

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

8. SOME TEXTULARIIDAE FROM THE MIOCENE OF
CALIFORNIA

By JOSEPH A. CUSHMAN

Plate 5

A close study of some of the Textulariidae from the Monterey shale of the Miocene of California has shown that the stratigraphic data makes distinct many closely allied species. The differences when individual specimens, such as those figured on Plate 5, are shown together are not so striking as when groups of individuals from the same stratigraphic levels are compared with one another.

All the specimens recorded in this paper are from Miocene Monterey shales, Sect. 24, T.28S., R.14E., San Luis Obispo County, California, collected by W. D. Kleinpell.

BOLIVINA ADVENA Cushman, n. sp.

Plate 5, figs. 1 *a*, *b*

Test of early portion compressed, later portion thickened; early chambers low, close-set, later ones higher; sutures of early portion slightly limbate, later portion very narrow, somewhat depressed, periphery of early portion acute, later rounded; wall smooth but distinctly punctate.

Length up to 0.60 mm.; breadth 0.22 mm.

Holotype (Cushman Coll. No. 4350).

BOLIVINA ADVENA Cushman, n. sp., var. **ORNATA** Cushman, n. var.

Plate 5, figs. 2 *a*, *b*

Variety differing from the typical in the larger size, greater roundness of the later portion, and the addition of numerous longitudinal costae, 10 to 12 on each side of the test.

Length up to 0.75 mm.; breadth 0.30 mm.

Holotype (Cushman Coll. No. 4351).

BOLIVINA ADVENA Cushman, n. sp., var. **STRIATELLA** Cushman, n. var.

Plate 5, figs. 3 a, b

Variety differing from the typical in the longer, more tapering form, the initial end subacute, about 9 chambers making up the last half of the test; sutures somewhat distinct, very slightly depressed; wall finely punctate, surface of the early portion ornamented with very fine, numerous, longitudinal costae, the later portion smooth.

Length up to 0.85 mm.; breadth 0.22 mm.

Holotype (Cushman Coll. No. 4352.)

BOLIVINA CONICA Cushman, n. sp.

Plate 5, figs. 4 a, b

Test rapidly tapering from the subacute initial end; very slightly compressed, periphery rounded, whole test in section circular; sutures and chambers indistinct; wall punctate, the early portion ornamented with very fine longitudinal costae, 15 to 20 in each side, all of about equal strength; later part of the test coarsely punctate.

Length 0.50 mm.; breadth 0.20 mm.

Holotype (Cushman Coll. No. 4352).

This somewhat resembles a species I have figured (Bull. 103, U. S. Nat. Mus., 1918, p. 54, pl. 21, fig. 3) from the Gatun Miocene of the Panama Canal Zone

BOLIVINA MARGINATA Cushman

Plate 5, figs. 5 a, b

Bolivina marginata CUSHMAN, Bull. 676, U. S. Geol. Surv., 1918, p. 48, pl. 10, fig. 1.

Test much compressed, of medium size for the genus, periphery acute, keeled throughout; sutures usually distinctly limbate, oblique; chambers numerous, distinct, 7 or 8 chambers making up the last half of the test; wall thin, rather coarsely punctate, surface without ornamentation; aperture elongate, narrow.

Length 0.65 mm.; breadth 0.25 mm.

Holotype (Cushman Coll. No. 4353).

This species was originally described from the Choctawhatchee Marl, one mile south of Red Bay, Florida. The specimens from the California Miocene are very close to the Florida ones, but are somewhat smaller.

BOLIVINA DECUSSATA H. B. BradyPlate 5, figs. 6 *a*, *b*

Bolivina decussata H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 58; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 423, pl. 53, figs. 12, 13.—Cushman, Bull. 71, U. S. Nat. Mus., pt. 2, 1911, p. 47, fig. 77 (in text).—Sidebottom, Journ. Roy. Micr. Soc., 1918, p. 128.—Cushman, Bull. 104, U. S. Nat. Mus., pt. 3, 1922, p. 32.—Heron-Allen and Earland, British Antarctic Exped., Zoology, vol. 6, 1922, p. 134.

Test stout, tapering, rapidly increasing in size from the narrowly rounded initial end, periphery squarely truncate or even slightly concave; chambers numerous, the last 6 making up more than half the test; sutures usually indistinct, sinuous, following the lobes and reëntrants of the basal part of the chamber; wall thick, punctate; surface with knoblike thickenings alternating with rounded depressions; aperture semicircular or somewhat rectangular; without a definite lip.

Length 0.65 mm.; breadth 0.30 mm.

~~Holotype~~ (Cushman Coll. No. 4354).

All the records which are unquestionably of this species are from the Pacific.

BOLIVINA IMBRICATA Cushman, n. sp.Plate 5, figs. 7 *a*, *b*

Test much compressed, of medium size for the genus, periphery acute, keeled throughout; sutures distinctly limbate, much curved; chambers numerous, distinct, 8 chambers making up the last half of the test; wall thin, very finely punctate, surface with longitudinal costae, 8 to 10 on each side, the costae for the most part limited to the first third of the test except the central costa which is the most prominent and often continues nearly to the apertural end of the test.

Length up to 0.75 mm.; breadth 0.30 mm.

Holotype (Cushman Coll. No. 4355).

In its fully developed characters the chambers are decidedly imbricate, the basal half of each overlapping the anterior half of the preceding chamber. The test often becomes thick and the wall coarsely perforate.

BOLIVINA BREVIOR Cushman, n. sp.Plate 5, figs. 8 *a*, *b*

Test minute, compressed, tapering from a subacute initial end, periphery broadly rounded throughout, chambers comparatively few, the last 6 making up more than half the test; sutures distinct, very slightly depressed; wall distinctly punctate.

Length up to 0.40 mm.; breadth 0.13-0.16 mm.

Holotype (Cushman Coll. No. 4356).

This species is smaller and much more compressed than *Bolivina tumida* Cushman, n. sp., which it resembles in some respects. The two are not found together, however.

BOLIVINA TUMIDA Cushman, n. sp.

Plate 5, figs. 9 *a, b*

Test comparatively small, only slightly compressed, tapering from a subacute initial end, periphery broadly rounded throughout; chambers numerous, high, the last 5 making up more than half the test; sutures distinct, very slightly depressed, nearly at right angles to the periphery, the later ones slightly oblique; wall distinctly punctate.

Length up to 0.50 mm.; breadth 0.20 mm.

Holotype (Cushman Coll. 4357).

BOLIVINA CALIFORNICA Cushman, n. sp.

Plate 5, figs. 10 *a, b*

Test fusiform, twisted, rapidly increasing in size from the subacute initial end, greatest width near the middle, thence slightly decreasing in width toward the apertural end, periphery broadly rounded; chambers numerous, distinct, somewhat inflated, the last 5 or 6 making up half the test; sutures distinct, slightly depressed; surface ornamented with longitudinal costae especially developed over the sutures, usually absent in the middle portion of the chambers; aperture elongate with a slight lip.

Length 0.60 mm.; breadth 0.22 mm.

Holotype (Cushman Coll. No. 4358).

VIRGULINA CALIFORNIENSIS Cushman, n. sp.

Plate 5, figs. 11 *a-c*

Test slightly more than twice as long as broad; early chambers spiral, later ones biserial, not twisted, periphery broadly rounded, the last 3 chambers making up nearly half the test, initial end subacute, apertural end broadly rounded, early chambers small, indistinct, later ones inflated, very distinct, biserial; sutures of the early portion indistinct, later ones very distinct, depressed; wall smooth but distinctly punctate; aperture comma-shaped.

Length 0.50 mm.; breadth 0.22 mm.

Holotype (Cushman Coll. No. 4359).

BULIMINELLA SUBFUSIFORMIS Cushman, n. sp.

Plate 5, fig. 12

Test spiral, much elongate, subcylindrical, early portion tapering, sides for most of the test nearly parallel, periphery lobulate; chambers numerous, inflated, distinct, 3 or 4 making up a coil; sutures distinct, depressed; wall smooth, very finely punctate; aperture narrow, elongate.

Length 0.60 mm.; breadth 0.20 mm.

Holotype (Cushman Coll. No. 4360).

This may be distinguished from *Buliminella curta* Cushman, n. sp., by the nearly parallel sides, and from *Buliminella brevior* Cushman, n. sp., by the distinct lobing of the periphery and the much more inflated chambers, as well as the much more elongate form with fewer chambers in each coil.

BULIMINELLA CURTA Cushman, n. sp.

Plate 5, fig. 13

Test spiral, tapering or fusiform, initial end rounded thence rapidly increasing in diameter nearly to the apertural end, periphery slightly lobulate; chambers numerous, 5 or 6 making up a coil in the adult, distinct, inflated; sutures distinct, slightly depressed; wall smooth, very finely punctate; aperture comma-shaped in a slightly concaved depression of the last-formed chamber.

Length 0.45-0.50 mm.; breadth 0.25 mm.

Holotype (Cushman Coll. No. 4361).

BULIMINELLA BREVIOR Cushman, n. sp.

Plate 5, fig. 14

Test short, broad, the initial end somewhat pointed, composed of about two whorls, the last-formed one of numerous chambers; sutures slightly depressed, the aperture at face involving the sides of several chambers.

Length 0.50 mm.; breadth 0.30 mm.

Holotype (Cushman Coll. No. 4362).

This resembles some of the forms from the Mediterranean and late Tertiary of this region.

BULIMINELLA CALIFORNICA Cushman, n. sp.

Plate 5, fig. 15

Test spiral, subcylindrical, much elongate, sides nearly parallel, early portion gently tapering from a subacute initial end, periphery very slightly or not at all lobulate; chambers numerous, 4 or 5 making up a coil in the adult, not inflated; sutures

very slightly if at all depressed, often indistinct, sometimes strongly limbate; wall fairly thick, very finely punctate, smooth; aperture either comma-shaped at the base of the last-formed chamber or rounded and terminal.

Length 0.50-0.55 mm.; breadth 0.15 mm.

Holotype (Cushman Coll. No. 4363).

This may be distinguished from all the other *Buliminellas* of this section by the limbate sutures, and the sides which are not lobulate.

CASSIDULINA PULCHELLA d'Orbigny

Plate 5, fig. 16

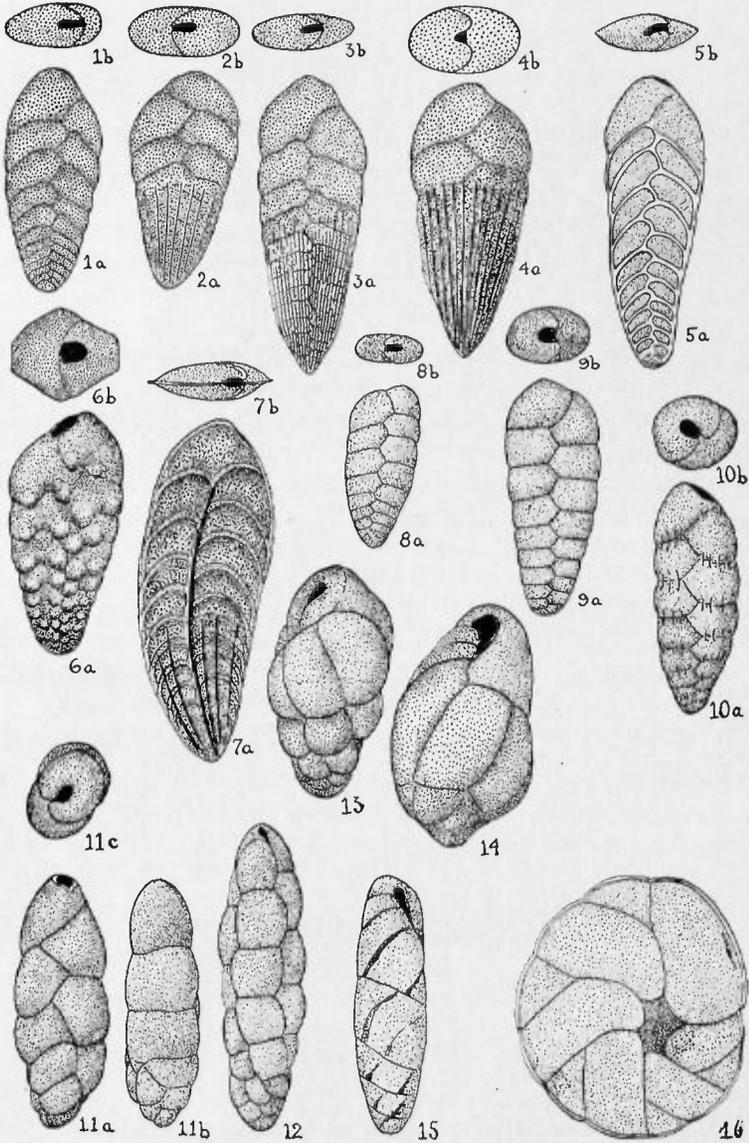
Cassidulina pulchella d'ORBIGNY, Voy. Amér. MÉR., 1839 "Foraminifères", p. 57, pl. 8, figs. 1-3.—Cushman and Hughes, Contrib. Cushman Lab. Foram. Research, vol. 1, pt. 1, 1923, p. 13, pl. 2, figs. 6 a, b.

This species known previously from the coast of Peru, and from the Pliocene of California, at Timms Point, seems also to be present in this Miocene California material.

EXPLANATION OF PLATE 5

All figures X 65

- Fig. 1. *Bolivina advena* Cushman, n. sp.
a, front view; b, apertural view.
- Fig. 2. *Bolivina advena* Cushman, n. sp., var. *ornata* Cushman, n. var.
a, front view; b, apertural view.
- Fig. 3. *Bolivina advena* Cushman, n. sp., var. *striatella* Cushman, n. var.
a, front view; b, apertural view.
- Fig. 4. *Bolivina conica* Cushman, n. sp.
a, front view; b, apertural view.
- Fig. 5. *Bolivina marginata* Cushman.
a, front view; b, apertural view.
- Fig. 6. *Bolivina decussata* H. B. Brady.
a, front view; b, apertural view.
- Fig. 7. *Bolivina imbricata* Cushman, n. sp.
a, front view; b, apertural view.
- Fig. 8. *Bolivina brevior* Cushman, n. sp.
a, front view; b, apertural view.
- Fig. 9. *Bolivina tumida* Cushman, n. sp.
a, front view; b, apertural view.
- Fig. 10. *Bolivina californica* Cushman, n. sp.
a, front view; b, apertural view.
- Fig. 11. *Virgulina californiensis* Cushman, n. sp.
a, front view; b, side view; c, apertural view.
- Fig. 12. *Buliminella subfusiformis* Cushman, n. sp.
- Fig. 13. *Buliminella curta* Cushman, n. sp.
- Fig. 14. *Buliminella brevior* Cushman, n. sp.
- Fig. 15. *Buliminella californica* Cushman, n. sp.
- Fig. 16. *Cassidulina pulchella* d'Orbigny.



9. SIPHOGENERINA HUGHESI A NEW SPECIES FROM CALIFORNIA

By JOSEPH A. CUSHMAN

Smooth species in the genus *Siphogenerina* are very rare. *S. columellaris* H. B. Brady and *S. bifrons* H. B. Brady, both recent species, are the only ones. *S. glabra* Schlumberger is a synonym of the first. *S. bifrons* is a peculiarly compressed and excavated species, leaving *S. columellaris* as the only one at all like this new one.

SIPHOGENERINA HUGHESI Cushman, n. sp.

Plate 7, figs. 4 *a*, *b*

Test elongate, fairly thick, two or three times as long as broad, circular in transverse section; chambers short and broad, the early chambers irregularly spiral, later ones uniserial; sutures distinct and depressed; wall thick, the exterior smooth throughout; aperture terminal, rounded, with a short neck and slight lip.

Length 1 mm. or slightly more; breadth 0.50 mm.

Holotype (Cushman Coll. No. 4364) from the Miocene Monterey shales near Chimney Rock, San Luis Obispo County, California.

The species is named for Donald D. Hughes, palaeontologist of California.

10. NEW SPECIES OF CASSIDULINA FROM THE PACIFIC

By JOSEPH A. CUSHMAN

A study of recent Pacific material has shown one very striking species of *Cassidulina*, and a comparison with other areas has shown that a second of these should be distinguished as new. As a rule the Pacific shows much more ornate and bizarre forms than those of any other region. Notes on these species follow:

CASSIDULINA ELEGANTISSIMA Cushman, n. sp.

Plate 7, figs. 5 a, b

Test somewhat compressed, nearly circular in outline, the periphery subacute, with a projecting spine on each of the newly added chambers, often wanting in the older part of the last-formed coil; chambers numerous, 5 or 6 pairs making up the last-formed coil, chambers elongate, curved; the sutures, except in the last-formed chamber, almost completely obscured by the surface ornamentation which consists of irregular, polygonal reticulations formed by rather distinct, sharp, raised regions of the surface; the aperture elongate, narrow, slightly below the periphery, but parallel to it.

Diameter up to 1 mm.; including spines; breadth 0.40 mm.

Holotype (U. S. N. M. Coll. No. 20,278), from *Nero* station 427, in the North Pacific, between Midway Island and Guam, 1,997 fathoms.

This species is distinct from any of the known *Cassidulinas* in its surface ornamentation. It remotely resembles *Cassidulina decorata* Sidebottom, described from the Southwest Pacific. In the apertural view the spines alternate from side to side, as shown in Plate 7, figure 5 b.

CASSIDULINA ORIENTALE Cushman, n. sp.

Plate 7, figs. 6 a-c

Cassidulina bradyi H. B. BRADY (in part) (not Norman), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 431, pl. 54, fig. 10 (not figs. 6-9).

Test much compressed, the periphery rounded; usually 5 or 6 pairs of chambers in the last-formed coil, tending in adult specimens to show a slight uncoiling in latest growth; sutures distinct but very slightly depressed, nearly straight; wall smooth finely punctate, the periphery near the aperture with a clear space without punctae; aperture an elongate, narrow slit, parallel to the periphery.

Length 0.40 mm.; breadth 0.32 mm.

Holotype (U. S. N. M. Coll. No. 20,279), from *Nero* station 1264, south of Japan, in 2,080 fathoms.

This species, which is apparently widely spread in the Pacific, was combined by Brady with *Cassidulina bradyi* Norman, which in its typical form seems to be a species of the northeastern Atlantic. Plate 54, figs. 6-9 of the *Challenger* report are from a *Porcupine* station off the British Isles; fig. 10 is probably the form recorded by numerous authors from the Pacific under the name of *C. bradyi*.

CASSIDULINA PARKERIANA H. B. BradyPlate 7, figs. 7 *a-c*

Cassidulina 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.

There is a very finely developed specimen of this species from *Nero* station 1702, in the North Pacific, between Guam and Midway Islands, 1,854 fathoms. The distribution of this species seems to be Indo-Pacific in comparatively deep water except in the Antarctic.

11. RECENT FORAMINIFERA FROM BRITISH COLUMBIA

By JOSEPH A. CUSHMAN

Very little is known of the recent foraminifera of the eastern part of the Pacific, in fact, it is one of the least known regions of the world, as far as the foraminifera are concerned. A small collection from this region, therefore, has been of more than usual interest, and fills in records for this almost unknown area. The species have a very definite relationship with the late Tertiary of California, and probably adjacent regions, as well as with the western coast of South America. At least three of the species described by d'Orbigny from the west coast of South America in 1839 have appeared in typical form in the British Columbian material. Only those species of greatest interest, or undescribed, are referred to in this short paper.

HAPLOPHRAGMOIDES ADVENA Cushman, n. sp.Plate 6, figs. 1 *a, b*

Test compressed, involute, close coiled, umbilicate, periphery broadly rounded; last formed coil consisting of about 10 chambers, only slightly inflated; sutures distinct, slightly depressed, very slightly curved; wall arenaceous, mostly of fine material but with numerous angular fragments, aperture a low, curved slit in the base of the apertural face.

Length up to 1.25 mm.; breadth 1 mm.

Type specimens from *Virago* Sound off British Columbia, 8-15 fathoms. It also occurred off Queen Charlotte Island, 20-25 fathoms.

This belongs to the general group of *Haplophragmoides canariensis* d'Orbigny, but is larger and has more chambers than the typical Atlantic form of that species.

HAPLOPHRAGMOIDES COLUMBIENSIS Cushman, n. sp.

Plate 6, figs. 2 a, b

Test small, compressed, very slightly umbilicate, periphery broadly rounded; chambers few, 6 making up the last formed coil, broad and slightly covering the umbilicus; sutures distinct, only slightly depressed, radial; wall smoothly finished of fine arenaceous material, with a very few larger angular grains; aperture very narrow at the base, and slightly to one side of the last-formed chamber.

Length 0.80 mm.; breadth 0.60 mm.

Type specimen from Queen Charlotte Sound, 25 fathoms.

This is a rather unusual form with a completely covered umbilicus, and a few chambers very smoothly finished.

TROCHAMMINA PACIFICA Cushman, n. sp.

Plate 6, figs. 3 a-c

Test small, composed of several coils, 4 to 5 chambers in the last-formed one, all the chambers visible from the dorsal side, only those of the last-formed coil from the ventral side, which is umbilicate, periphery rounded; sutures distinct but only slightly depressed, nearly radial; wall finely arenaceous, smoothly finished, of a yellowish brown color, with a few larger fragments; aperture a narrow slit on the ventral side, at the base of the last-formed chamber.

Diameter 0.40 mm.

Type specimen from off Virago Sound, off British Columbia, 8-15 fathoms. It also occurred in Queen Charlotte Sound, 20-25 fathoms.

TROCHAMMINA CHARLOTTENSIS Cushman, n. sp.

Plate 6, figs. 4 a, b

Test somewhat compressed, the periphery rounded, all the chambers visible from the dorsal side, those of the ventral side of the last-formed coil visible, very slightly umbilicate, 4 or 5 chambers in the last-formed coil; sutures very distinct, much curved on the dorsal side, slightly so on the ventral, the suture representing the line of growth of the coils also sharply distinct but not depressed; wall smoothly finished, dark reddish brown; aperture narrow, ventral near the umbilicus.

Diameter 0.30 mm.

Type specimen from Queen Charlotte Sound, 25 fathoms.

This is very distinct from *Trochammina pacifica* especially in the dorsal surface, which has very distinct, curved sutures, and the ventral side which is much less umbilicate.

BULIMINELLA ELEGANTISSIMA (d'Orbigny)

Plate 6, figs. 5 *a*, *b*

Bulimina elegantissima d'ORBIGNY, Voy. Amér. Mérid. 1839, "Foraminifères", p. 51, pl. 7, figs. 13, 14.

In Virago Sound, 8-15 fathoms, occurred specimens of this species, which are identical with the figured specimens from the west coast of South America given by d'Orbigny. From other parts of the world specimens have been referred to this species, but as a rule they are not so closely identical as are our British Columbian specimens.

CASSIDULINA PULCHELLA d'Orbigny

Cassidulina pulchella d'ORBIGNY, Voy. Amér. Mérid, 1839, "Foraminifères", p. 57, pl. 8, figs. 1-3.—Cushman and Hughes, Contrib. Cushman Lab. Foram. Research, vol. 1, pt. 1, 1925, p. 13, pl. 2, figs. 6 *a*, *b*.

From 25 fathoms, Queen Charlotte Sound, and 8-15 fathoms, Virago Sound, there are specimens which are identical with this species as described and figured by d'Orbigny from the coast of Peru. It has also occurred in the Pliocene of California.

CASSIDULINA TORTUOSA Cushman and Hughes

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

This species, already known from the Pliocene and Pleistocene of California, has occurred in typical form in 25 fathoms, Queen Charlotte Sound.

CASSIDULINA CALIFORNICA Cushman and Hughes

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

There is a single specimen from Queen Charlotte Sound in 25 fathoms, which is identical with this species recently described from the Pliocene and Pleistocene of California.

CASSIDULINA CHARLOTTENSIS Cushman, n. sp.

Plate 6, figs. 6, 7

Test loosely spiral, somewhat conical or cornucopia shaped, consisting of numerous chambers in an alternating biserial arrangement, initial end pointed, apertural end broadly rounded, in front view one side broadly convex, the other with a reëntrant angle; chambers distinct; sutures distinct, curved, but not depressed; wall smooth, punctate, of a yellowish brown color; aperture elongate at the base of the last-formed chamber.

Length up to almost 1 mm.; breadth of largest specimen 0.55 mm.

Type specimens from Queen Charlotte Sound, 20-25 fathoms.

This species is a peculiar one, in many respects resembling *Buliminella convoluta* (Williamson). A careful study of the specimens, however, seems to show a definite alternating series throughout, and it seems to be a *Cassidulina* of a very unusual type of coiling, not greatly unlike *C. bradyi* Norman in some respects. It also reminds one somewhat of a form recently described by Heron-Allen and Earland as *C. laevigata* d'Orbigny, var. *tumida*, from the Antarctic, in the peculiar alternating and coiled structure. This last resemblance, however, is only very remote.

LAGENA ORBIGNYANA (Seguenza)

Plate 6, fig. 8

A specimen which may be referred to this species occurred in 25 fathoms, Queen Charlotte Sound.

POLYMORPHINA CHARLOTTENSIS Cushman, n. sp.

Plate 6, fig. 9

Test large, tapering slightly from the broadly rounded initial end, compressed, with the periphery rounded; chambers comparatively few, irregularly biserial, peculiarly overlapping at one side; sutures fairly distinct but not depressed; wall smooth; aperture radiate.

Length up to 2 mm. or more; breadth 0.65 mm.

Type specimen from Queen Charlotte Sound, 25 fathoms.

This is probably identical with a large species of *Polymorphina*, which is found in the late Tertiary of California.

SPIRILLINA SPINIGERA Chapman, var. **REDUCTA** Cushman, n. var.

Plate 6, fig. 10

This form resembles Chapman's species, but the border is much less spinose, the channel between the coils is very distinctly depressed, and the general surface somewhat roughened.

Diameter 0.55 mm.

Type specimen from Queen Charlotte Sound, 25 fathoms.

DISCORBIS ORNATISSIMA Cushman n. sp.

Plate 6, figs. 11, 12

Test of medium size, thick, nearly circular in outline, the dorsal side broadly rounded, ventral side flattened, very slightly umbilicate in the center, the periphery broadly rounded; chambers few, four in the last-formed coil, distinct but not inflated; sutures distinct but not depressed, on the dorsal side gently curved, on the ventral nearly radiate; wall very coarsely punctate on the dorsal side except the broad band over the sutures and about the periphery, ventral side coarsely papillate with numerous inwardly pointing projections about the umbilicus; aperture ventral, narrow.

Diameter up to 0.80 mm.; thickness 0.30 mm.

Type specimens from Virago Sound, 8-15 fathoms. It also occurred in 20-25 fathoms, Queen Charlotte Sound.

This is one of the most common species in this material, a great many of the specimens showing plastogamy, the 2 chambers being attached by the ventral side, as in plate 6. fig. 12. As is usual in such forms as *Discorbis*, one specimen is very much smaller than the other. The two shown in the figures are nearly equal.

DISCORBIS CHARLOTTENSIS Cushman, n. sp.

Plate 7, figs. 2 a, b

Test minute, pyramidal, in a tapering cone with 5 distinct sides, the angles of the sides being the middle of the chamber; chambers few, 5 in each coil, rather indistinct; sutures not depressed except slightly on the ventral side; radiate; wall rather coarsely perforate; aperture ventral, elongate.

Length 0.20 mm.; diameter 0.15 mm.

Type specimens from Queen Charlotte Sound, 25 fathoms.

This is a very small species allied to some of the other pyramidal forms, which seem to be characteristic of the general Pacific region.

DISCORBIS COLUMBIENSIS Cushman n. sp.Plate 6, figs. 13 *a-c*

Test planoconvex, the dorsal side broadly rounded, ventral side flattened or even concave, the umbilical region much more deeply so, periphery broadly rounded; chambers few, 5 in the last-formed coil, distinct, slightly inflated on the ventral side; sutures distinct, those of the dorsal side gently curved, on the ventral side nearly radiate, that of the last-formed chamber on the ventral side with a distinct angle; wall on the dorsal side becoming more and more coarsely punctate with newly added chambers; aperture umbilicate, elongate.

Diameter 0.33 mm.; thickness 0.15 mm.

Type specimen from Queen Charlotte Sound, 20 fathoms.

This differs from other known species in several characters; the broadly depressed umbilicate region with its peculiarly angled form of the last chamber, the broadening of the chambers in the last-formed coil, and the progressively greater size of the punctae.

PULVINULINA REPANDA Fichtel and Moll

This species, which is typical of tropical and subtropical waters, usually in the vicinity of coral reefs, occurs in this British Columbian material. It is not entirely identical with that from tropical regions, but is very close to material which I have had from Samoa. It is less like the material from coral-reef regions of the West Indies.

PULVINULINA COLUMBIENSIS Cushman, n. sp.Plate 7, figs. 1 *a-c*

Test large, compressed, nearly circular from above, the periphery subacute or rounded, composed in the megalospheric form, which is figured, of but about 2 coils of chambers, the last-formed one with 8 chambers, which is a fairly constant number in the adult, the chambers on the dorsal side very distinct; the sutures clear and limbate, the ventral side very strongly ornamented by a secondary growth of shell material forming an irregular pattern of papillae and bosses, in the last-formed chambers, as in figure 1 *b*, some of the original thin wall of the chambers may be seen; aperture ventral, elongate, between the margin and the umbilical region.

Diameter up to 1.50 mm.; breadth 0.65 mm.

Type specimens from 20 fathoms, Queen Charlotte Sound. It also occurs in Virago Sound, 8-15 fathoms.

This is the largest and most striking species of the collection, and is a very distinctive one, on the dorsal side it resembles some of the other Pacific forms, but the ventral side is distinctive.

NONIONINA AURIS (d'Orbigny)

Plate 7, figs. 3 a-c

Valvulina auris d'ORBIGNY, Voy. Amér. Mérid., 1839, "Foraminifères", p. 47, pl. 2, figs. 15-17.

There is a species in this material which very much resembles the above species of d'Orbigny, described from the west coast of South America. It has, however, fewer chambers, and is a somewhat stouter form. It is very similar to a form which occurs in the late Tertiary of California.

CORNUSPIRA INVOLVENS Reuss

There are a few small specimens which may be referred to this species. Miliolidae are scarce in this British Columbian material.

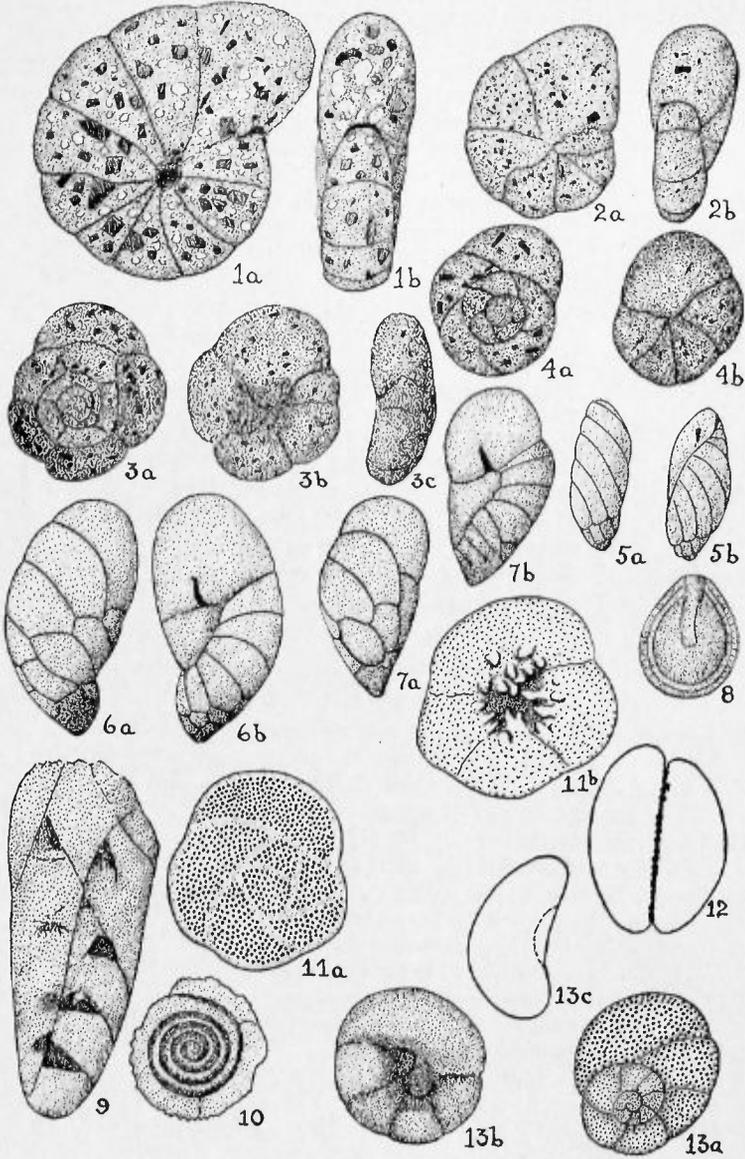
EXPLANATION OF PLATES

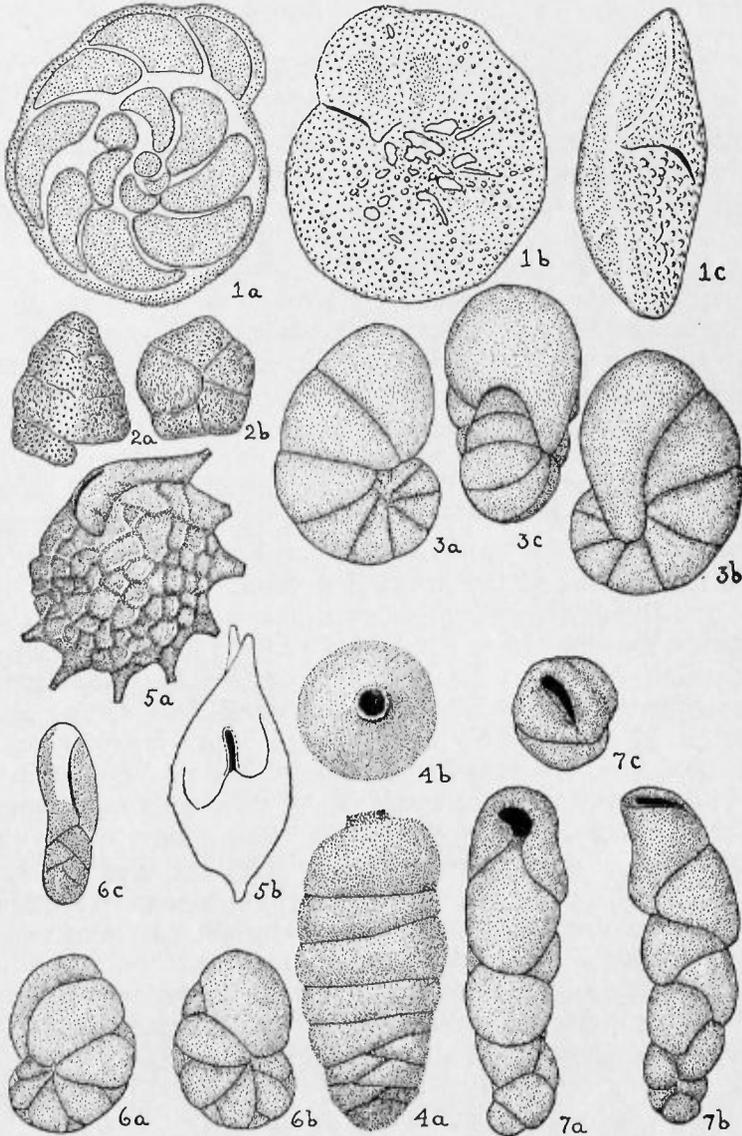
Plate 6

- FIGS. 1, *a, b.* *Haplophragmoides advena* Cushman, n. sp. X 35.
a, side view; *b*, apertural view.
- FIGS. 2 *a, b.* *Haplophragmoides columbiensis* Cushman, n. sp. X 35.
a, side view; *b*, apertural view.
- FIGS. 3 *a, c.* *Trochammina pacifica* Cushman, n. sp. X 66.
a, dorsal view; *b*, ventral view; *c*, peripheral view.
- FIGS. 4 *a, b.* *Trochammina charlottensis* Cushman, n. sp. X 66.
a, dorsal view; *b*, ventral view.
- FIGS. 5 *a, b.* *Buliminella elegantissima* (d'Orbigny). X 66.
a, dorsal view; *b*, ventral view.
- FIGS. 6, 7. *Cassidulina charlottensis* Cushman, n. sp. X 35.
a, dorsal view; *b*, ventral view.
- FIG. 8. *Lagena orbignyana* (Seguenza). X 66.
 Front view.
- FIG. 9. *Polymorphina charlottensis* Cushman, n. sp. X 25.
 Front view.
- FIG. 10. *Spirillina spinigera* Chapman, var. *reducta* Cushman, n. var. X 35.
- FIGS. 11 *a, b, 12.* *Discorbis ornatissima* Cushman, n. sp. X 35.
 11 *a*, dorsal view; 11 *b*, ventral view; 12, peripheral view of the plastogamic pair.
- FIGS. 13 *a-c* *Discorbis columbiensis* Cushman, n. sp. X 66.
a, dorsal view; *b*, ventral view; *c*, peripheral view.

PLATE 7

- FIGS. 1 *a-c.* *Pulvinulina columbiensis* Cushman, n. sp. X 25.
a, dorsal view; *b*, ventral view; *c*, peripheral view.
- FIGS. 2 *a, b.* *Discorbis charlottensis* Cushman, n. sp. X 125.
a, front view; *b*, ventral view.
- FIGS. 3 *a-c.* *Nonionina auris* (d'Orbigny). X 66.
a, dorsal view; *b*, ventral view; *c*, peripheral view.
- FIGS. 4 *a, b.* *Siphogenerina hughesi* Cushman, n. sp. X 35.
a, front view; *b*, apertural view.
- FIGS. 5 *a, b.* *Cassidulina ornatissima* Cushman, n. sp. X 30.
a, front view; *b*, apertural view.
- FIGS. 6 *a-c.* *Cassidulina orientale* Cushman, n. sp. X 66.
a, dorsal view; *b*, ventral view; *c*, apertural view.
- FIGS. 7 *a-c.* *Cassidulina parkeriana* H. B. Brady. X 50.
a, b, side views; *c*, apertural view.





12. FORAMINIFERA AS AN ORIGINAL SOURCE OF PETROLEUM

By JOSEPH A. CUSHMAN

There have been a very few suggestions made by palaeontologists working with petroleum problems that the foraminifera might be one of the sources of petroleum. This has been largely due to the fact that foraminifera are closely associated with oil bearing strata in many of the Tertiary and Cretaceous oil fields in various parts of the world. They also occur abundantly in the Subcarboniferous. In the Cretaceous and Tertiary particularly the forms found are reasonably closely allied to recent genera, and something may be definitely said about conditions in comparison with the present day ocean.

Very little has been done along the line of study of the living forms. However, I had an opportunity at the Tortugas Laboratory of the Carnegie Institution to study living tropical forms allied to such forms as occur in the Tertiary and Upper Cretaceous. One of the interesting results of this study was that the living protoplasm of many foraminifera, if not all, contain a greater or less amount of actual oil globules, usually of a yellowish color. In some genera and species these seem to be much more abundant than in others, and the resulting accumulation, if buried under favorable conditions, might conceivably produce a considerable amount of material, which later might be transposed into petroleum, or at least its early stages.

Another source, in connection with the foraminifera, is that many of the species, especially in tropical regions, have associated with them commensal algae, which are of low types, and in themselves might contribute materially to the source of material, which later might become petroleum.

A study of such living forms, especially in relation to their oil content, might prove very interesting from the point of view of their possibility as one of the original sources of petroleum.

RECENT LITERATURE ON THE FORAMINIFERA

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

Vaughan, T. W.

American and European Tertiary Larger Foraminifera.

(Bull. Geol. Soc. America, vol. 35, No. 4, 1924, pp. 785-822, pls. 30-36, text figures 1-6.) *Washington.*

A preliminary paper to a more comprehensive one on these larger forms. Several changes in the generic nomenclature are made, a new subgenus of *Lepidocyclina-Poly-lepidina* is described, as well as five new species of various genera.

Applin, E. R., Ellisor, A. E., and Kniker, H. T.

Subsurface Stratigraphy of the Coastal Plain of Texas and Louisiana.

(Bull. Amer. Assoc. Petrol. Geol., vol. 9, No. 1, 1925, pp. 79-122, pl. 3.) *Chicago.*

The Tertiary stratigraphy of this region is discussed at length, the faunal zones based on the small foraminifera which are found to be of great value. Mrs. Applin describes six new species and varieties which are figured.

Ozawa, Y.

On the Classification of Fusulinidae.

(Journ. Coll. Sci. Imper. Univ. Tokyo, vol. 45, Art. 4, 1925, pp. 1-26, pls. 1-4.) *Tokio.*

An important work for this family, giving keys to the subfamilies and genera, and discussing structure and phylogenetic relations. Many excellent figures are given and a new genus *Stafella* is described.

Yabe, H., and Hanzawa, S.

A Geological Problem concerning the Raised Coral-Reefs of the Riukiu Islands and Taiwan; A Consideration Based on the Fossil Foraminifera Faunas Contained in the Raised Coral-Reef Formation and the Youngest Deposits Underlying It.

(Sci. Rep. Tohoku Imper. Univ., ser. 2 [Geol.], vol. 7, No. 2, 1925, pp. 29-56 [1-28], pls. 5-10, [1-6].) *Tohoku. Sendai*

The relations of the foraminifera in the raised reefs to other known living faunas of the Indo-Pacific are given, and interpretations given. Many excellent figures from photographs are given. A full discussion is given of several species. There is one new variety of *Calcarina*.

Cushman, J. A.

An Eocene Fauna from the Moctezuma River, Mexico.

(Bull. Amer. Assoc. Petrol. Geol., vol. 9, No. 2, 1925, pp. 298-303, pls. 6-8.) *Chicago.*

Both the foraminifera and ostracoda of this Eocene deposit are described and figured. Five new species and one new variety of foraminifera are described, and three new species of ostracods.

Koch, R.

Die jungtertiäre foraminiferenfauna von Kabu (Res. Surabaja, Java).

(Ber. Schweizerischen Paläontologischen Gesellschaft, vol. 18, No. 2, 1923, pp. 342-361, 11 text figures.) *Basel.*

There are one hundred and seven species noted from this late Tertiary of Java. There are ten text figures illustrating the newly described forms, of which three are new species, five new varieties, and one unnamed *Globigerina*.

Koch, R.

Eine jungtertiäre Foraminiferenfauna aus Ost-Seran.

(Ber. Schweizerischen Paläontologischen Gesellschaft, vol. 19, No. 1, 1925, pp. 207-213, figs. 1-7 [in text].) *Basel.*

Eighty-five species and varieties are listed from this Pliocene material of which six are described and figured as new.

Cushman, J. A.

The genera *Pseudotextularia* and *Guembelina*.

(Journ. Washington Acad. Sci., vol. 15, 1925, pp. 133, 134.) *Washington.*

Notes on these two Upper Cretaceous genera are given, and the relations of certain of the Mexican species to those of Europe.