

CONTRIBUTIONS FROM THE CUSHMAN LABORATORY FOR FORAMINIFERAL RESEARCH

247. A NEW SPECIES OF *DICTYOCONUS* FROM THE EOCENE OF CALIFORNIA

By J. A. CUSHMAN and A. S. CAMPBELL

DICTYOCONUS PARVULA Cushman and Campbell, n. sp. (Pl. 13, figs. 1a-c)

Test small for the genus, low conical in shape, the breadth $1\frac{2}{3}$ to 2 times the height, basal-face flattened, periphery subacute; chambers few, the last five making up about $\frac{3}{4}$ the height of the test and nearly all its volume, marginal trough rather wide for the size of the test; sutures mostly distinct, slightly thickened, flush with the surface; wall smooth; apertures fairly numerous, rather evenly placed on the ventral face. Diameter 0.40-0.55 mm.; height 0.20-0.30 mm.

Holotype (Cushman Coll. No. 39616) from the middle Eocene, 1600 feet stratigraphically above the top of the Cretaceous, probably representing the Capay stage, 175 feet NW. of bridge, creek bed at Muir Station, near Martinez, Contra Costa Co., California.

This is a very small species and composed of but relatively few chambers. The initial chambers do not stand out above the general surface in side view as in some species. The entire structure of the test, while evidently typical of the genus, is relatively simple.

It has been noted by Woodring that *Dictyoconus* and allied genera were probably tropical forms. From the occurrence of our species and its consistently small size it may be that this represents a subtropical species in a less favorable environment.

248. SOME FORAMINIFERA FROM THE DEVONIAN OF IOWA

By J. A. CUSHMAN and M. A. STAINBROOK

The Independence shale was first discovered near Independence, Iowa, in working out the basal beds of a quarry in Cedar Valley limestone. Sometime later a shaft sunk in search of coal passed through twenty feet of Cedar Valley limestone into sixteen feet of shale immediately below. Dr. S. Calvin, learning of the discovery, visited the quarry and shaft dump and secured a number of macrofossils. In 1877

he described the fossils, discussed and named the shale formation, and indicated its true position. With the exception of one outcrop noted by Dr. W. H. Norton, the Independence shale remained unknown for nearly forty years. Nearly thirty outcrops have lately been found which, with well records and deep well samples, give a fairly adequate idea of the position and extent of the formation. Stratigraphically it lies below the Cedar Valley and above the Wapsipinicon limestones. Its position is thus homologous with that of the "Hoing sand" of Illinois and of a sandstone near Hannibal, Missouri, just below the Calaway (Cedar Valley equivalent) and above Cooper (Davenport equivalent) lithographic limestone. In Missouri as in Iowa these two formations may be unconformably juxtaposed with the sandstone or shale missing.

Macrofossils, though not abundant, are well preserved and extensive search has yielded some seventy species. Brachiopods are the most numerous and are succeeded in importance by corals, echinoderms, and mollusks respectively. The fauna is clearly Upper Devonian in age and appears, as Cooper¹ intimated, to be the North American homologue of the *Cuboides fauna* (Frasnian F₂) which, in Europe, is at the base of the series. Although similar in general aspect to the fauna of the Lime Creek (Hackberry) stage several hundred feet above, a recent study of the Independence macrofauna by the junior author shows that the faunas are different with few species in common.

Microfossils are especially abundant in the shale as nearly all outcrops yield many specimens on careful washing and sieving. Ostracodes predominate, are well preserved, and occur in all localities. Conodonts are less common but are secured from most outcrops. Foraminifera generally are rare and are obtained only after thorough search of washed residues. Two localities have yielded most of the study material. The number of foraminifera varies inversely with that of the conodonts. One locality affording conodonts by the hundred has as yet not given up a single foraminifer. Strata yielding many foraminifera have few conodonts.

Mr. and Mrs. Charles A. Renfroe, through long and patient labor, collected the majority of the study specimens and their assistance is gratefully acknowledged.

¹Cooper, G. A., Bull. Geol. Soc. Amer., vol. 53, 1942, p. 1767.

All of the study material was secured from surface exposures at these localities:

Harger's Spring—a spring on the right bank of the Cedar River in Benton County, three miles south and two miles west of Urbana, Iowa.

Wapsie No. 1—a spring on the east bank of the Wapsipinicon River in Buchanan County, two miles north and one-half mile west of Quasqueton, Iowa.

Brandon No. 3—two miles south and one mile west of Brandon, Iowa, on the east bank of Cedar River in Benton County.

Amana No. 1—road cut along north side of State highway between Middle and High Amana, Iowa County, Iowa.

Lafayette—east bank of creek one-half mile northeast of Lafayette, Linn County, Iowa.

The foraminifera described here are in some cases very excellently preserved as to detailed structure and in others much less so. A few species may be definitely described and named while others are uncertain as to species and some even to the genus. Three of the species, *Lituotuba dubia* Miller and Carmer, *Semitextularia thomasi* Miller and Carmer, and *Endothyra gallowayi* Thomas, have already been recorded from the Devonian of Iowa.

So far as they can be determined from available material the following forms occur in the Independence shale:

Family ASTRORHIZIDAE

Genus RHABDAMMINA M. Sars, 1869

RHABDAMMINA sp. (Pl. 13, figs. 2-4)

Broken specimens of a species which may be placed under *Rhabdammina* occur in the material from Harger's Spring. They are broken but consist of an undivided tubular chamber, the wall on the exterior composed of fine and rather evenly sized grains. Only a few specimens were found and these do not give enough details to warrant a specific identity for them.

Family SACCAMMINIDAE

Genus SACCAMMINA M. Sars, 1869

SACCAMMINA (?) sp. (Pl. 13, figs. 5-7)

Small specimens, generally subspherical in shape with one or more protuberances that suggest apertures, occur in considerable numbers

in the Harger's Spring material. These may possibly belong under *Thurammina* but the details of structure are not well marked.

Genus **PROTEONINA** Williamson, 1858

PROTEONINA PSEUDOSPIRALIS Cushman and Stainbrook, n. sp. (Pl. 13, figs. 8-13)

Test rounded, somewhat compressed, with a short apertural neck at one side giving a spiral appearance to the test; interior apparently not divided; wall rather coarsely arenaceous; aperture at the end of the compressed tubular neck. Length of holotype, 0.55 mm.; breadth 0.38 mm.; thickness 0.12 mm.

Holotype (Cushman Coll. No. 39465) from the Devonian, Independence shale, Harger's Spring, on right bank of Cedar River, 3 miles S. and 2 miles W. of Urbana, Benton Co., Iowa.

Specimens with the wall intact are not nearly as common as the forms which seem to be internal molds. These as figured (Pl. 13, figs. 12, 13) are very flat with a projection at one side in such a position as to indicate a spiral and the end representing the aperture slightly enlarged. Such forms are common in the material with the complete tests at the type locality and occur also at the Lafayette, Wapsie No. 1, Amana No. 1, and Brandon No. 3 exposures. From the abundance of specimens this should be a good index fossil for the Independence shale.

Family **HYPERAMMINIDAE**

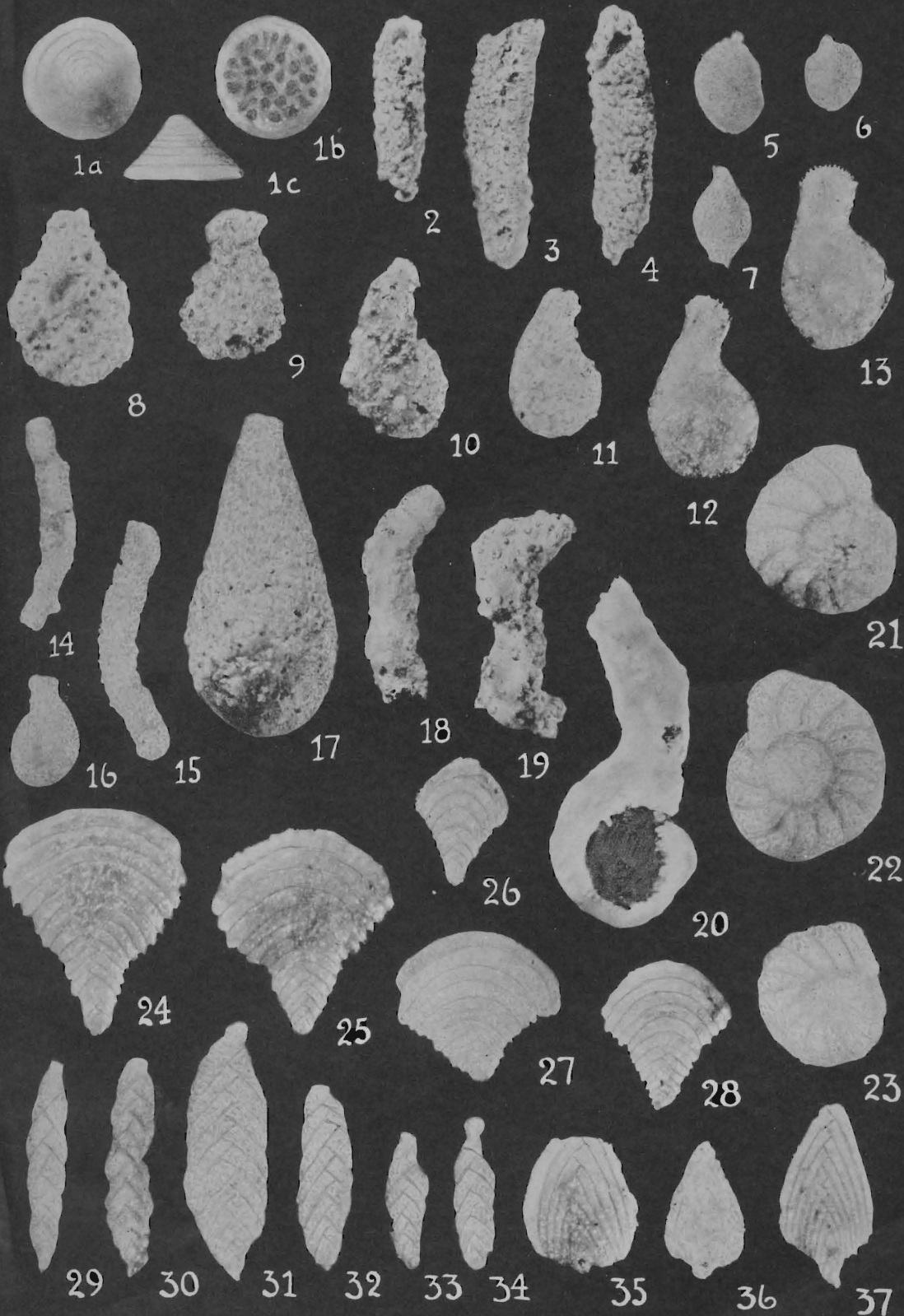
Genus **HYPERAMMINA** H. B. Brady, 1878

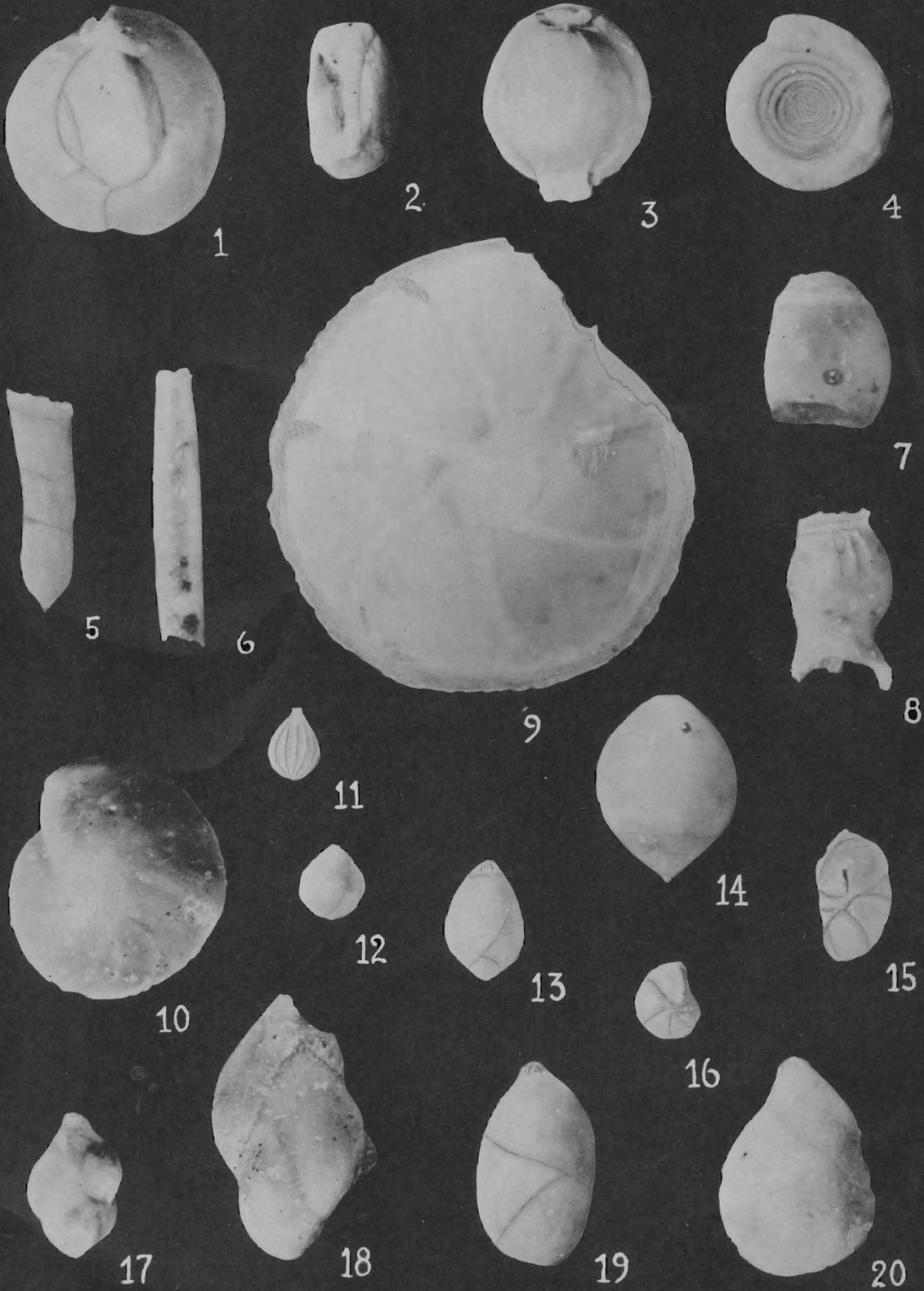
HYPERAMMINA (?) sp. (Pl. 13, figs. 14-17)

Tubular specimens with a rather coarsely arenaceous exterior may belong to this genus. They are from Wapsie No. 1 and Amana No. 1 localities. All of the specimens have the ends broken and one cannot be sure as to the generic position.

EXPLANATION OF PLATE 13

FIG. 1. *Dictyoconus parvula* Cushman and Campbell, n. sp. *a*, dorsal view; *b*, ventral view; *c*, peripheral view. $\times 50$. 2-4. *Rhabdammina* sp. $\times 25$. 5-7. *Saccammina* (?) sp. $\times 50$. 8-13. *Proteonina pseudospiralis* Cushman and Stainbrook, n. sp. $\times 50$. 8, Holotype. 9-13, Paratypes. 12, 13, Probably internal casts. 14-17. *Hyperammina* (?) sp. 14-16, $\times 50$. 17, $\times 25$. 14, 15, Tubular portions. 16, Proloculum. 17, Proloculum, possibly of megalospheric form. 18-20. *Lituotuba dubia* Miller and Carmer. 18, 19, Tubular portions. $\times 25$. 20, early coiled portion. $\times 50$. 21-23. *Endothyra galloswayi* Thomas. $\times 50$. 24-28. *Semitextularia thomasi* Miller and Carmer. $\times 50$. 29-34. *Textularia* (?) *proboscidea* Cushman and Stainbrook, n. sp. $\times 50$. 29, Holotype. 30-34, Paratypes. 35-37. *Pseudopalmula palmuloides* Cushman and Stainbrook, n. gen., n. sp. $\times 50$. 35, Holotype. 36, 37, Paratypes.





Family AMMODISCIDAE

Genus LITUOTUBA Rhumbler, 1895

LITUOTUBA DUBIA Miller and Carmer (Pl. 13, figs. 18-20)

Lituotuba dubia MILLER and CARMER, Journ. Pal., vol. 7, 1933, p. 430, pl. 50, figs. 11a-c.

A single specimen (Pl. 13, fig. 20) is evidently identical with that described in the reference above. Other tubular forms found with this may be broken portions of the same species. The types are from the Devonian of Iowa.

Family LITUOLIDAE

Genus ENDOTHYRA Phillips, 1846

ENDOTHYRA GALLOWAYI Thomas (Pl. 13, figs. 21-23)

Rotaline foraminifer THOMAS, Bull. Geol. Soc. Amer., vol. 32, 1921, p. 131.

Endothyra sp. THOMAS, Proc. Iowa Acad. Sci., vol. 36, 1930, p. 279.*Endothyra gallowayi* THOMAS, Journ. Pal., vol. 5, 1931, p. 40, pl. 7, figs. 1-9.—MILLER and CARMER, l. c., vol. 7, 1933, p. 427.

Our specimens have been compared with topotypes from the Devonian of Birds Hill, 4 miles SW. of Rockford, Iowa, and appear to be identical. We have specimens from the Independence shale from the Lafayette, Wapsie No. 1, and Brandon No. 3 localities.

Family TEXTULARIIDAE

Genus SEMITEXTULARIA Miller and Carmer, 1933

SEMITEXTULARIA THOMASI Miller and Carmer (Pl. 13, figs. 24-28)

Semitextularia thomasi MILLER and CARMER, Journ. Pal., vol. 7, 1933, p. 429, pl. 50, figs. 10a-e.—CUSHMAN, Foraminifera, their classification and economic use, 3rd Ed., 1940, pl. 42, figs. 22a-c.

The types of this species are from the Devonian, *Devonocidaris jacksoni* zonule, near middle of Cerro Gordo member of the Hackberry, Birds Hill, 4 miles SW. of Rockford, Iowa. Our figured specimens are from the Independence shale, Harger's Spring, Iowa, and are apparently identical. Some of the specimens represent young stages and have

EXPLANATION OF PLATE 14

FIG. 1. *Quinqueloculina imperialis* G. D. and M. A. Hanna. × 35. 2. *Q.* sp. × 55. 3. *Pyrgo* cf. *inornata* (d'Orbigny). × 35. 4. *Cornuspira byramensis* Cushman. × 35. 5, 7. *Dentalina* sp. A. × 55. 6. *Nodosaria* (?) sp. × 55. 8. *Dentalina* sp. B. × 55. 9. *Robulus* cf. *limbosus* (Reuss). × 35. 10. *R. articulatus* (Reuss), var. *texanus* (Cushman and Applin). × 35. 11. *Lagena* cf. *isabella* (d'Orbigny). × 55. 12. *Globulina gibba* d'Orbigny, juv. × 55. 13. *G.* cf. *ampulla* (Jones). × 55. 14. *Pseudoglandulina inflata* (Bornemann). × 55. 15. *Robertina angusta* (Cushman). × 55. 16. *Pullenia salisburyi* R. E. and K. C. Stewart. × 55. 17, 18. *Guttulina frankei* Cushman and Ozawa. × 35. 19. *Pyrrulina* cf. *fusiformis* (Roemer). × 35. 20. *Sigmomorphina cubensis* Cushman and Bermudez. × 35.

the apertures less numerous and in a narrower zone than in the adults. In the megalospheric form the coiled early stage is much reduced and the biserial stage is taken on very early in the development.

Genus *TEXTULARIA* DeFrance, 1824

TEXTULARIA (?) *PROBOSCIDEA* Cushman and Stainbrook, n. sp. (Pl. 13, figs. 29-34)

Test elongate, somewhat compressed, initial end subacute, biserial throughout; chambers distinct, increasing gradually in size as added, numerous, as many as ten pairs in the adult; sutures distinct, depressed, slightly curved; wall smooth in the early stages but in later development the inner portions become irregularly pustulose, especially in the broader specimens; aperture in the adult becoming terminal, rounded, occasionally with a short tubular neck. Length 0.45-0.75 mm.; breadth 0.12-0.25 mm.; thickness 0.08-0.12 mm.

Holotype (Cushman Coll. No. 39482) from the Devonian, Independence shale, Harger's Spring, on right bank of Cedar River, 3 miles S. and 2 miles W. of Urbana, Benton Co., Iowa.

The generic position of this species is in doubt. None of the numerous specimens appears to have a coiled early stage. The adult stage is similar to *Textularia* except in the apertural characters. The terminal aperture reminds one of that of *Loxostomum* in the Buliminidae.

Genus *PSEUDOPALMULA* Cushman and Stainbrook, new genus

Genotype: *Pseudopalmula palmuloides* CUSHMAN and STAINBROOK, n. sp.

Test in the earliest stages elongate and irregularly biserial, later much compressed and triangular; chambers biserial throughout, the later ones in the adult becoming much elongate, reaching backward nearly to the base of the test; wall finely arenaceous; aperture in the adult slightly elongate at one side of the apertural tip of the test, on the narrow edge.

This at first glance appears like *Palmula* in the Lagenidae but the wall is arenaceous and the test is biserial.

PSEUDOPALMULA PALMULOIDES Cushman and Stainbrook, n. sp. (Pl. 13, figs. 35-37)

Test much compressed, roughly triangular in outline with the initial end more or less extended; chambers distinct, earlier ones irregularly biserial making an elongate rhomboid test, in the adult regularly biserial, very narrow, elongate, slightly curved, extending from the apical end back to the broad base of the initial end; sutures distinct, very slightly depressed, slightly curved in the adult; wall finely arenaceous,

fairly smoothly finished; aperture in the adult nearly terminal, narrow, on the inner side of the end of the last-formed chamber. Length 0.40-0.50 mm.; breadth 0.25-0.35 mm.; thickness 0.07 mm.

Holotype (Cushman Coll. No. 39488) from the Devonian, Independence shale, exposure at a spring on east bank of Wapsipinicon River, 2 miles N. and ½ mile W. of Quasqueton, Buchanan Co., Iowa. It also occurs at the Amana No. 1 locality.

This is a peculiar form evidently belonging in the Textulariidae.

249. FORAMINIFERA FROM THE TYPE AREA OF THE LINCOLN FORMATION (OLIGOCENE) OF WASHINGTON STATE

BY JOSEPH A. CUSHMAN and DON L. FRIZZELL

The Lincoln formation of the State of Washington usually is placed in the Oligocene, and is currently included in the Refugian stage (Schenck and Kleinpell, 1936; Kleinpell, 1938). A detailed account of the stratigraphy has been published by Weaver (1937).

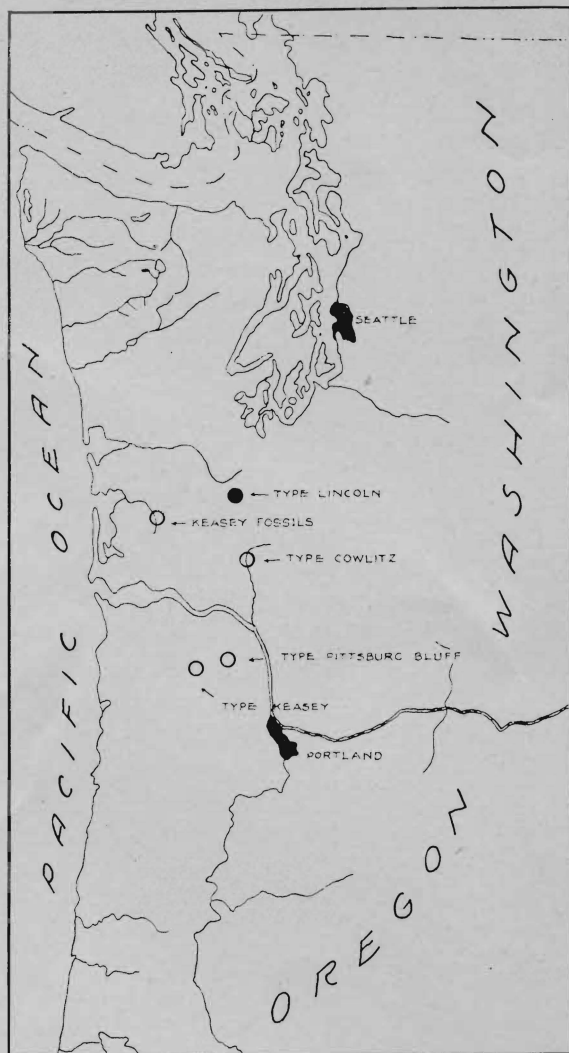
A small but well preserved foraminiferal assemblage was collected in the type area of the formation by the junior author in 1930 (Frizzell and Blackwelder, 1933; Cushman and Frizzell, 1940). This faunule was directly associated with well preserved mollusks, so may serve as an aid in correlating the results of molluscan paleontology with microfaunal zones. The assemblage is believed to occur at a stratigraphic level approximately 300 feet below the contact of the Lincoln formation with the superjacent Blakely formation.

Preliminary work on the type Lincoln faunule was done by the junior author at Stanford University, in 1932, and continued in 1940 at the Cushman Laboratory for Foraminiferal Research. The guidance of Prof. Hubert G. Schenck, of Stanford University, and the assistance of Dr. Richard E. Blackwelder, now of the U. S. National Museum, is gratefully acknowledged.

The specimens figured in this report have been deposited in the Cushman Laboratory for Foraminiferal Research, Sharon, Massachusetts.

Locality description

Leland Stanford Junior University Locality 1167: Latitude 46° 45' North, Longitude 123° West; Lewis County, Washington; in the southeast quarter of section 27, Township 15 North, Range 3 West; cuts along the O.W.R.R. & N. Co. railroad, a quarter of a mile to the north



Sketch map of a portion of Oregon and Washington, showing the geographic relationships of Eocene and Oligocene fossil localities.

of the town of Galvin (formerly Lincoln Creek). The general position of the locality is illustrated in figure 1; details are shown by Weaver (1937, plate 6, opposite page 88).

These deposits consist of gray, tuffaceous siltstone, massive and slightly indurated. A thin section showed angular and fairly well sorted grains, with average size about 0.06 mm. and a few fragments from 0.45 to 0.9 mm. Approximately 80 percent of the material is volcanic. Glass and plagioclase are abundant, both somewhat altered, with chlorite less common. Fragments of quartz, titanite, garnet, and basalt of detrital origin are present.

Associated mollusks

The following molluscan species are directly associated with the foraminiferal faunule. They have been identified by the junior author.

Pelecypoda

- Acila shumardi* Dall
- Crassatella washingtonensis* (Weaver)
- Glycymeris chehalisensis* Weaver
- "*Macrocallista*" sp. (immature)
- Nemocardium lorenzanum* (Arnold)
- Nuculana lincolnensis* (Weaver)
- Nuculana washingtonensis* (Weaver)
- Ostrea lincolnensis* Weaver
- Pitar dalli* (Weaver)
- Solen lincolnensis* Weaver

Scaphopoda

- Dentalium conradi* Dall

Gastropoda

- Acrilla lincolnensis* (Weaver)
- Acteon chehalisensis* (Weaver)
- Calyptraea washingtonensis* Weaver
- Exilia lincolnensis* Weaver
- Fusinus chehalisensis* (Weaver)
- Molopophorus lincolnensis* Weaver
- Polinices (Euspira) lincolnensis* (Weaver)
- Polinices (Euspira) washingtonensis* (Weaver)
- Scaphander washingtonensis* Weaver
- "*Strepsidura*" *lincolnensis* Weaver
- "*Strepsidura*" *washingtonensis* Weaver
- "*Turris*" *thurstonensis* Weaver
- Turritella porterensis* Weaver
- Whitneyella lincolnensis* (Van Winkle)

Environment of the faunule

The environment of the Lincoln formation has been considered tropical or subtropical, with a depth variously estimated from shore-line to 200 fathoms (Dickerson, 1917, p. 163; Clark and Arnold, 1918, p. 305; Smith, 1919, p. 162; Van Winkle, 1918, p. 77). Frizzell and Blackwelder (1933) concluded from the molluscan genera that the type Lincoln sediments were deposited in temperate marine water approximately 50 fathoms deep. The present authors believe that the foraminiferal assemblage, although small, confirms this interpretation.

The massive character of the tuffaceous siltstone in the area examined and the thickness of the formation, as well as the random occurrence of fossil mollusks, suggest a rapid rate of deposition.

Affinities of the Foraminifera

Those species which are most definitely identified indicate the middle Oligocene age of the Lincoln material. Other species are less well characterized or, with a lack of sufficient well preserved specimens, are identified with species hitherto known from the Eocene or Miocene.

SYSTEMATIC DESCRIPTIONS

Family MILIOLIDAE

Genus *QUINQUELOCULINA* d'Orbigny, 1826

QUINQUELOCULINA IMPERIALIS G. D. and M. A. Hanna (Pl. 14, fig. 1)

Quinqueloculina imperialis G. D. and M. A. HANNA, Univ. Washington Publ. Geol., vol. 1, No. 4, 1924, p. 58, pl. 13, figs. 7, 8, 10.

Moderately common specimens from the Lincoln locality agree closely with this species originally described from the Cowlitz Eocene of Washington.

QUINQUELOCULINA sp. (Pl. 14, fig. 2)

The broken specimen figured shows a *Quinqueloculina* with rather truncated ends. It is difficult to place this species without more adequate material. A second specimen at hand is considerably broken.

Genus *PYRGO* Defrance, 1824

PYRGO cf. *INORNATA* (d'Orbigny) (Pl. 14, fig. 3)

The specimen figured, although incomplete, resembles this species described by d'Orbigny (*Biloculina inornata* d'Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 266, pl. 16, figs. 7-9.) from the Miocene of the Vienna Basin and recorded from the Oligocene of Alabama (Cushman and McGlamery, U. S. Geol. Survey Prof. Paper 189-D,

1938, p. 104, pl. 24, figs. 6, 7.) and Mississippi (Howe and Wallace, Louisiana Geol. Bull. No. 2, 1932, p. 21.). The form is rare in the Lincoln formation.

Family OPHTHALMIDIIDAE

Genus CORNUSPIRA Schultze, 1854

CORNUSPIRA BYRAMENSIS Cushman (Pl. 14, fig. 4)

Cornuspira byramensis CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 11, 1935, p. 27, pl. 4, fig. 4.—CUSHMAN and GARRETT, l. c., vol. 15, 1939, p. 79, pl. 13, fig. 8.

Four specimens from the Lincoln material are identical in all visible characteristics with the types of this species from the Oligocene, Byram marl, of Mississippi. The species also has been recorded from the Wilcox Eocene of Woods Bluff, Alabama.

Family LAGENIDAE

Genus ROBULUS Montfort, 1808

ROBULUS ARTICULATUS (Reuss), var. TEXANUS (Cushman and Applin)
(Pl. 14, fig. 10)

Cristellaria articulata REUSS, var. *texana* CUSHMAN and APPLIN, Bull. Amer. Assoc. Petr. Geol., vol. 10, 1926, p. 170, pl. 8, figs. 1, 2.

Robulus articulatus (REUSS), var. *texanus* (CUSHMAN and APPLIN) Ellisor, l. c., vol. 17, No. 11, 1933, pl. 2, fig. 3.—CUSHMAN and DUSENBURY, Contr. Cushman Lab. Foram. Res., vol. 10, 1934, p. 53, pl. 7, figs. 2, 3.—CUSHMAN, U. S. Geol. Survey Prof. Paper 181, 1935, p. 16, pl. 4, figs. 16, 17.

Our specimens appear to be identical with this variety which is known to be rather widely distributed in the upper Eocene of the Gulf Coastal Plain region and California. The species is moderately rare in the Lincoln material.

ROBULUS cf. LIMBOSUS (Reuss) (Pl. 14, fig. 9)

Moderately common specimens from the Lincoln formation, with decided umbo and peripheral keel, resemble this species. *R. limbosus* (*Robulina limbosa* Reuss, Sitz. Akad. Wiss. Wien, vol. 48, pt. 1, 1863 (1864), p. 55, pl. 6, fig. 69; *Robulus limbosus* (Reuss) Cushman, U. S. Geol. Survey Prof. Paper 181, 1935, p. 16, pl. 6, fig. 5.) has been widely recorded in the upper Eocene and Oligocene.

Genus DENTALINA d'Orbigny, 1826

DENTALINA sp. A (Pl. 14, figs. 5, 7)

The figured specimen (fig. 5) is fragmentary, showing the first three chambers of a smooth species. No complete specimens were examined. The terminal chamber figured (fig. 7) may belong to the same species.

DENTALINA sp. B (Pl. 14, fig. 8)

A single chamber from the middle part of a *Dentalina*, or possibly an

Ellipsonodosaria, is figured for future reference and to record its occurrence.

Genus **NODOSARIA** Lamarck, 1812

NODOSARIA (?) sp. (Pl. 14, fig. 6)

An elongate chamber of a smooth form which may belong to *Nodosaria* is figured. It is similar to forms that have been referred variously to *N. exilis* Neugeboren (Denkschr. Akad. Wiss. Wien, vol. 12, 1856, p. 75.—Reuss, l. c., vol. 25, 1865, p. 130, pl. 2, fig. 17.), *N. arundinea* Schwager (*Novara-Exped.*, Geol. Theil, vol. 2, 1866, p. 211, pl. 5, figs. 43-45.), and other names. As some of these species, when complete, have been found to belong elsewhere than in *Nodosaria*, it is impossible to place such single chambers with any degree of certainty. The species is rare in the Lincoln material.

Genus **PSEUDOGLANDULINA** Cushman, 1929

PSEUDOGLANDULINA INFLATA (Bornemann) (Pl. 14, fig. 14)

Glandulina inflata BORNEMANN, Zeitschr. deutsch. geol. Ges., vol. 7, 1855, p. 320, pl. 12, figs. 6, 7.

The single specimen from the Lincoln formation appears to belong to Bornemann's species from the Oligocene of Germany.

Genus **LAGENA** Walker and Jacob, 1798

LAGENA cf. **ISABELLA** (d'Orbigny) (Pl. 14, fig. 11)

The very costate specimen figured agrees well with the figure of a Recent species described by d'Orbigny (*Oolina isabella* d'Orbigny, Voy. Amér. Mérid., vol. 5, pt. 5, "Foraminifères," 1839, p. 20, pl. 5, figs. 7, 8.) and also recorded by Reuss (*Lagena isabella* (d'Orbigny) Reuss, Sitz. Akad. Wiss. Wien, vol. 46, pt. 1, 1862, p. 330, pl. 4, figs. 55, 56.) from the Oligocene of Germany. The costae are high and plate-like and few in number. No additional specimens were found.

Family **POLYMORPHINIDAE**

Genus **GUTTULINA** d'Orbigny, 1839

GUTTULINA FRANKEI Cushman and Ozawa (Pl. 14, figs. 17, 18)

Polymorphina lactea WALKER and JACOB, var. *cuspidata* FRANKE, Abhandl. Ber. Mus. Naturw.-und-Heimatkunde und Nat. Ver., Bd. 4, Heft 2, 1925, p. 177, pl. 6, fig. 46b. (not *P. sororia* REUSS, var. *cuspidata* BRADY, 1884.)

Guttulina frankei CUSHMAN and OZAWA, Proc. U. S. Nat. Mus., vol. 77, Art. 6, 1930, p. 28, pl. 4, fig. 1.

Three specimens from the Lincoln formation are very similar to those described from the Oligocene of Germany.

Genus **GLOBULINA** d'Orbigny, 1839**GLOBULINA GIBBA** d'Orbigny (Pl. 14, fig. 12)

Globulina gibba D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 266, No. 20, Modèles No. 63.—CUSHMAN and OZAWA, Proc. U. S. Nat. Mus., vol. 77, Art. 6, 1930, p. 60, pl. 16, figs. 1-4.

A single young specimen found probably belongs to this common and widely ranging species.

GLOBULINA cf. **AMPULLA** (Jones) (Pl. 14, fig. 13)

The unique specimen figured is very close to figures of this species, largely known from the Eocene (*Polymorphina ampulla* Jones, Quart. Journ. Geol. Soc., vol. 8, 1852, p. 267, pl. 16, fig. 14; *Globulina ampulla* (Jones) Cushman and Ozawa, Proc. U. S. Nat. Mus., vol. 77, Art. 6, 1930, p. 79, pl. 19, fig. 9.)

Genus **PYRULINA** d'Orbigny, 1839**PYRULINA** cf. **FUSIFORMIS** (Roemer) (Pl. 14, fig. 19)

This is very close to some of the figures given by Cushman and Ozawa (Proc. U. S. Nat. Mus., vol. 77, Art. 6, 1930, p. 54, pl. 13, figs. 3-8.) of this species from the Oligocene of Germany. Three specimens were found in the Lincoln material.

Genus **SIGMOMORPHINA** Cushman and Ozawa, 1928**SIGMOMORPHINA CUBENSIS** Cushman and Bermudez (Pl. 14, fig. 20)

Sigmomorphina cubensis CUSHMAN and BERMUDEZ, Contr. Cushman Lab. Foram. Res., vol. 13, 1937, p. 12, pl. 1, fig. 41.

A specimen from the Lincoln formation, although slightly broken, appears to be identical with the holotype of this species described from the Eocene of Cuba. One mature and two immature specimens were found.

Family **HETEROHELICIDAE**Genus **PLECTOFRONDICULARIA** Liebus, 1903**PLECTOFRONDICULARIA PACKARDI** Cushman and Schenck

Plectofrondicularia packardi CUSHMAN and SCHENCK, Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 17, 1928, p. 311, pl. 43, figs. 14, 15.

This species, represented by specimens in the Stanford University micropaleontological collections (L.S.J.U. Slide No. 1541), has been compared with typical material from the Keasey shale of Oregon and Washington. It is rare in the Lincoln formation.

Family **BULIMINIDAE**Genus **ROBERTINA** d'Orbigny, 1846**ROBERTINA ANGUSTA** (Cushman) (Pl. 14, fig. 15)

Buliminella subieres (H. B. BRADY), var. *angusta* CUSHMAN, U. S. Geol. Survey Prof.

Paper 129-F, 1922, p. 127, pl. 29, figs. 8, 9; l. c., Prof. Paper 133, 1923, p. 24.—
 HOWE, Journ. Pal., vol. 2, 1928, p. 174 (list).—CUSHMAN, Contr. Cushman Lab.
 Foram. Res., vol. 5, 1929, p. 42, pl. 7, fig. 4.

Robertina angusta (CUSHMAN) CUSHMAN and PARKER, Contr. Cushman Lab. Foram.
 Res., vol. 12, 1936, p. 96, pl. 16, fig. 11.—CUSHMAN and McGLAMERY, U. S. Geol.
 Survey Prof. Paper 197-B, 1942, p. 70, pl. 5, fig. 15.

Two specimens in the Lincoln material seem to be identical with the types of this species, known from the Oligocene of the Gulf Coastal Plain and also apparently occurring in the Oligocene of Europe.

Genus UVIGERINA d'Orbigny, 1826

UVIGERINA sp.

Two immature specimens, with interrupted longitudinal costae, were found in the Lincoln material. They belong to the group of *U. pigmea* (d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 269, pl. 12, figs. 8, 9.), but more material is needed before they can be identified specifically.

Family ROTALIIDAE

Genus EPONIDES Montfort, 1808

EPONIDES KLEINPELLI Cushman and Frizzell (Pl. 15, fig. 1)

Eponides kleinpelli CUSHMAN and FRIZZELL, Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 42, pl. 8, fig. 11.

Original description: Test comparatively large for the genus, trochoid, biconvex, in peripheral view the ventral side flattened in the umbilical region and the dorsal side somewhat umbonate, periphery with a blunt keel; chambers distinct, of uniform shape, very gradually increasing in size as added, averaging about 15 in the last-formed whorl in the adult; sutures distinct, on the dorsal side nearly tangential, very slightly curved, limbate, on the ventral side depressed, nearly radial, slightly curved; wall distinctly perforate, the dorsal side smooth, the early chambers showing through the added thickness of shell material, ventrally with a cluster of irregular, raised bosses over the umbilical region; aperture on the ventral side a low, arched opening with a distinct lip. Diameter up to 1.35 mm.; height 0.70 mm.

This species was described from the Lincoln formation in its type area (L.S.J.U. Loc. 1167). It is a large, well characterized species. It differs from *Eponides guayabalensis* Cole in its larger size, greater number of chambers, and the cluster of bosses in the umbilical region instead of a thickened ring.

Genus *GYROIDINA* d'Orbigny, 1826

GYROIDINA ORBICULARIS d'Orbigny, var. *PLANATA* Cushman (Pl. 15, figs. 2-4)
Gyroidina orbicularis d'ORBIGNY, var. *planata* CUSHMAN, U. S. Geol. Survey Prof. Paper 181, 1935, p. 45, pl. 18, fig. 3.—CUSHMAN and STEGFUS, Trans. San Diego Soc. Nat. Hist., vol. 9, 1942, p. 419, pl. 17, fig. 32.

This variety was described from the upper Eocene of South Carolina and recorded from the Kreyenhagen shale of California. Comparison of the Lincoln specimens with the types shows that they apparently should be included under this varietal name. The form is moderately common.

Genus *EPISTOMINA* Terquem, 1883

EPISTOMINA EOCENICA Cushman and M. A. Hanna (Pl. 15, figs. 9, 10)
Epistomina eocenica CUSHMAN and M. A. HANNA, Trans. San Diego Soc. Nat. Hist., vol. 5, 1927, p. 53, pl. 5, figs. 4, 5.—CUSHMAN and SCHENCK, Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 17, 1928, p. 313, pl. 44, fig. 9.—WEINZIERL and APPLIN, Journ. Pal., vol. 3, 1929, p. 407.—CUSHMAN and McMASTERS, l. c., vol. 10, 1936, p. 515, pl. 76, fig. 5.

The species was originally described from the Eocene near La Jolla, California, and subsequently has been figured from the middle Eocene, Llajas formation, of California, and from the lower Oligocene of Oregon. It also has been recorded from the Claiborne Eocene of Texas. *Epistomina eocenica* is rare in the Lincoln material.

Family CASSIDULINIDAE

Genus *CERATOBULIMINA* Toulou, 1915

CERATOBULIMINA WASHBURNEI Cushman and Schenck
Ceratobulimina washburnei CUSHMAN and SCHENCK, Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 17, 1928, p. 314, pl. 45, fig. 1.

The Lincoln specimens apparently belong to this species which was described from the Keasey shale of Oregon. The species is rare.

Genus *CASSIDULINA* d'Orbigny, 1826

CASSIDULINA GALVINENSIS Cushman and Frizzell (Pl. 15, fig. 6)
Cassidulina galvinensis CUSHMAN and FRIZZELL, Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 43, pl. 8, fig. 10.

Original description: Test compressed, nearly circular in side view, periphery subacute, slightly keeled, slightly lobulate; chambers distinct, very slightly if at all inflated, four pairs making up the last-formed coil, on the ventral side the basal edge of the chamber somewhat concave where it meets the previous one, and each added nearly at right angles to it; sutures distinct, slightly if at all depressed, very slightly limbate; wall thin, finely perforate, polished; aperture an

elongate, elliptical opening, its axis parallel to the periphery. Diameter 0.45 mm.; thickness 0.20 mm.

This species was described from the Lincoln formation in its type area (L.S.J.U. Loc. 1167). It resembles *Cassidulina cushmani* R. E. and K. C. Stewart, but differs in the shape of the chambers which, in our species, are shorter and more nearly at right angles to each other, and in the wider aperture and less definite keel.

CASSIDULINA cf. CRASSIPUNCTATA Cushman and Hobson (Pl. 15, fig. 5)

A single specimen in the Lincoln material is similar to *C. crassipunctata* Cushman and Hobson (Contr. Cushman Lab. Foram. Res., vol. 11, 1935, p. 63, pl. 9, fig. 10.) from the San Lorenzo formation of northern California. Additional material may show the Lincoln form to be distinct.

Family CHILOSTOMELLIDAE

Genus **PULLENIA** Parker and Jones, 1862

PULLENIA SALISBURYI R. E. and K. C. Stewart (Pl. 14, fig. 16)

Pullenia salisburyi R. E. and K. C. Stewart, Journ. Pal., vol. 4, 1930, p. 72, pl. 8, fig. 2.—KLEINPELL, Miocene Stratig. Calif., 1938, p. 342, pl. 10, fig. 3 ("questionably identified form").

Three specimens from the Lincoln formation are very similar to the holotype of this species. *P. salisburyi* was described from the Pliocene of California and is recorded from the Miocene of that region.

PULLENIA (?) sp.

A single specimen has been found, apparently referable to the genus *Pullenia*, which is quite distinctive. Its relationships, however, cannot be determined with certainty without additional material.

Family GLOBIGERINIDAE

Genus **GLOBIGERINA** d'Orbigny, 1826

GLOBIGERINA cf. APERTURA Cushman (Pl. 15, figs. 7, 8)

In the Lincoln formation there occur a few specimens of *Globigerina*, somewhat resembling *G. apertura* Cushman (Bull. 676, U. S. Geol. Survey, 1918, p. 57, pl. 12, fig. 8.). Pending detailed revision of the family Globigerinidae by the senior author, these forms are left unidentified.

Family ANOMALINIDAE

Genus **CIBICIDES** Montfort, 1808

CIBICIDES FLORIDANUS (Cushman) (Pl. 15, figs. 11, 12)

Truncatulina floridana CUSHMAN, Bull. 676, U. S. Geol. Survey, 1918, p. 62, pl. 19, fig. 2.

Truncatulina lobatula (WALKER and JACOB), var. *ornata* CUSHMAN, l. c., p. 61, pl. 18, figs. 1, 2.

Cibicides floridana CUSHMAN, Bull. 4, Florida Geol. Survey, 1930, p. 61, pl. 12, fig. 3; Bull. 104, U. S. Nat. Mus., pt. 8, 1931, p. 122, pl. 23, figs. 3-5.—CUSHMAN and LAIMING, Journ. Pal., vol. 5, 1931, p. 119, pl. 14, fig. 8.—CUSHMAN and PARKER, Contr. Cushman Lab. Foram. Res., vol. 7, 1931, p. 16, pl. 3, fig. 2.—CUSHMAN and PONTON, Bull. 9, Florida Geol. Survey, 1932, p. 100.—CUSHMAN and CAHILL, U. S. Geol. Survey Prof. Paper 175-A, 1933, p. 34, pl. 13, fig. 1.—BERMUDEZ, Mem. Soc. Cubana Hist. Nat., vol. 9, 1935, p. 220.

This species is variable, as are most species of the genus *Cibicides*. The moderately common Lincoln specimens show characteristic variation and appear to be definitely referable to the species. Two forms have been observed in this suite of specimens, apparently as end members of a homogeneous series. One of these variants is characterized by moderately arched sutures and an umbonal plug on the ventral side; the other lacks the umbonal plug, and has slightly sinuous sutures. It was not found possible to effect a separation on these bases. The species is living in the western Atlantic and has been recorded from the Miocene of Florida and California.

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250. SOME NEW FORAMINIFERA FROM THE TERTIARY
OF THE ISLAND OF ST. CROIX

BY JOSEPH A. CUSHMAN

During a study of the foraminifera of three test wells drilled on the Island of St. Croix, a few new species and varieties were found in the rather rich fauna. The wells from which these forms were obtained are the Bethlehem Test Well No. 1, 500 yards ENE. of Bethlehem; the Jealousy Test Well No. 2, 300 yards W. of great-house at Jealousy; and the Fair Plain Test Well No. 3, $\frac{5}{8}$ mile W. of Anguilla at location known as Fair Plain along south shore.

Family HETEROHELICIDAE

Genus PLECTOFRONDICULARIA Liebus, 1903

PLECTOFRONDICULARIA HEDBERGI Cushman, n. name (Pl. 16, fig. 1)

Plectofrondicularia californica HEDBERG (not CUSHMAN and STEWART), Journ. Pal., vol. 11, 1937, p. 675, pl. 91, fig. 7.

Test compressed, elongate, sides nearly parallel for most of their length, broad faces flattened or slightly concave, periphery keeled with a lateral keel in addition at either side near the margin; chambers numerous, early ones biserial, uniserial in the adult increasing rapidly in height, in the adult higher than broad; sutures limbate, slightly depressed; wall smooth, except for a central costa for most of the length of the test and occasionally other less developed ones at each side. Length 0.50-0.60 mm.; breadth 0.20 mm.

Holotype (Cushman Coll. No. 23594) from the upper Oligocene, Carapita formation, District of Libertad, State of Anzoategui, Venezuela.

This species, which has been confused with *Plectofrondicularia californica*, differs from that species in the smaller size, nearly parallel sides throughout, more elongate median costae, and much higher chambers.

A re-study of the types of these two forms seems to show that they are distinct. It was found in well No. 1 at 580 and 1210 feet, and in well No. 2 at 30 feet.

Family BULIMINIDAE

Genus VIRGULINA d'Orbigny, 1826

VIRGULINA IMPLICATA Cushman, n. sp. (Pl. 16, fig. 3)

Test elongate, slender, strongly twisted, early portion triserial, re-

mainder of the test biserial, slightly fusiform; chambers distinct, slightly inflated, increasing gradually in height as added; sutures distinct, slightly depressed; wall smooth, coarsely perforate; aperture broadly rounded, at the base of the last-formed chamber. Length up to 0.40 mm.; diameter 0.12 mm.

Holotype (Cushman Coll. No. 39627) from material, probably Miocene, at a depth of 230 feet in Bethlehem Test Well No. 1, 500 yards ENE. of Bethlehem, Island of St. Croix.

This species differs from *Virgulina delmonteensis* Cushman and Galihier in the more slender, more strongly twisted test, and the larger, more rounded aperture.

It is common in the well samples from wells No. 1 and 2. In well No. 1 it occurs at intervals from 90 to 1270 feet, and in well No. 2 at 100, 280, 360, and 390 feet.

Genus BOLIVINA d'Orbigny, 1839

BOLIVINA PISCIFORMIS Galloway and Morrey, var. **OPTIMA** Cushman, n. var.
(Pl. 16, fig. 2)

Variety differing from the typical in having the early $\frac{1}{3}$ to $\frac{1}{2}$ of the test with numerous longitudinal costae, the later portion of the test smooth.

Holotype of variety (Cushman Coll. No. 39628) from material, probably Miocene, at a depth of 520 feet in Bethlehem Test Well No. 1, 500 yards ENE. of Bethlehem, Island of St. Croix.

The main characters of sutures and chambers are like those of typical *B. pisciformis* but the ornamentation of the early portion is distinctive. Specimens are common in the well samples.

Genus SIPHOGENERINA Schlumberger, 1883

SIPHOGENERINA MULTICOSTATA Cushman and Jarvis, var. **OPTIMA** Cushman, n. var.
(Pl. 16, figs. 9, 10)

Variety differing from the typical in the finer costae and the uniserial chambers which tend to be in an irregular line.

Holotype of variety (Cushman Coll. No. 39630) from material, probably Miocene, at a depth of 90 feet in Fair Plain Test Well No. 3, $\frac{5}{8}$ mile W. of Anguilla at location known as Fair Plain along south shore, Island of St. Croix.

Family ELLIPSOIDINIDAE

Genus NODOSARELLA Rzehak, 1895

NODOSARELLA SUBCYLINDRICA Cushman, n. sp. (Pl. 16, figs. 4, 5)

Test small, elongate, subcylindrical, slightly tapering, early stages

biserial, uniserial in the adult; chambers distinct, slightly inflated, those in the adult uniserial portion higher than broad; sutures distinct, slightly depressed; wall smooth, finely perforate; aperture terminal, narrow, with a slightly overhanging lip. Length 0.55-0.65 mm.; diameter 0.10-0.12 mm.

Holotype (Cushman Coll. No. 39634) from material, probably Miocene, at a depth of 90 feet in Jealousy Test Well No. 2, 300 yards W. of great-house at Jealousy, Island of St. Croix.

This species differs from *Nodosarella pacifica* Cushman in the much smaller size and higher chambers. It occurs in well No. 1 at depths of 230, 740, 1330, 1360, and 1450 feet; in well No. 2 at 90 feet only; and in well No. 3 at 90 and 130 feet.

NODOSARELLA ROBUSTA Cushman, n. sp. (Pl. 16, fig. 8)

Test of medium size, elongate, subcylindrical, biserial stage very short; chambers distinct, very slightly inflated, overlapping, broader than high except the final chamber; sutures fairly distinct, slightly if at all depressed; wall smooth and polished; aperture terminal, a narrow opening with a distinctly overhanging lip. Length 1.10-1.25 mm.; diameter 0.28-0.35 mm.

Holotype (Cushman Coll. No. 39635) from material, probably Miocene, at a depth of 100 feet in Bethlehem Test Well No. 1, 500 yards ENE. of Bethlehem, Island of St. Croix.

This species differs from *Nodosarella pacifica* Cushman in the typically shorter, stouter test, and more strongly overhanging lip. It occurs in well No. 1 at intervals from 100 to 1360 feet and in well No. 2 at 90 feet.

Genus ELLIPSONODOSARIA A. Silvestri, 1900

ELLIPSONODOSARIA SUBSPINOSA Cushman, n. sp. (Pl. 16, figs. 6, 7)

Ellipsonodosaria sp. CUSHMAN and JARVIS, Contr. Cushman Lab. For. Res., vol. 10, 1934, pl. 10, figs. 4, 5.

Test elongate, subcylindrical, slightly tapering, greatest breadth

EXPLANATION OF PLATE 15

FIG. 1. *Eponides kleinPELLI* Cushman and Frizzell. Holotype. *a*, dorsal view; *b*, ventral view; *c*, peripheral view. $\times 35$. 2-4. *Gyroidina orbicularis* d'Orbigny, var. *planata* Cushman. 2, ventral view; 3, peripheral view; 4, dorsal view. $\times 55$. 5. *Cassidulina* cf. *crassipunctata* Cushman and Hobson. $\times 55$. 6. *C. galvinensis* Cushman and Frizzell. Holotype. *a*, dorsal view; *b*, ventral view; *c*, peripheral view. $\times 90$. 7, 8. *Globigerina* cf. *apertura* Cushman. Ventral views. $\times 55$. 9, 10. *Epistomina eocenica* Cushman and M. A. Hanna. 9, dorsal view; 10, ventral view. $\times 35$. 11, 12. *Cibicides floridanus* (Cushman). 11, ventral view; 12, dorsal view. $\times 55$.



1b



1c



1a



2



3



4



5



6b



6c



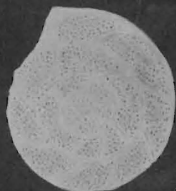
6a



7



8



9



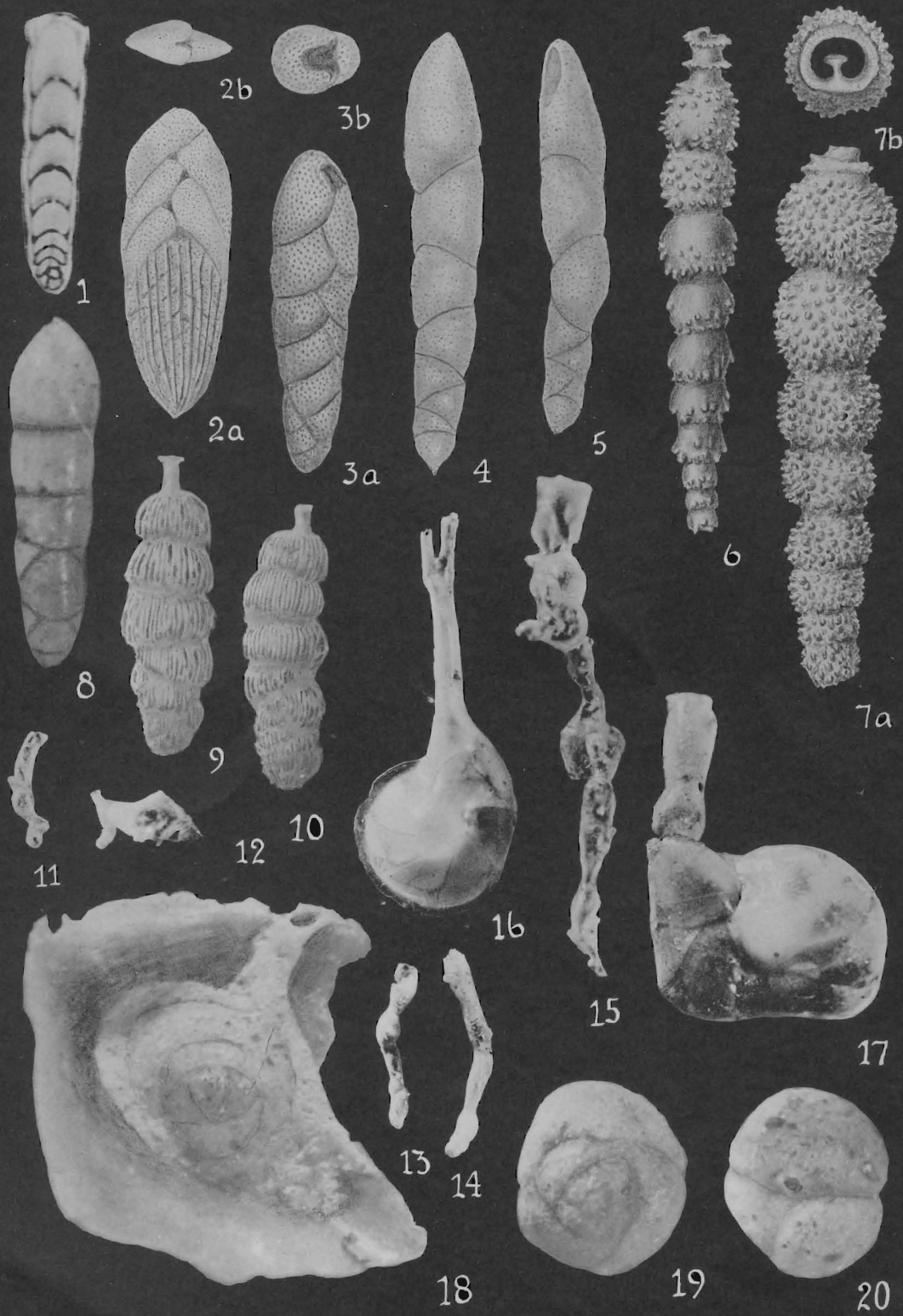
10



11



12



near the apertural end; chambers distinct, strongly inflated, increasing gradually in size as added; sutures distinct, strongly depressed; wall with short stout spines, either entirely covering the chamber or in the early stages confined to the lower portion of the chamber wall; aperture with a subcylindrical neck and distinct lip with an inwardly projecting tooth. Length 2.50-3.25 mm.; diameter 0.35-0.90 mm.

Holotype (Cushman Coll. No. 21484) from the lower middle Miocene, Green clay, Cipero section, San Fernando, Trinidad, B. W. I.

This species differs from *Ellipsonodosaria mappa* Cushman and Jarvis in the more elongate, tapering test, and the surface ornamentation of short spines. It occurs in well No. 1 at 640, 870, and 1430 feet.

251. RELATIONSHIPS OF THE GENUS *SPORADOGENERINA*

By JOSEPH A. CUSHMAN and RUTH TODD

Recently a fairly large series of specimens of *Sporadogenerina flintii* Cushman has been available for study. Examination of these additional specimens has shown certain features which indicate that the genus belongs in the Lagenidae rather than in the Buliminidae, in which family it was originally placed. The types, also, upon re-examination, bear out this conclusion.

This connection with the Lagenidae is shown particularly by the apertures which, although very small, are well preserved in the various stages in the specimens examined. They are definitely radiate and, by breaking down one of the larger specimens, the terminal apertures

EXPLANATION OF PLATE 16

FIG. 1. *Plectofrondicularia hedbergi* Cushman, n. name. Holotype. Upper Oligocene, Carapita formation, Venezuela. $\times 55$. (After Hedberg). 2. *Bolivina pisciformis* Galloway and Morrey, var. *optima* Cushman, n. var. Holotype. Miocene, Island of St. Croix. *a*, side view; *b*, apertural view. $\times 125$. 3. *Virgulina implicata* Cushman, n. sp. Holotype. Miocene, Island of St. Croix. *a*, side view; *b*, apertural view. $\times 125$. 4, 5. *Nodosarella subcylindrica* Cushman, n. sp. Miocene, Island of St. Croix. $\times 125$. 4, Holotype. 5, Paratype. 6, 7. *Ellipsonodosaria subspinososa* Cushman, n. sp. Lower middle Miocene, Green clay, Cipero section, San Fernando, Trinidad, B. W. I. 6, Paratype. $\times 36$. 7, Holotype. $\times 27$. (After Cushman and Jarvis). 8. *Nodosarella robusta* Cushman, n. sp. Holotype. Miocene, Island of St. Croix. $\times 50$. 9, 10. *Siphogenerina multicostata* Cushman and Jarvis, var. *optima* Cushman, n. var. Miocene, Island of St. Croix. $\times 50$. 9, Holotype. 10, Paratype. 11-15. *Sporadogenerina flintii* Cushman. Recent. $\times 18$. 11, 14, Johnson-Smithsonian Exped. Sta. 25. 12, 13, 15, Johnson-Smithsonian Exped. Sta. 93. 16, 17. *Robulus* sp. Recent, Johnson-Smithsonian Exped. Sta. 67. $\times 18$. 18-20. *Trochammina siphonifera* Cushman, n. gen., n. sp. Recent, Johnson-Smithsonian Exped. Sta. 25. 18, Holotype, attached form. 19, 20, Paratypes. 19, dorsal view; 20, ventral view. $\times 50$.

of the early stages were also found to be radiate. The projections shown in the type figures are likewise radiate apertures.

About twenty-five specimens were examined from the following two stations: Johnson-Smithsonian Exped. Sta. 25, 18° 32' 15" N., 66° 22' 10" W., 240-300 fathoms, and Sta. 93, 18° 38' 00" N., 65° 09' 30" W., 350-400 fathoms, off Porto Rico. The type locality for *S. flintii* is *Albatross D 2377*, 29° 07' 30" N., 88° 08' 00" W., 210 fathoms, Gulf of Mexico.

No additional specimens were found with the "roughly uvigerine" arrangement of the early chambers, as noted in the description of the genus and as present in the holotype. A number were found with the initial end complete and these show a series of globular chambers, much overlapping or irregularly placed, not increasing in size for the first 3 or 4 chambers, and then taking on the much enlarged, elongate, bulging, or branching form of chambers typical of the genus. One specimen (pl. 16, fig. 12), probably microspheric, shows a quite regular series of 5 chambers, gradually increasing in size, resembling a *Marginulina* or *Dentalina*, followed by a typical adult chamber which branches off from the fourth one.

The adult chambers are very irregular in size and shape and have several minute but definitely radiate protruding apertures situated without any apparent arrangement on the walls of the chambers, usually several on each of the larger chambers.

In the same material from off Porto Rico two specimens of different species of *Robulus* were found which may have some bearing on the relationships of the genus *Sporadogenerina*. In the one (pl. 16, fig. 16) there is an elongate tubular projection which, toward the end, branches into two, the whole projecting part composed of but two chambers. The other specimen (pl. 16, fig. 17) has two projecting chambers irregularly shaped and with the same type of small radiate apertures as in *Sporadogenerina*.

These cases of *Robulus* approaching *Sporadogenerina* in their final chambers, together with the radiate apertures and the fact that the early chambers in some of the specimens of *Sporadogenerina* are dentaline or marginuline, would seem to indicate that the genus definitely belongs in the family Lagenidae. There is the possibility that such abnormalities in *Robulus* are pathologic conditions resulting from some cause unknown at present, and it may be that all these specimens originate from some such cause.

The following is a revised definition of the genus:

Test with a globular proloculum followed by several globular chambers usually arranged in a dentaline or marginuline arrangement, later chambers irregularly uniserial and elongate, sometimes branching; wall calcareous, very finely perforate, glassy; apertures in the early stages one to each chamber, terminal, radiate, in the later chambers numerous, protruding, radiate, irregularly placed on the surface of the chamber.

252. A NEW GENUS OF THE TROCHAMMINIDAE

BY JOSEPH A. CUSHMAN

A study of Recent material from the Caribbean has included, among other things, a series of specimens related to *Trochammina*. These evidently represent a new genus as follows:

Genus TROCHAMMINELLA Cushman, new genus

Genoholotype: *Trochamminella siphonifera* CUSHMAN, n. sp.

Test trochoid, free in the early stages, sometimes attached in the later stages; wall arenaceous; aperture in the unattached forms a rounded opening near the margin of the ventral face of the last-formed chamber, usually surrounded by a slightly raised ring; the attached adult surrounded by an irregular rim of material similar to that of the wall and extending out in a tubular neck with a rounded aperture.

So far as at present known, this is represented by the following species:

TROCHAMMINELLA SIPHONIFERA Cushman, n. sp. (Pl. 16, figs. 18-20)

Test trochoid, composed of several whorls with three chambers to a whorl, dorsal side slightly convex, ventral side flattened, periphery slightly rounded; chambers elongate, increasing rather regularly in size as added, completely involute on the ventral side, in the attached adult with an irregular mass of material about the periphery, extending into a tubular neck; sutures distinct, slightly depressed, gently curved on the dorsal side, nearly radial on the ventral; wall rather finely arenaceous, smoothly finished, aperture in the unattached form a rounded opening surrounded by a slightly raised ring near the margin of the ventral face of the last-formed chamber, in the attached form at the end of the tubular neck extending out from the periphery. Diameter 0.60 mm., exclusive of the irregular surrounding mass; thickness 0.30 mm.

Holotype (Cushman Coll. No. 39619) from Johnson-Smithsonian Exped. Sta. 25, 18° 32' 15" N., 66° 22' 10" W., 240-300 fathoms, off Porto Rico.

This evidently represents a development from *Trochammina* with the specialized apertural features.

RECENT LITERATURE ON THE FORAMINIFERA

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

- Martin, Lois T.** Eocene Foraminifera from the Type Lodo Formation, Fresno County, California.—Stanford Univ. Publ., Univ. Ser., Geol. Sci., vol. III, No. 3, 1943, pp. 91-125 (1-35), pls. V-IX, 3 text figs., 2 tables.—30 new species and 2 new subspecies are described and figured, and the other species are listed.
- Lozo, Frank E., Jr.** Bearing of Foraminifera and Ostracoda on Lower Cretaceous Fredericksburg-Washita Boundary of North Texas.—Bull. Amer. Assoc. Petr. Geol., vol. 27, No. 8, August, 1943, pp. 1060-1080, 10 text figs.
- Earland, Arthur, and Margaret W. Jepps.** Note on an abnormal specimen of *Elphidium crispum* (L.).—Journ. Roy. Micr. Soc., Ser. III, vol. LXIII, Parts 1, 2, March and June 1943, pp. 43-47, figs. 1, 2 (in text). A new variety, *Elphidium crispum* (L.) var. *detorquens* n. var.
- Woodring, W. P., M. N. Bramlette, and K. E. Lohman.** Stratigraphy and Paleontology of Santa Maria District, California.—Bull. Amer. Assoc. Petr. Geol., vol. 27, No. 10, Oct. 1943, pp. 1335-1360, 4 figs. (in text).—Note occurrence of numerous foraminifera.
- Curran, John F.** Eocene Stratigraphy of Chico Martinez Creek area, Kern County, California.—L. c., pp. 1361-1386, 12 figs. (in text). Gives distribution lists and percentage charts of foraminifera.
- Tappan, Helen.** Foraminifera from the Duck Creek Formation of Oklahoma and Texas.—Journ. Pal., vol. 17, No. 5, Sept. 1943, pp. 476-517, pls. 77-83. There are described and figured 120 species of foraminifera, 37 new. A new genus, *Washitella*, is described, genotype, *Washitella typica*, n. sp.

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