THE DINOFLAGELLATES OF THE GENERA *CERATIUM* AND *ORNITHOCERCUS* COLLECTED IN THE GOLFO DE SALAMANCA, COLOMBIAN CARIBBEAN SEA

by

Carlos E. Fernández M.* and Camilo B. García**

Resumen

Fernández, C.E. & C.B. García: The Dinoflagellates of the genera *Ceratium* and *Ornithocercus* collected in the golfo de Salamanca, Colombian Caribbean sea. Rev. Acad. Colomb. Cienc. **22** (85): 539-559, 1998 ISSN 0370-3908.

Un estudio morfológico de los Dinoflagelados pertenecientes a los géneros *Ceratium* y *Ornithocercus* del material recolectado en el Golfo de Salamanca, Mar Caribe colombiano, durante 1996, fué realizado. Un total de 30 especies y tres morfotipos del primer género, y tres especies del segundo género, son complementariamente descritas.

Palabras claves: Morfología, *Ceratium, Ornithocercus,* Colombia, Mar Caribe

Abstract

A morphological study was done of the Dinoflagellates belonging to the genera *Ceratium* and *Ornithocercus* found on the samples collected in 1996 the Gulf of Salamanca, Colombian Caribbean Sea. A total of 30 species and three morphotypes of the first genus, and three species of the second one, are described complementarily .

Key words: Morphology, *Ceratium*, *Ornithocercus*, Colombia, Caribbean Sea.

Introduction

In general, within a planktonic patch; there are more species of diatoms than of dinoflagellates in open waters, the phytoplankton is dispersed over large extensions of water, while in confined areas, like estuaries, bays or gulfs, these assemblages can occur at greater concentrations and diversity of these organisms. The dinoflagellate species compo-

* Permanent Address: Apartado Aereo 7194, Cali, Colombia. INVEMAR, AA 1016, Santa Marta, Colombia

** INVEMAR, AA 1016, Santa Marta, Colombia. e-mail: cgarcia@200.25.13.3

sition within the Colombian Caribbean Sea neritic and oceanic areas are poorly studied, no species of dinoflagellates, including the genera *Ceratium* and *Ornithocercus,* have been reported for the region of Santa Marta, Colombian Caribbean Sea. One region of the Colombian Caribbean coast, the Golfo de Salamanca, was net sampled and studied during 1996 for both dinoflagellates and diatoms. The Golfo de Salamanca is located within the central Colombian Caribbean Sea between the cities of Santa Marta (74° 11′ W, 11° 18′ N) and Barranquilla (74° 51′ W, 11° 6′ N). Two nearby areas to the zone of study had been studied: Nenguange Bay (**Caycedo**, 1977) and Cartagena Bay (**Vidal and Carbonell**, 1977). There is an increasing interest among scientists to know the structure of planktonic community within large and small-scale geographical areas, as a basis to understand its biodiversity.

This study pretends to give a complementary morphological description of the dinoflagellates species of the genera *Ceratium* and *Ornithocercus*, found in the Gulf of Salamanca during 1996.

Materials and methods

A total of 40 phytoplankton samples was collected during four cruises from eight stations visited during the Cruise 9600 on the Dardanus in March of 1996, followed by 10 stations during the Cruise 9601 on the ARC Malpelo in April on 1996, 11 stations during the Cruise 9602 on the ARC Malpelo in August of 1996, and 11 stations during the Cruise 9603 on La Tutu in December of 1996. The stations were located at depths between 15 and 200 meters over the continental shelf of the Gulf of Salamanca. The semi-vertical hauls were done from a specific depth above a maximum depth of 150 meters, depending on the station´s depth, to the surface. The horizontal tows were performed at the surface. A standard nylon plankton net with a 105 micron mesb was used in the Cruise 9600; for the rest of the cruises, a 55 micron mesh was utilized. One to three aliquots of 0.063 ml, from each one of the samples, were examined under a high magnification power (40X) of a NIKON Alphaphot-2 light microscope and photographed with a MC-80 camera adapted to a Zeiss AXIOLAB binocular microscope The cells were individually identified to the species, when possible. The length of the cells was measured from the distal end of the apical horn to the base of the hypothecum. The height of the body was measured from the base of the apical horn to the base of the hypothecum, in a perpendicular direction to the girdle. In the genus *Ornithocercus,* the size of the cell is measured between the outer edge of the anterior and posterior lists.

Results and discussion

From the 40 samples of phytoplankton collected during four cruises in 1996, 33 species and three morphotypes belonging to two genera (*Ceratium* and *Ornithocercus*) were identified, described, and illustrated. The genus *Ceratium* is represented by 18 species, four forms and eight varieties, and three morphotypes to genus level. The genus *Ornithocercus* is represented by three species.

Order GONYAULACALES

Genus **CERATIUM** Schrank

Description - This genus has the body armored. Its overall cell size ranges from small to large dimensions, sometimes over 1 mm in length. The body is more or less dorsoventrally compressed. It usually has two or three horns, only one of them apical raises upwardly from the epithecum and is called apical and the other two emerge in a down or upwardly direction from the hypothecum, depending on the group to which the species belongs, and are called antapicals. The apical horn is formed by apical plaques. The right antapical horn is formed by the postcingular plaques and the left one is formed by the antapical ones. The right antapical horn is frequently present; sometimes it is observed only as a rudiment. All the horns are of similar width. The surface of the cell lacks of any obvious ornamentation, except for some pores and reticulated patterns. The plaque formula of the body is: Po, cp, 4′, 6", 5c, 2+s, 6′", 2"". On the ventral face of the body, there is a relatively large hollow or depressed area. It occupies most of the body face hypotheca, going deep into the epitheca. It has three hyaline plaques; 6", 5c and 6′". The epithecum is formed by 4 apical plaques and 5 precingular ones, besides a small Po. The hypothecum is formed by 5 postcingular plaques and 2 antapical ones. The cingulum has 4 plaques in the marine species. The sulcus is located on tbe left side of the ventral surface. The surface of the body and horns exhibit a variety of shallow markings and pores.

Remarks - There are fewer than 120 living species. They are differentiated by the presence or absence, and by the sizes of the apical and antapical horns; the presence of an inflated epithecum; the development, orientation, and degree of curvature of the horns; the relationship between the left and right antapical horns; the presence of open or closed ends of the antapical horns; the size or length of the whole cell; the shape and the size of the body cell; the relationship between the epithecum and the hypothecum; and the markings over the body surface.

Ceratium macroceros var. ***macroceros*** Balech, 1988 (Figure 1)

Sournia, 1967, p. 461, fig. 84; Balech, 1988, p. 146, pl. 64, fig. 4.

Description. - This solitary form has the body robust. The apical horn emerges almost from the middle of the epithecum. The apical horn length is 5.9 times the height of the body. Both antapical horns are larger. They start projecting upwardly well below the straight base of the hypothecum. The right antapical horn forms a sharp angle and it is almost straight when oriented upwardly. The left one is curved on all its extension ending in a extreme parallel to the apical horn. In temperate areas, the horns are short and massive with crests; in tropical waters, the horns are delicate, long and narrow, and the cells are smaller and delicate. The length of the right antapical horn is 4.6 times the height of the body and the left one is 6.6 times. The curvature of the antapical horns is smoother than in *C. m.* var. *gallicum*. The length of the cell is about 300 μ.

Remarks - Eight specimens were examined.

Distribution. - Neritic and oceanic. Temperate to tropical waters. SW Atlantic Ocean (**Balech**, 1988); Cartagena Bay (**Vidal and Carbonell**, 1977).

Ceratium tripos *var.* ***tripodioides*** Jorgensen, 1920 (Figure 2)

Halim, 1967, p. 726, fig. 27; Sournia, 1967, p. 419; Balech, 1988, p. 139, pl. 59, figs. 3 & 4.

Description. - The body of this solitary variety is high, regular. The apical horn is relatively large and thin. Apical horn length is 2.5 times the height of the body. The two antapical horns are very dissimilar. The right horn is considerably shorter. The length of the right antapical horn is 1.2 times the height of the body and the left one is 1.5 times. The cells can reach lengths of 280 to 410 μ (**Balech,** 1988).

Remarks. One specimen examined.

Distribution. - Neritic. Temperate to tropical waters. SE Caribbean Sea (**Halim,** 1967); SW Atlantic Ocean (**Balech,** 1988).

Ceratium bigelowi Kofoid, 1907 (Figure 3)

Balech, 1988, pp. 135-136, pl. 55, figs. 14-15.

Description. - This species has a large body. It is a solitary form that looks like two pins joined together. The hypothecum is low, while the epitheca is slightly higher and conical with an irregular form in the frontal view. There is a constriction in the area where the precingular plates unite with the apical plate. In side view, there is a noticeable engrossment above the mentioned constriction. The long and narrow apical horn, which is slightly curved toward the right side at the distal end, emerges and projects upwardly from the hypothecum. Its length is about 1.85 times the height of the body. The antapical horns start projecting upwardly below the concave basal area of the hypotheca. The right antapical horn is extremely short, sometimes almost non-observable; the left one is strongly curved at the end of the horn. The length of the left antapical horn is 1.8 times the height of the body. All the horns are very narrow. The cell can reach lengths of 1000 to 1120 μ (**Balech,** 1988).

Remarks - One specimen examined.

Distribution. - Neritic and oceanic from temperate to tropical waters. SW Atlantic Ocean (Balech, 1988).

Ceratium longirostrum Gourret, 1883 (Figure 4)

Halim, 1967, p. 722, fig. 40; Sournia, 1967, p. 413, fig. 37; Ferguson-Wood, 1968, p. 35, fig. 75; Balech, 1988, p. 134, pl. 55, figs. 10 & 11.

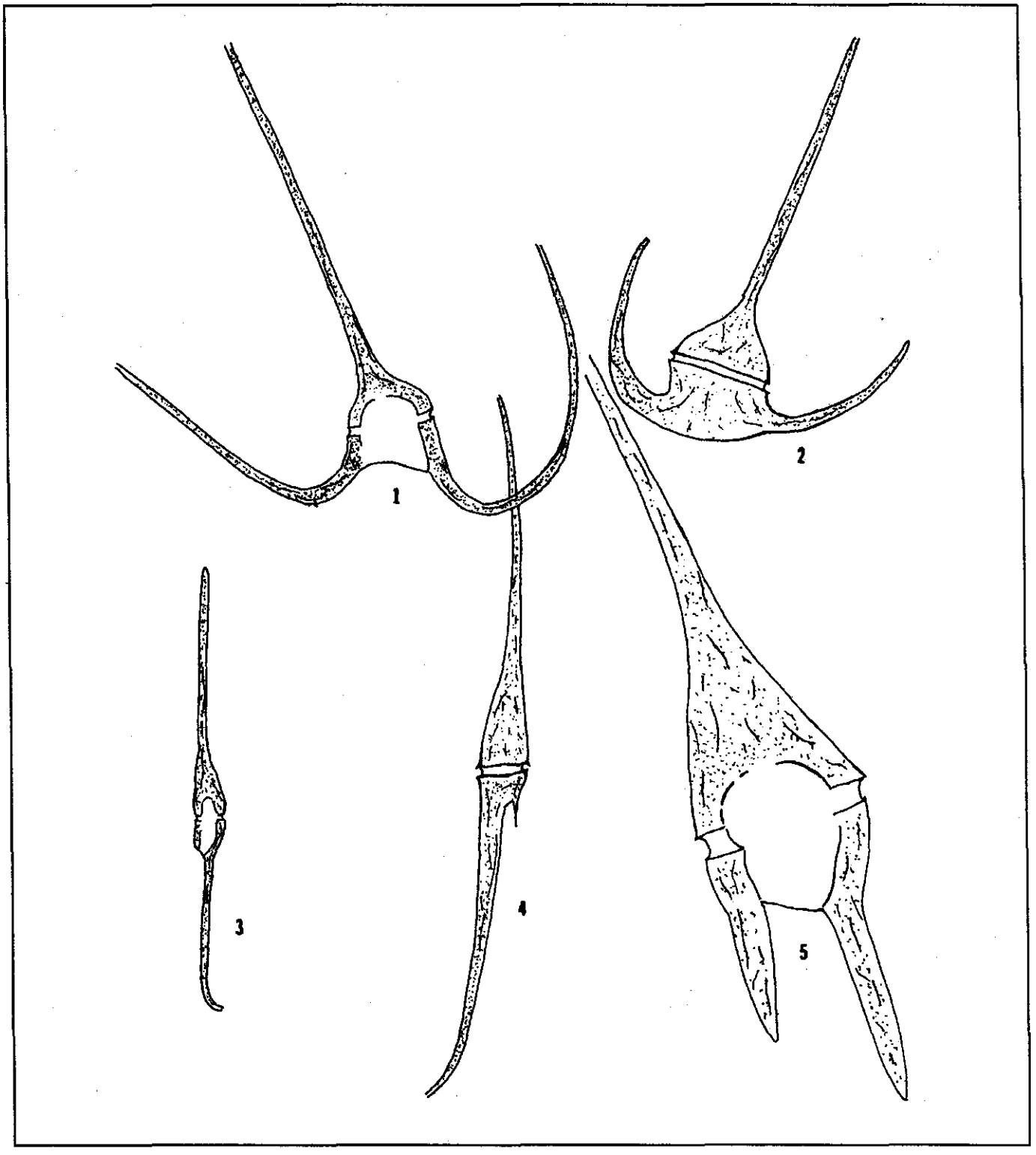
Description. - This species, with resembles *C. bigelowi,* is found solitary in plankton communities. The hypotheca is always shorter than the epitheca and the cell is smaller than *C. bigelowi*. A bent apical horn is projected from it. The apical horn is slightly curved toward the left side of the body. The apical horn length is 2.16 times the height of the body. The antapical horns start projecting themselves below the base of the hypotheca. The left antapical horn is long, curved, blunt and widen over the concave side. The right antapical horn is very short and needle-like. The length of the right antapical horn is 0.16 times the height of the body and the left one is 2.2 times. The cell has a size of about 500 μ.

Remarks - Three specimens examined.

Distribution. - Oceanic. Tropical and subtropical waters. SE Caribbean Sea (**Halim**, 1967); Santaren Channel, Traits of Florida, Benguela Current, Caribbean Sea (**Ferguson-Wood**, 1968); SW Atlantic Ocean (**Balech**, 1988).

Ceratium lineatum (Ehrenberg) Cleve, 1899 (Figure 5)

Halim, 1967, p. 722, fig. 37; Sournia, 1967, p. 404, figs. 25-26; Ferguson-Wood, 1968, p. 34, fig. 72; Balech, 1988, pp. 130-31, pl. 56, figs. 10-13.



Figures 1-5. Dinoflagellates species of the genus *Ceratium*, 1. *Ceratium macroceros* var. *macroceros*, 2. *Ceratium tripos var. tripodioides*, 3. *Ceratium bigelowi*, 4. *Ceratium longirostrum*, 5. *Ceratium lineatum*.

Description. - The cells, which are similar to those of *C. furca*, have a medium to small size body. The body is shaped like a pentagon. The species is solitary. The blunt apical horn that is oriented slightly toward the right side, is projected from a triangular epitheca. The apical horn length is 1.2 times the height of the body. The hypotheca has a quadrate formation in frontal view. The straight and close antapical horns have a divergent orientation to the apical horn and to one other; they are directed posteriorly, further away from the posterior margin of the body. The length of the right antapical horn is 0.4 times the height of the body and the left one is 0.8 times. The ends of the antapical horns are blunt. The surface of the body exhibits numerous linear markings and pores. The body has a length of 30 to 40 µ and the cell is about 100 µ.

Remarks - This species can be confused with *C. pentagonium*, which is larger and broader in nine specimens examined.

Distribution. - Neritic and oceanic. Temperate to tropical waters. SE Caribbean Sea (**Halim**, 1967); Caribbean Sea (**Ferguson-Wood**, 1968); SW Atlantic Ocean (**Balech**, 1988).

Ceratium buceros form ***tenue*** (Ostenfeld & Schmidt) Schiller, 1937 (Figure 6)

Sournia, 1967, p. 477

Description. - This is a solitary species. The body is of medium size, slightly wider than high. The epitheca is always smaller than the hypotheca. The left side of the epitheca is slightly convex, and the right side is concave to nearly straight. A long, narrow apical horn (4.4 times the height of the body) emerges from the epitheca; it bends in an angle to the right and tends to curve toward the right side over the distal closed end. The base of the hypotheca is convex to nearly straight. The antapical horns start projecting upwardly slightly below the concave basal area of the hypotheca. They are spinulated and as narrow as the apical horn. The right antapical horn shows a small and wide curvature near its base before it projects itself straight outward diagonal to the side; it is strongly divergent from the body axis. The left horn curves smoothly from the base outwardly ; it is somewhat divergent to the body axis and tends to be in an almost perpendicular orientation to the girdle. The length of the right antapical horn is 2.25 times the height of the body and the left one is 2.33 times. The distal ends of both horns reach the first ¼ distance of the apical horn over a line parallel to the girdle. The length of the cell varies between 50 and 100 µ.

Remarks - Many different forms had been described. One specimen examined.

Distribution. - Oceanic, neritic and estuarine form present in template and tropical waters. Cosmopolitan. SE Caribbean Sea (**Halim**, 1967).

Ceratium longinum *Karsten, 1906* (Figure 7)

Sournia, 1967, p. 444, fig. 68; Ferguson-Wood, 1968, p. 34, fig. 73.

Description. - This solitary species is quite similar to *C. contortum*. The epitheca is slightly shorter than the hypotheca. Both margins of the epitheca are slightly convex, the right margin being larger than the left. Throughout most of its extension, the long apical horn is straight to slightly curved with its distal end bend perpendicular to the body axis. The apical horn length is 5.9 times the height of the body. The base of the hypotheca is straight or slightly convex. The antapical horns start projecting upward at the same level of the base of the hypotheca. They are slender, serrated and bent forward and ventrally. They are straight to somewhat curved. The bend of the left horn is more pronounced and wider than the right one. The base of the right antapical horn is placed slightly below the girdle. Both horns are relatively parallel to the vertical body axis. The right antapical horn is about 3.5 times the height of the body and the left one is 4.6 times. The length of this species is about 600 µ.

Remarks - Four specimens examined.

Distribution. - Marine neritic and coastal areas. Atlantic and Indian Oceans, rare in the Pacific Ocean, Straits of Florida (**Ferguson-Wood**, 1968).

Ceratium contortum (Gourret) Cleve, 1900 = *C. arcuatum* (Gourret) Cleve (Figure 8)

Graham & Bronikovsky, 1944, fig. 18; Ferguson-Wood, 1968, p. 26, fig. 48; Sournia, 1967, pp. 441-446, figs. 67-72; Balech, 1988, p. 145, pl. 62, fig. 4 & pl. 63, fig. 2.

Description. - This solitary species is slightly similar to *C. tripos*. The posterior margin of the relatively large body is straight or roundish. The epitheca is smaller than the hypotheca. The left side margin of the epitheca is shorter, convex, and more pronounced than the right margin, which is slightly convex to straight. The apical horn is long, usually 6.15 times the height of the body, and strongly bent toward the left side of the cell near its base. Most of the length of the apical horn is perpendicular to the girdle with a slight curvature toward the

right side. This horn arises from a point on the epitheca perpendicular to the base of the left antapical horn. The apical horn and the right side of the body are almost on the same vertical line. The epitheca is almost rectangular in a frontal view. The contour of the hypotheca base is slightly convex.. The antapical horns start projecting themselves from the concave basal area of the hypotheca. The antapical horns are of medium size and oriented upward. The right horn is 2.8 times the height of the body and the left one is 3.7 times. The distal extremes of these horns reaches the proximal 1/8 part of the apical horn, along a projected horizontal axis, parallel to the girdle. The right antapical horn curves smoothly outwardly until reaching the middle of the horn where it sharply bends almost horizontally toward the apical horn; the distal portion of the horn bends slightly upwardly. In some individuals, the tip of the right antapical horn is projected beyond the apical horn. The extremes of both horns are closed. The length of the cell varies between 300 - 500μ.

Remarks - Several varieties of this species are recognized, based on the general dimensions of the cell, diameter and length of the horns and orientation of the antapical horns. Five specimens examined.

Distribution. - Oceanic and coastal species from warm temperate to tropical waters. Cosmopolitan and worldwide distribution. Straits of Florida (**Ferguson-Wood**, 1968); SW Atlantic Ocean (**Balech**, 1988).

Ceratium tripos (O.F. Muller) Nitzsch, 1817 (Figure 9)

Jorgensen, 1920, figs.33-39; Bohm, 1931, p. 5, fig. 12; Nie, 1936, p. 48, fig. 17; Schiller, 1937, fig. 4021; Graham & Bronikovsky, 1944, fig. 13; Halim, 1967, p. 725, figs. 26-27; Ferguson-Wood, 1968, p. 41, fig. 92; Sournia, 1967, pp. 416-25, figs. 40-43; Steindinger & Williams, 1970, pl. XIV, fig. 37 & pl. XV, fig. 38; Carbonell, 1979, p. 31-32, fig. 9; Balech, 1988, p. 138

Description. - The large and strong cell of this solitary species presents a triangular to roundish epitheca. Both sides of the epitheca edge are slightly convex to almost straight. A straight, long to short, apical horn emerges from it. Sometimes the apical horn is bent toward the left near its base. Its length is 1.5 times the height of the body. The margins of the epitheca are nearly straight to convex. The posterior contour of the body is roundish and continuous with the two antapical horns which are directed upward and are somewhat curved. The base of the hypotheca is nearly straight to concave. When the two antapical horns are completely formed, they are almost parallel with the apical horn over most of their distal length. The antapical horns start projecting themselves upwardly almost above the base of the hypotheca. The length of the right antapical horn is 1.52 times the height of the body and the left one is 1.65 times. In some individuous, the right antapical horn is directed toward the right and the left antapical horn is oriented toward the left, away from the apical horn. The surface of the body presents many linear markings. The body is about 75 to 90 μ in length and the cell reaches 150 to 180 μ.

Remarks - This species has many varieties reported. Eight specimens examined.

Distribution. - Marine coastal and oceanic waters from cold temperate to tropical areas. Worldwide distribution. Straits of Florida, Benguela Current, Gulf of Mexico, northern coast of Brazil, Caribbean Sea (**Ferguson-Wood**, 1968); Cartagena Bay (**Vidal and Carbonell**, 1977; **Carbonell**, 1979); SW Atlantic Ocean (**Balech**, 1988).

Ceratium macroceros var. ***gallicum*** (Kofoid) Sournia, 1966 (Figure 10)

Sournia, 1967, p. 462, fig. 85; Balech, 1988, pp. 146-147, pl. 64, fig. 1.

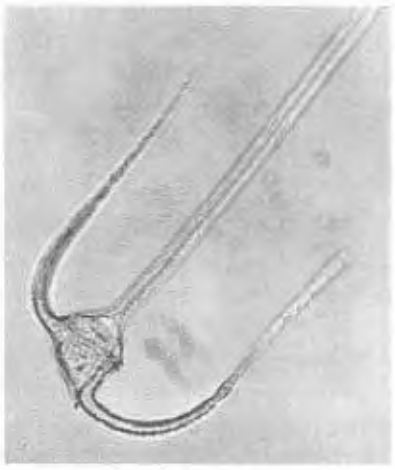
Description. - This variety of the species is solitary and has a smaller body than *C. trichoceros* and is more delicate with slender and shorter horns. The body is more triangular, and the epitheca is slightly larger than the hypotheca. Both margins of the epitheca are slightly convex to almost straight; the one on the right side is less pronounced. The apical horn is long, slender and straight to slightly curved. It presents a length of 4.2 times the height of the body. The antapical horns start projecting upwardly below the straight basal area of the hypotheca. The antapical horns are divergent and oriented outwardly from the apical horn. The right antapical horn length is about 3.3 times the height of the body and the left one is 3.1 times. The basal portion of the two horns form a pair of obtuse angles that looks like a wide and shallow "W". These horns are quite open, almost horizontal. Crests and spines on the cell are reduced or are absent. The length of the body ranges between 40 and 50 μ and the cell is about 360 μ in length.

Remarks - Two specimens examined.

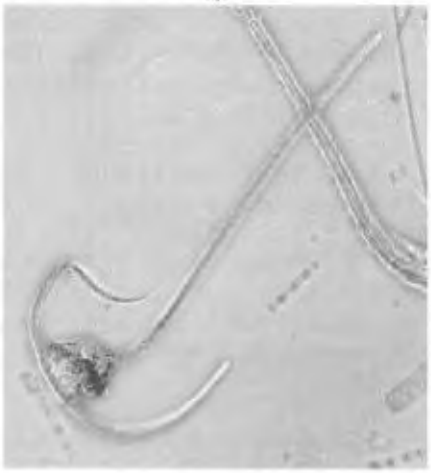
Distribution. - Oceanic distribution in subtropical and tropical areas. Strait of Florida, Northern coast of Brazil, Caribbean Sea (**Ferguson-Wood**, 1968); SW Atlantic Ocean (**Balech**, 1988).

Ceratium macroceros *n.d.* (Ehrenberg) Cleve, 1900 (Figure 11)

6

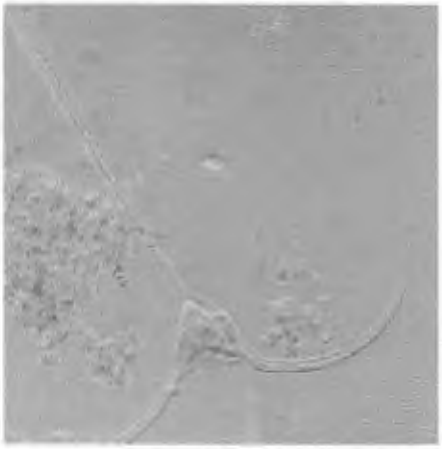


7



8

9



10

11

Figures 6-11. Dinoflagellates species of the genus *Ceratium*, 6. *Ceratium buceros* form *tenue*, 7. *Ceratium longinum*, 8. *Ceratium contortum* (=*C. arcuatum*), 9. *Ceratium tripos*, 10. *Ceratium macroceros* var. *gallicum*, 11. *Ceratium macroceros*.

Jorgensen, 1920, p. 88, fig. 77; Bohm, 1931, p. 39, fig. 35; Graham & Bronikovsky, 1944, p. 177, fig. 21; Ferguson-Wood, 1968, p. 36, fig. 77; Sournia, 1967, pp. 460-464, figs. 83-85; Steindinger & Williams, 1970, p. 145, pl. XI, fig. 29; Carbonell, 1979, p. 34-35, fig. 12; Balech, 1988, p. 146.

Description. - This is a large and solitary species that resembles *C. massiliense*. It has a small angular body that resembles a box. A long slender apical horn emerges from the left half of the epitheca. This straight to somewhat curved horn is slightly bent toward the left side. The epitheca and the hypotheca are of similar size. Both apical margins, on either side of the apical horn base, are convex; the one on the right side is larger and more pronounced than the other. The apical horn length is 5.8 times the height of the body. The basal margin of the hypotheca is straight. Both antapical horns are slender. These horns extend themselves beyond the straight posterior margin of the cell's body almost the same length before they curve or bend outwardly; after the bent zone, the horn is straight or nearly so. The antapical horns start projecting upwardly well below the base of the hypotheca. The left horn bends anteriorly, while the right one does it to the right. The bending of both antapical horns is strongly angular. The right antapical horn is almost diagonal outwardly to the apical horn; the left one is more divergent. The left antapical horn is 3.4 times the height of the body and the right one is 2.4 times. Both antapical horns are finely serrated basally. The right antapical horn base is attached to the body a distance equal to 1-1.3 times the width of the proximal area of the horn below the girdle. The body has a length of about 50 to 60 µ and the cell is about 270 µ.

Remarks - Five specimens examined.

Distribution. - Worldwide distribution in cold temperate to tropical waters of marine coastal and oceanic areas. SE Caribbean Sea (**Halim**, 1967); Gulf of Mexico, Amazon delta, Straits of Florida (**Ferguson-Wood**, 1968); Cartagena Bay (**Carbonell**, 1979).

Ceratium horridum (Cleve) Gran, 1902 (Figure 12)

Jorgensen, 1920, p. 96, figs. 86-92; Bohm, 1931, fig. 36; Graham & Bronikovsky, 1944, figs. 23-25; Halim, 1967, p. 720, figs. 11, 36 & 153; Ferguson-Wood, 1968, p. 32, fig. 65; Sournia, 1967, pp. 474-480, figs. 91-96; Balech, 1988, p. 148, pl. 65, fig. 3.

Description. - This solitary species has a large to medium size body. It presents a triangular epitheca from which a straight, relatively broad and short, apical horn emerges from the third section of the epitheca on the left side. Both epitheca edges are convex ; the right side margin is less prominent than the left one. The apical horn bends slightly toward the right side. The length of the apical horn is 3.6 times the height of the body. The epitheca and the hypotheca are of similar size. The hypotheca base is flat or slightly convex. The antapical horns start projecting upwardly slightly below the base of the hypotheca. Both horns are level with the posterior margin of the body. These horns are projected outwardly with some forward curvature. The distal portion of the right antapical horn is almost parallel with the apical horn; the left one shows a slight divergence toward the left. The right and left antapical horns are both 2.5 times the height of the body. The base of the right antapical horn is located just over the lower edge of the girdle. Both antapical horns present small wings and fine serrations. The ends of all the horns are closed. The surface of the cells shows various markings. The size of the body is about 50 µ and the cell is about 150 µ.

Remarks - Several varieties of this species are known. Three specimens examined.

Distribution. - Cold temperate to tropical waters of marine coastal and oceanic areas. Wide distribution in the Atlantic, Pacific and Indian oceans. Bahamas Banks, Santaren Channel, Straits of Florida (**Ferguson-Wood**, 1968).

Ceratium horridum var. ***burceros*** (Zacharias) Sournia, 1966 (Figure 13)

Sournia, 1967, p. 477, fig. 95; Ferguson-Wood, 1968, p. 24, fig. 43; Sournia, 1967, p. 480, fig. 92; Carbonell, 1979, p. 38, fig. 17b.

Description. - The cell is fragile, solitary and relatively smaller than *C. horridum*, but is morphological similar to *C. horridum*. The right margin of the epitheca is flat or slightly convex; the left margin is strongly convex. The horns are narrower than in *C. horridum*. The apical horn is straight and sometimes it bends slightly toward the right side of the body. The horn length is 3.2 times the height of the body. The antapical horns start projecting upwardly slightly below the straight basal area of the hypotheca. The right antapical horn is slightly divergent outwardly to the apical horn; the left one shows a much more pronounced divergence toward the left. The right antapical horn is 1.4 times the height of the body and the left one is 2.85 times. The antapical horns are open and present some fine spines basally. The cell can reach lengths between 50 and 200 µ.

Remarks - Twelve specimens examined.

Distribution. - Tropical waters in oceanic and neritic areas. Strait of Florida, Benguela Current, northern coast of Brazil, Caribbean Sea (**Ferguson-Wood**, 1968); Cartagena Bay (**Vidal and Carbonell**, 1977; **Carbonell,** 1979).

Ceratium tenue var. ***tenue*** Balech, 1988 (Figure 14)

Balech, 1988, p. 149, pl. 66, fig. 1.

Description. - This solitary form is similar to *C. horridum*. The body is almost irregularly pentagonal and of medium size. The epitheca and hypotheca are of similar sizes. The edges of the epitheca are convex to slightly straight; they are both of similar length. The apical horn is long and thin; it is relatively straight except on the basal section, where it is conspicuously bent toward the left. Its length is about 7.9 times the height of the body. The base of the hypotheca is slightly convex. The antapical horns start projecting themselves outward and upwardly slightly below the basal area of the hypotheca. They diverge strongly from one other and from the apical horn. The right antapical horn emerges from a point very close to the girdle. It strongly bends outwardly to continue relatively straight upwardly. Near the distal extreme of the horn, a smooth bending toward the apical horn is observed. The left antapical horn presents a smoother bending in an outwardly direction. The length of the right antapical horn is about 5.2 times the height of the body and the left one is 5.6 times. All the horns are thin and only the apical horn is large in relation to the other two horns. The base of the body is straight or slightly convex. It can reach a length of 112 to 300 µ (**Balech**, 1988).

Remarks - One specimen examined.

Distribution. - SW Atlantic Ocean (**Balech**, 1988).

Ceratium trichoceros (Ehrenberg) Kofoid, 1908 (Figures 15-16)

Jorgensen, 1920, p. 88, fig.85; Nie, 1936, fig. 33; Graham & Bronikovsky, 1944, p. 179, fig. 22; Halim, 1967, p. 725, fig. 25; Sournia, 1967, pp. 472-473, fig. 89; Ferguson-Wood, 1968, p. 40, fig. 21; Steindinger & Williams, 1970, p. 151, pl. XIV, fig. 36; Carbonell, 1979, p. 37, fig. 16; Balech, 1988, pp. 150-151, pl. 66, fig. 4.

Description. - This is a delicate species of large to medium size, and that resembles *C. massiliense*. This solitary species has an U-like configuration. The epitheca and the hypotheca are triangular and of similar sizes. The edges of the epitheca are slightly concave to straight with a bending near the girdle. A long, delicate, straight to slightly curved horn emerges from the epitheca. Its length is 5.1 times the height of the body. The base of the hypotheca is nearly straight to convex. The antapical horns are parallel to the girdle on their proximal ends. The posterior curvature of the antapical horns is symmetrical, smooth and relatively wide, after which it take an upward and parallel orientation to the apical horn. The length of the right horn is 6.6 times the height of the body and the left one is 7.13 times. The antapical horns are serrated basally. The apical and antapical horns are very large and have a parallel plane orientation to each other over the same body plane. The antapical horns start projecting themselves upwardly below the base of the hypotheca. All the horns are of similar width; they are straight or slightly curved. The cells has a length of 300 to 500 µ.

Remarks - A specimen (Figure 16) that looks like *C. trichoceros* was observed. The apical horn is almost straight and long. Its length is 5.5 times the height of the body. The curvature of the antapical horns is more pronounced. The length of the right antapical horn is 4.3 times the height of the body and the left one is 4.35 times. It presents a similar size as *C. trichoceros*. Six specimens examined.

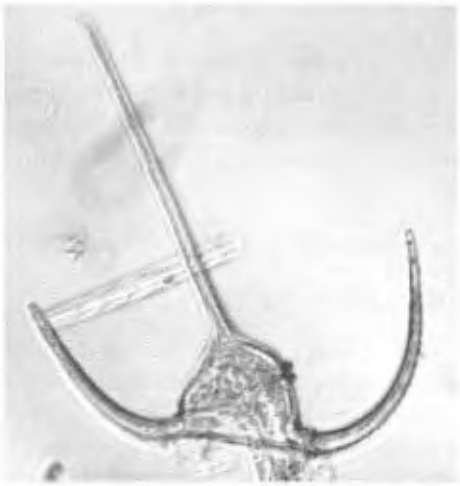
Distribution. - Marine coastal, neritic and oceanic species from warm temperate to tropical waters. Worldwide distribution. SE Caribbean Sea (**Halim**, 1967); Straits of Florida, Benguela Current, Gulf of Mexico, Sargasso Sea, Gulf Stream, northern coast of Brazil, Caribbean Sea (**Ferguson-Wood**, 1968); Cartagena Bay (**Vidal and Carbonell**, 1977; **Carbonell**, 1979); SW Atlantic Ocean (**Balech**, 1988).

Ceratium massiliense var. ***massiliense*** Balech, *1988* (Figure 17)

Jorgensen, 1920, figs. 78-79; Graham & Bronikovsky, 1944, fig. 22; Sournia, 1967, p. 465-469, figs. 87-88; Ferguson-Wood, 1968, p. 36, fig. 78; Steindinger & Williams, 1970, p. 145, pl. XI, fig. 30; Balech, 1988, p. 147, pl. 64, figs. 2, 3 & 5.

Description. - This is a solitary species of large size. It is very similar to *C. massiliense* var. *macroceroides*, but the apical straight horn is much shorter than the two antapical horns in this variety. It shows a delicate appearance. Both the apical and antapical horns are nar-

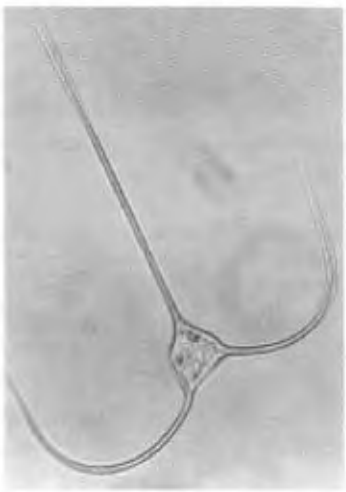
12



13

14

15



16

17

Figures 12-17. Dinoflagellates species of the genus *Ceratium*, 12. *Ceratium horridum*, 13. *Ceratium horridum* var. *burceros*, 14. *Ceratium tenue* var. *tenue*, 15-16. *Ceratium trichoceros*, 17 *Ceratium massiliense* var. *massiliense*.

row ; the apical horn is almost half the length of the size of the antapical horns. The body has a triangular configuration. The right margin of the epitheca is slightly curved, and the left one is more pronounced. The short apical horn is perpendicular to the girdle and it projects itself from the middle of the epitheca. Its length is about 3.9 times the height of the body. It presents a diagonal straight posterior margin, which allows the proximal extreme of the left antapical horn to be wider than that of the right side. The hypotheca base is concave or nearly straight. The antapical horns start projecting themselves upwardly slightly below the concave basal area of the hypotheca. The length of the right antapical horn is about 10 times the height of the body and the left one is 9.3 times. The left antapical horn curves just before directing itself anteriorly, the right one has a proximal bending and then it bends to the right side of the body. The antapical horns are not straight but waving over all their extension. The antapical horns have the distal extremes open. The basal sections of the antapical horns lack teeth or they are very inconspicuous. The length of the body is 50 to 80 µ and the cell is 300-360 µ long.

Remarks - Nine specimens examined.

Distribution. - Marine coastal and oceanic areas. Warm temperate to tropical waters. Cosmopolitan. SW Atlantic Ocean (**Balech**, 1988).

Ceratium massiliense form macroceroides (Karsten) Jorgensen, 1920 (Figures 18-19).

Jorgensen, 1920, figs. 78 & 79; Graham & Bronikovsky, 1944, fig. 22; Halim, 1967, p. 723, figs. 22, 23 & 41; Ferguson-Wood, 1968, p. 36, fig. 78; Sournia, 1967, pp. 465-469, figs. 87 & 88; Steindinger & Williams, 1970, p. 145, pl. XI, fig. 30.

Description. - It differs from *C. macroceros* in its larger size and because the bases of the antapical horns lack a rearward direction. The body of this solitary form is small with large and straight horns. The epitheca is triangular and smaller than the hypotheca, which is relatively rectangular. The margins of the epitheca are straight or relatively convex. The left one is steeper. The apical horn is straight, perpendicular to the girdle, projecting itself from the middle or slightly to the left of the epitheca. Its length is 5.9 times the height of the body. The antapical horns start projecting upwardly below the concave basal area of the hypotheca. Both antapical horns present a strong bending ; the rest of the extension of the horns is straight to the closed end. The right horn length is about 7 times the height of the body and the left one is 5.6 times. The right horn is displaced further away to the apical horn. The distal extremes of the two antapical horns reach, over an horizontal line, the proximal second half section of the apical horn. The insertion of the right antapical horn is at a distance equal to 1-1.5 times the width of the basal part of the horns. Over the bending of the antapical horns, some conspicuous serration is observed on the basal section. It shows a body length of about 60 µ and the cell is 460 µ.

Remarks - Eight specimens examined.

Distribution. - Marine neritic and coastal. SE Caribbean Sea (**Halim**, 1967).

Ceratium vultur var. ***japonicum*** (Schroder) Wood, 1954 (Figure 20).

Sournia, 1967, p. 481, fig. 96; Ferguson-Wood, 1968, p. 41, fig. 94; Balech, 1988, pp. 151-152.

Description. - This robust species can be found solitary or forming chains. The epitheca is low and wide, and the hypotheca is almost triangular. The margins of the epitheca are nearly straight to slightly convex. A straight apical horn emerges from the triangular epitheca. The apical horn is long on the cell located on the distal end of the chain, 8.5 times the height of the body; the rest of the cells have a shorter apical horns, 2 times the height of the body. The base of the hypotheca is almost straight. Both antapical horns are well developed and have closed ends. The antapical horns start projecting themselves upwardly slightly below the base of the hypotheca. The left antapical horn starts projecting at a right angle with respect to the apical horn and turns forward; it diverges away from the apical horn. This horn is curved further away from the posterior margin of the cell body. The right antapical horn is parallel to this margin and either bends upward and to the right, or bends beyond the posterior margin of the body and orients itself outwardly; after its elbow, it turns forward to be parallel to the apical horn. The length of the right horn is 5.75 times the height of the body (on the cells with large apical horns) and 6.8 times (on those with shorter apical horns); the left horns are about 4.2 times the height of the body for all the cells in the chain. The size of the cells varies greatly. The body has a height about 80 µ and the the cell ranges between 120 and 396 µ.

Remarks - Eight specimens examined.

Distribution. - Oceanic areas of warm temperate and tropical waters. Worldwide distribution. Mediterranean Sea, Straits of Florida, northern coast of Brazil. SW Atlantic Ocean (**Balech**, 1988).

Ceratium vultur var. ***sumatranum*** (Karsten) Sournia, 1967 (Figures 21)

Sournia, 1967, p. 482; Balech, 1988, p. 198, pl. 68, figs. 1.

Description. - This variety of the species is found in straight to slightly curving chains. It is quite similar to *C. vultur*. The width of the body is much greater than its height. The epitheca and the hypotheca are of the same height. Both the margins of the epitheca are straight to slightly convex. The apical horn of the distal extreme cell of the chain is a shallow sigmoid; the rest of the cells's horns are straight. The length of the apical horn on the distal extreme of the chain is 9.75 times the height of the body; the length of the rest of the cells are about is 1.45 times the height of the body. The antapical horns start projecting themselves upward slightly below the base of the hypotheca. The left antapical horn has a stronger bending at its base, before it projects itself upwardly. The right antapical horn is bent smoothly bend, projecting itself almost diagonally to the girdle. The length of the right horn is 6.0 to 7.75 times the height of the body and the left one is 5.25 to 3.75 times. The height of the body varies between 60 and 80 μ and the length of the cell is around 54 and 420 μ.

Remarks - Six specimens examined.

Distribution. - Neritic. Warm temperate to tropical waters. SW Atlantic Ocean (**Balech**, 1988).

Ceratium contrarium (Gourret) Pavillard, 1905 (Figure 22)

Sournia, 1967, p. 473, fig. 90; Ferguson-Wood, 1968, p. 26, fig. 49; Balech, 1988, p. 151, pl. 66, fig. 5.

Description. This species resembles at *C. trichoceros*. It is a solitary form. The body is small. The epitheca and the hypotheca show similar size with triangular-shapes. The right epitheca edge is somewhat convex to nearly straight; the left one is much more pronounced. The apical horn is long, about 6.4 times the height of the body ; it is straight, slender and perpendicular to the girdle. The antapical horns start rising upwardly below the base of the hypotheca; they first direct themselves toward a transverse body axis and then the horns are oriented forward, outward, and upwardly. The antapical horns curve themselves outward halfway to the tips and in some cases they curve forward again. Both of them are parallel and as narrow as the apical horn and very long. The right antapical horn is about 6.4 times the height of the body and the left one is 7.6 times. The antapical horns are slightly divergent from the apical horn and from each other. The distal extreme of both horns reaches almost the last third distal section of the apical horn. The length of the cell ranges between 200 and 400 μ.

Remarks - Four specimens examined.

Distribution. - Present in all the oceans with warm waters. SE Caribbean Sea (**Halim**, 1967); Straits of Florida, Caribbean Sea (**Ferguson-Wood**, 1968); SW Atlantic Ocean (**Balech**, 1988).

Ceratium furca (Ehrenberg) Claparede & Lachmann, 1858-1861 (Figures 23-25)

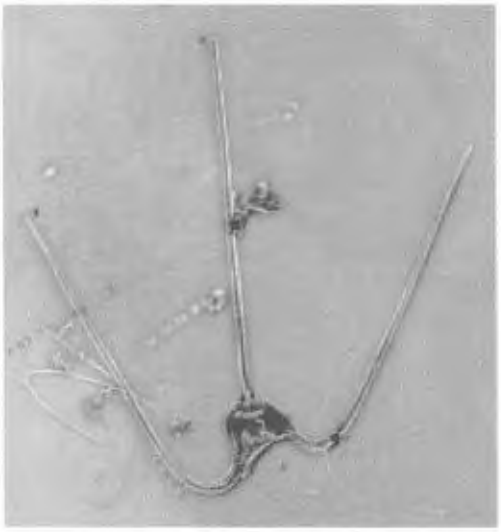
Jorgensen, 1920, p. 21, figs. 7-12; Bohm, 1931, pp. 8-12, figs. 4-7; Schiller, 1937, pp. 367-368, figs. 404-405; Graham & Bronikovsky, 1944, p. 167, fig. 7; Halim, 1967, p. 716, figs. 7, 8, 19 & 32; Ferguson-Wood, 1968, p. 30, fig. 57; Sournia, 1967, pp. 395-399, figs. 18-22; Steindinger & Williams, 1970, p. 137, pl. VII, fig. 20; Carbonell, 1979, p. 25-26, fig. 2; Balech, 1988, p.131, pl. 56, figs. 4 & 6.

Description. - This large solitary species is often confused with *Ceratium hircus* (= *C. furca* var. *hircus)*. The antapical horns are not of the same length, and are parallel or slightly divergent to each other. The body is not too robust. The epitheca is higher than the hypotheca. The margins of the epitheca are straight or slightly convex. From it, the apical horn, which can be short or large, merges gradually, oriented slightly away from the vertical central body axis toward the right side. The length of the apical horn is about 1.1 times the height of the body. The base of the hypotheca is slightly concave to flat. Both antapical horns are oriented downwardly from the hypotheca base. The right antapical horn is 2.8 times the height of the body. The length of the left antapical horn is about 0.8 times the height of the body. Both horns are serrated, strong and pointed. Cell length varies between 70 and 160 μ.

Remarks - Some specimens (Figures 24 & 25) which are very similar to *C. furca* were observed. The apical horn is curved slightly toward the right. Two forms are observed, with distinguishable apical and antapical horns. The length of the apical horn is 0.8 times the height of the body on one form and for the other one, it is 1.0 times. The left antapical horn of the first form is 0.75 times the height of the body and for the second form it is about 0.85 times ; the right horn is 0.55 and 0.7 times, respectively. Thirty five specimens examined.

Distribution. - Coastal areas, estuarine and oceanic waters. Cosmopolitan from cold temperate to tropical waters; absent in the Arctic and Subarctic zones. SE Car-

18

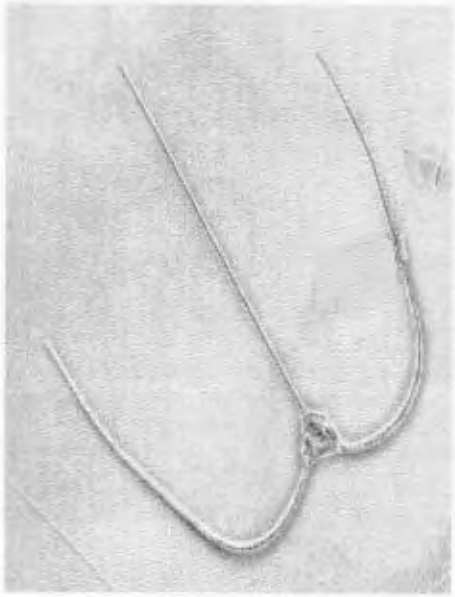


19

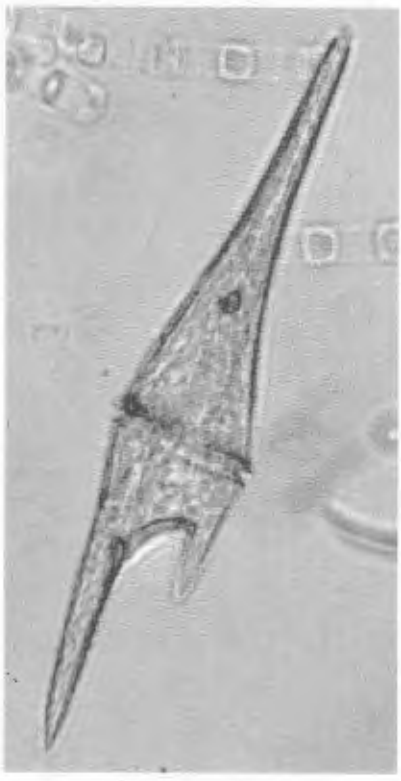
20

21

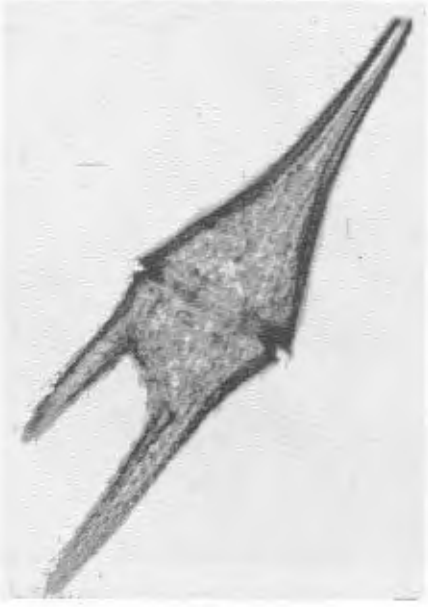
Figures 18-21. Dinoflagellates species of the genus *Ceratium*, 18-19. *Ceratium massiliense* form *macroceroides*, 20. *Ceratium vultur* var. *japonicum*, 21. *Ceratium vultur* var. *sumatranum*.



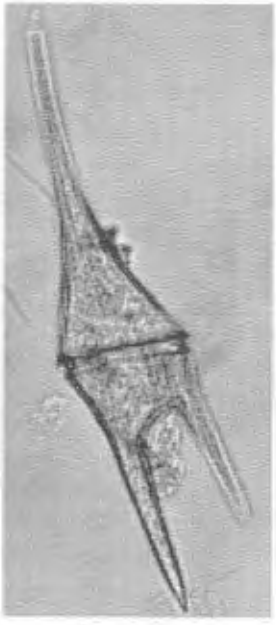
22



23



24



25

Figures 22-25. Dinoflagellates species of the genus *Ceratium*, 22. *Ceratium contrarium*, 23-25. *Ceratium furca*.

ibbean Sea (**Halim**, 1967); Gulf Stream, Gulf of Mexico, Santaren Channel, Strait of Florida, Benguela Current, northern coast of Brazil, Florida Everglades, Caribbean Sea (**Ferguson-Wood**, 1968); two varieties of the species (var. *furca* and var. *eugrammum*) have been reported for the Cartagena Bay (**Vidal and Carbonell**, 1977; **Carbonell**, 1979); SW Atlantic Ocean (**Balech**, 1988).

Ceratium hircus Schroder, 1909

= *Ceratium furca* var. *hircus* (Schroder) Margalef ex Sournia (Figure 26)

Nie, 1936, pp. 34-35, fig. 5; Schiller, 1937, p. 369, figs. 404-405; Steindinger & Williams, 1970, p. 141, pl. IX, fig. 24; Carbonell, 1979, pp. 26-27, fig. 3; Balech, 1988, p. 196, pl. 69, fig. 6.

Description. - This species is very much like *C. furca* but is larger with a less robust body. It is found solitary in plankton samples. The straight apical horn emerges perpendicular to the girdle from the epitheca. It is 0.7 times the height of the body. Both antapical horns are similar in length. The left antapical horn is 0.7 times larger than the height of the body; the right one is 0.6 times. The antapical horns are toothless, slightly divergent from each other, and directed downwardly from the body. The body has a dark brown to brown-yellow color when alive. The cell length is about 130 µ.

Remarks - Nine specimens examined.

Distribution. - SE Caribbean Sea (**Halim**, 1967); Cartagena Bay (**Carbonell**, 1979); SW Atlantic Ocean and the neritic areas of the Caribbean Sea (**Balech**, 1988).

Ceratium pentagonum Gourret, 1883 (Figure 28)

Jorgensen, 1920, p. 28, figs. 15-18; Bohm, 1931, p. 13, fig. 9b; Schiller, 1937, p. 371, fig. 408; Graham & Bronikovsky, 1944, p. 169, fig. 10; Curl, 1959, p. 306, fig. 120; Halim, 1967, p. 724, figs. 24 & 60; Ferguson-Wood, 1968, p. 37, fig. 82; Sournia, 1967, pp. 400-404, figs. 23-24; Balech, 1988, p. 128.

Description. - The cell, similar to *C. furca*, is large and has a wider the central body area. The body of this solitary species is clearly pentagonal. The sides of the epitheca are straight or slightly convex. A short, straight and relatively broad apical horn emerges from the center of the epitheca. It is perpendicular to the girdle or slightly bent toward the right side. The apical horn length is 0.65 times the height of the body. Both the epitheca and the hypotheca are of similar size. The antapical horns are slightly divergent to each other; they extend further away from the posterior margin of the body. These horns are short, thick and different in form. The length of the left antapical horn is 0.4 times the height of the body and the right one is 0.25 times. The surface of the body has several prominent ornaments. The body length can vary from 50 to 150 µ and the cell is about 250 µ long.

Remarks - This species has a very diverse morphology, presenting various forms. One specimen examined.

Distribution. - Wide distribution, from eurithermic, between warm temperate and tropical zones, and eurihaline areas of oceanic and neritic waters. SE Caribbean Sea (**Halim**, 1967); Bahamas Banks, Santaren Channel, Straits of Florida, Tongue of the Ocean, Benguela Current, Gulf of Mexico, Gulf Stream, Sargasso Sea, northern coast of Florida, Caribbean Sea (**Ferguson-Wood**, 1968); SW Atlantic Ocean (**Balech**, 1988).

Ceratium candelabrum (Ehrenberg) Stein, 1883 (Figure 29)

Jorgensen, 1920, p. 11, figs. 5-6; Bohm, 1931, p. 8, fig. 3; Nie, 1936, p. 30, figs. 1-2; Graham & Bronikovsky, 1944, fig. 6; Halim, 1967, pp. 713-714, fig. 18; Ferguson-Wood, 1968, p. 25, fig. 44; Sournia, 1967, p. 390, figs. 14-17; Balech, 1988, p. 128, pl. 56, figs. 17-18 & pl. 57, figs. 4-5.

Description. - The cell looks like *C. furca*, but its body is wider than high. This species is solitary or forms short straight chains. Both the epitheca and hypotheca show similar dimensions; they are relatively flat. The epitheca is obliquely conical and it is tapered in an angle into a short straight apical horn, wich is bent slightly to the right from a perpendicular line to the girdle. Both sides of the epitheca are nearly straight or slightly concave; the right side is larger than the left one, which has a more pronounced slope. The length of the apical horn is at least 1.3 times the height of the body. The hypotheca is irregularly triangular and shallow. The antapical horns are divergent laterally from each other and is directed posteriorly far from the posterior margin of the cell. Neither of these horns are parallel to the apical horn and they are oriented outward and downward from the hypotheca base. The length of the right antapical horn is 0.8 times the height of the body and the left one is 1.3 times. Both antapical horns are serrated over the inner side; they are usually thick, straight or slightly curved. The left horn is broader and stronger than the right one. The length of the cell ranges between 100 and 200 µ.

Remarks - Several varieties have been described. Three specimens examined.

Distribution. - Marine neritic and oceanic waters from warm temperate and tropical areas. Worldwide distribution. SE Caribbean Sea (**Halim**, 1967); Straits of Florida, Benguela Current, northern coast of Brazil, Caribbean Sea (**Ferguson-Wood**, 1968); SW Atlantic Ocean (**Balech**, 1988).

Ceratium teres Kofoid, 1907 (Figures 27-30)

Jorgensen, 1920, p. 28, fig. 18; Nie, 1936, pp. 36-37, fig. 7; Schiller, 1937, p. 372, fig. 409; Graham & Bronikovsky, 1944, fig. 11; Sournia, 1967, p. 405, fig. 28; Ferguson-Wood, 1968, p. 40, fig. 90; Steindinger & Williams, 1970, pl. XIII, fig. 35; Carbonell, 1979, p. 28, fig. 5; Balech, 1988, p. 131, pl. 56, fig. 7.

Description. - The body of this solitary species is small with slightly convex sides. The species resembles *C. pentagonium*. The epitheca is conical, larger than the hypotheca, and the hypotheca looks trapezoidal. The apical horn is long, slender and relatively straight. Its length is about 2.3 times the height of the body. The antapical horns are thick and pointed but not sharp. The length of the right antapical horn is about 0.1 times the height of the body and the left one is 0.25 times. Both of these horns are oriented down and outwardly, slightly divergent. The body size ranges between 30 and 50 µ and the cell varies between 120 and 150 µ. A specimen (Figure 27) showing a much shorter apical horn, about 0.5 times the height of the body, was observed. Both antapical horns are thicker and stronger in appearance. The length of the right horn is 0.18 times the height of the body and the left one is 0.32 times. The body length varies between 30 and 50 µ, and the cell reaches 200-300 µ.

Remarks - Nine specimens examined.

Distribution. - Oceanic in subtropical and tropical waters. Bahamas Banks, Santaren Channel, West Channel, Straits of Florida, Benguela Current, Sargasso Sea, Bermuda, northern coast of Brazil, Caribbean Sea (**Ferguson-Wood**, 1968); Cartagena Bay (**Carbonell**, 1979); SW Atlantic Ocean (**Balech**, 1988).

Ceratium fusus (Ehrenberg) Dujardin, 1841 (Figures 31-32)

Bohm, 1931, p. 14, fig. 10; Graham & Bronikovsky, 1944, p. 169, fig. 12; Curl. 1959, p. 320, fig. 116; Halim, 1967, p. 718, fig. 33; Ferguson-Wood, 1968, p. 29, fig. 58; Sournia, 1967, pp. 408-411, figs. 32-34; Steindinger & Williams, 1970, p. 139, pl. VIII, fig. 21; Carbonell, 1979, p. 29-30, fig. 6; Balech, 1988, pp. 132-133, pl. 54, figs. 5, 6 & 8.

Description. - This solitary species is similar to *C. extensus*, but is smaller in size and has a long and slightly curved left antapical horn. It presents a medium to small fusiform cell, is small to medium-sized. The epitheca is 2.2 times higher than the hypotheca. The epitheca merges into a long, and a slightly bent or straight apical horn. This horn is 2.6 times the height of the body. The apical and left tapering antapical horns are fully formed, while the right antapical horn is rudimentary or completely absent. The left antapical horn is long, straight or slightly curved, and about 2.2 times the height of the body. Both the apical and antapical horns are of similar length. The surface of the cell presents various linear markings. The length of the cells vary between 200 and 300 µ.

Remarks - Eleven specimens examined.

Distribution. - Oceanic, coastal and estuarine areas in cold temperate to tropical waters. Cosmopolitan distribution; absent from the Antarctic and sub-Antarctic regions. SE Caribbean Sea (**Halim**, 1967); Sargasso Sea, Gulf Stream, Gulf of Mexico, Benguela Current, Pigeon Key, Santaren Channel, West Channel, Straits of Florida, northern coast of Brazil, Caribbean Sea (**Ferguson-Wood**, 1968); Cartagena Bay (**Vidal and Carbonell**, 1977; **Carbonell**, 1979); SW Atlantic Ocean (**Balech**, 1988).

Ceratium candelabrum form ***commune*** Bohm, 1931 (Figure 33)

Bohm, 1931, p. 1, figs. 1-2

Description. - This form is solitary and has a larger apical horn, 1.6 times the height of the body. The apical horn is almost perpendicular to the girdle, with a slight curvature along its length and bends toward the right side. The length of the right antapical horn is 0.7 times the height of the body and the left one is 1.4 times. The saw-like teeth are absent from the antapical horns; their sides are smooth. The length of the cell is about 250 µ.

Remarks - Three specimens examined.

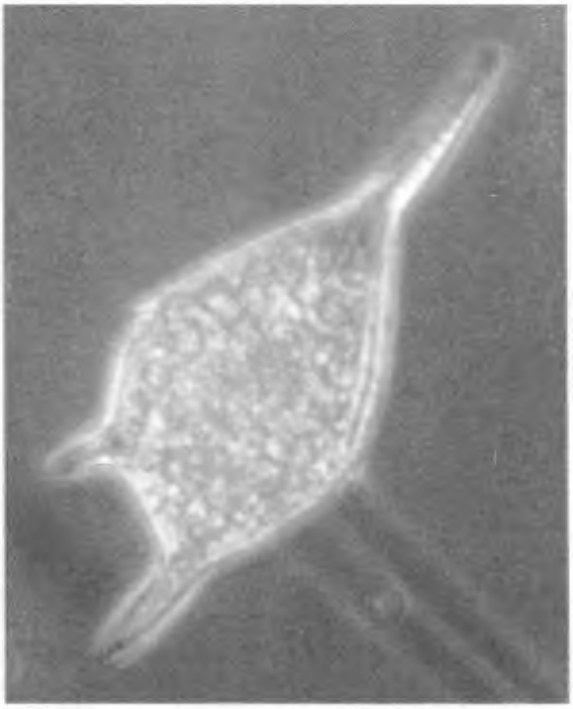
Distribution. - There are no reports for the Caribbean Sea region.

Ceratium candelabrum form ***curvatulum*** Jorgensen, 1920 (Figure 34)

Jorgensen, 1920, p. 15, fig. 6

Description. - This solitary species is very similar to *C. c.* form *commune*. It presents a very elongated apical horn, usually 3.1 times the height of the body. This horn is slightly curved toward the right side but it is more perpendicular to the girdle than in *C. c.* form *commune*.

26

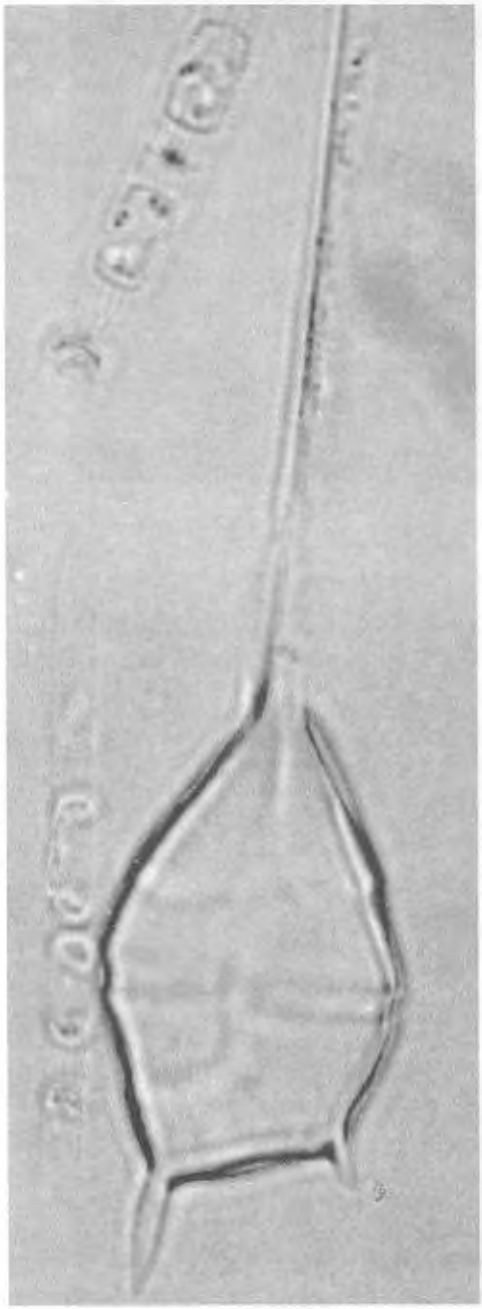


27

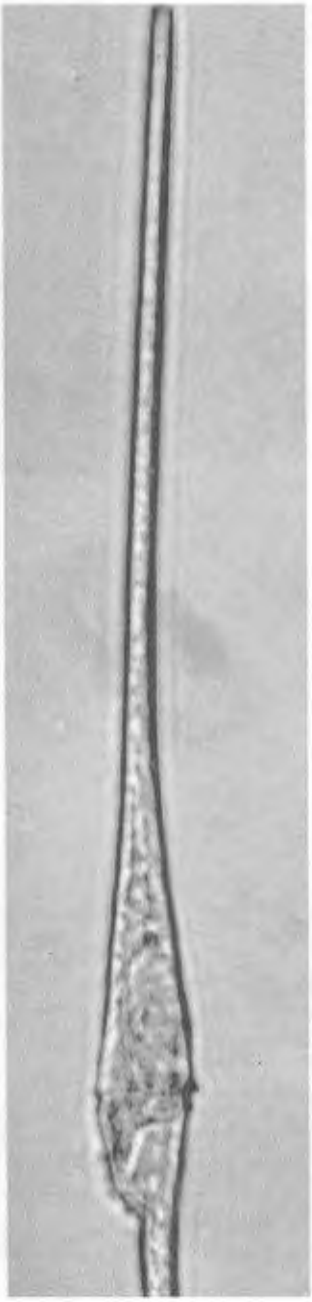
28

29

Figures 26-29. Dinoflagellates species of the genus *Ceratium*, 26. *Ceratium hircus* (=*Ceratium furca* var. *hircus*), 27. *Ceratium teres*, 28. *Ceratium pentagonium*, 29. *Ceratium candelabrum*.



30



31

32

Figures 30-32. Dinoflagellates species of the genus *Ceratium*. 30. *Ceratium teres*, 31-32. *Ceratium fusus*.

The length of the right antapical horn is about 0.9 times the height of the body and the left one is 1.6 times. The surface of the antapical horns is smooth, without serrations. The cell length is almost 250 µ.

Remarks - Two specimens examined.

Distribution. - There are no reports for the Caribbean Sea region.

Ceratium extensum (Gourret) Cleve, 1901 (Figures 35)

Jorgensen, 1920, p. 40, fig. 31; Nie, 1936, p. 40, fig. 11; Halim, 1967, p. 716; Sournia, 1967, p. 412; Ferguson-Wood, 1968, p. 28, fig. 54; Steindinger & Williams, 1970, p. 137, pl. VII, fig. 19; Carbonell, 1979, p. 30, fig. 7; Balech, 1988, p. 133, pl. 55, figs. 1-2.

Description. - This is a large species that looks like *C. fusus* (Figs. 31-32). This solitary species looks like two pins joined together. The epitheca is long and conical from which a medium size, straight and narrow apical horn emerges. The apical horn is 1.5 times the height of the body. The hypotheca is almost half the height of the epitheca. The left antapical horn is long, narrow and almost straight. It is about 2.6 times the height of the body. This horn is projected over a parallel line to the apical horn, directed downwardly to the body. The right antapical horn is absent or is needle-like and extremely small. The apical horn is always shorter than the antapical one. The length ranges from 500 to 1.200 µ.

Remarks - Eight specimens examined.

Distribution. - Oceanic areas from tropical waters. SE Caribbean Sea (**Halim**, 1967); Sargasso Sea, West Channel, Straits of Florida, Benguela Current, northern coast of Brazil, Caribbean Sea (**Ferguson-Wood**, 1968); Cartagena Bay (**Carbonell**, 1979); SW Atlantic Ocean (**Balech**, 1988).

Genus **ORNITHOCERCUS**

Description. - The body of the genus is subcircular to subovate and is compressed laterally. The epitheca is low and looks like a disk. The girdle is broad and bears some large and funnel-like lists, which extend forward from the body. The lists are usually ribbed or reticulated. The left ribbed or reticulated sulcal list is large and resembles a sail extended dorsally to the antapex.

Ornithocercus quadratus *Schutts, 1900* (Figure 36)

Ferguson-Wood, 1968, p. 86, fig. 242; Balech, 1988, p. 60, pl. 14, fig 10.

Description. - The body is rounded. Its girdle is broader over the dorsal side. The epitheca is flattened. Both the anterior and posterior girdle lists have a funnel-shape with many ribs supporting them. The left sulcal list is quadrate; it ends almost parallel to the dorsal plane, with a submarginal rib. The posterior edge of the left list is wide and almost straight, without marked lobes. The anterior list has no appreciable ornaments, but a few radii of varying sizes. The length of the body ranges between 50 and 75 µ.

Remarks - Three specimens examined.

Distribution. - Mainly oceanic. Temperate to tropical species from all the oceans. Worldwide distribution. Straits of Florida, Benguela Current (**Ferguson-Wood**, 1968); SW Atlantic Ocean (**Balech**, 1988).

Ornithocercus steini Schutt, 1900 (Figure 37)

Halim, 1967, p. 731, fig. 65; Ferguson-Wood, 1968, p. 86, fig. 244; Balech, 1988, p. 61, pl. 15, fig. 1.

Description. - The body is subspheric. The girdle is broader dorsally than ventrally. The epitheca is flattened or oblique. The anterior girdle funnel-like list is supported by a few strong ribs. The posterior list is also supported by numerous ribs. The left sulcal list is wide with its margins rounded and oriented parallel to the body; it ends dorsally. This left list shows four posterior lobes with relatively weak rib. The ribs are uniformly distributed. The last rib reaches the edge of the ventral side of the wing. The cell has a size that ranges between 50 and 70 µ.

Remarks - One specimen examined.

Distribution. - Oceanic. Temperate and tropical waters. Cosmopolitan distribution. SE Caribbean Sea (**Halim**, 1967); Straits of Florida, Benguela Current, Caribbean Sea (**Ferguson-Wood**, 1968); SW Atlantic Ocean (**Balech**, 1988).

Ornithocercus magnificus Stein, 1883 (Figure 38)

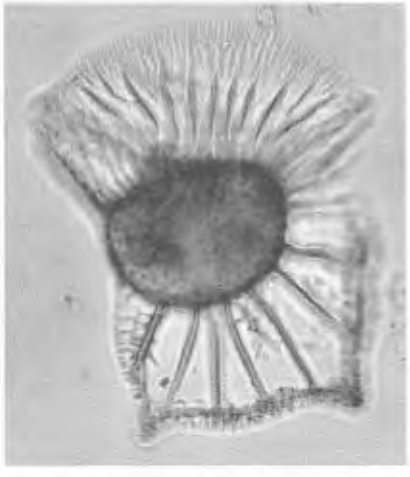
Halim, 1967, p. 731; Ferguson-Wood, 1968, p. 86, fig. 241; Balech, 1988, p. 61, pl. 14, figs. 7-8.

Description. - The body is subcircular. The epitheca is flattened or somewhat convex. The girdle list is relatively large, funnel-like and ribbed. The anterior list shows some rays, with a diffuse ornamentation over its surface. The left sulcal list ends over the dorsal side with two or three lobes. The central lobe is held by two or three ribs. The length of the cell ranges between 40 and 100 µ.

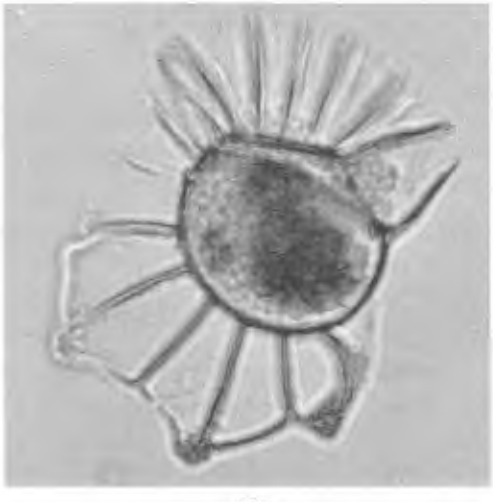
33

34

35



36



37

38

Figures 33-38. Dinoflagellates species of the genus *Ceratium* and *Ornithocercus*, 33. *Ceratium candelabrum* form *commune*, 34. *Ceratium candelabrum* form *curvatulum*, 35. *Ceratium extensum*, 36. *Ornithocercus quadratus*, 37. *Ornithocercus steini*, 38. *Ornithocercus magnificus*.

Remarks - Two specimens examined.

Distribution. - Oceanic. Tropical waters. Cosmopolitan. SE Caribbean Sea (**Halim**, 1967); West Channel, Straits of Florida, Benguela Current, northern coast of Brazil, Caribbean Sea (**Ferguson-Wood**, 1968); SW Atlantic Ocean (**Balech**, 1988).

Discussion

All of these species and morphotypes are new records for the Gulf of Salamanca. These dinoflagellates belong to the pelagic zone of the water column of neritic and oceanic areas of the Gulf of Salamanca. Most of them have a cosmopolitan or wide distribution reported in the literature, except in polar or very cold waters. Several specimens of dinoflagellates, such as *Ceratium lineatum*, *C. macroceros*, *C. trichoceros*, did not agree completely with either the description or the illustrations of different taxonomic works, which makes the categorization of the species difficult. The first author thinks that there is an urgent need to make exhaustive samplings, analysis and revisions of most of the phytoplanktonic dinoflagellates genera.

Acknowledgments

This work was made possible by a COLCIENCIAS Grant No. 2105-04-176-94 for the project "Estudio Ecológico-Pesquero del Golfo de Salamanca, Caribe Colombiano. Estimación de la Variabilidad de los Componentes del Sistema". A sincere appreciation is given to Mr. Alfonso Vidal for lending literature and useful advise and to the crews of the ships ARC MALPELO, DARDANUS, B/I ANCON and LA TUTU that assisted in the collection of the samples. Additional thanks are given to two anonymous persons for the revision and critical reading of the manuscript.

Literature cited

Balech, E. 1988. Los dinoflagelados del Atlantico Sudoccidental. Publ. Especiales Inst. Español de Oceanografia, No. 1.

Bohm, A. 1931. Distribution and variability of *Ceratium* in the northern and western Pacific. Bull. Bishop Mus., Honolulu, 87:3-46.

Carbonell, M.C. 1979. *Ceratium* Schrank (Peridiniales) en la Bahía de Cartagena. Boletin Científico (CIOH) (2):21-53

Caycedo, Ivan Enrique. 1977. Fitoplancton de la Bahia de Nenguange (Parque Nacional Tayrona), Mar Caribe, Colombia. An. Inst. Inv. Mar., Punta Betin (9) :17-44.

Ferguson-Wood, E.J.F. 1968. Dinoflagellates of the Caribbean Sea and adjacent areas. Univ. Miami Press, 143 pp.

Graham, H.W. and N. Bronikovsky. 1944. The genus *Ceratium* in the Pacific and North Atlantic Oceans. Carnegie Inst. Wash. Publ. (565):1-209.

Halim, Y. 1967. Dinoflagellates of the South-East Caribbean Sea (East-Venezuela). Int. Revue ges. Hydrobiol. **52**(5): 701-755.

Jorgensen, E. 1920. Mediterranean Ceratia. Rep. Dan. Oceanogr. Exped. Medietr., 2(Biol. J.1):1-110.

Nie, D. 1936. Dinoflagellata of the Hainan region, I. *Ceratium*. Contr. Biol. Lab. Sci. Soc. of China, Zool. Ser., XII(3): 29-73.

Schiller, J. 1937. Dinoflagellata (Peridineae) in monographischer Behandlung. (I & II). Rabenhorsts Kryptogamen-Flora, Leipzig, I (1937): **10**(3). Teil 2, pp. 1-589.

Sournia, A. 1967. Le genre *Ceratium* (Peridinien planctonique) dans le Canal de Mozamhique. Contribution a une revision mondiale. Vie et Milieu, 18(2-3 A): 375-500.

Steidinger, K.A. and J. Williams. 1970. Dinoflagellates. Mem. Hourglass Cruises Mar. Res. Lab., II:1-251.

Vidal, L.A. and M.C. Carbonell. 1977. Diatomeas y Dinoflagelados de la Bahia de Cartagena. Fundacion Universidad de Bogota Jorge Tadeo Lozano, Thesis, 387 pp. 56 plates.