Foraminifera of the
Lodo Formation
Central California

Part 2, Calcareous Foraminifera (Miliolidae and Lagenidae, part)

GEOLOGICAL SURVEY PROFESSIONAL PAPER 240-B
Foraminifera of the Lodo Formation
Central California

By M. C. ISRAELSKY

Part 2, Calcareous Foraminifera (Miliolidae and Lagenidae, part)

A study of the foraminiferal fauna of a Paleocene and Eocene formation of scientific and economic importance

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Stratigraphic distribution of calcereous Foraminifera in the Lodo formation of northwestern Tumey Hills | In pocket
FORAMINIFERA OF THE LODO FORMATION
CENTRAL CALIFORNIA

BY
M. C. ISRAELSKY

PART 2, CALCAREOUS FORAMINIFERA (MILIOLIDAE AND LAGENIDAE, PART)

ABSTRACT

In part 2 are described and illustrated 169 species or other systematic variations, one a miliolid, the others belonging to the lagenid genera Oristellarina, Robulus and Hemirobula. Most of the systematic variations are too rare to merit naming. Their observed stratigraphic distribution is shown in a table.

STRATIGRAPHIC DISTRIBUTION OF MILIOLIDAE AND LAGENIDAE, PART

The distribution of the 169 forms here considered in the sampled sections of the Lodo formation is shown in the table (in pocket). The thickness of the sections and the stratigraphic positions of the samples listed in the table are shown in plate 1 (in pocket, Part I). The names of the Foraminifera are listed from left to right in order of their highest stratigraphic appearance within each genus.

SYSTEMATIC DESCRIPTIONS

Family MILIOLIDAE

Except for the following form, the family is represented in this section of the Lodo formation by only a few internal molds, probably of Quinqueloculina.

Genus SIGMOILINA Schlumberger 1887

Sigmoilina frequens Israelsky n. sp.

Plate 12, figures 1-13

Test compressed, proportions of length to width somewhat variable, lateral surfaces subflattened, concave-convex transversely, thickest near rounded periphery, width of exposed portions of chambers subequal, with either the final pair or earlier chambers appearing slightly the wider; chambers and sutures flush, though refraction makes the former appear raised and the latter depressed; last chamber terminated with neck that tends to point along the longitudinal axis, the opposite end of last chamber projecting in varying degree; aperture a subelliptical to circular opening in the terminal neck without tooth or swelling; in transverse cross section test weakly sigmoid, the microspheric form (plate 12, fig. 8) showing the first two chambers twisted about 40 degrees with respect to a median line and cavities lie on a distinctly sigmoid line; megaspheric form less obviously sigmoid.

Specimen | Sample | USNM | Dimensions in millimeters
--- | --- | --- | ---
Paratype | 67 548651 | 0.38 | 0.19 | 0.06
Paratype | 67 548652 | 0.38 | 0.28 | 0.06
Paratype | 75 548653 | 0.39 | 0.24 | 0.06
Paratype | 75 548654 | 0.39 | 0.24 | 0.06
Paratype | 75 548655 | 0.39 | 0.24 | 0.06

Very similar is Sigmoilina tenuis (Czjzek), the type figure of which was reillustrated by Cushman (1946a, pi. 5, fig. 13, Miocene), though that species appears more compressed, has chambers increasing more noticeably in width with growth, and has the test proportionately narrower and with the early end of the final chamber projecting less strongly. Cushman's description (p. 32) does not mention a tooth, but does note that the early portion is quinqueloculine.

S. frequens is probably the species referred to by L. Martin (1943, p. 12, Eocene) as Spiroloculina sp. of Church (1931, pi. A, fig. 11, Eocene). Church's form appears more like Sigmoilina tenuis (Czjzek) than the present species.

The sigmoid cross section precludes this species being placed in Spiroloculina, the lack of a quinqueloculine early portion is abnormal for Sigmoilina and the early portion of the microspheric form seems biloculine as in Flintia. Each of these three genera has a toothed aperture.

The closest relationship appears to be with Sigmoilina and there the species is tentatively so placed.

Family LAGENIDAE

In measurements given for the coiled lagenids the length is considered to be the distance from the apical
angle through the center of the umbo (or umbilicus) to the periphery. Width is considered the distance between two lines erected parallel to the length and tangent to the periphery (text fig. 3).

Marie's (1941, p. 97, 98) terms "greater" or "final" diameter coincide with the present use of "length." His "median diameter" is the distance along a line at right angles to the length (his greater diameter) through the center of the umbo, between the two intercepts with the periphery. In the tightly coiled forms width as here used agrees closely with Marie's median diameter; in the more eccentric forms a marked departure may result.

Marie's scheme, proposed for planispiral Foraminifera in general, affords a method of expressing the degree in which the spiral flares. It appears that the method lends itself to evolute forms, although it would be more readily applicable to involute forms if they were sectioned.

**Genus CRISTELLARIA Lamarck 1816**

In using *Cristellaria* Lamarck 1816 rather than *Lenticulina* Lamarck 1804 the reasoning of H. E. Thal- mann (1949, pp. 508-509) has been accepted. His contention that the original figure of the genotype of *Lenticulina, Lenticulina (Lenticulities) rotulata* Lamarck 1804 (figured 1806), does not represent a foraminifer seems justified. Certainly the Foraminifera subsequently assigned to this species have little resemblance to the original figure.

Fortunately, as Thalmann points out, *Cristellaria* Lamarck 1816 with the genotype *Cristellaria producta* Lamarck 1816, is available.

*Cristellaria proinops* Israelsky n. sp.

Plate 12, figures 14, 15

In side view subovate, acutely pointed at apertural end, rounded at opposite end, final margin of last cham-
vex and rounding into lateral faces of final chamber, apertural process poorly defined, aperture apparently terminal with three radiating ridges on final face.

**Robulites iotus** (Cushman) as figured by Cushman and Cahill (1933, pl. 4, fig. 1, Miocene) has some resemblance in edge view but is proportionately thinner, has more strongly bowed sutures and lacks the conspicuous keel of *Cristellaria sp. B*.

**Cristellaria sp. C**

Plate 12, figures 20, 21

In side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber meeting periphery of earliest visible chamber in an obtuse angle, earlier sutures raised, last two depressed with corresponding inflation of last two chambers, sutures nearly straight, tangential to umbo, inclined backwards and meeting the periphery at about 45 degrees except for the last two which approximate 60 and 90 degrees respectively, umbo subcentral, height of chambers at periphery increasing regularly, well defined thin keel on all chambers; in edge view subelliptical, produced at end away from aperture, outline from umbos to apertural end somewhat sinuous, greatest thickness through umbos, apertural area broken but apparently terminal and simple.

**Cristellaria sp. D**

Plate 12, figures 22, 23

In side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber forming an acute angle, final margin of last chamber and periphery of early portion of test meeting in an obtuse angle, sutures broad, flush, very slightly reflexed, the last almost perpendicular to periphery, umbonal area central, well-defined rim on periphery; in edge view subelliptical, thickest through umbonal region, septal face convex and grading smoothly into lateral faces of final chambers; aperture terminal with fine radial grooving.

---

### Dimensions in millimeters

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Sample</th>
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<th>Length</th>
<th>Width</th>
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<td>0.35</td>
<td>0.45</td>
<td>0.25</td>
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**Cristellaria** sp. D is similar in side view to *Robulites* sp. BN but lacks the robuline slit and flattened final face of that species.

**Cristellaria mediolodensis** Israelsky n. sp.

Plate 12, figures 24, 25

In side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber merging with periphery of earliest visible chamber without offset, sutures flush, earliest radial, nearly straight and meeting periphery at nearly 90 degrees, later sutures tangential to umbo, two previous to last weakly reflexed, meeting periphery at about 45 degrees, the last slightly sinusous and meeting periphery at nearly 90 degrees, umbo slightly eccentric, height of chambers at periphery irregular, rim well defined on early chambers, poorly defined on later; in edge view subelliptical, weakly produced at either end, greatest thickness through umbos, final face strongly convex blending imperceptibly into lateral faces of final chamber; aperture terminal with few radial striae.

**Cristellaria socia** Israelsky n. sp.

Plate 12, figures 26–29

In side view subovate, apertural end acutely pointed, opposite end rounded, final margin and periphery of earliest visible chamber forming an obtuse angle, sutural bands flush, all tangential to umbo, strongly reflexed, meeting periphery at about 45 degrees, umbo slightly eccentric, height of chambers at periphery irregular, fairly well defined rim present, better developed on large than on small specimens; in edge view subelliptical, somewhat produced at end away from aperture, greatest thickness through umbos, septal face heart-shaped, weakly convex and rounding into lateral faces of final chamber; apertural process subconoidal, aperture terminal with radial ridges and grooves.

---

### Dimensions in millimeters

<table>
<thead>
<tr>
<th>Specimen</th>
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**Cristellaria** sp. C superficially but is proportionately broader, more umbonate, all sutures tangential and a robuline slit is present.

**Cristellaria convergens** Bornemann of Brady, (1884, pl. 69, figs. 6, 7, Recent) has less excentric umbos, is proportionately thinner and also shows a robuline slit.

**Cristellaria socia** Israelsky n. sp.

Plate 12, figures 26–29

In side view subovate, apertural end acutely pointed, opposite end rounded, final margin and periphery of earliest visible chamber forming an obtuse angle, sutural bands flush, all tangential to umbo, strongly reflexed, meeting periphery at about 45 degrees, umbo slightly eccentric, height of chambers at periphery irregular, fairly well defined rim present, better developed on large than on small specimens; in edge view subelliptical, somewhat produced at end away from aperture, greatest thickness through umbos, septal face heart-shaped, weakly convex and rounding into lateral faces of final chamber; apertural process subconoidal, aperture terminal with radial ridges and grooves.
The opening near the aperture in fig. 27 is due to breakage.

This species bears a close resemblance to *Robulus fresnoensis* Israelsky n. sp., but that species has a partially angulate outline, a less distinctive apertural process without striae, a more convex final face and a robuline slit.

**Cristellaria sp. E**  
Plate 12, figures 30, 31

In side view, subovate, subtrigonal, bluntly pointed at apertural end, rounded at opposite end, final margin strongly bowed, meeting periphery of earliest visible chamber in a high obtuse angle, sutural bands flush, weakly reflexed, narrowing from umbo toward periphery, all except earliest sutures meeting periphery at about 45 degrees, first few sutures radial from umbo, later sutures tangential to umbo, umbo sub-central, height of chambers at periphery irregular, well-defined rim on all chambers; in edge view, sub-elliptical, greatest thickness through umbos, septal face elongate heart-shaped, strongly convex and merging imperceptibly with lateral faces of final chambers, apertural process subconoidal, aperture terminal with some radial striae present.

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A form figured by Cushman (1922, pl. 4, fig. 2, side view only, Oligocene) as *Cristellaria convergens* Bornemann has superficial resemblance but is much closer coiled and the final suture is much less curved.

**Cristellaria sp. F**  
Plate 12, figures 32, 33

In side view subovate, apertural end bluntly pointed, opposite end rounded, periphery of final chamber straightened, giving an angulate appearance, final margin merging into periphery of first visible chamber without offset, sutural bands flush, weakly reflexed, irregularly varying from tangential to radiate from umbo, meeting periphery irregularly at from about thirty degrees to right angles, umbo eccentric, height of chambers at periphery irregular, well-defined rim on all chambers; in edge view sub-elliptical, greatest thickness through umbos, septal face strongly convex, heart-shaped, merging smoothly with lateral faces of final chamber, apertural region broken, probably with simple terminal radiate aperture.

<table>
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<tr>
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<td>0.40 0.33 0.23</td>
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This form is much like *Robulus fresnoensis* Israelsky n. sp., but even the relatively small specimen figured shows a more eccentric umbo. The apertural process of *C. sp. F* probably projects more than that of *R. fresnoensis*.

**Cristellaria sp. G**  
Plate 12, figures 36, 37

In side view angulate ovate, the final chamber broadly pointed, the opposite end rounded, periphery of early portion smoothly curved, that of each of the last two chambers nearly straight and meeting at an obtuse angle, final margin and periphery of earliest visible chamber meeting at a high obtuse angle, sutures flush, reflected, umbo eccentric, peripheral height of earlier chambers subequal, height of last two each nearly three times that of the earlier chambers, periphery with weak suggestion of rim; in edge view, sub-elliptical, compressed, slightly produced at either end, greatest thickness through umbos, septal face convex, not distinctly separated from lateral faces of final chamber, apertural process subconoidal, prominent, aperture terminal, no radial striae observed.

<table>
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In side view this species might easily be mistaken for *Robulus sp. BS*. but that species has a depressed final face and a robuline slit.

**Cristellaria sp. A** is similar but lacks the crowded early chambers and at the same size stage has but one chamber with straightened periphery and the sutures become more nearly tangential to the umbo.

**Cristellaria subangulata** Reuss as interpreted by Franke (1925, pl. 6, fig. 11, Cretaceous) seems to be the most similar figured form but its length is proportionally greater, its umbo is more eccentric, the peripheral height of its chambers is more regular and the final margin meets the periphery of the earliest visible chamber in a low, rather than high, obtuse angle.

**Cristellaria sp. H**  
Plate 12, figures 38, 39

In side view subovate, apertural end acutely pointed, opposite end rounded, periphery of last three chambers straightened with resultant angulate appearance, final margin of last chamber forming obtuse angle with periphery of first visible chamber, sutures flush, gently reflexed, first visible suture tangent to umbo, remainder radiate, first suture meeting periphery at about 45 degrees, others at nearly right angles, umbo sub-central, somewhat raised, no rim apparent, height of
chambers at periphery irregular; in edge view subelliptical, slightly produced toward both ends from umbo, greatest thickness through umbos, contact between lateral faces sharp, acutely rounded, septal faces broken on available specimens, probably strongly convex, aperture terminal, radiate in unfigured specimen from sample 81.

<table>
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<td>Length 0.55 Width 0.71 Thickness 0.43</td>
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The nearest figure appears to be that of Cristellaria polygona Perner (1892, pl. 5, figs. 3, 4, Cretaceous) but that species is angulate throughout, more closely coiled and proportionally thicker than Cristellaria sp. H. Robulus pondi Cushman (1931a, pl. 2, fig. 9, Cretaceous) is also angulate throughout, but the umbo is more nearly central.

**Cristellaria sp. I**

Plate 12, figures 34, 35

In side view broadly subovate, the apertural end obtusely pointed, opposite end rounded, periphery of each of last four chambers tending to straighten giving an angulate appearance, final margin of last chamber and periphery of earliest visible chamber meeting without offset, a weak node present at the peripheral juncture of the last two chambers, sutures nearly straight, slightly reflexed, meeting periphery at high angles, umbo subcentral, height of chambers at periphery irregular, well developed rim on first few chambers only; in edge view subelliptical, slightly produced at end away from aperture, greatest thickness through umbonal area, septal face heart-shaped, convex, merging into lateral faces of final chamber, aperture terminal in subconoidal process with fine radiating striae.

<table>
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<th>Specimen</th>
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<td>Length 0.55 Width 0.38 Thickness 0.26</td>
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</table>

The form figured by Franke (1927, pl. 2, fig. 18, Paleocene) as Cristellaria beyrichi Bornemann is very similar, but has more numerous chambers, the sutures are more strongly arched and a callus is lacking at the umbo. Large suites from the two localities might well show the two forms to be intergradational.

**Cristellaria sp. K**

Plate 12, figures 44, 45

In side view subovate, apertural end acutely pointed, opposite end rounded, periphery of last two chambers straightened, resulting in an angulate appearance, final margin of last chamber merging with periphery of earliest visible chamber without offset, sutures flush, gently reflexed, meeting periphery at various angles, about 45 to 90 degrees without regular sequence, umbo slightly eccentric, height of chambers at periphery irregular, rim poorly defined; in edge view subelliptical, greatest thickness through umbo, septal face heart-shaped, somewhat flattened, rounding into lateral faces of final chamber; aperture terminal in subconoidal process with radiating ridges.

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Sample USNM</th>
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<td>Length 0.27 Width 0.20 Thickness 0.14</td>
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**Cristellaria sp. L**

Plate 12, figures 46, 47

In side view subhemicircular, apertural end acutely pointed, opposite end rounded, final face of last chamber and periphery of earliest visible chamber meeting in almost a straight line, sutures flush, slightly reflexed, meeting periphery at angles approaching 90 degrees, radiate from umbo, umbo strongly eccentric, raised, height of chambers at periphery apparently increasing regularly, poorly developed rim on early portion of periphery only; in edge view fusiform, produced at both ends, greatest thickness through swollen umbos, septal face convex, elongate, about three times as long as thick, bounded laterally by umbonal area and lateral faces of final chambers into which it grades imperce-
tibly; aperture terminal in produced subconical process with radiating striae.

<table>
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<th>Specimen</th>
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<td>548971</td>
<td>Length Width Thickness</td>
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The form called *Lenticulina navicula* (d'Orbigny) by Cushman and Renz (1946, pl. 3, fig. 26, Cretaceous) has some resemblance but is not fusiform in edge view. Their form is not conspecific with that figured under the same name by Cushman and Jarvis (1982, pl. 7, fig. 5, Cretaceous) which has an inflated final chamber and differs otherwise from Cushman and Renz's form and from *Cristellaria* sp. L.

### Cristellaria? sp. M

Plate 12, figures 40, 41

In side view subovate, aperture end acutely pointed, opposite end rounded, periphery of at least each of last three chambers straightened, giving angular appearance, final margin of last chamber and periphery of earliest visible chamber meeting in an obtuse angle, sutures raised, gently reflexed, radial, meeting periphery at 45 degrees and higher angles, umbo eccentric, somewhat raised, height of chambers at periphery increasing irregularly, well-defined rim on all chambers; in edge view subelliptical, thickest through umbos, sides somewhat produced toward either end, septal face of available specimens broken, probably weakly convex, aperture not seen but probably terminal.

<table>
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<tr>
<th>Specimen</th>
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<tr>
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<td>548972</td>
<td>Length Width Thickness</td>
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*Robulus pondi* Cushman (1946, pl. 16, figs. 1–5 Cretaceous) and *Cristellaria secans* Reuss var. *angulosa* Chapman (1896, pl. 1, fig. 4, Cretaceous) are both related but each is angular throughout its periphery.

### Cristellaria? sp. N

Plate 12, figures 48, 49

In side view subovate, aperture end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber meeting in slight sinus, sutural bands gently reflexed, meeting periphery irregularly from about 45 to nearly 90 degrees, radial from umbo, umbo eccentric, height of chambers at periphery increasing gradually, poorly defined rim on periphery of all chambers; in edge view subelliptical, greatest thickness through umbos, septal face convex, elongate, grading imperceptibly into lateral faces of final chamber, aperture area broken in available specimens but aperture probably terminal.

<table>
<thead>
<tr>
<th>Specimen</th>
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<tr>
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<td>70</td>
<td>548973</td>
<td>Length Width Thickness</td>
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A figure referred to *Robulus discrepans* (Reuss) (Cushman, 1946, pl. 17, fig. 15, Cretaceous) is very similar in side view, but has a concave final face and a robustine slit.

Though none of fairly numerous specimens shows an elongate uniserial portion the species might perhaps be better placed in *Vaginulinopsis*.

### Cristellaria sp. P

Plate 12, figures 54, 55

In side view subovate, irregularly weakly angulate, aperture end acutely pointed, opposite end rounded, final margin and periphery of earliest visible chamber
forming very wide obtuse angle, sutures flush, gently reflexed, radiate from umbo, earlier sutures not discernible, last two meeting periphery at about 45 degrees, umbo eccentric; in edge view subelliptical, greatest thickness through umbos, septal face heart-shaped, weakly convex, rounding into lateral faces of final chamber; apertural process subconoidal, aperture terminal with radiate ridges appearing on the final face giving the false appearance of a robuline aperture.

Specimen Sample USNM Dimensions in millimeters
Figured. 71 548976 Length Width Thickness

Cristellaria sp. Q
Plate 13, figures 1, 2

In side view angulate ovate, the final chamber broadly pointed, the opposite end rounded, periphery of early portion smoothly curved, that of each of the last two chambers nearly straight, meeting at an obtuse angle, final margin of last chamber and periphery of earliest visible chamber meeting in an obtuse angle, sutures flush, gently reflexed, radial from umbo, umbo eccentric, height of last three chambers at periphery subequal, suggestion of rim only; in edge view subelliptical, slightly produced at apertural end, opposite end rounded, final margin and periphery of earliest visible chamber meeting without offset, forming an almost straight line, periphery weakly angled at intersections with sutures, sutures straight, radiate from umbo, meeting periphery irregularly at angles ranging from about 45 to nearly 90 degrees, umbo subcentral, height of chambers at periphery irregular, rim poorly defined; in edge view subovate, apertural end slightly produced, rim projecting at opposite end, greatest thickness through umbos, septal face convex, merging imperceptibly with lateral faces of final chamber, aperture terminal in protruding compressed subconoidal process, no radial striae noted.

Specimen Sample USNM Dimensions in millimeters
Figured. 641' 548977 Length Width Thickness

The closest figure appears to be one referred to Cristellaria convergens Bornemann by Cushman (1931, pl. 44, fig. 4, Recent) but that form is thinner and less angulate, its later sutures are more tangential, and an earlier whorl is exposed in the umbonal area.

Cristellaria sp. G has similar outlines but the pre-angulate chambers are much more crowded. Possibly it represents the microspheric form of Cristellaria sp. Q.

Cristellaria sp. R
Plate 13, figures 3, 4

In side view roundly subtrigonal, final chamber acutely pointed, apertural process somewhat produced, opposite end rounded, periphery of final chamber nearly straight, final margin of last chamber and periphery of earliest visible chamber meeting in an obtuse angle, sutures flush, nearly straight, meeting periphery at from about 45 to nearly 90 degrees, early sutures radial, last tangential to umbo and transgressing it, umbo very eccentric, height of chambers at periphery irregular, weak rim on early chambers; in edge view broadly subelliptical, produced at either end, greatest thickness through umbos, septal face convex, blending imperceptibly into lateral faces of final chamber; aperture terminal, in produced end of final chamber, no radial striae noted.

Specimen Sample USNM Dimensions in millimeters
Figured. 38 548980 Length Width Thickness

This form bears a superficial resemblance to Cristellaria convergens Bornemann as interpreted by Chapman (1896, pl. 1, fig. 6, Cretaceous).

Cristellaria sp. T
Plate 13, figures 7, 8

In side view elongate, roundly subtrigonal, with parts of five slightly inflated chambers visible, first three visible chambers closely coiled, fourth truncating the first, a broken fifth chamber in contact with only the terminal half of the final face of the fourth chamber, last three chambers practically uniserial, sutures strongly depressed, those of coiled portion radiate, umbo slightly excentric, height of the fully exposed chambers at periphery subequal, no rim nor keel developed; in edge view subelliptical, strongly compressed, thickest through the early coiled portion, sides of fourth visible chamber parallel with those of the fifth visible chamber converging toward aperture; apertural area not seen.
Cristellaria rotabilis Israelsky n. sp.

Plate 13, figures 9, 10

Test lenticular; in side view subcircular, apertural end very bluntly pointed, opposite end rounded, final margin and periphery of earliest visible chamber forming a high obtuse angle; sutural bands proportionately wide, flush, comma-shaped with greatest width toward umbo, tangent to umbo and meeting periphery at about 45 degrees, umbo central, height of chambers at periphery irregular, well-defined keel on all chambers; in edge view subelliptical, somewhat produced at either end, greatest thickness through umbos, septal face elongate arrow-shaped, strongly concave, bounded on either side by rounded rims; apertural process terminal, subconoidal, with the aperture a simple opening within radiating striae.

Specimen Sample USNM Dimensions in millimeters
Holotype.................. 64 548982 Length Width Thickness 0.34 0.31 0.18

This species might be mistaken for Robulus pudibundus Israelsky n. sp. in side view, but the lack of a robuline aperture and the constricted final face distinguishes it from that apparently longer ranging species.

Cristellaria turbinata Plummer (1926, pl. 7, fig. 4, pl. 13, fig. 2, Eocene) is a similar form but it is notably thinner and its sutures are proportionally narrower and less commalike and tend to be raised. Under the name Robulus turbinatus (Plummer), Cushman (1940, pl. 9, fig. 17, Paleocene), Kline (1943, pl. 1, fig. 7, Paleocene) and Harris and Jobe (1951, pl. 3, fig. 15, Paleocene) all illustrate side views only which appear to be Plummer's species. Some other references seem to be in error.

Cristellaria incuriosa Israelsky n. sp.

Plate 13, figures 11, 12

Test lenticular; in side view polygonally subcircular, periphery straightened on all except first two chambers (were it is rounded) some points of angulation not coincident with intersections of sutures and periphery, apertural end obtusely pointed, opposite end angulate, final margin of last chamber straight, meeting periphery of earliest visible chamber forming an obtuse angle, sutures slightly reflected, later nearly straight, all radiating from umbo, meeting periphery irregularly at angles from about 45 to nearly 90 degrees, umbo subcentral, height of chambers at periphery irregular, well-defined rim on all chambers; in edge view crudely subelliptical, swollen through the umbos, produced toward either end, septal face flattened, slightly depressed, elongate subtriangular, bounded on either side by low rims; aperture terminal in inconspicuous process with radial striae.

Specimen Sample USNM Dimensions in millimeters
Holotype.................. 548983 Length Width Thickness 0.55 0.48 0.30

Cristellaria perna Israelsky n. sp.

Plate 13, figures 13, 14

In side view subovate, roundly subtrigonal, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber meeting in a high obtuse angle, sutures flush, earlier ones reflected, later nearly straight, all radiating from umbo, meeting periphery irregularly at angles from about 45 to nearly 90 degrees, umbo subcentral, height of chambers at periphery irregular, well-defined rim on all chambers; in edge view subelliptical, swollen through the umbos, produced toward either end, septal face flattened, slightly depressed, elongate subtriangular, bounded on either side by low rims; aperture terminal in subconoidal process with radial striae.

Specimen Sample USNM Dimensions in millimeters
Holotype.................. 18 548984 Length Width Thickness 0.57 0.56 0.36

Cristellaria sp. U

Plate 13, figures 9, 10

In side view subovate, weakly subquadrate, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutures slightly reflected, almost straight, tangent to umbo, meeting periphery at about 45 degrees, umbo subcentral, somewhat raised, height of chambers at periphery irregular, poorly defined rim present; in edge view subelliptical, greatest thickness through umbos, septal face heart-shaped, weakly concave, bounded on either side by a low rounded rim, aperture terminal in inconspicuous process with radial ridges.

Specimen Sample USNM Dimensions in millimeters
Figured.................... 18 548984 Length Width Thickness 0.57 0.56 0.36

The darkened radial ridge extending onto the final face gives the false appearance of a robuline aperture in the illustration.

Lenticulina incrassata Marie (1941, pl. 10, fig. 108, Cretaceous) is less quadrate, more loosely coiled and more strongly produced at the end away from aperture than the present form.

Cristellaria sp. V

Plate 13, figures 17, 18

In side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber
meeting periphery of earliest visible chamber in a high obtuse angle, periphery of last chamber nearly straight giving slight angularity to outline, sutureal bands slightly curved, early bands radiate, later tangent to umbo, meeting periphery irregularly at various angles, umbo subcentral, height of chambers at periphery irregular, rim well defined on early chambers, indistinct on later; in edge view outline subelliptical, greatest thickness through umbos, septal face elongate heart-shaped, flattened but not depressed, rounding into lateral faces of final chamber, aperture terminal in produced subconoidal process with radial striae.

**Cristellaria sp. W**

Plate 13, figures 19, 20

In side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber meeting in an obtuse angle, final suture slightly depressed, others flush, all gently flexed, earlier sutures tangent to umbo, later radiate, sutures meeting periphery at about right angles, umbonal areas eccentric, height of chambers at periphery irregular, rim poorly defined; in edge view subelliptical, compressed, greatest thickness through the umbos, septal face elongate heart-shaped, weakly depressed, bounded on either side by low rounded ridge; aperture terminal in subconoidal projection with radial striae.

**Cristellaria sp. X**

Plate 13, figures 21, 22

In side view subovate, apertural end broadly pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber meeting in wide obtuse angle, periphery of last two chambers straightened giving weak angulate appearance, sutures flush, earliest almost straight, intermediate sutures gently bent, last suture straight, all sutures tangent to umbo, sutures meeting periphery irregularly at various angles from about 45 to nearly 90 degrees, umbo eccentric, callused, height in chambers at periphery irregular, well-defined rim on all chambers; in edge view subelliptical, greatest thickness through umbos, septal face flattened, elongate, heart-shaped, rounding into lateral faces of final chamber, aperture terminal in subconoidal process with striae present.
Cristellaria sp. AA
Plate 13, figures 27, 28

In side view, subovate, the final chamber obtusely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutures flush, gently reflexed, tangent to umbonal area, meeting periphery at about 45 degrees, umbo eccentric, rim on all chambers but best defined on earlier half of periphery; in edge view broadly subelliptical, somewhat produced at end away from aperture, septal face subtrigonal heart-shaped, depressed, bounded on either side by rounded ridge which grades into lateral faces of final chamber; aperture terminal in subconoidal process, weak radial striae present.

Specimen Sample USNM Dimensions in millimeters
Figured........................................ 617 548990 Length Width Thickness 0.95 0.80 0.55

Cristellaria sp. Q contrasts in having a somewhat angulate periphery and a convex final face.

Cristellaria sp. AB
Plate 13, figures 29, 30

In side view subovate, apertural end bluntly pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber meeting without apparent offset, sulptural bands flush, except last which is slightly depressed, tangent to umbo, last two sutures nearly straight, meeting periphery at about 60 degrees and nearly 90 degrees respectively, first visible suture strongly reflexed, meeting periphery at about 45 degrees, umbo eccentric, height of chambers at periphery irregular, well-defined rim on all chambers; in edge view subelliptical, greatest thickness through the umbo, septal face subtrigonal, slightly depressed, bounded on either side by low rims that merge into the lateral faces of final chamber; aperture terminal in inconspicuous subconoidal process, with radiating striae.

Specimen Sample USNM Dimensions in millimeters
Figured........................................ 68 548990 Length Width Thickness 0.21 0.18 0.13

This form might be mistaken for Cristellaria socia Israelsky n. sp. but that form has an offset final margin and its sutures are markedly more strongly reflexed.

Cristellaria sp. AC
Plate 13, figures 31, 32

In side view subovate, roundly subtrigonal, rapidly uncoiling, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sulptural bands gently reflexed, last suture slightly depressed, others flush, sutures radiate, meeting periphery at about 45 degrees, umbo eccentric, height of chambers at periphery irregular, well-defined keel on all chambers, final margin with slightly raised ridge; in edge view subelliptical, greatest thickness through flattened umbos, septal face acutely heart-shaped, slightly depressed, bounded laterally by low rounded ridges; aperture terminal in striate subhemispherical process.

Specimen Sample USNM Dimensions in millimeters
Figured........................................ 20 548992 Length Width Thickness 0.60 0.44 0.34

Egger's (1899, pl. 11, figs. 7, 8, Cretaceous) version of Cristellaria williamsioni Reuss has a superficial resemblance to Cristellaria sp. AC, but it is proportionally narrower and thinner, sutures are more numerous and more strongly bent and the greatest thickness is through the last chamber rather than through the umbos.

Cristellaria alucina Israelsky n. sp.
Plate 13, figures 33, 34

Robulus williamsoni Cushman and Jarvis (not Reuss), U. S. Natl. Museum Proc., v. 80, part. 14, p. 22, pl. 6, fig. 7, 1932. [Cretaceous]
Cushman, Cushman Lab. Foram. Research Contr., v. 17, p. 61, pl. 16, fig. 2. (not fig. 1), 1941. [Cretaceous]
Cushman, U. S. Geol. Survey Prof. Paper 206, p. 54, pl. 18, fig. 5, (not fig. 2). [Cretaceous]

In side view broadly subovate, broadly rounded both at apertural and opposite end, chambers somewhat inflated, rimmed final margin and periphery of earliest visible chamber meeting in an obtuse angle, sutures depressed, gently reflexed, radiate from weak umbilicus, meeting periphery at about 90 degrees, keel on all chambers, umbilical area eccentric; in edge view subelliptical, greatest thickness through final chamber, septal face heart-shaped, depressed, bounded laterally by rounded rims; aperture terminal in subconoidal projection, surrounded by radiating ridges and grooves.

Specimen Sample USNM Dimensions in millimeters
Holotype........................................ 617 548990 Length Width Thickness 0.78 0.60 0.45

The most similar figure is that of a specimen from the Lizard Springs formation of Trinidad, B. W. L, which as shown in the above synonymy has been several times repeated. It is almost identical with the present specimen and is considered conspecific.

Cushman and Church (1929, pl. 36, figs. 13, 14, Cretaceous) figure a specimen as Lenticiulinua williamseni (Reuss). Cushman (1931b, p. 5, fig. 2, Cretaceous) refers a specimen to Robulus williamsoni (Reuss) and twice repeats the figures (1941, pl. 16, fig. 1, Cretaceous; 1946, pl. 18, fig. 2, Cretaceous).

Of these figures only that of Cushman and Jarvis representing a specimen which is considered conspecific
CALCAREOUS FORAMINIFERA (MILIOLIDAE AND LAGENIDAE, PART) 41

to the present form, found in the Lodo formation, is reasonably close to Cristellaria williamsoni Reuss (1862, pl. 6, fig. 4, Cretaceous). However, in the side view Cristellaria alucinans Israelsky n. sp. is fewer chambered, lacks the partly scalloped periphery, and is narrower and more tightly coiled than Reuss’ species. In edge view the present species is much less compressed and, perhaps more important, the greatest thickness is well within the final chamber rather than through the umbilical area.

The specimen referred to Robulus williamsoni (Reuss) by Cushman and Renz (1946, pl. 3, fig. 30, Cretaceous) is not the same as the earlier references to that species from the same (Lizard Springs) formation. This specimen has raised rather than depressed sutures and the swollen chambers are lacking.

In an unnumbered Cushman Collection slide labelled “Robulus arkansasana Cushman and Todd, Paleocene, Midway, 4.6 miles N. of Pentress, Caldwell Co., Tex. Coll. by L. W. Stephenson” two specimens seem to be Cristellaria alucinans Israelsky n. sp.

Of the described West Coast species Robulus kincaidi Beck (1943, pl. 102, figs. 1, 7, Eocene) is the most similar but according to the author the sutures are flush. Beck’s species is also proportionally wider and has an unusually high final chamber.

Cristellaria sp. AD
Plate 13, figures 35, 36

In side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber meeting in an obtuse angle, sutures flush, weakly reflexed, sutures radiate from umbo, earlier sutures indistinct but apparently meeting periphery at about 90 degrees, last two meeting periphery at about 45 degrees, umbo strongly eccentric, callused, height of chambers at periphery increasing regularly, well-defined rim on all chambers; in edge view sagittate, greatest thickness through umbos, somewhat produced at end away from aperture, septal face elongate, heart-shaped, depressed, bounded laterally by rounded rims, aperture terminal in radiately grooved process.

Specimen Sample USNM Dimensions in millimeters
Figured......................... 78 548994 Length 0.43 Width 0.33 Thickness 0.25

Cristellaria laimigni Israelsky n. sp.
Plate 13, figures 37, 38

In side view suboblate, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber meeting in a low obtuse angle, periphery of last two chambers straightened giving angulate appearance, inside part of chambers strongly inflated, swollen portion with circular outlines, in later chambers the swellings transversely subelliptical, sutures radiate from umbilicus, strongly reflexed and meeting periphery at nearly 45 degrees except last which intercepts at nearly 90 degrees, umbilicus eccentric, height of chambers at periphery increasing regularly, well-defined thin keel present on all chambers; in edge view crudely subelliptical, somewhat scalloped due to swollen portions of chambers, thickest through last chamber, septal face flattened, bounded laterally by slight ridges, aperture terminal in well-defined subconoidal process without definite striae.

Specimen Sample USNM Dimensions in millimeters
Prototype....................... 30 548995 Length 0.43 Width 0.31 Thickness 0.19

Named for Boris Laiming in recognition of his excellent zonation of the Eocene formations in California.

The most similar figure seems to be that of Cristellaria protuberans Cushman (1919 a, pl. 22, fig. 2, side view only, Oligocene), in which, however, the inflated parts are more nearly central within the chambers, the side outline of the final chamber is much more acute and the apertural process is less prominent.

Cristellaria tendami Israelsky n. sp.
Plate 13, figures 39–42

In side view subovate, broadly pointed at apertural end, rounded at opposite end, final margin of last chamber and periphery of earliest visible chamber meeting at an obtuse angle, sutures covered by strongly raised rounded ridges extending various distances from the umbo toward the periphery, differing with the individual, sutures tangent to umbo, intercepts with periphery not clear, umbo eccentric, proportionally larger in the megalospheric (figs. 41, 42) than in the microspheric (figs. 39, 40) form, height of chambers at periphery irregular, well-defined thin keel present on all chambers; in edge view subelliptical, produced in varying degree from umbo toward either end, thickest through umbos, proportionally thicker in the megalospheric than in the microspheric form, septal face heart-shaped, depressed, bounded laterally by rounded rims; aperture terminal in subconoidal process with radial grooves.

Specimen Sample USNM Dimensions in millimeters
Prototype....................... 6+1' 548996 Length 1.45 Width 1.32 Thickness 0.70
Paratype......................... 6+1' broken

Cristellaria (Lenticulina) multiformis var. rotunda Franke as interpreted by ten Dam (1944, pl. 1, fig. 9, Paleocene) is very similar in side view, except that it is proportionally narrower, but in edge view ten Dam’s
Cristellaria evanescens Israelsky n. sp.

Plate 13, figures 43-45

In side view subelliptical, greatest width at early end, final margin of last chamber and periphery of earliest visible chamber meeting at an obtuse angle, sutures raised, most strongly at end toward final margin, only three sutures visible, the first truncated by the second, the last two apparently having a common meeting point, final margin with a strongly raised rounded ridge, umbo very eccentric, height of chambers at periphery irregular, well-developed broad thin keel present on all chambers; in edge view sagittate, keel projecting, greatest thickness through umbonal area. Kline (1943, pl. 1, fig. 12, Paleocene) figures a specimen in side view in which the later chambers tend to diminish in width and again the beading is confined to the umbonal region. None of the cited references supplies either an edge view or an explanation of why Cristellaria pseiidomamiligera was removed to Robulus. Several specimens of that species from the Midway group of Texas show a more obese outline in edge view than is shown by Cristellaria variipapillata Israelsky n. sp., and lack a robuline aperture.

Cristellaria dissectans Israelsky n. sp.

Plate 14, figures 3, 4

In side view subovate, obliquely pointed at apertural end, rounded at opposite end, final margin of last chamber and periphery of earliest visible chamber meeting in an obtuse angle, later sutures strongly reflexed, the last strongly depressed, the preceding several strongly ridged, the ridges reaching varying distances toward the periphery, early sutures not discernible and early chambers with apparently irregular beading, visible sutures radial and meeting periphery at about 45 degrees, umbonal area eccentric, height of chambers at periphery irregular, well-defined broad thin keel present on all chambers; in edge view subelliptical, thickness through umbonal area and final chamber subequal, septal face elongate heart-shaped, slightly depressed, bounded laterally by low rounded rims; aperture terminal in low subconoidal process, weak suggestion of radial striae observed.
CALCAREOUS FORAMINIFERA (MILIOLIDAE AND LAGENIDAE, PART)

43

Specimen Sample USNM Dimensions in millimeters
Holotype:............. 6+1' 540000 Length Width Thickness

Differs from the preceding species, Cristellaria varipapillata Israelsky in its more circular outline and in details of ornamentation.

Cristellaria platypleura Jones (1852, pl. 16, fig. 12, Eocene) is similar both in side and edge views but the sutural ridges seem to be entire and no beaded area is present.

Cristellaria sp. AE
Plate 14, figures 5, 6

In side view subovate, acutely pointed at apertural end, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber meeting in a low obtuse angle, sutures flush, very gently reflexed, radiate, meeting periphery at about 45 degrees, umbo very eccentric, height of chambers at periphery irregular, thin keel present on early chambers; in edge view subelliptical, greatest thickness through umbos produced at end away from aperture, septal face elongate heart-shaped, slightly depressed, bounded laterally by low rounded rims, aperture terminal, in low subconoidal process, radial striae present.

Specimen Sample USNM Dimensions in millimeters
Figured:.................. 6+1' 540000 Length Width Thickness

Only worn-looking specimens of this form were found. It is entirely possible a complete keel was originally present.

Cristellaria? sp. AF
Plate 14, figures 7, 8

In side view subovate, anterior end acutely pointed opposite end rounded, nearly straight margin of final chamber and periphery of earliest visible chamber meeting in a low obtuse angle, early sutures flush, later weakly ridged, all gently reflexed and radial from umbo, meeting periphery at about 45 degrees, umbo very eccentric, swollen, height of chambers at periphery irregular, well defined broad thin keel on all chambers; in edge view sagittate, produced at end away from aperture, greatest thickness through swollen umbos; aperture in question.

Specimen Sample USNM Dimensions in millimeters
Figured:.................. 6+1' 540000 Length Width Thickness

In two available specimens the final face is broken away and the character of that face and the aperture remain in doubt.

Both Robulus klaghammensis Brotzen (1948, pl. 7, figs. 1, 2, Paleocene) and Robulus discus Brotzen (1948, pl. 7, figs. 3–5, Paleocene) are similar but in both species the umbos are subcentral.

The form figured as Cristellaria d’Orbignyi (Bailey) by Cushman (1923a, pl. 26, fig. 3, Recent) is very similar in side view, the only one given, but lacks sutural ridges.

Genus ROBULUS Montfort 1808

Robulus? sp. AF
Plate 14, figures 9, 10

Test lenticular; in side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber probably meeting in a low obtuse angle, sutures gently raised, gently reflexed, earlier sutures tangential to and later radiating from umbo, earliest sutures inclined rearward and meeting periphery at about 45 degrees, intermediate sutures meeting periphery at nearly 90 degrees, later inclined toward terminal end and meeting periphery at gradually decreasing angles, umbo subcentral, height of chambers at periphery irregular, well defined keel present on all chambers; in edge view subelliptical with keel projecting, greatest thickness through umbos, septal face heart-shaped, probably depressed, a robuline slit probably present.

Specimen Sample USNM Dimensions in millimeters
Figured:.................. 104 540002 Length Width Thickness

Each of the specimens listed under this designation is poorly preserved and it may well be that more than one species is included.

Robulus remissus Israelsky n. sp.
Plate 14, figures 11, 12

Test lenticular; in side view subcircular, apertural end obtusely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, surface of last chamber strongly depressed inwardly from apertural process, sutures flush, reflexed, radiate from umbo, meeting periphery at about 45 degrees, umbo subcentral, height of chambers at periphery irregular, well-defined thin keel on all chambers; in edge view subelliptical, produced at either end, greatest thickness through umbos, final face V-shaped; slightly depressed, rounding into lateral faces of last chamber; septal process subconoidal with terminal radial ridges, an elongate collared slit present on final face of process.

Specimen Sample USNM Dimensions in millimeters

Robulus chehalisensis Rau (1948, pl. 29, figs. 14, 15, Oligocene) is superficially similar but lacks the con-
spicuous apertural process and keel, and in edge view is not produced at either end.

**Robulus sp. aff. Robulus carolinianus Cushman**

Plate 14, figures 13, 14

Test lenticular; in side view subcircular, apertural end bluntly pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber meeting in a low obtuse angle, apertural process conspicuous, sutural bands flush, gently reflexed, tangent to umbo, meeting periphery irregularly at about 30 to nearly 45 degrees, umbo subcentral, height of chambers at periphery irregular, well-defined narrow thin keel present on all chambers; in edge view subelliptical, greatest thickness through umbos, septal face V-shaped, concave; apertural process subconoidal, with radial ridges terminally, a short collared slit extending onto final face of process.

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The figure called *Robulus arcuato-striatus* (Hantken) var. *carolinianus* Cushman by Bergquist (1942, pl. 2, fig. 23, side view only, Eocene) is very close and Cushman's type figures (1933, pl. 1, fig. 9, Eocene) are but slightly less so. The form from the Lodo formation is more tightly coiled than either of these and in edge view slopes more gently toward either end.

More specimens are needed to differentiate these forms accurately.

**Robulus inenodabilis Israelsky n. sp.**

Plate 14, figures 15, 16

Test lenticular; in side view subcircular, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutural bands flush, in part gently reflected, in part nearly straight, earlier sutures meeting periphery at about 45 degrees, later at nearly 60 degrees, umbo central, height of chambers at periphery irregular, well-defined narrow thin keel on all chambers, apertural process strongly projecting; in edge view subelliptical, greatest thickness through umbos, septal face heart-shaped, flattened, rounding into lateral surfaces of final chamber; apertural process subconoidal, aperture a narrow subelliptical rimmed opening in final face of process.

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This species differs from the preceding, *Robulus sp. aff. Robulus carolinianus* Cushman in its less circular outline, greater projection of the apertural process and the differences in angles of interception between the periphery and sutures.

**Robulus vanus** Israelsky n. sp. also differs in the angles of interception between the periphery and sutures.

**Robulus vanus** Israelsky n. sp.

Plate 14, figures 17, 18

Test lenticular; in side view subcircular, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber meeting in an obtuse angle, periphery of last chamber straightened giving weakly angled appearance, sutural bands flush, gently reflected, tangent to umbo, meeting periphery at about 45 degrees, umbo subcentral, height of chambers at periphery irregular, well-defined narrow thick rim on all chambers; in edge view subelliptical, greatest thickness through umbos, final face U-shaped, flattened, very constricted, rounding into lateral faces of final chamber; apertural process subconoidal with radial ridges terminally, aperturate an elongate collared slit extending onto final face of process.

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The straightened periphery of the final chamber and the proportionally thicker rim set this species off from *Robulus sp. aff. carolinianus* Cushman and *Robulus inenodabilis* Israelsky n. sp.

Both this species and *Robulus sp. aff. carolinianus* Cushman are similar to *Lenticulina (Robulus) suborbicularis* Parr (1950, pl. 11, figs. 5, 6, Recent) in side view though Parr's figures show the sutures to be more strongly bent; in edge view Parr's species is proportionally thinner and strongly produced toward the apertural end.

*Robulus cf. arcuato-striatus* (Hantken) var. *carolinianus* Cushman of Cushman and Simonson (1944, 1, pl. 30, fig. 10, side view only, Eocene) is in comparison to *Robulus vanus* Israelsky n. sp. markedly compressed in edge view.

**Robulus valens** Israelsky n. sp.

Plate 14, figures 19, 20

Test lenticular; in side view subcircular, apertural end rounded with projecting apertural process, opposite end rounded, final margin and periphery of earliest visible chamber forming an obtuse angle, sutural bands, notably wide proportionally, gently reflected, tangent to umbo, meeting periphery irregularly from about 45 degrees to nearly 90 degrees, umbo subcentral, height of chambers at periphery irregular, well-defined wide
thin keel present on all chambers; in edge view subelliptical, slightly produced at apertural end, greatest thickness through umbos, septal face broadly V-shaped, concave, bounded laterally by rounded rims, apertural process subconoidal with radial striae terminally, aperture an elliptical collared opening in the final face of process.

The most similar figured specimen seems to be that assigned to *Robulus pseudovortex* Cole by Bandy (1949, pl. 8, figs. 9, 10, Eocene) in which, however, the sutural bands are much less conspicuous and the apertural process is not projecting.

**Robulus conspicatus** Israelsky n. sp.

Plate 14, figures 21, 22

Test lenticular; in side view subcircular, apertural end pointed at nearly 90 degrees, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber meeting in an obtuse angle, sutures, flush, reflected, tangent to umbo, meeting periphery at about 45 degrees, umbo eccentric, height of chambers at periphery irregular, well-defined wide thick keel on all chambers; in edge view subelliptical, only the keel produced, greatest thickness through umbos, septal face elongate heart-shaped, depressed, bounded laterally by rounded rims, apertural process subconoidal, aperture an elongate collared slit in final face of process.

The decidedly excentric umbo and lack of sutural banding serves to distinguish this form from *Robulus pudibundus* Israelsky n. sp.

In side view there is superficial resemblance to *Oristellaria ortulata* d'Orbigny as figured by Egger (1900, pl. 11, figs. 11, 12, Cretaceous) but that specimen has more strongly curved sutures, the umbo is distinctly raised and there is no robuline aperture.

In *Robulus arcuatostriatus* (Hantken) of Bermudez (1949, pl. 7, figs. 27, 28, Miocene) the sutures are more strongly curved, the umbo more central and in edge view the end away from the aperture is produced.

**Robulus pudibundus** Israelsky n. sp.

Plate 14, figures 23, 24

Test lenticular; in side view subcircular, apertural end bluntly pointed with projecting apertural process, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutural bands extraordinarily wide proportionately, tending to be slightly raised toward umbo, becoming more strongly reflexed with growth, tangent to umbo, meeting periphery at about 45 degrees, umbo central, height of chambers at periphery irregular, well-defined keel on all chambers; in edge view subelliptical, produced at apertural end, greatest thickness through umbos, septal face broadly V-shaped, slightly depressed, bounded laterally by low rounded rims that merge into lateral surfaces of final chamber, apertural process subconoidal, aperture an elongate collared slit on final face of process, no striae noted.

**Robulus tumeyensis** Israelsky n. sp.

Plate 14, figures 25, 26

Test lenticular; in side view subcircular, apertural end obtusely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutural bands covered by ridges, earlier ones reflected, comma-shaped, later ones nearly straight, all tangent to umbo and meeting periphery at about 45 degrees, umbo subcentral, height of chambers at periphery irregular, well-defined keel on all chambers; in edge view subelliptical, strongly produced at end away from aperture, greatest thickness through umbos, septal face broadly V-shaped, depressed, weakly concave, bounded laterally by low inwardly beveled rims, apertural process subconoidal with weak radial striae terminally, aperture an elliptical collared opening in final face of process.
comma-shaped early sutural ridges and the straightened later sutures.

*Cristellaria laticostata* Tutkowski (1888, pl. 5, fig. 2, Eocene) in addition to the above distinctions has more eccentric umbos.

*Robulus chambersi* Garrett (1939, pl. 65, figs. 8, 9, Oligocene) agrees in the straightening of the later sutural ridges but lacks the comma-like early sutural ridges and the apertural opening is much more elongate.

*Robulus globangulata* Israelsky n. sp.
Plate 14, figures 27, 28

Test lenticular; in side view crudely subcircular or roundly angulate, apertural end obtusely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutural ridges weakly raised, almost straight, tangential to umbo, irregularly meeting periphery at about 30 to nearly 45 degrees due to irregular curvature of periphery, umbo central, height of chambers at periphery irregular, well-defined thick rim on all chambers; in edge view subelliptical, weakly produced at either end, greatest thickness through umbos, septal face elongate heart-shaped, depressed, bounded laterally by low rims; apertural process subconoidal, aperture an elongate collared slit in the final face of process.

Specimen Sample USNM
Dimensions in millimeters

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The apertural area is broken in the figured specimen, but it is believed that a portion of the collar can be detected.

*Robulus? sp. A1*
Plate 14, figures 31, 32

In side view subovate, apertural end broadly pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutures slightly raised, gently reflexed, tangential to umbo, meeting periphery at about 45 degrees, umbo slightly eccentric, height of chambers at periphery irregular, well-defined thin keel on all chambers; in edge view subelliptical, strongly produced at end away from aperture, greatest thickness through flattened umbos, septal face broadly heart-shaped, bounded laterally by low rims; apertural process subconoidal, terminated with stellate ridges, the aperture probably a subelliptical collared opening in final face of process.

Specimen Sample USNM
Dimensions in millimeters

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The preservation is such that the presence of a robustine aperture is uncertain. The two strongly developed elongate ridges running toward the final face strongly support the probability of such an aperture.

*Robulus sp. AK*
Plate 14, figures 33, 34

Test lenticular; in side view subcircular, apertural end bluntly pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutural bands flush, tangential to umbo, meeting periphery at about 45 degrees, umbo somewhat eccentric, height of chambers at periphery increasing regularly, well-defined rim on all chambers; in edge view subelliptical, greatest thickness through umbos, septal face heart-shaped, slightly depressed, bounded laterally by low rounded rims which blend into lateral surfaces of final chamber; apertural process subconoidal, aperture a subelliptical collared opening in final face of process.

Specimen Sample USNM
Dimensions in millimeters

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*Robulus sp. AL*
Plate 14, figures 35, 36

Test lenticular; in side view subcircular, apertural end obtusely pointed, opposite end rounded, final mar-
gin of last chamber and periphery of earliest visible chamber meeting in a high obtuse angle; sutural bands very weakly raised, reflexed, tangent to umbo, meeting periphery at about 45 degrees, last two sutures notably overlapping previous ones, umbo subcentral, height of chambers at periphery irregular, well-defined keel on all chambers; in edge view subelliptical, greatest thickness through umbos, septal face elongate heart-shaped, concave, bounded laterally by rounded rims; apertural process incomnspicuous, toothed in side view, aperture an elliptical collared opening on final face of process.

Test lenticular; in side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutures flush, all except last radiating from umbo, reflexed and meeting periphery irregularly at angles of from about 45 to nearly 60 degrees, final suture tangential to umbo, nearly straight, meeting periphery at about 60 degrees, umbo subcentral, height of chambers at periphery irregular, well-defined keel on all chambers; in edge view subelliptical, keel produced at end away from aperture, greatest thickness through umbos, septal face broadly V-shaped, flattened, bounded by flush rims which round into lateral faces of final chamber; apertural process subconoidal, aperture a subelliptical collared opening in final face of process.

Test lenticular; in side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutures flush, all except last radiating from umbo, reflexed and meeting periphery irregularly at angles of from about 45 to nearly 60 degrees, final suture tangential to umbo, nearly straight, meeting periphery at about 60 degrees, umbo subcentral, height of chambers at periphery irregular, well-defined keel on all chambers; in edge view subelliptical, keel produced at end away from aperture, greatest thickness through umbos, septal face broadly V-shaped, flattened, bounded by flush rims which round into lateral faces of final chamber; apertural process subconoidal, aperture a subelliptical collared opening in final face of process.

Test lenticular; in side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutures flush, all except last radiating from umbo, reflexed and meeting periphery irregularly at angles of from about 45 to nearly 60 degrees, final suture tangential to umbo, nearly straight, meeting periphery at about 60 degrees, umbo subcentral, height of chambers at periphery irregular, well-defined keel on all chambers; in edge view subelliptical, keel produced at end away from aperture, greatest thickness through umbos, septal face broadly V-shaped, flattened, bounded by flush rims which round into lateral faces of final chamber; apertural process subconoidal, aperture a subelliptical collared opening in final face of process.

Test lenticular; in side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutures flush, all except last radiating from umbo, reflexed and meeting periphery irregularly at angles of from about 45 to nearly 60 degrees, final suture tangential to umbo, nearly straight, meeting periphery at about 60 degrees, umbo subcentral, height of chambers at periphery irregular, well-defined keel on all chambers; in edge view subelliptical, keel produced at end away from aperture, greatest thickness through umbos, septal face broadly V-shaped, flattened, bounded by flush rims which round into lateral faces of final chamber; apertural process subconoidal, aperture a subelliptical collared opening in final face of process.

The form referred to *Robulus duracina* (Stache) by Galloway and Morrey (1929, pl. 15, fig. 13, Eocene) is is similar in side view, but in edge view is much less swollen through the umbos, has a more truly

heart-shaped final face and a circular rather than an elongate aperture.  

*Robulus intusvortex* Bermudez (1949, pl. 7, figs. 25, 26, Oligocene) has more strongly reflexed sutures, apparently no rim and is proportionately thinner than the present species.

*Robulus ruinosus* Israelsky n. sp.

Plate 14, figures 39, 40

The specimen figured by Egger (1907, pl. 2, figs. 14, 15, Cretaceous) as *Cristellaria* (Robulina) münsteri Römer has some resemblance, but all sutures are more strongly curved, the test is less tightly coiled and proportionately less compressed.
Robulus sp. A0
Plate 14, figures 43, 44

Test lenticular; in side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, periphery tending to straighten irregularly giving a weakly subangulate appearance, sutures poorly visible, all apparently tangent to umbo, all except last meeting periphery at about 45 degrees, the last at nearly 90 degrees, umbo subcentral, height of chambers at periphery irregular, poorly defined rim present; in edge view subelliptical, greatest thickness through umbos, septal face broadly V-shaped, concave bounded laterally by inwardly bevelled ridges; apertural process subconoidal, aperture an elongate collared slit in the final face of process.

Specimen Sample USNM Dimensions in millimeters
Figured..................... 12 549019 Length Width Thickness 0.49 0.45 0.26

Lenticulina frankei Marie (1941, pl. 9, fig. 105, Cretaceous) has a very similar appearance but is described as being noncarinate.

Robulus usitatus Israelsky n. sp.
Plate 14, figures 45, 46

Test lenticular; in side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming a low obtuse angle, sutures flush, gently reflexed, radiate from umbo, meeting periphery irregularly at angles of from about 45 to nearly 90 degrees, umbo slightly excentric, height of chambers at periphery irregular, well-defined broad keel on all chambers; in edge view subelliptical, produced at either end, greatest thickness through umbos, septal face broadly V-shaped, concave bounded laterally by inwardly bevelled ridges; apertural process subconoidal, aperture an elongate collared slit in the final face of process.

Specimen Sample USNM Dimensions in millimeters
Holotype................... 104 549020 Length Width Thickness 0.50 0.43 0.25

Robulus sp. AM may be distinguished by its proportionately greater width, its narrower apertural process and the tangential final suture; Robulus morsus Israelsky n. sp. by its tangential sutures; and Robulus sp. AP by its greatest thickness being through the final chamber rather than through the umbos.

Robulus morsus Israelsky n. sp.
Plate 14, figures 47, 48

In side view subovate, apertural end acutely pointed, opposite end rounded, final margin and periphery of earliest visible chamber forming an obtuse angle, sutural bands gently reflexed, tangential to umbo, meeting periphery irregularly at angles from about 45 to 90 degrees, umbo slightly eccentric, height of chambers at periphery increasing regularly, well-defined broad keel on all chambers except last; in edge view subelliptical, somewhat produced at either end, greatest thickness through umbos, septal face heart-shaped, slightly depressed, bounded laterally by low rounded rims; apertural process subconoidal, strongly compressed, aperture a small subcircular opening with U-shaped collar which opens onto the final face.

Specimen Sample USNM Dimensions in millimeters
Holotype................... 18 549021 Length Width Thickness 0.54 0.48 0.26

A specimen figured by Bandy (1949, pl. 8, fig. 1, Eocene) as Robulus alato-limbatus Gümbel is close, but has less tangential sutures, a proportionately thinner and narrower keel and is more tightly coiled.

Robulus usitatus Israelsky n. sp. which has much the same outline may be distinguished readily by its radiate sutures.

Several specimens labeled “Robulus antipodum Stache (Cushman Coll. 24089), Eocene, Poway Conglomerate, Murray Canyon, La Jolla Quad., Calif.” show more strongly curved sutures, a more open septal face, are more tightly coiled and lack attenuation in edge view.

Robulus sp. AP
Plate 14, figures 49, 50

Test lenticular; in side view subovate, apertural end bluntly pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber meeting in an obtuse angle, sutural bands except last flush, last slightly depressed with corresponding slight swelling of final chamber, all reflexed, early sutures meeting periphery at about 45 degrees, later at nearly 60 degrees, umbo very eccentric, height of chambers at periphery apparently increasing regularly, well-defined wide thin keel on all chambers; in edge view subelliptical, strongly produced at either end, greatest thickness through final chamber, septal face elongate heart-shaped, depressed, bounded laterally by rounded rims which merge into lateral faces of final chamber; apertural process subconoidal, compressed, aperture a subelliptical collared opening on final face of process.

Specimen Sample USNM Dimensions in millimeters
Figured..................... 0+1' 549022 Length Width Thickness 0.79 0.71 0.38

Lenticulina rotulata Lamarck as figured by Cushman (1941, pl. 16, fig. 13, side view only, Cretaceous) appears similar but the umbo is less eccentric and Cush-
CALCAREOUS FORAMINIFERA (MILIOLIDAE AND LAGENIDAE, PART)

man's assignment of the form to *Lenticulina* implies absence of a robuline slit.

In edge view a figure referred to *Robulus stephen-soni* Cushman by Cushman (1946, pl. 18, fig. 13, not 12, the holotype, Cretaceous) from the Saratoga chalk of Arkansas is similar in having flattened sides but is proportionally thinner and the sutures are less reflexed and more numerous.

*Robulus requietus* Israelsky n. sp.

Plate 14, figures 51, 52

Test lenticular; in side view subovate, apertural end bluntly pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutural bands flush, varying from radiate to somewhat tangent to umbo, irregularly meeting periphery at from about 45 to nearly 90 degrees, umbo somewhat eccentric, height of chambers at periphery increasing regularly, well-defined keel present on all chambers; in edge view subelliptical, strongly produced at either end, strongly compressed through the umbonal area, greatest thickness through umbos, septal face U-shaped, depressed; apertural process subconoidal, aperture an elliptical opening within greatly thickened collar, the collar forming the final face of the process.

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*Robulus mediocris* Israelsky n. sp.

Plate 14, figures 53, 54

Test lenticular; in side view subcircular, apertural end acutely pointed, opposite end roundly angulate, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutures flush, tangent to umbo, meeting periphery irregularly at angles of from about 45 degrees to nearly 60 degrees, umbo subcentral, height of chambers at periphery irregular, well-defined broad thin keel on all chambers; in edge view subelliptical, produced at either end, strongly compressed through umbos, septal face V-shaped, slightly depressed, bounded laterally by low rounded rims; apertural process subconoidal, aperture of subelliptical collared opening in the final face of the process.

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*Robulus sp. AQ*

Plate 15, figures 1, 2

In side view subovate, somewhat angulate, apertural end acutely pointed, opposite end roundly angulate, final margin of last chamber gently bowed and meeting periphery of earliest visible chamber in an obtuse angle, periphery angling without regard to sutures, sutural bands flush, almost straight, except last which is sinusous and somewhat comma-shaped, all tangent to umbo and all except last meeting periphery at nearly 45 degrees, last at a somewhat higher angle, umbo subcentral, height of chambers at periphery irregular, thin keel present on all chambers; in edge view subelliptical, somewhat produced at either end, greatest thickness through umbos, septal face heart-shaped with long lobes, flattened; apertural process subconoidal, strongly compressed, aperture an elongate collared slit in final face of process.

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*Robulus revolutus* Israelsky n. sp.

Plate 15, figures 3-6

Test lenticular; in side view subcircular, apertural end obtusely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutures flush, tangent to umbo, meeting periphery at about 45 degrees, umbo subcentral, height of chambers at periphery irregular, well-defined keel present on all chambers; in edge view subelliptical with keel projecting, greatest thickness through umbos, septal face broadly V-shaped, slightly depressed, bounded laterally by low rounded rims; apertural process subconoidal, aperture of subelliptical collared opening in the final face of the process.

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*Robulus arcuato-striatus* (Hantken) var. *carolinus* Cushman (1933, pl. 1, fig. 9, Eocene) has a more eccentric umbo and slightly raised sutures which are more strongly bent near the umbo than in *Robulus revolutus* Israelsky n. sp.

The specimen referred to *Robulus pseudocultratus* Cole by Bandy (1951, pl. 72, fig. 5, Cretaceous) is very similar in side view but is proportionally thinner and has a different apertural process than does *Robulus revolutus* Israelsky n. sp.
Robulus prosperous Israelsky n. sp.

Plate 15, figures 7, 8

Test lenticular; in side view subcircular, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber meeting in an obtuse angle, sutural bands varying from flush to gently raised, most raised, gently reflexed, tangential toumbo, meeting periphery at about 45 degrees, umbo central, height of chambers at periphery irregular, well-defined keel on all chambers; in edge view subelliptical, slightly produced at end away from aperture, greatest thickness through umbos, septal face broadly V-shaped, gently depressed, bounded laterally by low ridges which round into the lateral faces of final chamber; apertural process subconoidal, aperture an elongate collared slit in final face of process.

Specimen Sample USNM Dimensions in millimeters
Holotype 103 549025 Length Width Thickness 0.40 0.38 0.25

The figure referred to Lenticulina rotulata Lamarck by Cushman (1941, pl. 16, fig. 13, side view only, Cretaceous) is related but the sutures are more strongly scalloped, umbos are more central, and tests are less strongly compressed, very prominent, several radial grooves detectable on lateral faces, aperture a comparatively large elliptical collared opening on final face of process.

Robulus mundialis Israelsky n. sp.

Plate 15, figures 9, 10

Test lenticular; in edge view subcircular, apertural end bluntly pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutural bands slightly reflexed to nearly straight, tangential toumbo, meeting periphery at about 45 degrees, earlier sutures slightly raised,umbo central, height of chambers at periphery irregular, thin keel on all chambers; in edge view subelliptical, slightly produced at end away from aperture, greatest thickness through umbos; septal face heart-shaped, subtriangular, depressed, bounded laterally by inwardly bevelled ridges, apertural process subconoidal, aperture an elongate collared slit in final face of process. The aperture is described from better preserved specimens.

Specimen Sample USNM Dimensions in millimeters
Holotype 22 549029 Length Width Thickness 1.18 1.13 0.70

The figure referred to Lenticulina rotulata Lamarck by Cushman (1941, pl. 16, fig. 13, side view only, Cretaceous) is less tightly coiled, has a slightly more eccentric umbo, the final margin is more curved and presumably a robuline aperture is lacking.

Loetterle's (1931, pl. 2, fig. 1, Cretaceous) version of Lenticulina macrodisca (Reuss) lacks a robuline aperture, the umbo is more eccentric and the final chamber is more produced than in Robulus mundialis Israelsky n. sp.

Robulus prosperous Israelsky n. sp. may be distinguished by its better developed final face and thicker keel.

Robulus sp. AR

Plate 15, figures 11, 12

In side view subovate, periphery of chambers indented at sutures giving scalloped appearance, keel not indented but tending to irregularly straighten with resulting subangulate outline, apertural end acutely pointed, opposite end somewhat straightened, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, final margin with a low rim, sutures gently depressed with resultant slight inflation of chambers, varying from gently reflexed to nearly straight, early sutures meeting periphery at about 45 degrees, later sutures at nearly 90 degrees, umbo eccentric, height of chambers at periphery increasing regularly, well-defined keel on all chambers; in edge view subelliptical with compressed sides, somewhat produced at either end, greatest thickness through umbos, final face broadly V-shaped, depressed, bounded laterally by rounded rims which merge into lateral faces of final chamber; apertural process subconoidal, strongly compressed, very prominent, several radial grooves detectable on lateral faces, aperture a comparatively large elliptical collared opening on final face of process.

Specimen Sample USNM Dimensions in millimeters
Figured 72 549030 Length Width Thickness 0.43 0.38 0.28

Robulus melvilli Cushman and Renz (1941, 1, fig. 12, Miocene) and Robulus adelinensis Keijzer var. nipeensis Keijzer (1945, pl. 2, figs. 23, 24, Oligomioocene) are more angulate, chamber peripheries are less strongly scalloped, umbos are more central, and tests are less compressed through the umbos. The holotype of Robulus melvilli has flush sutures.

A specimen figured by Cushman (1946b, pl. 12, fig. 8, side view only, Eocene) as Robulus cf. depauperatus (Reuss) is related but the sutures are more strongly bent and the umbo more central.

Robulus sp. AS

Plate 15, figures 13, 14

Test lenticular; in side view subcircular, apertural end acutely pointed, opposite end rounded, final margin

FORAMINIFERAL OF THE LODO FORMATION, CENTRAL CALIFORNIA

Lenticulina rotulata

Sample USNM

Dimensions in millimeters

Length Width Thickness

Holotype 103 549025 0.40 0.38 0.22

Lamarck

A specimen figured by Cushman (1946b, pl. 12, fig. 8, side view only, Eocene) as Robulus cf. depauperatus (Reuss) is related but the sutures are more strongly bent and the umbo more central.
of last chamber and periphery of earliest visible chamber forming a low obtuse angle, sutures with slightly raised ridges except the last, more strongly raised in early sutures, the last suture depressed with corresponding slight swelling of the final chamber, sutures gently reflexed, radiate from umbo, earlier sutures meeting the periphery at about 45 degrees, later sutures at nearly 90 degrees, umbo subcentral, slightly eccentric, strongly swollen, height of chambers at periphery in general increasing regularly, well-defined broad thin keel on all chambers; in edge view subelliptical, weakly diamond-shaped, produced toward either end, more strongly in end away from aperture, greatest thickness through umbos, septal face broadly V-shaped, very constricted, slightly depressed, bounded laterally by low rounded rims; apertural process subconoidal, aperture an elongate collared slit in final face of process.

The comparisons made for Robulus sp. AS in contrasting with Robulus navaroensis Plummer and Robulus midwayensis Plummer apply equally well here.

In side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutures flush, tangent to umbo, meeting periphery irregularly at angles of about 45 and 60 degrees, umbo subcentral, height of chamber at periphery increasingly regularly, well-defined rim on all chambers; in edge view subelliptical, weakly produced at apertural end, strongly produced at opposite end, greatest thickness through umbos; septal face heart-shaped, subtrigonal, slightly depressed, bounded laterally by low rounded rims which merge into lateral faces of last chamber; apertural process subconoidal, compressed, aperture a subelliptical collared opening in the final face of process.

Robulus sp. AT
Plate 15, figures 21, 22

In side view subovate, rounded subquadrangular, apertural end acutely pointed, opposite end angulately rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, periphery in early portion regularly curved, thereafter tending to irregularly straighten without regard to chamber boundaries, sutures flush, gently reflexed, radial from umbo, meeting periphery irregularly at from about 45 to nearly 90 degrees, umbo eccentric, height of chambers at periphery irregular, rim present

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**Specimen Sample USNM**

| Figured | 74 | 549031 |

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This form is related to that figured as Robulus navaroensis (Plummer) by Cushman (1946, pl. 16, figs. 6–8, especially 8, side views only, Cretaceous) which in two figures show depressed sutures late in the growth of the test. In Cushman's figures the umbos are more central, the sutures more bent near the periphery and the sutures are somewhat commalike, broadest toward the umbo.

In the original figure of Cristellaria navaroensis Plummer (1926, p. 40, text fig. 4, Cretaceous) the umbos appear to be flush.

In Cristellaria midwayensis Plummer (1926, pl. 13, fig. 5, Eocene), refigured by Cushman (1951, pl. 3, figs. 14, 15, Paleocene) as Robulus midwayensis (Plummer) and Cristellaria midwayensis Plummer var. carinata Plummer (1926, p. 41, text figure 5, Eocene) refigured by Cushman (1951, pl. 3, fig. 18, Paleocene) the sutural ridges are somewhat comma-shaped and touch the periphery at nearly 45 degrees throughout, the septal faces are proportionally larger, the tests proportionally thicker and the umbo is not swollen.

Also similar is Cristellaria secans Reuss (1860, pl. 9, fig. 7, Cretaceous) but that form appears less tightly coiled, has a less well defined keel and is less swollen through the umbos.

Robulus? sp. AT differs by having tangential sutures.

**Robulus? sp. AT**
Plate 15, figures 15–18

Test lenticular; in side view subcircular, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutures flush, gently reflexed except last which is sometimes nearly straight, tangential to umbo, meeting periphery at about 45 degrees except occasionally the last which may approach 90 degrees, umbo central, slightly swollen, height of chambers at periphery irregular, well-defined broad thin keel on all chambers; in edge view subelliptical, somewhat diamond shaped, greatest thickness through the swollen umbos, septal face V-shaped, depressed, bounded laterally by sharp inwardly beveled ridges, aperture broken away in available specimens but probably robuline. The length of USNM 549033 is estimated.

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| Figured | 0104+1` | 549033 |

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Robulus sp. AU
Plate 15, figures 19, 20

In side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutures flush, tangential to umbo, meeting periphery irregularly at angles of about 45 and 60 degrees, umbo subcentral, height of chamber at periphery increasingly regularly, well-defined rim on all chambers; in edge view subelliptical, weakly produced at apertural end, strongly produced at opposite end, greatest thickness through umbos; septal face heart-shaped, subtrigonal, slightly depressed, bounded laterally by low rounded rims which merge into lateral faces of last chamber; apertural process subconoidal, compressed, aperture a subelliptical collared opening in the final face of process.

**Robulus sp. AV**
Plate 15, figures 21, 22

In side view subovate, rounded subquadrangular, apertural end acutely pointed, opposite end angulately rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, periphery in early portion regularly curved, thereafter tending to irregularly straighten without regard to chamber boundaries, sutures flush, gently reflexed, radial from umbo, meeting periphery irregularly at from about 45 to nearly 90 degrees, umbo eccentric, height of chambers at periphery irregular, rim present
but poorly defined on later chambers; in edge view subelliptical, greatest thickness through umbo, final face heart-shaped, weakly bounded laterally by low rims; apertural process subconoidal, radial grooves on sides, aperture a triangular opening in the final face of process.

**Figured**

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**Robulus sp. AW**

Plate 15, figures 23, 24

In side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutures flush, gently reflexed, tangent toumbo, meeting periphery at about 45 degrees, umbo eccentric, height of chambers at periphery increasing regularly, rim poorly defined except on early portion of periphery; in edge view subelliptical, rim projecting, greatest thickness through umbos, septal face subtrigonal, slightly depressed, bounded laterally by low rounded rims which merge into lateral faces of final chamber; apertural process subconoidal, aperture a subelliptical opening on final face of process, widest toward periphery, enclosed by liplike collar.

**Figured**

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**Robulus sp. AX**

Plate 15, figures 25, 26

In side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber meeting in a low obtuse angle, sutures flush, gently reflexed, tangent toumbo, meeting periphery irregularly at from about 45 to nearly 90 degrees, umbo eccentric, height of chambers at periphery irregular, weak suggestion only of rim; in edge view subelliptical, greatest thickness through umbos, septal face broadly V-shaped, weakly depressed, bounded laterally by low rounded rims; apertural process subconoidal, aperture a trigonal opening with lips on either side in final face of process.

**Robulus alexanderi** Sandige as figured by Cushman (1941, pl. 15, fig. 15, Cretaceous) is similar in outline and chamber form but is proportionately much thinner and appears to have a slitlike aperture. The same remarks apply to *Robulina depauwera* Reuss (1851a, pl. 4, fig. 29, Oligocene).

**Robulus sp. AY**

Plate 15, figures 27, 28

In side view subovate, apertural end bluntly pointed, opposite end rounded, margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutural bands flush, tangential toumbo, earliest visible suture strongly reflexed, each successive suture less so, sutures meeting periphery at about 45 degrees except last which meets at nearly 90 degrees, umbo somewhat eccentric, height of chambers at periphery irregular, well-defined rim on periphery of all chambers; in edge view subelliptical, somewhat produced at either end, greatest thickness through umbos, septal face elongate, heart-shaped, depressed, bounded laterally by narrow rims; apertural process subconoidal with radial grooves on sides, aperture apparently a semicircular opening in the final face of process bounded by U-shaped collar which opens on the final face of the test.

**Figured**

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A specimen figured by Cushman and Todd (1945b, pl. 13, fig. 25, side view only, Eocene) as *Robulus cf. alatolimbatus* (Gümobel) is in close agreement but the offset between the final margin of the last chamber and the periphery of the earliest chamber is much more marked.

**Robulus sp. AZ**

Plate 15, figures 29, 30

In side view subovate, apertural end obtusely pointed, opposite end rounded, final margin meeting periphery of first visible chamber in an obtuse angle, sutural bands flush, tangent toumbo, meeting periphery at about 45 degrees, umbo eccentric, height of chambers at periphery irregular, well-defined rim on periphery of all chambers; in edge view subelliptical, weakly produced at apertural end, strongly produced at opposite end, greatest thickness through umbos, septal face trigonally heart-shaped, depressed, bounded laterally by rounded rims; apertural process subconoidal with radial striae on sides, aperture an elongate opening in final face of process, widest toward terminus, bounded by U-shaped rim which opens onto septal face of test.

**Figured**

<table>
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<th>Specimen</th>
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**Robulus sp. BA**

Plate 15, figures 31, 32

In side view subovate, apertural end bluntly pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse
angle, sutures flush to weakly raised, comma-shaped, radiate from umbo, earliest visible suture meeting periphery at about 30 degrees, others at nearly 60 degrees, umbo slightly eccentric, height of chambers at periphery irregular, narrow thin keel on all chambers; in edge view subelliptical, strongly produced at end away from aperture, greatest thickness through umbos, septal face heart-shaped, very weakly convex, bounded laterally by weak rims; apertural process subconoidal, aperture an elongate collared opening in final face of process.

In side view there is resemblance to *Robulus dissimilis* Bermudez (1949, pl. 7, figs. 15, 16, Oligocene) but that species has distinctly raised and partly beaded sutures and is proportionately much thinner than the umbos.

The specimen figured as *Robulus alato-limbatus* (Gümbel) by Cushman and Todd (1945a, pl. 3, fig. 11, side view only, Eocene) is similar but the sutures appear quite flush and less strongly reflexed.

**Robulus nobilitatus** Israelsky n. sp.

*Plate 15, figures 33, 34*

In side view subovate, strongly rounded, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutural bands flush, straight, tangential to umbo, inclined rearwards, meeting periphery at about 45 degrees or a higher angle, umbo subcentral, height of chambers at periphery irregular, well-defined thin keel on all chambers; in edge view subelliptical, weakly produced at either end, septal face broadly V-shaped, depressed, bounded laterally by rounded ridges which grade into lateral faces of final chamber; apertural process subconoidal, aperture an elongate collared slit in the final face of process.

**Robulus fictus** Israelsky n. sp.

*Plate 15, figures 37, 38*

In side view subovate, apertural end acutely pointed, opposite end angularly rounded, periphery irregularly straightening without regard to chamber boundaries, final margin of last chamber meeting periphery of earliest visible chamber in an obtuse angle, sutural bands flush, earlier ones radial, later ones tangent, meeting periphery irregularly at from about 45 to nearly 90 degrees, umbo subcentral, height of chambers at periphery irregular, well-defined keel on all chambers; in edge view subelliptical, greatest thickness through umbo, septal face heart-shaped, depressed, bounded laterally by rounded rims; apertural process subconoidal, aperture a short collared elliptical opening in final face of process.

**Robulus odiosus** Israelsky n. sp. has more strongly reflexed sutural bands which are all tangential to the umbo.

**Robulus jocosus** Israelsky n. sp.

*Plate 15, figures 39, 40*

In side view subovate, apertural end acutely pointed, opposite end angularly rounded, final margin of last chamber and periphery of earliest visible chamber meeting in an obtuse angle, early part of periphery regularly rounded, remainder irregularly angulate with straightened segments that disregard chamber boundaries, sutures flush, irregularly varying from radiate to tangential to umbo, meeting periphery at about 45 degrees, umbo subcentral, prominent, height of chambers...
Holotype.

**Robulus jocosus**

Test lenticular; in side view subovate, apertural end bluntly pointed, opposite end rounded, approximately last half of periphery weakly angulate, angulations not necessarily corresponding to chamber boundaries, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutures flush, slightly reflexed to almost straight, tangent to umbo, meeting periphery at nearly 45 degrees, umbo subcentral, height of chambers at periphery irregular, well-defined rim on all chambers; in edge view subelliptical, greatest thickness through umbo, septal face heart-shaped, very constricted, shallowly concave and rounding into lateral faces of final chamber; apertural process subconoidal, aperture an elongate collared slit in the final face of process.

This form differs notably from the preceding species, *Robulus jocosus* Israelsky n. sp., in its consistently tangential sutures, very restricted final face and lack of attenuation at either end.

**Robulus sp. BD**

In side view subovate, apertural end acutely pointed, opposite end rounded, margin and periphery of earliest visible chamber forming an obtuse angle, periphery of final chamber somewhat straightened giving a weakly angulate appearance, sutural bands flush, gently reflexed, tangential to umbo, earlier sutures meeting periphery at about 60 degrees, last at nearly 45 degrees, umbo slightly eccentric, height of chambers at periphery irregular, well-defined keel on all chambers; in edge view subelliptical, greatest thickness through umbo, septal face heart-shaped, subtriangular, depressed, bounded laterally by inwardly beveled ridges; aperture an elliptical collared opening on final face of process.
their septal faces are more triangular and simply depressed rather than concave.

**Robulus infortunatus** Israelsky n. sp.

Plate 16, figures 3, 4

In side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber meeting in a very high obtuse angle, sutureal bands flush, gently reflexed, tangential to umbo, meeting periphery at about 45 degrees, umbo eccentric, height of chambers at periphery irregular, well-defined thick rim on all chambers; in edge view subelliptical, septal face elongate heart-shaped, depressed, bounded laterally by low rounded rims; apertural process subconoidal, aperture an elliptical collared opening in the final face of process.

**Robulus sp. BG**

Plate 16, figures 5, 6

In side view subovate, apertural end obtusely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, periphery of both chambers and rim tending to irregularly straighten resulting in a weakly subangulate outline, sutures flush, tangential to umbo, all except last meeting periphery at about 45 degrees, the last at almost 90 degrees, umbo subcentral, height of chambers at periphery increasing irregularly, well-defined thick keel on all chambers; in edge view broadly subelliptical, greatest thickness through umbos, slightly produced at either end, septal face broadly heart-shaped, depressed, bounded laterally by inwardly beveled ridges; apertural process subconoidal, the aperture an elongate collared slit in final face of process.

**Robulus sp. BI**

Plate 16, figures 9, 10

In side view subovate, obtusely pointed at apertural end, rounded on opposite end, periphery weakly angulate due to straightening on last two chambers, final margin of last chamber angulate, meeting periphery of earliest visible chamber in a low obtuse angle, sutures flush, tangential to umbo and meeting periphery at nearly 45 degrees, umbo eccentric, height of chambers at periphery irregular, well-defined thick rim on all chambers; in edge view subelliptical, greatest thickness through umbos, septal face broadly heart-shaped, depressed, bounded laterally by rounded rims; apertural process subconoidal, aperture a roundly triangular collared opening in the final face of process.

**Robulus latexpandus** Israelsky n. sp.

Plate 16, figures 11, 12

In edge view subovate, apertural end obtusely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, apertural process prominently projecting, broad sutureal bands gently reflexed, tangential to umbo, meeting periphery irregularly from about 45 degrees to nearly 90 degrees, umbo subcentral, height of chambers at periphery irregular, well-defined keel on all chambers; in edge view subelliptical, produced at end away from aperture, greatest thickness through umbos, septal face triangularly heart-shaped, bounded laterally by rounded rims; apertural process subconoidal, strongly compressed, aperture an elongate collared slit on the final face of process.
This form may be distinguished from *Robulus comis* Israelsky n. sp. by its less strongly tangential and proportionately broader sutures, narrower aperture and less elliptical outline in side view.

*Robulus coloratus* (Stache) of Cushman (1953a, pl. 1, fig. 8, Recent) is somewhat similar in outline but the sutures are not banded, the umbos are more eccentric and the thickness is proportionately less.

*Robulus midwayensis* (Plummer) var. *virginianus* Shifflet (1948, pl. 1, fig. 18, side view only, not fig. 15, Eocene) is similar in side view but the sutures are described as raised and the chambers are more numerous. Two forms seem confused by that author, the smaller specimen (her fig. 16) being considered the young of the larger (her fig. 15). The larger specimen is more tightly coiled and has fewer chambers than the smaller, which is contrary to our usual experience.

*Robulus comis* Israelsky n. sp.

Plate 16, figures 13, 14

In side view subovate, apertural end obtusely pointed, apertural process strongly projecting, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber meeting in an obtuse angle, sutural bands flush, gently reflexed, strongly tangential to umbos, meeting periphery at about 45 degrees except the last at nearly 60 degrees, umbo slightly eccentric, height of chambers at periphery irregular, well defined keel on all chambers; in edge view subelliptical, greatest thickness through umbos, septal face heart-shaped, depressed, bordered laterally by inwardly beveled ridges; apertural process subconoidal, aperture an elongate opening in final face of process.

**Dimensions in millimeters**

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*Robulus comis* Israelsky n. sp. is distinguished from *Robulus latexpandus* Israelsky n. sp. by its more tangential sutures, proportionally narrower sutural bands, more open aperture and its more gibbous outline in edge view. It may eventually be demonstrated that *R. comis* is a variety of *R. latexpandus*, but satisfactory intergradation was not made with the available specimens.

*Robulus adelinensis* Keijzer var. *nipeensis* Keijzer (1945, pl. 2, figs. 24, 25, Oligomiocene) has a similar appearance but a tendency towards angularity of outline with scalloping in later chambers.

*Robulus sp. B1*

Plate 16, figures 15, 16

In side view subcircular, apertural end obtusely pointed, opposite end rounded, final margin of last chamber sinuous, meeting periphery of earliest visible chamber in a high obtuse angle, sutures gently reflexed, first and third visible sutures raised, others flush, all tangential to umbo and meeting periphery at about 45 degrees, umbo subcentral, height of chambers at periphery irregular, well-defined keel on periphery of all chambers; in edge view subelliptical, slightly produced at end away from aperture, greatest thickness through umbos, septal face V-shaped, concavely depressed, bounded laterally by inwardly beveled ridges; apertural process flush with periphery, aperture an elongate collared slit in final face of process.

**Dimensions in millimeters**

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*Robulus gyroscalprum* (Stache) as figured by Dorre (1948, pl. 37, fig. 1, Eocene) is very closely related but is proportionally thicker and has a more conspicuous apertural process.

*Robulus paucicameratus* Israelsky n. sp.

Plate 16, figures 17, 18

In side view subovate, apertural end obtusely pointed, opposite end rounded, final margin of last chamber with slightly raised rim which extends onto first visible chamber, final margin and periphery of first visible chamber forming an obtuse angle, sutural ridges raised, comma-shaped, broadest toward umbo, not reaching to keel, radiate to umbo, meeting periphery at about 45 degrees, umbo eccentric, height of chambers at periphery irregular, well-defined keel on periphery of all chambers; in edge view subelliptical, strongly produced at end away from aperture, greatest thickness through umbo, septal face heart-shaped, depressed, very constricted, bounded laterally by inwardly beveled rims; apertural process subconoidal, inconspicuous, aperture an elongate collared slit in final face of process.

**Dimensions in millimeters**

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The apertural region is imperfect in the figured specimen but a specimen in sample 77 shows the aperture as described. Other specimens show more chambers. Differs from *Robulus mysticus* Israelsky n. sp. notably in having radiate rather than tangential sutures.

*Robulus proclivis* Israelsky n. sp.

Plate 16, figures 19, 20

In side view subovate, apertural end bluntly pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber meeting in an obtuse angle, sutural bands flush, gently reflexed, meeting periphery at nearly 45 degrees, several radial grooves visible on apertural process, umbo subcentral,
height of chambers at periphery irregular, well-defined keel on all chambers; in edge view subelliptical, end away from aperture strongly produced, greatest thickness through umbo, septal face V-shaped, depressed, bounded laterally by inwardly beveled ridges; apertural process subconoidal, aperture an elongate collared slit in final face of process.

Robulus mysticus Israelsky n. sp.
Plate 16, figures 21-24

In side view subovate, apertural end bluntly pointed, opposite end rounded, final margin of last chamber and periphery of first visible chamber meeting in an obtuse angle, sutural ridges weakly raised, comma-shaped, tangential to umbo, meeting periphery at about 45 degrees, umbo eccentric, well-defined keel on all chambers; in edge view subelliptical, greatest thickness through umbos, septal face in adult elongate heart-shaped, gently concave, bounded laterally by inwardly beveled ridges, apertural process subconoidal, aperture a small elongate trigonal opening in final face of process.

The young form is proportionally thicker with only the earlier sutural ridges raised, the later slightly depressed, the umbo is less eccentric, the septal face broadly V-shaped and the beveled ridges proportionally narrower.

Robulus cf. rosetta (Gümbel) of Cushman and Renz (1942, pl. 1, fig. 4, Eocene) is very similar but its outline appears more angulate and the well-defined keel of the present form is lacking.

The original figures of Robulina rosetta Gümbel (1868, pl. 1, fig. 73, Eocene) have little resemblance to either the species from the Lodo formation or that figured by Cushman and Renz.

Robulus sp. BL
Plate 16, figures 29, 30

In side view subovate, roundly subquadrangular, straighter portions of the outline unrelated to cham-
bers, swelling on rim near final suture, apertural end acutely pointed, opposite end angulately rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutures flush, gently reflexed, earlier radiate from umbo, later tangential to umbo, irregularly meeting periphery at various angles of from about 45 to nearly 90 degrees, umbo somewhat eccentric, height of chambers at periphery irregular, well-defined keel except on last chamber; in edge view subelliptical, slightly produced at either end, greatest thickness through umbos, septal face heart-shaped, much broader subelliptical, produced at either end, greatest thickness on all chambers; in edge view subelliptical, slightly produced at either end, greatest thickness through umbos, septal face V-shaped, very restricted, depressed, bounded laterally by inwardly bev­eled rims which round outwardly into the later faces of final chamber; apertural process subconoidal, strongly compressed, aperture an elongate collared slit in final face of process.

Test lenticular; in side view subcircular, apertural end bluntly pointed, opposite end rounded, final margin of last chamber and periphery of first visible chamber meeting in an obtuse angle, sutural bands flush except occasionally raised in earliest visible portions of test, gently reflexed, tangential to umbo, meeting periphery at about 45 degrees, umbo somewhat eccentric, height of chambers at periphery irregular, well-defined rim on all chambers; in edge view subelliptical, greatest thickness through umbos, septal face V-shaped, very restricted, depressed, bounded laterally by inwardly bev­eled rims which round outwardly into the later faces of final chamber; apertural process subconoidal, compressed, aperture an elliptical opening on final face of process bounded on either side by a flaplike lip that together form an inwardly opening V; with growth, more abrupt increase of diameters than thickness.

Comparison with Cushman and Hanna's specimen showed it to be identical with the present species. D'Orbigny's figures show a more nearly circular outline, a central umbo, no rim and much less curve between umbo and periphery.

_Cristellaria kemperi_ G. D. Hanna (1923, pl. 59, fig. 1, Eocene), _Cristellaria midwayensis_ Plummer (1926, pl. 13, fig. 5, Eocene) and _Robulus dumbeii_ Weinzel and Applin (1929, pl. 48, fig. 3, Eocene) all bear resemblance to _Robulus supra­lodoensis_ Israelsky n. sp. but each has raised sutures and differs in other respects. Perhaps the closest figured form is _Robulus mellahensis_ Nakkady var. _obesus_ (1950, pl. 89, figs. 10, 11, Eocene) but it also has raised sutures, a proportionately much thinner rim and apparently an even more restricted septal face than _Robulus supra­lodoensis_ Israelsky n. sp.

_Robulus sp. BN_

Plate 17, figures 1, 2

In side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber meeting in an obtuse angle, broad sutural bands flush, reflexed, first visible suture tangential to umbo, others radiate, sutures meeting periphery at about 45 degrees, umbo somewhat eccentric, height of chambers at periphery regularly increasing, well-defined keel on all chambers; in edge view subelliptical, slightly produced at end away from aperture, greatest thickness through umbo, septal face heart­shaped, flattened, rounding into lateral faces of final chamber; apertural process subconoidal, aperture an elongate collared slit in final face of process.
**CALCAREOUS FORAMINIFERA (MILIOLIDAE AND LAGENIDAE, PART)**

<table>
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<th>Specimen</th>
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<th>Dimensions in millimeters</th>
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A three-chambered specimen (Cushman Coll. 9404), labeled as a toptype of *Robulus crusianus* (d'Orbigny), resembles *Robulus* sp. BN but differs in having a smoothly curved periphery and proportionally narrower suture lines.

**Robulus sp. BO**

Plate 17, figures 3, 4

In side view subovate, apertural end bluntly pointed, opposite end rounded, final margin of last chamber meeting periphery of earliest visible chamber in an obtuse angle, sutural bands flush, earlier sutures tangential to umbo, intermediate sutures radiate, final suture tangential to umbo, earlier sutures meeting periphery at about 45 degrees, later at nearly 60, umbo slightly eccentric, height of chambers at periphery irregular, well-defined rim on all chambers; in edge view subelliptical, somewhat produced at end away from aperture, greatest thickness through umbos, septal face heart-shaped, concave, bounded laterally by inwardly beveled rims that round into the lateral faces of final chamber; apertural process subconoidal, compressed, aperture an elongate slit bordered by flaplike lips in final face of process.

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The differences in the aperture and the irregular suture pattern in *Robulus* sp. BO serve to distinguish it from *Robulus* sp. BN.

**Robulus turpis Israelsky n. sp.**

Plate 17, figures 5–8

In side view oblately subelliptical, apertural end forming almost a right angle in the young, a low obtuse angle in the adult, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber meeting in an obtuse angle, sutural bands flush except the earlier sutures of the young, tangent to umbo, meeting periphery irregularly at various angles from about 45 to nearly 90 degrees, umbo eccentric, height of chambers at periphery irregular, poorly defined rim on all chambers; in edge view elliptical, greatest thickness through umbos, septal face subtrigonal in the young, heart-shaped, bounded laterally by low rims; apertural process subconoidal, aperture an elongate collared slit on final face of process.

Calcareous Foraminifera (Miliolidae and Lagenidae, Part)

<table>
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*Robulus weaveri* Beck (1943, pl. 103, figs. 3, 8, Eocene) is very similar and the present form may be but a variant of that species.

**Robulus manifestus Israelsky n. sp.**

Plate 17, figures 9, 10

Test lenticular; in side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber meeting periphery of earliest visible chamber in an obtuse angle, sutures flush, gently reflected, radial from umbo, meeting periphery at about 90 degrees, umbo slightly eccentric, height of chambers at periphery irregular, well-defined rim on all chambers; in edge view subelliptical, greatest thickness through umbos, septal face very constricted, depressed, bounded laterally by rounded rims that merge into lateral faces of final chamber; apertural process subconoidal, aperture an elongate opening widening inwardly and bounded by flaplike lips.

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*Robulus aff. ornatus* (d'Orbigny) of LeRoy (1944b, pl. 3, figs. 3, 4, Miocene) is similar in side view but the apertural process is less conspicuous, the umbo more central, the septal face less pinched and the thickness proportionately greater than in *Robulus manifestus* Israelsky n. sp.

**Robulus arcanus Israelsky**

Plate 17, figures 11, 12

In side view subovate, apertural end acutely pointed, opposite end rounded, final margin and periphery of earliest visible chamber forming an obtuse angle, sutures flush, varying from gently reflected to nearly straight, tangent to umbo except last (which is radiate), meeting periphery irregularly at from about 45 to nearly 90 degrees, umbo prominent, subcentral, height of chambers at periphery irregular, well-defined rim on all chambers; in edge view subelliptical, greatest thickness through somewhat swollen umbos, septal face heart-shaped, somewhat subtrigonal, depressed, bounded laterally by rounded rims that round into lateral faces of final chamber; apertural process subconoidal, aperture a narrow elliptical collared opening in the final face of process.

<table>
<thead>
<tr>
<th>Specimen</th>
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</table>
This form has tangential sutures, a more open septal face, and a more central umbo than *Robulus manifestus* Israelsky n. sp.

*Robulus* sp. F of LeRoy (1944, pt. 2, pl. 4, figs. 19, 20, Miocene) is similar but all sutures appear tangential to the umbo, the angle at which the sutures intersect the periphery increases regularly and the septal face is more V-shaped than in the Lodo species.

The specimen illustrated as *Cristellaria alato-limbata* (Gümbel) by Cushman and Applin (1926, pl. 8, fig. 8, Eocene) is more loosely coiled, the later sutures tend to be more strongly tangential, and the final suture is depressed.

*Robulus habilis* Israelsky n. sp.

Plate 17, figures 13, 14

Test lenticular; in side view subovate, apertural end obtusely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutures flush except the last (which is slightly depressed), tangential to umbo, meeting periphery at about 45 degrees, umbo somewhat eccentric, height of chambers at periphery irregular, in general later chambers lower than earlier ones, well-defined rim on all chambers; in edge view subelliptical, greatest thickness through umbos, septal face elongate heart-shaped, depressed, bounded laterally by inwardly beveled rims; apertural process subconoidal, aperture a trigonal opening in final face of process.

<table>
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*Robulus euglypheus* Bandy (1949, pl. 8, fig. 7, Eocene) has a more circular outline, more central umbos, and the early sutures appear more reflected than in *Robulus habilis* Israelsky n. sp.

*Robulus eumengii* Michelotti as figured by Bornemann (1860, pl. 6, fig. 1, Tertiary) seems to be very similar but is closer coiled and more produced at end away from aperture, giving a more sagitate outline than in *Robulus habilis* Israelsky n. sp.

*Robulus sp. BR*

Plate 17, figures 15, 16

In side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber meeting periphery of earliest visible chamber forming an obtuse angle, early sutures radiate, later tangential to umbo, weakly reflected, early and last meeting periphery at about 90 degrees, intermediate meeting periphery at nearly 45 degrees, umbo very eccentric, height of chambers at periphery increasing regularly, well-defined rim on all chambers; in edge view subelliptical, slightly produced at either end, septal face weakly heart-shaped, flattened; apertural process subconoidal with radial grooves on lateral faces, aperture a weakly collared elongate slit on the final face of process.

<table>
<thead>
<tr>
<th>Specimen</th>
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**Robulus iracundus** Israelsky n. sp.

Plate 17, figures 21, 22

Test lenticular; in side view subcircular, apertural end bluntly pointed, opposite end rounded, final margin and periphery of first visible chamber meeting in an obtuse angle, sutural bands flush except a few raised in earliest visible portions of test, gently reflexed, tangent to umbo, meeting periphery at about 45 degrees, umbo somewhat eccentric, height of chambers at periphery irregular, well-defined rim on all chambers; in edge view subelliptical, greatest thickness through umbos, septal face heart-shaped, but slightly depressed, bounded laterally by low rims that round into lateral faces of final chamber; apertural process subconoidal, aperture an elliptical opening in final face of process bounded to either side by flampilike lips that form an inwardly opening V.

**Robulus inhabilis** Israelsky n. sp.

Plate 17, figures 23, 24

Test lenticular; in side view subcircular, apertural end obtusely pointed, opposite end rounded, final margin and periphery of earliest visible chamber forming an obtuse angle, umbo somewhat eccentric, height of chambers at periphery irregular, well-defined rim on all chambers; in edge view subelliptical, greatest thickness through umbos, septal face heart-shaped, slightly depressed, bounded on either side by low rounded rims that blend into lateral faces of final chamber; apertural process subconoidal, aperture an elongate collared slit in final face of process.

**Robulus pseudocultus** Israelsky n. sp.

In side view subovate, acutely pointed at apertural end, rounded at opposite end, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutural bands flush, tangent to umbo, earlier sutures meeting periphery at about 45 degrees, the last at almost right angles, early sutures strongly reflexed, later gently reflexed, umbo eccentric, height of chambers at periphery irregular, well-defined rim on all chambers; in edge view subelliptical, slightly produced at either end, greatest thickness through the umbos, septal face heart-shaped, slightly convex, almost flat, rounding imperceptibly into lateral faces of last chamber; apertural process terminal, compressed subconoidal, aperture an elliptical collared opening in final face of process.

**Robulus fatigatus** Israelsky n. sp.

In side view subovate, acutely pointed at apertural end, rounded at opposite end, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutural bands flush, tangent to umbo, earlier sutures meeting periphery at about 45 degrees, the last at almost right angles, early sutures strongly reflexed, later gently reflexed, umbo eccentric, height of chambers at periphery irregular, well-defined rim on all chambers; in edge view subelliptical, slightly produced at either end, greatest thickness through the umbos, septal face heart-shaped, slightly convex, almost flat, rounding imperceptibly into lateral faces of last chamber; apertural process terminal, compressed subconoidal, aperture an elliptical collared opening in final face of process.

<table>
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The much less rounded apertural end and the open septal face distinguish this species from *Robulus supralodoensis* n. sp.

*Robulus sp. H* (LeRoy 1944, pl. 5, figs. 45, 46, Miocene) is similar but seems to have more strongly reflexed sutures, a more sharply pointed apertural end, a more sunken septal face, and is proportionately thinner than *Robulus inhabilis* Israelsky, n. sp.

In side view *Robulus inhabilis* Israelsky n. sp. resembles topotypes of *Robulina incornata* d'Orbigny (1846, pl. 4, figs. 25, 26, Miocene) in the U. S. National Museum collections, but the umbos in those specimens are more central and the sutures straighter. The topotypes are proportionately much thicker than is indicated by the type figure.

<table>
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<td>0.78 0.73 0.45</td>
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</table>

The closest figured form seems to be that referred to *Robulus pseudocultratus* Cole by Howe (1939, pl. 5, figs. 2, 3, Eocene) in which, however, the periphery lacks the angulation present in *Robulus cultus* Israelsky n. sp.; the umbo appears more eccentric and the septal face is more V-shaped.

Cole's original figure (1927, pl. 1, fig. 5, side view only, Eocene) shows all sutures to be radial and lacks the protruding apertural process present in Howe's specimen and the present species.
Robulus ponderosus Israelsky n. sp.

Plate 17, figures 29-32

In side view subovate, apertural end bluntly pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming a low obtuse angle, sutures slightly depressed, tangential to umbo, meeting periphery at about 45 degrees, umbo eccentric, slightly swollen, height of chamber at periphery irregular, well-defined keel on all chambers; in edge view subelliptical, slightly produced at either end, greatest thickness through umbos, septal face subtrigonal, depressed, bounded laterally by low rounded rims; apertural process conspicuous, subconoidal, compressed; aperture an elongate collared slit in final face of process.

Specimen Sample USNM Dimensions in millimeters

<table>
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<tr>
<th>Specimen</th>
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The highly inflated smaller specimen (figs. 31, 32) is taken to be the young of the species.

Robulina gravida Sequenza (1880, pl. 13, fig. 23, Miocene) has some resemblance but its outline is scalloped, it has a less accentuated apertural process and a less eccentric umbo, it is proportionally thicker and its final face is more V-shaped than in Robulus ponderosus Israelsky n. sp.

Robulus sp. BS

Plate 17, figures 33, 34

In side view subovate, bluntly pointed at apertural end, rounded at opposite end, periphery of each of last two chambers straightened with resulting angulate appearance, final margin of last chamber and periphery of earliest visible chamber meeting in an obtuse angle, sutures flush, reflexed, meeting periphery at about 45 degrees, umbo eccentric, height of chambers at periphery irregular, last two chambers noticeably higher than the earlier chambers, poorly defined narrow thin rim present; in edge view subelliptical, slightly produced at either end, greatest thickness through umbos, septal face elongate heart-shaped, depressed, bounded laterally by gently rounded rims; apertural process subconoidal, aperture an elongate triangular opening in final face of process.

Specimen Sample USNM Dimensions in millimeters

<table>
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<tr>
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</table>

Cristellaria protuberans Cushman (1919a, pl. 22, fig. 2, side view only, Oligocene) has some resemblance but is much more uncoiled and proportionally elongate.

Robulus sp. BT

Plate 17, figures 37, 38

In side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber meeting periphery of earliest visible chamber in an obtuse angle, sutures flush, gently reflexed, meeting periphery at about 45 degrees, with low blisterlike swellings covering the periphery, umbilicus subcentral, height of chambers at periphery irregular, poorly defined rims on periphery and final margin of last chamber; in edge view subelliptical, indented through umbilici, greatest thickness through final chamber, septal face elongate heart-shaped, bounded laterally by well-defined rounded rims; apertural process subconoidal, aperture an elongate triangular opening in final face of process, with rims on either side.

Specimen Sample USNM Dimensions in millimeters

<table>
<thead>
<tr>
<th>Specimen</th>
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Robulina deformis Reuss (1851, pl. 4, fig. 30, Oligocene) has some resemblance but it has more reflexed sutures, a depressed septal face and is proportionately broader and thicker.

Robulus sp. BU

Plate 17, figures 39, 40

In side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber
and periphery of earliest visible chamber forming angle slightly greater than a right angle, sutures except last flush, nearly straight, radiate, meeting periphery at nearly 90 degrees, final suture gently curved, depressed, meeting periphery at nearly 45 degrees, final chamber swollen, umbo eccentric, height of chambers at periphery irregular, well-defined broad thin keel on all chambers; in edge view crudely subelliptical, bilobate, indented at juncture of last chamber with earliest visible chamber, somewhat produced at apertural end, greatest thickness through last chamber, septal face heart-shaped, rounded laterally by sharp ridges; apertural process subconoidal, aperture an elongate collared slit in final face of process.

Specimen | Sample | USNM | Dimensions in millimeters
--- | --- | --- | ---
Figured | 74 | 549067 | Length 0.28 Width 0.23 Thickness 0.12

**Robulus sp. BV**  
Plate 17, figures 41, 42

In side view subovate, apertural end pointed, opposite end rounded, reflexed, final margin of last chamber and periphery of earliest visible chamber meeting in an obtuse angle, sutures flux, gently reflexed, radiate from umbo, meeting periphery irregularly at from about 45 degrees to nearly 90 degrees, umbo eccentric, height of chambers at periphery increasing regularly, well-defined rim on all chambers; in edge view subelliptical, slightly produced at apertural end, greatest thickness through last chamber, septal face elongate heart-shaped, depressed, transversely flattened, bounded laterally by low rounded rims; apertural process subconoidal, aperture an elongate collared slit in final face of process.

Specimen | Sample | USNM | Dimensions in millimeters
--- | --- | --- | ---
Figured | 78 | 549068 | Length 0.33 Width 0.24 Thickness 0.13

This form bears some resemblance to **Cristellaria inaequalis** Costa of Fornasini (1898, pl. 2, fig. 6, Tertiary) but is proportionately thinner, sutures are less strongly bent and the septal face is proportionately longer. There is perhaps closer resemblance to **Cristellaria dubiensis** Berthelin (1880, pl. 3, fig. 24, Cretaceous) but the same contrasts exist.

**Robulus sp. BW**  
Plate 17, figures 43, 44

In side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutural bands flush, earlier sutures almost straight, last slightly reflexed, tangent to umbo, meeting periphery at nearly 90 degrees, umbo very eccentric, height of chambers at periphery irregular, that of last chamber about double that of previous chamber, poorly defined rim present; in edge view subelliptical, greatest thickness through final chamber, septal face elongate heart-shaped, weakly depressed, bounded laterally by low rounded rims; apertural process subconoidal, aperture an elongate collared slit in final face of process.

Specimen | Sample | USNM | Dimensions in millimeters
--- | --- | --- | ---
Figured | 87 | 549087 | Length 0.27 Width 0.20 Thickness 0.12

There is some resemblance to **Robulina depauperalis** Reuss (1863, pl. 6, figs. 67, 68, Oligocene) but that form is proportionally both broader and thicker as well as having fewer chambers.

**Robulus sp. BY**  
Plate 18, figures 1, 2

In side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber meeting in a low obtuse angle, sutural bands flush, earlier ones radiate, nearly straight, later ones tangential to umbo, gently reflexed, all meeting periphery at nearly 90 degrees, umbo eccentric, height of chambers at periphery irregular, final chamber notably higher than previous one, poorly defined rim on all chambers; in edge view subelliptical, somewhat produced at end away from aperture, greatest thickness through final chamber close to umbo, septal face heart-shaped, slightly depressed, bounded laterally by low rounded rims which merge into lateral faces of final chamber; apertural process subconoidal with few striae on sides, aperture an elon-
gate elliptical opening in the final face of process bounded by a U-shaped collar which opens onto septal face of test.

<table>
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This form bears some resemblance to Liebus' (1921, p. 53, fig. 3, Tertiary) Cristellaria crassa d'Orbigny var., but that species has a more eccentric umbo, its early sutures are distinctly reflexed and it is proportionally much thinner.

**Robulus serenus** Israelsky, n. sp.

**Plate 18, figures 3, 4**

In side view subovate, roundly subtrigonal, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber meeting in a high obtuse angle, sutures flush, slightly reflexed, early ones inclined forward, meeting periphery at about 45 degrees, last two meeting periphery at nearly 90 degrees,umbo very eccentric, height of chambers at periphery irregular, accelerating in last two chambers, well-defined rim on all chambers; in edge view subelliptical, somewhat produced at apertural end, greatest thickness through last chamber, septal face strongly convex, merging imperceptibly into lateral faces of final chamber; apertural process subconoidal with radial striae, aperture an elongate collared slit on final face of process.

<table>
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A far-fetched comparison may be made with Brady's (1884, pl. 69, figs. 8, 9, Recent) figure of Cristellaria gibba d'Orbigny which has a more central umbo, more strongly curved sutures and is proportionally much thinner.

Cushman's (1926, p. 19, fig. 10, Cretaceous) specimen called Cristellaria cf. lepida (Reuss) is possibly identical but the presence or absence of a robuline aperture could not satisfactorily be determined.

**Robulus ligatus** Israelsky n. sp.

**Plate 18, figures 5–8**

In side view subovate, roundly subtrigonal, acutely pointed at apertural end, rounded at opposite end, slight angularity between last two chambers with node at intersection, weak sinus at juncture of final margin of last chamber and periphery of earliest visible chamber, sutureal bands flush, gently reflexed, radiate, inclined forward, meeting the periphery irregularly in angles varying from about 45 to nearly 90 degrees,umbo very eccentric, height of chambers in early portion increasing irregularly, height of later chambers increasing gradually, well-defined keel on all chambers; in edge view subelliptical, weakly produced at end away from aperture, greatest width slightly toward aperture from umbos, septal face convex, rounding into lateral faces of final chamber; apertural process subconoidal, aperture an elongate opening bounded by V-shaped collar which opens onto septal face.

In young the septal face is somewhat flattened and the angulation between the last two chambers is very weak.

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The form figured by Cushman and Todd (1945b, pl. 13, figs. 26, 27, side views only, Eocene) as Planularia danvillensis Howe and Wallace has more strongly reflexed sutures, but lacks the angle and node at juncture of the last two chambers, has nonbanded sutures and supposedly has a nonrobuline aperture.

**Robulus frustatus** Israelsky n. sp.

**Plate 18, figures 9, 10**

In side view subovate, acutely pointed at apertural end, rounded at opposite end, periphery of final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutures flush, earlier ones more strongly reflexed than later, all tangential toumbo, earliest visible suture meeting periphery at about 45 degrees, later sutures steepening to nearly 90 degrees in the last suture,umbo somewhat eccentric, height of chambers at periphery irregular, well-defined keel on all chambers; in edge view subelliptical, produced at either end, greatest thickness through umbos, septal face strongly convex, merging imperceptibly into lateral faces of final chamber; apertural process subconoidal, aperture an elongate collared slit in the final face of process.

<table>
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Robulina magnifica Costa MS of Fornasini (1897, p. 112, 3 text figures, Tertiary) has much the same outline in side view but its sutures appear radial throughout, the angulation of the periphery is lacking, the septal face appears depressed and it is proportionately much thinner than the form found in Lodo formation.

Franke's (1927, pl. 2, fig. 18, Paleocene) version of Cristellaria beyrichi Bornemann also lacks the weakly angulated periphery and all sutures are radiate.
**Robulus sp. BZ**  
Plate 18, figures 11, 12

In side view subovate, acutely pointed at apertural end, rounded at opposite end, final margin of last chamber and periphery of earliest visible chamber merging without offset, sutures flush, radiate, gently reflexed, meeting periphery irregularly from about 45 degrees to nearly 90 degrees, the last suture sinuous and inclined toward apertural end at periphery, umbo eccentric, height of chambers at periphery irregular, poorly defined rim on all chambers; in edge view subelliptical, greatest thickness through umbos, sepal face convex, merging imperceptibly into lateral faces of final chamber; apertural process subconoidal, aperture an elongate weakly rimmed slit on final face of process.

**Marginulina ovata** (Galloway and Hemingway) as figured by Cushman and Renz (1947, pl. 4, fig. 3, side view only, Oligocene) has a robuline aperture. It is proportionally both narrower and thinner than *Robulus* sp. BZ and the umbonal area is even more eccentric.

**Robulus sp. CA**  
Plate 18, figures 13, 14

In side view subovate, roundly subtrigonal, acutely pointed at apertural end, rounded at opposite end, final margin of last chamber and periphery of earliest visible chamber meeting in an obtuse angle, sutures except last flush, first visible sutures reflexed, strongly bent toward umbo and radiate, the next weakly sinuous and tangent to umbo, last suture somewhat depressed and tangent to umbo, first two sutures meeting periphery at nearly 45 degrees, last two at about 90 degrees, last chamber somewhat inflated and projecting over onto first visible chamber, umbo eccentric, height of chambers at periphery increasing regularly, poorly defined rim on all chambers; in edge view subelliptical, sepal face elongate subtriangular, slightly concave, bounded laterally by weak rims that round into lateral faces of final chamber; apertural process subconoidal, grooved on lateral faces, aperture an elongate slit in final face of process.

**Lenticulina cf. theta** Cole of Cushman and R. E. and K. C. Stewart (1947 (1948), pl. 11, fig. 3, Eocene) is very similar in side view but the final chamber is less inflated, and the edge view outline is distinctly bilobate; early sutures are indistinct but seem to be less strongly bent. A robuline aperture is present in the figured specimen.

**Robulus sp. CB**  
Plate 18, figures 15, 16

In side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber meeting in an obtuse angle, sutures flush, all except last radiate, last tangential to and strongly bent near umbo, meeting periphery irregularly at from about 60 to nearly 90 degrees, umbo eccentric, height of chambers at periphery increasing regularly, poorly defined rim on all chambers; in edge view subelliptical, sepal face elongate subtriangular, slightly concave, bounded laterally by weak rims that round into lateral faces of final chamber; apertural process subconoidal, grooved on lateral faces, aperture a collared slit in final face of process.

**Lenticulina gibbus** (d'Orbigny) by LeRoy, (1941, pl. 3, figs. 53, 59, Late Tertiary) which is very similar in edge view but in side view shows a much straighter periphery on the last chamber and a much more strongly bent final margin.

**Robulus projectus** Israelsky n. sp.  
Plate 18, figures 17, 18

In side view subovate, bluntly pointed at apertural end, rounded at opposite end, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, proportionally broad sutural bands flush except the last which is slightly depressed, all except last nearly straight, last slightly sinuous, all bands inclined forward, radiate, meeting periphery at angles of about 45 to 60 degrees, umbo very eccentric, apertural process quite prominent, with single radial groove discernible, height of chambers at periphery irregular, well-defined rim present on all chambers with node at peripheral end of last suture; in edge view subelliptical, slightly produced at end away from aperture, greatest thickness through umbos, sepal face convex, rounding into lateral faces of final chamber; aperture a collared slit in the final face of process.
Robulus sp. GC
Plate 18, figures 19, 20

In side view subovate, acutely pointed at apertural end, rounded at opposite end, final margin of last chamber and periphery of earliest visible chamber meeting in an obtuse angle, sutures flush, earliest visible two strongly reflexed, next two hooked nearumbo, the fourth straightening between the hook and the periphery, fifth suture nearly straight, tangential to strong bow in previous suture, final suture slightly bent at contact with previous suture truncating the earlier whorl, all except last suture meeting periphery at about 45 degrees, the last at about 60 degrees,umbo eccentric, height of chambers at periphery increasing regularly, broad keel on all chambers; in edge view, outline compressed subelliptical, slightly produced toward either end, thickest through umbo, septal face V-shaped, slightly depressed, bounded laterally by weak rims, aperture an elongate collared slit in final face of process.

Perhaps the closest figured specimen is that referred to Robulus dicampyla (Franzenau) by Bermudez (1949, p. 7, figs. 23, 24, Miocene) in which, however, none of the sutures become tangential.

Robulus odiosus Israelsky n. sp.
Plate 18, figures 21-26

In side view subovate, apertural end acutely pointed, opposite end rounded, in adult periphery of last few chambers tending to straighten giving angulate appearance, in young periphery smoothly curved throughout, final margin of last chamber meeting periphery of earliest visible chamber in a very low obtuse angle in the adult, in a larger obtuse angle in the young; sutures flush, reflexed, tangential to umbo, early sutures meeting periphery at about 45 degrees, later at nearly 90 degrees, in adult covered by bands,umbo eccentric, height of chambers, at periphery irregular, rim present on all chambers, becoming more pronounced with growth; in edge view subelliptical, produced at either end, greatest thickness throughumbo, septal face heart-shaped, more elongate in the adult than in the young, slightly depressed, bounded laterally by weak rims; apertural process subconoidal, compressed, the aperture an elongate collared slit in final face of process.

Cristellaria degolyeri Plummer (1926, pi. 7, fig. 7, Eocene) has a similar outline but its sutures are more strongly reflexed, the test is proportionally much thinner and a robuline slit is neither illustrated nor mentioned in the text.

Robulus degolyeri (Plummer) of Bandy (1944, pl. 60, fig. 5, Eocene) has more strongly reflexed sutures, is more tightly coiled and the apertural process is proportionally broader and thinner than is the case with Robulus tardus Israelsky n. sp.

Robulus sp. CD
Plate 18, figures 29, 30

In side view subovate, acutely pointed at apertural end, rounded at opposite end, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutural bands flush, ranging from radiate to tangential, meeting periphery at about 45 degrees,umbo subcentral, height of chambers at periphery irregular, well-defined keel on all chambers; in edge view subelliptical, somewhat produced at either end, greatest thickness through umbo, septal face broadly V-shaped, slightly depressed, bounded laterally by low ridges which round into the lateral faces of final chamber; apertural process subconoidal, aperture an elongate rimmed slit in final face of process.

Lenticulina incrassata Marie (1941, pl. 10, fig. 108, Cretaceous) is very similar in outline but has straight sutures and lacks a robuline aperture.

Robulus tardus Israelsky n. sp.
Plate 18, figures 27, 28

In side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, early sutures slightly raised, later flush, sutural bands varying irregularly from gently reflexed to almost straight, tangential toumbo, earlier sutures meeting periphery irregularly from about 60 to nearly 90 degrees,umbo eccentric, height of chambers at periphery irregular, well-defined keel on all chambers; in edge view subelliptical, weakly produced at apertural end, more strongly produced at opposite end, greatest thickness through umbo, septal face elongate heart-shaped, slightly depressed, bounded laterally by low rims; apertural process subconoidal, aperture an elliptical collared opening in final face of process.

FORAMINIFERA OF THE LODO FORMATION, CENTRAL CALIFORNIA

Dimensions in millimeters

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Sample</th>
<th>USNM</th>
<th>Length</th>
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Lenticulina incrassata Marie (1941, pl. 10, fig. 108, Cretaceous) is very similar in outline but has straight sutures and lacks a robuline aperture.

Robulus tardus Israelsky n. sp.
Plate 18, figures 27, 28

In side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, early sutures slightly raised, later flush, sutural bands varying irregularly from gently reflexed to almost straight, tangential toumbo, earlier sutures meeting periphery irregularly from about 60 to nearly 90 degrees,umbo eccentric, height of chambers at periphery irregular, well-defined keel on all chambers; in edge view subelliptical, weakly produced at apertural end, more strongly produced at opposite end, greatest thickness through umbo, septal face elongate heart-shaped, slightly depressed, bounded laterally by low rims; apertural process subconoidal, aperture an elliptical collared opening in final face of process.

Robulus tardus Israelsky n. sp.
Plate 18, figures 27, 28

In side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, early sutures slightly raised, later flush, sutural bands varying irregularly from gently reflexed to almost straight, tangential toumbo, earlier sutures meeting periphery irregularly from about 60 to nearly 90 degrees,umbo eccentric, height of chambers at periphery irregular, well-defined keel on all chambers; in edge view subelliptical, weakly produced at apertural end, more strongly produced at opposite end, greatest thickness through umbo, septal face elongate heart-shaped, slightly depressed, bounded laterally by low rims; apertural process subconoidal, aperture an elliptical collared opening in final face of process.
Cristellaria (Cristellaria) semi-impressa Reuss (1866, pl. 3, fig. 13, Oligocene) is very similar but has all sutures tangential to the umbo and is more compressed than the present form.

Robulus convergens (Bornemann) of Bermudez (1949, pl. 7, figs. 49, 50, Oligocene) has a very similar outline but its sutures are much straighter.

Robulus sp. CE
Plate 18, figures 31, 32

In side view subovate, apertural end broadly pointed, opposite end rounded, periphery of last chamber straightened, resulting in angulate appearance, final margin of last chamber meeting periphery of earliest visible chamber in an obtuse angle, sutural bands flush, gently reflected, all radial from umbo and meeting periphery at about 45 degrees, umbo somewhat eccentric, height of chambers at periphery irregular, well-defined rim on all chambers; in edge view subelliptical, greatest thickness through umbo, septal face flatly convex, rounding into lateral faces of last chamber; apertural process subconoidal, aperture an elongate collared slit in final face of process.

Robulus sp. CG
Plate 18, figures 37, 38

In side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber strongly bowed, meeting periphery of earliest visible chamber in an obtuse angle, sutural bands flush, gently reflected, tangential to umbo, all except last meeting periphery at about 45 degrees, last at nearly 60 degrees, umbo subcentral, chamber heights at periphery subequal, well-defined rim on all chambers; in edge view subelliptical, slightly produced at apertural end, greatest thickness through umbo, septal face heart-shaped, convex, merging into lateral faces of final chamber; apertural process subconoidal, compressed, aperture an elongate slit in final face of process.

The apertural process is imperfect in the figured specimen and is described from one in sample 65.
well-defined rim on all chambers; in edge view sub-elliptical, produced toward either end, greatest thickness through umbos, septal face elongate heart-shaped, weakly depressed, bounded laterally by low rounded rims which merge into lateral faces of final chamber; apertural process broken.

**Specimen**

**Sample USNM**

**Dimensions in millimeters**

<table>
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**Robulus sanus** Israelsky n. sp.

Plate 18, figures 41, 42

In side view subovate, acutely pointed at apertural end, rounded at opposite end, final margin of last chamber and periphery of earliest visible chamber meeting in an obtuse angle, sutural bands very slightly reflexed, tangential to umbo, all except last meeting periphery at about 45 degrees, last at nearly 90 degrees, umbo subcentral, height of chambers at periphery irregular, well-defined rim on all chambers; in edge view subelliptical, slightly produced at either end, septal face weakly convex and rounding into lateral faces of final chamber; apertural process subconoidal, compressed, aperture an elongate rimmed slit in the final face of process.

**Specimen**

**Sample USNM**

**Dimensions in millimeters**

<table>
<thead>
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**Robulus fresnoensis** Israelsky n. sp. may be distinguished by its somewhat angulate outline, its more blunt apertural end, its truncating final suture and the greater curve of its sutures.

In the specimens referred by Brady (1884, pl. 69, figs. 6, 7, Recent) to *Cristellaria conoidea* Bornemann each has the final face of last chamber and periphery of first visible chamber meeting in almost a straight line and the sutures are more strongly bent.

**Robulus sp. CI**

Plate 18, figures 43, 44

In side view subovate, periphery of final chamber straightened giving angulate appearance, apertural end broadly pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber meeting in very large obtuse angle, almost in a straight line, sutures flush, gently reflexed to nearly straight, radiate from umbo, meeting periphery at nearly 90 degrees and tangential to umbo, umbo subcentral, height of chambers at periphery irregular, peripheral rim poorly defined; in edge view subelliptical, slightly produced at apertural end, septal face convex, merging imperceptibly into lateral faces of final chamber; apertural process subconoidal, slightly compressed, aperture an elongate collared slit in final face of process.

**Specimen**

**Sample USNM**

**Dimensions in millimeters**

<table>
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This form is readily distinguished from *Robulus sanus* Israelsky n. sp. and *Robulus fresnoensis* Israelsky n. sp. by its more radial sutures.

*Robulus alato-limbatus* (Günbel) of Cushman and Siegfus (1942, pl. 15, fig. 20, not 19, 21, Eocene) has a practically identical suture pattern, but the peripheral angulation is notably stronger and it is proportionally thicker.

**Robulus fractus** Israelsky n. sp.

Plate 18, figures 45, 46

In side view semicirculoid, apertural end acutely pointed, opposite end rounded, final margin and periphery of earliest visible chamber merging without offset and forming almost a straight line, sutural bands flush, tangential to umbo, meeting periphery irregularly at about 45 degrees to nearly 90 degrees, umbo eccentric, height of chambers at periphery irregular, well-defined rim on all chambers; in edge view subelliptical, greatest thickness through umbos, septal face subtrigonal, slightly depressed, bounded laterally by low rounded rims, apertural process subconoidal, aperture an elongate collared slit in final face of process.

**Specimen**

**Sample USNM**

**Dimensions in millimeters**

<table>
<thead>
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Various specimens of Cretaceous age in the U. S. National Museum referred to *Cristellaria ovalis* Reuss have superficial resemblances to the present form but most of them are proportionally thicker and lack the sutural bands of *Robulus fractus* Israelsky n. sp.

**Robulus roscidus** Israelsky n. sp.

Plate 18, figures 47, 48

In side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber merging gently with periphery of earliest visible chamber, sutural bands flush, gently reflexed, earlier bands meeting periphery at nearly 90 degrees and radiate from umbo, later sutures meeting the periphery at nearly 45 degrees and tangential to umbo, umbo slightly eccentric, height of chambers at periphery subequal, well-defined rim on all chambers; in edge view subelliptical, weakly produced toward apertural end, greatest thickness through umbos, septal face very elongate heart-shaped, weakly concave, bounded laterally by low rounded rims which merge into lateral faces of final chamber; apertural process subconoidal, slightly compressed, aperture an elongate collared slit in final face of process.

**Specimen**

**Sample USNM**

**Dimensions in millimeters**

<table>
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<th>Specimen</th>
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compressed, aperture an elongate collared slit in final face of process.

**Robulus spasticus** Israelsky n. sp. may be distinguished from its more strongly bowed final margin, its proportionally lesser width and its smoothly convex septal face.

**Robulus volaticus** Israelsky n. sp.

Plate 18, figures 49, 50

In side view subovate, acutely pointed at apertural end, rounded at opposite end, final margin of last chamber and periphery of earliest visible chamber blending smoothly without offset, sutures flush, almost straight, tangential to umbo, all except last suture meeting periphery at about 45 to nearly 60 degrees, the last at nearly 90 degrees, umbo slightly eccentric, height of chambers at periphery irregular, rim on all chambers; in edge view subelliptical, slightly produced at end away from aperture, greatest thickness through umbos; septal face quadrately heart-shaped, slightly convex, rounding into lateral faces of final chamber; apertural process subconoidal, aperture an elongate collared slit in final face of process.

**Robulus sanus** Israelsky n. sp. by the lack of offset between the final margin of the last chamber and the periphery of the earliest visible chamber, its more quadrate septal face, and its less tangent early sutures.

**Robulus transilis** Israelsky n. sp.

Plate 18, figures 51, 52

In side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, sutural bands flush, tangent to umbo, meeting periphery irregularly at various angles of about 45 degrees to nearly 60 degrees, umbo subcentral, height of chambers at periphery irregular, keel well defined on early portion of periphery, poorly defined on later portion; in edge view subelliptical, somewhat produced at end away from aperture, greatest thickness through umbos, septal face indistinctly rounded, flatly convex, rounding into lateral faces of final chamber; aperture

**Robulus fresnoensis** Israelsky n. sp.

Plate 18, figures 53, 54

In side view subovate, broadly pointed at apertural end, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber meeting in a high obtuse angle, merging smoothly without noticable offset, periphery tending to straighten on each side and periphery increasing regularly, well-defined rim on all chambers; in edge view subelliptical, slightly produced at either end, greatest thickness through umbos, septal face convex, merging imperceptibly into lateral faces of final chamber; apertural process subconoidal, compressed, aperture an elongate collared slit in final face of process.

**Robulus alabamensis** Cushman (1944, pl. 5, fig. 13, Paleocene) is close but its umbo appears more eccentric, the final margin of the last chamber and the periphery of the earliest visible chamber are offset, the septal face flattened, and it seems to be proportionally thinner.

**Robulus sp. C1**

Plate 19, figures 1, 2

In side view subcircular, apertural end acutely pointed, opposite end rounded, final margin and periphery of earliest visible chamber forming an obtuse angle, sutural bands flush, tangent to umbo, meeting periphery irregularly at various angles of about 45 degrees to nearly 60 degrees, umbo subcentral, height of chambers at periphery irregular, keel well defined on early portion of periphery, poorly defined on later portion; in edge view subelliptical, somewhat produced at end away from aperture, greatest thickness through umbos, septal face indistinctly rounded, flatly convex, rounding into lateral faces of final chamber; aperture
FORAMINIFERA OF THE LODO FORMATION, CENTRAL CALIFORNIA

process subconoidal, aperture an elongate collared slit in the final face of process.

<table>
<thead>
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<th>Specimen</th>
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</tbody>
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The convex septal face contrasts with the depressed septal face found in *Robulus arcanus* Israelsky n. sp.

### Robulus sp. CK

Plate 19, figures 3, 4

In side view subovate, acutely pointed at apertural end, angulately rounded at opposite end, periphery of each chamber except first visible one straightened, giving angulate outline, sutural bands flush, nearly straight, radially from umbo, meeting periphery at nearly 90 degrees, umbo very eccentric, height of chambers at periphery irregular, well-defined rim on all chambers, nodded at contact with sutures; in edge view subelliptical, greatest thickness through umbos, septal face elongate heart-shaped, flattened, rounding into lateral faces of final chamber; apertural process subconoidal, aperture an elongate collared slit in final face of process.

<table>
<thead>
<tr>
<th>Specimen</th>
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<td>Length 0.25 Width 0.19 Thickness 0.11</td>
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</table>

### Robulus sp. CL

Plate 19, figures 5, 6

In side view subovate, acutely pointed at apertural end, rounded at opposite end, periphery of final chamber straightened giving weakly angulate appearance, apertural process subconoidal, transversely compressed, aperture an elongate collared slit in final face of process.

<table>
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<tr>
<th>Specimen</th>
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### Robulus sp. CN

Plate 19, figures 9, 10

In side view subovate, acutely pointed at apertural end, rounded at opposite end, weakly rimmed final margin of last chamber and periphery of earliest visible chamber meeting smoothly with very slight offset, sutural bands flush, radially, first visible sutures meeting periphery at about 45 degrees, later at nearly 90 degrees, umbo very eccentric, height of chambers at periphery irregular, well-defined rim on all chambers; in edge view subelliptical, somewhat produced at end away from aperture, greatest thickness toward apertural end from umbos, septal face elongate heart-shaped, weakly depressed, bounded laterally by weak rims; apertural process subconoidal, slightly produced at end away from aperture, greatest thickness toward apertural end from umbos, septal face elongate heart-shaped, weakly concave, bounded laterally by weak ridges; apertural process subconoidal, aperture an elongate collared slit in final face of process.

<table>
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<th>Specimen</th>
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### Robulus sp. CO

Plate 19, figures 11, 12

In side view subovate, apertural end acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber meeting in an obtuse angle, early sutures flush, final two slightly depressed, all sutures radially from umbo, two earliest visible sutures meeting periphery at nearly 45 degrees, others irregularly from about 60 to nearly 90 degrees, umbo slightly eccentric, height of chambers at periphery irregular, well-defined rim on periphery of all chambers; in edge view subelliptical, slightly produced at apertural end, greatest thickness through umbos, septal face elongate heart-shaped, flattened, bounded laterally by weak ridges, apertural process subconoidal, aperture an elongate collared slit in final face of process.

<table>
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<th>Specimen</th>
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### Cristellaria (Cristellaria) impressa Reuss (1862, pl. 9, fig. 2, Cretaceous)

Cristellaria (Cristellaria) impressa Reuss (1862, pl. 9, fig. 2, Cretaceous) has some resemblance but is proportionately narrower and thicker and has a proportionately smaller umbo.

### Cristellaria (Robulina) inornata d'Orbigny of Franke (1927, pl. 3, fig. 2, Paleocene)

Cristellaria (Robulina) inornata d'Orbigny of Franke (1927, pl. 3, fig. 2, Paleocene) is also close but has more strongly reflexed and tangential sutures.

### Robulus sp. CP

Plate 19, figures 13, 14

In side view subovate, acutely pointed at apertural end, rounded at opposite end, periphery of last chamber becoming almost straight, resulting in weakly angulate outline, final margin of last chamber and periphery of earliest visible chamber meeting in an obtuse angle, sutures flush, gently reflexed, tangential to umbo, meeting periphery irregularly at from about 45 degrees to nearly 90 degrees, umbo eccentric, height of chambers at periphery irregular, well-defined rim on all chambers; in edge view subelliptical, slightly produced at end away from aperture, greatest thickness through umbos, septal face elongate heart-shaped, flattened, very slightly depressed, rounded laterally by weak rims; apertural process subconoidal, aperture an elongate collared slit in final face of process.

### Robulus sp. CR

Plate 19, figures 17, 18

In side view subovate, rounded subtrigonal, apertural end acutely pointed, opposite end rounded, final margin of last chamber meeting periphery of earliest visible chamber in an obtuse angle, first three sutural lands flush, reflexed, radiate, meeting periphery at about 45 degrees, final suture truncating previous suture and tangential to umbo, meeting periphery at nearly 90 degrees, umbo subcentral, height of chambers at periphery irregular, well-defined rim on all chambers; in edge view subelliptical, compressed through umbonal area, greatest thickness through umbos, septal face elongate heart-shaped, concave, apertural process subconoidal, aperture an elongate collared slit in the final face of process.

### Robulus sp. CS

Plate 19, figures 19, 20

In side view subovate, crudely subquadrangular, periphery bending without respect to sutural intersections, apertural end obtusely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber forming an obtuse angle, first visible suture weakly reflexed, inclined forward, meeting periphery at about a 60 degree angle, truncated by second sutural band, other sutures gently reflexed, inclined rearwards, tangential to umbo and meeting periphery at about 45 degrees, umbo eccentric, swollen, height of chambers at periphery increasing regularly, well-defined keel on whole of periphery; in edge view broadly subelliptical, produced at either end, greatest thickness through umbos, septal face broadly V-shaped, transversely concave, bounded laterally by inwardly beveled rims; apertural process subconoidal, aperture an elongate subtriangular opening in final face of process bounded by a U-shaped collar which opens onto the septal face.
Robulus sp. CT
Plate 19, figures 21, 22

In side view subovate, apertural end acutely pointed, opposite end rounded, low rimmed final margin of last chamber (which extends onto earlier chambers) and periphery of earliest visible chamber forming an obtuse angle, earlier sutures probably radiate (not clearly seen), two final sutures reflexed, tangential to umbo, meeting periphery at about 45 degrees, umbo very eccentric, well-defined rim on all chambers; in edge view subovate, acutely pointed at apertural end with projecting apertural process, opposite end broadly rounded with projecting rim, greatest thickness through umbos: septal face broadly V-shaped, depressed, bounded laterally by low rounded rims; apertural process subconoidal, aperture an elongate collared slit in final face of process.

---

The strongly angulate outline precludes this form from being considered the young of Robulus sp. CR.

Robulus vatius Israelsky n. sp.
Plate 19, figures 25, 26

In side view subovate, broadly pointed at apertural end, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber meeting in an obtuse angle, broad sutural bands flush, gently reflexed, radiate from umbo, meeting periphery irregularly at angles ranging from about 45 to nearly 90 degrees, umbo subcentral, height of chambers at periphery increasing gradually, poorly-defined rim on all chambers; in edge view subelliptical, greatest thickness through umbos, septal face convex, rounding into lateral faces of final chamber; apertural process subconoidal, compressed, aperture an elongate slit in final face of process.

---

In side view subovate, roundly subquadrate, broadly pointed at apertural end, rounded at opposite end, periphery occasionally tending to straighten giving outline a subquadrate appearance, final margin of last chamber and periphery of earliest visible chamber meeting in an obtuse angle, sutures flush, gently reflexed, tangential to umbo, meeting periphery irregularly at about 45 to 90 degrees, umbo subcentral, height of chambers at periphery irregular, narrow rim on all chambers; greatest thickness through umbos, septal face convex, rounding into lateral faces of final chamber; apertural process subconoidal, compressed, aperture an elongate slit bounded by inwardly opening U-shaped collar.
periphery of earliest visible chamber forming an obtuse angle, sutural bands broad, gently reflexed, all except last narrowing toward periphery, radiate from umbo, meeting periphery at about 45 degrees, final suture S-shaped, truncating earlier whorl and not touching umbo, early sutures flush, last three depressed, with resulting inflation of final three chambers, umbo subcentral, height of chambers at periphery irregular, well-defined rim on all chambers; in edge view irregularly subelliptical, the last and penultimate chambers distinctly swollen, greatest thickness through the penultimate chamber, septal face convex, rounding into lateral faces of final chamber; apertural process subconoidal, compressed, with radial groove on lateral face, aperture an elongate collared slit on final face of process bounded by inwardly opening U-shaped collar.

Specimen | Sample | USNM | Dimensions in millimeters
--- | --- | --- | ---
Holotype | 19 | 549132 | Length 0.57 Width 0.48 Thickness 0.20

Robulus? sp. CV

Plate 19, figures 35, 36

In side view subovate, apertural end probably acutely pointed, opposite end rounded, final margin of last chamber and periphery of earliest visible chamber meeting in an obtuse angle, early sutures flush, last three depressed with corresponding inflation of last three chambers, sutures radiate, nearly straight, slightly inclined forward, umbo subcentral, raised, height of chambers at periphery irregular; in edge view subelliptical, weakly bilobate, slightly produced at end away from aperture, greatest thickness through umbo, septal face strongly convex, aperture probably an oval collared opening on final face of conoidal apertural process.

Specimen | Sample | USNM | Dimensions in millimeters
--- | --- | --- | ---
Figured | 67 | 549135 | Length 0.70 Width 0.54 Thickness 0.47

The rather straight radiating sutures serve to distinguish this form from other bilobate species from the Lodo formation.

Genus HEMIROBULINA Stache 1964

In his manual, Galloway (1933, p. 251) designated Hemirobulina arcuata Stache as the genotype of this genus. In his last edition Cushman (1948) still did not regard Stache’s genus as valid. Galloway conceived the genus as including forms which have robustine apertures but otherwise are similar to Vaginulinopsis (his Hemiceristellaria), Astacolus, and Saracenaria. The genotype is Vaginulinopsis-like.

Hemirobulina sp. CW

Plate 19, figures 37, 38

In side view subovate, acutely pointed at apertural end, rounded at opposite end, final margin of last chamber and periphery of earliest visible chamber meeting in an obtuse angle, sutures flush, gently reflexed, sutures in coiled portion tangent to umbo, final suture not touching umbo or previous suture, all sutures meeting periphery at nearly 90 degrees, umbo eccentric, height of chambers at periphery irregular, well-defined rim on all chambers; in edge view crudely subelliptical, strongly produced at apertural end, septal face convex, merging imperceptibly with lateral faces of final chambers, apertural process subconoidal, very strongly compressed with depressions at contact with chamber proper, aperture an elongate slit in final face of process.

Specimen | Sample | USNM | Dimensions in millimeters
--- | --- | --- | ---
Figured | 103 | 549136 | Length 0.38 Width 0.27 Thickness 0.14

This form is readily distinguished from Robulus loisemartinae Israelsky n. sp. by its less inflated chambers and more tangential sutures.

This form is readily distinguished from Robulus loisemartinae Israelsky n. sp. by its less inflated chambers and more tangential sutures.
Hemirobulina sp. CX
Plate 19, figures 30, 40

In side view subovate, acutely pointed at apertural end, rounded at opposite end, final margin meeting rim of earliest visible chamber in a high obtuse angle, sutures flush, gently reflexed, those of coiled portion inclined forward, except the last which meets periphery at about 90 degrees, sutures of coiled portion radial, final suture of uniserial portion of test strongly reflexed, the last suture meeting periphery at about 60 degrees, the previous at about 45 degrees, umbos very eccentric, height of chambers at periphery irregular in coiled portion, well-defined rim on all chambers; in edge view subelliptical, slightly produced at either end, greatest thickness within uncoiled portion of test, septal face convex, merging imperceptibly with lateral faces of final chamber; apertural process subconoidal, compressed, aperture an elongate rimmed slit in final face of process.

Specimen Sample USNM Dimensions in millimeters
Figured.......................... 60 549137 Length Width Thickness
0.41 0.28 0.18

Hantken’s (1881, pl. 13, fig. 20; pl. 14, fig. 12, Eocene) version of Cristellaria galeata Reuss appears to be a similar form but is proportionately broader and its apertural process is much less prominent.

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 37, 38. *Robulus* sp. BT. (p. 62)
   USNM 549086, side and edge views, × 117.
 39, 40. *Robulus* sp. BU. (p. 62)
   USNM 549087, side and edge views, × 145.
 41, 42. *Robulus* sp. BV. (p. 63)
   USNM 549088, side and edge views, × 115.
 43, 44. *Robulus* sp. BW. (p. 63)
   USNM 549089, side and edge views, × 117.
 45, 46. *Robulus* sp. BX. (p. 63)
   USNM 549090, side and edge views, × 118.
FIGURES 1, 2. *Robulus* sp. BY. (p. 63)  
USNM 549091, side and edge views, × 124.

3-4. *Robulus serenus* Israelsky, n. sp. (p. 64)  
Holotype, USNM 549092, side and edge views, × 90.

5-8. *Robulus ligatus* Israelsky, n. sp. (p. 64)  
5, 6. Holotype, USNM 549093, side and edge views, × 118.  
7, 8. Paratype, USNM 549094, side and edge views, × 111.

9, 10. *Robulus frustratus* Israelsky, n. sp. (p. 64)  
Holotype, USNM 549095, side and edge views, × 132.

11, 12. *Robulus* sp. BZ. (p. 65)  
USNM 549096, side and edge views, × 124.

13, 14. *Robulus* sp. CA. (p. 65)  
USNM 549097, side and edge views, × 117.

15, 16. *Robulus* sp. CB. (p. 65)  
USNM 549098, side and edge views, × 122.

17, 18. *Robulus projectus* Israelsky, n. sp. (p. 65)  
Holotype, USNM 549099, side and edge views, × 125.

19, 20. *Robulus* sp. CC. (p. 66)  
USNM 549100, side and edge views, × 127.

21-26. *Robulus odiosus* Israelsky, n. sp. (p. 66)  
21, 22. Holotype, USNM 549101, side and edge views, × 83.  
23, 24. Paratype, USNM 549102, side and edge views, × 84.  
25, 26. Paratype, USNM 549103, side and edge views, × 85.

27, 28. *Robulus tardus* Israelsky, n. sp. (p. 66)  
Holotype, USNM 549104, side and edge views, × 113.

29, 30. *Robulus* sp. CD. (p. 66)  
USNM 549105, side and edge views, × 40.

31, 32. *Robulus* sp. CE. (p. 67)  
USNM 549106, side and edge views, × 59.

33, 34. *Robulus spasticus* Israelsky, n. sp. (p. 67)  
Holotype, USNM 549107, side and edge views, × 59.

35, 36. *Robulus* sp. CF. (p. 67)  
USNM 549108, side and edge views, × 73.

37, 38. *Robulus* sp. CG. (p. 67)  
USNM 549109, side and edge views, × 99.

39, 40. *Robulus* sp. CH. (p. 67)  
USNM 549110, side and edge views, × 71.

41, 42. *Robulus sanus* Israelsky, n. sp. (p. 68)  
Holotype, USNM 549112, side and edge views, × 60.

43, 44. *Robulus* sp. CI. (p. 68)  
USNM 549111, side and edge views, × 59.

45, 46. *Robulus fractus* Israelsky, n. sp. (p. 68)  
Holotype, USNM 549113, side and edge views, × 158.

47, 48. *Robulus roceidus* Israelsky, n. sp. (p. 68)  
Holotype, USNM 549114, side and edge views, × 84.

49, 50. *Robulus solaticus* Israelsky, n. sp. (p. 69)  
Holotype, USNM 549115, side and edge views, × 125.

51, 52. *Robulus transilis* Israelsky, n. sp. (p. 69)  
Holotype, USNM 549116, side and edge views, × 81.

53, 54. *Robulus frequonsis* Israelsky, n. sp. (p. 69)  
Holotype, USNM 549117, side and edge views, × 83.
ROBULUS
ROBULUS AND HEMIROBULINA
PLATE 19

FIGURES 1, 2. *Robulus* sp. CJ. (p. 69)
USNM 549118, side and edge views, X 129.

3, 4. *Robulus* sp. CK. (p. 70)
USNM 549119, side and edge views, X 119.

5, 6. *Robulus* sp. CL. (p. 70)
USNM 549120, side and edge views, X 138.

7, 8. *Robulus* sp. CM. (p. 70)
USNM 549121, side and edge views, X 121.

9, 10. *Robulus* sp. CN. (p. 70)
USNM 549122, side and edge views, X 121.

11, 12. *Robulus* sp. CO. (p. 70)
USNM 549123, side and edge views, X 50.

13, 14. *Robulus* sp. CP. (p. 71)
USNM 549124, side and edge views, X 78.

15, 16. *Robulus* sp. CQ. (p. 71)
USNM 549125, side and edge views, X 61.

17, 18. *Robulus* sp. CR. (p. 71)
USNM 549126, side and edge views, X 78.

19, 20. *Robulus* sp. CS. (p. 71)
USNM 549127, side and edge views, X 41.

21, 22. *Robulus* sp. CT. (p. 72)
USNM 549128, side and edge views, X 61.

23, 24. *Robulus* sp. CU. (p. 72)
USNM 549129, side and edge views, X 134.

25, 26. *Robulus* rutius Israelsky, n. sp. (p. 72)
Holotype, USNM 549130, side and edge views, X 58.

27, 28. *Robulus* plicatus Israelsky, n. sp. (p. 72)
Holotype, USNM 549131, side and edge views, X 61.

29, 30. *Robulus loismartinae* Israelsky, n. sp. (p. 72)
Holotype, USNM 549132, side and edge views, X 58.

31–34. *Robulus interritus* Israelsky, n. sp. (p. 73)
31, 32. Paratype, USNM 549133, side and edge views, X 81.
33, 34. Holotype, USNM 549134, side and edge views, X 62.

35, 36. *Robulus* sp. CV. (p. 73)
USNM 549135, side and edge views, X 43.

37, 38. *Hemirobulina* sp. CW. (p. 73)
USNM 549136, side and edge views, X 82.

39, 40. *Hemirobulina* sp. CX. (p. 74)
USNM 549137, side and edge views, X 82.