

APERTURAL FEATURES AND SURFACE TEXTURE OF UPPER PALEOGENE BISERIAL PLANKTONIC FORAMINIFERS: LINKS BETWEEN *CHILOGUEMBELINA* AND *STREPTOCHILUS*

RICHARD Z. POORE AND LINDA B. GOSNELL

Branch of Paleontology and Stratigraphy, Mail Stop 970, U.S. Geological Survey, Reston, VA 22092

ABSTRACT

Several upper Paleogene species of *Chiloguembelina* have an internal apertural plate that is very similar to the internal plate typical of the Neogene genus *Streptochilus*. The type species of *Chiloguembelina*, *C. midwayensis midwayensis* (Cushman), however, lacks any internal apertural structure or modifications. Therefore, the following "*Chiloguembelina*", which have an internal plate, are assigned to *Streptochilus*: *S. cubensis* (Palmer), *S. martini* (Pijpers) and *S. sp. aff. S. martini*.

INTRODUCTION

Cenozoic biserial planktonic foraminifers are grouped into two genera. Paleogene forms are referred to *Chiloguembelina* and Neogene forms are referred to *Streptochilus*. As presently defined and understood, the two are primarily differentiated by apertural features. *Chiloguembelina* is characterized by a simple rimmed aperture without an infolded margin or internal plate (Brönnimann and Resig, 1971; Beckmann, 1957). In contrast, the aperture of *Streptochilus* has an internal plate that is formed by the infolding and downward extension of one margin of the rimmed aperture (Brönnimann and Resig, 1971; Resig and Kroopnick, 1983).

In the course of a reconnaissance study of upper Paleogene biserial planktonic foraminifers, however, we have found that an internal apertural plate is a consistent feature in several species of *Chiloguembelina*. We have also found that upper Paleogene *Chiloguembelina* exhibit two basic types of surface texture; one of which is nearly identical to the surface texture of *Streptochilus*. Thus, the separation of *Chiloguembelina* and *Streptochilus* requires reevaluation.

The purpose of this note is to document the apertural and surface texture features we have noted in upper Paleogene *Chiloguembelina*, and to show how these data warrant extension of the range of the genus *Streptochilus* into the Paleogene. Results reported here are based on study of biserial forms in upper Eocene and Oligocene samples from Deep Sea Drilling Project Sites (DSDP) 366, 522 (Atlantic Ocean), and Eureka Core E-67-128 (Gulf of Mexico), middle Eocene through Oligocene samples from DSDP Site 317 (Pacific Ocean) and from upper Paleocene samples from DSDP Site 524 (Atlantic Ocean) and 577 (Pacific Ocean). A JOEL JSM-35C was used for the scanning electron microscope work. Illustrated specimens are deposited in the Cushman Collection of the U.S. National Museum.

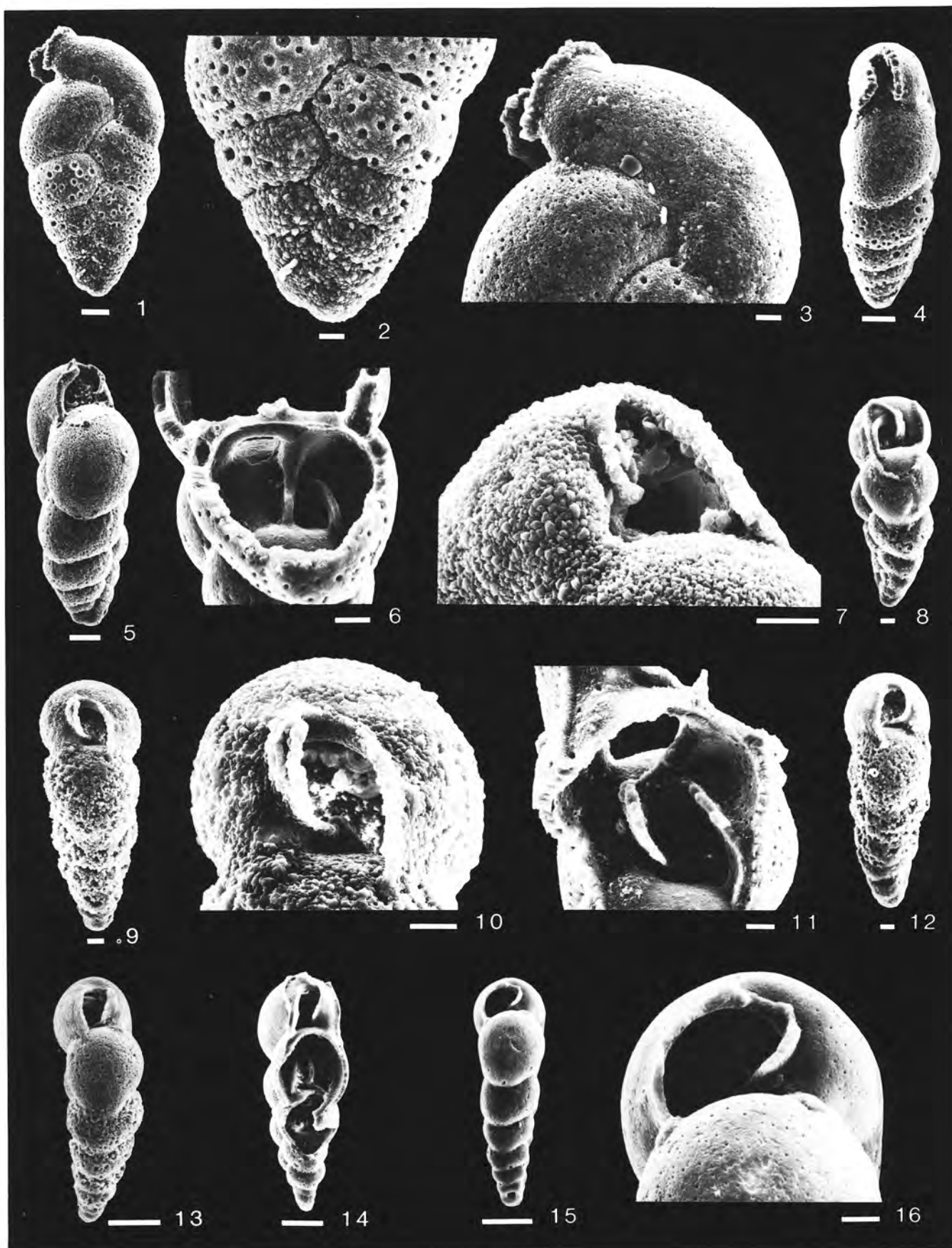
APERTURAL AND SURFACE TEXTURE FEATURES

INTERNAL PLATE

Chiloguembelina examined during this study exhibit arched, highly asymmetrical to symmetrical apertures that are bordered by a distinct rim or collar. In most specimens the aperture is infolded on one side and the apertural rim extends inside the aperture and down to connect with the rim of the preceding aperture, thus forming an internal plate (Pl. 1, Figs. 6, 11). The internal plate observed in upper Paleogene *Chiloguembelina* (this study) and in Neogene *Streptochilus* (Brönnimann and Resig, 1971; Resig and Kroopnick 1983) differs from a tooth plate in that the internal plate of these biserial planktonic foraminifers does not extend out into the aperture. Our studies to date have focused on three taxa: "*Chiloguembelina*" *martini* (Pijpers), "*C.*" sp. aff. "*C.*" *martini* and "*C.*" *cubensis* (Palmer). Although internal plates occur in all three of these taxa, the details of the internal plates show variation between and within taxa.

The aperture of "*Chiloguembelina*" *martini* has a prominent rim along its margin. The lower portion of one margin is infolded and the rim extends straight down to and along the infolded margin of the previous aperture (Pl. 1, Fig. 6). A straight internal plate that connects the infolded margins of successive apertures appears to be a uniform feature in "*C.*" *martini*. Comparison of Pl. 1, Fig. 6 with Pl. 1 of Resig and Kroopnick (1983) shows that the internal plate of "*Chiloguembelina*" *martini* is identical to the internal plate of *Streptochilus*.

In contrast, the internal plate of "*Chiloguembelina*" sp. aff. "*C.*" *martini* usually intersects the rim of the previous aperture near the middle of the loop-like opening. The aperture of this form is usually slanted towards alternate sides of the test, and the internal plate in these specimens intersects the previous aperture at a distinct angle forming a herringbone pattern (Pl. 1, Fig. 11). The orientation and shape of the aperture of "*Chiloguembelina*" sp. aff. "*C.*" *martini* are quite variable. Some individuals have a broadly oval, almost subcircular aperture that is strongly slanted towards one side of the test (Pl. 1, Fig. 15), whereas other individuals have more elongated and slightly slanted apertures (Pl. 1, Figs. 9, 10, 12, 13). Some individuals exhibit very narrow, elongated apertures that are almost parallel to the long axis of the test. These latter forms closely approach the external and internal morphology of "*Chiloguembelina*" *martini* (Pl. 1, Fig. 14).



The development of an internal plate in "*Chiloguembelina*" *cubensis* is very variable. Figures 7, 8, 12, and 13 of Pl. 2 show that the internal plate of "*C.*" *cubensis* can be attached near the infolded or the protruding side of the previous aperture. The position of the internal plate can change within individual specimens. Commonly, the attachment point of the internal plate progressively migrates away from the infolded edge of the previous chamber during ontogeny (Pl. 2, Fig. 8). In some cases, this trend results in the absence of an internal plate in the last formed chambers (Pl. 2, Fig. 7).

Differences in the position of the internal plate are associated with a wide range of variation in the aperture of "*Chiloguembelina*" *cubensis*. Highly arched, strongly asymmetrical apertures that are restricted to one side of the test (Pl. 2, Figs. 1, 2) coincide with internal plates that are attached at or near the infolded edge of the previous aperture. Broad, low-arched, but still clearly asymmetrical apertures (Pl. 2, Fig. 3), coincide with internal plates that are attached near the protruding edge of the previous aperture. Broad, slightly asymmetrical to symmetrical apertures (Pl. 2, Figs. 4–7) occur when an internal plate is absent. In addition to variability in the symmetry and extent of its aperture, "*Chiloguembelina*" *cubensis* can also develop multiple apertures (Pl. 2, Figs. 9, 11, 12). Multiple apertures appear to be a modification of broad, slightly asymmetrical to symmetrical apertures (Pl. 2, Fig. 12).

SURFACE TEXTURE

Two basic types of surface texture occur on upper Eocene and Oligocene "*Chiloguembelina*." One type is characteristic of "*Chiloguembelina*" *cubensis* whereas the other type is characteristic of "*C.*" *martini*.

The youngest chambers of well-preserved "*Chiloguembelina*" *cubensis* have a smooth, more or less uniformly perforate surface, that has numerous small, randomly oriented pustules interspersed among the pores (Pl. 2, Fig. 10). On progressively older, more calcified chambers, the individual pustules of calcite tend to grow and coalesce into parallel ridges with pores being concentrated between the ridges (Pl. 2, Figs. 3–6). Heavily calcified specimens develop very prominent ridges that impart a striated appearance to the

test (Pl. 2, Fig. 6). The striated surface texture of heavily calcified "*Chiloguembelina*" *cubensis* is very similar to the striated surface texture of several species of Cretaceous biserial planktonic foraminifers (for example, Smith and Pessagano, 1973, Pl. 5 and 9).

The second basic type of surface texture is illustrated by "*Chiloguembelina*" *martini*. The youngest chambers of well-preserved specimens have a very fine granular surface with irregularly spaced small pores. The test surface lacks any indications of discrete pustules or other structures. Pores on older chambers of most specimens generally increase in size, and selected pores on some specimens are quite enlarged (Pl. 1, Figs. 1–4). Increased calcification on older chambers results in a coarser granular texture which may constrict and even totally obscure pores on the oldest chambers of the test. In rare heavily encrusted specimens, a very coarse granular texture covers the entire test including the ultimate chamber (Pl. 1, Fig. 7).

We have not observed any evidence for the development of ridges or other raised structures on the test surface of "*Chiloguembelina*" *martini*. In fact, encrusted specimens of "*Chiloguembelina*" *martini* are sparse; more commonly, specimens show indications of etching and exfoliation of the test surface. Granular surface texture is also typical of "*Chiloguembelina*" sp. aff. "*C.*" *martini*. The similarity of surface texture and the morphologic gradation between "*Chiloguembelina*" *martini* and "*C.*" sp. aff. "*C.*" *martini* suggest that these two forms represent subspecies rather than separate species. We prefer to delay formal classification and description of "*Chiloguembelina*" sp. aff. "*C.*" *martini* until additional information is obtained on its stratigraphic and geographic range.

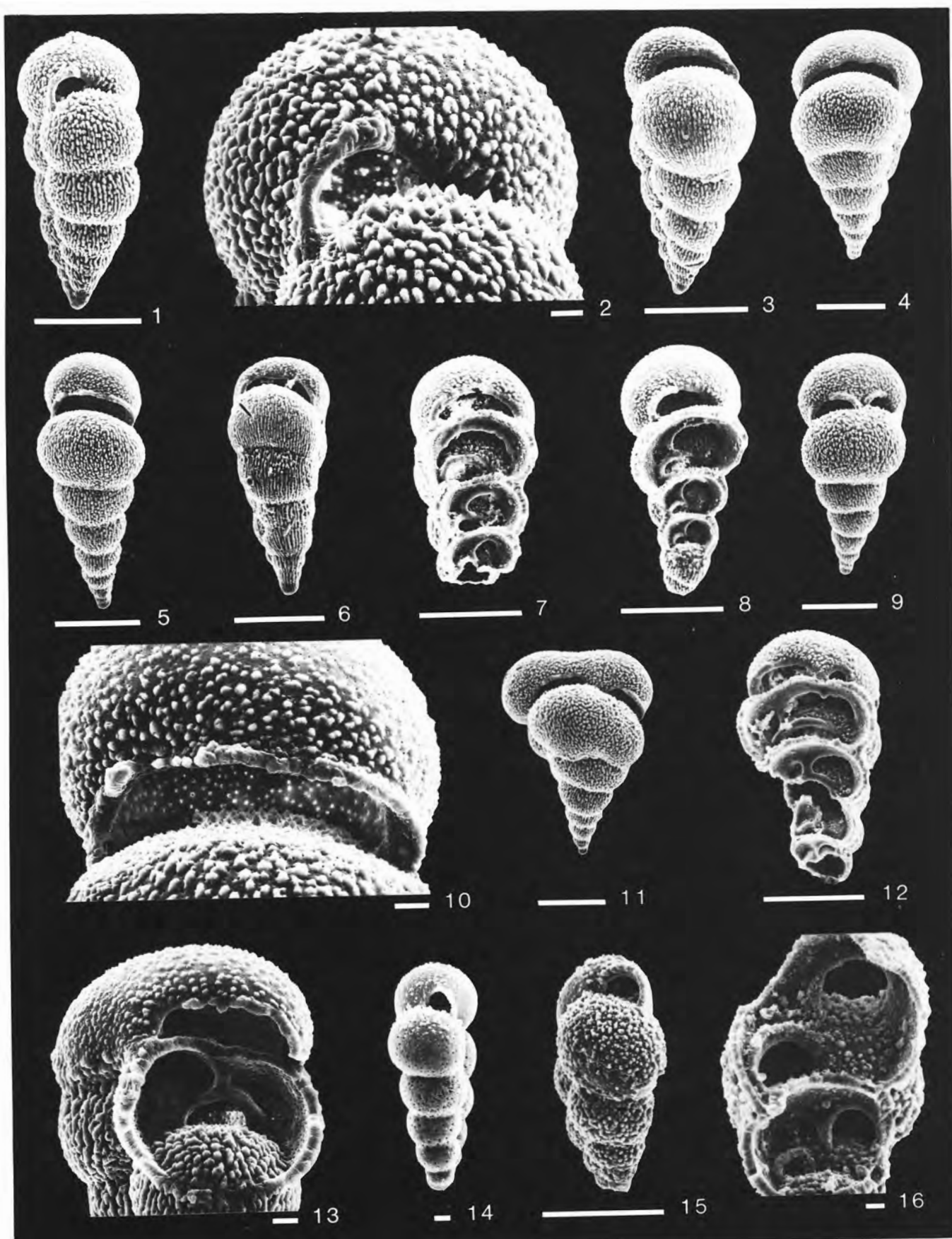
Whereas one of the two basic surface texture types is characteristic of most individuals, some individuals exhibit features of both. For example, the minute "*Chiloguembelina*" shown on Pl. 2, Fig. 14 has granular surface texture, but pustules occur on the ultimate and penultimate chambers.

The granular surface texture typical of "*Chiloguembelina*" *martini* is very similar to the surface texture observed on most species of *Streptochilus*. In addition, the selective enlargement of pores, presumably by dissolution, seen in "*Chiloguembelina*" *martini* also occurs in *Streptochilus* (e.g., Brönnimann and Resig, 1971,

PLATE 1

Figures 1–7, *Streptochilus martini* (Pijpers). 1 Side view, DSDP Site 522 37, core catcher, upper Eocene; scale bar = 30 μ m. 2, 3 Detail of Fig. 1, note enlargement of pores on older chambers of the test and granular secondary calcite at apex; scale bar = 10 μ m for both. 4, 5 Edge views of different specimens, DSDP Site 522 37, core catcher; scale bar = 30 μ m. 6 Dissected specimen, note internal plate connecting infolded margins of adjacent chambers, E-67-128, 5,192 ft.; lower Oligocene; scale bar = 10 μ m. 7 Detail of final chamber showing coarse granular surface texture, DSDP 522 38-2, 32-34 cm.; upper Eocene; scale bar = 10 μ m.

Figures 8–16, *Streptochilus* sp. aff. *S. martini* (Pijpers). 8 Edge view, E-67-128, 5,192 ft.; upper Eocene; scale bar = 10 μ m. 9 Edge view, DSDP 317B 39-5, 90–93 cm; middle Eocene; scale bar = 10 μ m. 10 Detail of Fig. 9, note infolded margin of aperture and granular surface texture; scale bar = 10 μ m. 11 Dissected specimen showing internal plate, E-67-128, 5,212 ft.; upper Eocene; scale bar = 10 μ m. 12, 13 Edge views, DSDP 317B 39-5, 90–93 cm; middle Eocene; scale bar = 10 μ m for Fig. 12 and 50 μ m for Fig. 13. 14 Dissected specimen, E-67-128, 5,194 ft.; upper Eocene; scale bar = 50 μ m. 15 Edge view, E-67-128, 5,192 ft.; lower Oligocene; scale bar = 50 μ m. 16 Detail of Fig. 15, compare surface texture with Fig. 3; scale bar = 10 μ m.



Pl. 51, Figs. 1 and 3; Saito and others, 1981, Pl. 55). Thus, both apertural features and test surface texture link upper Paleogene "*Chiloguembelina*" and *Streptochilus*.

CHILOGUEMBELINA OR STREPTOCHILUS

Hofker (1963) reported tooth plates in several species of *Chiloguembelina* including the type species, *C. midwayensis* (Cushman). When they defined *Streptochilus*, Brönnimann and Resig (1971, p. 1265) rejected Hofker's report and concluded, primarily on the basis of their own examination of "*Chiloguembelina*" *cubensis*, that *Chiloguembelina* has a simple aperture without an infolded margin, a tooth plate or other type of internal modification. Our study indicates that Hofker (1963) was at least partly correct, and we surmise that Brönnimann and Resig (1971) were misled by the tendency of "*Chiloguembelina*" *cubensis* to develop a simple aperture in the final one or two chambers of its test. In order to check the validity of *Streptochilus*, we looked for internal structures in *Chiloguembelina midwayensis*. Relatively well-preserved specimens from the upper Paleocene of DSDP Sites 524 and 577 show that, although one margin of its aperture is infolded, *Chiloguembelina midwayensis* does not have an internal plate or other type of internal modification connecting successive apertures (Pl. 2, Figs. 15, 16).

Therefore, we conclude that both *Chiloguembelina* and *Streptochilus* are valid genera. Paleogene biserial planktonic foraminifers with an internal plate should be assigned to *Streptochilus* whereas those that lack an internal plate should be retained in *Chiloguembelina*. We regard the variable internal structure of *Streptochilus cubensis* as evidence of a primitive internal plate

and thus, *S. cubensis* may represent the transition from *Chiloguembelina* to *Streptochilus*. Our limited study indicates that *Chiloguembelina* evolved into *Streptochilus* through development of an internal plate prior to the late Eocene. Additional work is required to establish the stratigraphic limits of *Chiloguembelina* and *Streptochilus*.

ACKNOWLEDGMENTS

We thank Tom Cronin, Johanna Resig, and Paul Brönnimann for constructive comments on this manuscript. We thank the Deep Sea Drilling Project and the National Science Foundation for making samples available for this study.

REFERENCES

- BECKMANN, J. P., 1957, *Chiloguembelina* Loeblich and Tappan and related foraminifera from the lower Tertiary of Trinidad, B.W.I.: U.S. National Museum Bulletin 215, p. 83-95.
- BRÖNNIMANN, PAUL, and RESIG, JOHANNA, 1971, A Neogene Globigerinacean biochronologic time-scale of the southwestern Pacific: Initial Reports of the Deep Sea Drilling Project, v. 7, p. 1235-1469.
- HOFKER, JAN, 1963, *Stainforthia* Hofker or *Chiloguembelina* Loeblich and Tappan?: Cushman Foundation for Foraminiferal Research, Contributions, v. 14, p. 150-152.
- RESIG, JOHANNA, M., and KROOPNICK, PETER, M., 1983, Isotopic and distributional evidence of a planktonic habit for the foraminiferal genus *Streptochilus* Brönnimann and Resig, 1971: Marine Micropaleontology, v. 8, p. 235-248.
- SAITO, TSUNEMASA, THOMPSON, PETER R., and BREGER, DEE, 1981, Systematic Index of Recent and Pleistocene Planktonic Foraminifera: University of Tokyo Press, Tokyo, Japan, 190 p.

Received June 14, 1984

Accepted July 30, 1984

PLATE 2

Figures 1-13, *Streptochilus cubensis* (Palmer). 1 Edge view, E-67-128, 5,191 ft.; lower Oligocene; scale bar = 10 μ m. 2 Detail of Fig. 1, note infolded margin of aperture; scale bar = 10 μ m. 3-5 Edge views, E-67-128, 5,083 ft.; lower Oligocene; scale bars = 100 μ m. 6 Edge view of heavily calcified specimen, DSDP 366A 37-3, 34-38 cm; lower Oligocene; scale bar = 100 μ m. 7 Dissected specimen, note internal plate is present in older chambers but is absent in youngest chambers, E-67-128, 5,188 ft.; lower Oligocene; scale bar = 10 μ m. 8 Dissected specimen, E-67-128, 5,191 ft.; lower Oligocene; scale bar = 100 μ m. 9 Edge view showing multiple apertures, E-67-128, 5,148 ft.; lower Oligocene; scale bar = 100 μ m. 10 Detail of Fig. 5, note aperture is symmetrical and lacks an infolded margin; scale bar = 10 μ m. 11 Edge view, E-67-128, 5,191 ft.; lower Oligocene; scale bar = 100 μ m. 12 Dissected specimen, E-67-128, 5,188 ft.; lower Oligocene; scale bar = 100 μ m. 13 Dissected specimen, E-67-128, 5,083 ft.; lower Oligocene; scale bar = 10 μ m.

Figure 14, *Streptochilus* (?) sp. 14 Edge view, note fine granular surface texture over most of test with pustules of calcite developed on final two chambers, E-67-128, 5,195 ft.; lower Oligocene; scale bar = 10 μ m.

Figures 15 and 16, *Chiloguembelina midwayensis midwayensis* (Cushman). 15 Edge view, note infolded margin of aperture, DSDP 524 11, core catcher; upper Paleocene; scale bar = 100 μ m. 16 Dissected specimen, note lack of internal plate, DSDP 524 11, core catcher; scale bar = 10 μ m.