range, but comparatively short vertical range. It seems to show very little variation in the material examined although specimens were numerous.



GENUS *PULVINULINA* Parker and Jones, 1862  
*PULVINULINA ARCA* Cushman, n. sp.

Plate 3, figs. 1 a-c

Test biconvex, the periphery truncate, about 7 chambers in the last-formed coil; chambers very distinct; sutures both on the dorsal and ventral sides limbate, on the dorsal side curved, raised above the general surface in a distinctly beaded ornamentation, fusing with the raised periphery, the early sutures often more beaded than later ones, on the ventral side the chambers of the last-formed coil do not extend in to the center, leaving a distinct umbilical area; aperture elongate on the ventral side at the base of the last-formed chamber.

Diameter usually less than 1 mm.

Holotype (Cushman Coll. No. 5078) from near Huiches, Hacienda El Limon, San Luis Potosi, Mexico.

This is the most abundant of all the species of the so-called Papagallos series in the Upper Cretaceous of the Tampico region. It has a very broad distribution both geographically and vertically, in the Upper Cretaceous series. Through its wide vertical distribution, it shows several varietal forms, some of which may be more easily distinguished than others. In one of these the entire test becomes much flattened and the truncate character of the periphery is much more marked than in the typical form. In another the periphery is developed into distinct angles. Of the various varieties *Pulvinulina arca* Cushman, n. sp., var *contusa* Cushman, n. var. is perhaps the most distinctive.

*PULVINULINA ARCA* Cushman, n. sp., var. *CONTUSA* Cushman, n. var.

Variety differing from the typical in the greater size, much greater elevation of the spire on the dorsal side, and particularly striking the concave appearance of the chambers on the dorsal side, those of one coil coming in line with preceding ones so that the entire test develops something of a pyramidal form.

Holotype (Cushman Coll. No. 5079) from near Coco, Hacienda El Limon, San Luis Potosi, Mexico.

This variety has much the appearance of a conical, soft hat, in which there are made dents running from the apex to the border. This variety is often very abundant in certain horizons replacing to a large measure the typical form.

**GENUS CORNUSPIRA** Schultze, 1854  
**CORNUSPIRA CRETACEA** Reuss

Plate 3, fig. 3

*Cornuspira cretacea* REUSS, Sitz. Akad. Wiss. Wien, vol. 40, 1860, p. 177, pl. 1, figs. 1 a, b.

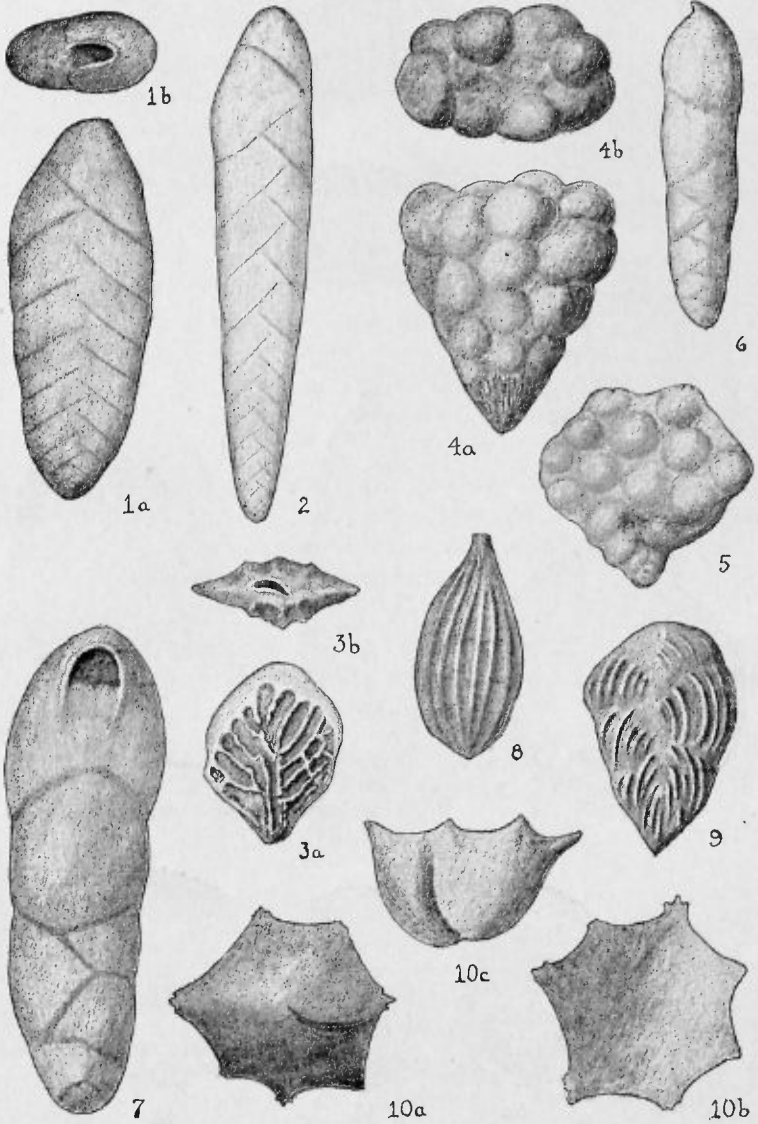
There are specimens which occur in the Mendez shales, which agree very closely with the figure and description of this species as described and figured by Reuss from the Upper Cretaceous of Europe. Specimens are very apt to be somewhat contorted possibly due to conditions of preservation.

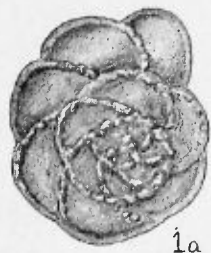
EXPLANATION OF PLATE 2

- FIGS. 1 a, b. *Bolivina incrassata* Reuss. X 45.  
 a, front view; b, apertural view.
- FIG. 2. *Bolivina incrassata* Reuss, var. *limonensis* Cushman, n. var.  
 X 45.
- FIGS. 3 a, b. *Bolivina rhomboidea* Cushman, n. sp. X 45.  
 a, front view; b, apertural view.
- FIGS. 4 a, b. *Pseudotextularia varians* Rzehak. X 50.  
 a, front view; b, end view.
- FIG. 5. *Pseudotextularia acervulinoidea* (Egger). X 50.
- FIG. 6. *Ellipsopleurostomella pleurostomelloidea* Heron-Allen and Earland. X 50.
- FIG. 7. *Pleurostomella torta* Cushman, n. sp. X 35.
- FIG. 8. *Nodosaria obscura* Reuss. X 45.
- FIG. 9. *Guembelina excolata* Cushman, n. sp. X 65.
- FIGS. 10 a-c. *Truncatulina spinea* Cushman, n. sp. X 100.  
 a, ventral view; b, dorsal view; c, side view.

EXPLANATION OF PLATE 3

- FIGS. 1 a-c. *Pulvinulina arca* Cushman, n. sp. X 65.  
 a, dorsal view; b, ventral view; c, peripheral view.
- FIGS. 2 a, b. *Truncatulina excolata* Cushman, n. sp. X 65.  
 a, dorsal view; b, peripheral view.
- FIG. 3. *Cornuspira cretacea* Reuss. X 50.
- FIG. 4. *Frondicularia archiaciana* d'Orbigny. X 45.
- FIG. 5. *Frondicularia baudouiniana* d'Orbigny. X 65.
- FIGS. 6 a-c. *Lamarckina rugulosa* Plummer, MS. X 65.  
 a, dorsal view; b, peripheral view; c, ventral view.





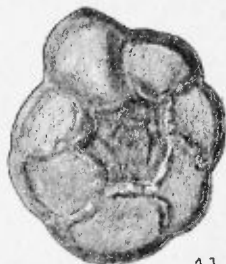
1a



1c



2b



1b



2a



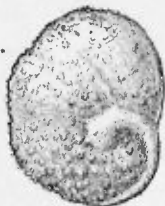
4



5



3



6a



6b



6c

## RECENT LITERATURE ON THE FORAMINIFERA

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

Yabe, H. and Hanzawa, S.

A *Lepidocyclina*-Limestone from Klias Peninsula, B. N. Borneo.

(Verhandl. Geol.-Mijn. Gen. Ned. Kol. Geol. Ser., vol. 8, 1925, pp. 617-632, pls. 1-4, 4 text figs.) *The Hague.*

A number of species and varieties of *Spiroclypeus* and *Lepidocyclina* are fully described and well illustrated by photographs of exteriors and sections as well as a few text figures. One new variety is described.

Yabe, H. and Hanzawa, S.

A *Lepidocyclina*-Limestone from Sangkoelirang, D. E. Borneo.

(Japanese Journ. Geol. Geog., vol. 3, 1924, pp. 71-76, pls. 9-12, 1 text fig.) *Tokyo.*

The several species from this limestone are illustrated by excellent plates from photographs of thin sections. Species of *Lepidocyclina*, *Miogypsina* and *Cycloclypeus* are included and described in detail.

Ellisor, A. C.

The Age and Correlation of the Chalk at White Cliffs, Arkansas, with Notes on the Subsurface Correlations of Northeast Texas.

(Bull. Amer. Assoc. Petr. Geol., vol. 9, 1925, pp. 1152-1164, pls. 20, 21.) *Chicago.*

Several lists of foraminifera are given from Texas localities. The plates give map and well sections.

Cushman, J. A.

Recent Foraminifera from Porto Rico.

(Publ. 344, Carnegie Inst. Washington, Feb. 1926, pp. 73-84, pl. 1.) *Washington.*

This paper records the results of a study of the shallow water foraminifera of several bottom samples especially from San Juan Harbor and comparison with other West Indian areas.

Cushman, J. A.

Foraminifera of the genera *Siphogenerina* and *Pavonina*.

(Proc. U. S. Nat. Mus., vol. 67, 1926, pp. 1-24, pls. 1-6.)

*Washington.*

This paper brings together what is known in regard to the species, both recent and fossil, of these two genera, with figures of most of the species except those already published in these Contributions.

Cushman, J. A. and Applin, E. R.

Texas Jackson Foraminifera.

(Bull. Amer. Assoc. Petr. Geol., vol. 10, 1926, pp. 154-89, pls. 5-10.)

*Chicago.*

The species of the Upper Eocene (Jackson) of Texas as they are found in surface outcrops and well samples are described and figured. Many of these are closely related to species which occur in the Jackson of the other portions of the Gulf Coastal Plain and in the Alazan of Mexico.

J. A. C.