typically has more whorls—about 4.5 - 5.5. Test also wider, resulting in a more lenticular (rather than flattened) shape. Also described previously as *Camerina* or *Operculinoides moodysbranchensis.* Test diameter ~2.5 - 3.5 mm. Ocala Limestone.

Heterostegina ocalana Cushman 1921

Plate 3 (figure G)

An easily-recognizable nummulitid. Each chamber is subdivided by several secondary septa, creating many smaller chamberlets within each main chamber. Traces of septa and secondary septa are usually discernable on the surface of the test. Test diameter up to ~4 mm. Ocala Limestone.

Planispiral-Biloculine Forms—Fabularia. Planispiral-biloculine forms coil about an axis in the same plane as do normal planispiral forms, but in the case of *Fabularia*, forms an egg-shaped test. The coiling axis extends through the narrowest part of the "egg", and two chambers are added per full whorl (biloculine). Two species have been described in Florida, *F. gunteri* and *F. vaughani*, and although their tests are highly variable, it is generally agreed that only one species should be recognized. Since *F. vaughani* was first described, that name has priority.

Fabularia vaughani Cole & Ponton, 1934

Plate 1 (figures C, D)

Long axis of test ~1 - 2 mm. Lower Ocala Limestone.

Radial Forms—Lepidocyclinids. Radial forms grow symmetrically from a central point or axis (like rays from the sun), and often grow lateral chambers as well. They may look like flat discs or "flying saucers." Like planispiral forms, most radial forms also exhibit a *bilateral* ("mirror-image") symmetry. Lepidocyclinid larger foraminifera are perhaps the most abundant and distinctive fossils in the Eocene and Oligocene of the Gulf Coastal Plain and Caribbean, and many taxonomic names have been applied to them. Species names for the lepidocyclinids proliferated in the 1920's and 1930's, during the early geological investigations of the Caribbean and adjacent areas. But as Adams (1987, p. 313) has noted, "at least half of all the original species descriptions are inadequate by modern standards, and only a few of the many species names are justified". This excess of names is due primarily to the fact that most of the earlier researchers did not recognize the potential range of ecologically-controlled variability of the large foram test, and many were motivated to use these fossils for biostratigraphic use only. Ecologically-controlled characters include the size, shape, and the external appearance of the test. Test characters that are useful in truly differentiating species include the shape of equatorial chambers and the character of the lateral chambers. Test morphology of *Lepidocyclina* is illustrated in Figure 3.

Lepidocyclina Gumbel, 1870

The genus *Lepidocyclina* is divided into three subgenera (Figure 4), an understanding of which is essential in identification (see Adams, 1987). Many species have very little surface ornament, so equatorial views are usually necessary for identification.

Subgenus ***Lepidocyclina*** Gumbel, 1870

Protoconch and deuteroconch are equal or nearly equal in size and separated by a common wall (a condition also called *isolepidine*). Two principal auxiliary chambers, and no adauxiliary chambers. Periembryonic chambers are often large, sometimes irregular in size and shape, and arranged in four spires. Equatorial chambers may be arcuate, spatulate, or hexagonal, and arranged so as to appear as either intersecting curves or concentric circles (called *annuli*) (see Adams, 1987, p. 302).

Lepidocyclina (Lepidocyclina) mantelli (Morton, 1833)

Plate 5 (figure D)

This is the type species for the subgenus *Lepidocyclina.* Large, usually very thin test with hexagonal equatorial chambers. A variant of *mantelli* was previously named *supera*. Test diameter may reach up to 40 mm. Marianna Limestone and Bridgeboro Limestone.

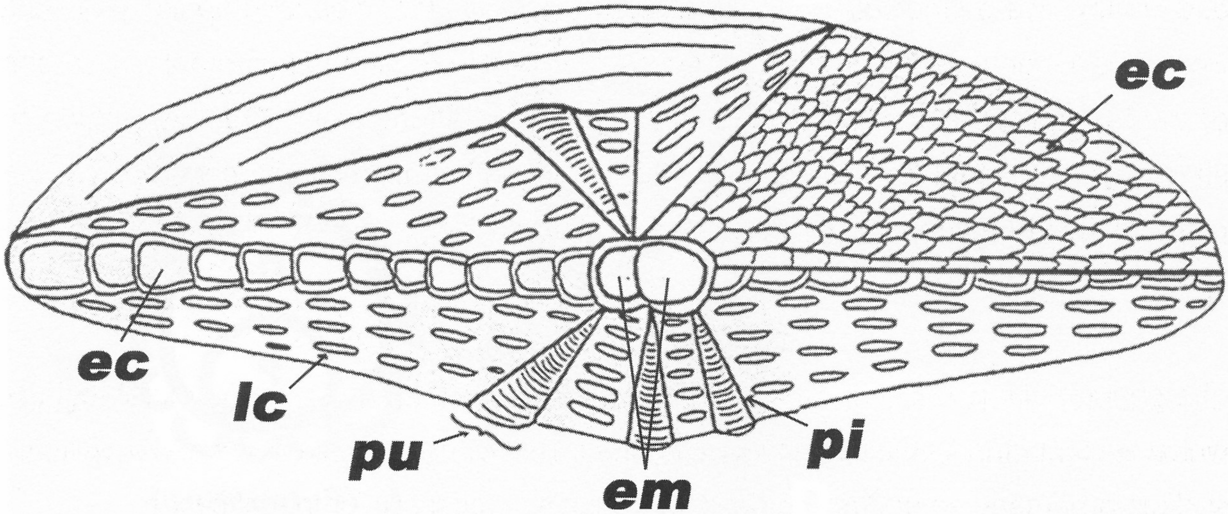


Figure 3. Test morphology of *Lepidocyclina*. ***em*** = embryonic chambers ***ec*** = equatorial chambers, ***lc*** = lateral chambers, ***pi*** = pillars, ***pu*** = pustules (the surface expression of pillars). From Bryan, J., 1991, Stratigraphic and Paleontologic Studies of Paleocene and Oligocene Carbonate Facies of the Eastern Gulf Coastal Plain. Dissertation, University of Tennessee, Knoxville, 324 p.

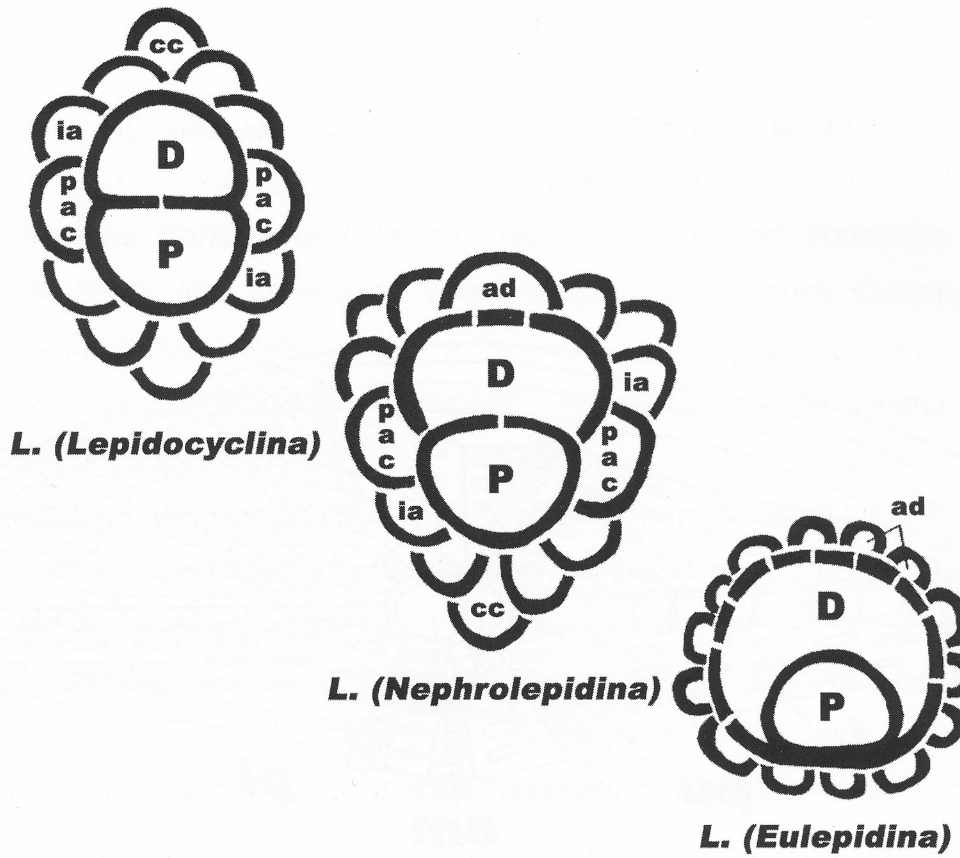


Figure 4. Embryonic and periembryonic chambers of subgenera of *Lepidocyclina.* In *L.* (*Lepidocyclina*), protoconch and deuteroconch are subequal and true adauxillary chambers are lacking. In *L.* (*Nephrolepidina*), deuteroconch is reiniform and partially embraces the protoconch, and at least one adauxillary chamber (which has a direct stoloniferous connection to the deuteroconch) is present. In *L.* (*Eulepidina*), deuteroconch embraces over half (usually all) of the protoconch, there are numerous adauxillary chambers, and principal auxiliary chambers are rarely seen in equatorial view. ***P***, protoconch; ***D***, deuteroconch; ***pac***, principal auxiliary chamber (which rests on both P and D); ***ia***, interauxillary chamber; ***ad***, adauxillary chamber; ***cc***, closing chamber. From Bryan, J., and Huddlestun, P., 1991, Correlation and age of the Bridgeboro Limestone, a coralgal limestone from southwestern Georgia. *Journal of Paleontology* 65(5): 864-868.

Lepidocyclina (Lepidocyclina) ocalana Cushman 1920

Plate 2 (figures E, F)

The dominant lepidocyclinid in the Ocala Limestone (also reported are *L.* (*L.*) *mortoni* and an unidentified, noded form). Characterized by arcuate to short *spatulate* (radially elongated, parallel-sided, with arcuate distal ends, and slightly pointed proximal ends) equatorial chambers. Several varieties, or subspecies - all probably ecological variants - have been recognized (viz., *attenuata, cookei, floridana, pseudocarinata,* and *pseudomarginata*). It has been proposed that *L. ocalana* was ancestral to two major groups of isolepidine species. One of these groups most likely became extinct at the end of the Eocene, and the other gave rise to several Oligocene forms. Test diameter may reach up to ~60 mm in microspheric forms. Ocala Limestone.

Subgenus ***Nephrolepidina*** H. Douville, 1911

Protoconch and deuteroconch usually unequal (P<D) in size. Deuteroconch is reniform (kidney- or bean-shaped) and embraces the protoconch. Two principal auxiliary chambers, and 1 - 8 (usually 2 - 6) adauxiliary chambers, usually separated by interauxiliary chambers. Equatorial chambers rhombic (diamond-shaped), ogival (pointed arch), or hexagonal. Lateral chambers are well developed and usually numerous (see Adams, 1987, p. 306).

Lepidocyclina* (*Nephrolepidina*) *chaperi Lemoine & R. Douville, 1904

Plate 5 (figures E, F)

Typically large test (up to 18 mm in diameter, but can be much smaller) with well-developed tiers of lateral chambers, usually giving the test a smooth, broadly biconvex shape. Other names applied to *chaperi* are *semmesi*, *fragilis, sanfernandensis, tallahasseensis* and others. *L.* (*N.*) *chaperi* is the probable ancestor of *L.* (*E.*) *undosa*. May occur in rock-forming abundance in the Bumpnose Limestone. Upper Ocala Limestone and Bumpnose Limestone.

Lepidocyclina* (*Nephrolepidina*) *yurnagunensis Cushman, 1919

Plate 5 (figures G, H)

Easily recognized by the reniform (kidney- or bean-shaped) deuteroconch and rhombic (diamond-shaped) equatorial chambers. Commonly with pustules on centrum. The arrangement of the rhombic equatorial chambers often gives this species the so-called "engine-turned" appearance. Test is biconvex with a diameter up to 4 mm. Bridgeboro Limestone.

Subgenus ***Eulepidina*** H. Douville, 1911

Protoconch and deuteroconch are always unequal in size, with the deuteroconch surrounding well over half the circumference of the protoconch, and may entirely surround the protoconch. The wall of the embryonic apparatus is usually coarsely perforate. There are two principal auxiliary chambers and numerous adauxiliary chambers. Equatorial chambers are spatulate or hexagonal, and lateral chambers always well developed (see Adams, 1987, p. 304).

Lepidocyclina* (*Eulepidina*) *undosa Cushman, 1919

Plate 6 (figure A)

Easily recognizable in equatorial view by the eulepidine embryonic chambers and rather large, hexagonal-spatulate equatorial chambers. Common in ancient reef environments. Ecological variants with thick layers of lateral chambers have been named *favosa*, *tumida*, and *chattahoocheensis*. Large, microspheric forms were once given the species name *gigas*. Tests are commonly selliform (saddle-shaped). Likely evolved from *L.* (*N.*) *chaperi.* Tests can be large, up to 20 mm in diameter. Bridgeboro Limestone (common) and Marianna Limestone (rare).

Radial Forms—Asterocyclinids. This group consists of the genera *Asterocyclina* and *Pseudophragmina*. Most Florida species of both genera can be recognized by their external features alone. *Asterocyclina* is easily recognizable by its stellate (star-like) test, with 4 to 20 radiating ridges (rays) that are visible on the exterior surface.

Pseudophragmina has a rather fragile, thin, circular test that may be ornamented by rounded bumps called papillae, or annular (concentric) ridges on the surface of the test (which may consist of papillae). Equatorial chambers in *Pseudophragmina* occur in annular (concentric) rings, and are subdivided into narrow, radially elongated, rectangular chamberlets. Asterocyclinid test morphology is shown in Figure 5.

Asterocyclina americana (Cushman, 1918)
Plate 4 (figure A)

The largest of Floridan species of *Asterocyclina*, with a test diameter up to ~55 mm, and up to twenty raised ribs that radiate from a central umbo. Upper Ocala Limestone.

Asterocyclina chipolensis (Vaughan, 1928)
Plate 4 (figure B)

A small species, with about eight smooth ribs radiating from central area (but not the center) of the test. Test surface between ribs has a pitted appearance. Test diameter ~ 4 - 5 mm. Upper Ocala Limestone.

Asterocyclina georgiana (Cushman, 1918)
Plate 4 (figure C)

Square- to diamond-shaped test, with four thin ribs radiating from a central umbo, forming an X-pattern. Test diameter ~6 - 7 mm. Upper Ocala Limestone. (A similar species, *Asterocyclina vaughani* (Cushman, 1918), is larger, has four coarsely papillate ribs radiating from a central umbo, broader ribs than *A. georgiana*, and a papillate test surface). Test diameter ~8 - 10 mm. *Asterocyclina georgiana* and *A. vaughani* may be conspecific.

Asterocyclina mariannensis (Cushman, 1918)
Plate 4 (figure D)

Has a distinctive, stellate outline, usually with eight to twelve raised, finely papillate ribs radiating from a central umbo. Concave margins between ribs at the test margin,

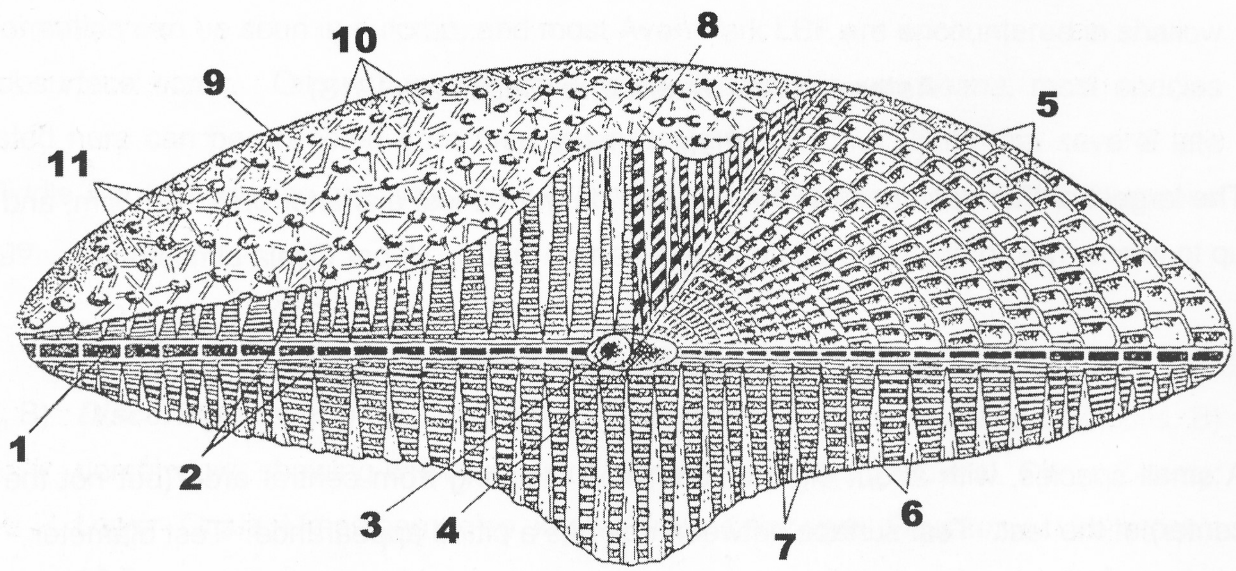


Figure 5. Test features of Asterocyclinids. ***1***, equatorial layer; ***2***, lateral layer; ***3***, protoconch; ***4***, deuteroconch; ***5***, equatorial chambers; ***6***, pillars; ***7***, lateral chambers in axial section view; ***8***, umbo; ***9***, collar; ***10***, granules (ends of pillars); ***11***, lateral chambers on test surface. From Less, G., 1987, Paleontology and Stratigraphy of the European Orthophragminae. *Geologica Hungarica*, Series Palaeontologica, Fasciculus 51, figure 1.

creating an umbrella-like test shape. Test diameter ~15 - 25 mm. Upper Ocala Limestone.

Asterocyclina nassauensis (Cole, 1944)

Plate 4 (figure E)

A small asterocyclinid with a squarish/quadrate test, and four or five radiating arms. Test surface is covered with small papillae. Some specimens have elongated corners ("arms"), and these isolated arms may be all that remain of the original test. Test diameter ~1.5-2.0 mm. Upper Ocala Limestone.

Pseudophragmina flintensis (Cushman, 1918)

Plate 4 (figure F)

Has finely papillate, concentric ridges on the test surface, with a large umbo at the center. Similar to *P. floridana*, but *P. flintensis* is smaller, has finer ridges with much smaller papillae, and smaller embryonic chambers and periembryonic chambers. Test diameter ~3-5 mm. Upper Ocala Limestone.

Pseudophragmina floridana (Cushman, 1918)

Plate 4 (figure G)

Type species of the genus *Pseudophragmina.* Has coarsely papillate, concentric ridges on the test surface. Similar to *P. flintensis*, but *P. floridana* is larger; has coarser ridges with much larger, raised papillae; larger embryonic chambers surrounded by large periembryonic chambers; and a less distinct umbo. Test diameter ~10-14 mm. Upper Ocala Limestone.

For more information pertaining to the geology of Florida Eocene formations or Oligocene and Miocene formations, see Florida Fossil Invertebrates Part 1 and Part 2, respectively.

PLATE 1

Common Late Middle Eocene Larger Foraminifera of Florida

The species listed below are known from the Avon Park Formation and the Lower Ocala Limestone (formerly the Inglis Limestone). Only the uppermost part of the Avon Park Formation can be seen in outcrop, and most Avon Park LBF are encountered in shallow subsurface cores. Other than the well-known *Cushmania americana*, most species listed here can be collected from the Lower Ocala Limestone. Note that several late Middle Eocene species are also found in the Suwannee Limestone of Early Oligocene age.

Family Valvulamminidae Loeblich & Tappan, 1986

A, B) ***Discorinopsis gunteri*** Cole, 1941. A) lateral/ventral view, showing umbilicus. B) dorsal view, showing whorls of spire. Cross Florida Barge Canal, Citrus County; Lower Ocala Limestone (also known from Oligocene Suwannee Limestone); 16.5x.

Family Fabulariidae Ehrenberg, 1830

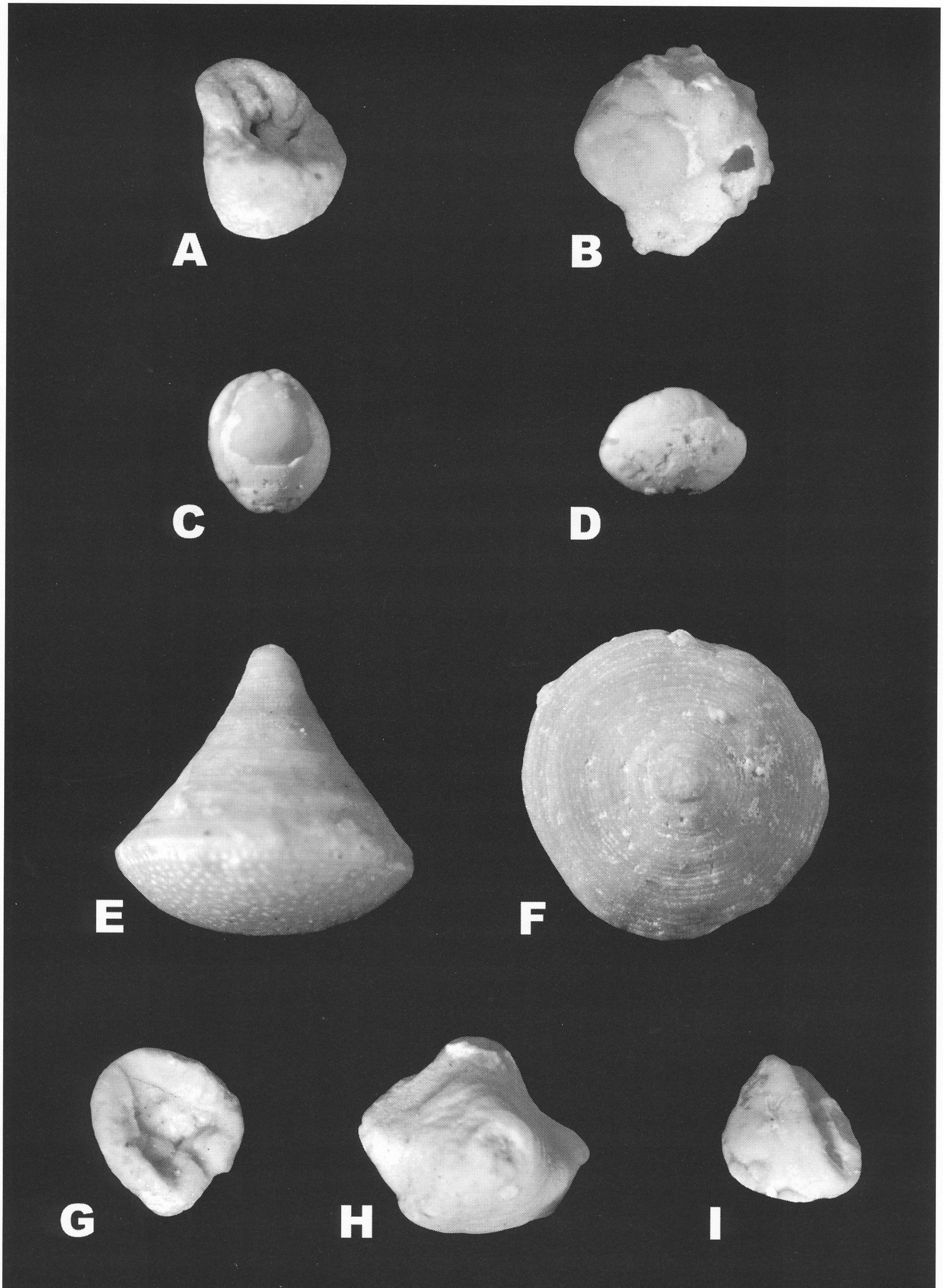
C, D) ***Fabularia vaughani*** Cole & Ponton, 1934; Lateral and top views of test, respectively; Dolime Quarry, Citrus County; Lower Ocala Limestone; 16.5x.

Family Orbitolinidae Martin, 1890

E, F) ***Cushmania americana*** (Cushman, 1919); Lateral and dorsal view of test, respectively; Florida Geological Survey well W-15890 retrieved at 660' depth, Brevard County; Avon Park Formation; 16.5x.

Family Cymbaloporidae Cushman, 1927

G - I) ***Fabiana cassis*** (Oppenheim, 1896); Ventral, dorsal, and lateral views, respectively; Barge Canal, Citrus County; Lower Ocala Limestone; 16.5x.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