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3. Radiolarians from Northern Cape Basin, Site 1082[1]

A.L. Weinheimer[2]

INTRODUCTION

A primary objective of Leg 175 was to investigate the upwelling history of the Benguela Current. Site 1082 (21°5.6373′S, 11°49.2361′E) lies at the landward end of a transect extending from the coast across the Benguela Current. Located adjacent to the Walvis Bay in 1280 m water depth, Site 1082 recovered sediments are expected to reveal variability in upwelling dating as far back as the late Pliocene. Off the coast of Walvis Bay, the Benguela Current transports subpolar transition waters northward to the Walvis Ridge. A front forms there between the Benguela Current and tropical waters in the southward-flowing Angola Current (Salat et al., 1992). This front moves in response to seasonal-interannual changes in the wind field (Shannon, 1985; Shannon et al., 1986, 1987; Meeuwis and Lutjeharms, 1990). Upwelling along the coast is found over the shelf in several well-established cells, as well as along the shelf-slope break, and extends over the 1000-m isobath. Streaming filaments along the coast also carry upwelled water off shore (Shannon, 1985). The upwelled nutrient-rich waters are sourced from the South Atlantic central water mass, which is a mixture of subtropical and subantarctic water masses. Below the central water mass lies Antarctic intermediate water (Shannon and Hunter, 1988; Stramma and Peterson, 1989).

The upwelling system supports a robust marine community (Shannon and Pillar, 1986) where radiolarians are abundant (Bishop et al., 1978). The endemic nature of radiolarians makes them useful in reconstructing the paleocirculation patterns. The biogeographic distribution of many species is limited by water-mass distribution. In a given geographic region, species may also have discrete depth habitats. However, their depth of occurrence can change worldwide because the depths of

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[2]Scripps Institution of Oceanography, La Jolla CA 92093-0244, USA. **aweinheimer@ucsd.edu**

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water masses vary with latitude (Boltovskoy, 1999). Consequently, species found at shallow depths at high latitudes (cold-water fauna) are observed deeper in the water column at lower latitudes. The low-latitude submergence of cold-water species broadens their distribution, resulting in species distributions that can cover multiple geographic regions (Kling, 1976; Casey, 1971; Boltovskoy, 1988). Since radiolarian distribution is closely related to water-mass distribution and controlled by climatic conditions rather than geographic regions, similar assemblages characterize the equatorial, subtropical, transition, subpolar, and polar regions of ocean basins (Petrushevskaya, 1971a; Casey, 1989; Boltovskoy, 1999).

Numerous radiolarian species found in water masses in the Angola and Benguela Current systems have also been observed in plankton net samples, sediment traps, and surface-sediment studies in the Atlantic sector of the Southern Ocean, where they exhibited particular water-mass affinities (Abelmann, 1992a, 1992b; Abelmann and Gowing, 1997). This report presents data on the radiolarian fauna recovered from Site 1082 sediments in the form of a survey of species reflecting the latitudinal migration of the Angola-Benguela Front and upwelling. The data constitute a time series of relative radiolarian abundances at very high resolution (every 20 cm) of the upper 12 m of Hole 1082A.

METHODS

Samples were prepared in the typical manner (Sanfilippo et al., 1985; Boltovskoy, 1999) by treating the sediments with a solution of 10% H_2O_2 neutralized with sodium pyrophosphate to a pH of 7. Successive treatments were conducted until the radiolarian skeletons were clean. The carbonate fraction was removed with HCl. Sediments were sieved over a 45-µm screen, and strewn slides were mounted with Canada balsam made with the >45-µm fraction. Analyses of the slides were made using a Zeiss Photomicroscope I at 100×. Selected species were counted along 1–3 transects until a total of 300 specimens were counted. Qualitative estimates of total radiolarian abundance and preservation were made using the following criteria:

A = >1000 skeletons per slide.
C = >500–1000 skeletons per slide.
F = >100–500 skeletons per slide.
R = >10–100 skeletons per slide.
T = 1–10 skeletons per slide.
B = barren of skeletons.
G = no sign of dissolution and only minor fragmentation.
M = dissolution and obvious fragmentation.
P = high degree of dissolution and very few skeletons intact.

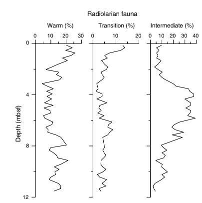
Sixty-two species were counted, and species with well-constrained habitats were used to make environmental groups that reflect specific water masses. Species were assigned to a water mass based on published occurrences, which are cited in the species list. These water masses include the warm-water mass carried by the Angola Current (warm fauna), transition water in the Benguela Current (transition fauna), and intermediate waters upwelled along the continental margin by oceanic upwelling (intermediate fauna). A more detailed description of the hydrographic setting can be found in Chapter 1 of the Leg 175 *Initial Reports* volume (Wefer, Berger, Richter, et al., 1998). The majority of data cited are from sediment trap, plankton tow, and surface-sediment studies with concurrently collected hydrographic data, so the data are suitable for determining which water mass the species occur in.

RESULTS AND DISCUSSION

Counts of each species by sample are presented in Table T1. The percentage of each environmental group is shown in Figure F1. Note that the total percentage accounted for by these groups is ~35%, so it is possible for them to covary, as well as be inversely related. In general, the percentages of warm and transition fauna are inversely related (though not statistically significant) to intermediate fauna, suggesting that these groups may be useful in reconstructing the upwelling history and latitudinal movement of the Angola-Benguela Current system.

T1. Range chart of radiolarian occurrences, in number of skeletons counted, in the upper 12 m, Hole 1082A, p. 13.

F1. Downcore percentages of warm, transition, and intermediate radiolarian fauna, p. 12.



SPECIES LIST

The following species list includes references for the species concept used, a recent reference, and the reference used in assigning species to environmental groups. The species number (sp. no.) following the species name refers to its number in Table T1.

Spumellaria

Acrosphaera murrayana (Haeckel) (sp. no. 15)
Choenicosphaera murrayana Haeckel, 1887, p. 102, pl. VIII, fig. 4; Strelkov and Reshetnyak, 1971, p. 347, fig. 25.

Actinomma cf. leptodermum (sp. no. 56)
Abelmann and Gowing, 1997, p. 22, pl. I, fig. 4; *Actinomma* spp. 1, Morley, 1977, p. 253, pl. 3 figs. 1–3 (with description and synonymy).

Amphirhopalum ypsilon Haeckel (sp. no. 49)
Amphirhopalum ypsilon Haeckel, 1887, p. 522; Boltovskoy and Riedel, 1980, p. 117, pl. 3, fig. 16 (Warm; Boltovskoy and Riedel, 1980).

Dictyocoryne profunda Ehrenberg (sp. no. 2)
Dictyocoryne profunda Ehrenberg, 1860, p. 767; Nigrini and Moore, 1979, p. S87, pl. 12, fig. 1 (Warm; Boltovskoy and Riedel, 1980).

Dictyocoryne sp. (sp. no. 6)
Dictyocoryne with arms too short for making species identification.

Didymocyrtis tetrathalamus (Haeckel) Sanfilippo and Riedel (sp. no. 32)
Panartus tetrathalamus Haeckel 1887, p. 378, pl. 40, fig. 3. *Ommatartus tetrathalamus* (Haeckel), Nigrini and Moore, 1979, p. S49, pl. 6, figs. 1a–d (with synonymy). *Didymocyrtis tetrathalamus* (Haeckel), Sanfilippo and Riedel, 1980, p. 1010; Abelmann and Gowing, 1997, p. 380, pl. 1, fig. 8 (Warm; Kling, 1979).

Hexacontium enthcanthum Jørgensen (sp. no. 54)
Hexacontium enthcanthum Jørgensen, 1900; p. 52, pl. 2, fig. 14, pl. 4, fig. 20; Nigrini and Moore, 1979, p. S45, pl. 5, figs. 1a, b.

Larcopyle butschlii Dreyer (sp. no. 12)
Larcopyle butschlii Dreyer, 1889, p. 124, pl. 10, fig. 70; Nigrini and Moore, 1979, p. S131, pl. 17, figs. 1a, b (Transition; Kling, 1977).

Lithelius minor Jørgensen (sp. no. 13)
Jørgensen, 1900, p. 65, pl. 5, fig. 24; Benson, 1966, p. 262, pl. 17, figs. 9, 10;

Nigrini and Moore, 1979, p. S135, pl. 17, figs. 3, 4a, b; Abelmann, 1992b, p. 380, pl. 2, fig. 13 (Transition; Molina-Cruz, 1977).

Rhizoplegma boreale (Cleve) Jørgensen (sp. no. 62)
Jørgensen, 1899, p. 61; 1905, p. 118, pl. 9, fig. 38, pl. 10, fig. 38e, f; Abelmann, 1992b, p. 382, pl. 1, fig. 13; Abelmann and Gowing, 1997, p. 25. *Hexadoras borealis* Cleve, 1899, p. 30, pl. 2, figs. 2f, 4a–c.

Spongaster tetras Ehrenberg tetras Nigrini (sp. no. 35)
Spongaster tetras Ehrenberg, 1860, p. 833; *Spongaster tetras* Ehrenberg tetras Nigrini, 1967, p. 41, pl. 5, figs. 1a, b; Nigrini and Moore, 1979, p. N93, pl. 13, fig. 1.

Spongocore puella Haeckel (sp. no. 20)
Haeckel, 1887, p. 347, pl. 48, fig. 6; Nigrini and Moore, 1979, p. S69, pl. 8, figs. 5a–c (Warm; Boltovskoy and Riedel, 1980).

Spongodiscid sp. (sp. no. 1)
Spongotrochus sp. 1, Abelmann and Gowing, 1997, p. 25, pl. II, fig. 4.

Spongopyle osculosa Dreyer (sp. no. 9)
Dreyer, 1889, p. 42, pl. 11, figs. 99, 100; Nigrini and Moore, 1979, pp. S115–S116, pl. 15, fig. 1 (with synonymy); Abelmann, 1992b, p. 382 (Intermediate; Morley, 1977).

Spongotrochus glacialis Popofsky group (sp. no. 39)
Spongotrochus glacialis Popofsky, 1908, p. 228, pl. 26, fig. 8, pl. 27, fig. 1, pl. 28, fig. 2. *Spongotrochus glacialis* Popofsky group, Petrushevskaya, 1975, p. 575, pl. 5, fig. 8, pl. 35, figs. 1–6; Nigrini and Moore, 1979, pp. S117–S118, pl. 15, figs. 2a–d (with synonymy); Abelmann, 1992b, p. 382 (Intermediate; Boltovskoy and Riedel, 1980).

Spongotrochus (?) venustum (Bailey) (sp. no. 25)
Perichlamidium venustum Bailey, 1856, p. 5, pl. 1, figs. 16, 17; *Stylochlamydium venustum* (Bailey) Renz, 1976, p. 110, pl. 3, fig. 11; *Spongotrochus* (?) *venustum* (Bailey) Nigrini and Moore, 1979, p. S119, pl. 15, fig. 3a, b; Abelmann and Gowing, 1997, p. 25, pl. II, figs. 1–3 (Transition; Kling, 1979).

Spongurus cf. *S. elliptica* (Ehrenberg) (sp. no. 5)
?*Acanthosphaera elliptica* Ehrenberg, 1873, p. 310; Spongurus cf. *S. elliptica* (Ehrenberg) Benson, 1966, p. 189, pl. 8 figs. 4, 5; Boltovskoy and Riedel, 1987, pl. II, fig. 27 (Warm; Johnson and Nigrini, 1982).

Spongurus pylomaticus Riedel (sp. no. 33)
Riedel, 1958, p. 226, pl. 1, figs. 10, 11; Nigrini and Moore, 1979, p. S65, pl. 8, figs. 3a, b (with synonymy); Abelmann, 1992b, p. 382, pl. 1, fig. 11.

Stylodictya aculeata Jørgensen (sp. no. 34)
Jørgensen, 1905, p. 119, pl. 10, fig. 41; Nigrini and Moore, 1979, p. S101, pl. 13, figs. 3, 4.

Tetrapyle octacantha/*Octapyle stenozona* group (sp. no. 3)
Both species, *T. octacantha* and *O. stenozona,* are included in this group. *Octapyle stenozona* Haeckel, 1887, p. 652, pl. 9, fig. 11; Benson, 1966, p. 251, pl. 16, figs. 3, 4, Nigrini and Moore, 1979, p. S123, pl. 16, figs. 2a, b; Abelmann, 1992b, p. 380, pl. 1, fig. 9. *Tetrapyle octacantha* Müller, Nigrini and Moore, 1979, p. S125, pl. 16, fig. 3a, b; Abelmann and Gowing, 1997, p. 25, pl. II, fig. 9 (Warm; Molina-Cruz, 1977).

Nassellaria

Anthocyrtidium ophirense (Ehrenberg) Nigrini (sp. no. 46)
Anthocyrtis ophirensis Ehrenberg 1872a, p. 301; Ehrenberg 1872b, p. 285, pl. 9, fig. 13. *Anthocyrtidium ophirense* (Ehrenberg) Nigrini and Caulet 1988, p. 352, pl. 2, figs. 1–4 (with synonymy) (Warm; Johnson and Nigrini, 1982).

Anthocyrtidium zanguebaricum (Ehrenberg) (sp. no. 26)
Anthocyrtis zanguebarica Ehrenberg, 1872a, p. 301; *Anthocyrtidium zanguebaricum* (Ehrenberg) Nigrini, 1967; Nigrini and Moore, 1979, p. N69, p. 25, fig. 3 (Warm; Johnson and Nigrini, 1982).

Arachnocorys circumtexta Haeckel (sp. no. 51)
Haeckel, 1860, p. 837; 1862, p. 542, pl. 6, figs. 9–11; Boltovskoy and Riedel, 1980, p. 121, pl. 4, figs. 18a, b (Warm; Boltovskoy and Riedel, 1980).

Arachnocorys pentacantha Popofsky (sp. no. 59)
Arachnocorys pentacantha Popofsky, 1913, p. 366, text figs. 84–86; Kling, 1977, p. 215, pl. 1, fig. 10.

Botryocyrtis scutum (Harting) (sp. no. 60)
Haliomma scutum Harting, 1863, p. 11, pl. 1, fig. 18; *Botryocyrtis scutum* (Harting) Nigrini, 1967, p. 52, pl. 6, figs. 1a–c; Nigrini and Moore, 1979, p. N105, pl. 28, figs. 1a, b (Warm; Johnson and Nigrini, 1982).

Botryostrobus aquilonaris (Bailey) (sp. no. 42)
Eucyrtidium aquilonaris Bailey, 1856, p. 4, pl. 1, fig. 9; *Botryostrobus aquilonaris* (Bailey) Nigrini, 1977, p. 246, pl. 1, fig. 1; Nigrini and Moore, 1979, p. N99, pl. 27, fig. 1 (Intermediate; Kling, 1979).

Botryostrobus auritus/australis (Ehrenberg) group Nigrini (sp. no. 4)
Lithocampe aurita Ehrenberg, 1844b, p. 84; *Lithocampe australe* Ehrenberg, 1844a, p. 187; *Botryostrobus auritus/australis* (Ehrenberg) group Nigrini, 1971, p. 246, pl. 1, figs. 2–5; Nigrini and Moore, 1979, p. N101, pl. 27, figs. 2a–d (Warm; Petrushevskaya, 1971a).

Carpocanarium papilosum (Ehrenberg) group (sp. no. 7)
Eucyrtidium papillium Ehrenberg, 1872a, p. 310; 1872b, pl. 7, fig. 10; *Dictyocephalus papillosus* (Ehrenberg), Haeckel, 1887, p. 1307; Riedel, 1958, p. 236, pl. 3, fig. 10, text fig. 8; *Dictyocryphalus papillosus* (Ehrenberg), Nigrini, 1967, p. 63, pl. 6, fig. 6; Nigrini and Moore, 1979, p. N27, pl. 21, fig. 3.

Carpocanistrum sp. (sp. no. 31)
Haeckel, 1887, Renz, 1976, p. 202, pl. 6, fig. 4 (Warm; Boltovskoy and Riedel, 1987).

Clathrocyclas bicornis Hays (sp. no. 40)
Hays, 1965, p. 179, pl. 3, fig. 3; Nishimura and Yamauchi, 1984, pl. 36, figs. 8a, b, 12 (Transition; Kling, 1979).

Cornutella profunda Ehrenberg (sp. no. 8)
Ehrenberg, 1858, p. 31; Boltovskoy and Riedel, 1980, p. 123, pl. 5, fig. 6 (Intermediate; Kling, 1979).

Corocalyptra columba (sp. no. 10)
Pterocorys volumns Haeckel, 1887, pl. 71, fig. 2; *Corocalyptra columba* (Haeckel) Takahashi and Honjo, 1981, p. 153, pl. 9, fig. 16; Boltovskoy and Riedel, 1987, pl. IV, fig. 21.

Cycladophora bicornis (Popofsky) (sp. no. 36)
Pterocorys bicornis Popofsky, 1908, p. 288, pl. 34, figs. 7, 8; *Theocalyptra bicornis* (Popofsky) Riedel, 1958, p. 240, pl. 4, fig. 4 (Intermediate; Morley, 1989).

Cycladophora davisiana (Ehrenberg) var. *cornutoides* Petrushevskaya (sp. no. 52)
Cycladophora (?) *davisiana* Ehrenberg, 1872b, p. 289; *Cycladophora davisiana* (Ehrenberg) var. *cornutoides* Petrushevskaya, 1967, p. 124, pl. 70, figs. 1–3; *Theocalyptra davisiana* (Ehrenberg) *cornutoides* (Petrushevskaya) Kling, 1977, p. 217, pl. 1, fig. 20 (Transition; Kling, 1977).

Cycladophora davisiana (Ehrenberg) (sp. no. 22)
Ehrenberg, 1861, p. 297; *Cycladophora* (?) *davisiana* Ehrenberg, 1872b, p. 289; Petrushevskaya, 1967, p. 122, pl. 69, figs. I–VII; *Theocalyptra davisiana* (Ehrenberg) *davisiana* (Petrushevskaya) Kling, 1977, p. 217, pl. II, fig. 17 (Intermediate; Kling, 1977).

Cyrtolagena laguncula Haeckel (sp. no. 61)
Haeckel, 1887, p. 1451, pl. 75, fig. 10; Petrushevskaya, 1971a, p. 171, pl. 89, figs. I–III.

Dictyophimus crisiae Ehrenberg (sp. no. 23)
Ehrenberg, 1854, p. 241; Nigrini and Moore, 1979, p. N22, figs. 1a, b (Transition; Weinheimer et al., 1986).

Dictyophimus gracilipes Bailey (sp. no. 14)
Bailey, 1856, p. 4, pl. 1, fig. 8; Petrushevskaya, 1967, pp. 65–67, figs. 38, 39 (with synonymy); Boltovskoy and Riedel, 1980, p. 124, pl. 5, fig. 8 (Intermediate; Abelmann and Gowing, 1997).

Dictyophimus infabricatus Nigrini (sp. no. 44)
Nigrini, 1968, p. 56, pl. 1, fig. 6; Nigrini and Moore, 1979, p. N37, pl. 22, fig. 5 (Transition; Kling, 1979).

Eucyrtidium acuminatum (Ehrenberg) (sp. no.17)
Lithocampe acuminatum Ehrenberg, 1844b, p. 84; *Eucyrtidium acuminatum* (Ehrenberg) Nigrini, 1967, p. 81, pl. 8, figs. 3a, b; Nigrini and Moore, 1979, p. N61, pl. 24, figs. 3a, b (Warm; Petrushevskaya, 1971b).

Eucyrtidium cf. *E. teuscheri* (Haeckel) Caulet (sp. no. 53)
Caulet, 1985, p. 851, pl. 5, figs. 5–8; Abelmann and Gowing, 1997, p. 22, pl. II, fig. 14.

Helotholus histricosa Jørgensen (sp. no. 18)
Jørgensen, 1905, p. 137, pl. 16, figs. 86–88; Kling, 1977, pl. 1, fig. 6 (Transition; Kling, 1977).

Lamprocyclas maritalis Haeckel (sp. no. 19)
Haeckel, 1887, p. 1390, pl. 74, figs. 13–14; Nigrini and Moore, 1979, N75, pl. 25, fig. 4 (Intermediate; Renz, 1976).

Lamprocyrtis (?) *hannai* (Campbell and Clark) (sp. no. 11)
Calocyclas hannai Campbell and Clark, 1944, p. 48, pl. 6, figs. 21, 22; *Lamprocyrtis* (?) *hannai* (Campbell and Clark) Kling, 1973; p. 638, pl. 5, figs. 12–14, pl. 12, figs. 10–14; Nigrini and Moore, 1979, p. N83, pl. 25, fig. 8.

Lamprocyrtis nigriniae (Caulet) Nigrini and Moore (sp. no. 47)
Nigrini and Moore, 1979, p. N81, pl. 25, fig. 7 (with synonymy); *Conarachnium nigriniae* Caulet 1971, p. 3, pl. 3, figs. 1–4, pl. 4, figs. 1–4 (Intermediate; Kling, 1979).

Lampromitra coronata Haeckel (sp. no. 50)
Haeckel, 1887, p. 1214, pl. 60, figs. 7a, b; Boltovskoy and Riedel, 1987, pl. IV, fig. 5.

Lampromitra quadricuspus Haeckel (sp. no. 27)
Haeckel, 1887, pp. 1214–1215, pl. 58, fig. 7; Boltovskoy and Riedel, 1987, pl. IV, fig. 6.

Lipmanella dictyoceras (Haeckel) (sp. no.41)
Lithornithium dictyoceras Haeckel, 1860, p. 840; *Lipmanella dictyoceras* (Haeckel) Kling, 1973, p. 636, pl. 4, figs. 24–26 (Warm; Kling, 1979).

Lithomelissa setosa Jørgensen (sp. no. 37)
Jørgensen, 1900, pp. 81–83, pl. 4, figs. 21, 22; Bjørklund, 1974, pp. 24–26, text fig. 8 (with synonymy); Abelmann 1992b, p. 380, pl. 3, fig. 14 (Intermediate; Kling, 1977).

Lithostrobus hexagonalis Haeckel (sp. no. 43)
Haeckel, 1887, p. 1475, pl. 79, fig. 20; Boltovskoy and Riedel, 1987, p. 100, pl. V, fig. 11 (Warm; Renz, 1976).

Lophospyris pentagona pentagona (Ehrenberg) (sp. no. 57)
Ceratospyris pentagona Ehrenberg, 1872a, p. 303; 1872b, pl. 15, fig. 15; *Lophospyris pentagona pentagona* (Ehrenberg) Goll, 1976, p. 398, pl. 10, figs.

1–7, pl. 11, figs. 1–3, 5; Nigrini and Moore, 1979, p. N15, pl. 19, fig. 5 (Warm; Johnson and Nigrini, 1982).

Lophospyris/Phormospyris group (sp. no. 48)
Boltovskoy and Riedel, 1987, pl. III, figs. 14a, b.

Peripyramis circumtexta Haeckel (sp. no. 38)
Haeckel, 1887, p. 1162, pl. 54, fig. 5; Nigrini and Moore, 1979, p. N29, pl. 21, figs. 4a, b (Intermediate; Kling, 1979).

Phormospyris stabilis stabilis (Goll) (sp. no. 58)
Dendrospyris stabilis Goll, 1968, pp. 1422–1423, pl. 173, figs. 16–18; *Phormospyris stabilis stabilis* (Goll) Goll, 1976, p. 390, pl. 1, figs. 1–13 (Warm; Kling, 1979).

Phormostichoartus corbula (Harting) (sp. no. 21)
Lithocampe corbula Harting, 1863, p. 12, pl. 1, fig. 21; *Siphocampe corbula* (Harting) Nigrini, 1967, p. 85, pl. 8, fig. 5, pl. 9, fig. 3; *Phormostichoartus corbula* (Harting) Nigrini, 1977, p. 252, pl. 1, fig. 10; Nigrini and Moore, 1979, p. N103, pl. 27, fig. 3 (Warm; Kling, 1979).

Pterocanium praetextum (Ehrenberg) *eucolpum* Haeckel (sp. no. 28)
Pterocanium eucolpum Haeckel, 1887, p. 1322, pl. 73, fig. 4; *Pterocanium praetextum* (Ehrenberg) *eucolpum* Haeckel, Nigrini, 1967, p. 70, pl. 7, fig. 2; Nigrini and Moore, 1979, p. N43, pl. 23, fig. 3 (Transition; Nigrini, 1970).

Pterocanium praetextum praetextum (Ehrenberg) (sp. no. 55)
Lychnocanium praetextum Ehrenberg, 1872a, p. 316; *Pterocanium praetextum* (Ehrenberg) Haeckel, 1887, p. 1330, pl. 73, fig. 6; *Pterocanium praetextum praetextum* (Ehrenberg) Nigrini, 1967, p. 68, pl. 7, fig. 1 (Warm; Johnson and Nigrini, 1982).

Pterocanium trilobum (Haeckel) Nigrini (sp. no. 16)
Dictyopodium trilobum Haeckel, 1860, p. 839; *Pterocanium trilobum* (Haeckel) Nigrini, 1967, p. 71, pl. 7, figs. 3a, b; Nigrini and Moore, 1979, p. N45, pl. 23, figs. 4a–c.

Pterocanium sp. 1 (sp. no. 29)
Nigrini and Moore, 1979, pl. 23, fig. 6a, b.

Pterocorys minythorax (Nigrini) (sp. no. 24)
Theoconus minythorax Nigrini, 1968, p. 57, pl. 1, fig. 8; *Pterocorys minythorax* (Nigrini), Nigrini and Moore, 1979, p. N85, pl. 25, fig. 10. (Warm; Molina-Cruz, 1977)

Pterocorys zancleus (Müller) (sp. no. 30)
Eucyrtidium zanclaeum Müller, 1858, p. 41, pl. 6, figs. 1–3; *Theoconus zancleus* (Müller) Benson, 1966, p. 482, pl. 33, fig. 4 (not 5); Nigrini and Moore, 1979, p. N89, pl. 25, figs. 11a, b; Abelmann and Gowing, 1997, p. 25 (Warm; Petrushevskaya, 1971c).

Theocorythium trachelium (Ehrenberg) (sp. no. 45)
Eucyrtidium trachelius Ehrenberg, 1872a, p. 312; *Theocorythium trachelium* (Ehrenberg) Petrushevskaya, 1971a, p. 22, pl. 118, figs. I, II; Boltovskoy and Riedel, 1980, p. 127, pl. 5, fig. 22 (Warm; Boltovskoy and Riedel, 1980).

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Figure F1. Downcore percentages of warm, transition, and intermediate radiolarian fauna. The percent scale differs for each environmental goup.

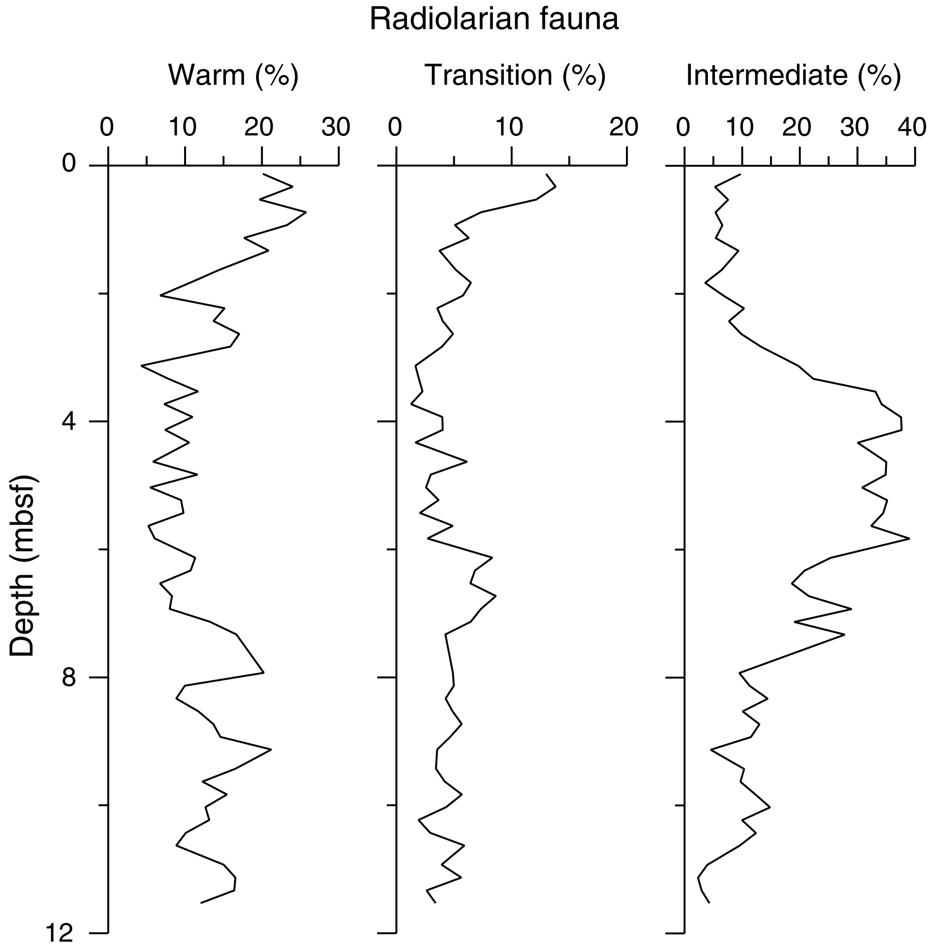

Table T1. Range chart of radiolarian occurrences, in number of skeletons counted, in the upper 12 m of Hole 1082A. (See table notes. Continued on next three pages.)

Core, section, interval (cm)	Abundance/ Preservation	*Spongodiscid* sp.	*Dictyocoryne profunda*	*Tetrapyle octa./Octapyle stenozona*	*Botryostrobus auritus/australis*	*Spongurus* cf. *S. elliptica*	*Dictyocoryne* sp.	*Carpocanarium papillosum*	*Cornutella profunda*	*Spongopyle osculosa*	*Corocalyptra columba*	*Lamprocyrtis* (?) *hannai*	*Larcopyle butschlii*	*Lithelius minor*	*Dictyophimus gracilipes*	*Acrosphaera murrayana*	*Pterocanium trilobum*	*Eucyrtidium acuminatum*	*Helotholus histricosa*	*Lamprocyclas maritalis*	*Spongocore puella*	*Phormostichoartus corbula*	*Cycladophora davisiana*	*Dictyophimus crisiae*	*Pterocorys minythorax*	*Spongotrochus* (?) *venustum*	*Anthocyrtidium zanguebaricum*	*Lampromitra quadricuspus*	*Pterocanium praetextum eucolpum*	*Pterocanium* sp. 1	*Pterocorys zancleus*	*Carpocanistrum* sp.	*Didymocyrtis tetrathalamus*	*Spongurus pylomaticus*	*Stylodictya aculeata*	*Spongaster tetras tetras*	*Theocalyptra bicornis*	*Lithomelissa setosa*	*Peripyramis circumtexta*	*Spongotrochus glacialis*	*Clathrocyclas bicornis*	*Lipmanella dictyoceras*	*Botryostrobus aquilonaris*	*Lithostrobus hexagonalis*	*Dictyophimus infabricatus*	*Theocorythium trachelium*	*Anthocyrtidium ophirense*	*Lamprocyrtis nigriniae*	*Lophospyris/Phormospyris* group
	Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
	Group		W	W	W	W			I	I			T	T	I			W	T	I	W	W	I	T	W	T	W		T		W	W	W				I	I	I	I	T	W	I	W	T	W	W	I	
189-1082A-																																																	
1H-1, 13-15	A, G	13	1	11	27	5	2	4	2	1	2	2	13	23	4	4	2			6	4		5	2	1	2		2		1	3	2	2		1		3					1	2	1			1		3
1H-1, 33-35	A, G	20	2	15	30	9	8	2	2			4	9	31	1	7	1		1	2	2		3			1				1	5		8		3			1	1	1			2	1					1
1H-1, 53-55	A, G	9	5	14	19	1	8	4	2	2		1	9	25	1	6				4	3	2	3				1	2	1				10		2			2					2		1			1	6
1H-1, 73-75	A, G	10		11	24	8	1	3	2	2	1	1	9	6	2	1	6		3	2	1		2	1			1	1	1		2	2	21		2	1		2			1		1	1	1	1			
1H-1, 93-95	A, G	17	4	13	11	18	4	2	7		1		9	7	2		1		1		1	2	5					1			1	3	16		2		2	4	2			1							
1H-1, 113-115	A, G	10	6	11	8	8	4	2			1	3	5	15	1	6	2		1	5	2	4	7				1				2	1	11		1			2	1			1	1					1	
1H-1, 133-135	A, G	9	3	15	5	14	3	4	1	1	1	1	5	6	4	2				3		5	21			1	1	1		3			6		1							2		2					
1H-2, 13-15	A, G	7	6	7	11	3	1		2	1	1		6	8	1	2	1			5	1	1	7			1		2	1	2	1	1	3				1					2		1				1	
1H-2, 33-35	A, G	6	2	15	4	7	1	1	1			2	5	12		14				4		1			1							1	1		2				1		1	1	3					2	
1H-2, 53-55	C, P	4	2	11	1	5	3	1	2	1		1	5	7		1	1			5			8	4				1					1		3				1	2	1		2						
1H-2, 73-75	A, M	15	2	9	6	9	3	5		3		3	3	8	1	3	1	1		6	2	3	15		1			1		1			10		2			4	1			2	1			1		1	
1H-2, 93-95	F, M	9	7	8	8	6	5	2	2	2			3	5	1	5	3			2	1		7	2	1	2		1					9		2			1	1				6					1	
1H-2, 113-115	C, G	16	1	11	10	5	3	4		3			1	9			3			4	1	5	17	1							2		4	2							2	3	6				2		
1H-2, 133-135	F, M	11	2	18	10	7	1	3		3			5	4	5	1				6	2	4	21	1				1			1		3						2		1		3						
1H-3, 13-15	F, P	2	1	3	7								1	3	1					3			9	1									2										47						
1H-3, 33-35	C, G	12		8		5	3	4	1					4	1			1		6	1	3	15	2							2		3	1		1		1	1				43					1	
1H-3, 53-55	A, M	5		12	8	9	4	2		2			2	5			1	1		4			45								3	1	2										51						
1H-3, 73-75	A, G	9	1	13	8		3	3		2			2	2	2	2	5			10			74																1			1	19						
1H-3, 93-95	A, M	13	1	17	5	6	2	1	1	2	1		1	11	1	2	1			10		1	40								1		2	1	2			2		1			56						
1H-3, 113-115	A, M-G	2	1	10	6	5		2					2	9	2					5		1	75			1		1						1	1			7			1		33	1					
1H-3, 133-135	A, M	13	6	15	3	4		1	1	3			1	1		1			1	5		2	72	2				1				1						4					6	1					
1H-4, 13-15	C, M	2	3	6	2	4	2	2	2	8	2		2	11		1				1		4	68	3		4								1				1					34						
1H-4, 33-35	A, M	8	4	11	4	8		1	1	3			2	2	2	1			3	4	1	4	81				1	1					1					5		1	2		8						
1H-4, 53-55	A, M-G	7	2	4	3	5	1	2				2	5	2	2		1		1	2		3	71					1										8		2			11						
1H-4, 73-75	A, M-G	6	1	7	2	15	1	2		2		1		11	1				1	7		3	73		1							1						16		6		1	10						
1H-4, 93-95	A, G	8	7	6	2	5	1	1		6		1	1	3	2	2			2	1	1	1	74		1			1				3						4	2	4		2	9			1			
1H-4, 113-115	A, G	10	1	8	7		2	3		4			1	14	2	2	3			2			72															3	1	1			14						
1H-4, 133-135	A, G	3		2	2	7	3	5		2			4	2	3	1			2	3		3	89		2						1	1			1			12		1			6						
1H-5, 13-15	A, M-G	8		7	9	16	5	7	1				8	14	1	3	1		1	6			44	1		1		1				1		3				7		1			16	1					
1H-5, 33-35	C, M	9		11	4	15	4	5	4				3	15		8			1	3	1	1	33	2	1													2					22						
1H-5, 53-55	A, M	17	1	10	4	4	4	2	2				2	17	1	2				5		1	16	1								1		6					1	1			32						

Table T1 (continued).

Core, section, interval (cm)	Abundance/ Preservation	*Lophospyris/Phormospyris* group	*Amphirhopalum ypsilon*	*Lampromitra coronata*	*Arachnocorys circumtexta*	*Cycladophora dav.* var. *cornutoides*	*Eucyrtidium* cf. *E. teuscheri*	*Hexacontium enthcanthum*	*Pterocanium praetextum praetextum*	*Actinomma* cf. *leptodermum*	*Lophospyris pentagona pentagona*	*Phormospyris stabilis stabilis*	*Arachnocorys pentacantha*	*Botryocyrtis scutum*	*Cyrtolagena laguncula*	*Rhizoplegma boreale*	Total identified	Total counted
	Number	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62		
	Group		W		W	T			W	I	W	W		W				
189-1082A-																		
1H-1, 13-15	A, G	3		1	2					7	1		1			1	171	308
1H-1, 33-35	A, G	1						6		3		1			1		185	304
1H-1, 53-55	A, G	6	2	1	3	1		4		6							163	305
1H-1, 73-75	A, G				2			4	1	3	1			1			146	299
1H-1, 93-95	A, G				4			4			1	1	1	2			150	335
1H-1, 113-115	A, G		1		3			7									134	334
1H-1, 133-135	A, G				12			1			1	1					135	321
1H-2, 13-15	A, G			1	8			3		2							101	311
1H-2, 33-35	A, G					2		4									94	309
1H-2, 53-55	C, P				1	1											75	311
1H-2, 73-75	A, M				1		1	1									126	310
1H-2, 93-95	F, M				1												103	299
1H-2, 113-115	C, G			2	7	2			1								127	305
1H-2, 133-135	F, M				1	1											117	302
1H-3, 13-15	F, P																80	304
1H-3, 33-35	C, G				1												120	309
1H-3, 53-55	A, M																157	308
1H-3, 73-75	A, G																157	316
1H-3, 93-95	A, M							1									182	301
1H-3, 113-115	A, M-G							1									167	324
1H-3, 133-135	A, M							1									145	303
1H-4, 13-15	C, M																163	326
1H-4, 33-35	A, M				1			2									162	301
1H-4, 53-55	A, M-G							2									137	312
1H-4, 73-75	A, M-G																168	327
1H-4, 93-95	A, G																151	296
1H-4, 113-115	A, G																150	306
1H-4, 133-135	A, G																155	297
1H-5, 13-15	A, M-G						1										164	300
1H-5, 33-35	C, M																144	308
1H-5, 53-55	A, M																130	312

Table T1 (continued).

Core, section, interval (cm)	Abundance/ Preservation	*Spongodiscid* sp.	*Dictyocoryne profunda*	*Tetrapyle octa./Octapyle stenozona*	*Botryostrobus auritus/australis*	*Spongurus* cf. *S. elliptica*	*Dictyocoryne* sp.	*Carpocanarium papillosum*	*Cornutella profunda*	*Spongopyle osculosa*	*Corocalyptra columba*	*Lamprocyrtis* (?) *hannai*	*Larcopyle butschlii*	*Lithelius minor*	*Dictyophimus gracilipes*	*Acrosphaera murrayana*	*Pterocanium trilobum*	*Eucyrtidium acuminatum*	*Helotholus histricosa*	*Lamprocyclas maritalis*	*Spongocore puella*
	Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Group		W	W	W	W			I	I			T	T	I			W	T	I	W
1H-5, 73-75	C, M	18	1	8	6	7	1	5	2			1	2	18	1	2			2	3	
1H-5, 93-95	A, M	20	3	6	4	8	2	3	2				5	17						6	
1H-5, 113-115	A, M-G	14		6	17	14	2	2				2	1	16	5	2			2	7	
1H-5, 133-135	A, M-G	7	4	12	7	21	1	2				1	2	6					2	2	1
2H-1, 13-15	A, M-G	13	14	12	9	16	4	2	1	1		4	1	11	1			1		1	
2H-1, 33-35	A, M-G	15	7	8	3	4	1	4	1	7		7	1	5	2	3					2
2H-1, 53-55	A, M-G	20	3	6	5	4	3	2	2	2		7	1	9	7		2	1	2		1
2H-1, 73-75	A, M-G	7	4	12	6	4	2	2		2		11	3	4	3	2	2	1	2		2
2H-1, 93-95	A, M-G	11	9	12	6	5	5	8	2	2	3	8	6	3	2		3		1	1	4
2H-1, 113-115	A, M-G	10	6	21	4	9	7	5				12	5	3	2		3		1	1	2
2H-1, 133-135	A, M-G	8	10	18	7	17	7	7		1		11	5	3	3	2					2
2H-2, 13-15	A, M-G	9	6	13	7	18	2	3	1	1		14	2	9		2	1			3	
2H-2, 33-35	A, M-G	6	6	9	4	12	6	5	1	3		11		12	3	4	1	1		4	1
2H-2, 53-55	A, M-G	13	6	13	5	14	3	3		1		9	6	11	4	2	1		1	4	1
2H-2, 73-75	A, M-G	14	4	7	7	10	5	3	2	2		9	3	8	1	3	2		2	1	5
2H-2, 93-95	A, M-G	10	7	6	7	10	2	3	1	1		9	1	2		2			1		2
2H-2, 113-115	A, G	13	5	8	4	9	4	2	1			10	5	1	2	2			1	1	
2H-2, 133-135	A, M	18	3	4	5	9	7	15	4	2		7	3	10	1	2				2	
2H-3, 13-15	A, M	12	11	12	6	9	10	2		1		2	1	8		1			2	3	1
2H-3, 33-35	A, M	5	16	15	5	4	5	6	1			7	3	14	1	3					1
2H-3, 53-55	A, M-G	18	6	15	5	11	5	9	3	3		7	4	3	1	1	1				4
2H-3, 73-75	A, M	14	12	7	7	6	6	4	4	4	4	3	3	3	3	2	2	2	2	2	1

Core, section, interval (cm)	*Phormostichoartus corbula*	*Cycladophora davisiana*	*Dictyophimus crisiae*	*Pterocorys minythorax*	*Spongotrochus* (?) *venustum*	*Anthocyrtidium zanguebaricum*	*Lampromitra quadricuspus*	*Pterocanium praetextum eucolpum*	*Pterocanium* sp. 1	*Pterocorys zancleus*	*Carpocanistrum* sp.	*Didymocyrtis tetrathalamus*	*Spongurus pylomaticus*	*Stylodictya aculeata*	*Spongaster tetras tetras*	*Theocalyptra bicornis*	*Lithomelissa setosa*	*Peripyramis circumtexta*	*Spongotrochus glacialis*	*Clathrocyclas bicornis*	*Lipmanella dictyoceras*	*Botryostrobus aquilonaris*	*Lithostrobus hexagonalis*	*Dictyophimus infabricatus*	*Theocorythium trachelium*	*Anthocyrtidium ophirense*	*Lamprocyrtis nigriniae*
Number	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
Group	W	I	T	W	T	W		T		W	W	W				I	I	I	I	T	W	I	W	T	W	W	I
1H-5, 73-75		32	2					1				3					3	1	1	1		22					
1H-5, 93-95	2	39								1			2	2			3	2				35					
1H-5, 113-115	1	30									3		1				3	2	1			11					
1H-5, 133-135	2	55	1							3				1			3			1		25					
2H-1, 13-15	2	8	2	2					1			3	1	2		1	5		1	1		10			1		
2H-1, 33-35	1	12	2	1	2	1	1	1	1	1		2	2				1			1		11		3			
2H-1, 53-55	3	14		2								1					1	1	1	1		15	1				1
2H-1, 73-75	3	13	2	3	1		1	3		1								1				12					
2H-1, 93-95	2	15	1					5	1			2		3			1	1	3			12		1	1		
2H-1, 113-115	1	27				1		5		1			1				3	2		1	2	2					
2H-1, 133-135	4	8		1		1		3		2	1	1	1									2			1		
2H-2, 13-15	1	19		1					2	1	2	2	1	1			2				1	6				1	1
2H-2, 33-35	3	7					1	1				2		1				2	1			9					
2H-2, 53-55	2	14		2			2					3	2	1							2	16			1		
2H-2, 73-75	1	29	1	3			1					2	1	1			2		1		2	10					
2H-2, 93-95	1	20	1	3						1	1	2	1	3			1	2	1		1	5		1			
2H-2, 113-115	1	23		1				2				2	1				2					9	1				
2H-2, 133-135	1	16	3	1		1		1		1		1	1	3			1		3	1	1						
2H-3, 13-15		3		2				1			1	4		1				5									
2H-3, 33-35	1	3		2							1	5		6			1	1									
2H-3, 53-55	2	1	1								4	3	2	1	1	1											
2H-3, 73-75	1	1	1	1	1	1	1	1	1	1																	

Notes: The second column (Group) indicates to which environmental group a species is assigned, where W = warm, I = intermediate, and T = transition water mass fauna. Abundance and preservation abbreviations are as follows: A = >1000 skeletons per slide, G = no sign of dissolution and only minor fragmentation, C = >5001000 skeletons per slide, P = high degree of dissolution and very few skeletons intact, M = dissolution and obvious fragmentation, F = >100500 skeletons per slide.

Table T1 (continued).

Core, section, interval (cm)	Abundance/ Preservation	*Lophospyris/Phormospyris* group	*Amphirhopalum ypsilon*	*Lampromitra coronata*	*Arachnocorys circumtexta*	*Cycladophora dav.* var. *cornutoides*	*Eucyrtidium* cf. *E. teuscheri*	*Hexacontium enthcanthum*	*Pterocanium praetextum praetextum*	*Actinomma* cf. *leptodermum*	*Lophospyris pentagona pentagona*	*Phormospyris stabilis stabilis*	*Arachnocorys pentacantha*	*Botryocyrtis scutum*	*Cyrtolagena laguncula*	*Rhizoplegma boreale*	Total identified	Total counted
	Number	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62		
	Group		W		W	T			W	I	W	W		W				
1H-5, 73-75	C, M						1										144	301
1H-5, 93-95	A, M																162	300
1H-5, 113-115	A, M-G					1											143	310
1H-5, 133-135	A, M-G		1			1	1										162	306
2H-1, 13-15	A, M-G			1	2												134	306
2H-1, 33-35	A, M-G																113	301
2H-1, 53-55	A, M-G																118	305
2H-1, 73-75	A, M-G			1													110	308
2H-1, 93-95	A, M-G																139	300
2H-1, 113-115	A, M-G																137	322
2H-1, 133-135	A, M-G		1														127	311
2H-2, 13-15	A, M-G	1															133	320
2H-2, 33-35	A, M-G																116	310
2H-2, 53-55	A, M-G																142	317
2H-2, 73-75	A, M-G																142	324
2H-2, 93-95	A, M-G																108	312
2H-2, 113-115	A, G																110	307
2H-2, 133-135	A, M																127	305
2H-3, 13-15	A, M																98	306
2H-3, 33-35	A, M																106	302
2H-3, 53-55	A, M-G																112	305
2H-3, 73-75	A, M																101	324