CONTRIBUTIONS

FROM THE

CUSHMAN LABORATORY

FOR

FORAMINIFERAL RESEARCH

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SHARON, MASSACHUSETTS, U. S. A.

CONTENTS

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

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CONTRIBUTIONS FROM THE CUSHMAN LABORATORY FOR FORAMINIFERAL RESEARCH

13. NOTES ON THE GENUS CASSIDULINA

By JOSEPH A. CUSHMAN

While Mr. Donald D. Hughes and I were studying species of *Cassidulina* here at the laboratory, it became necessary to consult the original references of all the species of the genus. These references are all in my library here. As this work was of great use in the study of these species, it is here presented in outline for the guidance of others. There is often such a discrepancy between the figures given by later authors and the original type figure that the original must needs be seen and studied to determine what is meant by the author himself. It is also very valuable to know the type region of the species. Recent specimens referred to species described as fossils are often found to be different when type material is available. The species are here grouped by geologic periods, and the recent species by regions. Only the original reference is given with a copy of the type figure, and no attempt is here made to give a complete synonymy.

Genus CASSIDULINA d'Orbigny, 1826

Cassidulina d'Orbigny (type, *C. laevigata* d'Orbigny), Ann. Sci. Nat., vol. 7, 1826, p. 282.

Burseolina Seguenza, Atti Accad. Lincei, ser. 3, vol. 6, 1880, p. 138.

Text complex, at least the early portion coiled, the chambers arranged biserially, alternating on the sides of the axis of coiling, chambers usually extending to the umbilicus on the sides, in some species the later portion of the test uncoiling; wall calcareous, perforate, usually smooth and without ornamentation; chambers numerous, the sutures usually distinct; aperture looplike, modified in breadth and length in the different species.

The species are widely distributed in the present ocean, usually in fairly deep or cool water. The species seem to be fewer as

they go back into the geologic formations. Although there are records from the Cretaceous, the genus is most abundant from Miocene time to the present.

GENOTYPE

Cassidulina laevigata d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 282, pl. 15, figs. 4, 5.

There is unfortunately no type locality for this species as it was described from ship's ballast, the source of which is unknown. (Pl. 8, figs. 1, 2.)

SPECIES, WITH TYPES FROM THE EASTERN ATLANTIC

Cassidulina bradyi Norman, in Wright, Proc. Belfast Nat. Field Club, 1880, Appendix, p. 152.

The first actual figures are given by Brady in the Challenger Report, pl. 54, figs. 6-10. Of these, figs. 6-9 are from *Porcupine* station 3, off Ireland; fig. 10 probably from a Pacific specimen not this species. (Pl. 8, figs. 3-5.) Norman's originals were from "Estuarine Clay," at Limarady Junction, Northeast Ireland.

C. bradyi Norman, var. *stenostegica* Goes, Kongl. Svensk, Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 44, pl. 8, fig. 427.

Types from Baltic Sea and Coast of Norway, 180-360 meters. (Pl. 8, fig. 6.)

C. obtusa Williamson, Recent British Foraminifera, 1858, p. 69, pl. 6, figs. 143, 144.

Types from Shetland (abundant), Fowey, Bixham, Hunde Island, Davis Strait. (Pl. 8, figs. 7, 8.)

SPECIES, WITH TYPES FROM THE WESTERN ATLANTIC

Cassidulina braziliensis Cushman, Bull. 104, U. S. Nat. Mus., pt. 3, 1922, p. 130, pl. 25, figs. 4, 5.

Types from off the coast of Brazil, 417 fathoms. (Pl. 8, figs. 9, 10.)

C. laevigata d'Orbigny, var. *carinata* Cushman, Bull. 104, U. S. Nat. Mus., pt. 3, 1922, p. 124, pl. 25, figs. 6, 7.

Types from off Ragged Key, Florida, 75 fathoms. (Pl. 8, figs. 11, 12.)

C. mexicana Cushman, Bull. 104, U. S. Nat. Mus., pt. 3, 1922, p. 131, pl. 24, fig. 5.

Types from off Bell, Fowey Rocks, Florida, 22 fathoms. (Pl. 8, fig.13.)

SPECIES, WITH TYPES FROM THE MEDITERRANEAN

Cassidulina bradyi Norman, var. *elongata* Sidebottom, Mem. Proc. Manchester Lit. Philos. Soc., vol. 49, No. 5, 1905, p. 17, pl. 3, fig. 11.

Types from off the Island of Delos, 8-14 fathoms. (Pl. 8, figs. 14, 15.)

SPECIES, WITH TYPES FROM THE PACIFIC

Cassidulina bradyi Norman, var. *attenuata* Chapman, Journ. Linn. Soc. Zool., vol. 30, 1910, p. 406, pl. 54, fig. 4.

Types from off Funafuti, 2400 fathoms. (Pl. 8, fig. 16.)

C. charlottensis Cushman, Contrib. Cushman Lab. Foram. Research, vol. 1, pt. 2, 1925, p. 41, pl. 6, figs. 6, 7.

Types from Queen Charlotte Sound, British Columbia, 20-25 fathoms. (Pl. 8, figs. 17, 18.)

C. clavata H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 432, pl. 113, fig. 9.

Types from Nares Harbor, Admiralty Islands, 17 fathoms. (Pl. 8, fig. 19.)

C. decorata Sidebottom, Journ. Quekett Micr. Club, ser. 2, vol. 11, 1910, p. 107, pl. 4, figs. 2*a-c*.

Types from Southwest Pacific, 19°04′S.; 179°43′E.; 1,050 fathoms. (Pl. 8, figs. 20-22.)

C. elegans Sidebottom, Journ. Quekett Micr. Club, ser. 2, vol. 11, 1910, p. 106, pl. 4, figs. 1*a-c*.

Types from Southwest Pacific, 19°04′S.; 179°43′E.; 1,050 fathoms. (Pl. 8, figs. 23-25.)

C. elegantissima Cushman, Contrib. Cushman Lab. Foram. Research, vol. 1, pt. 2, 1925, p. 37, pl. 7, figs. 5*a, b*.

Types from North Pacific, 1,997 fathoms, between Midway Island and Guam. (Pl. 8, figs. 26, 27.)

C. orientale Cushman, Contrib. Cushman Lab. Foram. Research, vol. 1, pt. 2, 1925, p. 37, pl. 7, figs. 6*a-c*.

Types from south of Japan, 2,080 fathoms. (Pl. 8, figs. 28, 29.)

C. pacifica Cushman, new name. See note under *C. calabra* (Seguenza) below. (Pl. 9, figs. 14-16.)

C. parkeriana H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 59: Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 432, pl. 54, figs. 11-16.

Types from "amongst the Islands on the west coast of Patagonia", 45-175 fathoms. (Pl. 8, figs. 30, 33.)

C. pulchella d'Orbigny, Voy. Amèr. Mèrid., vol. 5, pt. 5, "Foraminifères", 1839, p. 57, pl. 8, figs. 1-3.

Types from the coast of Peru. (Pl. 8, figs. 34-36.)

SPECIES, WITH TYPES FROM THE ANTARCTIC

Cassidulina crassa d'Orbigny, Voy. Amér. Mérid., vol. 5, pt. 5, "Foraminifères," 1839, p. 56, pl. 7, figs. 18-20.

Types from Falkland Islands and Cape Horn. (Pl. 8, figs. 37-39.)

C. laevigata d'Orbigny, var. *tumida* Heron-Allen and Earland, Brit. Antarctic Exped., Zool., vol. 6, 1922, p. 138, pl. 5, figs. 36-38.

Types from off Three Kings Island, New Zealand, 90-300 fathoms. (Pl. 8, figs. 40-42.)

C. pupa d'Orbigny, Voy. Amér. Mérid., vol. 5, pt. 5, "Foraminifères," 1839, p. 57, pl. 7, figs. 21-23.

Types from Falkland Islands. -*Ehrenbergina.*

C. subglobosa H. B. Brady, var. *tuberculata* Heron-Allen and Earland, Brit. Antarctic Exped., Zool., vol. 6, 1922, p. 138, pl. 4, figs. 36-38.

Types from the Antarctic, 69°15'S.; 58°E.; 245 fathoms. (Pl. 8, figs. 43-45.)

SPECIES, WITH TYPE LOCALITY NOT DESIGNATED

Cassidulina subglobosa H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 60: Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 430, pl. 54, figs. 17*a–c*. (Pl. 8, figs. 48-50.)

SPECIES, WITH TYPES FROM PLEISTOCENE

Cassidulina sicula Seguenza, Atti Accad. Gioenia Sci. Nat., ser. 2, vol. 18, 1862, p. 111, pl. 1, figs. 7, 7*a*.

Types from Catania, Sicily. (Pl. 8, figs. 46, 47.)

C. subglobosa H. B. Brady, var. *quadrata* Cushman and Hughes, Contrib. Cushman Lab. Foram. Research, vol. 1, pt. 1, 1925, p. 15, pl. 2, figs. 7*a-c*.

Types from Lomita Quarry, Palos Verdes Hills, Los Angeles Co., California. (Pl. 9, figs. 1, 2.)

C. translucens Cushman and Hughes. Contrib. Cushman Lab. Foram. Research, vol. 1, pt. 1, 1925, p. 15, pl. 2, figs. 5*a-c*.

Types from Lomita Quarry, Palos Verdes Hills, Los Angeles Co., California. (Pl. 9, figs. 3, 4.)

SPECIES, WITH TYPES FROM PLIOCENE

Cassidulina californica Cushman and Hughes, Contrib. Cushman Lab. Foram. Research, vol. 1, pt. 1, 1925, p. 12, pl. 2, figs. 1*a–c*.

Types from Timms Point, San Pedro, California. (Pl. 9, figs. 5, 6.)

C. corbyi Cushman and Hughes, Contrib. Cushman Lab. Foram. Research, vol. 1, pt. 1, 1925, p. 14, pl. 2, figs. 3*a*, *b*.

Types from Ventura Co., California. (Pl. 9, figs. 9, 10.)

C. limbata Cushman and Hughes, Contrib. Cushman Lab. Foram. Research, vol. 1, pt. 1, 1925, p. 12, pl. 2, figs. 2*a-c*.

Types from Timms Point, San Pedro, California. (Pl. 9, figs. 7, 8.)

C. murrhyna (Schwager), *Sphaeroidina murrhyna* Schwager, *Novara* Exped., Geol. Theil, vol. 2, 1866, p. 250, pl. 7, fig. 97.

Types from Kar Nicobar. (Pl. 9, fig. 11.)

C. tortuosa Cushman and Hughes, Contrib. Cushman Lab. Foram. Research, vol. 1, pt. 1, 1925, p. 14, pl. 2, figs. 4*a-c*.

Types from Timms Point, San Pedro, California. (Pl. 9, figs. 12, 13.)

SPECIES, WITH TYPES FROM MIOCENE

Cassidulina alata Seguenza, Atti R. Accad. Lincei, ser. 3, vol. 6, 1880, p. 65, pl. 7, fig. 5.

Types from Reggio, Calabria, Italy. (Pl. 9, figs. 17, 18.)

C. calabra (Seguenza). *Burseolina calabra* Seguenza, Atti R. Accad. Lincei, ser. 3, vol. 6, 1880, p. 138, pl. 13, figs. 7*a*, *b*.

Types from Reggio, Calabria, Italy.

The original figures given by Seguenza does not at all resemble a *Cassidulina*. Brady had type material sent him for examination, and placed them under *Cassidulina* although Seguenza places his genus *Burseolina* between *Pullenia* and *Nonionina*, and his figures certainly resemble these. Brady refers material from the South Pacific to this species of Seguenza, and figures what is certainly a *Cassidulina* from this region. There are numerous other records based on Brady's figure in the *Challenger* Report, and these are all from the Pacific or Antarctic. It would seem, therefore, that the Pacific species is different from that of Seguenza, and might deserve a new name, which we will propose as *Cassidulina pacifica* Cushman, new name. (Pl. 9, figs. 14-16.) Brady's *Challenger* specimen figured, which has a different shape and certainly a very different aperture from that figured and described by Seguenza, may be taken as the type.

C. globulosa Egger, Neues Jahrb. für Min., 1857, p. 296, pl. 11, figs. 4-7.

Types from Bavaria. -Globigeriniidae.

C. oblonga Reuss, Denkschr. Akad. Wiss. Wien, vol. 1, 1850, p. 376, pl. 48, figs. 5, 6.

Types from Austria. (Pl. 9, figs. 19-22.)

C. punctata Reuss, Denkschr. Akad. Wiss. Wien, vol. 1, 1850, p. 376, pl. 48, fig. 4.

Types from Austria. (Pl. 9, figs. 23, 24.)

SPECIES, WITH TYPES FROM OLIGOCENE

Cassidulina margareta Karrer, Abhandl. k. k. geol. Reichs., vol. 9, 1877, p. 386, pl. 16*b*, fig. 52.

Types from Baden, Austria. (Pl. 9, figs. 29, 30.)

SPECIES, WITH TYPES FROM EOCENE

Cassidulina globosa Hantken, A. magy. kir. földt. int. evkoyve, vol. 4, 1875 (1876), p. 54, pl. 16, fig. 2.

Types from Austria Hungary. (Pl. 9, figs. 25, 26.)

C. inexculta Franzenau, Math. Naturw. Bericht. aus Ungarn, vol. 7, 1889, p. 66, pl. 3, fig. 2.

Types from near Budapest. (Pl. 9, figs. 27, 28.) This very much resembles Seguenza's *Burseolina.*

EXPLANATION OF PLATES

PLATE 8

FIGS. 1, 2. *Cassidulina laevigata* d'Orbigny. (After d'Orbigny, 1826.)
FIGS. 3–5. *Cassidulina bradyi* Norman. (After H. B. Brady, 1884.)
FIG. 6. *Cassidulina bradyi* Norman, var. *stenostegica* Goës. (After Goës, 1894.)
FIGS. 7, 8. *Cassidulina obtusa* Williamson. (After Williamson, 1858.)
FIGS. 9, 10. *Cassidulina braziliensis* Cushman. (After Cushman, 1922.)
FIGS. 11, 12. *Cassidulina laevigata* d'Orbigny, var. *carinata* Cushman. (After Cushman, 1922.)
FIG. 13. *Cassidulina mexicana* Cushman. (After Cushman, 1922.)
FIGS. 14, 15. *Cassidulina bradyi* Norman, var. *elongata* Sidebottom. (After Sidebottom, 1905.)
FIG. 16. *Cassidulina bradyi* Norman, var. *attenuata* Chapman. (After Chapman, 1910.)
FIGS. 17, 18. *Cassidulina charlottensis* Cushman. (After Cushman, 1925.)
FIG. 19. *Cassidulina clavata* H. B. Brady. (After H. B. Brady, 1884.)
FIGS. 20–22. *Cassidulina decorata* Sidebottom. (After Sidebottom, 1910.)
FIGS. 23–25. *Cassidulina elegans* Sidebottom. (After Sidebottom, 1910.)
FIGS. 26, 27. *Cassidulina elegantissima* Cushman. (After Cushman, 1925.)
FIGS. 28, 29. *Cassidulina orientale* Cushman. (After Cushman, 1925.)
FIGS. 30–33. *Cassidulina parkeriana* H. B. Brady. (After H. B. Brady, 1884.)
FIGS. 34–36. *Cassidulina pulchella* d'Orbigny. (After d'Orbigny, 1839.)
FIGS. 37–39. *Cassidulina crassa* d'Orbigny. (After d'Orbigny, 1839.)
FIGS. 40–42. *Cassidulina laevigata* d'Orbigny, var. *tumida* Heron-Allen and Earland. (After Heron-Allen and Earland, 1922.)
FIGS. 43–45. *Cassidulina subglobosa* H. B. Brady, var. *tuberculata* Heron-Allen and Earland. (After Heron-Allen and Earland, 1922.)
FIGS. 46, 47. *Cassidulina sicula* Seguenza. (After Seguenza, 1862.)
FIGS. 48–50. *Cassidulina subglobosa* H. B. Brady. (After H. B. Brady, 1884.)

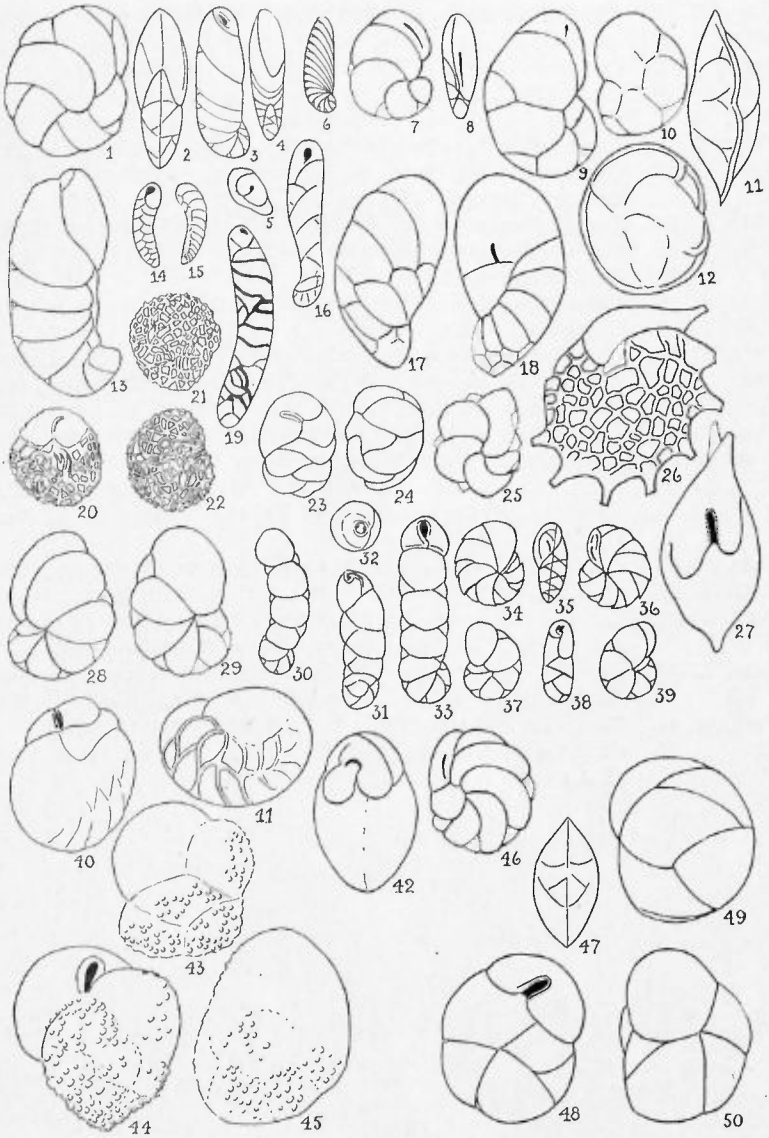


PLATE 9

FIGS. 1, 2, *Cassidulina subglobosa* H. B. Brady, var. *quadrata* Cushman and Hughes. (After Cushman and Hughes, 1925.)

FIGS. 3, 4. *Cassidulina translucens* Cushman and Hughes. (After Cushman and Hughes, 1925.)

FIGS. 5, 6. *Cassidulina californica* Cushman and Hughes. (After Cushman and Hughes, 1925)

FIGS. 7, 8. *Cassidulina limbata* Cushman and Hughes. (After Cushman and Hughes, 1925.)

FIGS. 9, 10. *Cassidulina corbyi* Cushman and Hughes. (After Cushman and Hughes, 1925.)

FIG. 11. *Cassidulina murrhyna* (Schwager). (After Schwager, 1866.)

FIGS. 12, 13. *Cassidulina tortuosa* Cushman and Hughes. (After Cushman and Hughes, 1925.)

FIGS. 14–16. *Cassidulina pacifica* Cushman, new name. (After H. B. Brady, 1884.)

FIGS. 17, 18. *Cassidulina alata* Seguenza. (After Seguenza, 1880.)

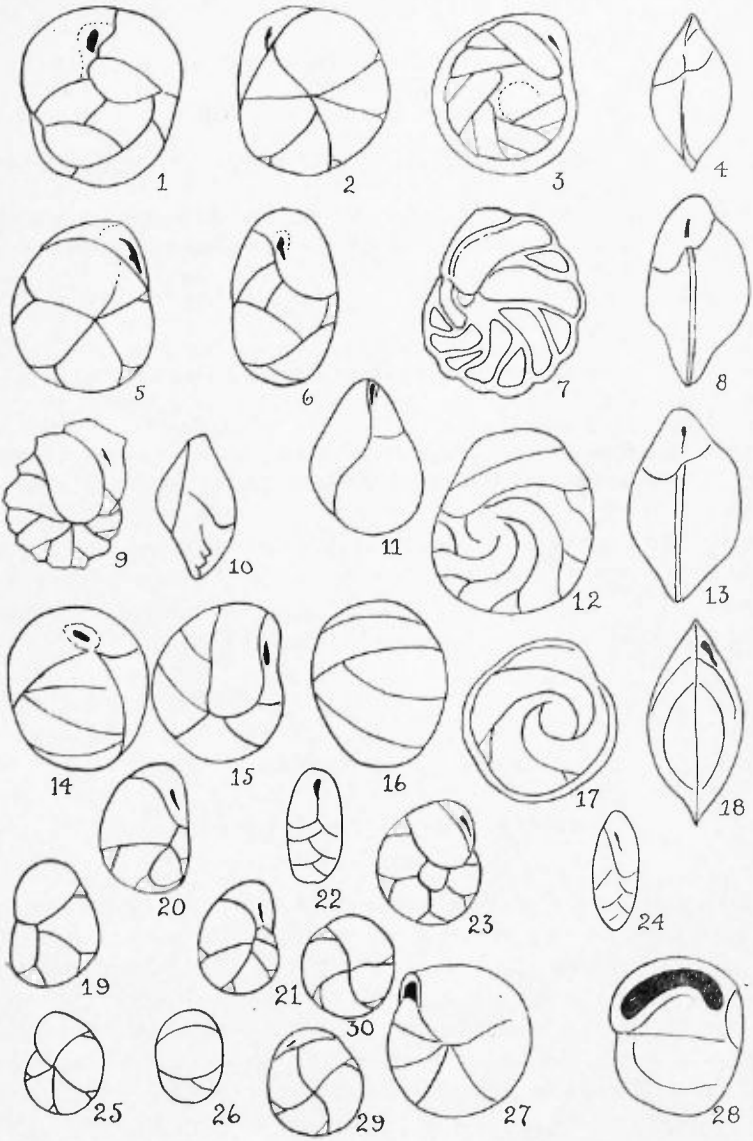
FIGS. 19–22. *Cassidulina oblonga* Reuss. (After Reuss, 1850.)

FIGS. 23, 24. *Cassidulina punctata* Reuss. (After Reuss, 1850.)

FIGS. 25, 26. *Cassidulina globosa* Hantken. (After Hantken, 1876.)

FIGS. 27, 28. *Cassidulina inexculta* Franzenau. (After Franzenau, 1889.)

FIGS. 29, 30. *Cassidulina margareta* Karrer. (After Karrer, 1877.)



14. MEXICAN SPECIES OF MARGINULINA

By JOSEPH A. CUSHMAN

There are a few species of *Marginulina* in the Oligocene and Eocene of the Coastal Plain of Mexico, which are of especial interest in that they do not as a rule occur together, but are distinctive of rather definite horizons. A study of these shows that two of them at least are new, and the other has interesting relationships to European species. They may be classed as follows:

MARGINULINA MEXICANA Cushman, n. sp.

Plate 10, figs. 1*a*, *b*

Test elongate, compressed, especially in the earlier portion, early chambers close coiled, but soon becoming uncoiled, and the last two or three uniserial; chambers indistinct in the earlier portion, later ones becoming more distinct, inflated; sutures depressed; surface ornamented with a few sharp longitudinal costae, 10-12 in number, the last-formed chamber sometimes with more; aperture with a definite constricted neck.

Length up to 1 mm.

Type specimen (U. S. N. M. Coll. No. 353679), from San Rafael formation, Huasteca R. R., km. post 9, 0.8 kms. east of Big Cut, Mexico, collected by T. Wayland Vaughan.

MARGINULINA PULCHRA Cushman, n. sp.

Plate 10, figs. 2*a*, *b*

Test elongate, tapering, consisting of 7 or 8 chambers, the earliest very slightly compressed in the microspheric form, subglobular in the megalospheric, the first 3 or 4 chambers in an arcuate curve, later ones straight, subglobular in form; sutures deeply depressed; wall ornamented with high, thin longitudinal costae, 13-15 in the later chambers, the basal angle of each costa sometimes produced and spinelike; aperture with a short slender cylindrical neck with annular costae and a slight lip.

Length up to 1 mm.

Type specimen (U. S. N. M. Coll. No. 353680), from southwest slope of Cuesta Blanca, near Zacamixtle, Vera Cruz, Mexico, collected by T. Wayland Vaughan.

This is very distinct from the preceding species in the more

inflated, less compressed form, the larger number of costae, and much more distinct chambers. It is more tapering and the costae different from the figures Halkyard gives of *Marginulina brehmi* (Reuss), from the Upper Eocene of Biarritz (Mem. Pros. Manchester Lit. Philos. Soc., vol. 62, pt. 2, 1919, p. 85, pl. 5, figs. 3, 4), but has a distinct resemblance.

MARGINULINA SUBBULLATA Hantken

Plate 10, figs. 3*a*, *b*

Marginulina subbullata HANTKEN, Amagy. kir. földt. int. évkön, vol. 4, 1875 (1876), p. 39, pl. 4, figs. 9, 10; pl. 5, fig. 9.

Test subcylindrical, the initial end broadly rounded, the first three chambers arranged in a loose coil, later two or three uniserial; chambers few, inflated; sutures distinct and depressed; wall smooth and polished; apertural end produced with a small tapering neck and radiate aperture.

Length up to 0.75 mm.

This few-chambered inflated form very closely resembles that described and figured by Hantken from the Upper Eocene of Central Europe. It also somewhat resembles *Marginulina pachygaster* described by Gümbel from the Upper Eocene of Bavaria, but the chambers of the Mexican specimens are identical with those of Hantken's species whereas those of Gümbel are more elongate. The early chambers also are identical with Hantken's figures.

The Mexican specimens are from Rio Buena Vista, 2 kms. in a straight line above its confluence with Rio Tuxpan, Vera Cruz, Mexico, collected by T. Wayland Vaughan.

15. NOTES ON THE GENUS TRITAXILINA

By JOSEPH A. CUSHMAN

In 1911 I erected the genus *Tritaxilina* for the species described by H. B. Brady as *Tritaxia caperata* (earlier *Clavulina caperata*). The form of the test, in general fusiform, with an early triserial arrangement of the chambers, later biserial and finally uniserial, as well as the labyrinthic form of the interior, all serve to separate it from *Tritaxia*. The Atlantic form was separated in 1922, and a fossil species is here described from the Upper Eocene of Mexico.

Genus TRITAXILINA Cushman, 1911

Clavulina (part) H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 54.

Tritaxia (part) H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 390.

Tritaxilina CUSHMAN (type, *T. caperata* (H. B. Brady)), Bull. 71, U. S. Nat. Mus., pt. 2, 1911, p. 71; Bull. 104, U. S. Nat. Mus., pt. 3, 1922, p. 79.

Test in its early development triserial, later becoming biserial, and in the adult typically uniserial; chambers numerous, distinct, interior labyrinthic; wall arenaceous; aperture in the triserial portion elongate with a valvular lip, at the edge of the inner side of the chamber, in the adult central, terminal, usually with a series of peripheral teeth projecting in and partially closing the opening.

The genus now includes the type species from the tropical Pacific, a recent species from the tropical Atlantic, and a fossil species from the Upper Eocene of Mexico.

TRITAXILINA CAPERATA (H. B. Brady)

Clavulina caperata H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 54.

Tritaxia caperata H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 390, pl. 49, figs. 1, 2, 4–7 (not fig. 3).

Tritaxilina caperata CUSHMAN, Bull. 71, U. S. Nat. Mus., pt. 2, 1911, p. 71, figs. 112, 113 (in text); Bull. 100, U. S. Nat. Mus., vol. 4, 1921, p. 153, pl. 28, figs. 4*a*, *b*.

Test fusiform, early portion triserial, roughly triangular in transverse section, the angles much rounded; later portion biserial or finally uniserial, circular in section, apical end somewhat pointed, apertural end truncate or broadly rounded; chambers numerous; the wall thick, of fine arenaceous material with pore canals, interior labyrinthic; outer surface of the test with a wrinkled appearance due to the thickening of the chamber wall just above the sutures; sutures distinct, depressed; aperture in the young as in *Verneuilina*, in the adult becoming terminal and central with a border of inwardly projecting teeth.

Length up to 2.25 mm.

The type specimens were from a *Challenger* station off the Philippines in 95 fathoms. In addition Brady had material from off Kandavu, Fiji Islands in 250 fathoms. I recorded the species from *Albatross* station 4781 in 482 fathoms in the North Pacific, and from five Philippine stations at depths ranging from 80 to 340 fathoms. Nothing further is known of the species.

TRITAXILINA ATLANTICA Cushman

Tritaxilina caperata H. B. BRADY (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 390, pl. 49, figs. 3*a*, *b* (not figs. 1, 2, 4–7).
Tritaxilina caperata (H. B. BRADY), var. *atlantica* CUSHMAN, Bull. 104, U. S. Nat. Mus., pt. 3, 1922, p. 79, pl. 15, figs. 1, 2.

Test rapidly increasing in diameter from the subacute base, the sides for the most part nearly parallel, slightly contracted toward the apertural end, early portion triserial, roughly triangular in transverse section, angles rounded; chambers fairly distinct; sutures slightly depressed; wall arenaceous, light yellowish brown; aperture of the triserial and biserial portions very small, subcircular at the inner margin of the apertural face.

Maximum length 1.75 mm.

Type specimens were from *Albatross* station D2150 in 382 fathoms in the Caribbean Sea. Brady's records from *Challenger* stations 23, in 450 fathoms, and 24, in 390 fathoms, off the Leeward Islands, are in the same vicinity. From the *Challenger* material from station 23, figure 3 of plate 49 was drawn. It is typical *Tritaxilina atlantica*. Outside of its occurrence at these three closely adjacent stations nothing is known of this species which cannot be mistaken for the one of the tropical Pacific.

TRITAXILINA MEXICANA Cushman, n. sp.

Plate 10, fig. 4

Test somewhat fusiform, the sides of the median portion nearly parallel, thence converging toward the truncate apertural end, early portion triserial, the biserial portion making up most of the test; chambers numerous, fairly distinct; wall arenaceous; sutures only slightly depressed; aperture rounded, fairly large, becoming somewhat terminal in the adult.

Length up to nearly 3 mm.

Type specimen (U. S. N. M. Coll. No. 353681), from Rio Buena Vista, just south of crossing of Alazan to Moyutla road, Vera Cruz, Mexico, collected by T. Wayland Vaughan.

This is the first occurrence of the genus in the fossil state. The Mexican species may well be the ancestral form of the other two as it holds the characters of both. The general form is somewhat intermediate, being more fusiform than the Atlantic species, but less elongate fusiform than the Pacific one. Its surface appearance is more like *T. atlantica*, the chambers not so indistinct but much less so than in *T. caperata*. The thickening of the basal portion of the chambers is also intermediate between the two. *Tritaxilina mexicana* is associated with species known from the Eocene of America and Europe.

One of the interesting things about *Tritaxilina* is its known distribution in the tropical Atlantic and Pacific, and in the Eocene of a tropical region. With it in all these regions is associated *Bigenerina pennatula* Batsch or a closely allied species. A similar form occurs in Mexico associated with *Tritaxilina mexicana*. *Bigenerina pennatula* is recorded from Albatross D2150, the type locality of *Tritaxilina atlantica*, and also from D5318 from a Philippine station from which *T. caperata* is recorded. The group represented by *Bigenerina pennatula* (Batsch) and *B. capreolus* (d'Orbigny) has a very interesting geologic history and recent distribution, and will be discussed in another paper.

16. EOCENE FORAMINIFERA FROM THE COCOA SAND OF ALABAMA

By JOSEPH A. CUSHMAN

The Cocoa sand, which occurs in its typical form at Cocoa Post Office, Alabama, contains an abundance of foraminifera. It is of Upper Eocene, Jackson, age, and has many species of foraminifera which are widely distributed in the Upper Eocene of the general Gulf Coastal Plain, extending through the Jackson of Texas into the Alazan and Tantoyuca formations of Mexico. Excellent material of this Upper Eocene of Cocoa Post Office was placed in my hands for study by Dr. R. S. Bassler of the U. S. National Museum. Some of the species are closely related to or identical with those of the Upper Eocene of Europe. A few of the species are described here.

BULIMINA JACKSONENSIS Cushman

Bulimina jacksonensis CUSHMAN, Contrib. Cushman Lab. Foram. Res., vol. 1, pt. 1, 1925, p. 6, pl. 1, figs. 6, 7.

This species already described from the Tantoyuca formation of the Upper Eocene of Mexico is abundant in the Upper Eocene of the United States, and occurs in the material from Cocoa Post Office.

NODOSARIA COCOAENSIS Cushman, n. sp.

Plate 10, figs. 5, 6

Test elongate, very slender, slightly curved, gradually tapering from the acute or spinose initial end, early portions with the sides straight, toward the apertural end with the chambers slightly inflated; chambers in the adult 11-14, in the very early portion only slightly longer than broad, becoming as much as 2½-3 times as long as broad in the last-formed ones; sutures very distinct, of clear shell material, but not depressed; wall very smooth, slightly glossy in well-preserved specimens; apertural end produced.

Maximum length 2.25 mm.; maximum breadth 0.20 mm.

Type specimens (U. S. N. M. Coll. No. 353682), from Cocoa Post Office, Alabama.

This species is allied to *Nodosaria filiformis* d'Orbigny, and other species. It is very close to Hantken's figure of *Dentalina consobrina* d'Orbigny from the Eocene of the *Clavulina szaboi* beds of Hungary, but the early portion is different. It is also close to the recent material figured by Flint from off the Coast of the United States as *Nodosaria filiformis*.

NODOSARIA LATEJUGATA Gümbel

Plate 10, fig. 7

Nodosaria latejugata GÜMBEL, Abh. kön. bay. Akad. Wiss. München, vol. 10, 1868 (1870), p. 619, pl. 1, fig. 32.—Hantken, A. magy. kir. földt. int. evkön., vol. 4, 1875 (1876), p. 21, pl. 2, figs. 6*a–d*.

Nodosaria budensis HANTKEN, *l. c.*, p. 23, pl. 2, fig. 10; pl. 16, fig. 4.

Length of American specimens up to 8 mm.; breadth 0.5 mm.

Gümbel originally described this species from the Upper Eocene of Bavaria, and Hantken figures it from the Upper Eocene of Hungary. Our American Upper Eocene specimens are very similar except that the microspheric form also occurs. It belongs to the general *Nodosaria raphanus* group, which occurs in many species from the Cretaceous onward.

It occurs at Cocoa Post Office, Alabama.

NODOSARIA FISSICOSTATA (Gümbel)

Plate 10, fig. 8

Dentalina fissicostata GÜMBEL, Abh. kön. bay. Akad. Wiss. München, vol. 10, 1868 (1870), p. 626, pl. 1, fig. 46.—Hantken, A. magy. kir. földt. int. evkön., vol. 4, 1875 (1876), p. 37, pl. 3, fig. 19.

Gümbel described this species from the Upper Eocene of Bavaria, and Hantken records it from the Eocene of Central

Europe and Italy with numerous localities. He gives as measurements, length 3-6 mm.; breadth of last chamber 0.6-1 mm. Our American specimens measure up to 6 mm. in length and 0.6 mm. in breadth. The specimens are easily broken, and complete specimens are rare.

It occurs at Cocoa Post Office, Alabama.

CRISTELLARIA GUTTICOSTATA (Gümbel), var. COCOAENSIS Cushman, n. var.

Plate 10, fig. 11

This variety is very beautifully developed, the beading very prominent with a group of large beads in the umbilical area, in the adults having the last-formed suture often without beads and slightly depressed.

This variety occurs in the Cocoa sand while the typical form occurs in other parts of the Upper Eocene.

Types of variety (U. S. N. M Coll. No. 353683), from Cocoa Post Office, Alabama.

MARGINULINA COCOAENSIS Cushman, n. sp.

Plate 10, figs. 9, 10

Test elongate, compressed, initial end composed of a few partially coiled chambers much compressed, later and major portions composed of 6-10 more rounded chambers; sutures fairly distinct, of clear shell material; ornamentation consisting of 9 or 11 lamellate costae running from the initial end to the base of the last-formed chamber in adults, the last chamber usually smooth in completely developed specimens, two of the costae forming keels on the compressed portion; aperture on the peripheral side of the apertural face; radiate, at the end of a distinct projection.

Maximum length 1.60 mm.; breadth 0.25 mm.

Types (U. S. N. M. Coll. No. 353684), from Cocoa Post Office, Alabama.

UVIGERINA JACKSONENSIS Cushman, n. sp.

Plate 10, fig. 13

Test large for the genus, stout, broadly fusiform, greatest width at the middle, periphery slightly lobulated; chambers few, inflated; sutures somewhat depressed, basal part of chamber not conspicuously overhanging, evenly curved; wall with coarse longitudinal costae, in the early portion usually limited to the individual chamber, in the later portion usually becoming con-

fluent with those of the chamber above and below, 18-22 costae in the complete circumference in the widest region; apertural end with a cylindrical neck of medium length and phialine lip.

Maximum length 0.90 mm.; breadth 0.45 mm.

Type specimen (U. S. N. M. Coll. No. 353685), from Cocoa Post Office, Alabama.

UVIGERINA COCOAENSIS Cushman, n. sp.

Plate 10, fig. 12

Test of medium size, elongate, fusiform, greatest width somewhat above the middle, periphery very slightly lobulate; chambers rather few, inflated, evenly rounded; sutures slightly depressed; wall with coarse longitudinal costae, not usually confluent with those of adjacent chambers, becoming lower and less conspicuous in later chambers, last-formed chamber in the adult usually smooth, 12-16 costae in the complete circumference in the widest region; apertural end with a short cylindrical neck and phialine lip.

Maximum length 0.80 mm.; breadth 0.30-0.35 mm.

Type specimen (U. S. N. M. Coll. No. 353686), from Cocoa Post Office, Alabama.

This species is nearest to *U. jacksonensis*, but is somewhat smaller, more slender, and has fewer costae.

HANTKENINA ALABAMENSIS Cushman

Hantkenina alabamensis CUSHMAN, Proc. U. S. Nat. Mus., vol. 66, 1924, p. 3, pl. 1, figs. 1–6; pl. 2, fig. 5; Contrib. Cushman Lab. Foram. Research, vol. 1, pt. 1, 1925, p. 7, pl. 1, fig. 11.

This species was originally described from this material from Cocoa Post Office, Alabama, where it is abundant. It is known from the Upper Eocene of Texas, and the Upper Eocene (Alazan) of Mexico.

EXPLANATION OF PLATE 10

FIGS. 1*a*, *b*. *Marginulina mexicana* Cushman, n. sp. *a*, front view; *b*, apertural view.

FIGS. 2*a*, *b*. *Marginulina pulchra* Cushman, n. sp. *a*, front view; *b*, apertural view.

FIGS. 3*a*, *b*. *Marginulina subbullata* Hantken. *a*, front view; *b*, apertural view.

FIG. 4. *Tritaxilina mexicana* Cushman, n. sp.

FIGS. 5, 6. *Nodosaria cocoaensis* Cushman, n. sp. 5, end of specimen, showing the apertural characters; 6, showing the initial end, apertural end broken.

FIG. 7. *Nodosaria latejugata* Gümbel.

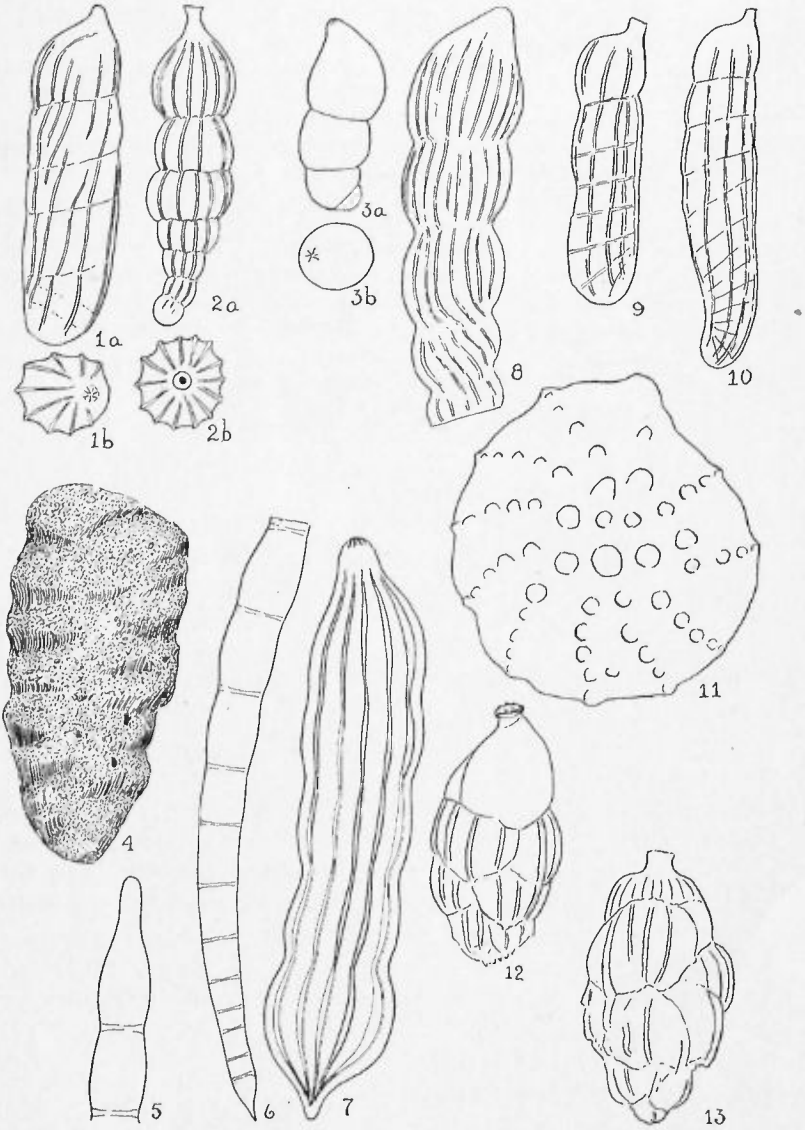
FIG. 8. *Nodosaria fissicostata* (Gümbel).

FIGS. 9, 10. *Marginlina cocoaensis* Cushman, n. sp. 9, megalospheric form; 10, microspheric form.

FIG. 11. *Cristellaria gutticostata* (Gümbel), var. *cocoaensis* Cushman. n. sp.

FIG. 12. *Uvigerina cocoaensis* Cushman, n. sp.

FIG. 13. *Uvigerina jacksonensis* Cushman, n. sp.



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.

Nummulitic Rocks of the Islands of Amakusa (Kyushu, Japan).

(Sci. Rep. Tohoku Imp. Univ., sec. ser. (Geol.), vol. 7, No. 3, 1925, pp. 73-82 (1-10), pls. 18-22 (1-5), 2 text figures.) *Sendai.*

An interesting Eocene foraminiferal fauna is described from these Japanese Islands. A new species of *Nummulites* is described, and the paper is illustrated by unusually beautiful plates from photographs.

Silvestri, A.

Sulla "Bradya tergestina" Stache.

Riv. Ital. Pal., Ann. 30, 1924, pp. 17-26, 1 plate. *Parma.*

Copious notes are given on this peculiar form, and a double plate of excellent sections.

Silvestri, A.

Sulle Ellissonodosarine della Molassa di Varano in Lombardia.

Atti Soc. Ital. Sci. Nat., vol. 64, 1925, pp. 49-60, text figs. 1-8. *Parvia.*

Notes are given on the foraminifera of this locality, and figures given of several of the Nodosarine forms.

Cushman, J. A.

An introduction to the Morphology and Classification of the Foraminifera.

Smithsonian Misc. Coll., vol. 77, No. 4, July 21, 1925, pp. 1-77, pls. 1-16, 11 text figures. *Washington.*

This paper is intended as an introduction to the study of this group, and to give to the beginner some of the necessary tools to use in the way of general hints, the general scheme of classification as found in recent works, and a fairly extensive bibliography. It is not intended to be exhaustive or to set forth new ideas.

Nuttall, W. L. F.

Indian Reticulate Nummulites.

Ann. Mag. Nat. Hist., ser. 9, vol. 15, June 1925, pp. 661-667, pls. 37, 38. *London.*

Several species of *Nummulites* from the Oligocene of India are figured and described. Two of the four species are new.

Thomas, E. T.

An Aid to the Study of Foraminifera.

Bull. Amer. Assoc. Petr. Geol., vol. 9, No. 3, May-June, 1925, pp. 667-669, 1 text figure. *Chicago.*

This paper describes a new form of slide, a combination of celluloid punched with numerous holes cemented to a glass slide by the use of acetone. These are used for filing species from a single station.

Rutten, L.

Some notes on Foraminifera from the Dutch Indies.

Proceedings, Kon. Akad. Wetenschappen Amsterdam, vol. 27, 1924, pp. 1-6, text figures 1-9. *Amsterdam.*

Figures of *Linderina* and *Lepidocyclina* are given with special reference to the embryonic chambers. The occurrence of various forms in the Dutch Indies is discussed.

Rutten, L.

Over de Foraminiferenfauna en den Ouderdom van Kalksteenen uit Zuid-Celebes, Afkomstig uit de Groep der Vischresten-berattende Gesteenten.

Verh. Jaarboek van het Mijnwezen in Ned. Oost-Indie, 1923 (1924), pp. 180-183, plate. *The Hague.*

Figures of *Spiroclypeus, Heterostegina* and *Lepidocyclina* are given, and a new species, *Lepidocyclina brouweri,* is described.

Ozawa, Y.

Palaeontological and Stratigraphical Studies in the Permo-Carboniferous Limestone of Nagato. Part II. Paleontology.

Journ. Coll. Sci. Imp. Univ. Tokyo, vol. 45, Art. 6, June, 1925, pp. 1-90, pls. 1-14. *Tokio.*

This is an important and well illustrated paper on the later Palaeozoic of Japan, in which 67 species and varieties are discussed with much detail and excellently figured. The family Fusulinidae is recognized, and a new classification given. A total of 21 new species and varieties are described.

Hofker, J.

On Heterogamy in Foraminifera.

Tijdschr. d. Ned. Dierk. Vereen, ser. 2, vol. 19, 1925, pp. 68-70. *The Hague.*

Notes are given on the cultivation of living foraminifera, and the life cycle. Several megalospheric generations followed in succession before a microspheric one developed.