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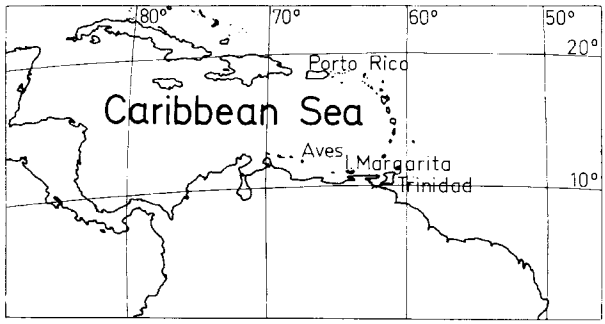
Dinoflagellates of the South-East Caribbean Sea (East-Venezuela)

Contents

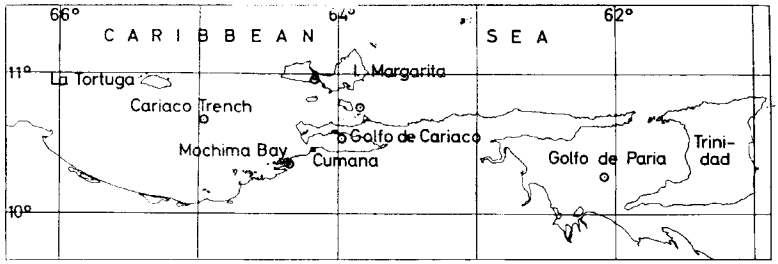
The present account of the Dinoflagellates of East Venezuela is based on the examination of 28 samples of surface plankton collected by Professor Dr. F. GESSNER and Dr. L. HAMMER from different localities, in the period from October 1960 to March 1963. Eighteen of the samples come from Mochima Bay, two are from the Mangrove Bay of Margarita Island, three from the Gulf of Cariaco, one from the Gulf of Paria, one from the vicinity of Caribe Island, one from a position at mid-distance between Aves Island and La Guaira, and two from the Cariaco Trench. The locality and date of sampling are given in Table 1, the composition of each sample in Table 6.

Table 1. Locality and date of sampling

Sample	locality	date	Sample	locality	date
1	Mochima Bay	25. 9. 1961	15	Mochima Bay	19. 10. 1962
2	Mochima Bay	5. 10. 1961	16	Mochima Bay	30. 11. 1962
3	Mochima Bay	10. 11. 1961	17	Mochima Bay	8. 3. 1963
4	Mochima Bay	3. 5. 1962	18	Mochima Bay	19. 3. 1963
5	Mochima Bay	25. 5. 1962	19	Gulf of Cariaco	12. 3. 1962
6	Mochima Bay	1. 6. 1962	20	Gulf of Cariaco	29. 3. 1962
7	Mochima Bay	28. 6. 1962	21	Gulf of Cariaco	9. 9. 1960
8	Mochima Bay	28. 6. 1962	22	Mangrove Bay	31. 10. 1960
9	Mochima Bay	17. 8. 1962	23	Mangrove Bay	11. 10. 1961
10	Mochima Bay	30. 8. 1962	24	Gulf of Paria	11. 4. 1962
11	Mochima Bay	7. 9. 1962	25	Caribe Island	11. 10. 1961
12	Mochima Bay	5. 10. 1962	26	Aves to La Guaira	22. 9. ?
13	Mochima Bay	11. 10. 1962	27	Cariaco Trench	10. 10. 1960
14	Mochima Bay	15. 10. 1962	28	Cariaco Trench	27. 10. 1960



Map 1. The Caribbean Sea



Map 2. The South-East Caribbean Sea. The circles indicate the positions of sampling

I. General

The composition was fairly diversified. Of the 116 species and varieties observed, two are new, several are not known from the Atlantic waters, and many are insufficiently known rare forms. A number of other species are also noteworthy because of their value as biological indicators.

Peridinium symmetricum n. sp. and *Gessnerium mochimaensis* n. gen. n. sp. have been described. Five species were only known from the Pacific or Indian Oceans: *Ceratium scapiforme*, *Dinophysis monacantha*, *Heterodinium superbum*, *Peridinium matzenaueri*, *P. pentagonum* f. *depressum*. Among the rare or less well known should be mentioned: *Ceratium humile*, *C. scapiforme*, *Peridinium deficiens*, *P. exiquipes*, *P. matzenaueri*, *P. quinquecorn*, *Phalacroma cuneolus*, *Pyrodinium bahamense*. Some of them have been redescribed or their description completed.

The great majority of the Dinoflagellates of this area are more or less tolerant warm-water forms, but some are more strictly tropical (Table 2).

Table 2. Some strictly tropical forms

Ceratium gibberum subaequale	*Heterodinium superbum*
C. humile	*Ornithocercus splendidus*
C. incisum	*Peridinium exiquipes*
C. lunula	*P. grande*
C. praelongum	*P. matzenaueri*
C. scapiforme	*P. pentagonum depressum*
Dinophysis monacantha	*P. quinquecorn*
D. schütti	*Pyrodinium bahamense*

With the exception of the little known *Peridinium deficiens*, no distinctly boreal or northern forms occurred, but a small contingent of cosmopolitan species. Most of these are quantitatively predominant and indifferently "oceanic" and "neritic".

Table 3. Cosmopolitan species

Species	Remarks
Ceratium furca	Dominant
C. fusus	Very common
Dinophysis caudata	Dominant
Gonyaulax diacantha	Very common
Peridiniopsis asymmetrica	Dominant
Peridinium crassipes	Dominant
P. depressum	Dominant
P. conicum	Very common
P. punctulatum	Irregular
P. globulus quarnerense	Present off-shore
Prorocentrum micans	Common

"Shade" species were abundantly represented among the surface plankton over the Cariaco Trench in October 1960 (Table 4) and several were also recorded within Mochima Bay in August 1962. The occurrence of large numbers of pronounced shade species among surface tropical plankton, during the warm season, is a most unusual observation. It should be interpreted in connection with the upwelling observed in the Cariaco Trench (FUKUOKA, 1963, FUKUOKA and BALLESTER, 1963).

Table 4. Upwelling indicator species in the Cariaco Trench

Amphisolenia bidentata	
Ceratium arietinum	*Ceratium symmetricum*
C. buceros	*Dinophysis monacantha*
C. coarctatum	*D. schütti*
C. gravidum	*Heterodinium agassizi*
C. incisum	*H. superbum*
C. longissimum	*Kofoidinium velelloides*
C. pavillardi	*Ornithocercus splendidus*
C. praelongum	*O. steini*
C. platycorne	*Phalacroma cuneus*
C. ranipes	*P. cuneolus*

Beside the "shade" community, another well characterized category is constituted by surface "oceanic" species, restricted, as a rule, to offshore waters (Table 5). Most of them were, in fact, exclusively observed over the Cariaco Trench, and in the samples from Caribe Island and Aves-La Guaira. It is not possible from the examined material to ascertain whether such "oceanic" forms are indigenous in the Caribbean Sea or introduced by the surface Atlantic current (SVERDRUP, JOHNSON, FLEMMING, 1942).

Table 5. Surface "oceanic" species

Ceratium azoricum	*Peridinium exiquipes*
C. carriense	*P. grande*
C. concilians	*P. oceanicum*
C. lunula	*Phalacroma ovum*
Ceratocorys armata	*P. rotundatum*
C. horrida	*Podolampas elegans*
Dinophysis recurva	*P. palmipes*
Ornithocercus magnificus	*Spiraulax jollifei*

The "physionomy" of the inshore plankton of Mochima Bay and the Gulf of Cariaco acquires its main features from the occurrence of tropical neritic forms, mixed with an important cosmopolitan population of indifferent distribution, together with occasional shade or surface oceanic species. Among the typical "neritic" species should be mentioned *Exuviella marina*, *Gessnerium mochimaensis*, *Gonyaulax tamarensis excavata* (see however GAARDER, 1954), *Peridinium quinquecorn*, and *Pyrodinium bahamense*. *Peridinium* spp. belonging to the section *Conica* were strikingly abundant and dominant in the two near-shore samples of the Mangrove Bay.

Acknowledgement. I wish to express my gratitude to Professor Dr. F. GESSNER for his support and constant interest in my work, and also for providing facilities in the Department of Botany, Institut für Meereskunde, Kiel. My thanks are also due to all the members of this Department for their help in many ways.

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II. Systematic

Genus ***Amphisolenia*** STEIN

A. bidentata SCHRÖDER
(Fig. 2, pl. I; fig. 15, pl. II)

JÖRGENSEN (1923)
SCHILLER (1933)

A. bidentata is characterised by its bidentate "foot", incurved ventrally and by its elongated S-shaped body. The epitheca is convexe, the middle body spindle shaped. The "foot", or posterior tip of the body, makes an angle of 25—40° with the hypotheca. It is slightly dilated and carries two short cuneate

Plate I.

1 *Amphisolenia bidentata*. Anterior part. × 530;
2 *A. bidentata*, posterior end showing the bidentate "foot" and the spur-like spine. × 530;
3 *Ceratium arietinum* f. *detortum*. × 185;
4 *C. azoricum*. Ab. × 420;
5 *C. breve* v. *parallelum*. × 180;
6 *C. breve* v. *curvulum*. × 215;
7 *C. furca*. Ab. × 265;
8 *C. furca*, corresponding to f. *berghi*. × 260;
9 *C. gravidum*, corresponding to f. *angustum*. × 130;
10 *C. gravidum*. × 140;
11 *C. horridum* f. *molle*. × 215;
12 *C. humile*, a chain of three specimens. × 130;
13 *C. symmetricum*. × 240;
14 *Ceratocorys horrida*. × 380.

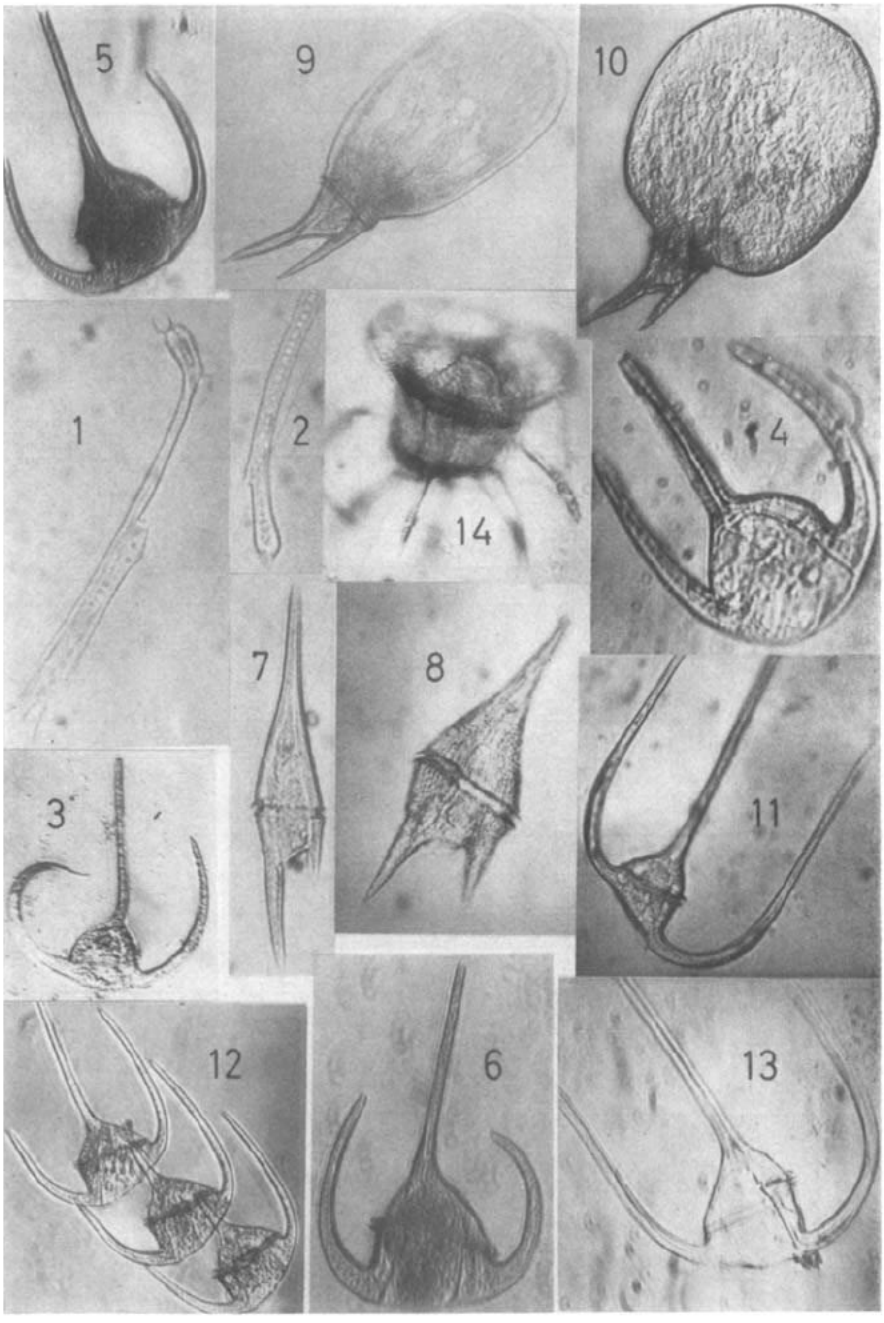

Plate I

Table 6. Dinoflagellates recorded in the South-East Caribbean Sea (East Venezuela)
s = single; r = rare; c = common; cc = very common; d = dominant

	Mochima Bay																	Cariaco Gulf			Mangrove Bay		Gulf of Paria	Caribe	Aves	Cariaco Trench	
	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
Amphisolenia																												
A. bidentata																												c
Blepharocysta																												
B. splendor-maris	r		r						r										c	c					r			
Cenchridium																												
C. globosum																						s						s
Ceratium																												
C. arietinum detortum																											r	r
C. arietinum gracilentum																											r	r
C. azoricum																											r	r
C. breve																								r				
C. breve curvulum																r												
C. breve parallelum		c	c		c	cc				d	c	c	c	c	c	c	c	c		c	c			c	c		c	c
C. buceros denticulatum																											c	c
C. buceros tenue																											cc	cc
C. buceros tenuissimum																											c	c
C. candelabrum					r	c			r	c			c	r			r			r	c				c		c	c
C. carriense																												r
C. carriense volans																												r
C. coarctatum																											r	r
C. concilians																											r	r
C. contrarium										c							c											c
C. extensum																					s				s			
C. furca	cc	d	cc		cc	cc		c	c	d	c	c	d		c	cc	cc	d		cc	cc	d		c	cc	c		cc
C. furca hircus																		cc		r								
C. fusus	cc	cc	cc		cc	cc		c	c	c	c		d	d	c	d	cc				c	d		cc	cc			cc
C. gibberum dispar										c							c											c
C. gibberum subaequale																	d	d						r				r

C. gravidum																											r	r
C. hexacanthum		cc	cc							cc			cc			cc	cc								cc		cc	cc
C. horridum molle						cc		c	c	cc		c		d	c	d		c						c	cc		cc	d
C. horridum claviger														s														
C. humile														cc	c	cc	cc			c	c						c	
C. incisum										s																		s
C. inflatum																								c				
C. karsteni										cc						cc											cc	cc
C. lineatum ?																									s			
C. longirostrum																								r	c		c	c
C. longissimum																												s
C. lunula			c													c											c	c
C. macroceros																	r							r				
C. massiliense																												
C. macroceroides		c	c		c	c		c	c	c	c		c	d	c		c	c		c	c	c			c		c	c
C. pavillardi																											c	r
C. pentagonum										r																		r
C. platycorne																											c	r
C. praelongum																											c	c
C. ranipes																											c	c
C. scapiforme																											s	
C. symmetricum	r																											r
C. trichoceros	c	cc	c		c					cc	c	c	cc	cc	c		d	c			c	c	c	c	c	c	c	c
C. tripos atlanticum																								r				
C. tripos tripodioides		cc				cc		c		cc	c		cc		c	cc		c	cc	c		c			c	c	c	cc
Ceratocorys																												
C. armata																												r
C. horrida																												r
Dinophysis																												
D. caudata	c		d		d			cc	cc	d	c		d	cc	cc	cc	cc			cc	d	d			d	d	cc	cc
D. monacantha																											c	
D. recurva																												r
D. schütti																											r	r
Exuviella																												
E. marina			d																									
Gessnerium, n. gen.																												
G. mochimaensis, n. sp.												cc				cc												

Table 6 (continued)

	Mochima Bay																		Cariaco Gulf			Mangrove Bay		Gulf of Paria	Caribe	Aves	Cariaco Trench	
	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
Goniodoma																												
G. polyedricum			c						c	c																	c	c
Gonyaulax																												
G. diacantha		cc	cc							cc														cc	d	cc		
G. diegensis																									cc	cc		
G. polygramma	cc	cc											c										cc		cc		c	
G. tamarensis excavata	c															e				c								
Heterodinium																												
H. agassizi																											c	
H. superbum																											r	
Kofoidinium																												
K. velelloides		r									r																c	
Noctiluca																												
N. miliaris	c	c							c	d		c							c	c					d		c	
Ornithocercus																												
O. magnificus										r																		c
O. splendidus																											c	
O. steini										r																		c
Oxytoxum																												
O. longiceps	s																											
Peridiniopsis																												
P. asymmetrica	d	cc	d			d		cc	c	c		cc	cc			cc			cc		cc	cc	cc		d	cc	d	d
Peridinium																												
P. abei	cc	cc																				c			c	cc		
P. achromaticum																												
P. brochi	cc	d			d	d		cc	cc	d	c	c					cc	cc			cc		cc	cc	d	d		c
P. cerasus																											r	
P. claudicans																									c	cc		

P. conicum	c																		cc			d	cc		c		
P. crassipes	cc	d	d		d	c			c	d		c				cc							cc		d			cc
P. deficiens																									s			
P. depressum	cc				d										cc	d	d	cc	cc	cc		cc		cc	cc	cc	d	d
P. diabolus																												r
P. exiquipes																								c				
P. fatulipes																												r
P. globulus																											c	c
P. globulus quarnerense																											c	
P. grande			c							c																	c	c
P. leonis			c																			c						
P. minutum																									c			
P. obtusum																			cc			cc	cc		c			
P. oceanicum																			r						cc		c	
P. oceanicum oblongum		cc	cc							cc			c					cc		cc		cc		cc	d	cc	cc	cc
P. oceanicum spiniferum																												s
P. ovum																												s
P. pentagonum depressum																					c	c			c			
P. pallidum										s																		
P. punctulatum			r									c	c									cc			c			cc
P. punctulatum																												
P. asymmetricum																					r	c			c			
P. quinquecorn			d																									
P. solidicorn			s								s																	
P. steini	r		r																									
P. subinerme												c	c									c	c					
P. symmetricum n. sp.																									r			
Phalacroma																												
P. cuneolus			c																								c	c
P. cuneus			r		c																						c	
P. ovum									c	r																		r
P. rotundatum																									r			r
Podolampas																												
P. elegans																												r
P. palmipes																												
Prorocentrum																												
P. maximum			r																									r
P. micans			c			c		c	c	c			d	c		c			c	c		c			c		c	c

Table 6 (continued)

	Mochima Bay																	Cariaco Gulf			Mangrove Bay		Gulf of Paria	Caribe	Aves	Cariaco Trench	
	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
P. rostratum																												s
Pyrocystis																												
P. fusiformis																											c	c
P. hamulus inaequalis																												s
P. robusta																											c	c
Pyrodinium																												
P. bahamense																		cc										
Pyrophacus																												
P. horologicum	cc	cc	cc	cc		cc		cc	cc	d				cc		d	cc	cc		cc	d			c	d	cc	d	c
Spiraulax																												
S. jollifei																											cc	c

spines. Shortly above, there is a third "spur" like spine (Fig. 2, I). The figured specimen had a length of 744 μ, but longer specimens, up to 990 μ, have been observed (SCHILLER, op. cit.).

Occurrence. *A. bidentata* is frequent in the North Atlantic up to 38° N (PAVILLARD, 1931). It constituted 70.3% of all records of *Amphisolenia* in the "Meteor" plankton, where it was observed only till 37° S (KÄSLER, 1938). It was also commonly found between the Canaries and Newfoundland banks by the "Michael Sars" (GAARDER, 1954) and is known from the Mediterranean, where it occurs in the winter plankton (JÖRGENSEN, op. cit.; PAVILLARD, 1937 b; HALIM, 1965). From these and other observations (SCHILLER, op. cit.), *A. bidentata* can be classified as an interoceanic tropical-subtropical species of wide occurrence.

In the plankton of Venezuela, it was fairly common over the "Trench" among typical upwelling-plankton in October 1960. On the other hand, it was totally absent from Mochima Bay and other neritic areas. Absent also from Porto-Rico (MARGALEF, 1961) and the Amazon region (WOOD, 1966).

Genus ***Blepharocysta*** EHRENBERG

B. splendor-maris EHRENB.

SCHILLER (1937)
BALECH (1963)

This tolerant warm water species was observed in six samples but always in small numbers: two from the Gulf of Cariaco (March 1962), three from Mochima Bay (Sept. and Nov. 1961, Aug. 1962), and one near Caribe Island.

The shape and dimensions were slightly variable: length, 49—54.5 μ; diameter in lateral view, 43—47.5 μ. The sulcal structure was examined and found to confirm the description and figures of BALECH (op. cit.).

Genus ***Cenchridium*** EHRENBERG
LINDEMANN (1928)

Exclusively marine, warm water species. The theca is bivalved as in all Prorocentraceae and ornamented with dissimilar pores. The pore slit is continuous with an inner membranous (LINDEMANN, op. cit.) tube of variable length. The genus as a whole is of rare occurrence.

C. globosum (WILLIAMSON) STEIN
(Fig. 133, pl. IX)

SCHILLER (1933)

The theca is oval in shape with the greatest diameter at midbody. The inner tube is of equal diameter throughout, not reaching to mid-body. In valve view, the theca is entirely covered with small pores among which larger pores occur, disposed in a symmetrical pattern (Fig. 133).

Dimensions: STEIN gave no measurements in his description (SCHILLER, op. cit.). The observed specimens had a length of 35 μ and a greatest diameter of 27 μ. MARGALEF (1961) gives 50×31 μ.

Occurrence. Described from the Pacific, it was recorded only once from the Mediterranean by PAVILLARD (1937). GAARDER (1954) observed other *Cenchridium* sp. from the North Atlantic but not *C. globosum*. MARGALEF (1961),

who records it as rare from the offshore plankton of Porto-Rico, expressed doubts about wether it is a Dinoflagellate at all. Recorded also by SCHRÖDER (1909) from St. Thomas (W. INDIES). In the plankton of Venezuela two specimens were observed in the "Trench" (Oct. 1960) and an empty damaged shell among the "Mangrove" plankton.

Genus ***Ceratium*** SCHRANK.

C. arietinum CLEVE
(Fig. 3, pl. I)

JÖRGENSEN (1911)
SCHILLER (1937)

An interoceanic tropical species of a decidedly deep-water habitat. Of the four forms distinguished by JÖRGENSEN (1920) only *f. detortum* (STÜWE) JÖRG. and *f. gracilentum* JÖRG. were observed.

C. arietinum f. *detortum* (STÜWE) JÖRG. The apical horn is slightly curved at the tip and the right posterior horn shows an inward curvature (Fig. 3).

C. arietinum f. *gracilentum* JÖRG. Similar to the preceding, except for the lengthening and proximal curvature of the apical horn. PETERS (1932) found this form in the "Meteor" plankton only between 12° N and 10° S in the Atlantic. It was also found to be limited to quite warm waters and to be distinctly more frequent around the depth of 100 m by GRAHAM and BRONIKOWSKY (1944).

Both forms occurred only among the upwelling plankton over the Cariaco Trench (Oct. 1960). They are neither recorded by WOOD (1966) in the Amazon region nor by MARGALEF (1961) in the plankton of Porto Rico. Transdiameter, 50 μ.

C. azoricum CLEVE
(Fig. 4, pl. I)

JÖRGENSEN (1911)

A slightly variable but well characterized little species. *C. azoricum* is recorded from waters of 8.9 °C between Iceland and the Faeroes, as well as from the equatorial Atlantic and Pacific at 29.5 °C (GRAHAM and BRONIKOWSKY, 1944). It was also found by GAARDER (1954) in the whole N. Atlantic up to about 60° N, probably carried by the Gulf Stream. The species is well known from the Mediterranean (JÖRGENSEN, 1920; PAVILLARD, 1937; HALIM, 1960a). Its vertical distribution shows a greater frequency in the upper levels, although it is not restricted to the surface (STEEMANN-NIELSEN, 1934; PAVILLARD, 1937b; GRAHAM and BRONIKOWSKY, 1944). *C. azoricum* can be classified as a very tolerant interoceanic tropical species, mainly of surface occurrence.

C. azoricum was observed over the Cariaco Trench in October 1960 in small numbers. It was also recorded as rare from the Amazon region (WOOD, 1966). Transdiameter, 38—51 μ.

C. breve (OSTENFELD and SCHMIDT) SCHRÖDER.
(Fig. 5 & 6, pl. I; 16, pl. II; 28, pl. III)

JÖRGENSEN (1911)

A variable species with regards to the length and shape of the right posterior horn. The length of the apical horn which was taken in consideration by JÖRGENSEN (1911) should be disregarded as the species is often chain-forming. The

main species is characterized by a plump body with short apical and short antapical horns, incurved and close to the body. JÖRGENSEN (op. cit.) distinguished two varietes: v. *curvulum* JÖRG., which is similar to the main species except for the shape of the right posterior horn which is more arcuate, its tip assuming a converging direction towards the apical horn; and v. *parallelum* (SCHMIDT) JÖRG. with the posterior horns much more distant from the body than in the main species, regularly curved at the base but nearly parallel to the apical horn. As numerous intergrading forms occur, these varieties were disregarded by STEEMANN-NIELSEN (1934) and SCHILLER (1937). GRAHAM and BRONIKOWSKY (1944) found this variable species to exhibit transitions also to many others: *C. schmidti*, *C. tripos* and *C. arcuatum*. In the plankton of Venezuela, forms corresponding respectively to the main species (Fig. 16 & 28) the var. *curvulum* (Fig. 6) & the var. *parallelum* (Fig. 5) were observed in varying abundance. Continuous intergrading was also observed as can be seen from the figures.

Occurrence. *C. breve* s. l. is a strictly tropical species of surface occurrence, indifferently oceanic as well as neritic (PETERS, 1932; ST.-NIELSEN, 1934; GRAHAM and BRONIKOWSKY, 1944). The mention of *C. breve* from the Weddell Sea by PETERS (1928) is not convincing (see his Fig. 23 p. 84). The var. *parallelum* occurs all the year round and is a regular component of the plankton of Mochima Bay. It was also observed over the "Trench". Var. *curvulum* was observed very sporadically in Mochima, while the main species occurred only in one sample (Gulf of Paria; April 1962). The var. *parallelum* was present in 75% of all samples. *C. breve* is not recorded by MARGALEF (1961) in Porto Rico, but his fig. 26, j, p. 77, designated as *C. tripos*, most probably represents the var. *curvulum* of this species. It was also observed by WOOD (1966) as "not common" in the Amazon region. Transdiameter, 74—84 μ. JÖRGENSEN gives 64—90 μ.

C. buceros ZACHARIAS s. l.
(Fig. 17, pl. II & 29, pl. III)

SCHILLER (1937)

Different forms belonging to this variable species were exclusively observed in two samples from the Cariaco Trench (10 and 27 Oct. 1960). They were fairly common in both samples. The forms observed answer to f. *tenuissimum* (KOF.) (Fig. 17) f. *denticulatum* (JÖRG.) and f. *tenue* (OST. and SCHMIDT), the latter form numerically predominant (Fig. 29). Contrary to *C. horridum*, *C. buceros* in the Venezuelan plankton was of relatively rare occurrence and totally absent from the inshore waters. As it occurred exclusively among the upwelling plankton of the Trench, it is most probably a shade species as concluded by STEEMANN-NIELSEN (1932, *C. tenue*), GRAHAM and BRONIKOWSKY (1944, *C. tenue*), and HALIM (1963). Transdiameter, 35—37 μ.

C. candelabrum (EHRENB.) STEIN
(Fig. 18, pl. II)

SCHILLER (1937)

A common interoceanic surface species, occurring in tropical as well as in temperate habitats. Of the three forms admitted by SCHILLER (op. cit.), f. *commune* BÖHM, f. *curvatulum* JÖRG. and f. *depressum* POUCHET only the latter was observed in the Venezuelan plankton (Fig. 18). It occurred in 44% of all samples throughout the year, but was particulary abundant during September—October. The records are from Mochima Bay, the Gulf of Cariaco, the "Trench"

and the Island of Caribe. Its oceanic distribution appears to be restricted to the area between about 40° N and 40° S in both Pacific and Atlantic Oceans (PETERS, 1932; STEEMANN-NIELSEN, 1934; GRAHAM and BRONIKOWSKY, 1944; GAARDER, 1954). It was recorded as rare by WOOD (1966) in the Amazon region. *C. candelabrum* is a perennant and tolerant warm water species of surface habitat. It occurs indifferently in neritic as well as in off-shore waters. Transdiameter, 80 μ.

C. carriense GOURRET
(Fig. 30, pl. III)

SCHILLER (1937)

A variable species with long widespreading posterior horns, often irregulary curved. Only rare specimens were observed and exclusively over the "Trench" (Oct. 1960). They correspond respectively to the f. *volans* (CLEVE) JÖRG. and to the main species. *C. carriense* is an interoceanic tropical form occurring mainly in surface off-shore waters (PAVILLARD, 1931; PETERS, 1932; STEEMANN-NIELSEN, 1934; GRAHAM and BRONIKOWSKY, 1944).

C. coarctatum PAVILLARD
(Fig. 31, pl. III)

SCHILLER (1937, p. 401, fig. 441 a, b, *C. symmetricum* PAVILLARD 1905, in part.)
JÖRGENSEN (1911, 1920, *C. gracile* GOURRET, in part.)

C. coarctatum is a fairly common tropical — subtropical and Mediterranean shade species. Its occurrence in Venezuelan plankton was restricted to the Cariaco Trench, where it was recorded as a rare species. Transdiameter, 54 μ.

C. concilians JÖRGENSEN

JÖRGENSEN (1920)

C. concilians formerly included under *C. gibberum* to wich it is similar, was separated from this species by JÖRGENSEN (1920). The theca is smooth, lacking the characteristic ridges of *C. gibberum* and the diameter much smaller, $t = 62-85$ μ. The apical horn is curved and the right posterior horn often distally dorsal to the apical horn.

Occurrence. *C. concilians* is much less common than *C. gibberum*. In the "Meteor" material from the S. Atlantic it was rare and restricted to warm oligotrophic waters (PETERS, 1932). GRAHAM and BRONIKOWSKY (1944) observed

Plate II

15 *Amphisolenia bidentata*, dorsal view of the dilated bidentate "foot". × 530;
16 *Ceratium breve*, the main species. × 290.
17 *C. buceros*. × 190;
18 *C. candelabrum*. × 330;
19 *C. furca*, a specimen corresponding to *C. hircus* SCHRÖDER. × 265;
20 *C. gibberum* f. *subaequale*. × 150;
21 *C. lunula*. × 105;
22 *C. massiliense*, an abnormal specimen with two apical horns. × 85;
23 The preceding specimen magnified. The theca is partly dissociated and regularly spaced poroids can be seen to the left. × 445;
24 *C. pentagonum*, the specimen shown in fig. 60, pl. 4, magnified. × 600;
25 *C. trichoceros*. × 110;
26 *C. tripos* v. *atlanticum*. × 170;
27 *C. tripos* f. *tripodioides*. × 240.

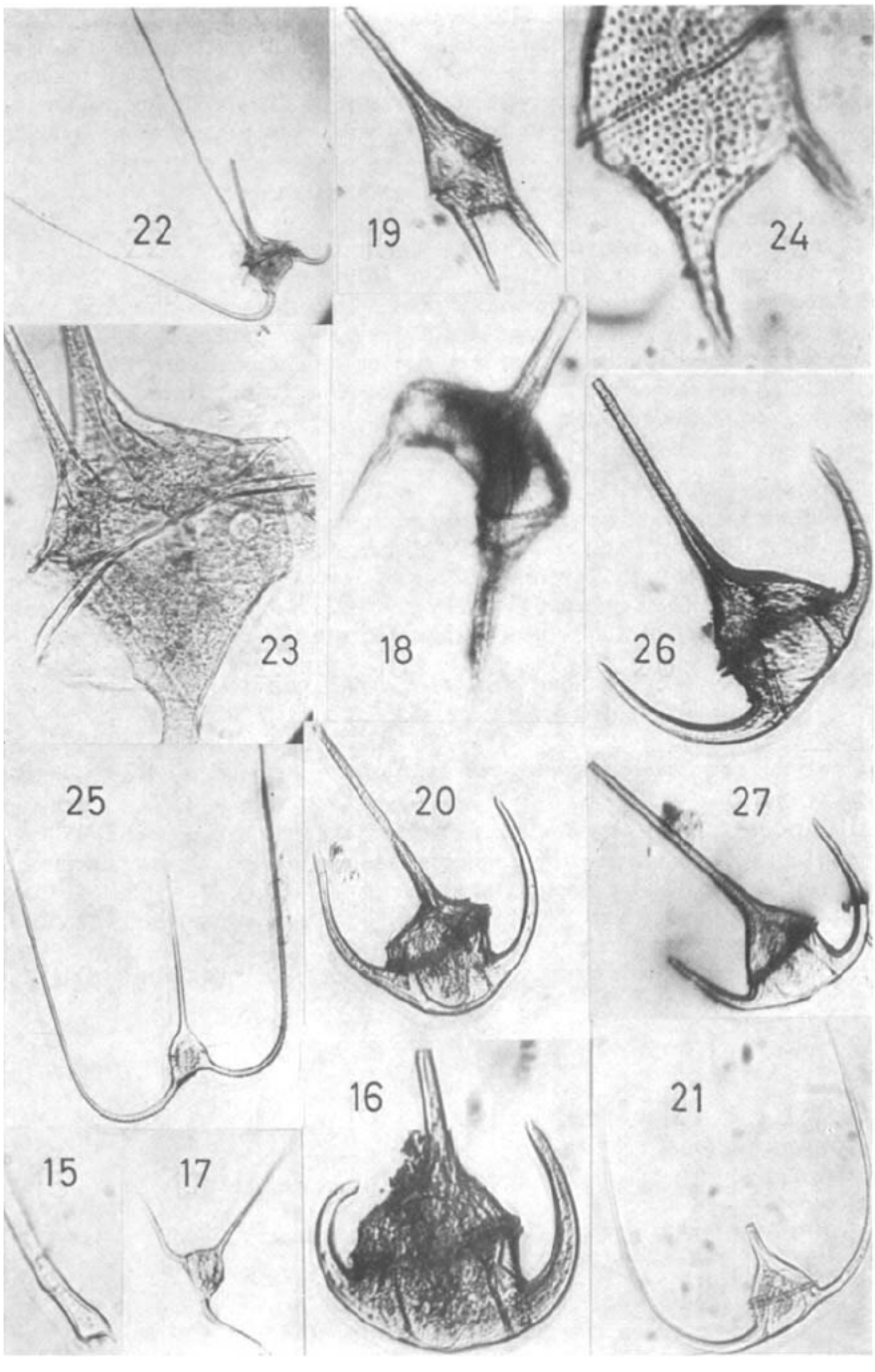

Plate II

it at only one Atlantic station, although it was common in the Pacific. While it appears to be absent from the "Michael Sars" collection (GAARDER, 1954), it was recorded at numerous N. Atlantic stations by PAVILLARD (1931), but not beyond 42° N. In the Venezuela plankton it was totally absent from the near-shore samples and only appeared in single specimens among the "Trench" plankton.

C. contrarium (GOURRET) PAVILLARD

JÖRGENSEN (1920)

C. trichoceros var. *contrarium* (GOURRET) SCHILLER (1937)

C. inflexum, JÖRGENSEN (1911)

Although a widely occurring warm water form often more abundant than *C. trichoceros*, in the Venezuela plankton it was far less common than the latter. *C. contrarium* was only observed in two samples from Mochima Bay (Aug. 1962, March 1963) and among the "Trench" plankton (Oct. 1960). Transitional forms to *C. trichoceros* also occurred.

C. extensum GOURRET CLEVE

JÖRGENSEN (1911)

A widespread tolerant warm water species. It extends in the Atlantic between about 40° S (PETERS, 1932) and 50° N (GRAHAM and BRONIKOWSKY, 1944). It is classified by STEEMANN-NIELSEN (1934) as a tropical-subtropical surface form in the Pacific. In the Venezuela plankton *C. extensum* was remarkably rare and occurred only twice, in the Gulf of Cariaco and near the Island of Caribe.

C. furca (EHRENB.) CLAP. and LACHMANN
(Fig. 7 & 8, pl. I; 19, pl. II; 32, pl. III)

JÖRGENSEN (1911)

A variable cosmopolitan species and one of the commonest of all Dinoflagellates.

Historical. JÖRGENSEN (op. cit.) distinguished two subspecies: a) Subsp. *berghi* (LEMM.), characterized by its plumpish shape, due to a greater epithecal angle (40° or more) and a greater transdiameter (40—50 μ). It is admitted that subsp. *berghi* is the northern form of *C. furca*. b) Subsp. *eugrammum* (EHRENB.) which is more slender. The epitheca tapers more gradually into the apical horn, the epithecal angle usually not exceeding 30°, and the transdiameter is

Plate III

28 *Ceratium breve*. × 180;
29 *C. buceros*. × 170;
30 *C. carriense*. × 90;
31 *C. coarctatum*. × 155;
32 *C. furca*, a specimen corresponding to *C. hircus* (see also fig. 19). × 315;
33 *C. fusus*. × 110;
34 *C. hexacanthum*. × 170;
35 The preceding specimen magnified to show the reticulation of the theca. × 230;
36 *C. horridum* f. *molle*. × 180;
37 *C. lineatum*. × 265;
38 *C. inflatum*, mid body. × 230;
39 *C. karsteni*. × 100;
40 *C. longirostrum*. × 80;
41 *C. massiliense*. × 70;
42 *C. platycorn*. × 200;
43 *C. praelongum*. × 100;
44 *C. ranipes*. × 190;
45 *C. scapiform*. × 90

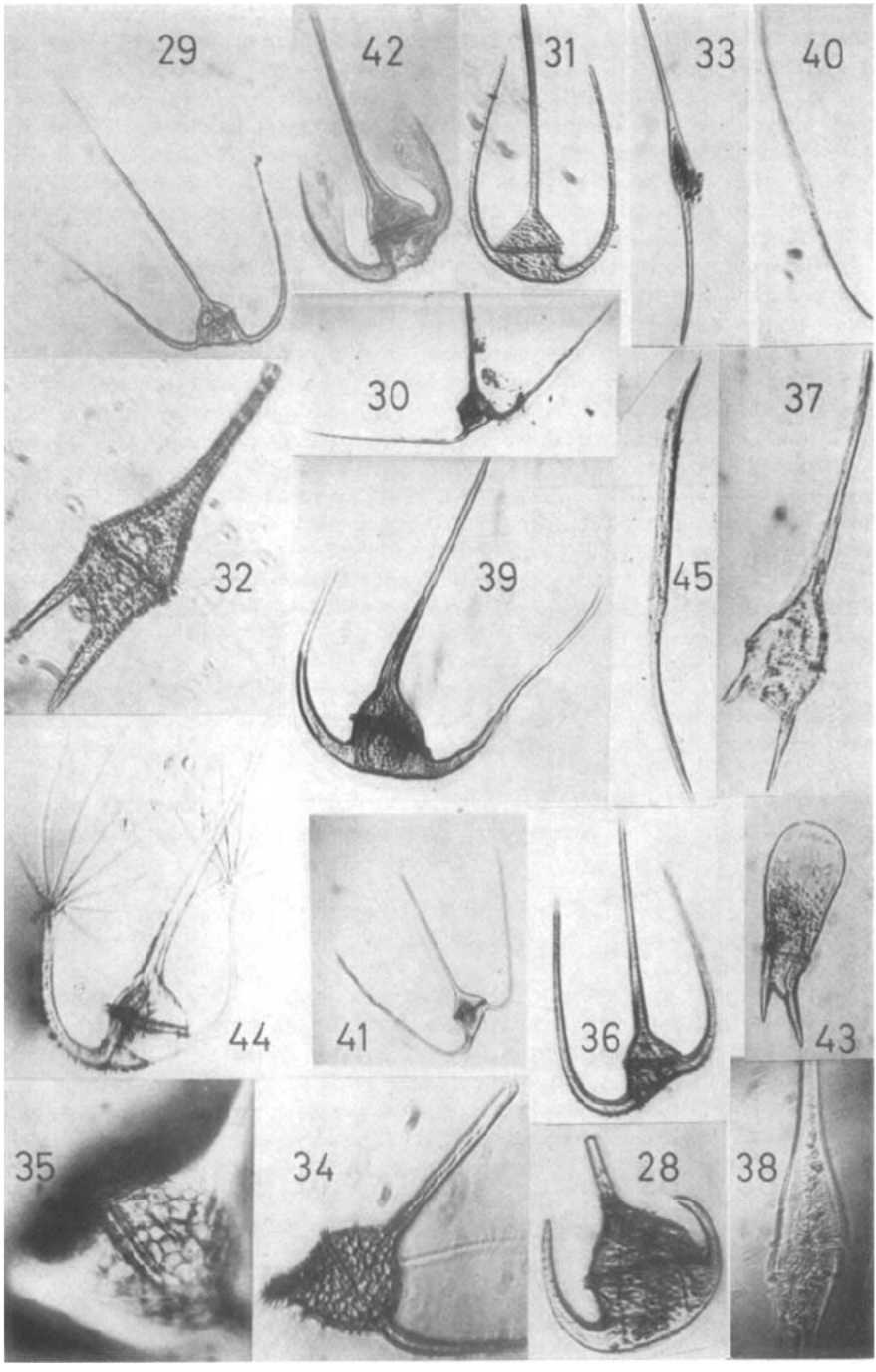

Plate III

usually 30—35 μ. Subsp. *eugrammum* is of warm water occurrence. Later, JÖRGENSEN (1920) subdivided the latter subspecies into a number of forms and BÖHM (1931) considered both subspecies as genotypically different in the western Pacific. PETERS (1932) mentioned the great variability of *C. furca* in the "Meteor" plankton of the Atlantic but he made no attempt to distinguish the different variants as there are many intergrading forms. GRAHAM and BRONIKOWSKY (1944) on the other hand confirmed JÖRGENSEN's view that *C. furca* is a complexe of many varieties and races but found their number too great in the "Carnegie" material to allow for any segregation.

In the Venezuelan plankton, populations of *C. furca* corresponding to both subspecies and to intermediate forms were observed, together with other types. Fig. 7 represents a specimen similar to subsp. *eugrammum* (t. 36 μ, epithecal angle 30°). This was the commonest form. Fig. 8 represents an extreme case of subsp. *berghi* with a large transdiameter (54 μ) and a large epithecal angle (56°). Intermediate forms (t. 39 μ, epithecal angle 35—36°) were more common than the latter. Fig. 19 & 32 represent a different type corresponding to *C. hircus* SCHRÖDER (1909), described from St. Thomas, West-Indies, but also known from the China Sea (NIE, 1936). MARGALEF (1961) designated the same form from Porto-Rico as *C. furca* var. *hircus* (SCHRÖDER) nov. comb., as originally suggested by JÖRGENSEN (1911) and SCHILLER (1937). Although the three forms and their intermediates were commonly observed to coexist, it seems convenient to maintain the designations *eugrammum*, *berghi* and *hircus* as form names for the dominant variants of *C. furca*.

Occurrence. *C. furca* s. dil. was the commonest of all Dinoflagellates recorded. It occurred in 81% of the samples and in most of them as a dominant species. Its occurrence is not restricted to neritic waters nor is it to any particular season.

C. furca s. dil. is a truely cosmopolitan species extending from the tropical waters (PETERS, 1932; GRAHAM and BRONIKOWSKY, 1944), to the Subarctic (PAVILLARD, 1931).

C. fusus (EHR.) DUJARDIN
(Fig. 33, pl. III)

JÖRGENSEN (1911)

A cosmopolitan species in which JÖRGENSEN (op. cit.) has distinguished a temperate — northern form, var. *schütti* LEMM. and a warm water form, var. *seta* (EHR.) JÖRG. The latter form he distinguished by its more delicate, very slightly curved to straight, smooth horns and by its smaller transdiameter. This distinction is partly confirmed by the statistical measurements of GRAHAM and BRONIKOWSKY (1944), although PETERS (1932) and STEEMANN-NIELSEN (1934) were not able to verify it. The observed specimens in the plankton of Venezuela correspond to the var. *seta*, by their relatively short length (391—404 μ) and slender appearance (t. 21—23.5 μ). But larger specimens also occur (t. 31 μ).

Occurrence. *C. fusus* is one of the regular and most abundant components of the examined material. It occurred in 77% of all samples from all seasons. Its highest abundance occurred in Spring and Autumn at Mochima Bay.

C. fusus is a cosmopolitan species of common occurrence in warm waters as well as in the Sub-arctic waters (PAVILLARD, 1931).

C. gibberum GOURRET
(Fig. 20, pl. II; 46, pl. IV)

JÖRGENSEN (1911, 1920)

A large and easily recognisable species by its heavy theca and short horns. The common form, f. *dispar* (POUCHET) JÖRG. has a strongly curved right posterior horn. The f. *subaequale* JÖRG. is less common and shows regulary curved posterior horns.

C. gibberum f. *dispar* (Fig. 46). A common, slightly tolerant tropical species which occurs rather uniformly in all warm seas (PAVILLARD, 1931; PETERS, 1932; STEEMANN-NIELSEN, 1934; GRAHAM and BRONIKOWSKY, 1944; GAARDER, 1954). In the Venezuelan plankton it was observed in 18% of the samples. It appears to be more frequent in Summer, but it is never abundant.

C. gibberum f. *subaequale* (Fig. 20). This form was remarkably abundant in March 1963 (Mochima Bay) and was also observed among the "Trench" plankton. The f. *subaequale* is otherwise recorded as rare or very rare from the Atlantic (PETERS, 1932; GRAHAM and BRONIKOWSKY, 1944; GAARDER, 1954). Transdiameter, 89—97 μ.

C. gravidum GOURRET
(Fig. 9 & 10, pl. I)

JÖRGENSEN (1911, 1920)

In addition to the main species, JÖRGENSEN (op. cit.) described several varieties and forms. These were more or less accepted by PETERS (1932) and STEEMANN-NIELSEN (1934). From the examination of several hundreds of specimens however, GRAHAM and BRONIKOWSKY (1944) found complete intergrading between JÖRGENSEN's varieties. The different variants were found to be geographically indiscriminately scattered, as was also found by PETERS (1932).

C. gravidum s. dil. is a widespread but relatively uncommon warm water species. Its greatest frequency is below 50—100 m (STEEMANN-NIELSEN, 1934; GRAHAM and BRONIKOWSKY, 1944), but it also occurs in surface waters in the areas of upwelling (HALIM 1960a). In the samples of Venezuela it was only found among the "Trench" plankton.

C. hexacanthum GOURRET
(Fig. 34 & 35, pl. III)

JÖRGENSEN (1920)

SCHILLER (1937)

In this species the antapical horns occur in a variety of shapes and are often thin and curly. Of the various forms described, the specimens of Venezuela are nearest to the f. *spirale*. Their shape was invariably similar to Fig. 34 and chains of several individuals were not uncommon. Transdiameter, 85 μ.

C. hexanthum is a common tolerant tropical form of wide occurrence in warm waters. Its extension in the S. Atlantic does not exceed about 37° S. (PETERS, 1932), while in the N. Atlantic it was recorded near Iceland, probably carried by the Gulf-Stream (GRAHAM and BRONIKOWSKY, 1944). In the Venezuela plankton it was common and perennant though irregular, occurring in 30% of the samples. It was equally frequent in Mochima Bay and among the "Trench" plankton.

C. horridum GRAN, *C. buceros* ZACHARIAS and related forms

JÖRGENSEN (1911, 1920)

SCHILLER (1937)

The interrelations and the synonymy of *C. horridum*, *C. buceros* and related forms remain complex and intricate.

In order to account for the occurrence in tropical seas of numerous forms connected to GRAN's boreal *C. horridum* and to each other, JÖRGENSEN (1920) found it necessary to modify his system of 1911. He distinguished two subspecies within *C. horridum*, subspecies *horridum* a cold water form and subspecies *buceros*, the latter comprising various tropical thin horned forms, previously described as separate species by different authors. Under subspecies *buceros*, he also introduced *C. molle*, a coarse form, although he himself admitted that it was unnatural to separate it from *C. intermedium* (now a variety of subspecies *horridum*). This classification was not admitted by PAVILLARD (1931). PAVILLARD maintained the denominations *C. intermedium* JÖRGENSEN for the northern form which he found strikingly abundant in boreal waters, *C. molle* KOFOID and *C. inclinatum* KOFOID, for the forms of warmer water occurrence. PETERS (1932) mentions *C. horridum* as a widely occurring tropical–sub-tropical species in the S. Atlantic, without giving any figures or descriptions. STEEMANN-NIELSEN (1934) does not mention *C. horridum* but *C. tenue* OST. a. SCHMIDT, *C. claviger* KOFOID and *C. molle* KOF. and classifies them as tropical-sub-tropical shade species in the Pacific. GRAHAM and BRONIKOWSKY (1944) mention *C. horridum* and *C. tenue* separately, both shade species (although their table 46 p. 42 does not confirm this conclusion for *C. horridum*). They found *C. horridum* to comprise a cosmopolitan form (var. *horridum*) and two tropical forms (var. *molle* and var. *claviger*). *C. tenue* was found to be more strictly tropical.

SCHILLER (1937), following BÖHM (reference not stated in SCHILLER), has simplified the system of JÖRGENSEN (1920) by splitting his two subspecies and raising them once more to the rank of species: *C. horridum* GRAN, comprising the thick horned forms which are stated to only occur in cold and temperate waters, and *C. buceros* ZACHARIAS s. l., the latter comprising the same delicate forms and f. *molle*, namely, f. *tenue* (OST. a. SCHMIDT), f. *inclinatum* (KOF.), f. *leptosomum* (JÖRG.), f. *claviger* (KOF.), f. *molle* (KOF.), f. *tenuissimum* (KOF.), f. *denticulatum* (JÖRG.). It appears from the foregoing that: a) there is a general agreement on the necessity of distinguishing the "delicate, longhorned" forms of strictly tropical occurrence from the robust and cosmopolitan *C. horridum*; b) the recognised closed affinities of the former types justify their bringing together into one species, as was done by SCHILLER (op. cit.) under *C. buceros*; c) on the other hand f. *claviger* (KOF.), characterised only by its clavate ends, is otherwise indistinguishable from f. *molle* (KOF.) and should be dropped as synonym of the latter (see also JÖRGENSEN, 1920). Finally f. *molle*, a coarse form, is obviously a variant from *C. horridum* and not of *C. buceros* and should be transferred to the former species.

C. horridum (GRAN) SCHILLER

(Fig. 11, pl. I; 36, pl. III & 153, pl. X)

SCHILLER (1937)

The species is a regular element in the plankton of Venezuela where it occurred abundantly and in all seasons. It was observed in 63% of all samples. The

predominating form answers to f. *molle* (Fig. 11 & 36), sometimes but rarely with clavate ends (f. *claviger*, fig. 153). In contradiction with the results of STEEMANN-NIELSEN (1934) and GRAHAM and BRONIKOWSKY (1944), its great abundance and its regularity in the inshore waters of Mochima Bay show a decided surface habit. Transdiameter, 43—45 μ.

C. humile JÖRGENSEN
(Fig. 12, pl. I)

JÖRGENSEN (1911)

A characteristic, relatively stable species. The epitheca is very low, the hypotheca being about twice as high. The hind contour is strongly convexe. Left posterior horn short, about 1 1/2 the body height, while the right horn is distinctly longer, hardly curved.

C. humile is one of the rarest neritic tropical *Ceratia* and presents a remarkable distribution. It was recorded by JÖRGENSEN (1911) from the Japan Sea, by STEEMANN-NIELSEN (1934) from the neritic waters of East Australia and later by WOOD (1954) from Storm Bay in Tasmania. The only observation from the Atlantic is a single record by GRAHAM and BRONIKOWSKY (1944). Its remarkable absence from the collections of "Prince Albert" (PAVILLARD, 1931), of the "Meteor" (PETERS, 1932) and the "Michael Sars" (GAARDER, 1954) in both South and North Atlantic confirms the scarcity and the neritic character of this species.

C. humile occurred in 25% of the examined material. Its occurrence was noted as common in the records from Mochima Bay (October and November 1962; March 1963). It also occurred in the Gulf of Cariaco (September 1960, March 1962) and among the "Trench" plankton (Oct. 1960). Transdiameter: 75—78 μ.

C. inflatum (KOFOID) JÖRGENSEN
(Fig. 38, pl. III)

JÖRGENSEN (1911, 1920)

C. inflatum can be differentiated from *C. longirostrum* by its dilated body, abruptly contracted at the beginning of the apical horn. The posterior horn is strongly curved dorsally, towards its distal end. The ratio of epitheca to hypotheca is also different (JÖRGENSEN, 1920).

C. inflatum is a strictly warm water species of relatively rare occurrence (PAVILLARD 1931; PETERS 1932; GRAHAM and BRONIKOWSKY 1944). In the Plankton of Venezuela several specimens were found but only in one sample from the Gulf of Paria in April 1962. Transdiameter, 43 μ; ratio of epitheca to hypotheca, 1.12.

C. incisum (KARSTEN) JÖRGENSEN
(Fig. 152, pl. X)

JÖRGENSEN (1911)

A rare strictly tropical species of limited distribution. PETERS (1932) found it only eight times in the tropical S. Atlantic while it is neither recorded by PAVILLARD (1931) nor by GAARDER (1954). GRAHAM and BRONIKOWSKY (1944) found it only at two Atlantic stations one of which in the Caribbean. It is mentioned by WOOD (1966) as very rare in the Amazon Region. The species is also known from the Pacific and Indian Oceans.

C. incisum was observed twice in the Venezuelan plankton, once over the "Trench" and again in Mochima Bay (Aug. 1962).

C. karsteni PAVILLARD
(Fig. 39, pl. III & 151, pl. X)

JÖRGENSEN (1911)

A large species, with both posterior horns nearly always irregular and variable in shape.

C. karsteni is one of the commonest *Ceratia* in all warm waters. In the Atlantic it extends between about 45° N (GRAHAM and BRONIKOWSKY, 1944, included in *C. contortum* CLEVE) and 45° S (PETERS, 1932, given as *C. arcuatum arcuatum* CLEVE). It is classified by STEEMANN-NIELSEN (1934) as a tropical-subtropical surface form in the Pacific.

C. karsteni was an irregular species in the material examined as it occurred in only 15% of the samples. It was observed in good numbers in Mochima Bay (August and November 1962) and among the "Trench" plankton.

C. lineatum (EHRENB.) CLEVE ?
(Fig. 37, pl. III)

JÖRGENSEN (1911)

A rare northern-temperate form (JÖRGENSEN, op. cit.; GRAHAM and BRONIKOWSKY, 1944), to which the specimen in Fig. 37 has been ascribed with some doubt. A single observation near the Island of Caribe. Transdiameter, 35 μ.

C. longirostrum GOURRET
(Fig. 40, pl. III)

JÖRGENSEN (1911)

Epitheca very gradually extending into the apical horn. The posterior horn slightly but distinctly arcuate. Although not uncommon in the Mediterrenean (JÖRGENSEN, 1920; PAVILLARD, 1937), nearly all records from the Atlantic show *C. longirostrum* to be a scarce, irregular species, restricted to the tropical-subtropical area (PAVILLARD, 1931; PETERS, 1932; GRAHAM and BRONIKOWSKY, 1944). Its northern extension with the Gulf Stream does not seem to exceed about 48° N (GAARDER, 1954). It was classified by STEEMANN-NIELSEN (1934) as a tropical-subtropical surface form in the Pacific, although GRAHAM and BRONIKOWSKY (1944) found it to be a pronounced shade species.

In the Venezuela plankton it was totally absent from Mochima Bay, but occurred in fairly good numbers among the "Trench" plankton, in the Gulf of Paria and near Caribe Island. Transdiameter, 20 μ; ratio of epitheca to hypotheca 1.21.

C. longissimum (SCHRÖDER) KOFOID

JÖRGENSEN (1911)

C. longissimum is a rare intolerant tropical species. Classified by STEEMANN-NIELSEN (1934) among the tropical-subtropical "Schatten-Arten" it was also found to be a pronounced shade species in the Mediterranean by PAVILLARD (1937) and HALIM (1960a) and in both Pacific and Atlantic Oceans by GRAHAM and BRONIKOWSKY (1944). Its rarity is shown by its absence from the records of PAVILLARD (1931) from the Atlantic, and by the occurrence of one specimen

in the collection of the "Michael Sars" from the N. Atlantic (GAARDER, 1954). Only one specimen was observed among the upwelling plankton over the "Trench" (Oct. 1960). Transdiameter, 61 μ.

C. lunula SCHIMPER
(Fig. 21, pl. II)

JÖRGENSEN (1911)

A large long horned species with a triangular epitheca and a smaller hypotheca. The posterior horns are very long and diverging, but often parallel at their distal ends. JÖRGENSEN's distinction of two forms in this species on the basis of the length of the apical horn is not justified, as his two forms correspond respectively to the anterior cell and to the remaining cells of a chain.

C. lunula is a strictly tropical shade species (STEEMANN-NIELSEN, 1934). In the Atlantic Ocean it is only found between 30° S (PETERS, 1932) and 39° N PAVILLARD, 1931; GRAHAM and BRONIKOWSKY, 1944; GAARDER, 1954). *C. lunula* is neither recorded by WOOD (1966) in the Amazon Region nor by MARGALEF (1961) in Porto-Rico.

In the Venezuelan plankton *C. lunula* was recorded in 15% of the samples. It was common among the "Trench" upwelling plankton (Oct. 1960) and also in Mochima Bay in both November 1961 and 1962. Its presence in this Bay is an evidence of offshore influences. Transdiameter, 88 μ.

C. massiliense (GOURRET) JÖRGENSEN f. *macroceroides* (KARST.) JÖRG.
(Fig. 22 & 23, pl. II; fig. 41, pl. III)

SCHILLER (1937)

A variable long-horned species of common occurrence. The *f. macroceroides* which corresponds to the main species of *C. massiliense* (JÖRGENSEN, 1911) was the only one observed in the material examined.

C. massiliense is a tolerant warm water species and one of the commonest of all Ceratia. The main species, according to PETERS (1932), is however less tolerant than var. *armatum* (KARST.) JÖRGENSEN and only reaches to 37° S in the Atlantic. In the N. Atlantic it extends up to 47—50° N probably transported by the Gulf Stream (GRAHAM and BRONIKOWSKY, 1944; GAARDER, 1954). *C. massiliense* is classified by STEEMANN-NIELSEN (1934) as a tropical-subtropical species occurring indifferently in neritic and oceanic waters.

In the plankton of Venezuela *C. massiliense* was recorded as a perennant and fairly regular species. It occurred in 66% of all samples. Transdiameter, 68 μ.

C. pavillardi JÖRGENSEN

JÖRGENSEN (1911)

A relatively large-sized species of a characteristic shape. The posterior outline of the body is angular as the left posterior horn turns abruptly forward, immediately after leaving the body. All horns much thickened in their proximal part. GRAHAM and BRONIKOWSKY (1944) have included *C. pavillardi* into *C. vultur* as a variety of the latter. Together with BALECH (1962) however, it was thought more justified to maintain *C. pavillardi* as an independent species.

C. pavillardi is a well characterized shade species in the Oceans (STEEMANN-NIELSEN, 1934; GRAHAM and BRONIKOWSKY, 1944) as well as in the Mediterran-

ean (PAVILLARD, 1937; HALIM, 1960a). It is relatively uncommon and restricted to warm waters (PAVILLARD, 1931; GAARDER, 1954).

The species was found in only two samples from the "Trench".

C. pentagonum GOURRET
(Fig. 24, pl. II & 60, pl. V)

JÖRGENSEN (1911)

Of this common tolerant warm water form only few specimens were observed. Its occurrence in Venezuelan waters is apparently that of an offshore species as it was only observed among the Trench plankton, except once in Mochima Bay in association with several offshore forms (August 1962).

C. platycorne DADAY
(Fig. 42, pl. III)

JÖRGENSEN (1920)

A relatively small, easily recognisable species of tropical occurrence in all Oceans. Its records in the "Meteor" material do not extend beyond about 33° S (PETERS, 1932), but it has been observed in the Weddell Sea (PETERS, 1929), and in the N. Atlantic it was also recorded in cold waters off Iceland (GRAHAM and BRONIKOWSKY, 1944). It is a pronounced shade species in the Mediterranean (HALIM, 1960a), as well as in the Oceans (GRAHAM and BRONIKOWSKY, 1944; STEEMANN-NIELSEN, 1934).

In the Venezuelan material it was fairly common among the "Trench" plankton (Oct. 1960), but was totally absent from the inshore samples.

C. praelongum (LEMM.) KOFOID
(Fig. 43, pl. III)

JÖRGENSEN (1911)

This rare species can be distinguished from *C. gravidum* GOURRET var. *angustum* JÖRG. by its epithecal sides gradually and regularly broadening into an oblong anterior end, and by the displacement of its apical pore to the right. Transdiameter, 60—65 μ.

C. praelongum is a strictly tropical shade species. Its occurrence in the Atlantic seems to be limited to the area between 25° S (PETERS, 1932) and 38.5° N (GRAHAM and BRONIYKOWSK, 1944). It was found in fairly good numbers among the "Trench" plankton (Oct. 1960).

C. ranipes CLEVE
(Fig. 44, pl. III)

JÖRGENSEN (1920)

C. ranipes is a tropical shade species of wide occurrence in the Oceans as well as in the Mediterranean (STEEMANN-NIELSEN, 1934; GRAHAM and BRONIKOWSKY, 1944; PAVILLARD, 1937).

In the Venezuelan waters it was common among the upwelling plankton over the "Trench" (Oct. 1960).

C. scapiforme KOFOID
(Fig. 45, pl. III)

KOFOID (1907)

non *C. pennatum* var. *scapiforme* JÖRGENSEN (1911)

This is an extremly rare species. Since its description by KOFOID from the Eastern tropical Pacific, it does not seem to have been observed again. A single

specimen was found among the "Trench" plancton (Oct. 1960) with a length of 604.5 μ, a transdiameter of 30 μ and an epitheca to hypotheca ratio of 1.81 (Fig. 45).

The specimen showed a tapering blade-like epitheca and a short, oblique, scarcely differentiated apical horn, as described by KOFOID.

C. symmetricum PAVILLARD
(Fig. 13, pl. 1)

SCHILLER (1937), p. 401, fig. 411 d.)

C. symmetricum is analogous in its distribution and shade habit to *C. coarctatum*. In the Venezuelan plankton however, it was even rarer and occurred only once.

C. trichoceros (EHREN.) KOFOID
(Fig. 25, pl. II)

JÖRGENSEN (1911)

The body is small with thin and elongated horns. All three horns are characteristically parallel in their distal part.

Occurrence: *C. trichoceros* is a widespread strictly intertropical species (PETERS, 1932; STEEMANN-NIELSEN, 1934; GRAHAM and BRONIKOWSKY, 1944; GAARDER, 1954). It is also of common occurrence in the Mediterranean.

C. trichoceros is one of the commonest *Ceratium* species in the Venezuelan plankton. It occurred indifferently in all seasons and in inshore as well as in offshore samples. It is recorded in 70% of all samples.

C. tripos (O. F. MÜLLER) NITZSCH
(Fig. 26 & 27, pl. II)

JÖRGENSEN (1920)
SCHILLER (1937)

One of the most complexe and variable species of the Dinoflagellates. Its world-wide cosmopolitan distribution is accompanied by a highly labile character, which has led to the description of numerous subspecies, varieties, forms and races (JÖRGENSEN, 1911 and 1920; SCHILLER, op. cit.; PAVILLARD, 1931). In the material examined however, the *C. tripos* population was represented by only two forms: *C. tripos* var. *atlanticum* OSTENFELD and *C. tripos* f. *tripodioides* (JÖRGENSEN) PAULSEN. The typical f. *tripodioides* has a slender body, distinctly longer than broad, with a much smaller transdiameter (about 50 μ). The total height of the epivalve (comprising the apical horn) is at least three times the transdiameter. In the typical var. *atlanticum* the body is robust, usually thickened, with a larger transdiameter (about 78 μ) and its height is about equal to the breadth. The height of the epivalve is about twice the transdiameter and the antapical horns are more spreading away from the body. Intermediate forms, however, are common.

C. tripos var. *atlanticum* OSTENFELD (Fig. 26.)

Few specimens of this variety were observed in only one sample from the Gulf of Paria. It is admitted that this variety is more representative of temperate and cold waters in both Atlantic and Pacific Oceans, although it is not absent from tropical waters (PAVILLARD, 1931; PETERS, 1932; GRAHAM and BRONIKOWSKY, 1944).

C. tripos f. *tripodioides* (JÖRG.) PAULSEN (Fig. 27)

This form of *C. tripos* occurred fairly regularly in all seasons. It was recorded in 55% of all samples. The f. *tripodioides* is more restricted in its geographical distribution. It was observed by PETERS (1932), in the S. Atlantic only down to 35° S and by GRAHAM and BRONIKOWSKY (1944) and PAVILLARD (1931) up to 45°N and 47° N.

Genus ***Ceratocorys*** STEIN

C. armata KOFOID
C. horrida STEIN
(Fig. 14, pl. I)

SCHILLER (1937)

Both *C. armata* & *C. horrida* are tropical oceanic species which occurred in single specimens among the "Trench" plankton. They are otherwise of common occurrence in all warm waters although rarely abundant (GRAHAM, 1942).

Genus ***Dinophysis*** EHRENBERG

D. caudata SAVILLE-KENT
(Fig. 48, pl. IV)

SCHILLER (1937)

A common and variable form. *D. caudata* is an interoceanic tolerant warm water species. In the S. Atlantic it is reported by KÄSLER (1938) to be restricted to the warmer neritic waters, although avoiding river mouths. PAVILLARD (1931) however observed it commonly in the central part of the tropical N. Atlantic. It is also reported by various authors from the northern latitudes, probably transported by the Gulf Stream. *D. caudata* is one of the most predominant forms of the Venezuela plankton. Observed in 74% of the samples, it was extremely abundant in the nearshore waters.

D. monacantha KOFOID a. SKOGSBERG
(Fig. 47, pl. IV)

SCHILLER (1933)

Many specimens of this rare species were observed in the Venezuela plankton. They agree with KOFOID's description (in SCHILLER) but for minor differences.

Plate IV

46 *Ceratium gibberum* f. *dispar*, a recently divided specimen. × 200;
47 *Dinophysis monacantha*. The theca is ornamented with two types of poroids × ab. 485;
48 *D. caudata*. × ab. 485;
49 *Gessnerium mochimaensis* n. gen., n. sp., a chain of three cells. × 350;
50 *Gonyaulax diacantha*. × ab. 1000;
51 *G. diegensis*. × 800;
52 *G. tamarensis* v. *excavata*, a chain of three cells. × 465;
53 *Goniodoma polyedricum*, ventral view. × 445;
54 The same specimen in apical view. × 445;
55 *Heterodinium agassizi*, dorsal view × 265;
56 *H agassizi*, left lateral view. × 265;
57 *H. agassizi*, ventral view. × 265;
58 *H. superbum*, ventral view. × 530;
59 *Kofoidinium velelloides*, right lateral view. × 200.

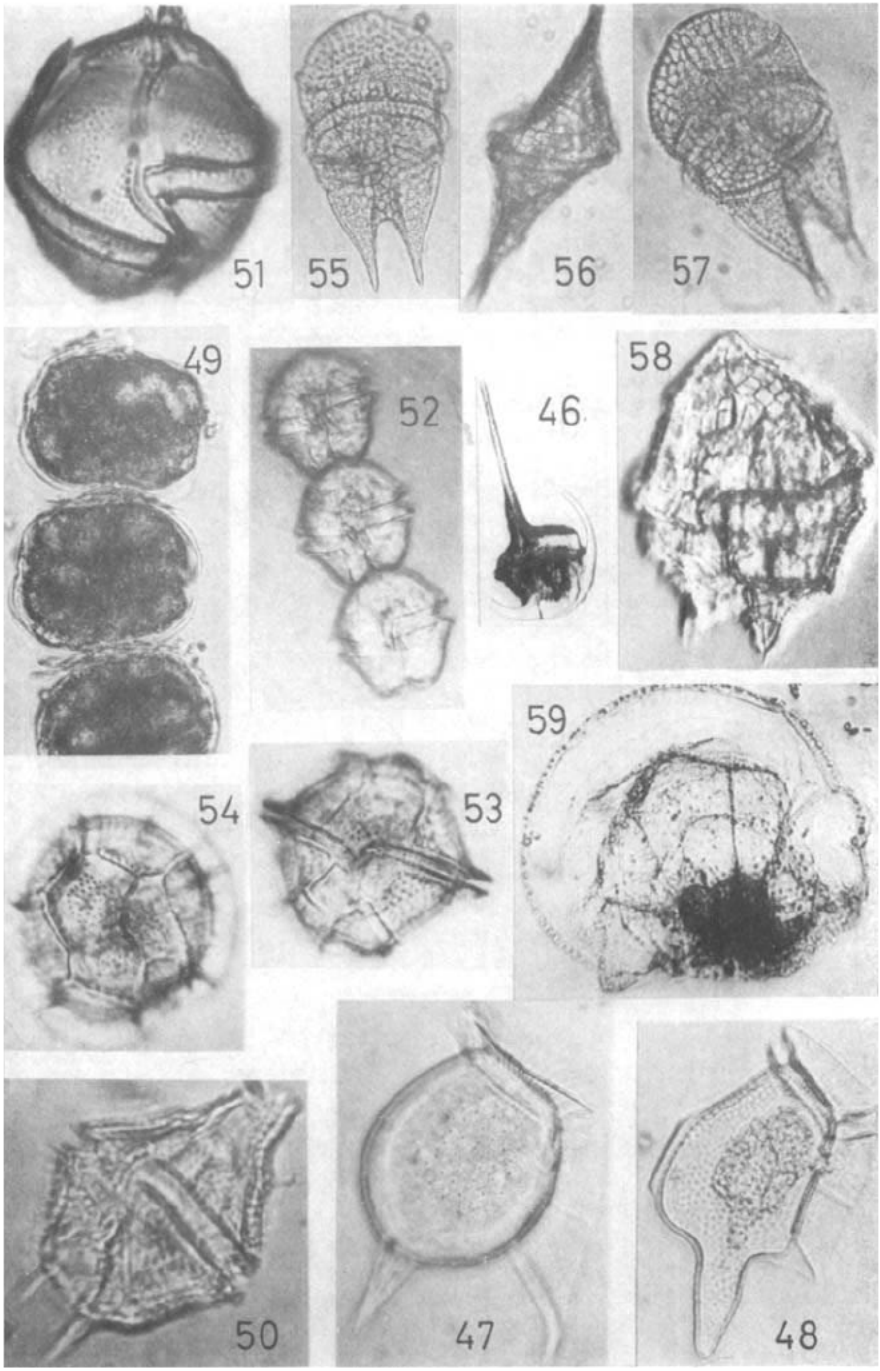

Plate IV

The body is oval to trapezoid with a flattened epitheca, resembling *D. hastata* (see also JÖRGENSEN 1923, *D. hastata* f. *uracanthides*). Distance between R1 and R3 about 0.5 the body length. R3 inclined posteriorly at its distal end by 30°. Antapical wing triangular, median and with a distinct median rib. The presence of this rib together with the absence of a narrow longitudinal list along the dorsal margin are differences with KOFOID's description. The thickened structure of the body wall however might appear as a longitudinal list on focussing downward. The theca is ornamented with larger and smaller poroids, arranged in a regular pattern (fig. 47).

Dimensions: height 59 μ, greatest width 52 μ.

D. monacantha occurred exclusively among the "Trench" plankton. It was previously known from the tropical Pacific (KOFOID and SKOGSLERG in SCHILLER op. cit.; BALECH, 1962).

D. recurva KOF. a. SKOGSBERG
(Fig. 136, pl. IX)

SCHILLER (1933)

D. recurva and *D. punctata* JÖRGENSEN (1920) are two similar species which can not be satisfactorily distinguished from each other.

Single specimens from *D. recurva* were met with among the "Trench" plankton (Oct. 1960) and in the Gulf of Cariaco (Sept. 1960). The theca showed a coarse ornamentation of uniform pit-like areoles. Length, 37—41 μ; greatest diameter, 29—33 μ.

The species is otherwise of common occurrence in the West Mediterranean (JÖRGENSEN, 1923; PAVILLARD, 1937 b; RAMPI, 1940; HALIM, 1960 a) the Adriatic (SCHILLER, op. cit.) and the N. Atlantic (LEBOUR, 1925; GAARDER, 1954).

D. schütti MURRAY a. WHITTING
(Fig. 135, pl. IX)

SCHILLER (1933)

Very few specimens of this warm-water species were found among the "Trench" plankton. The specimen in fig. 135 had a thecal length of 40 μ, greatest diameter 36 μ, height of anterior girdle list, 9.6 μ, and length of antapical wing, 32 μ. The theca is ornamented with uniform pore-like areoles.

Genus ***Exuviella*** CIENKOWSKY

E. marina CIENKOWSKY
(Fig. 61, pl. V)

SCHILLER (1933)

This neritic form was abundant in Mochima Bay in Nov. 1961, and otherwise totally absent. Its dimensions were relatively small: length 29 μ, breadth 16 μ.

Genus ***Gessnerium*** nov. gen.

Diagnosis. Shape broadly lenticular, girdle about equatorial, apical horn very reduced, no antapical horns or spines. Theca transparent, delicate. Epithecal plates ten, three apical and seven precingulars; no intercalary plates present. Precingular plates 1″ and 7″ more reduced in size; first apical plate not connected to girdle; a large apical closing-platelet present. Hypothecal plates eight, five postcingular, one antapical and two posterior intercalary plates. The

antapical plate squarish, indented by the sulcal plates, carrying a central circular ring and radiating ridges. Girdle deeply cavozone; girdle plates seven, equal in size, except g_1 much smaller, crescent shaped. Sulcal area deep, V shaped in optical cross-section; sulcal plates six; flagella pore median. Both girdle and sulcus with margins thickened but devoid of lists.

Discussion: the epithecal structure is analogous to *Goniodoma* and *Pyrodinium* in the number of plates (ten) and their arrangement: 3′, Oa, 7″. The hypothecal structure is similar to *Alexandrium* and *Goniodoma* in the number of plates (eight), but their arrangement is different. Distinctive features in *Gessnerium* however are the girdle plates, the structure of the sulcal area, the hypothecal pattern, with its square antapical plate of a unique shape, and the very light texture of the theca.

Type species: *G. mochimaensis* nov. sp.

G. mochimaensis nov. sp.
(Fig. 49, pl. IV, Fig. 101—108, pl. VIII)

See generic diagnosis.

A chain forming species occurring in Mochima Bay (Fig. 49). The theca is particularly delicate, fragile and weakly resistant to pressure. For this reason, the general outline is not stable as the theca is liable to be slightly deformed. It is characteristically smooth except for a very fine reticulation, lacking any lists or wings. The smoothness and delicate nature of the theca are additional distinctive characters from *Goniodoma* sp. Intact specimens are much larger than high with an l/d ratio of about 0.7. Variable in dimensions, often within the same chain; diameter 57—70 μ. In apical view, circular to oval, g/d ratio, 0.7—1. The epitheca is lenticular, the hypotheca depressed, the antapical plate being concave to fit the following cell of the chain. Apical horn inconspicuous, apical closing-platelet large, well developped, oblong in shape, with thickened margins. The apical pore is surrounded by a circular ridge. The antapical plate is large, squarish but for a deep indentation into which fit the sulcal plates. It shows a cental ring — like alveole with a number of radiating ridges. At the center of the alveole, the posterior attachment pore is to be found.

The sulcal plates (fig. 107—108) are six: two posterior, r.p.s. and l.p.s., one right, r.s., one anterior, a.s., one left, l.s., and a small left acessory, l.ac.s., between l.s. and l.p.s. The anterior sulcal a.s., fits into the cavity of the crescent shaped first girdle plate. All sulcal plates are connected to the flagella pore.

Genus ***Goniodoma*** Stein

G. polyedricum (Pouchet) Jörg.
(Fig. 53 & 54, pl. IV)

Schiller (1937)

A characteristic polyedrical species of moderate size. The theca is robust and angular, covered with large pits having pores at their center. All plate sutures are marked by thick lists.

Occurrence. *G. polyedricum* is a tolerant tropical-subtropical species widespread in the Atlantic (Pavillard, 1931; Graham, 1942; Gaarder, 1954) the Baltic (Aurivillius in Schiller op. cit.) the Mediterranean (Pavillard, 1937 b) and the Pacific (Graham, 1942; Rampi, 1952; Balech, 1962).

In the plankton of Venezuela it occurred in fairly good numbers in 18% of the samples, but mostly in Summer and Autumn.

Dimensions. The specimen in fig. 53 is 62.5 μ in height and 58 μ in diameter. GRAHAM (1962) gives a wide range: length 40-93 μ, diameter 45—100 μ.

Genus ***Gonyaulax*** DIESING

G. diacantha (MEUNIER) SCHILLER
(Fig. 50, pl. IV)

SCHILLER (1937)

An irregular but often abundant species in the plankton of Venezuela. Although it occurred in Mochima Bay, it seems to be more abundant in the open waters, near Caribe Island, between Aves and Lo Guaira and also in the Gulf of Paria. Recorded by MARGALEF (1961) near Porto-Rico, it is also found off Dakar (SILVA, 1956), in the West Mediterranean (HALIM, 1960, a) and at Dröbak, Oslofjord (HASLE and SMAYDA, 1960).

G. diacantha was frequent in 22% of all samples.

G. diegensis KOFOID
(Fig. 51, pl. IV)

SCHILLER (1937)

G. diegensis was especially abundant in Autumn near Caribe Island and in Mochima Bay.

G. polygramma STEIN

SCHILLER (1937)

This widespread warm-temperate species was recorded in 22% of the samples. It is numerically less frequent than *G. diacantha*.

G. tamarensis LEBOUR var. *excavata* BRAARUD
(Fig. 52, pl. IV)

GAARDER (1954)

A chain forming species which was common in Mochima Bay in Nov. 1962. Observed by GAARDER (1954) off the west coast of Marocco. The specimens from Mochima Bay are similar in all respects, except that plate 4'' is here connected to both 3' and 4' as in *G. tamarensis* and not to 3' only (GAARDER 1954, fig. 30c, p. 27). Length, 37 μ; width 35 μ.

Genus ***Heterodinium*** KOFOID

H. agassizi KOFOID
(Fig. 55—57, pl. IV)

SCHILLER (1937)

H. agassizi was fairly common among the "Trench" plankton. It was observed by GAARDER (1954) in the Sargasso Sea and the Spanish Bay and by PAVILLARD (1937 b) off Monaco. In both cases it only occurred in vertical hauls. The species is previously known also from the Pacific Ocean.

H. superbum KOFOID
(Fig. 58, pl. IV)

SCHILLER (1937)

This rare species was only known from the Pacific. Observed twice among the "Trench" plankton.

Length 83 μ; breadth 64 μ.

Genus ***Kofoidinium*** PAVILLARD

Only one species described.

K. velelloides PAVILLARD
(Fig. 59, pl. IV)

CHATTON (1952)

A large sized heterotrophic Dinoflagellate, probably related to the Noctilucidae. The body is flattened, discoidal and transparent. The semicircular thicker margin, termed "veliger arch", is dorsal, while the denser cytoplasmic mass is ventral. The "anterior chamber" of unknown function, mentioned by PAVILLARD, appears at the anterior pole (fig. 59). A large nucleus can be seen, contiguous and posterior to the denser cytoplasmic mass. FENAUX (1958) has described several slightly different stages which were also observed in the Venezuelan plankton. *K. velelloides* is not uncommon in the winter surface plankton of the Mediterranean (PAVILLARD, 1936b; MARGALEF, 1957; HALIM, 1960a). It is much more frequent however in the deeper strata down to 900 m, but mainly in the upper 300 m (FENAUX, 1958). It was observed in the Pacific by RAMPI (1952) and BALECH (1962) and in the Atlantic by PAVILLARD (1931). All records are from tropical–subtropical waters, although PAVILLARD found it once at 61° N in the Atlantic.

Several specimens occurred among the "Trench" plankton and one specimen was observed in Mochima Bay (Aug. 1962).

Genus ***Noctiluca*** SURIRAY

N. miliaris SURIRAY

SCHILLER (1937)

Common and often in large numbers, especially in Summer.

Genus ***Ornithocercus*** STEIN

O. magnificus STEIN

SCHILLER (1937)

A common tropical–subtropical species. KÄSLER (1938) reported *O. magnificus* as the commonest and most widely distributed species of the Dinophysiales in the warm waters of the S. Atlantic. It constituted 37.1% of all recorded *Ornithocercus* species.

In the plankton of Venezuela it was not uncommon over the "Trench" (Oct. 1960) and also occurred once in Mochima Bay (Aug. 1962).

O. steini SCHÜTT
(Fig. 65, pl. V)

SCHILLER (1937)

Although widely distributed in all warm waters, *O. steini* is less common than the preceding. It was fairly regularly observed by KÄSLER (1938) in the tropical and equatorial Atlantic but made up only 13% of *Ornithocercus* records. Its occurrence in the N. Atlantic does not exceed 40° N (GAARDER, 1954).

In the waters of Venezuela, *O. steini* occurred among the "Trench" plankton (Oct. 1961), but also once in Mochima Bay (Aug. 1962). The occurrence of both *O. magnificus* and *O. steini* in Mochima Bay during August 1962 is an evidence of offshore influences.

O. splendidus SCHÜTT
(Fig. 62—64, pl. V)

SCHILLER (1937)

The body of this beautiful species is some what variable in outline and in dimensions. In the specimen of fig. 64 the greatest diameter of the wing-like lists is of 214 μ, the oblong theca is only 45 μ in width and 72 μ in length. Recently divided specimens were also observed.

O. splendidus, although occurring in the Mediterranean (PAVILLARD, 1937 b), is a relatively rare, strictly inter-tropical and equatorial species (MATZENAUER, 1933; KÄSLER, 1938; RAMPI, 1952; GAARDER, 1954; BALECH, 1962). It is also a pronounced shade species. KÄSLER observed a frequency of 56% relative to all *Ornithocercus* below 100 m and only 6.1% from 100 to 0 m.

In the Venezuela material several specimens were observed but only among the upwelling plankton of the "Trench" (Oct. 1961).

Genus *Oxytoxum* STEIN
O. longiceps SCHILLER
(Fig. 149, X)

SCHILLER (1937)

One specimen was observed in Mochima Bay (Sept. 1961).
Length, 54.5 μ; breadth 17.5 μ.

Genus ***Peridiniopsis*** MANGIN

P. asymmetrica MANGIN
(Fig. 66 & 67, pl. V; 109—111, pl. VIII)

SCHILLER (1937, *Glenodinium lenticula* f. *asymmetrica*)

A cosmopolitan and variable species, lenticular to nearly spherical in shape. *P. asymmetrica* is a widespread euryhaline and eurythermal species, occurring in the Subarctic (PAVILLARD, 1931), the Baltic Sea and English Channel (SCHILLER op. cit.; LEBOUR 1925), the Mediterranean (PAVILLARD, 1937 b; HALIM, 1960 a), the Indian Ocean (MATZENAUER, 1933) and the Chinese waters (WANG, 1936 a). A regular and perennant form in the plankton of Venezuela, it was highly abundant in inshore as well as in offshore waters. Recorded in 60% of all samples.

The plate pattern in the examined material was highly variable and the variations affected both epithecal and hypothecal plates: a) in some specimens the small epithecal intercalary is totally absent (fig. 110) but in one case, two inter-

Plate V.

60 *Ceratium pentagonum* × 330;

61 *Exuviella marina*. × 1665;

62 *Ornithocercus splendidus*, posterior dorsal view. × 185;

63 *O. splendidus*, the same specimen in apical view showing the girdle lists. × 170;

46 *O. splendidus*, another specimen in apical view. × 170;

65 *O. steini*, lateral view. × 290;

66 *Peridiniopsis asymmetrica*, antapical view. × 570;

67 *P. asymmetrica*, apical view. The poroids and the denticulate sutures of the plates are visible;

68 *Peridinium abei*, right lateral view. × 665;

69 *P. abei*, dorso-lateral-view;

70 *P. claudicans*, ventral view. × 540;

71 *P. claudicans*, inclined ventral view, showing the ventral epithecal plates.

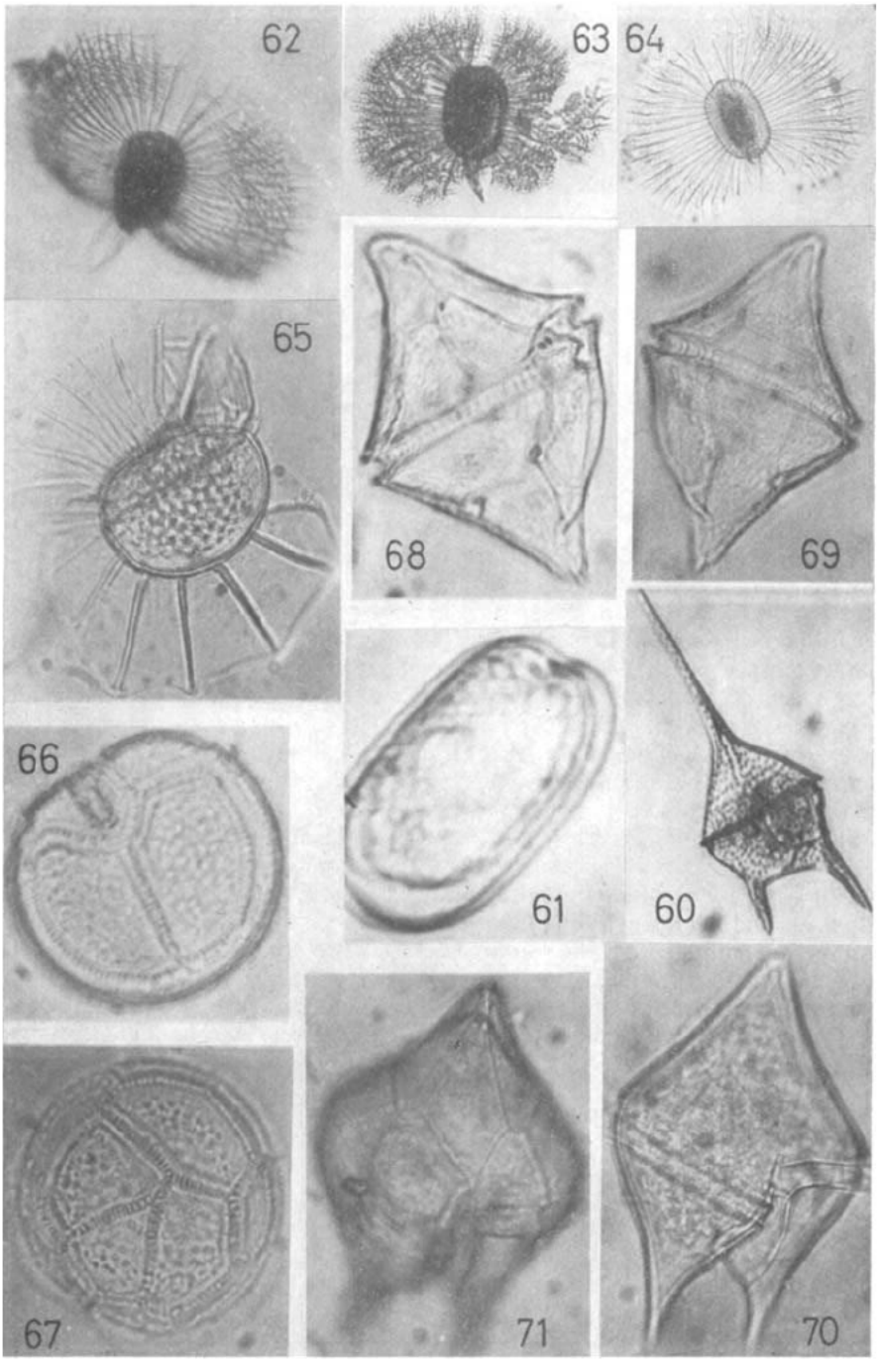

Plate V

calaries were observed (fig. 109). b) The precingular plates are normally six, but specimens with five (fig. 110; see also SCHILLER, op. cit., fig. 97f, g.) or seven (fig. 67) were also observed. c) The antapical plates are normally two in number, but specimens with only one large antapical plate, as in *Diplopeltopsis minor* (PAULSEN) PAVILLARD, occurred.

Dimensions: width (lateral diameter), 45—64 μ; dorso-ventral diameter, 43—62 μ; six specimens measured.

Genus ***Peridinium*** EHRENBERG

P. abei PAULSEN
(Fig. 68 & 69, pl. V)

SCHILLER (1937)

P. biconicum ABÉ (1927, p. 416, Fig. 34 A—G)

A characteristic medium sized species. In ventral view, the body is biconical to fusiform, with straight to slightly concave sides. The plate formula is 4, 2a, 7″, 5‴, 2⁗. The first apical is an elongated plate and the two intercalaries, both hexa, are slightly asymmetrical, plate 1a being smaller. The girdle is deeply cavozone, median in position but descending (left handed), with distinct "overhang".

Dimensions: *P. abei* is variable in length and breadth, and variability affects also its relative dimensions. The specimens of ABÉ measured 70 μ in length (l), 47 μ in breadth (d) and 44 μ in dorso-ventral diameter (g). The Venezuela specimens measured respectively 70—80 μ and 52.8—58.5 μ. The l/d ratio for ABÉ's specimen is 1.4, while the observed ratio in my specimens varies from 1.3 to 1.5. MATZENAUER (1933) on the other hand found a slender and much elongated form in the Indian Ocean with an l/d ratio of 1.8 which he designated as f. *elongata*, while SCHILLER (1937) figures a specimen from Sumatra with a much plumpish outline, which according to his figure would have an l/d ratio of 1.09.

Occurrence: Mutsu Bay (ABÉ, 1927); common in the Red Sea and the tropical Indian Ocean (MATZENAUER, 1933). It was also observed by KISSELEV (1950) in the Peter-the-Great Gulf and by WOOD (1954) in the neritic and estuarine waters of Australia. Recorded by PAULSEN (1931) from the Mediterranean, it is absent from the records of PAVILLARD (1931) and GAARDER (1954) from the Atlantic and of WOOD (1966) in the Amazon Region. MARGALEF (1961) has recorded its occurrence as rare in Porto-Rico. In the Venezuela plankton, *P. abei* occurred in 18% of all samples, but exclusively during September–October in different years.

P. brochi KOFOID and SWEZY
(Fig. 72 & 73, pl. VI)

SCHILLER (1937)

A variable species of common occurrence in temperate seas, *P. brochi* has been often confused with *P. divergens* EHRENB. It is characterized by its rounded mid-body in ventral view, by its flat to slightly cavozone girdle, very slightly ascending (right-handed). *P. divergens* should be distinguished by its descending (left-handed) girdle (PAULSEN, 1949) and less rounded mid-body (SCHILLER, 1937). The relation between the two species however is still confused and misleading.

Dimensions. BÖHM (1933) in the Adriatic has observed a continuous range of variation in length from 62.7 to 96.2 μ and in diameter from 55.4 μ to 75.8 μ. The observed specimens in the Venezuela plankton were of two types, a larger type with an average l of 109 μ and average d 86.8 μ and a smaller type with an average l 69.5 μ and an average d 51.0 μ. The l/d ratio is nearly constant, respectively 1.26 and 1.35.

Occurrence. The confusion of *P. brochi* with *P. divergens* in the literature has somewhat obscured its geographical distribution. In spite of this, *P. brochi* appears to be a tolerant very common sub-tropical species. It is common in the Red Sea, in the equatorial and tropical Indian Ocean (MATZENAUER, 1933), in the tropical Pacific (BALECH, 1962), in the Atlantic around the British Isles and North of Ireland (GAARDER, 1954) in the Argentine waters around 31° S (BALECH 1959) as well as in the Mediterranean where it is very common (BÖHM, 1933; PAVILLARD 1937) and the Black Sea (KISSELEV, 1950).

P. brochi is a perennant and predominating species in the plankton of Venezuela. It occurred in 63% of all samples. It was highly abundant in the Summer from May to August.

P. cerasus PAULSEN
(Fig. 122, pl. IX)

LEBOUR (1925)

Exclusively observed among the "Trench" plankton in single specimens.

P. claudicans PAULSEN
(Fig. 70 & 71, pl. V; 118, pl. VIII)

SCHILLER (1937)

BALECH (1951)

A species of average dimensions, related to the "Formenkreis" of *P. oceanicum*. *P. claudicans* can be distinguished from the latter by its relatively larger mid-body and its short and stout horns. The body sides are only slightly concave, while in *P. oceanicum* they are deeply so. As the body is relatively larger, the length to width ratio is smaller: 1.5 as an average, for 1.9 as given by GRAHAM (1942) for *P. oceanicum*. In the observed specimens the posterior horns are parallel, cuneate with a large base. They are slightly unequal in length, the right horn being longer by little more than one girdle width. The dorsal tabulation is known to be variable (SCHILLER, op. cit.). About two-thirds of the specimens showed plate 2a to be five sided, while in the remaining third it was four sided as observed also by BALECH (1951).

Dimensions: length 96—107 μ; diameter 64—70.5 μ.

Occurrence: as already mentioned *P. claudicans* has been often confused in the literature with the varieties of *P. oceanicum*, and in particular var. *oblonga*. For this reason it is difficult to ascertain its geographical distribution.

P. claudicans is generally admitted to be a neritic species of temperate-boreal occurrence. There are many mentions of *P. claudicans* from neritic and brackish European waters (SCHILLER, 1937) and from the Mediterranean. It is also recorded off Angola by 16° S (SILVA, 1958) and Uruguay (BALECH 1951). BÖHM (1931) has described a *P. claudicans* f. *crassa* from the Persian Gulf which is probably this species. It was also observed in the Pacific by BALECH (1962) but only at one station (34° N) and by KISSELEV (1950) in the Japan Sea. WOOD (1954) mentions *P. claudicans* as very widely distributed from Tasmania to

Solomon Isles but his fig. 155a, given under *P. claudicans* probably represents the var. *oblonga* of *P. oceanicum*. In the examined material *P. claudicans* occurred only in offshore samples near Aves and Caribe Islands, but it was abundantly represented.

P. conicum GRAN
(Fig. 74, pl. VI)

SCHILLER (1937)

A variable but easily recognisable species of wide occurrence.

Dimensions. *P. conicum* is variable in dimensions. Its length is given by SCHILLER (op. cit.) as 70—80 μ. BÖHM (1933) found two length-types in the Adriatic, one with l 52—60 μ and the other with l 64—78 μ. BALECH (1949) also mentions the occurrence of dwarf-forms (the locality is not stated) which otherwise do not differ from the others. His specimens measured 67.5—105 μ (l) and 59.5—89.5 μ (d). ABÉ (1927) gives 95 μ and 80 μ for the Mutsu Bay specimens. The Venezuela specimens on the other hand were relatively homogeneous with l 70—82 μ, d 65.6—74 μ and an l/d of 1:1.2—1:1.10.

Occurrence. *P. conicum* is a cosmopolitan eurythermal and euryhaline species. Of common occurrence in the tropical and temperate Atlantic (GAARDER, 1954), it is also observed in the Oslo Fjord (BRAARUD and BURSA, 1939; BRAARUD and others, 1958), in the Rovdefjord and up to 65° in the North Atlantic (PAVILLARD, 1931). It was recorded in several samples from Porto-Rico by MARGALEF (1961) and occurs also in the Amazon Region (WOOD, 1966). *P. conicum* is also of common occurrence in the Mediterranean (BÖHM, 1933; PAVILLARD, 1937b; HALIM, 1960a), the Pacific and Indian Oceans (ABÉ, 1927; MATZENAUER, 1933; KISSELEV, 1950; WOOD, 1954). In the plankton of Venezuela, *P. conicum* was perennant and common, although somewhat irregular. It was recorded in 18% of all samples, with a distinct increase in September–October. Its high abundance among the neritic plankton of the Mangrove Bay is noteworthy.

P. crassipes KOFOID
(Fig. 75, pl. VI)

SCHILLER (1937)

GRAHAM (1942)

A variable but recognisable species of a moderately large size. Both epithecal and hypothecal margins pronouncedly concave in ventral view (Fig. 75). The

Plate VI

72 *Peridinium brochi*, dporsal view of a "dwarf" specimen. × 560;

73 Apical view of the same specimen showing the apithecal plates and their thin reticulation × 720;

74 *P. conicum*, ventral view. × 600;

75 *P. crassipes*, ventral view. × 395;

76 *P. exiquipes*, inclined ventral view. × 390;

77 *P. exiquipes*, showing the outline in apical view at girdle level. × 230;

78 *P. grande*, ventral view. × 450;

79 *P. grande*, epitheca, ventral view. The first apical plate can be seen to be of the mêta-type;

80 *P. grande*, partly dissociated sulcal plates. All plates are finely reticulate;

81 *P. obtusum*, inclined ventral view × 340;

82 *P. pentagonum* f. *depressum*, ventral view; the girdle ends are on the same level. × 530;

83 *Peridinium pentagonum* f. *depressum*, showing the outline in apical view at girdle level. × 710;

84 *P. subinerme*, ventral view. × 500

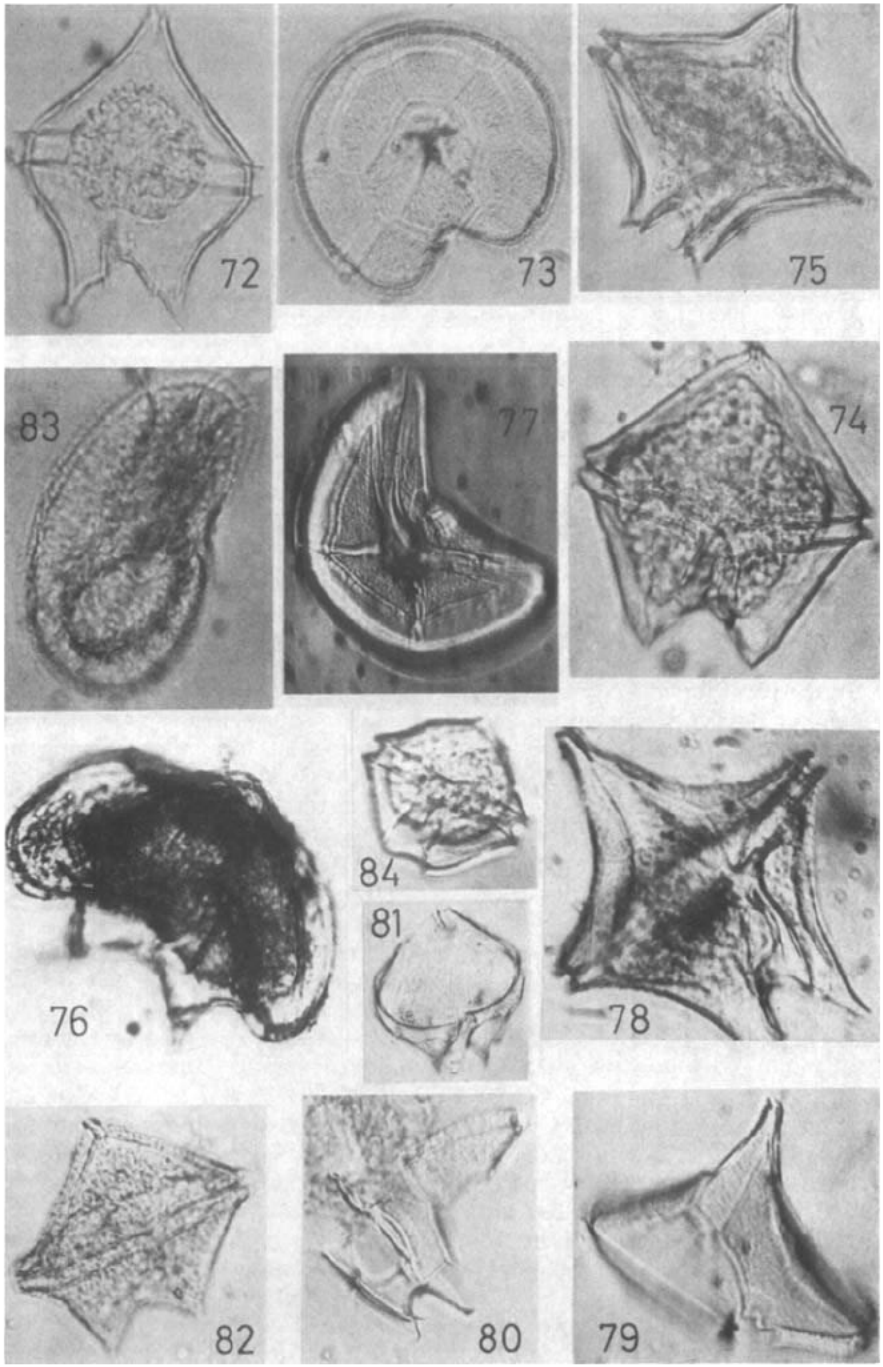

Plate VI

right posterior horn usually longer than the left. The girdle is equatorial, descending (left-handed) but its ends are only displaced by about one half girdle-width. The left part of the girdle is arched in ventral view, but the extent of the curvature is variable and it might be nearly level. In apical view it is almost circular except for the ventral depression. Plate pattern mêta-quadra. According to SCHILLER (op. cit.) and PETERS (1928), however, plate 2a can be sometimes five-sided.

Dimensions. The specimens of Venezuela are nearer to the lower limit of the range found by GRAHAM (1942) for the Pacific representatives of *P. crassipes*, but they agree in relative dimensions. Length l, 92 μ; breadth d, 96 μ; dorso-ventral diameter g 68.8. The l/d ratio is 0.95 (for 0.95) and the g/d ratio 0.74 (for 0.73). The angle α which measures the extent of flattening at the girdle level, is also exactly 89°.

Occurrence. *P. crassipes* was described by KOFOID from the neritic plankton of San-Diego, California. It occurs also in the tropical and equatorial Pacific, Indian and Atlantic Oceans (PAVILLARD, 1931; MATZENAUER, 1933; GRAHAM, 1942) as well as in the Antarctic (PETERS, 1928). It is common in the N. Atlantic at least up to 60° N (GAARDER, 1954) and in the Oslo Fjord (BRAARUD and BURSA, 1939). If we admit the identity of *P. curtipes* JÖRGENSEN with *P. crassipes* KOFOID as suggested by PETERS (1928) and SCHILLER (1937), the species also occurs in the Arctic Sea (PAVILLARD, 1931). This wide range of habitats might explain its variability. It can be concluded that *P. crassipes* is a truely cosmopolitan species, euryhaline and eurythermal, which is not restricted to any particular type of sea water.

In the plankton of Venezuela *P. crassipes* occurred in 43% of all samples. In Mochima Bay, it was recorded as a perennant form particulary abundant in Summer and Autumn. It also occurred in considerable numbers among the "Trench" plankton (Oct. 1960), near the Island of Caribe (Oct. 1961) and in the Mangrove Bay (Oct. 1961).

P. deficiens MEUNIER
(Fig. 123 & 124, pl. IX)

SCHILLER (1937)
GAARDER (1954)
? *P. conicum* f. *islandica* BRAARUD (in SCHILLER, 1937); KISSELEV (1950)

This rare species is characterized by an abnormal plate pattern, the large asymmetrical first apical plate being fused with the fourth apical. The hypotheca is smaller than the epitheca (Fig. 123) as was also observed by GAARDER (1954) and as appears from the figures of WOLOSZYNSKA (SCHILLER, op. cit., p. 267, fig. 267a). The cell is distinctly larger than high (l/d ratio, 1:1.3). Except for the absence of plate 4′ and the shape of 1′, the plate formula is normal: 3′, 3a, 7″, 5‴, 2⁗. Plate 2a is quadrangular. Girdle cavozone, without displacement. GAARDER (1954) has suggested a connection between this species and *P. conicum* f. *islandica* BRAARUD. This connection is corroborated by the identity of the two forms in general outline, as well as in the anomalous plate 1′. BRAARUD's figures, however, show a distinct ascending displacement of the girdle.

Dimensions: *P. deficiens* shows a wide range of dimensions: MEUNIER observed a diameter of 40—55 μ, and GAARDER of 35—85 μ. The observed specimen had a diameter d of 78 μ and a height of 58.5 μ; dorso-ventral diameter g: 54.5 μ.

Occurrence: It was first reported by MEUNIER from the Belgian coastal waters, then by WOLOSZYNSKA (in SCHILLER, op. cit.) from the brackish Baltic Sea and by GAARDER (1954) from the N. Atlantic. The latter author found it at several stations between 25° and 50° N. Its occurrence in the Baltic and the North Seas is also reported by KISSELEV (1950).

In the Venezuelan plankton a single specimen was found near the Island of Caribe (Oct. 1961).

P. depressum BAILEY

SCHILLER (1937)
GRAHAM (1942)

A cosmopolitan and variable species of common occurrence in all seas and often in great numbers. Quantitatively one of the dominant forms of the Venezuela plankton. It occurred abundantly in 50% of the samples.

P. diabolus CLEVE
(Fig. 116 & 117, pl. VIII)

SCHILLER (1937)

Observed among the "Trench" plankton in small numbers.

P. exiquipes (MANGIN)
(Fig. 76 & 77, pl. VI)

SCHILLER (1937)
WANG (1936), *P. parapentagonum*

A characteristic, relatively large-sized species. MANGIN who named it has given a figure without diagnose.

Body shape. *P. exiquipes* exhibits a pronounced asymmetry in both ventral and apical views. In ventral view (Fig. 76, 77) the cell is pentagonal, larger than high (l/d, 1: 0.80—0.89), and distinctly compressed antero-posteriorly at the girdle level. Epithecal margins slightly concave, while hypothecal margins strongly so. The posterior horns are separated by a large although relatively shallow depression. The girdle does not lie in one plane, being spiral and descending. Besides, its proximal (left) end is arched and raised above the girdle plane, in a similar manner to *P. depressum*. Girdle ends displaced by more than one girdle width. The epitheca culminates into an apical slit but there is no distinct apical horn. Posterior horns short and strongly cuneate. The sulcum does not reach the antapical pole.

In apical view the cell is basically kidney-shaped, strongly depressed dorso-ventrally along the median axis, but the lateral limbs are well developped and extend ventrally. The ventral margin of the cell in this view is broadly V shaped (Fig. 77), a major difference with *P. pentagonum* f. *depressum* ABÉ (= *P. pentagonum* f. *latissimum* (KOF.) SCHILLER) which is flat reniform. The epitheca shows a pronounced asymmetry as already mentioned. The asymmetry first appears from the lateral displacement of the apex into the right limb and second from the unequal development of the two body limbs. This asymmetry is due to plates 2′, 2″, 3″ and 1a being more developped than their homologues on the right side. As a consequence, other epithecal plates have been displaced from their normal position towards the right, into the right epithecal limb. All plates are covered with a conspicuous spiny reticulation. The plate pattern is ortho-quadra.

Dimensions. *P. exiquipes* appears to be variable in size but fairly stable in body shape, as indicated by its relative dimensions (ratio of length to breadth l/d, and of dorso-ventral diameter to breadth, g/d). The measurements given by MANGIN (in SCHILLER, op. cit.) are l, 155 µ and d, 190 µ (l/d 0.81). The Mediterranean specimens (see below) are much smaller: l 87 µ, d 108 µ but the l/d ratio is constant (0.80).

The Venezuelan representatives are of an average size (d 144—160) and their l/d ratio is comparable. The specimen given by PAVILLARD (1931, fig. 5B, plate II) must have measured 120 µ in diameter d according to the figure scale. The ratio d/g which expresses the dorso-ventral flattening is slightly more variable (d/g, 2.4 for the Mediterranean and 1.9 to 2.0 for the Venezuelan specimens).

Affinities. SCHILLER (op. cit.), although maintaining the species of MANGIN, suggests that it is probably identical to *P. pentagonum* var. *latissimum* (KOF.) SCHILLER. In fact the two forms have been confused by PAVILLARD (1931), as his fig. 5A and B, plate II, given under *P. latissimum* KOFOID represents nothing but *P. exiquipes* MANGIN. A similar confusion was made by HALIM (1965). The latter species however can easily be separated from *P. pentagonum* var. *depressum* ABÉ (= *P. pentagonum* var. *latissimum* (KOF.) SCHILLER) not only by its greater dimensions but first of all by its strongly left-handed girdle and broadly V-shaped apical view. ABÉ's variety has a closed girdle and in apical view, it is flat reniform, nearly oval in outline (fig. 82—83).

Occurrence. *P. exiquipes* was described by MANGIN from China, and later by WANG (1936), from the same region, under *P. parapentagonum*. It was also recorded several times within the Straits of Gibraltar and the neighbouring Atlantic waters by PAVILLARD (1931), and in the East Mediterranean (Alexandria) by HALIM (1965). In the Venezuela plankton it was only observed in one sample from the Gulf of Paria (April 1962), where it was abundant.

P. fatulipes KOFOID
(Fig. 127, pl. IX)

KOFOID (1907)

Observed in single specimens among the "Trench" plankton. Length, 200 µ; breadth, 156 µ.

The species created by KOFOID is most probably an "aged" form of *P. elegans* CLEVE. The broadly enlarged intercalary bands and the heavily sculptured plates result from growth and enlargement of the theca. Such characters can not be retained as diagnostic features, as KOFOID (1907) and subsequent authors did (PAVILLARD, 1931; MATZENAUER, 1933; SCHILLER, 1937). *P. fatulipes* however has been maintained as a separate species until more is known about its sulcal tabulation.

P. globulus (STEIN) SCHILLER s. dil.
P. globulus var. *quarnerense* BR. SCHRÖDER

SCHILLER (1937)

Several globular and lenticular forms belonging to the species included by SCHILLER under *P. globulus* were common among the "Trench" plankton. They will be later subjected to a more close examination.

P. grande KOFOID
(Fig. 78—80, pl. VI)

KOFOID (1907)

P. grande is a relatively large sized species characteristic of warm seas. The body sides in ventral view (Fig. 78) are deeply concave as the theca is strongy compressed at girdle level (angle about 75°). In the observed specimens the length is 1.15—1.30 times the transdiameter. Girdle equatorial, without displacement. Apical horn well defined, antapicals cuneate but stout at their base. KOFOID has stated that *P. grande* belongs to the *divergens*, but he has given no ventral view of his specimen. SCHILLER (1937) gives it as *meta* or *ortho*. PAVILLARD (1931) however, and MATZENAUER (1933) have represented *P. grande* as *meta*. All observed specimens in the examined material were metaquadra (Fig. 78 & 79).

Dimensions: The specimens of Venezuela are slightly smaller than those of KOFOID from the Pacific. Length, 124—141 μ; diameter, 93—122 μ.

Occurrence. A strictly tropical, relatively rare species, as appears from its distribution in the Atlantic (PAVILLARD, 1931), the Pacific (BALECH, 1962) the Red Sea and Indian Ocean (MATZENAUER, 1933). WOOD (1954) mentions *P. grande* from several places in Australia. His specimens however seem to be of the ortho-type (Fig. 142, p. 245). It is most probably a shade species as appears from its occurrence in the Mediterranean (PAVILLARD, 1937; HALIM, 1960a). GAARDER (1954) observed it in only one vertical haul (0—100 m) at the border of the Sargasso Sea.

In the Venezuela plankton it was not uncommon among the "Trench" plankton, but single specimens also occurred in Mochima Bay (August 1962) together with other deep water forms.

P. minutum KOFOID
(Fig. 125 & 126, pl. IX)

SCHILLER (1937)

BALECH (1964)

Observed in the offshore samples in limited numbers, it was particularly abundant near Caribe Island (Oct. 1961). Length, 45 μ; breadth, 43 μ.

P. matzenaueri BÖHM
(Fig. 89, pl. VII)

BÖHM (1936)

MATZENAUER (1933), *P. punctulatum* f. *asymmetrica*

? Syn. *P. persicum* SCHILLER (= *P. schilleri* BÖHM), SCHILLER (1937)

This easily recognisable form is characterised by the asymmetry of its hypothecal outline, due to the greater development of the left posterior horn. Both horns are more or less rounded and devoid of spines. The tabulation is orthohexa and the girdle slightly left-handed. The sulcal area is strongly depressed.

Occurrence. *P. matzenaueri* (= *P. punctulatum* f. *asymmetrica* MATZ.) is a rare form. It was described from the Indian Ocean where it only occurred in two samples (MATZENAUER, op. cit.), and later observed by BÖHM (1936) in the W. Pacific. In the Venezuelan plankton it was common in the Mangrove Bay (Oct. 1960) and also occurred near Caribe Island and in the Gulf of Cariaco, but in smaller numbers.

P. obtusum (KARSTEN) BALECH
(Fig. 81, pl. VI)

BALECH (1949)
SCHILLER (1937)

An insufficiently known little species which was redescribed by BALECH (op. cit.). Pentagonal in ventral view, the cell is slightly larger than high. The girdle plane is strongly inclined. Antapical horns short and pointed. A distinctive character is the asymmetry of the losange plate 1'. The upper triangle has a smaller area than the lower one and the right triangle is also more developed than the left one (BALECH, op. cit.). All plates show a reticulate ornamentation which can appear as longitudinal striae. The species is likely to have been often confused with *P. punctulatum* and *P. subinerme*.

Occurrence: previously known from the Atlantic, it was also found off Argentine (38° 30 S) by BALECH (op. cit.) and from Cape Finisterre to Morocco by GAARDER (1954). Observed in the Gulf of Cariaco and off Caribe Island, it was particularly abundant among the Mangrove Bay plankton.

P. oceanicum VANHÖFFEN
(Fig. 87, pl. VII)

SCHILLER (1937)
GRAHAM (1942)

A variable and complex species. Sporadically observed in 10% of the samples it does not seem to be indigenous in the inshore waters of Venezuela.

The specimens observed are of smaller dimensions than those reported by GRAHAM (1942) and BALECH (1951). Length, 136—144 μ; transdiameter 74 to 78 μ; l/d ratio 1.8.

P. oceanicum VANH. var. *oblongum* AURIVILLIUS
(Fig. 88, pl. VII)

SCHILLER (1937, p. 261, fig. 257 c, d, e. *P. oceanicum* in part)

In the material examined, specimens belonging to this varicty were always observed to be fairly stable in shape and distinctly differentiated from the main

Plate VII

85 *Peridinium subinerme*, apical view showing the epithecal plates. The second medio-dorsal plate is of the hexatype. × 830;
86 *P. pentagonum* f. *depressum*, ventral epitecal plates;
87 *P. oceanicum*. × 365;
88 *P. oceanicum* v. *oblongum*. × 410;
89 *P. Matzenaueri*. × 565;
90 *P. quinquecorn*, apical view showing the presence of three intercalary plates. The second and third are not connected. × 600;
91 *Phalacroma cuneolus*, detached left valve, showing the structure of the theca. × 435;
92 *P. cuneus*, the bivalved shell is dissociated;
93 *P. cuneus*, left lateral view of a half shell showing the coarsely reticulate ornamentation. The ventral list is not visible. × 130;
94 *P. rotundatum*, right lateral view of a megacytic specimen. × 480;
95 Apical view of the same specimen;
96 *Prorocentrum maximum*, a half shell showing the 2 types of poroids. × 990;
97 *P. rostratum*. × 445;
98 *Pyrocystis robusta*. × ab. 1100;
99 *Pyrodinium bahamense*, apical view, showing the large apical-closing platelet and the three apical plates. × 375;
100 *Spiraulax Jollifei*. × 330.

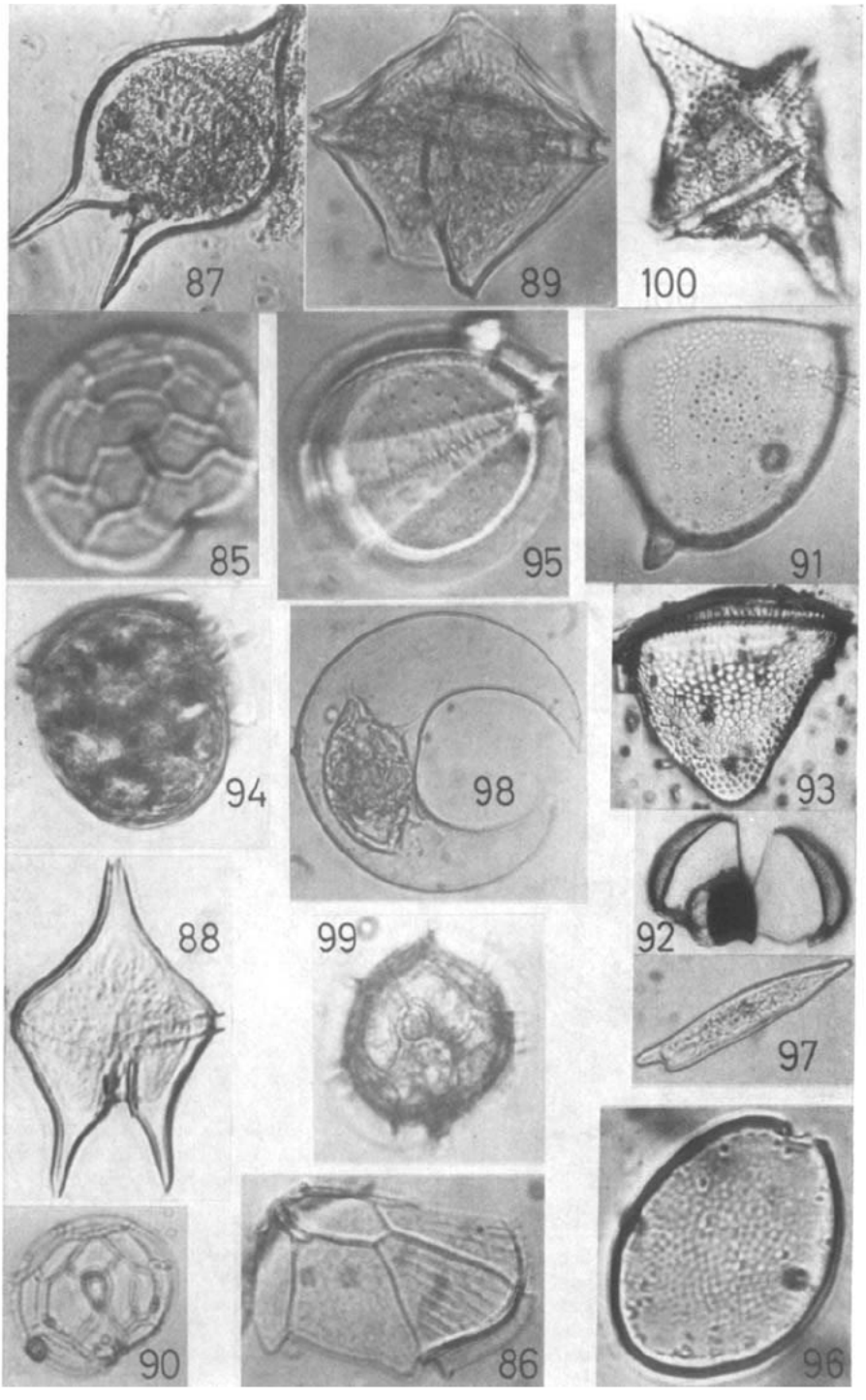

Plate VII

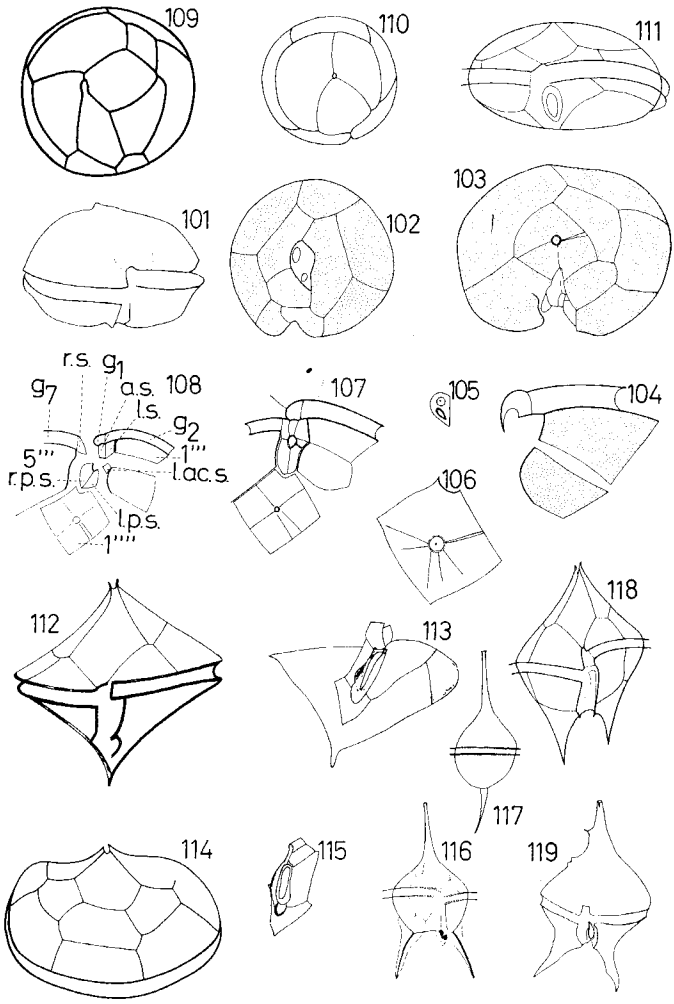

Plate VIII

101 *Gessnerium mochimaensis* n. gen., n. sp., ventral view. × 540;
102 *G. mochimaensis*, apical view. × 430;
103 *G. mochimaensis*, the hypotheca seen from above;
104 *G. mochimaensis*, the first and second girdle plates, the first postcingular and the first posterior intercalary;
105 The apical closing platelet;
106 The antapical plate, showing the circular alveole with the central attachment pore and the radiating ridges. × 910;
107 *G. mochimaensis*, semidiagrammatic representation of the sulcal area in relation to the surrounding plates;
108 Dissociated sulcal plates:

a. s., anterior sulcal
l. s., left sulcal
r. s., right sulcal
g_1, g_2, g_7 girdle plates
l. ac. s left accessory sulcal
l. p. s. left posterior sulcal
r. p. s right posterior sulcal;

species as described by GRAHAM (1942) and BALECH (1951). The cell is ovate and more rounded at mid body, although the angle α is equal (119°). It is distinctly smaller than the main species; length, 102 μ (89—110), diameter 70.5 μ (59—74). The main difference however is the relatively greater width, expressed by the smaller l/d ratio in var. *oblongum*: 1.45 (1.31—1.62) for 1.9 (GRAHAM ,1942) —1.8 (Venezuela specimens). Ten specimens from two different samples were measured. *P. oblongum* AURIVILL., accepted as an independent species by BÖHM (1936), MATZENAUER (1933), PAVILLARD (1937a) and PAULSEN (1949), was included under *P. oceanicum* as a variety of the latter by BROCH (1906), ABÉ (1927), and BALECH (1951). SCHILLER (1937) abolished the var. *oblongum* altogether, including it in the synonymy of *P. oceanicum*. The relatively stable shape of this form, as described also from various localities (LEBOUR, 1925, Plymouth; PAVILLARD, 1937a, Mediterranean; ABÉ, 1927, Mutsu Bay), justifies however its segregation from *P. oceanicum*, at least as a variety of the latter.

Occurrence. The var. *oblongum* is considerably more frequent in the neritic plankton of Venezuela than *P. oceanicum* proper. It was observed in all seasons, but was notably abundant in Autumn (1960 and 1961) in Mochima Bay, in the Mangrove Bay and near Caribe Island. Its occurrence however is not restricted to the inshore waters as it was also common among the "Trench" plankton. Observed in 43% of the samples.

P. oceanicum VANHÖFFEN f. *spiniferum* GRAHAM
(Fig. 118, pl. VIII)

GRAHAM (1942)

Only one specimen was observed among the "Trench" plankton. Length, 152 μ; transdiameter, 85.8 μ; l/d ratio 1.76.

P. pentagonum GRAN f. *depressum* ABÉ
(Fig. 82 & 83, pl. VI; 86, pl. VII)

ABÉ (1927)

Syn.: *P. pentagonum* var. *latissimum* (KOF.) SCHILLER in part.

A flattened, asymmetrical form described by ABÉ (op. cit.) from the plankton of Mutsu Bay.

The cell is strongly flattened dorso-ventrally. In apical view it is flat reniform, with the right limb distinctly more developed (Fig. 83). In ventral view (Fig. 82) the right epithecal margin is sligtly concave while the left margin is straight to

109 *Peridiniopsis asymmetrica*, an abnormal specimen with two epithecal intercalaries. × 500;

110 *P. asymmetrica*, another abnormal specimen without epithecal intercalary and with only five precingular plates. × 480;

111 *P. asymmetrica*, slightly inclined ventral view. × 625;

112 *Peridinium symmetricum* n. sp., ventral view. × 580;

113 *P. symmetricum*, detached hypotheca showing the flagella pore and the sulcal plates;

114 *P. symmetricum*, dorsal view of epitheca;

115 *P. symmetricum*, sulcal plates, seen from the inner side (i. e. reversed), the right sulcal is not visible;

116 *P. diabolus*, ventral view. × 250;

117 *P. diabolus*, left lateral view;

118 *P. claudicans*. × 350;

119 *P. oceanicum* f. *spiniferum*. × 220.

slightly convexe. Both hypothecal margins are concave. Posterior horns conical and pointed, separated by a relatively deep arch. The cell is often larger than high. All plates are finely reticulate.

Dimensions. *P. pentagonum* f. *depressum* is somewhat variable in dimensions. In the material examined the length l varied from 66 to 94 μ and the breadth d from 70 to 96.3. The average l/d ratio is of 0.98 (0.88 to 1.02). ABÉ gives l 72 μ and d 87, l/d 0.82. The dorso-ventral diameter is about 0.5 d.

Discussion: *P. pentagonum* f. *depressum* ABÉ is to be distinguished from *P. exiquipes* MANGIN (see under *P. exiquipes*) with wich it has been confused by PAVILLARD (1931), SCHILLER (1937, Fig. 243, j) and HALIM (1965). On the other hand its similarity to *P. latissimum* KOFOID led SCHILLER to unite both under the name *P. pentagonum* var. *latissimum* (KOF.). This is overlooking the *para* pattern of KOFOID's species.

Occurrence. Uptil now only known from Mutsu Bay (ABÉ, 1927), the tropical Indian Ocean (MATZENAUER, 1933) and Australia (WOOD, 1954). Its occurrence in the Venezuelan plankton is therefore a new record in the Atlantic ocean. *P. pentagonum* f. *depressum* was observed in only three samples where it was abundant: in the Mangrove Bay (Oct. 1960), near the Island of Caribe (Oct. 1961) and in the Gulf of Cariaco (Sept. 1960).

P. punctulatum PAULSEN
(Fig. 128, pl. IX)

PAULSEN (1949)

The distinction between *P. punctulatum* PAULSEN and *P. subinerme* PAULSEN is still controversial and doubtful (see also BALECH, 1949). In his posthumous work of 1949, PAULSEN has redefined the species and discussed its relation to *P. subinerme*. "The main differences between the two species are: *P. punctulatum* has a lower epitheca, as a rule 2a penta and a rounded hypotheca without spines, where as *P. subinerme* has a higher epitheca, 2a as a rule hexa and an angular hypotheca with two small spines". The observed specimens agree with this description, but plate 2a is often hexa, as already reported by MATZENAUER (1933) and PAULSEN himself (see his fig. 20A and C). They also showed the same characteristic spiny theca as the specimens described by PAULSEN from the Faeroes.

Dimensions. For the Faeroes specimens PAULSEN gives l 50—57 μ and d 57—60. The Venezuela specimens were more variable: l 44.8—64 and d 64—75.

Occurrence. *P. punctulatum* occurred in 22% of the samples examined and always in small or moderate amounts. It was observed in Mochima Bay (Oct. 1962), over the "Trench" (Oct. 1960), near the Island of Caribe (Oct. 1961) and among the Mangrove Bay plankton (Oct. 1960 and 1961). Its oceanic distribution is difficult to ascertain due to its frequent confusion with *P. subinerme* as already mentioned. However it appears to be an eurythermal species as it occurs near the Faeroes, as well as in the Caribbean.

P. quinquecorn (ABÉ)
(Fig. 90, pl. VII; 129—132, pl. IX)

ABÉ (1927, p. 410, fig. 30A, B and C)

General outline variable, irregularly pear-shaped. Epitheca subconical, with strongly convex margins. Apical horn very reduced. Hypothecal outline

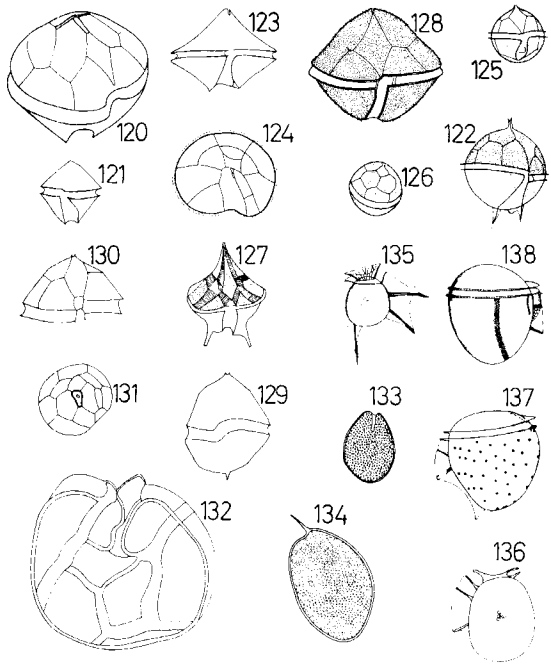

Plate IX

120 *Peridinium achromaticum*, strongly inclined ventral view. × 635;
121 *P. achromaticum*, showing the outline in ventral view. × 245;
122 *P. cerasus*. × 305;
123 *P. deficiens*, outline in ventral view. × 280;
124 *P. deficiens*, epithecal plates, showing the abnormal first apical plate fused with the fourth apical;
125 *P. minutum*. × 290;
126 *P. minutum*, dorsal view;
127 *P. fatulipes*. × 115;
128 *P. punctulatum*. × 375;
129 *P. quinquecorn*, outline in ventral view of a specimen with only one hypothecal spine. × 665;
130 *P. quinquecorn*, ventral view of epitheca;
131 *P. quinquecorn*, apical veiw × 530;
132 *P. quinquecorn*, inclined ventral view of the hypotheca of a specimen with large intercalary bands, showing the arrangement of the sulcal plates. × 1600;
133 *Cenchridium globosum*. × 485;
134 *Prorocentrum maximum*. × 700;
135 *Dinophysis schütti*. × 290;
136 *D. recurva*. × 475;
137 *Phalacroma cuneolus*. × 200;
138 *P. ovum*. × 270.

rounded to tetrahedral, usually carrying one to four delicate antapical spines. The girdle is cavozone left-handed, displaced by half to one girdle width. There are no girdle lists. The sulcal area is a deep, posteriorly widening, groove. It does not reach the antapical pole.

Plate pattern. First apical plate of the "ortho" type. There is a large apical closing-platelet, "key-hole" in shape, with a central apical pore. ABÉ (op. cit.) stated that the intercalary plates are only two. On close examination

of several specimens, however, it appeared that they were three in number and of a peculiar asymmetrical pattern. Plate 1a is four-sided, plate 2a six sided and the two plates have a common suture. Plate 3a is five-sided and is separated from 2a by the downward extension of the third apical, reaching to precingular 4. Plate 2a as a result, is no more medio-dorsal but becomes displaced into the left part of the epitheca (Fig. 90 & 131).

Plate-formula: 4′, 3a, 7″, 5‴, 2⁗, ortho-hexa.

Dimensions: length, 31—35 μ; breadth, 27—30 μ; l/d ratio 1.14—1.23.

Occurrence. A neritic warm-water species, restricted in its distribution. Mutsu Bay (ABÉ, op. cit.); Porto-Rico (MARGALEF, 1961); Alexandria, East Mediterranean (HALIM, 1965).

It was abundant in Mochima Bay in November 1961.

P. solidicorne MANGIN

SCHILLER (1937)

Syn. *P. spiniferum* SCHILLER; *P. areolatum* PETERS (1928)

A relatively large species of cosmopolitan occurrence. It is known from the Antarctic (PETERS, 1928), the Indian and Atlantic Oceans and the Mediterranean (MATZENAUER, 1933; SCHILLER, op. cit.; GAARDER, 1954). The tabulation is para-hexa but para-quadra has been reported by several authors. The general outline is similar to *P. brochi*, with diverging hyaline antapical horns.

Observed in only two samples of Mochima Bay in small numbers (Nov. 1961; Sept. 1962).

Dimensions: l 113 μ, d 74 μ.

P. subinerme PAULSEN
(Fig. 84, pl. VI; 85, pl. VII)

SCHILLER (1937)

PAULSEN (1949)

As already mentioned the distinction between *P. subinerme* PAULSEN and *P. punctulatum* PAULSEN remains subjective and still requires a thorough comparative investigation of the two species (see also BALECH, 1949). In the material examined however the name *P. subinerme* is applied to specimens of smaller dimensions than *P. punctulatum*, with an angular contour, a deep widening longitudinal furrow bordered by lists which slightly project beyond the theca like minute spines. Plate 2a was always found to be six sided. Its occurrence is similar to that of *P. punctulatum*.

Dimensions: length, 40—46.5 μ; diameter, 43—52.5 μ.

P. symmetricum nov. sp.
(Fig. 112—115, pl. VIII)

A moderate size form, nearer to *P. biconicum* DANGEARD than to *P. munobis* ABÉ.

Body shape. Shell biconical, symmetrical, nearly as high as large. Both epitheca and hypotheca a low cone, with concave margins. Epitheca culminating into apical slit but there is no distinct apical horn. Hypotheca rapidly tapering posteriorly, its posterior tip projecting into a stout and pointed hyaline horn. Girdle a deep groove, equatorial in position, slightly descending. It is displaced by less than half its width (fig. 112). In apical view the cell is basically circular but for a moderate ventral depression. Plate formula: 4, 3a, 7″, 5‴,

2''''. Sulcal plates, 5. Plate 1' is of the ortho-type and plate 2a is six-sided (Fig. 114). Except for the sulcal plates the shell is entirely covered with thick spiny processes, which when observed at low power might be mistaken for pores.

Sulcal area. The sulcal area is, a somewhat deep groove. The left edge of this groove is raised ventrally and stands more or less at right angle to the right edge. Flagella pore an oval slit, opening towards the right and protected by the thickened hyaline margins of the surrounding sulcal plates. These are five in number, but only four are connected to the pore (Fig. 113). The posterior sulcal is V shaped. The right sulcal is elongated and narrowing anteriorly. The left sulcal, forming the left edge of the sulcal groove is twisted at right angle to the remaining sulcal plates, as already mentioned, so that it can only be seen when dissected apart. Anteriorly, the flagella pore is limited by the anterior sulcal plate, which is connected to the girdle plates and to the first apical. In addition, a small accessory plate (a. l. a.) was found between the left sulcal and the anterior sulcal.

Dimensions: length, 64 μ; breadth, 65 μ.

Occurrence: five specimens only were found in the plankton of the Island of Caribe (Oct. 1961).

Affinities: *P. symmetricum* n. sp. resembles *P. biconicum* DANGEARD (SCHILLER, 1937) by its biconical shape and its orthohexa pattern. The latter species however differs from *P. symmetricum* by its squarish outline, its smaller dorso-ventral diameter, the total absence of an antapical spine and the oval shape of its sulcal area. The structure of its sulcal area is not known.

Genus ***Phalacroma*** STEIN

P. cuneolus KOFOID a. SKOGSBERG
(Fig. 137, pl. IX)

SCHILLER (1933)

A rare species described from the Eastern Tropical Pacific. *P. cuneolus* was only reported from the Atlantic by KÄSLER (1938) from the "Meteor" material, where it was recorded five times and always in vertical hauls (200—0 m). In the Venezuelan waters it was fairly common among the sub-surface (100—50 m) plankton of the Cariaco Trench (Oct. 1960). Several specimens were also observed in Mochima Bay in November 1961. Length, 113 μ; transdiameter, 75 μ.

P. cuneus SCHÜTT
(Fig. 92 & 93, pl. VII)

SCHILLER (1933)

A common species, restricted to warm waters (PAVILLARD, 1931; GAARDER, 1954). Its vertical distribution in the Atlantic (KÄSLER, 1938) as well as in the Mediterranean is that of a shade species (JÖRGENSEN, 1923; PAVILLARD, 1937b; HALIM, 1960a). In the Venezuelan waters it was fairly common among the "Trench" plankton and occurred also twice in Mochima Bay.

P. ovum SCHÜTT
(Fig. 138, pl. IX)

SCHILLER (1933)

Single specimens were observed among the "Trench" plankton (Oct. 1960) and once in Mochima Bay (Aug. 1962).

P. rotundatum (CLAP. a. LACK.) KOFOID and MICHENER
(Fig. 94 & 95, pl. VII)

JÖRGENSEN (1923)

This variable cosmopolitan species was very rare in the Venezuela plankton. Otherwise, *P. rotundatum* has a wide distribution in the N. Atlantic up to Greenland, in the Mediterranean and in the Baltic Seas, in the Indian (JÖRGENSEN, op. cit.) and in the Pacific (BALECH, 1962) Oceans, as well as in the Subantarctic (BÖHM, 1933). Megacytic forms (Fig. 94 & 95) are not uncommon (PAVILLARD, 1931).

Genus ***Podolampas*** STEIN

P. elegans SCHÜTT
P. palmipes STEIN

Both *P. elegans* and *P. palmipes* were observed exclusively among the Trench plankton and insingle specimens.

Genus ***Prorocentrum*** EHRENBERG

P. maximum MATZENAUER
(Fig. 96, pl. VII and 134, pl. IX)

Several specimens were observed among the "Trench" plankton and only once in Mochima Bay.

P. micans EHRENBERG

SCHILLER (1937)

A cosmopolitan and widely distributed species. It occurred in 50% of all samples and often in considerable numbers, in offshore as well as in inshore waters.

P. rostratum STEIN
(Fig. 97, pl. VII)

SCHILLER (1937)

A single specimen was found among the "Trench" plankton. Length, 67.2 μ; width in lateral view, 12 μ.

Genus ***Pyrocystis*** MURRAY

P. fusiformis (WYVILLE THOMPSON) MURRAY

SCHILLER (1937)

This large sized species was the commonest *Pyrocystis* among the "Trench" plankton. Length, 960 μ.

P. hamulus CLEVE var. *inaequalis* SCHRÖDER
(Fig. 150, pl. X)

SCHILLER (1937)

Observed only once among the "Trench" plankton.

P. robusta
(Fig. 98, pl. VII)

SCHILLER (1937)

P. robusta was also common exclusively among the "Trench" plankton.

Genus ***Pyrodinium*** PLATE

PLATE (1906)

Body spheroidal with a rugose angular contour. Theca thick walled, heavily sculptured. Apex present; a short and stout apical horn. Girdle equatorial. Sulcus does not extend to epitheca, reaching antapical pole. Girdle lists well developed. Plate pattern: 3′, 0a, 7″, 5g, 2s, 5‴, 1p, 1⁗.

Discussion. The plate pattern as given by PLATE included two uncertainities, the number of precingular plates and the number of girdle plates. The number of sulcal plates is not given. Thus the plate pattern as given by PLATE (1906) followed by LINDEMANN (1928) was: 3′, 0a, 6(7)″, (8g), 5‴, 1p, 1⁗. The introduction of *Gonyaulax schilleri* MATZENAUER (1933) into *Pyrodinium* by SCHILLER (1937) — which is justified, as MATZENAUER's species is beyond doubt a *Pyrodinium* — has later confused the diagnosis of the Genus. Interpreting the plate pattern as that of a *Gonyaulax*, MATZENAUER obviously considered plate 1″ as a sulcal plate, extending over to the epitheca as in all *Gonyaulax*. Examination of several specimens of *P. bahamense*, the type species, from Mochima Bay, has allowed me to ascertain the plate formula given in the diagnosis.

P. bahamense PLATE
(Fig. 139—145, pl. X)

PLATE (1906)

Described from Nassau, Bahamas. It was observed by MARGALEF (1961) on the southern coast of Porto-Rico and in massive amounts in the Bahia Fosforescente. In Mochima Bay it occurred in good numbers in March 1963. *P. bahamense* also occurs in the Persian Gulf (BÖHM, 1931).

Genus ***Pyrophacus*** STEIN

P. horologicum STEIN var. *steini* SCHILLER

SCHILLER (1937)

One of the most regular and abundant Dinoflagellates of the Venezuela plankton. It was indifferently common in all seasons in inshore as well as in offshore waters. Observed in 75% of the samples, it was numerically predominant in most of them. *P. horologicum* is a widespread tolerant warm water species. The main form, considered as more or less of Northern occurrence has also been observed in tropical waters
(RAMPI, 1952).

Genus ***Spiraulax*** KOFOID

S. jollifei (MURRAY a. WHITTING) KOFOID
(Fig. 100, pl. VII)

SCHILLER (1937)

Syn. *Spiraulax kofoidi* GRAHAM 1942

A well characterized species with its fusiform body, heavily sculptured theca and widely displaced girdle. Its occurrence is that of an offshore strictly warm water form. Widely distributed in the tropical waters of all oceans, it is also common as a summer form in the Mediterranean. In the Venezuela plankton it only occurred among the "Trench" plankton although it is not a shade form. Previously recorded from the Caribbean by GRAHAM (1942) and the Amazon Region by WOOD (1966).

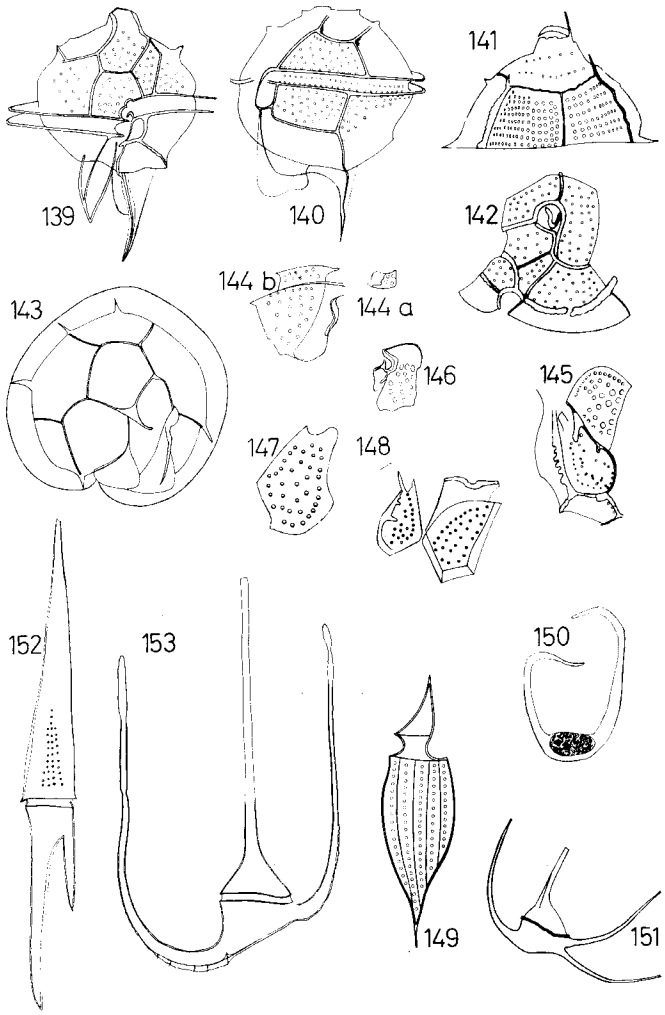

Plate X

139 *Pyrodinium bahamense*, ventral view. × 580;

140 *P. bahamense*, left lateral view. × 000;

141 *P. bahamense*, lateral view of epitheca showing the thickened lists along the plate sutures and the crest-like spines;

142 *P. bahamense*, the apical-closing platelet, the three apical plates and precingular plates 1″, 5″ and 7″;

143 *P. bahamense*, antapical view;

144 *a*. Girdle plate 5;

144 b. Girdle plate 4 and post-cingular 5;

145 The sulcus, inner (reversed) view. To the right, the last post-cingular plate 5‴ to the left, post-cingular 1‴ and the posterior intercalary;

146 Anterior sulcal plate with flagella pore;

147 Posterior sulcal plate, inner side (reversed);

148 Another view of the posterior sulcal plate (reversed); to the right, the last post-cingular plate, carrying the right sulcal list;

149 *Oxytoxum longiceps*. + 925;

150 *Pyrocystis hamulus*. v. *inaequale*. × 110;

151 *Ceratium karsteni*, abnormal specimen with three posterior hors. × 90;

152 *C. incisum*. × 600;

153 *C. horridum* f. *claviger*. × 370.

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