

37. ANTARCTIC SILICOFLAGELLATES FROM THE SOUTHEAST PACIFIC, DEEP SEA DRILLING PROJECT LEG 35

Bilal U. Haq and Anne Riley, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts

INTRODUCTION

During February/March 1974, four sites were drilled during the Deep Sea Drilling Project Leg 35 in the Southeast Pacific Basin (two on the Bellingshausen Abyssal Plain and two on the Antarctic continental rise) (Figure 1). This was the third cruise of D/V *Glomar Challenger* in the Antarctic waters, the earlier cruises being Legs 28 and 29. Sediment recovery was poor at all sites and siliceous microfossils were recovered from relatively few diatomaceous layers in the cores. A summary of site locations, coring data, and recovery of silicoflagellates is given in Table 1.

SILICOFLAGELLATES OF LEG 35

Poorly to moderately well preserved silicoflagellates were recovered at all sites, but specimens were rare to very rare, and only occurred at intermittent levels of the cored intervals. One silicoflagellate slide was prepared from each sample studied for radiolarians (Weaver, this volume). A total of 219 samples were examined from the four sites. Only 65 of these contained silicoflagellates, which are middle Miocene to Pliocene in age. All specimens were counted. The species distribution is presented in Tables 2-4.

Biostratigraphic Considerations

Silicoflagellates have evolved at a slower pace relative to other microfossil groups, and thus silicoflagellate zones are inherently of longer durations. A number of zonal schemes have been suggested in recent years for the Mio-Pliocene interval. Bukry (1973, 1975), Ling (1973), and Perch-Nielsen (1975) have all proposed zonations for the Mio-Pliocene interval of nontropical areas based on the material cored during DSDP Legs 16, 19, and 29. However, due to the very high latitudinal position of the area studied here (south of 60°S), these zonations could not be used effectively. The zonal scheme suggested by Ciesielski (1975) based on DSDP Leg 28 material (also in latitudes south of 60°S), and ELTANIN piston-cores was found to be more useful, and we have tried to follow this scheme as much as possible. However, due to lack of continuous coring during Leg 35, general paucity of silicoflagellates and problems of poor preservation, no detailed biostratigraphic work could be accomplished on the present material.

The zonal concepts we used for the Mio-Pliocene interval and based on Ciesielski (1975) are summarized below:

1) *Corbisema triacantha* Zone (late early Miocene) Interval from the last occurrence of *Naviculopsis navicula* and/or *N. regularis* to the last consistent occurrence of *Corbisema triacantha*.

2) *Distephanus longispinus* Zone (early middle Miocene)

Interval from last consistent occurrence of *Corbisema triacantha* to first appearance of *Dictyocha mutabilis*.

3) *Dictyocha mutabilis* Zone (middle Miocene)

Range zone of *D. mutabilis*.

4) *Paradictyocha circulus* Zone (late Miocene)

Interval from first to last consistent occurrence of *P. circulus*.

5) *Mesocena diodon* Zone (late Miocene-early Pliocene)

Interval from last consistent occurrence of *Paradictyocha circulus* to first common occurrence of *Dictyocha pseudofibula*.

6) *Dictyocha pseudofibula* Zone (mid early Pliocene)

Interval from first common occurrence of *D. pseudofibula* to the first common occurrence of *D. aspera* var. *pygmaea* and *D. fibula* var. *pumila*.

7) *Dictyocha aspera* Zone (late early Pliocene)

Interval from first to last common occurrences of *D. aspera* var. *pygmaea* and *D. fibula* var. *pumila*.

8) *Distephanus boliviensis* Zone (middle Pliocene)

Interval from last common occurrences of *Dictyocha aspera* var. *pygmaea* and *D. fibula* var. *pumila* to the last common occurrence of *Distephanus boliviensis*.

Not all of these zones were found in the material from Leg 35 and in some cases the diagnostic species were present but in very rare numbers. Silicoflagellates of each site are described below.

Site 322

Twenty species of silicoflagellates were observed, mostly in few to rare numbers, in Core 1, Section 1 through Core 4, Section 2. Below Core 2, Section 2 only rare fragments of the species more common in upper levels were seen. All sections between 4-2 and 10, CC were barren of silicoflagellates. The distribution of various species at this site is presented in Table 2.

Distephanus boliviensis is rare in the core-catcher of Core 1 and above; however, the "short-spined" variety of *D. speculum* is common and there were also rare occurrences of the "long-spined" variety. Based on this evidence alone, it is difficult to assign a biostratigraphic zone to this interval. On the basis of the whole assemblage, however, it is assigned an age of late Miocene to early Pliocene.

Site 323

Out of the 18 cores recovered from Site 323, only the upper 9 yielded silicoflagellates. Silicoflagellates were very rare in Cores 9, CC through 7-1. Similarly, other intermittent layers (6-1 to 5-1, 3-1, and 1-3 to 1-1) either contained very rare silicoflagellates or were completely barren. Twenty-one species were observed in the 32

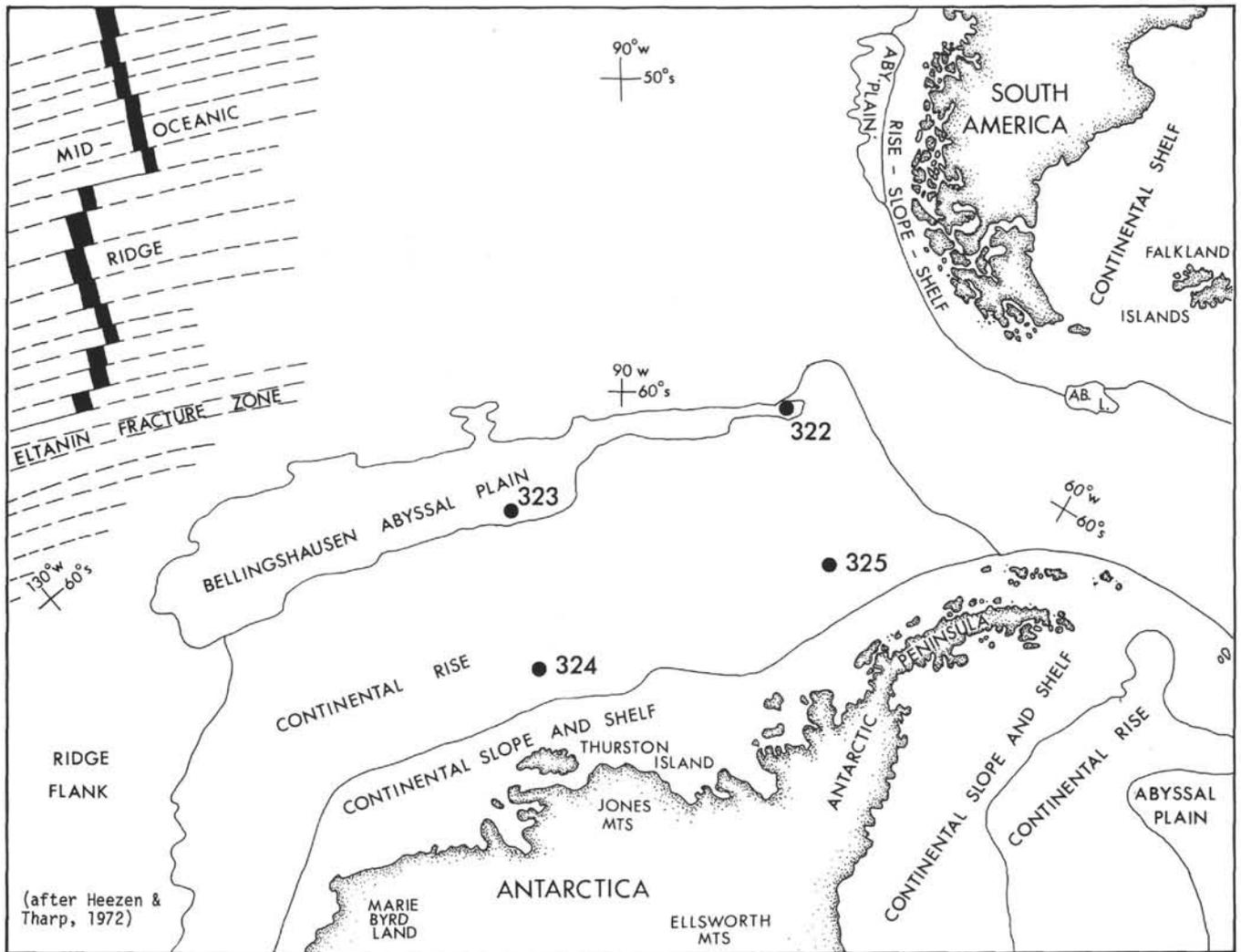


Figure 1. Locations of DSDP Leg 35 sites.

TABLE 1
Core Locations and Recovery Data for DSDP Leg 35

| Site | Latitude, Longitude | Water Depth (m) | Penetration (m) | No. of Cores | Meters Cored | Meters Recovered | Oldest Sediments | Silicoflagellates Recovered (Core-Section) |
|------|--------------------------|-----------------|-----------------|--------------|--------------|------------------|--------------------------------|--|
| 322 | 60° 01.45'S, 79° 25.49'W | 5026 | 544 | 14 | 125.5 | 34.2 | Miocene | 4-2 to 1-1 |
| 323 | 63° 40.84'S, 97° 59.69'W | 4993 | 731 | 21 | 199.5 | 76.7 | Upper Cretaceous | 9, CC to 1-1 |
| 324 | 69° 03.21'S, 98° 47.20'W | 4449 | 218 | 10 | 95.0 | 48.1 | Pliocene | 1-6 to 1-1 |
| 325 | 65° 02.79'S, 73° 40.40'W | 3745 | 718 | 10 | 95.0 | 34.4 | Upper Oligocene/ lower Miocene | 3, CC to 2-1 |

samples that yielded silicoflagellates. The distribution of various species is shown in Table 3.

Most zone-diagnostic species in this material occur only in rare to very rare numbers and thus the zonal scheme, which is mainly based on consistent or common occurrence of taxa, can be used only tentatively at best.

The interval from 9, CC to 6, CC is tentatively placed within the late early Miocene *Corbisema triacantha* Zone due to the presence of this species in Sample 6, CC. The base of this zone, which is defined by the last occurrence of *Naviculopsis navicula*, is not observed in the present material and thus all samples up to 9, CC are included in

TABLE 2
Distribution of Silicoflagellates at Site 322, Late Miocene/Early Pliocene

| Sample (Interval in cm) | Taxa | | | | | | | | | | | | | Silicoflagellate Zone | Age | | | | | | | | | | | | |
|----------------------------|-----------------------------|-------------------------|-------------------|---------------------------|-------------------------|---------------------------------------|------------------------|--------------------------------|----------------|-------------------|----------------------|--------------------------|-----------------------|--------------------------|-----|--------------------|------------------------------|-------------------------------|-------------------------|---|-------------------------------------|--------------------------------|--------------------|----------------------|-----------------------------|--|--|
| | <i>Cannopilus binoculus</i> | <i>Dictyocha aspera</i> | <i>D. epiodon</i> | <i>D. fibula aculeata</i> | <i>D. fibula fibula</i> | <i>D. fibula cf. rotundata</i> Schulz | <i>D. pseudofibula</i> | <i>Distephanus boliviensis</i> | <i>D. crux</i> | <i>D. minutus</i> | <i>D. octonarius</i> | <i>D. quinquantellus</i> | <i>D. septenarius</i> | | | <i>D. speculum</i> | <i>D. speculum binoculus</i> | <i>D. speculum pseudocrux</i> | <i>D. speculum s.s.</i> | <i>Lyramula tenuipertica</i> var. <i>laevis</i> | <i>Mesocena elliptica triangula</i> | <i>Paradictyocha apiculata</i> | <i>P. circulus</i> | <i>P. dumitricae</i> | Total Whole Specimens | | |
| 1-1, 44-46 | | | | | | 1 | | | | | | | | | | | | | | | | | 1 | | | | |
| 1-1, 78-80 | | 1 | 3 | 1 | 2 | 1 | | 1 | 4 | | | | 1 | 1 | | | 17 | 1 | | | 1 | | | 33 | | | |
| 1-2, 64-66 | 2 | 1 | | | | 1 | 5 | | 4 | | | | | | 5 | | 1 | 42 | | 1 | | | | 62 | | | |
| 1-2, 114-116 | | 1 | | | | 1 | 2 | | 2 | | 1 | 1 | 5 | | | | 1 | 15 | 6 | 1 | | | | 36 | | | |
| 1-3, 19-21 | | 1 | | | | | 2 | | | | 1 | | 3 | | | | 15 | | | | 3 | | | 25 | | | |
| 1-3, 90-92 | | 3 | | | | | | | | | | | 12 | | | | 1 | | | | | | | 16 | | | |
| 1-4, 70-72 | | | | | | | | | | | | | | | | | + | | | | | | | 2 | | | |
| 1-6, 127-129 | | | | | | | | | | | | | 2 | | | | | | | | | | | 2 | | | |
| 1, CC | | | | | | | | | | | | | | | | | + | | | | | | | | | | |
| 2-2, 97-99 | 1 | | | | | | 2 | 16 | | 1 | 4 | 8 | 2 | | | | 20 | 3 | | | 1 | | | 58 | Late Miocene/Early Pliocene | | |
| 2-2, 142-144 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2, CC | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3-1, 46-48 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4-1, 73-75 | | | | | | | | | | | | | + | | | | | | | | | | + | | | | |
| 4-2, 62-64 | | | | | | | | | | | | | + | | | | | | | + | | | + | | | | |
| 4, CC | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5, CC | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6-1, 42-44 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6-1, 84-86 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6, CC | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7, CC | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8, CC | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9-2, 75-72 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9-2, 133-135 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9, CC (Top) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9, CC (Bottom) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10-1, 46-48 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10-1, 114-117 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10-2, 41-42 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10, CC | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Note: + = Fragments only.

this zone. *Dictyocha mutabilis* was observed in Sample 4, CC only and *Paradictyocha circulus* was observed in 3, CC through 3-2, 80-82 cm. Based on these taxa, Sample 4, CC is assigned to the middle Miocene *Dictyocha mutabilis* Zone and 3, CC through 3-2, 80-82 cm to the late Miocene *Paradictyocha circulus* Zone. A few specimens of *Dictyocha pseudofibula* were found in 2, CC, and thus it is assigned to that zone. All samples above 2, CC through 1-4, 16-18 cm are tentatively placed within the middle Pliocene *Distephanus boliviensis* Zone due to the presence of this species together with the "short-spined" variety of *D. speculum*.

The size of individuals within species varies with depth at this site. Cores 9 through 5 contain very small

silicoflagellates; Cores 4 through 2 contain the same forms almost double in size. Most of Core 1 (1, CC to 1-3) resembles Cores 9 through 5 in size of individuals, but the upper sections (1-2 and 1-1) contain rare but larger forms once again.

Site 324

Silicoflagellates were found only in Core 1 at this site; all the other cores (2 through 9) were barren. Twelve species were recognized and species distributions are noted on Table 4. The presence of *Distephanus boliviensis* together with the "short-spined" variety of *D. speculum* places this core within the mid-Pliocene *D. boliviensis* Zone. The silicoflagellates are small

TABLE 3 – Continued

| Sample (Interval in cm) | Taxa | | | | | | | | | | | Total Whole Specimens | Silicoflagellate Zone | Age |
|----------------------------|--|---|---|---|-------------------------------|--|--|--|--|--|--|-----------------------|--------------------------|-----|
| | <i>Cannopilus ernestinae</i> <i>C. quintus</i> <i>Corbisema bimucronata</i> <i>C. hastata hastata</i> <i>C. triacantha</i> | <i>Dictyocha aspera</i> <i>D. fibula fibula</i> <i>D. fibula perlaevis</i> <i>D. medusa</i> <i>D. mutabilis</i> | <i>D. pseudo-fibula</i> <i>Distephanus boliviensis</i> <i>D. crux</i> <i>D. longispinus</i> <i>D. minutus</i> | <i>D. quinquantellus</i> <i>D. speculum</i> <i>D. speculum s.s.</i> <i>Mesocena apiculata</i> <i>M. diodon</i> <i>M. elliptica</i> | <i>Paradictyocha circulus</i> | | | | | | | | | |
| 10-1, 96-98 | BARREN | | | | | | | | | | | | | |
| 10-2, 103-104 | | | | | | | | | | | | | | |
| 10-3, 67-68 | | | | | | | | | | | | | | |
| 10, CC | | | | | | | | | | | | | | |
| 11-1, 36-38 | | | | | | | | | | | | | | |
| 11-1, 130-132 | | | | | | | | | | | | | | |
| 11-2, 66-68 | | | | | | | | | | | | | | |
| 11, CC | | | | | | | | | | | | | | |
| 12-1, 129-131 | | | | | | | | | | | | | | |
| 12-2, 14-16 | | | | | | | | | | | | | | |
| 12-2, 74-76 | | | | | | | | | | | | | | |
| 12, CC | | | | | | | | | | | | | | |
| 13-1, 104-106 | | | | | | | | | | | | | | |
| 13-5, 83-84 | | | | | | | | | | | | | | |
| 13-6, 31-32 | | | | | | | | | | | | | | |
| 13-6, 108-110 | | | | | | | | | | | | | | |
| 13, CC | | | | | | | | | | | | | | |
| 14-2, 69-71 | | | | | | | | | | | | | | |
| 14-2, 122-124 | | | | | | | | | | | | | | |
| 14, CC | | | | | | | | | | | | | | |
| 15-1, 110-112 | | | | | | | | | | | | | | |
| 15-2, 105-107 | | | | | | | | | | | | | | |
| 15-3, 116-118 | | | | | | | | | | | | | | |
| 15-4, 24-26 | | | | | | | | | | | | | | |
| 15-6, 18-20 | | | | | | | | | | | | | | |
| 15, CC | | | | | | | | | | | | | | |
| 16-1, 37-39 | | | | | | | | | | | | | | |
| 16-1, 94-96 | | | | | | | | | | | | | | |
| 16-2, 40-42 | | | | | | | | | | | | | | |
| 16-2, 90-92 | | | | | | | | | | | | | | |
| 16-3, 90-92 | | | | | | | | | | | | | | |
| 16-4, 57-59 | | | | | | | | | | | | | | |
| 16, CC | | | | | | | | | | | | | | |
| 17-1, 81-83 | | | | | | | | | | | | | | |
| 17, CC | | | | | | | | | | | | | | |
| 18-2, 138-140 | | | | | | | | | | | | | | |
| 18-3, 63-65 | | | | | | | | | | | | | | |
| 18-3, 127-129 | | | | | | | | | | | | | | |
| 18-3, 143-145 | | | | | | | | | | | | | | |
| 18-4, 16-18 | | | | | | | | | | | | | | |
| 18-4, 32-34 | | | | | | | | | | | | | | |
| 18-4, 58-60 | | | | | | | | | | | | | | |
| 18-4, 85-87 | | | | | | | | | | | | | | |
| 18-4, 105-107 | | | | | | | | | | | | | | |
| 18-5, 0-2 | | | | | | | | | | | | | | |
| 18-5, 47-49 | | | | | | | | | | | | | | |
| 18-5, 138-140 | | | | | | | | | | | | | | |
| 18-6, basalt contact | | | | | | | | | | | | | | |

Note: + = fragments only.

TABLE 4
Distribution of Silicoflagellates at Site 324, Middle Pliocene

| Sample (Interval in cm) | Taxa | | | | | | | | | | Silicoflagellate Zone | Age | | |
|----------------------------|-----------------------------|--------------------------|-------------------------|------------------------|--------------------------------|-------------------|----------------------|---------------------|--------------------------|-----------------------|--------------------------|--------------------------------|--|-----------------------|
| | <i>Cannopilus binoculus</i> | <i>Dictyochoa aspera</i> | <i>D. fibula fibula</i> | <i>D. pseudofibula</i> | <i>Distephanus boliviensis</i> | <i>D. minutus</i> | <i>D. octonarius</i> | <i>D. polyactis</i> | <i>D. quinquangellus</i> | <i>D. septenarius</i> | | | <i>D. speculum</i> <i>D. speculum s. s.</i> | Total Whole Specimens |
| 1-1, 143-145 | | | 1 | 7 | 4 | 1 | | 4 | 11 | 24 | 52 | <i>Distephanus boliviensis</i> | Middle Pliocene | |
| 1-2, 53-55 | | | | 3 | 1 | | | | 3 | 7 | 14 | | | |
| 1-2, 138-140 | | | | | | | | | | | | | | |
| 1-3, 30-32 | 3 | | | | | | | | | 12 | 15 | | | |
| 1-3, 82-84 | | 3 | 3 | | 2 | | | 1 | 5 | 9 | 23 | | | |
| 1-3, 134-136 | | | | | | | | | | | | | | |
| 1-4, 34-36 | | | | | | | | | | | | | | |
| 1-4, 68-70 | | | | | | | | | | | | | | |
| 1-5, 28-30 | | | | | 3 | 2 | | | 3 | 13 | 22 | | | |
| 1-5, 86-88 | 1 | | | 3 | | | 1 | 3 | | 10 | 17 | | | |
| 1-5, 127-129 | | | | | | | | | | | | | | |
| 1-6, 17-19 | | | | 2 | | | | 1 | | 2 | 5 | | | |
| 1-6, 53-55 | BARREN | | | | | | | | | | | | | |
| 1-6, 128-130 | BARREN | | | | | | | | | | | | | |
| 1, CC | BARREN | | | | | | | | | | | | | |
| 2-1, 78-80 | BARREN | | | | | | | | | | | | | |
| 2-2, 74-76 | BARREN | | | | | | | | | | | | | |
| 2-2, 146-148 | BARREN | | | | | | | | | | | | | |
| 2-3, 75-77 | BARREN | | | | | | | | | | | | | |
| 2-3, 111-113 | BARREN | | | | | | | | | | | | | |
| 2-4, 77-79 | BARREN | | | | | | | | | | | | | |
| 2-5, 72-74 | BARREN | | | | | | | | | | | | | |
| 2-6, 112-114 | BARREN | | | | | | | | | | | | | |
| 2, CC | BARREN | | | | | | | | | | | | | |
| 3-1, 19-21 | BARREN | | | | | | | | | | | | | |
| 3-1, 101-103 | BARREN | | | | | | | | | | | | | |
| 3-2, 23-25 | BARREN | | | | | | | | | | | | | |
| 3-2, 111-113 | BARREN | | | | | | | | | | | | | |
| 3-3, 49-51 | BARREN | | | | | | | | | | | | | |
| 3-3, 110-112 | BARREN | | | | | | | | | | | | | |
| 3-4, 44-46 | BARREN | | | | | | | | | | | | | |
| 3-4, 119-121 | BARREN | | | | | | | | | | | | | |
| 3-5, 86-88 | BARREN | | | | | | | | | | | | | |
| 3-6, 119-121 | BARREN | | | | | | | | | | | | | |
| 3, CC | BARREN | | | | | | | | | | | | | |
| 4-1, 141-143 | BARREN | | | | | | | | | | | | | |
| 4-2, 22-24 | BARREN | | | | | | | | | | | | | |
| 4-2, 68-70 | BARREN | | | | | | | | | | | | | |
| 4-2, 143-145 | BARREN | | | | | | | | | | | | | |
| 4-3, 50-52 | BARREN | | | | | | | | | | | | | |
| 4-3, 108-110 | BARREN | | | | | | | | | | | | | |
| 4-4, 57-59 | BARREN | | | | | | | | | | | | | |
| 4, CC | BARREN | | | | | | | | | | | | | |
| 5-1, 96-98 | BARREN | | | | | | | | | | | | | |
| 5-2, 94-86 | BARREN | | | | | | | | | | | | | |
| 5-2, 122-123 | BARREN | | | | | | | | | | | | | |
| 5-3, 43-45 | BARREN | | | | | | | | | | | | | |
| 5-3, 89-91 | BARREN | | | | | | | | | | | | | |
| 5, CC | BARREN | | | | | | | | | | | | | |
| 6-1, 100-102 | BARREN | | | | | | | | | | | | | |
| 6-2, 34-36 | BARREN | | | | | | | | | | | | | |
| 6-6, 133-135 | BARREN | | | | | | | | | | | | | |
| 6, CC | BARREN | | | | | | | | | | | | | |
| 7-1, 83-85 | BARREN | | | | | | | | | | | | | |
| 7-2, 114-116 | BARREN | | | | | | | | | | | | | |
| 7-3, 129-131 | BARREN | | | | | | | | | | | | | |
| 7-4, 140-142 | BARREN | | | | | | | | | | | | | |
| 7-6, 141-143 | BARREN | | | | | | | | | | | | | |
| 7, CC | BARREN | | | | | | | | | | | | | |
| 8-2, 129-131 | BARREN | | | | | | | | | | | | | |
| 8-3, 23-25 | BARREN | | | | | | | | | | | | | |
| 8-3, 103-105 | BARREN | | | | | | | | | | | | | |
| 8, CC | BARREN | | | | | | | | | | | | | |
| 9-1, 117-119 | BARREN | | | | | | | | | | | | | |
| 9, CC | BARREN | | | | | | | | | | | | | |

throughout this core, but they tend to be even smaller in the upper part of Core 1.

Site 325

At this site silicoflagellates were recovered only from Cores 2 and 3; Cores 1, and 5 through 9 are barren. Thirteen species from 14 samples are recognized; in some samples silicoflagellates are common (see Table 5). We place Cores 2 and 3 within the mid-Pliocene *Distephanus boliviensis* Zone due to the presence of *D. speculum* of both short- and long-spined varieties. In the lower two samples (Core 3, Section 4, 106-108 and 45-47 cm intervals) the average species size is large, but above this level it reduces considerably and in all samples in 3-2 through 2-1 only small forms were found.

DISCUSSION

Due to the poor sediment recovery and intermittent coring during Leg 35 and the general scarcity of silicoflagellates, we cannot attempt paleoceanographic and paleoclimatological interpretations based on our data. The only factor worth further consideration is the systematic changes in the size of individuals of a species at different levels of the cored sites.

At Site 323 the average specimen is small to intermediate in the middle Miocene, changing to predominantly large specimens in the late Miocene (*Paradictyocha circulus* and *Dictyocha pseudofibula* zones) and returning to forms of reduced size in the middle Pliocene *Distephanus boliviensis* Zone. In this zone at other sites (324 and 325) the average specimen size is also predominantly small diminishing in size in the upper parts of the zone. The reason for such size variations is unknown. However, during periods of smaller average sizes specimens are generally more numerous, and it can be speculated that either these periods represent times of enriched nutrient levels or even possibly higher temperatures. A higher nutrient level may lead to more rapid turnover and average smaller size but greater diversity. If the repeatability of such size variation could be demonstrated elsewhere and its constancy ascertained, this factor may eventually prove to be an important biostratigraphic and paleoecologic tool in the higher latitudes.

TAXONOMIC NOTES

In the next pages we briefly remark on our concepts of the taxa encountered. We have made extensive use of the annotated index of silicoflagellates by Loeblich et al. (1968) for the original descriptions of most of the taxa described before 1967.

Order SIPHONOTESTALES Lemmermann, 1901

Genus CANNOPILUS Haeckel, 1887, emend. Bachmann, 1967

Cannopilus binoculus (Ehrenberg) Lemmermann (Plate 1, Figures 10-12)

Dictyocha binoculus Ehrenberg, 1844, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 83, pl. 8, fig. 8.

Cannopilus binoculus (Ehrenberg) Lemmermann, 1901, Bukry and Foster, 1973, Initial Reports of the Deep Sea Drilling Project, v. 16, p. 825, pl. 1, fig. 1, 2.

Remarks: This species has a large six- or seven-sided basal ring which is symmetric and has radial spines of equal length at each angle. It is characterized by a large apical ring symmetrically divided into two windows by a bar.

Cannopilus ernestinae Bachmann (Plate 1, Figures 1-3)

Cannopilus ernestinae Bachmann, 1962, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 64, pl. 1, fig. 6.

Remarks: One specimen, identified only in side view (see pl. 1, fig. 6, in Loeblich et al., 1968) was observed at Site 323. This species commonly has a pentagonal basal body ring, and five relatively long, straight, perpendicular, lateral rods which rise from slightly to one side of midpoints between five radial spines. Basal accessory spines are absent. The lateral rods support an apical structure of five windows and one or more vertical, apical spines. The five lateral windows, though unequal in size, are generally four times larger than the apical windows. Hexagonal forms of this species occur rarely.

Cannopilus major (Frenguelli)

Dictyocha boliviensis Frenguelli var. *major* Frenguelli, 1951, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 84, pl. 51, fig. 4-6.

Cannopilus major (Frenguelli), Bukry and Foster, 1973, Initial Reports of the Deep Sea Drilling Project, v. 16, p. 826, pl. 1, fig. 4-7.

Remarks: Typically large, *Cannopilus major* has a six- or seven-sided basal ring and is distinguished by a large apical ring with three to seven windows of varying size.

Cannopilus quintus Bukry and Foster

Cannopilus quintus Bukry and Foster, 1973, Initial Reports of the Deep Sea Drilling Project, v. 16, p. 826, fig. 8, 9.

Remarks: Having an essentially symmetric pentagonal basal ring with distal spines at the apices, this species is characterized by a large apical ring divided into four asymmetric openings. A single specimen was found at Site 323.

Genus CORBISEMA Hanna, 1928

Corbisema bimucronata Deflandre (Plate 1, Figure 4)

Corbisema bimucronata Deflandre, 1950, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 75, pl. 5, fig. 8-11.

Corbisema bimucronata Deflandre, Ling, 1972, Am. Paleontol. Bull., v. 62, no. 273, p. 153, pl. 24, fig. 1.

Remarks: The essentially triangular basal ring of this species is sharply truncated at each apex. Short spines occur at each end of the truncations. Basal accessory spines are short but generally present where three lateral rods join the basal ring at midpoints of the sides.

Corbisema hastata hastata (Lemmermann) (Plate 1, Figure 6)

Dictyocha triacantha Ehrenberg var. *hastata* Lemmermann, 1901, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 117, pl. 23, fig. 4, 5.

Corbisema hastata (Lemmermann), Bukry, 1973, Initial Reports of the Deep Sea Drilling Project, v. 21, p. 892, pl. 1, fig. 1.

Corbisema hastata hastata (Lemmermann), Bukry, 1975, Initial Reports of the Deep Sea Drilling Project, v. 29, p. 853, pl. 1, fig. 9.

Remarks: The isosceles form of this species has a distinctively indented basal side with radial spines at each end that are typically aligned with the long sides of the body ring.

Corbisema triacantha (Ehrenberg) (Plate 1, Figure 5)

Dictyocha triacantha Ehrenberg, 1844, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 116, pl. 23, fig. 1.

Corbisema triacantha (Ehrenberg), Hanna, 1931, Bukry and Foster, 1973, Initial Reports of the Deep Sea Drilling Project, v. 16, p. 826, pl. 2, fig. 3.

Corbisema triacantha (Ehrenberg), Mandra, 1968, Calif. Acad. Sci., Proc., ser. 4, v. 36, no. 9, p. 249, fig. 28, 31.

Remarks: The basal ring of *Corbisema triacantha* is triangular with one spine radiating from each of the three apices. Mandra (1968) describes the length of each spine as approximately equal to the length of one side of the triangle. Three bars meeting at the center of the triangle divide the area into three equal parts. These lateral bars rise from the midpoint of each side of the basal ring.

TABLE 5
Distribution of Silicoflagellates at Site 325

| Sample (Interval in cm) | Taxa | | | | | | | | Silicoflagellate Zone | Age | | | | | | |
|----------------------------|-----------------------------|-----------------|--------------------------------|--------------------------------|----------------|-----------------------|-------------------|--------------------------|--------------------------|-----|-----------------------|--------------------|------------------------------|-------------------------------|-------------------------|--|
| | <i>Cannopilus binoculus</i> | <i>C. major</i> | <i>Dictyochoa pseudofibula</i> | <i>Distephanus boliviensis</i> | <i>D. crux</i> | <i>D. longispinus</i> | <i>D. minutus</i> | <i>D. quinquantellus</i> | | | <i>D. septenarius</i> | <i>D. speculum</i> | <i>D. speculum binoculus</i> | <i>D. speculum pseudocrux</i> | <i>D. speculum s.s.</i> | <i>Lyramula tenuipertica var. laevis</i> |
| 1-1, 25-27 | BARREN | | | | | | | | | | | | | | | |
| 1-1, 41-43 | | | | | | | | | | | | | | | | |
| 1-1, 89-91 | | | | | | | | | | | | | | | | |
| 1-1, 123-125 | | | | | | | | | | | | | | | | |
| 1-2, 18-20 | | | | | | | | | | | | | | | | |
| 1-2, 49-51 | | | | | | | | | | | | | | | | |
| 1-2, 89-91 | | | | | | | | | | | | | | | | |
| 1-2, 115-117 | | | | | | | | | | | | | | | | |
| 1-2, 147-149 | | | | | | | | | | | | | | | | |
| 1-3, 13-15 | | | | | | | | | | | | | | | | |
| 1-3, 44-46 | | | | | | | | | | | | | | | | |
| 1-3, 58-60 | | | | | | | | | | | | | | | | |
| 1-3, 104-106 | | | | | | | | | | | | | | | | |
| 1-3, 125-127 | | | | | | | | | | | | | | | | |
| 1-4, 33-35 | | | | | | | | | | | | | | | | |
| 1-4, 96-98 | | | | | | | | | | | | | | | | |
| 1-4, 136-138 | | | | | | | | | | | | | | | | |
| 1-4, 144-146 | | | | | | | | | | | | | | | | |
| 1, CC | | | | | | | | | | | | | | | | |
| 2-1, 142-144 | | | | | | | | | | | | | | | | |
| 2-2, 22-24 | | | 2 | 7 | | 9 | 1 | 4 | 58 | 2 | 1 | 66 | | 150 | | |
| 2-2, 76-78 | 1 | | | | | 1 | | | 2 | | | 2 | | 6 | | |
| 2-2, 112-114 | 1 | | | | 1 | | | | 7 | | 1 | | | 10 | | |
| 2-2, 146-148 | | 1 | 1 | 1 | | 2 | | 4 | | | 2 | | | 10 | | |
| 2, CC | 1 | | | | | | | | 2 | | | | | 3 | | |
| 3-1, 123-125 | | | | | | | | | 3 | | | | | 3 | | |
| 3-2, 43-45 | 2 | 1 | | | | | | | 2 | | | | | 3 | | |
| 3-2, 105-107 | 1 | 1 | 1 | | | 4 | 1 | 6 | | | 4 | | | 18 | | |
| 3-3, 43-45 | 4 | 1 | 5 | | | 10 | 4 | 9 | 44 | 1 | 52 | 1 | | 131 | | |
| 3-3, 103-105 | | | | 2 | | 5 | 1 | 8 | | | 25 | | | 41 | | |
| 3-4, 45-47 | 1 | 6 | 8 | | | 10 | 7 | 9 | 65 | + | 3 | 77 | | 186 | | |
| 3-4, 106-108 | | | 1 | 1 | | 8 | 2 | 12 | 2 | | 13 | | | 39 | | |
| 3, CC | 1 | | 1 | | | 8 | | 12 | | 1 | 16 | | | 39 | | |
| 5-1, 102-104 | BARREN | | | | | | | | | | | | | | | |
| 5, CC | | | | | | | | | | | | | | | | |
| 6, CC | | | | | | | | | | | | | | | | |
| 7-1, 105-140 | | | | | | | | | | | | | | | | |
| 7-2, 51-53 | | | | | | | | | | | | | | | | |
| 7, CC | | | | | | | | | | | | | | | | |
| 8-1, 51-53 | | | | | | | | | | | | | | | | |
| 8-1, 90-92 | | | | | | | | | | | | | | | | |
| 8-1, 118-120 | | | | | | | | | | | | | | | | |
| 8-3, 10-12 | | | | | | | | | | | | | | | | |
| 8, CC | | | | | | | | | | | | | | | | |
| 9, CC | | | | | | | | | | | | | | | | |

Note: + = fragments only.

Genus DICTYOCHA Ehrenberg, 1837

Dictyochoa aspera (Lemmermann)
(Plate 1, Figures 7-9; Plate 2, Figure 6)

Dictyochoa fibula var. *aspera* Lemmermann, 1901, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 90-91, pl. 9, fig. 13, 14.

Dictyochoa aspera (Lemmermann) Bukry and Foster, 1973, Initial Reports of the Deep Sea Drilling Project, v. 16, p. 826, pl. 2, fig. 4-6.

Remarks: *Dictyochoa aspera* characteristically has an apical bar aligned with the short axis of a curving, essentially quadrate, basal ring. Short radial spines delineate the axes and basal accessory spines may or may not be present.

Dictyochoa epiodon Ehrenberg
(Plate 2, Figures 1-3)

Dictyochoa epiodon Ehrenberg, 1844, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 90, pl. 9, fig. 15-17.

Remarks: This species has an eight-sided basal ring with four major opposing spines and four alternate pikes. An apical bar, slightly offset to the long axis of the body ring, is supported by four lateral rods from the basal ring. Four proximally directed pikes generally occur on the body ring, one between each of the lateral struts.

Dictyochoa fibula var. aculeata Lemmermann

Dictyochoa fibula Ehrenberg var. *aculeata* Lemmermann, 1901, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 90, pl. 9, fig. 1, 2.

Remarks: The basal ring of *Dictyochoa fibula* var. *aculeata* is quadrate to octagonal and has four minor radial spines as well as four prominent ones. The apical bar is oriented parallel to the principal axis of the basal ring and characteristically has a vertical apical spine.

Dictyochoa fibula fibula Ehrenberg

Dictyochoa fibula Ehrenberg, 1839, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 90, pl. 9, fig. 7-12.

Dictyochoa fibula fibula Ehrenberg, Bukry, 1975, Initial Reports of the Deep Sea Drilling Project, v. 29, p. 854, pl. 3, fig. 2, 3.

Remarks: The basal ring of this species may be rhomboid to elliptic in outline, but parallel to the longer axis is an apical bar. The axial alignment of the apical bar may be hard to determine in specimens with equilateral frames. For such forms, the longer pair of opposing radial spines can be used as an indication of major axis. Auxiliary distal pikes may or may not be present on the basal ring.

Dictyochoa fibula perlaevis (Frenguelli)
(Plate 2, Figure 4)

Dictyochoa perlaevis Frenguelli, 1951, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 109, pl. 51, fig. 7, 8.

Dictyochoa fibula Ehrenberg, Bukry and Foster, 1973, Initial Reports of the Deep Sea Drilling Project, v. 16, p. 826, pl. 3, fig. 1.

Dictyochoa fibula perlaevis (Frenguelli) Bukry, 1975, Initial Reports of the Deep Sea Drilling Project, v. 29, p. 855, pl. 3, fig. 5.

Remarks: This species is similar to *Dictyochoa fibula fibula*, but is larger and has shorter radial spines. In outline it is distinguished by a pronounced four-lobed basal ring. A simple apical bar, aligned with the long axis, is supported by four lateral rods which join the body ring at the base of each lobe.

Dictyochoa fibula cf. rotundata Schulz
(Plate 2, Figure 5)

Dictyochoa fibula Ehrenberg var. *pentagona* Schulz forma *rotundata* Schulz, 1928, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 96, pl. 12, fig. 15.

Dictyochoa fibula var. *rotundata* (Schulz) Vozzhennikova, 1960, Akad. Nauk SSSR, Sibirskoe Otdel., Tr. Inst. geol. i geofiz., vyp. 1, Voprosy Stratigr. i Paleont. Zapadnoy Sibiri, p. 31, Table 6, p. 60.

Remarks: One small specimen from Site 322 resembled *Dictyochoa fibula* Ehrenberg var. *pentagona* Schulz forma *rotundata* Schulz as illustrated in Loeblich et al., 1968, p. 225, pl. 12, fig. 15. The basal ring is a prolate spheroid, flattened at the poles, having two radial spines midway along each curved side of the long axis. An apical bar aligned

to the long axis is supported by four lateral struts forming an H-shaped apical structure. Basal accessory spines are seen at the base of each strut which originate on the body ring at each end of the flattened polar areas.

Dictyochoa medusa Haeckel

Dictyochoa medusa Haeckel, 1887, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 103, pl. 17, fig. 22, 23.

Remarks: *Dictyochoa medusa* has no apical bar or apical ring. Its four-sided basal ring is conspicuously constricted where four opposed lateral rods rise from it. These four struts meet at a central point to form an X. The direct alignment of opposing struts across the central point distinguishes *D. medusa* from forms of *Dictyochoa aspera* that have a vestigial apical bar.

Dictyochoa mutabilis Deflandre

Dictyochoa mutabilis Deflandre 1950, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 105, pl. 18, fig. 7-14.

Remarks: The basal ring of *Dictyochoa mutabilis* is an elongated ellipse with distinct radial spines at each end of the long axis. An apical bar aligned with the short axis is supported by four short lateral rods which form two small windows between each end of the apical bar and the midpoint of each long curve of the basal ring. These windows may swell the basal ring slightly, and each may have a minor radial spine central to its basal ring side. Two large windows result from the division of the basal ring by the apical structure. Basal accessory spines are rare.

Dictyochoa pseudofibula (Schulz)
(Plate 2, Figure 7)

Distephanus speculum (Ehrenberg) Haeckel forma *pseudofibula* Schulz, 1928, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 123, pl. 25, fig. 12, 13.

Dictyochoa pseudofibula (Schulz) Tsumura var. *complexa* Tsumura, 1963, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 109, pl. 21, fig. 5a, 5b.

Dictyochoa pseudofibula (Schulz) Tsumura, 1963, Bukry and Foster, 1963, Initial Reports of the Deep Sea Drilling Project, v. 16, p. 827, pl. 3, fig. 2, 11.

Remarks: This species has a hexagonal basal ring with a radial spine at each angle. From each facet of the basal ring a strut of varying length rises to support an apical bar, either directly or by joining another to become a single auxiliary lateral rod. A complex apical structure with six openings of varying size and shape results. Basal accessory spines are present.

Genus DISTEPHANUS Stöhr, 1880

Distephanus boliviensis (Frenguelli)
(Plate 2, Figures 8-12)

Dictyochoa boliviensis Frenguelli, 1940, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 83, pl. 9, fig. 3.

Distephanus boliviensis (Frenguelli) Bukry and Foster, 1973, Initial Reports of the Deep Sea Drilling Project, v. 16, p. 827, pl. 4, fig. 1-3.

Remarks: *Distephanus boliviensis* has a large six- or seven-sided basal ring. Radial spines of equal length punctuate each angle of the body outline. Lateral rods from midpoints of each facet of the basal ring support an open apical ring. Proximal pikes, one per facet, usually occur on the basal ring. Bukry and Foster (1973) find characteristic forms most prominent in upper Pliocene samples from DSDP Site 157, but note smaller forms with one pair of opposing radial spines longer than the others (resembling *Distephanus speculum*) to occur in the lower Pliocene and upper upper Miocene.

Distephanus crux (Ehrenberg)
(Plate 3, Figures 1-3)

Dictyochoa crux Ehrenberg, 1940, fide Loeblich et al., 1968, p. 85, pl. 8, fig. 29-32.

Distephanus crux (Ehrenberg) Haeckel, Mandra, 1968, Calif. Acad. Sci., Proc., ser. 4, v. 36, no. 9, p. 254, fig. 59, 64, 81.

Remarks: *Distephanus crux* has a square or rhombic basal ring with four radial spines, one at each apex. One pair of opposite spines is

always longer than the other pair. From the middle of each side, which may be sinuous or rounded, a lateral rod rises to support an apical ring which is frequently square in shape. Basal accessory spines may or may not be present.

***Distephanus longispinus* (Schulz)**

Distephanus crux (Ehrenberg) Haeckel forma *longispina* Schulz, 1928, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 120, pl. 24, fig. 29.

Distephanus longispinus (Schulz) Bukry and Foster, 1973, Initial Reports of the Deep Sea Drilling Project, v. 16, p. 828, pl. 4, fig. 7, 8.

Remarks: *Distephanus longispinus* has a somewhat elliptic, four-sided body ring with an extremely long radial spine at each end of the long axis and two short spines opposite one another punctuating the shorter axis. Four lateral rods, one from the center of each basal side, rise to support a relatively large, square, apical ring.

***Distephanus minutus* (Bachmann)**

(Plate 3, Figures 4, 6)

Dictyocha speculum Ehrenberg forma *minuta* Bachmann in Ichikawa et al., 1967, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 115, pl. 52, fig. 25-39.

Distephanus minutus (Bachmann) Bukry and Foster, 1973, Initial Reports of the Deep Sea Drilling Project, v. 16, p. 828, pl. 4, fig. 10, 11.

Remarks: *Distephanus minutus* has a hexagonal basal ring with six radial spines, one at each apex. Two opposed spines are always longer than the other four. An exceptionally large, hexagonal apical ring distinguishes this species from *Distephanus speculum*. Because of the size of the apical ring, the six lateral rods connecting it to the facets of the body ring are frequently hard to see in apical view.

***Distephanus octonarius* (Ehrenberg)**

(Plate 3, Figure 9)

Dictyocha octonaria Ehrenberg, 1844, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 107, pl. 19, fig. 13.

Distephanus octonarius (Ehrenberg) Haeckel, 1887, Rept. Sci. Results Voyage of H.M.S. *Challenger* during the years 1873-1876, v. 18, p. 1566.

Remarks: An octagonal basal ring with eight radial spines, one at each apex, characterize this species. An apical ring of moderate size, distinguishes *Distephanus octonarius* from *D. octogonus*, which though sometimes eight-sided, may or may not have an apical structure. When present, the apical ring of *D. octogonus* is extremely large.

***Distephanus polyactis* (Ehrenberg)**

Dictyocha polyactis Ehrenberg, 1839, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 109, pl. 19, fig. 9.

Distephanus polyactis (Ehrenberg) Deflandre, 1932, Soc. Bot. France, Bull., v. 79, p. 501, fig. 40.

Distephanus polyactis (Ehrenberg) Ciesielski, 1975, Initial Reports of the Deep Sea Drilling Project, v. 28, pl. 10, fig. 12-17.

Remarks: One specimen resembling the forms chosen by Ciesielski to represent *Distephanus polyactis* was recorded from Site 324.

***Distephanus quinquangellus* Bukry and Foster**

(Plate 3, Figures 5, 8)

Distephanus speculum (Ehrenberg) Haeckel var. *pentagonus* Lemmermann, 1901, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 122, pl. 25, fig. 5.

Distephanus quinquangellus Bukry and Foster, 1973, Initial Reports of the Deep Sea Drilling Project, v. 16, p. 828, pl. 5, fig. 4.

Remarks: *Distephanus quinquangellus* has a symmetric five-sided basal ring with five radial spines, one at each apex. A lateral rod rising from each side of the body ring supports a symmetric pentagonal apical ring. Usually five small, proximally directed pikes occur on the basal ring.

***Distephanus septenarius* (Ehrenberg)**

(Plate 3, Figures 7, 10, 11)

Dictyocha septenaria Ehrenberg, 1844, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 113, pl. 21, fig. 18.

Distephanus septenarius (Ehrenberg) Frenguelli, 1938, La Plata Univ. Nac., Inst. Mus. La Plata, Notas, v. 3, Zool. no. 11, p. 121, fig. 1-3.

Distephanus septenarius (Ehrenberg), Perch-Nielsen, 1975, Initial Reports of the Deep Sea Drilling Project, v. 29, p. 688, pl. 7, fig. 21, 22.

Remarks: This species has a large seven-sided basal ring with a radial spine at each apex. Basal accessory pikes are usually present between seven lateral rods which support an apical ring.

***Distephanus speculum* (Ehrenberg)**

(Plate 3, Figure 12; Plate 4, Figures 1, 3)

Dictyocha speculum Ehrenberg, 1839, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 114, pl. 24, fig. 1-10.

Distephanus speculum (Ehrenberg) Haeckel, 1887, Rept. Sci. Results Voyage of H.M.S. *Challenger* during the years 1873-1876, v. 18, p. 1565.

Remarks: *Distephanus speculum* has a hexagonal basal ring, two opposing radial spines that are longer than the other four, and an apical ring of moderate proportions. Forms of *D. speculum* with six radial spines of approximately equal length have been tabulated as *D. speculum s. s.* (Plate 4, Figures 2, 5).

***Distephanus speculum binoculus* (Ehrenberg)**

Dictyocha binoculus Ehrenberg, 1844, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 83, pl. 8, fig. 8.

Distephanus speculum binoculus (Ehrenberg) Bukry, 1975, Initial Reports of the Deep Sea Drilling Project, v. 29, p. 855.

Remarks: An apical ring divided into two relatively equal windows distinguishes *Distephanus speculum binoculus* from *Distephanus speculum*. Both species have two opposing radial spines that are longer than the other four.

***Distephanus speculum* var. *pseudocrux* Schulz**

(Plate 4, Figure 6)

Distephanus speculum (Ehrenberg) Haeckel forma *pseudocrux* Schulz, 1928, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 122, pl. 25, fig. 14-16.

Distephanus speculum var. *pseudocrux* (Schulz) Tsumura, 1963, Yokohama Municipal Univ., J. C-45, no. 146, expl. pl. 12, fig. 2, 3.

Remarks: Ling (1972, p. 218, pl. 27, Fig. 5-7) shows this form with five- or six-sided basal rings. It is distinguished by the complex structure of lateral rods which supports a small apical window. From each facet of the basal ring a strut of varying length rises either directly to the window or joins another to become a single lateral support. Lateral windows are thus of various sizes and shapes.

Genus LYRAMULA Hanna, 1928

***Lynamula tenuipertica* var. *laevis* Tsumura**

(Plate 4, Figures 4, 7)

Lynamula tenuipertica Kokubo and Tsumura in Tsumura, var. *laevis* Tsumura, 1963, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 126, pl. 26, fig. 8a, 8b.

Remarks: The outline of this form is essentially V-shaped with a very small spine at the apex. It has long, slender, slightly undulate bars, the surface of which are quite smooth.

Genus MESOCENA Ehrenberg, 1843

***Mesocena apiculata* (Schulz)**

(Plate 4, Figures 10, 12)

Mesocena oamaruensis Schulz var. *apiculata* Schulz, 1928, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 129, pl. 28, fig. 6.

Mesocena apiculata (Schulz) Hanna, 1931, Mining in Calif., p. 198, pl. D, fig. 3.

Remarks: *Mesocena apiculata* is triangular in outline, varying in form from equilateral to isosceles, with sides either straight or somewhat bowed. The specimens found at Sites 322 and 323 had septae at the apices.

Mesocena diodon Ehrenberg

Mesocena diodon Ehrenberg, 1844, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 128, pl. 27, fig. 4.

Remarks: This species is elliptical in outline and has a distal spine at opposing ends of the major axis of the body ring.

Mesocena elliptica (Ehrenberg)

Dictyocha (Mesocena) elliptica Ehrenberg, 1840, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 89, pl. 8, fig. 25-26.

Mesocena elliptica (Ehrenberg) Ehrenberg, 1844, Ber. Verh. K. Preuss. Akad. Wiss. Berlin, p. 71, 84.

Remarks: The body ring of *Mesocena elliptica* varies in outline from rhomboid to circular. Four distally directed spines at the apices of rhomboid forms or symmetrically 90° apart on circular forms distinguish the species. The surface of the body ring may be smooth or ornamented by irregularly spaced pikes.

Mesocena elliptica var. triangula Bachmann and Ichikawa
(Plate 4, Figure 11)

Mesocena elliptica (Ehrenberg) Ehrenberg var. *triangula* Bachmann and Ichikawa, 1962, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 128, pl. 27, fig. 12, 13.

Remarks: This species has an elliptical body ring but is distinguished by having only three radial spines, two opposed at ends of the long axis and one punctuating one end of the short axis.

Genus PARADICTYOGA Frenguelli, 1940

Paradictyocha apiculata (Lemmermann)

Mesocena circulus (Ehrenberg) Ehrenberg var. *apiculata* Lemmermann, 1901, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 127, pl. 27, fig. 3a, 3b.

Paradictyocha apiculata (Lemmermann) Frenguelli, 1940, Rev. Mus. La Plata, ser. 2, v. 2, Paleontol. no. 7, p. 52, pl. 4, fig. 4.

Remarks: For synonymy and discussion of the species see Dumitrica (1973). One specimen of this form was found at Site 322.

Paradictyocha circulus (Ehrenberg)

(Plate 4, Figures 8, 9)

Dictyocha (Mesocena) circulus Ehrenberg, 1840, fide Loeblich et al., 1968, Geol. Soc. Am. Mem. 106, p. 84, pl. 8, fig. 20.

Paradictyocha circulus (Ehrenberg) Dumitrica, 1973, Initial Reports of the Deep Sea Drilling Project, v. 21, p. 853, pl. 9, fig. 7-10.

Remarks: *Paradictyocha circulus* is a simple circular or polygonal ring with 18-25 short, radial spines lying in the plane of the basal ring. The surface of the body has many scattered, minute thorns.

Paradictyocha dumitricae Perch-Nielsen

Paradictyocha dumitricae Perch-Nielsen, 1975, Initial Reports of the Deep Sea Drilling Project, v. 29, p. 689, pl. 11, fig. 1, 5-8.

Remarks: This species is polygonal in outline and has short, radial spines of equal length at each angle of its body ring. Specimens with 11-21 such spines have been reported. Lateral spines are absent in this form.

ACKNOWLEDGMENTS

We wish to thank the scientific party onboard *Glomar Challenger* Leg 35, especially F. Rögl, H.J. Schrader, and F.M. Weaver for their support. Most of the samples studied were provided by F.M. Weaver. P. Ciesielski made available his unpublished silicoflagellate zonation of DSDP Leg 28. We benefited from our discussions with L.H. Burckle. This paper was reviewed by D.A. Johnson and G.P. Lohmann. This is Woods Hole Oceanographic Institution Contribution 3565.

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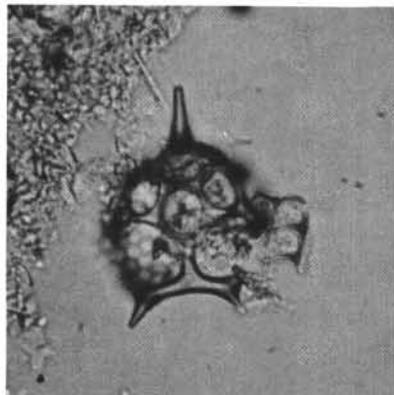
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PLATE 1

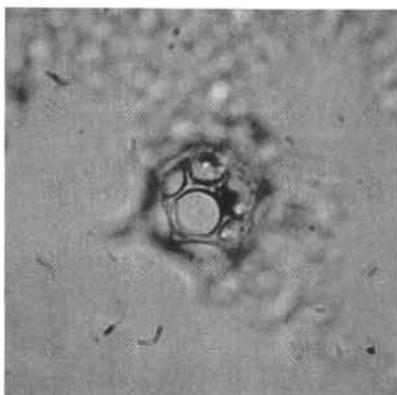
Silicoflagellates from DSDP Leg 35
(Figures 1-9, 11, and 12 magnified 500 ×,
Figure 10 magnified 625 ×)

- Figures 1-3 *Cannopilus ernestinae* Bachmann.
1-3. Sample 323-3-2, 130-132 cm.
2, 3. High and low focus on single specimen.
- Figure 4 *Corbisema bimucronata* Deflandre.
Sample 323-3, CC.
- Figure 5 *Corbisema triacantha* (Ehrenberg). Sample 323-6,
CC.
- Figure 6 *Corbisema hastata hastata* (Lemmermann).
Sample 323-3, CC.
- Figures 7-9 *Dictycha aspera* (Lemmermann).
7. Sample 34-1-3, 82-84 cm.
8. Sample 323-2-1, 65-67 cm.
9. Sample 322-1-2, 114-116 cm.
- Figures 10-12 *Cannopilus binoculus* (Ehrenberg) Lemmermann.
10. Sample 325-3-4, 45-47 cm.
11. Sample 324-1-3, 30-32 cm.
12. Sample 322-1-3, 90-92 cm.

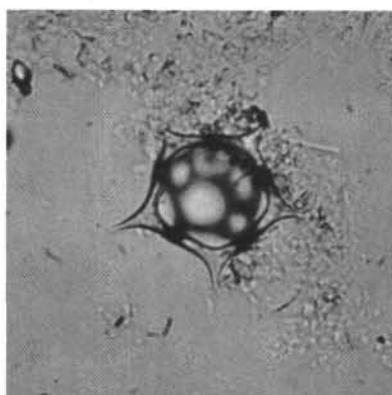
PLATE 1



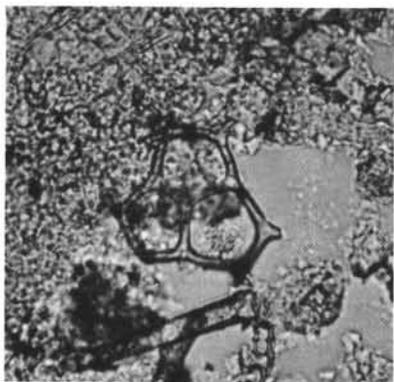
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2



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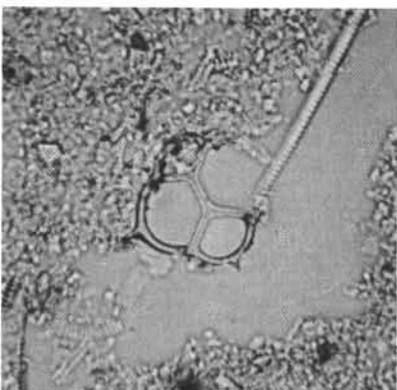
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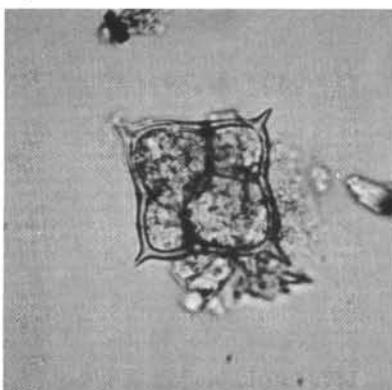
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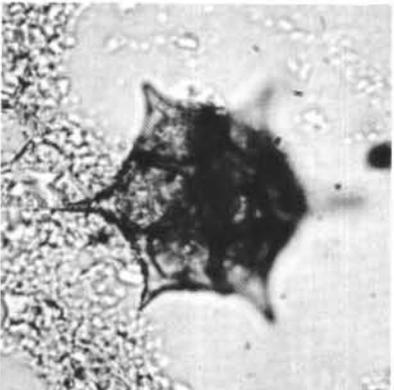
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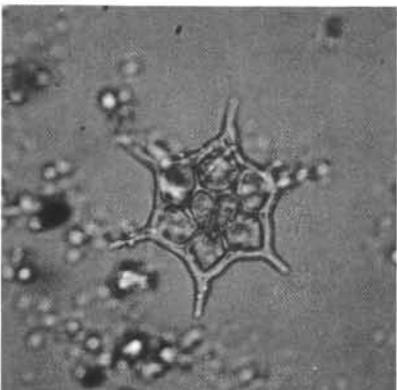
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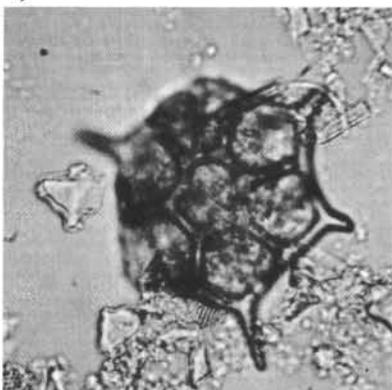
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10



11



12

PLATE 2

Silicoflagellates from DSDP Leg 35
(Magnification 500 ×)

- Figures 1-3 *Dictyocha epiodon* Ehrenberg. Sample 322-1-1, 78-80 cm.
- Figure 4 *Dictyocha fibula perlaevis* (Frenguelli). Sample 323-2-1, 65-67 cm.
- Figure 5 *Dictyocha fibula* cf. *rotundata* Schulz.
Sample 322-1-1, 78-80 cm.
- Figure 6 *Dictyocha aspera* (Lemmermann). Sample 323-3, CC.
- Figure 7 *Dictyocha pseudofibula* (Schulz).
Sample 322-1-2, 114-116 cm.
- Figures 8-12 *Distephanus boliviensis* (Frenguelli).
8. Sample 324-1-1, 143-145 cm.
9, 12. Sample 325-3, CC. High and low focus on single specimen.
10. Sample 322-2-2, 97-99 cm.
11. Sample 323-2-1, 65-67 cm.

PLATE 2

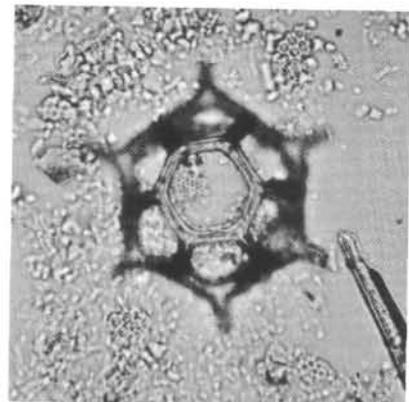
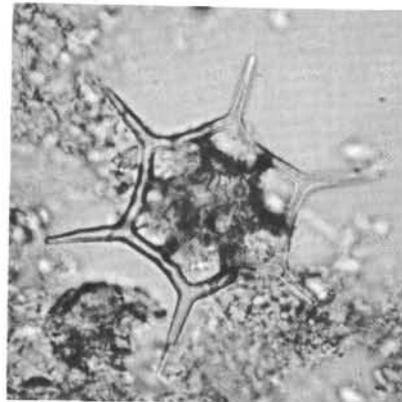
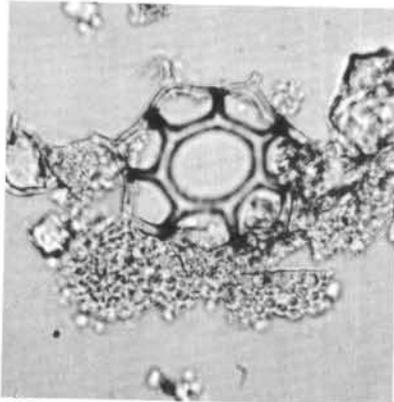
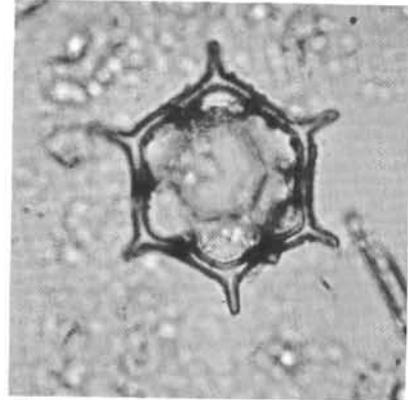
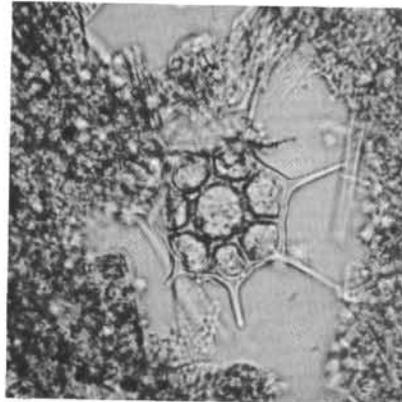
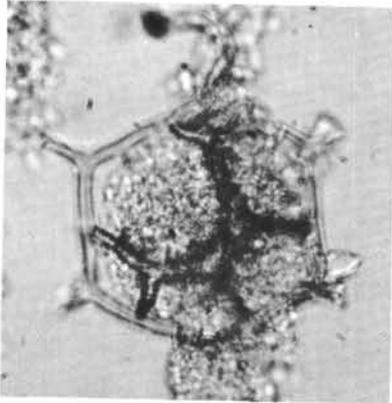
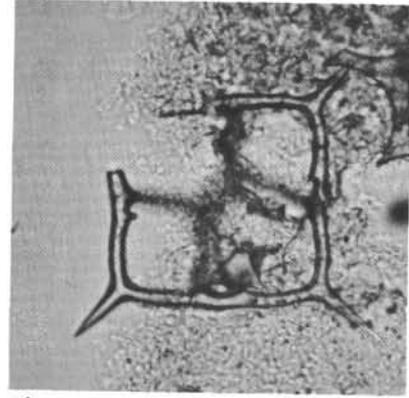
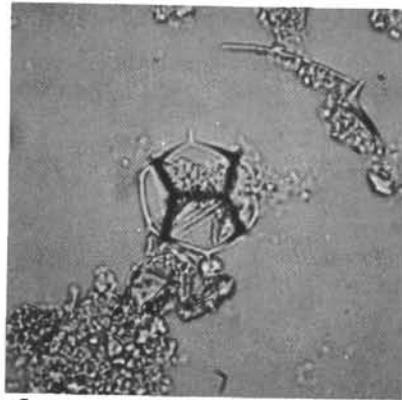
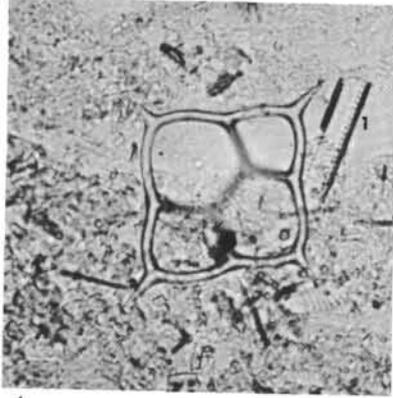
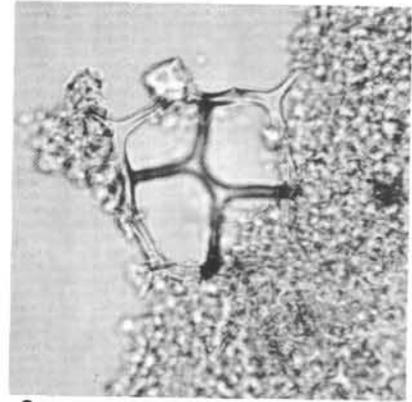
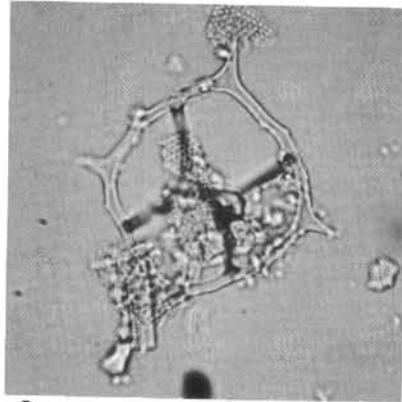
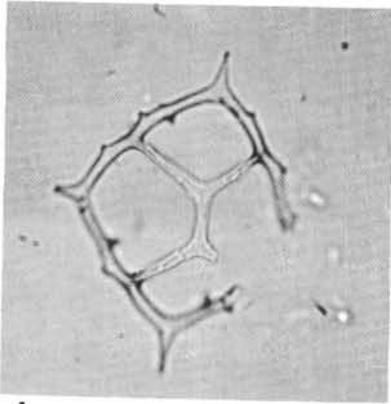
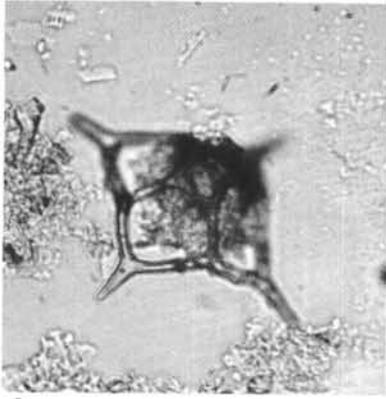


PLATE 3

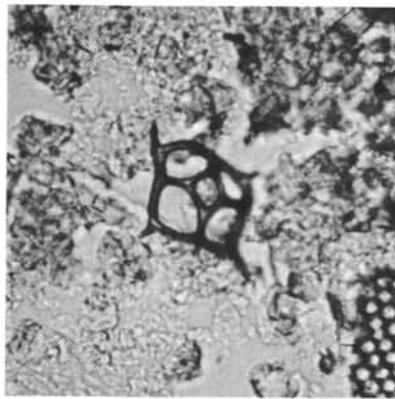
Silicoflagellates from DSDP Leg 35
(Figures 1-7 and 9-12 magnified 500 × Figure 8, magnified 625 ×)

- Figures 1-3 *Distephanus crux* (Ehrenberg).
1. Sample 323-6, CC.
2. Sample 323-3, CC.
3. Sample 323-7-1, Green.
- Figures 4, 6 *Distephanus minutus* (Bachmann).
4. Sample 325-3-4, 45-47 cm.
6. Sample 324-1-1, 143-145 cm.
- Figures 5, 8 *Distephanus quinquangellus* Bukry and Foster.
5. Sample 324-1-6, 17-19 cm.
8. Sample 324-1-5, 86-88 cm.
- Figures 7, 10, 11 *Distephanus septenarius* (Ehrenberg).
7. Sample 325-3-2, 105-107 cm.
10, 11. Sample 322-2-2, 97-99 cm. High and low focus on single specimen.
- Figure 9 *Distephanus octonarius* (Ehrenberg).
Sample 322-2-2, 97-99 cm.
- Figure 12 *Distephanus speculum* (Ehrenberg).
Sample 325-3, CC

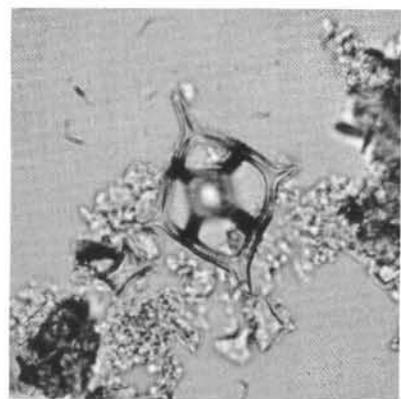
PLATE 3



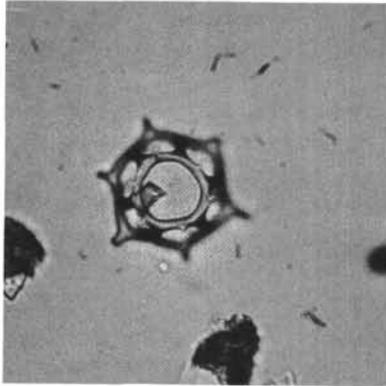
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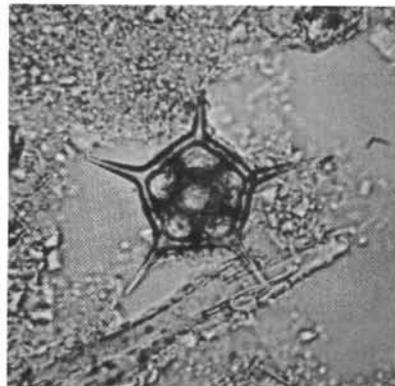
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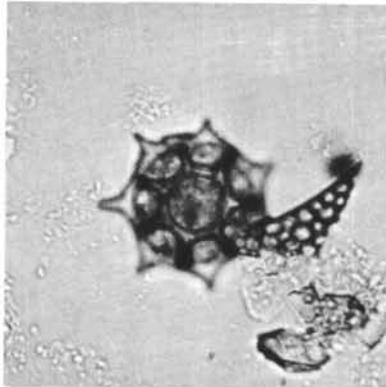
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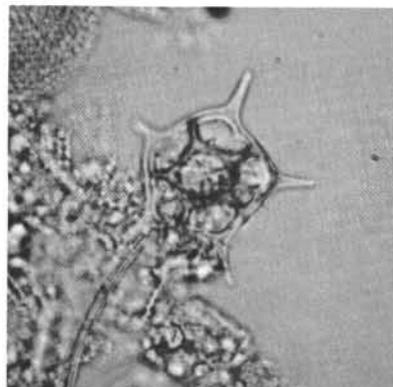
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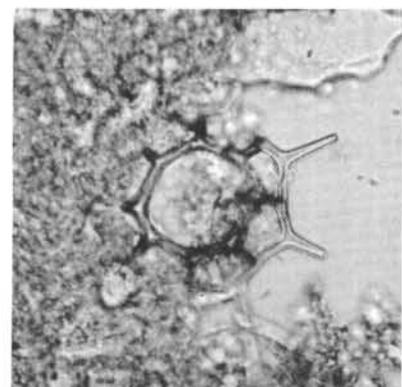
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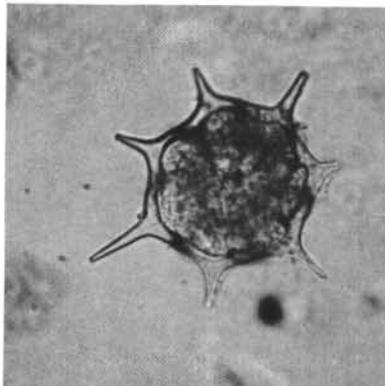
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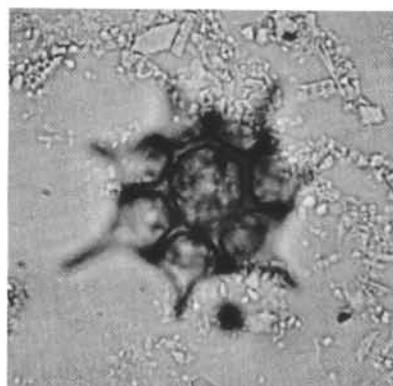
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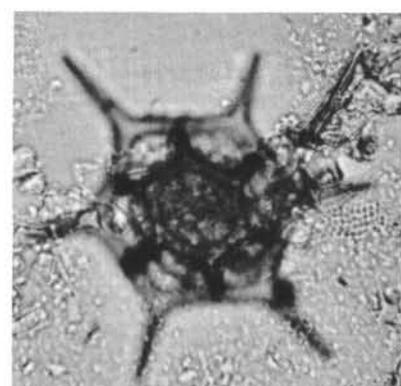
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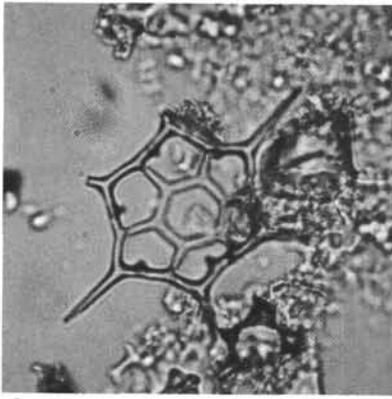
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PLATE 4

Silicoflagellates from DSDP Leg 35 (Magnification 500 ×)

- Figures 1, 3 *Distephanus speculum* (Ehrenberg).
1. Sample 323-2-1, 65-67 cm.
3. Sample 322-2-2, 97-99 cm.
- Figures 2, 5 *Distephanus speculum* s.s.
2. Sample 324-1-2, 53-55 cm.
5. Sample 324-1-1, 143-145 cm.
- Figures 4, 7 *Lynamula tenuipertica* var. *laevis* Tasmura.
Sample 322-2-2, 97-99 cm.
- Figure 6 *Distephanus speculum* var. *pseudocrux* Schulz.
Sample 322-1-2, 114-116 cm.
- Figures 8, 9 *Paradictyocha circulus* (Ehrenberg).
8. Sample 322-2-2, 97-99 cm.
9. Sample 322-1-3, 19-21 cm.
- Figures 10, 12 *Mesocena apiculata* (Schulz).
10. Sample 323-3, CC.
12. Sample 323-3-2, 80-82 cm.
- Figure 11 *Mesocena elliptica* var. *triangula* Bachmann and
Ichikawa.
Sample 322-1-2, 114-116 cm.

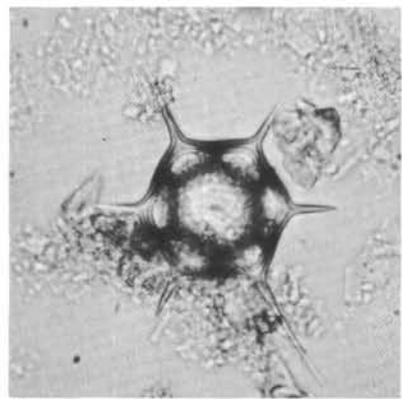
PLATE 4



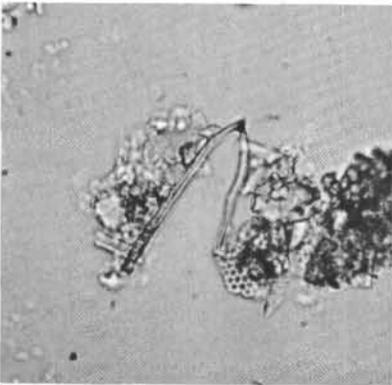
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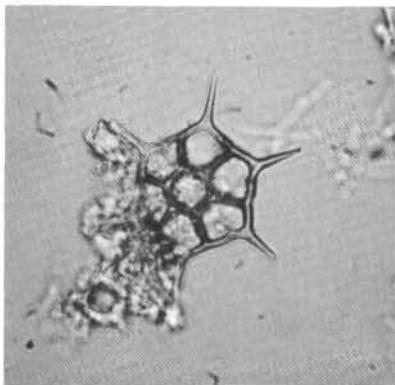
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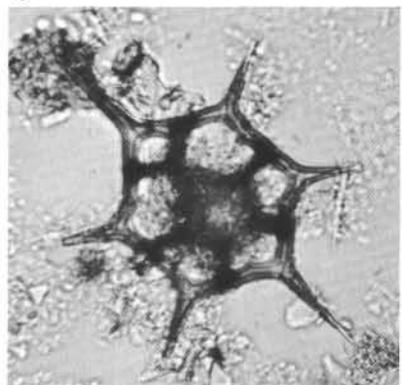
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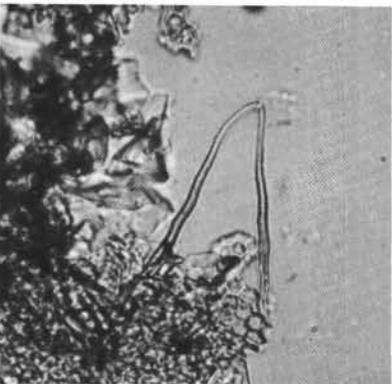
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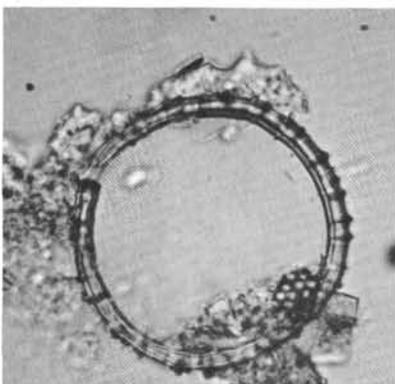
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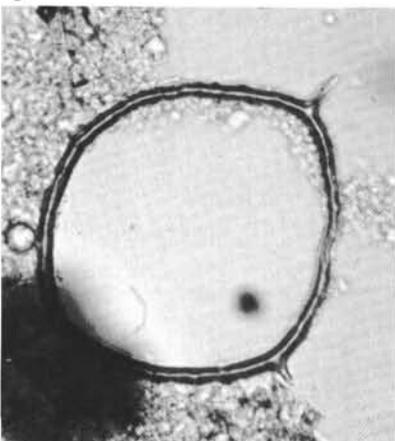
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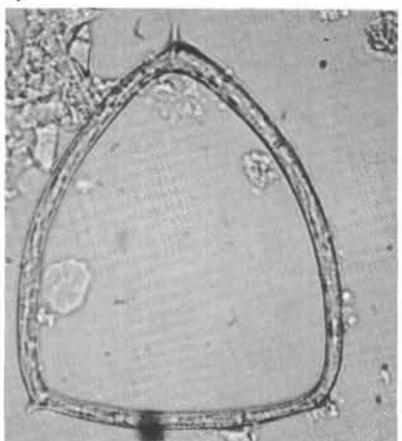
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