34. NEOGENE SILICOFLAGELLATES FROM THE EQUATORIAL PACIFIC

Erlend Martini,
Geologisch-Paläontologisches Institut der Universität Frankfurt a.M., Germany

INTRODUCTION

A certain stratigraphic value of silicoflagellates has been demonstrated earlier by Stradner (1961), Bachmann and Papp (1968) and Martini (in press), but investigations were based mainly on isolated samples. During Leg 7 of the Deep Sea Drilling Project, two continuous sequences from the Miocene to Quaternary, which contain silicoflagellates besides abundant Radiolaria and diatoms, have been recovered at Sites 65 and 66 in the equatorial Pacific. In addition to the Miocene-Pliocene samples of the Swedish Deep-Sea Core 76, material from continuous sequences can be used for the first time to test the stratigraphic value of silicoflagellates. Although the assemblages show a rather limited number of species due to the equatorial position of the cores, there are some indications of a stratigraphic value of silicoflagellates even in this exceptional region.

LOCALITIES AND STRATA RECOVERED

Geographical positions of the DSDP-holes and of the Swedish deep sea core are the following (Figure 1):

DSDP 65-0	lat. 4° 21.21′N, long. 176° 59.16′E (J 65).
DSDP 66-0 and 66-1	lat. 2° 23.63′N, long. 166° 07.28′W (J 66).
SDSE 76	lat. 3° 45′N, long. 149° 44′W (S 76).

In Hole 65-0 the terminal depth was 145 meters, and a continuous siliceous sequence from the Quaternary to the Lower Miocene has been sampled down to 89 meters for silicoflagellates. In Hole 66-1 the terminal depth was 86 meters, and the whole siliceous sequence from the Quaternary to the Middle Miocene has been sampled. Selected samples of Cores 1 and 2 of Hole 66-0 have been added for comparison. In the Swedish Deep Sea Core 76 a depth of 13.5 meters was reached, and 16 samples have been selected from the Upper Miocene-Pliocene and lower Middle Miocene siliceous-calcareous sequence.

SILICOFLAGELLATE ZONATION IN THE EQUATORIAL PACIFIC

Four different silicoflagellate assemblages have been identified in the material studied. At present the following zones can be used only in the equatorial region of the Pacific for identifying silicoflagellate samples, but some indications of long-distance correlations will be discussed below.

Mesocena quadrangula Zone

Definition: Interval above the first occurrence of *Mesocena quadrangula* Ehrenberg ex Haeckel.

Type locality: DSDP Hole 66-1, lat. 2° 23.63′N, long. 166° 07.28′W, sample from Core 1, Section 2-top.

Common species: *M. quadrangula* Ehrenberg ex Haeckel and *Dictyocha fibula* Ehrenberg, rare *Dictyocha rhombica* (Schultz), *Dictyocha speculum* Ehrenberg, and near the base *Dictyocha pentagona* (Lemmermann).

Stratigraphic position: Upper Pliocene to Recent.

Remarks: As discussed below, the lower boundary is within the *Spongaster pentas* Zone of the radiolarian zonation, and probably within NN 15 of the calcareous nannoplankton zonation.

Dictyocha fibula Zone

Definition: Interval from the *Dictyocha fibula/Dictyocha rhombica* datum to the first occurrence of *Mesocena quadrangula* Ehrenberg ex Haeckel.

Type locality: DSDP Hole 66-1, lat. 2° 23.63′N, long. 166° 07.28′W, sample from Core 4, Section 5 at 75 to 76 centimeters.

Common species: *Dictyocha fibula* Ehrenberg, less common *Dictyocha speculum* Ehrenberg, *Dictyocha rhombica* (Schulz), occasionally *Dictyocha medusa* Haeckel, *Dictyocha crux* Ehrenberg, *Dictyocha pentagona* (Lemmermann), and near the top *Mesocena circulus* (Ehrenberg).

Stratigraphic position: Upper Miocene to Lower Pliocene.

Remarks: As discussed below, the lower boundary is within the *Ommatartus antepenultimus* Zone of the radiolarian zonation and probably within NN 9 or basal NN 10 of the calcareous nannoplankton zonation.

Dictyocha rhombica Zone

Definition: Interval from the last occurrence of *Corbisema triacantha* (Ehrenberg) to the *Dictyocha fibula/Dictyocha rhombica* datum.

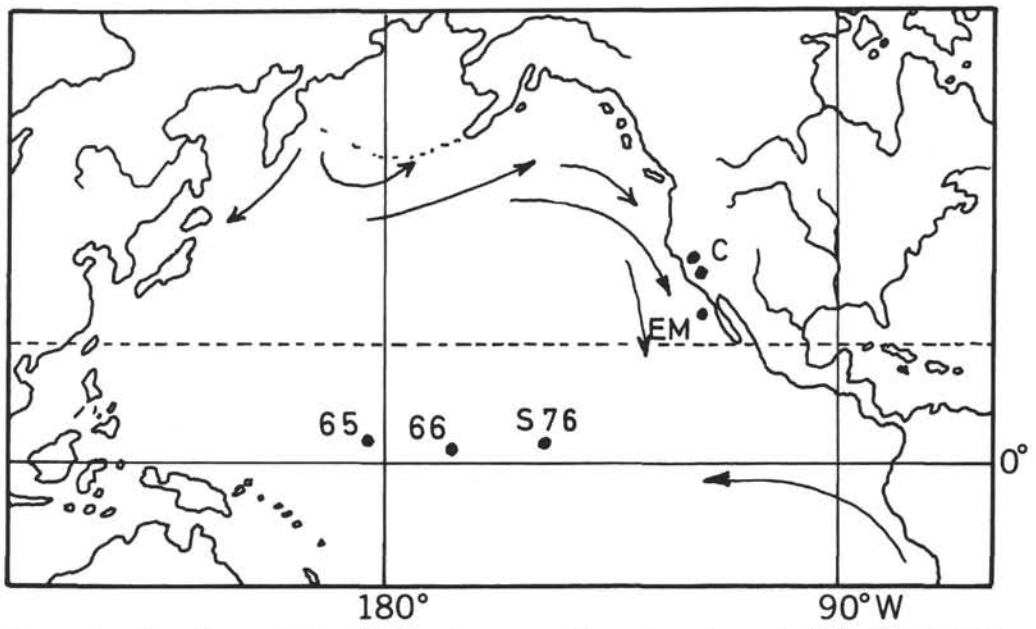


Figure 1. *Sites from which silicoflagellate assemblages have been studied. C = various localities in California; EM = experimental Mohole drilling; J 65 = DSDP Site 65; J 66 = DSDP Site 66; S 76 = Swedish Deep Sea Expedition Core 76.*

Type locality: DSDP Hole 66.1, lat. 2° 23.63′N, long. 166° 07.28′W, sample from Core 5, Section 2 at 75 to 76 centimeters.

Common species: *Dictyocha rhombica* (Schulz), less common *Dictyocha speculum* Ehrenberg, *Dictyocha fibula* Ehrenberg, occasionally *Dictyocha medusa* Haeckel, *Dictyocha crux* Ehrenberg, and *Dictyocha pentagona* (Lemmermann).

Stratigraphic position: Upper part of Middle Miocene

Remarks: As discussed below the lower boundary is in the uppermost part of the *Dorcadospyris alata* Zone or lowest part of the *Cannartus* (?) *petterssoni* Zone of the radiolarian zonation, and probably in the higher part of NN 6 of the calcareous nannoplankton zonation.

Corbisema triacantha Zone

Definition: Lower boundary as yet unknown, upper boundary is the last occurrence of *Corbisema triacantha* (Ehrenberg).

Type locality: DSDP Hole 66-1, lat. 2° 23.63′N, long. 166° 07.28′W, sample from Core 7, Section 5 at 75 to 76 centimeters.

Common species: *Dictyocha rhombica* (Schulz), less common *Dictyocha fibula* Ehrenberg, *Dictyocha medusa* Haeckel, *Dictyocha crux* Ehrenberg, *Corbisema triacantha* (Ehrenberg), and in the upper part *Dictyocha octacantha* (Desikachary and Maheshwari).

Stratigraphic position: Lower Miocene (?) to lower part of Middle Miocene.

Remarks: Lower boundary unknown, therefore no relations to other zonations known.

SPECIES PRESENT AND DISCUSSION OF VARIANTS

The systematic paleontology of the silicoflagellates is in a highly confused state due to the narrow variation limit used by many authors and to an overemphasizing of aberrant forms. Therefore, it seems necessary to add photographs of the species found and to indicate some variations. Species present in the cores are:

Corbisema triacantha (Ehrenberg 1844) Deflandre 1940–Plate 1, Figure 1

Mesocena quadrangula Ehrenberg ex Haeckel 1887–Plate 1, Figure 2

Dictyocha medusa Haeckel 1887–Plate 1, Figure 3

Dictyocha fibula Ehrenberg 1839 s.l.–Plate 1, Figures 4 through 7

Dictyocha rhombica (Schulz 1928) Deflandre 1941 s.l.–Plate 1, Figures 8, 9 and 10

Dictyocha crux Ehrenberg 1840 s.l.–Plate 1, Figure 11

Dictyocha pentagona (Lemmermann 1901) nov. comb.–Plate 1, Figure 12

Dictyocha speculum Ehrenberg 1839–Plate 1, Figures 13 and 14

Dictyocha octagona Tsumura 1963–Plate 1, Figure 15

Dictyocha octacantha Desikachary and Maheshwari 1956) nov. comb–Plate 1, Figure 16

Mesocena circulus (Ehrenberg 1840) Ehrenberg 1844

D. fibula Ehrenberg, *D. rhombica* (Schulz) and *D. crux* Ehrenberg show at some levels a great variety, but all gradiations may be found in large populations. In this and in an earlier paper (Martini, in press) the name *D. fibula* is used only for forms with a vertical apical bar, and *D. rhombica* for forms with a horizontal apical bar. Both names are used otherwise in a broad sense as indicated by the "s.l.". In both species very large specimens occur throughout the sections, but are common in the *Mesocena quadrangula* Zone for *D. fibula* s.l., whereas large specimens of *D. rhombica* s.l. occur mainly in the *D. rhombica* Zone and higher *C. triacantha* Zone, grading to forms similar to *Dictyocha mutabilis* Deflandre 1950 and *Dictyocha ausonia* Deflandre 1950 (Plate 1, Figures 9 and 10). *D. speculum* Ehrenberg commonly is robust, but in the lower part of the *Dictyocha fibula* Zone of Hole 65-0 most specimens are delicate (Plate 1, Figure 14) and the apical ring is broken or missing in many specimens, similar to forms called *Dictyocha aculeata* Ehrenberg (Loeblich *et al.*, 1968, Plate 8, Figure 3). The species listed here as *Mesocena circulus* (Ehrenberg) is the same as *Mesocena apiculata* in Martini (in press), namely *Mesocena circulus* var. *apiculata* Lemmermann 1901. According to Loeblich *et al.* (1968) *Mesocena apiculata* has already been used by Hanna in 1931 (Basionym: *Mesocena oamaruensis* var. *apiculata* Schulz) and is not available.

SILICOFLAGELLATE ASSEMBLAGES AND DISCREPANCIES IN CORES RECOVERED

The silicoflagellates found in the samples of Holes 65-0, 66-0, 66-1 and Core S 76 are listed in extensive range charts, and assignment to the silicoflagellate zones is shown in Figures 2 and 3. Some discrepancies, though not all obvious, need discussion.

The most obvious discrepancy occurs in Hole 65-0 at the *Dictyocha fibula–Dictyocha rhombica* datum (base Core 6 and top Core 7). In the core-catcher sample of Core 6 *D. rhombica* out-numbers *D. fibula,* but in a sample of Core 7, Section 1-top the predominance is reversed, and is again normal in the next lower sample (Core 7, Section 2, 75 to 76 centimeters). As shown in Figure 2 there is an uncored interval between Core 6 and Core 7, and the top of Core 7 probably represents broken-in material from above. Similar core-catcher Sample 66-0-1-CC and Core 2, Section 1 seem to be contaminated from above. Contamination obviously occurs also in Hole 66-1-4-1, where is a sample at 108 to 109 centimeters single specimens of *Mesocena quadrangula* Ehrenberg ex Haeckel and *Dictyocha octacantha* (Desikachary and Maheshwari) have been found together. *M. quadrangula* is restricted to the *M. quadrangula* Zone, and *D. octacantha* seems to occur only in the upper part of the *Corbisema triacantha* Zone (*D. octacantha* Horizon).

The single occurrence of *Dictyocha octagona* Tsumura in Hole 66-1-5, shown as *D. octagona* Horizon in Figure 2, may prove to be contamination, but a single specimen has been found in a similar stratigraphic position in the experimental Mohole drilling (EM 8-14: 100 centimeters).

In the Swedish Deep sea Core 76 and the *D. fibula–D. rhombica* datum is between 509.5 and 525.0 centimeters, but diatoms (Kanaya, in press) and calcareous nannoplankton indicate also a missing interval about this level. According to cross-correlation by calcareous nannoplankton and Radiolaria the lowest part of Core 76 may belong in the *Corbisema triacantha* Zone, but *C. triacantha* has not been found as yet.

DISCUSSION OF WATER TEMPERATURES

Yanagisawa (1943) indicated a relationship between water temperature and the occurrence of *D. fibula* and *D. speculum*, based on observations in recent ocean waters. Slightly modified, this ratio reads:

Dictyocha fibula	:	*Dictyocha speculum*	= water temperature
1	:	12	0°- 5° C
1	:	4	5°-10° C
1	:	2	10°-15° C
1	:	1, 5	15°-20° C
2	:	1	20°-25° C
21	:	1	25°-30° C

No indication has been given as to the use of the name *D. fibula* by Yanagisawa, and may include forms called *D. rhombica* in this paper, and is used exceptionally to include *D. rhombica*, but only for determination of water temperatures.

According to these values the water temperature in the Upper Miocene–Lower Pliocene part of Core S 76 shows a slight decrease from more than 25° C to about 20° C upwards. All ratios found in samples of DSDP Holes 65-0, 66-0 and 66-1 indicate a water temperature above 25° C from Middle Miocene onwards in this area, with the exception of 66-0-1-2-top and 66-0-1-CC which indicate a water temperature of about 20° C.

COMPARISON WITH THE RADIOLARIAN ZONATION AND THE CALCAREOUS NANNOPLANKTON ZONATION

In the DSDP Sites 65 and 66 comparison of the silicoflagellate zonation with the detailed radiolarian zona-

PLATE 1

All specimens approximately X 500

Figure 1 — *Corbisema triacantha* (Ehrenberg) DSDP 66-1-7-5, 75-76 cm, *C. triacantha* Zone.

Figure 2 — *Mesocena quadrangula* Ehrenberg ex Haeckel DSDP 66-1-1-2-top, *M. quadrangula* Zone.

Figure 3 — *Dictyocha medusa* Haeckel DSDP 66-0-1-4-top, *D. rhombica* Zone.

Figures 4-7 — *Dictyocha fibula* Ehrenberg s.l.
4. DSDP 66-1-4-1, 108-109 cm, *D. fibula* Zone.
5. DSDP 66-1-1-2, top, *M. quadrangula* Zone.
6. DSDP 66-1-4-1, 108-109 cm, *D. fibula* Zone.
7. DSDP 66-1-3-3, 75-76 cm, *D. fibula* Zone.

Figures 8-10 — *Dictyocha rhombica* (Schulz) s.l.
8. DSDP 66-1-5-1, 75-76 cm, *D. rhombica* Zone.
9. DSDP 66-1-7-5, 75-76 cm, *C. triacantha* Zone.
10. DSDP 66-1-4-1, 108-109 cm, *D. fibula* Zone.

Figure 11 — *Dictyocha crux* Ehrenberg s.l. DSDP 66-0-1-CC, *D. rhombica* Zone.

Figure 12 — *Dictyocha pentagona* (Lemmermann) DSDP 66-1-2-2, 75-76 cm, *M. quadrangula* Zone.

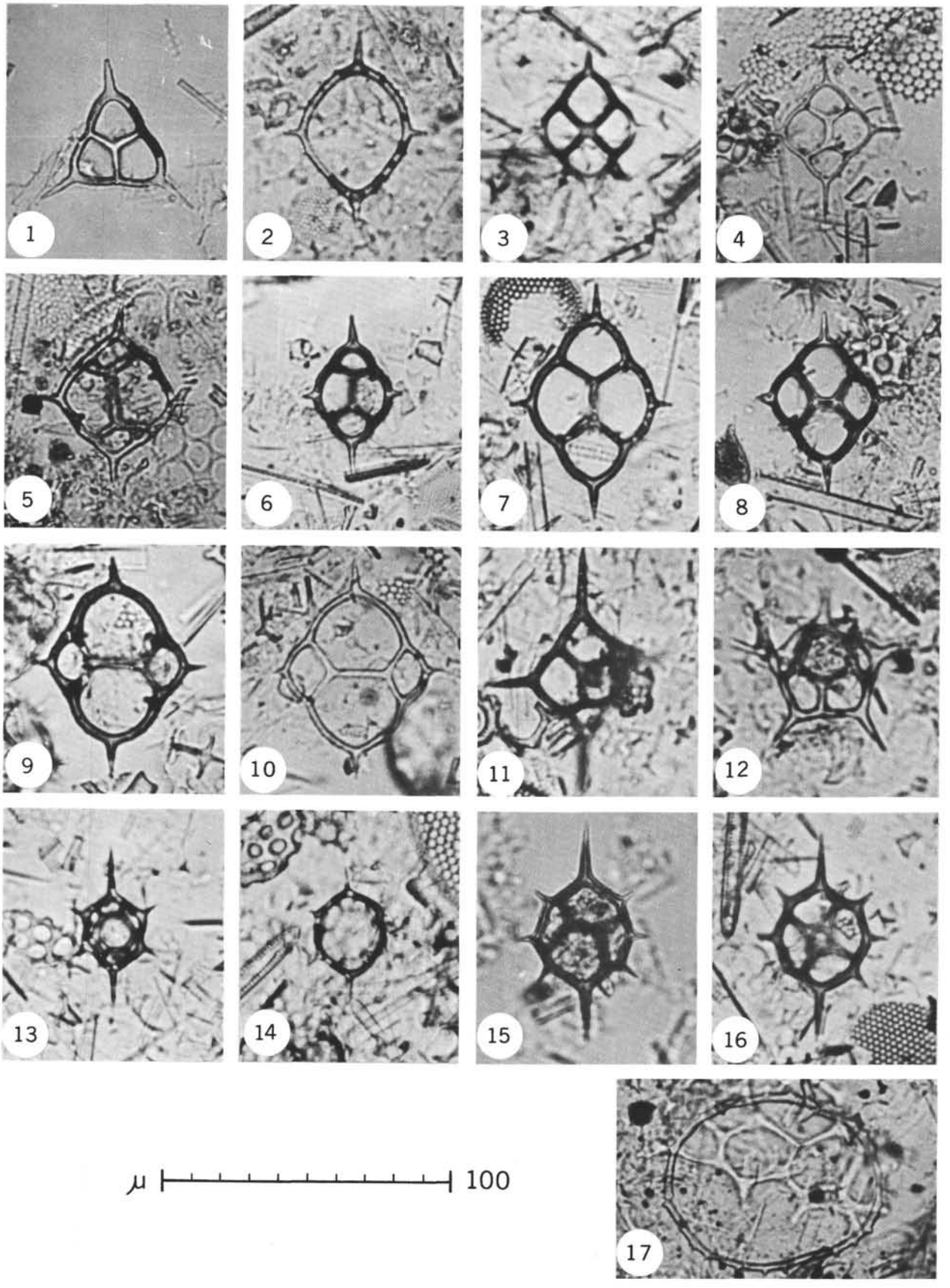
Figures 13-14 — *Dictyocha speculum* Ehrenberg.
13. DSDP 66-0-1-CC, *D. rhombica* Zone.
14. DSDP 65-0-4-5, 75-76 cm, *D. fibula* Zone.

Figure 15 — *Dictyocha octagona* Tsumura EM 7-1, 36-38 cm, *C. triacantha* Zone.

Figure 16 — *Dictyocha octacantha* (Desikachary and Maheshwari) DSDP 66-1-7-6, 75-76 cm, *C. triacantha* Zone.

Figure 17 — *Mesocena circulus* (Ehrenberg) DSDP 65-0-2-CC, *D. fibula* Zone.

PLATE 1



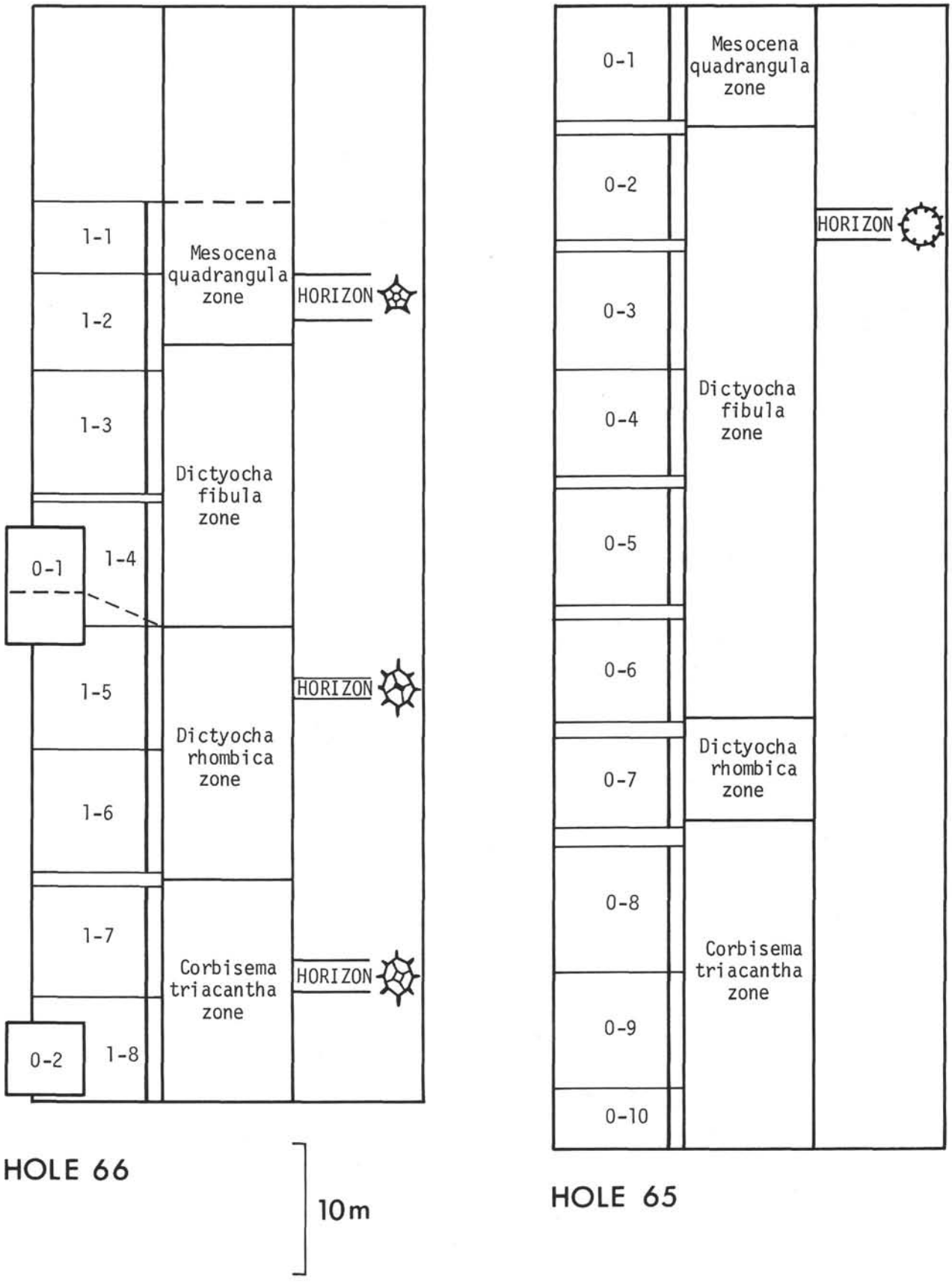


Figure 2. *Silicoflagellate zonation and certain silicoflagellate horizons of DSDP Holes 65-0, 66-0 and 66-1.*

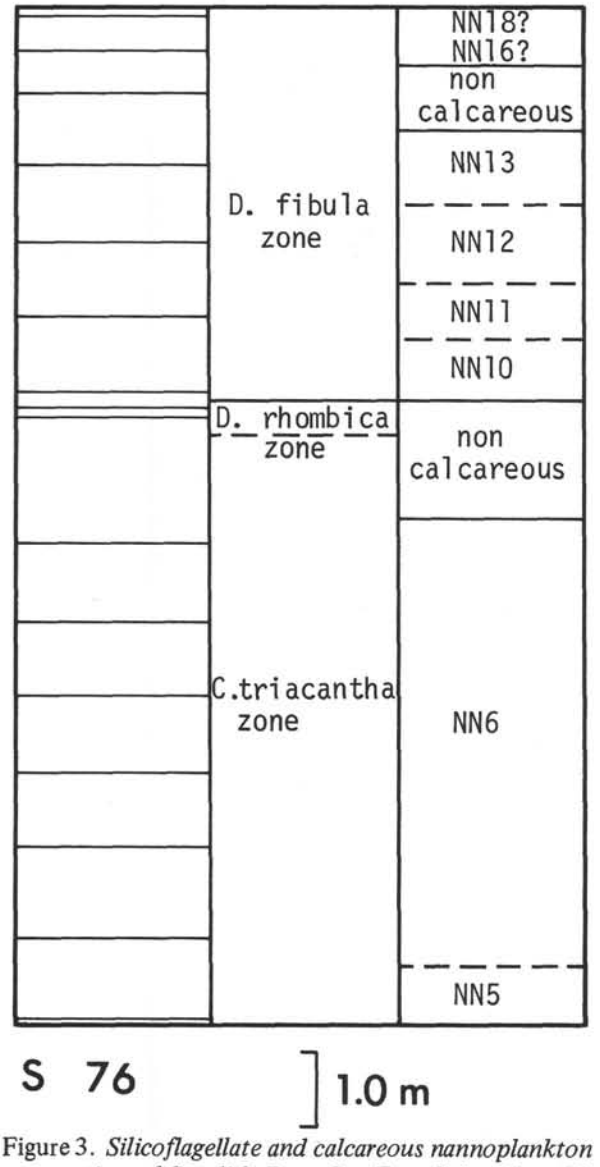


Figure 3. *Silicoflagellate and calcareous nannoplankton zonation of Swedish Deep Sea Expedition Core 76. Left column: samples studied.*

tion and some nannoplankton occurrences in these sections, and in SDSE Core 76 comparison with the calcareous nannoplankton zonation indicate the following correlations.

The lower boundary of the *Mesocena quadrangula* Zone, in Hole 65-0 between Core 1-CC and Core 2-1, 75 to 76 centimeters, in Hole 66-1 between Core 2-4 75 to 76 centimeters and Core 2-5, 75 to 76 centimeters is within the *Spongaster pentas* Zone of the radiolarian zonation (Riedel, personal communication). Calcareous nannoplankton in Hole 65-0-1-CC belong to Zone NN 15, indicating that the lower boundary of the *Mesocena quadrangula* Zone is in the upper part of NN 15 of the calcareous nannoplankton zonation.

The boundary between the *Dictyocha fibula* Zone and the *Dictyocha rhombica* Zone (= *D. fibula–D. rhombica* datum), in Hole 65-0 between Core 6, Section 6-top and Core 6-CC as discussed above, in Hole 66-0 between Core 1, Section 3-top and Core 1, Section 4-top, in Hole 66-1 between Core 4-CC and Core 5, Section 1, 75 to 76 centimeters, is within the *Ommatartus antepenultimus* Zone of the radiolarian zonation (Riedel, personal communication). In SDSE Core 76 sample 509.0 to 509.5 centimeters nannoplankton of Zone NN 10 is present, indicating that the *D. fibula–D. rhombica* datum is in the basal NN 10 or within Zone NN 9 of the calcareous nannoplankton zonation. Samples at 525.0 to 535.0 centimeters represent the *D. rhombica* Zone, but do not contain calcareous nannoplankton.

The boundary between the *Dictyocha rhombica* Zone and the *Corbisema triacantha* Zone, in Hole 65-0 between Core 7, Section 5, 75 to 76 centimeters and Core 7-CC, in Hole 66-1 between Core 6-CC and Core 7, Section 1, 75 to 76 centimeters, is in the uppermost part of the *Dorcadospyris alata* Zone or lowest part of the *Cannartus* (?) *petterssoni* Zone of the radiolarian zonation (Riedel, personal communication).

The occurrence of a selected calcareous nannoplankton population of Zone NN 5 or NN 6 in Hole 66-0, Core 2 indicate that the upper boundary of the *Corbisema triacantha* Zone, which is represented by these samples, probably belongs in the higher part of NN 6 of the calcareous nannoplankton zonation. The lower part of SDSE Core 76 belong to NN 6 (samples between 708.5 and 1229.0 centimeters) and NN 5 (sample at 1329.0 to 1330.0 centimeters) of the calcareous nannoplankton zonation. Between 1009.0 and 1110.0 centimeters reworked species from Zone NN 2 have been noted. This sequence probably represent already the *Corbisema triacantha* Zone below the *Dictyocha octacantha* Horizon, which may be present between 535.0 and 708.5 centimeters where samples are not available at this time.

In Hole 65-0 the Lower Miocene has been penetrated, but with a remarkable decrease in the diatom population in Core 7 and below, also a decrease in silicoflagellate population was noted, and the lower limit of the *Corbisema triacantha* Zone could not be determined.

SILICOFLAGELLATE LONG-DISTANCE CORRELATIONS

At present silicoflagellate long-distance correlations seem rather restricted, partially due to the systematic confusion and inaccurate knowledge of the stratigraphic position of isolated samples and localities. Some correlations are possible with the sequence obtained in

TABLE 1
Silicoflagellates in Samples Studied from DSDP Hole 65.0

(Numbers refer to specimens found in 10 rows of approximately 30 millimeters length, viewed with an ocular 12.5 X and an objective 25 X)

Hole	*Corbisema triacantha*	*Mesocena quadrangula*	*Dictyocha medusa*	*Dictyocha fibula* s.l.	*Dictyocha rhombica* s.l.	*Dictyocha crux* s.l.	*Dictyocha pentagona*	*Dictyocha speculum*	*Dictyocha octagona*	*Dictyocha octacantha*	*Mesocena circulus*
65.0-1-1-top				12							
65.0-1-2-top				18							
65.0-1-3-top				22	2						
65.0-1-4-top		2		10	2						
65.0-1-5-top		4		22	8						
65.0-1-CC		2		6	2						
65.0-2-1, 75-76			2	72	2			8			
65.0-2-2, 75-76				72	2			2			
65.0-2-3, 70-71				44	8						
65.0-2-4, 75-76				32	8			2			
65.0-2-5, 75-76				76	8			10			6
65.0-2-6-top				76				8			2
65.0-2-CC				88	4			18			10
65.0-3-1, 75-76				34	2						
65.0-3-2, 75-76				54	2			4			
65.0-3-3, 75-76				26							
65.0-3-4, 75-76				86	4						
65.0-3-5, 75-76				26	4						
65.0-3-6-top				62	2						
65.0-3-CC				18			2				
65.0-4-1-top				28				2			
65.0-4-2, 75-76				58	4						
65.0-4-3-top			2	56	2						
65.0-4-4, 75-76				110							
65.0-4-5, 75-76				126	2			18			
65.0-4-6-top				64				16			
65.0-4-CC				38	2			8			
65.0-5-1-top				100	4			4			
65.0-5-2, 75-76				98	4			2			
65.0-5-3-top				132	6			4			
65.0-5-4, 75-76				126	8						
65.0-5-5, 75-76				144	10			4			
65.0-5-6, 75-76				78	20			2			

TABLE 1 - *Continued*

Hole	*Corbisema triacantha*	*Mesocena quadrangula*	*Dictyocha medusa*	*Dictyocha fibula* s.l.	*Dictyocha rhombica* s.l.	*Dictyocha crux* s.l.	*Dictyocha pentagona*	*Dictyocha speculum*	*Dictyocha octagona*	*Dictyocha octacantha*	*Mesocena circulus*
65.0-5-CC				110	12						
65.0-6-1				110	12						
65.0-6-2, 75-76				64	20			4			
65.0-6-3-top			2	108	36			6			
65.0-6-4-top				98	10			2			
65.0-6-5-top				68	12			2			
65.0-6-6-top				96	28						
65.0-6-CC			2	46	106			6			
65.0-7-1-top				158	14			2			
65.0-7-2, 75-76					22						
65.0-7-3, 75-76					12						
65.0-7-4, 75-76				2	6						
65.0-7-5, 75-76					8						
65.0-7-CC	2				16						
65.0-8-CC				2	2						
65.0-9-CC						2					
65.0-10-CC					4						

TABLE 2
Silicoflagellates in Samples Studied from DSDP Hole 66.0

(Numbers refer to specimens found in 10 rows of approximately 30 millimeters length, viewed with an ocular 12.5 X and an objective 25 X.)

Hole	*Corbisema triacantha*	*Mesocena quadrangula*	*Dictyocha medusa*	*Dictyocha fibula* s.l.	*Dictyocha rhombica* s.l.	*Dictyocha crux* s.l.	*Dictyocha pentagona*	*Dictyocha speculum*	*Dictyocha octagona*	*Dictyocha octacantha*	*Mesocena circulus*
66.0-1-1-top				294	2			8			
66.0-1-2-top				58	4			38			
66.0-1-3-top			6	172	14			6			
66.0-1-4-top			34	68	286			10			
66.0-1-5-top			8	54	110			10			
66.0-1-6-top			20	70	258			14			
66.0-1-CC				54	8	4		38			
66.0-2-1, 75-76			2	70	6						
66.0-2-2, 75-76	12		2	4	160						
66.0-2-3, 75-76	2				32						
66.0-2-CC	2		4	4	48						

TABLE 3
Silicoflagellates in Samples Studied from DSDP Hole 66.1

(Numbers refer to specimens found in 10 rows of approximately 30 millimeters in length, viewed with an ocular 12.5 X and an objective 25 X.)

Hole	*Corbisema triacantha*	*Mesocena quadrangula*	*Dictyocha medusa*	*Dictyocha fibula* s.l.	*Dictyocha rhombica* s.l.	*Dictyocha crux* s.l.	*Dictyocha pentagona*	*Dictyocha speculum*	*Dictyocha octagona*	*Dictyocha octacantha*	*Mesocena circulus*
66.1-1-1-top		136		172	2			4			
66.1-1-2-top		256		200				2			
66.1-1-3-top		148		202	2			2			
66.1-1-4-top		190		180	2			4			
66.1-1-CC		170		478	6						
66.1-2-1, 75-76		18		636			2				
66.1-2-2, 75-76		2		284	2		8				
66.1-2-3, 75-76				136	4		2				
66.1-2-4, 75-76		38		192	4			4			
66.1-2-5, 75-76				92				2			
66.1-2-6, 75-76				346				18			
66.1-2-CC				188	2						
66.1-3-1, 90-91				48	16			6			
66.1-3-2, 75-76			2	110	6			36			
66.1-3-3, 75-76				188	2			18			
66.1-3-4, 75-76				136	52			20			
66.1-3-5, 75-76			4	180	18			18			
66.1-3-6, 75-76				136	8	2		24			
66.1-3-CC				238	2	2		34			
66.1-4-1, 108-109		(1)		528	24		2	12		(1)	
66.1-4-2, 75-76				416	6			6			
66.1-4-3, 75-76				440	32			6			
66.1-4-4, 75-76			4	104	22			8			
66.1-4-5, 75-76			12	560	24			2			
66.1-4-6, 75-76			6	222	32			14			
66.1-4-CC				218	16			10			
66.1-5-1, 75-76			2	14	216			64			
66.1-5-2, 75-76			6	24	212			4			
66.1-5-3, 75-76				4	70			4			
66.1-5-4, 75-76			2	4	56				1		
66.1-5-5, 75-76					82		2	4			
66.1-5-6, 75-76				4	20			2			
66.1-5-CC					66						
66.1-6-1-top				2	106	4					

TABLE 3 - *Continued*

Hole	*Corbisema triacantha*	*Mesocena quadrangula*	*Dictyocha medusa*	*Dictyocha fibula* s.l.	*Dictyocha rhombica* s.l.	*Dictyocha crux* s.l.	*Dictyocha pentagona*	*Dictyocha speculum*	*Dictyocha octagona*	*Dictyocha octacantha*	*Mesocena circulus*
66.1-6-2, 75-76				4	64						
66.1-6-3, 75-76				4	104						
66.1-6-4, 75-76					50						
66.1-6-5, 75-76				2	18						
66.1-6-6, 75-76				4	54						
66.1-6-CC				2	74			2			
66.1-7-1, 75-76	4				100	2					
66.1-7-2, 75-76				4	36	2					
66.1-7-3, 75-76					48						
66.1-7-4, 75-76	2				48	2					
66.1-7-5, 75-76	2				120	6				4	
66.1-7-6, 75-76	2				42					6	
66.1-7-CC				2	48						
66.1-8-1, 75-76	2		8	34	52	2					
66.1-8-2, 75-76				36	84						
66.1-8-3, 75-76	2		4	44	56	4					
66.1-8-4-top			2	26	60						
66.1-8-5-bottom			2	2	32						
66.1-8-6, 75-76			4	54	14						
66.1-8-CC				46	32	2					

TABLE 4
Silicoflagellates in Samples Studied from Swedish Deep Sea Expedition Core 76

Hole	*Corbisema triacantha*	*Mesocena quadrangula*	*Dictyocha medusa*	*Dictyocha fibula* s.l.	*Dictyocha rhombica* s.l.	*Dictyocha crux* s.l.	*Dictyocha pentagona*	*Dictyocha speculum*	*Dictyocha octagona*	*Dictyocha octacantha*	*Mesocena circulus*
7.5-8.0				15	3	1					
54.0-55.0				8	3			7			
108.5-109.0				12	3			9			
208.5-209.0				9	3			3			
308.5-309.0				14	6			4			
408.5-409.0				24	5		2	2			
509.0-509.5				6	3						
525.0-526.0				6	98			9			
534.0-535.0				14	65			1			
708.5-709.0				4	102						
809.0-810.0				1	49						
909.0-910.0				3	149	1					
1009.0-1010.0				3	18	2					
1109.0-1110.0					10	1					
1228.5-1229.0				1	14	1					
1329.0-1330.0				1	15						

the experimental Mohole drilling project near Guadalupe Island (EM in Figure 1) and with samples from California (Martini, in press). Compared with the data obtained by the calcareous nannoplankton (Martini and Bramlette, 1963) and Radiolaria, the upper boundary of the *Corbisema triacantha* Zone in the experimental Mohole drilling (between EM 8-13: 50 to 52 centimeters and EM 8-13: 260 centimeters), in siliceous samples from California (lower Mohnian), and in the DSDP Sites 65 and 66 is about the same stratigraphic level. The *Dictyocha octocantha* Horizon is found in an exactly the same position in the experimental Mohole cores (EM 7-1: 36-38 centimeters to EM 7-2: 4-7 centimeters) and in the DSDP Hole 66-1 (Core 7, Section 5, 75 to 76 centimeters to Core 7, Section 6, 75 to 76 centimeters), both occurrences belonging in the *Dorcadospyris alata* Zone of the radiolarian zonation (Riedel, personal communication).

Another horizon (*Dictyocha pseudofibula–Dictyocha pseudocrux*) not found as yet in the equatorial sequences, but present in Japan (Bachmann and Ichikawa, 1962), in California and the experimental Mohole drilling (Martini, in press) indicate the stratigraphic importance of the silicoflagellates. Further study is necessary, however, to improve the systematic situation and the zonation on basis of well known sequences in other parts of the world.

ACKNOWLEDGEMENTS

Thanks are due to A. Bachmann (Vienna) for helpful discussions and providing rare literature.

REFERENCES

Bachmann, A. and Ichikawa, W., 1962. The silicoflagellides in the Wakura Beds, Nanao City, Prefecture Ishikawa, Japan. *Sci. Rep. to Kanazawa Univ.*, **8** (1), 161, pls. 1-10.

Bachmann, A. and Papp, A., 1968. Vorkommen und Verbreitung der Silcoflagellaten im Neogen Österreichs. *Giorn. Geol.* Ser. 2, **35** (2), 117, pl. 3.

Kanaya, T., 1970. Some aspects of pre-Quaternary diatoms in the oceans. *The Micropaleontology of Oceans.* (in press) Cambridge S.C.O.R. Symposium Volume.

Loeblich, A. R. III, Loeblich, L. A., Tappan, H. and Loeblich, A. R. Jr., 1968. Annotated index of fossil and recent silicoflagellates and ebridians with descriptions and illustrations of validly proposed taxa. *Geol. Soc. Am. Mem.* **106**, 317 pp., 53 pls.

Martini, E., 1970. Der stratigraphische Wert von Silicoflagellaten im Jungtertiar von Kalifornien und des östlichen Pazifischen Ozeans. *Z. deutsch. Geol. Ges.* (in press).

Martini, E. and Bramlette, M. N., 1963. Calcareous nannoplankton from the experimental Mohole drilling. *J. Paleont.* **37**, 845, pls. 102-105.

Martini, E. and Worsley, T., 1970. Standard Neogene calcareous nannoplankton zonation. *Nature.* (In press).

Stradner, H. 1961. Über fossile Silicoflagelliden und die Moglichkeit ihrer Verwendung in der Erdölstratigraphie. *Erdöl u. Kohle, Erdgas, Petrochemie.* **14**, 87, pls. 1-3.

Yanagisawa, T., 1943. Klishitsu-benmochu nitsuite (Silicoflagellatae). *Umi to Sora.* **23**, 451 (11-29).