IS *BATHYSIPHON AALTOI* MILLER, 1986 THE LARGEST FORAMINIFERID?

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Species in the genus *Bathysiphon* are among the largest foraminiferids ever described. Bathysiphonids produce tests that may surpass the size of the associated metazoa (*e.g.*, Gage and Tyler, 1991; Gooday *et al.*, 1992). Large fossil tests also have been described (Miller, 1991, 1995). The tests are agglutinated, simple cylinders, often tens-of-centimeters long and several millimeters in diameter. Most of the modern species occur in deep marine environments at bathyal to abyssal depths. Fossil species are mostly restricted to off-shelf, basinal, and flysch deposits. Loeblich and Tappan (1988) give the geologic range for *Bathysiphon* as Upper Triassic to Recent; Conkin and Conkin (1977, text-fig. 1) extend the range of the genus back to the Middle Ordovician.

In 1986, I described a new bathysiphonid from mid-Cretaceous turbidite deposits in northwestern California. *Bathysiphon aaltoi* was originally described based on fragmentary specimens, which nonetheless suggested that the tests of this species were very large. Additional collecting at the type locality produced a nearly complete test 96 mm long and 3 - 4 mm in diameter (Miller, 1991). The collecting site was neglected for several years, but was revisited in March, 1997. During this latest visit, Mr. Richard Buckhart discovered the largest specimen yet: an *incomplete* test 124 mm in length and 4 mm in maximum diameter (Fig. 1). The original test may have exceeded 150 mm in length, making it one of the largest foraminiferids ever discovered. In this note I document this giant protistan skeleton, and consider some of the implications of its size and occurrence.

Locality: The new specimen was found by splitting open a float block of dark gray mudstone located in the base of a talus slope, on the west side of the quarry road 500 meters south of the old Coast Guard Station on Point Saint George, southwest quarter Crescent City 7.5' quadrangle, coastal Del Norte County, California. The block containing the test was derived from an upslope outcrop of interbedded sandy and muddy turbidites assignable to Facies D in the traditional classification of Mutti and Ricci Lucchi (1978). The thinly-laminated mudstone source rock would be considered a D2 or E2 deposit in the more recent classification of deep marine sediments (Pickering *et al.*, 1989). The fine-grained turbidites in the upslope outcrop probably represent an interchannel basin within a large, dominantly sandy fan system on the mid-Cretaceous seafloor. The deposits are now part of the Yolla Bolly terrane, one of about a dozen tectonostratigraphic divisions of the Franciscan Complex in northern California. Age and origin of the Franciscan rocks at Point Saint George have been discussed by Aalto (1989), Aalto and Murphy (1984), and Miller (1993).

Specimen: The specimen is a typical example of *B. aaltoi*, but very large (Fig. 1). As mentioned earlier, the test was at least 124 mm long. It is up to 4 mm wide, but has been flattened parallel to sedimentary layering so the original diameter can not be determined accurately. The specimen is incomplete, having the narrower, immature end (terminology of Miller, 1995, fig. 2) broken off. A total original length of 150 mm or slightly more is not at all unreasonable.

The specimen is straight, cylindrical, and features the axial striae typical of this species. The test has been flattened parallel to sedimentary layering and resembles a figure-eight in cross section. It was not possible to determine test wall thickness or lumen diameter from the specimen. Parallel, slightly diagonal fractures pass through the test at intervals of 2 - 6 mm, sometimes coinciding with slight constrictions in test width. Although the constrictions may be the same as the irregularities in test diameter mentioned in the literature of fossil and modern bathysiphonids,

the fractures clearly are diagenetic features. As described by Miller (1991, 1995), specimens of *B. aaltoi* are composed of microcrystalline quartz, but originally consisted of spicules and mineral grains.

Significance: The discovery of a bathysiphonid specimen of this size has a number of implications. The test was very large, and ranks among the largest of foraminiferid tests ever discovered. Previously, among fossil bathysiphonids, *B. palachei* (Ulrich, 1904), from the Late Cretaceous of southern Alaska and possibly other areas in the western Pacific, appeared to be the largest bathysiphonid with specimens up to 97 mm long (test originally 120 mm?; Miller, 1995, table 1). The largest living bathysiphonid may be the western Pacific species *B. lanosum* Saidova, 1970, which was reported to be up to 120 mm long (Saidova, 1970, p. 144). Recently, Gooday *et al.* (1992, pls. 5, 6) illustrated living specimens of *B. filiformis* M. Sars, 1872, in the western Atlantic Ocean having up to 10 cm of the test protruding from the seafloor. In the series of specimens they retrieved from bathyal depths off North Carolina, the largest was 119 mm long. If *Bathysiphon aaltoi* is not the largest foraminiferid volumetrically, it certainly ranks as one of the largest in terms of test length.

Another implication relates to living position of *B. aaltoi* and preservation of large tests in mud turbidites. In my study of the paleoecology of *B. aaltoi*, I concluded that the living position most likely was vertical with respect to the seafloor, with the wider, mature end of the test protruding from the substrate and the thinner, immature end positioned in a small pit (Miller, 1988, 1993). In sand turbidites at point Saint George, small immature test fragments can be observed within scoured, plug-like burrows exposed on the soles of the turbidite beds (Miller, 1993). Short barrel-shaped pieces of tests and longer test fragments, which are obviously transported and in some cases concentrated as density-graded lags, can be found within sandstone layers. The largest tests, however, typically occur in the mud turbidites oriented parallel to sedimentary layers. The specimens are rarely broken into small segments and could have been toppled by low-energy bottom currents or bull-dozing benthos before burial. Immature ends of tests are rarely seen oriented vertical to sedimentary layering in the mudstone. This suggests the possibility that vertical to subvertical orientation of tests may not be the exclusive living position of *B. aaltoi*. Although most living species are illustrated having an essentially vertical living position, Christiansen (1971, fig. 3) showed an example of *B. filiformis* having a horizontal orientation.

Finally, considering the size of the specimen described here, one is tempted to speculate about the size of the cell body. If the protoplasm occupied only 10% of the length of the test, it would have extended along the lumen for 10 - 15 mm, making the cell body enormous. There are few published illustrations of bathysiphonid cell bodies. Le Calvez (1938, fig. 1) illustrated a large multinucleate cell in the mature end of *B. filiformis*; the remainder of the test was occupied by a "detrital

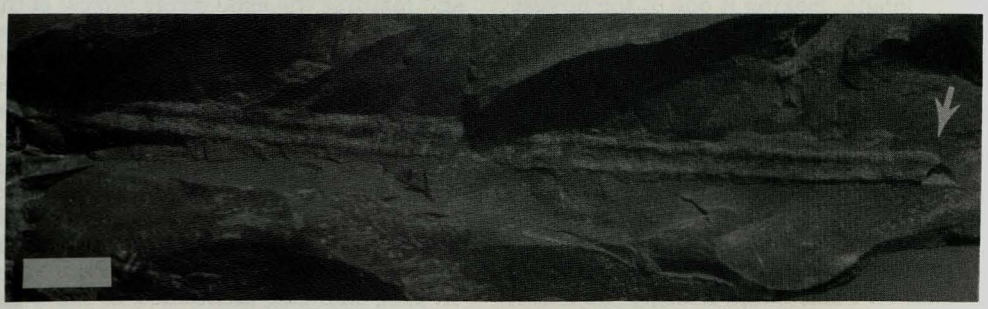

Figure 1. Large *Bathysiphon aaltoi* preserved in a mud turbidite. Arrow indicates broken immature end of test; scale represents 1 cm.

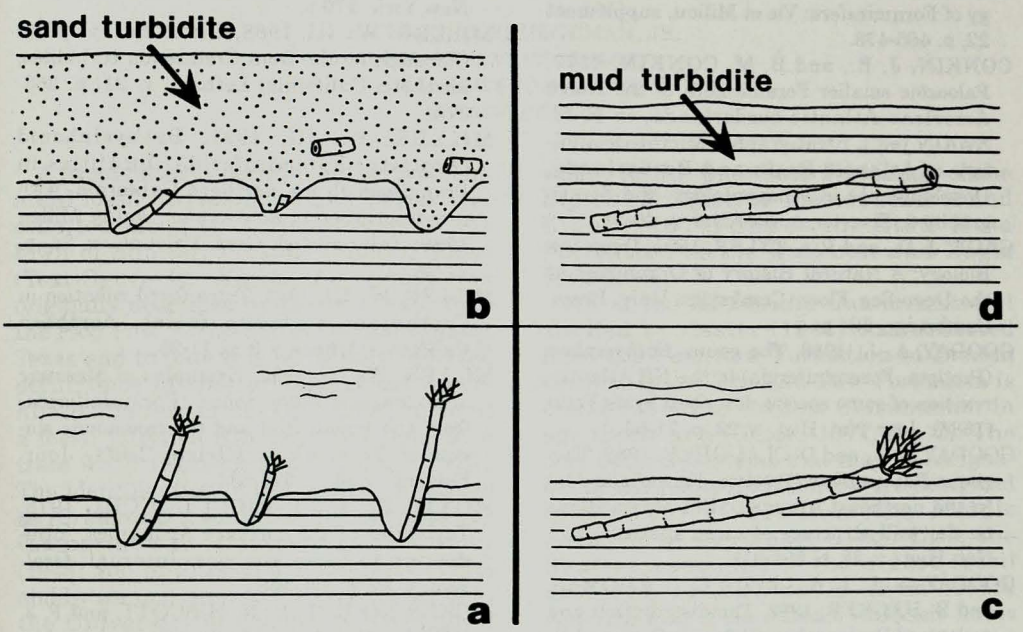

Figure 2. Living positions and preservation of *Bathysiphon aaltoi: a,* subvertical orientation of tests, with the mature ends protruding above the muddy seafloor and the immature ends positioned within a small pit-like burrow; *b,* disturbance and burial by a sand turbidite; *c,* very large test already toppled from the subvertical position; *d,* burial beneath a thin mud turbidite layer (the probable means of preservation recorded in Fig. 1).

plug." The illustration is an idealized sketch, so it is difficult to judge the actual size of the cell body. If the sketch represents the cell body dimensions accurately, the cell extends 9 - 10 mm along the lumen. Gooday (1988, figs. 9B, 11B) illustrated the cell body of *B. major* de Folin, 1886, describing the protoplasm as "... dense, granular and dark grey, sometimes almost black, in colour" (p. 84). In Gooday's figure 11B, the protoplasmic mass or sarcode appears to be approximately 4 mm long. Protoplasmic composition of several species has been illustrated by Gooday and Claugher (1989, fig. 14) and Gooday *et al.* (1992). Certainly, it is not possible to determine the cell-body size of *B. aaltoi*, but considering the overall size of their tests the species may have produced some of the largest protistan cells.

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