

## THE DINOFLAGELLATE OF THE GENUS *CERATIUM* SCHRANK COLLECTED IN THE GRAND-LAHOU LAGOON (CÔTE D'IVOIRE)

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### Abstract

A taxonomic survey of the dinoflagellate genus *Ceratium* Schrank was conducted on ten stations in the Grand-Lahou lagoon. A total of 27 species have been identified and described. Three species and one variety (*Ceratium arietinum*, *Ceratium dens*, *Ceratium pulchellum* and *Ceratium furca* var. *Berghii*) are new records for Côte d'Ivoire.

### Introduction

The genus *Ceratium* Schrank is one of the most important marine phytoplankton components, including around 80 "species" not considering other 30 dubious species (Sournia, 1986). For more than a century, *Ceratium* thecal tabulation has been known as a constant character (Kofoid, 1907a) with the formula 4', 5", 4-5c, 2+s, 5''', 2'''' (Steidinger & Tangen, 1997). Due to the larger cell size of *Ceratium* species and their relatively well-known latitudinal geographic distributions, in many cases rather well delimited (Dodge, 1993; Dodge & Marshall, 1994; Okolodkov, 2010), they have been used as biological indicators of water masses and currents (Frost & Wilson, 1938; Graham, 1941; Okolodkov, 1996). *Ceratium* has been suggested as an excellent, if not the best, dinoflagellate genus to use for biogeographic study and as a tool for defining ocean currents and temperature ranges and may be valuable in studies of global change (Dodge & Marshall, 1994). The dinoflagellate genus *Ceratium* Schrank has also been a recent focus of systematists and clades of related species have been transferred to newly erected genera (Gómez *et al.*, 2010).

In Côte d'Ivoire, there have been many studies on phytoplankton distribution, species composition and taxonomy including *Ceratium* (Reysac, 1970; Dandonneau, 1971; Maurer, 1978; Dufour & Durand, 1982; Couté & Iltis, 1985; Dufour, 1994; Komoé *et al.*, 2009), but no detailed taxonomic investigation was made so far. The present work

is a continuation of that study, which describes the taxonomy of *Ceratium* growing in the Grand-Lahou lagoon.

### Materials and methods

The Grand-Lahou Lagoon (5°, 07'-5°, 14' N, 4°-5°, 25' W, 190 km<sup>2</sup>, mean depth of ca. 3 m) spreads on about 50 km along the Gulf of Guinea coastline (Lecolle, 1971). It comprises four basins (Lae, 1982) (Fig. 1). The Tadio lagoon (90 km<sup>2</sup>, 2-3 m in maximum depth) is the largest one. It undergoes the influence of a small forest river (Boubo) having two floods in May-July and October-November, the former one being the most important. The Niouzoumou lagoon (15 km<sup>2</sup>, 3 m in maximum depth) is a narrow basin parallel to the coastline. It is enclosed and sheltered on the superior strand of a 3,000-ha coconut agro-industrial plantation. The Mackey lagoon (28 km<sup>2</sup>), the shallowest basin (2 m in maximum depth) joins the Tadio and Tagba lagoons. The Tagba Lagoon (57 km<sup>2</sup>) located at the eastern extremity has an average depth of 3 m, but its depth can reach 8 m at the level and near the channel. It communicates directly with the sea by the only outlet of the complex, the Grand-Lahou channel, and receives water inputs of the Bandama river during the unique floods occurring in October-November (Durand *et al.*, 1994; N'doua *et al.*, 2009).

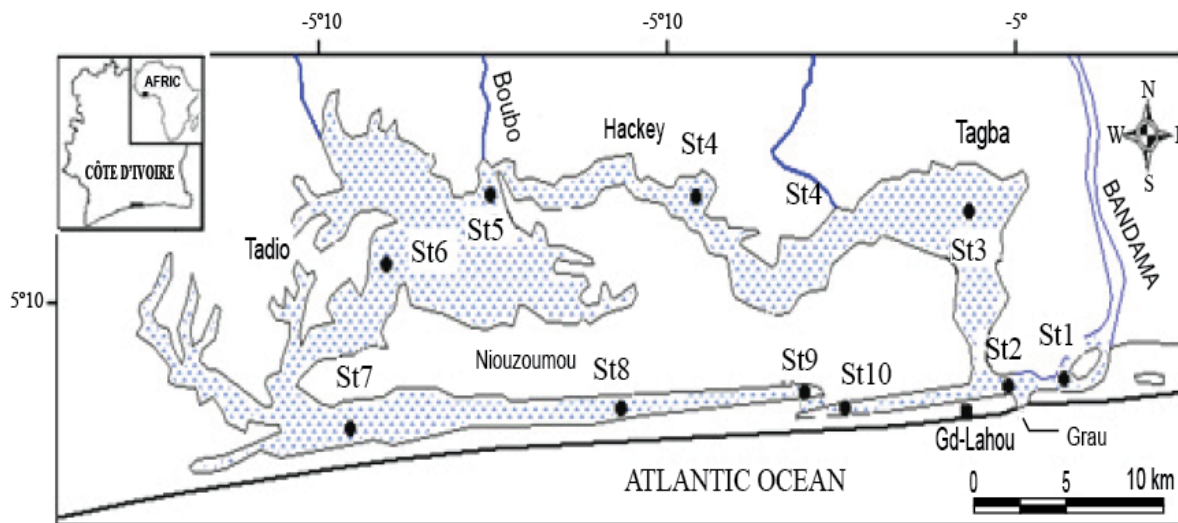


Fig. 1. Map of the study area, showing the sampling stations (St).

**Table 1. Sampling sites (stations) in the Grand-Lahou, July 2004 to June 2006.**

Station	Location	Geographic coordinates
1	Channel of the Bandama river	5°08'47.9''N, 4°59'19.3'' W
2	Grau of Lahou	5°08'17.3'' N, 5°00'16.9'' W
3	Tagba	5°11'28.4'' N, 5°04'09.9'' W
4	Mackey village	5°11'56.5'' N, 5°09'02.5'' W
5	Channel of Boubo river	5°12'39.6'' N, 5°14'23.6'' W
6	Ebounou	5°08'02.3'' N, 5°12'34.9'' W
7	Badadon	5°07'39.5''N, 5°17'58.2'' W
8	Coco village 3	5°08'15.3'' N, 5°09'04.6'' W
9	Factory of Sidor	5°08'32.9'' N, 5°05'11.1'' W
10	Groguida	5°08'11.3'' N, 5°04'49.3'' W

The phytoplankton samples for taxonomy studies were collected during the period from July 2004 through June 2006 with a 20 µm mesh plankton net by vertical tows in the centre of the stream at every sampling station (Table 1). Samples were transferred into plastic vessel (40 ml) and fixed with 40 % formalin buffered with borax to a final concentration of 5% (Thronsen, 1978). The qualitative phytoplankton analysis was carried out on microscope Olympus CX 31 type, by using certain keys for determination, for each algal group individually. Olympus-microscope is equipped with digital camera for photographing, measuring and stocking the photographs. The authors consulted for species identification were Kato (1957); Subrahmanyam (1968); Steidinger & Williams (1970); Taylor (1976); Sournia (1968); Steidinger & Tangen (1997), Okolodkov (2010) and others.

## Results and Discussion

Taxonomic remarks: The different species observed are described alphabetically. Rule scale bars in illustrations represent 20 µm. New taxa to the algal flora of Côte d'Ivoire are designated with one asterisk (\*).

### \**Ceratium arietinum* Cleve, Fig. 2

Karsten, 1907: pl. 48, fig. 3; Jörgensen, 1920: 62, figs. 60-62; Graham & Bronikovsky, 1944: 31, figs. 16a-k; Kato, 1957: 16, pl.6, figs. 21-22 ; López, 1966: fig. 27; Sournia, 1968: 429, figs. 51, 52, 54 ; Subrahmanyam, 1968: 54, figs. 95-97; Wood, 1968: 23, fig. 37; Taylor, 1976: 78, pl. 16, figs. 162, 165; Balech, 1988: 143, pl. 61, figs.4-6; Licea *et al.*, 1995, pl. 1, fig. 3, pl. 17, fig. 5; Steidinger & Tangen, 1997: 471, pl. 27.

Cell body rather delicate, with notably convex posterior margin, lacking a notch between the antapical horns. Apical horn short or moderately long, slightly curved at its base and distally straight, emerging from the left half of the cell body. Antapical horns are positioned at subequal distance from the cell body. Their proximal parts are directed laterally, distally they bend continuously, forming a semicircle. The distal part of the right antapical horn is perpendicular to the apical horn.

**Dimension: length 95-100 µm.**

**Local distribution: station Grau of Lahou.**

### *Ceratium azoricum* Cleve, Fig. 3

Karsten, 1907: pl. 48, figs. 1a, b; Paulsen, 1908: 76, fig. 99; Jörgensen, 1920: 69, fig. 66; Lebour, 1925: 151, fig. 48; Graham & Bronikovsky, 1944: 30, figs.16m-p; López, 1966:

fig. 26; Sournia, 1968: 435, fig. 58; Subrahmanyam, 1968: 56, fig. 102; Taylor, 1976: 79, pl.15, fig. 160; Balech, 1988: 137, pl. 57, fig. 6; Licea *et al.*, 1995: 30, pl. 1, fig. 4; Okolodkov, 2010: 70, Pl. 5, Fig. 7; Pl. 12, Fig. 7.

Cell body subglobular, with convex posterior margin, lacking a notch between the antapical horns. Epitheca and hypotheca more or less. Apical horn short, robust positioned centrally. Antapical horns relatively short, continuously curved and directed anteriorly. Left antapical horn is positioned very close to the cell body.

**Dimension: length 95 -110 µm.**

**Local distribution: station Grau of Lahou.**

### *Ceratium belone* Cleve, Fig. 4

Jörgensen, 1920: 22, fig. 14; Graham & Bronikovsky, 1944: 19, fig. 8; Sournia, 1968: 399, fig. 22; Subrahmanyam, 1968: 20, fig. 30; Wood, 1968: 24, fig. 40; Steidinger & Williams, 1970: 44, pl. 4, fig. 10; Taylor, 1976: 58, pl. 12, fig. 119; Balech, 1988: 132, pl. 56, fig. 1; Licea *et al.*, 1995: 30, pl. 17, fig. 6; Okolodkov, 2010: 53, Pl. 2, Figs. 1- 2; Pl. 10, Fig. 6.

Cells spindle-shaped, long. Epitheca continuously tapers into a long apical horn. Hypotheca with two well developed antapical horns, parallel to each other. Left antapical horn about twice as long as right one.

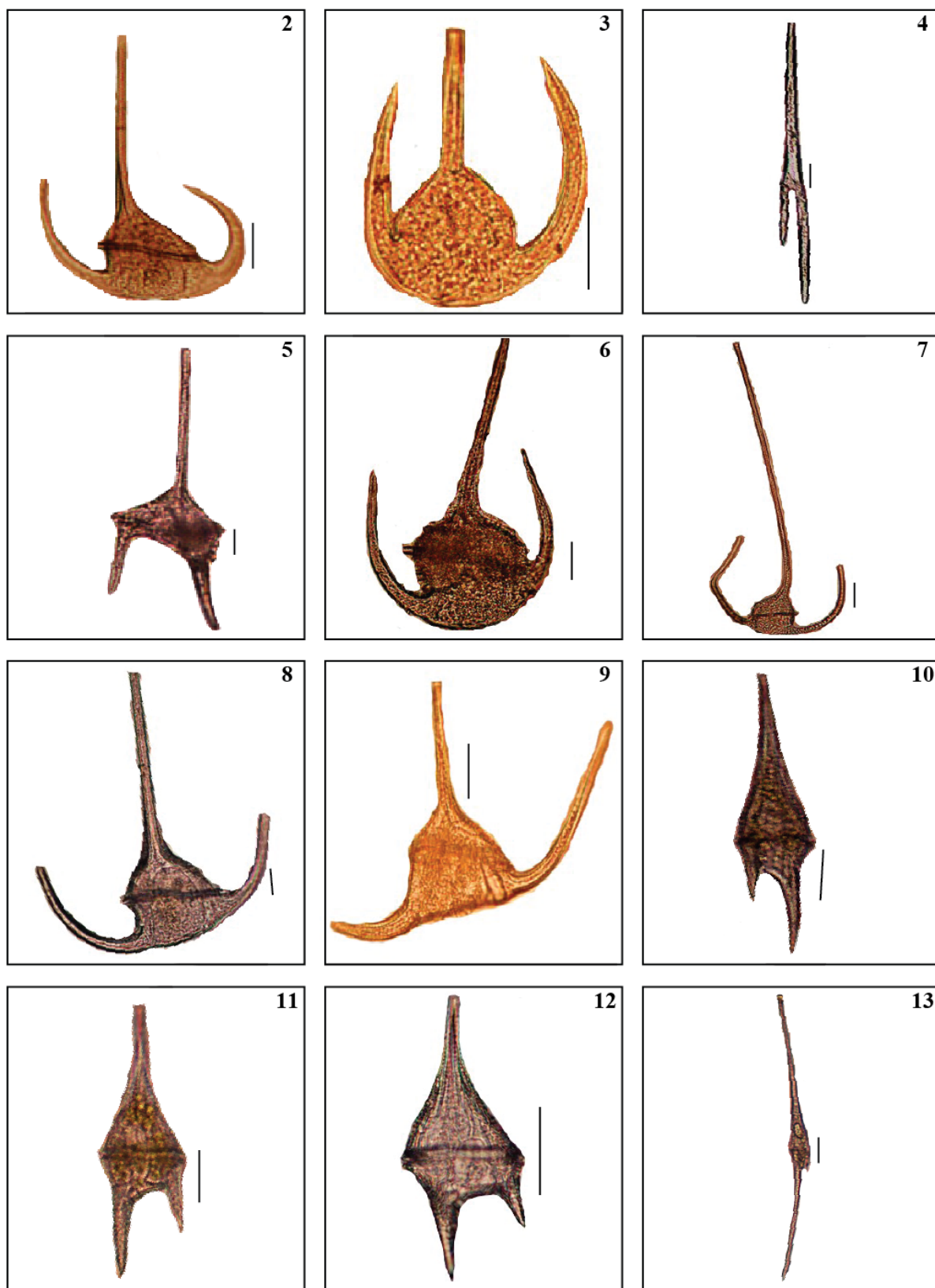
**Dimension: length 400-520 µm.**

**Local distribution: Stations Channel of the Bandama river and Grau of Lahou.**

### *Ceratium candelabrum* (Ehrenberg) Stein, Fig. 5

Paulsen, 1908: 88, fig. 120; Jörgensen, 1920: 11, figs. 5, 6; Lebour, 1925: 143, figs. 45b, c, pl. 30, fig. 2; Graham & Bronikovsky, 1944: 17, fig. 6; López, 1966: 362, figs. 3, 4, 52, 56-58, 88, 89; Sournia, 1968: 390, fig. 14; Subrahmanyam, 1968: 17, figs. 16-20; Wood, 1968: 25, fig. 44; Taylor, 1976: 59, pl. 12, figs. 124-126 ; Balech, 1988: 128, pl. 56, figs. 17- 18, pl. 57, figs. 4- 5; Licea *et al.*, 1995: 31, pl. 1, fig.5, pl. 17, fig. 8; Steidinger & Tangen, 1997: 471, pl. 27; Okolodkov, 2010: 54, Pl. 2, Fig. 5; Pl. 9, Fig. 1; Pl. 10, Fig. 8.

Cell body is about twice as broad as it is high. Anterior portion short, cone shaped, suddenly tapering at the sides into the apical horn. Apical horn straight or somewhat arched. Epitheca in the form of low cone, with well separated apical horn inserted eccentrically. Hypotheca between the antapical horns markedly inclined towards the cingulum.



Figs. 2-13. *Ceratium arietinum* (Fig. 2), *Ceratium azoricum* (Fig. 3), *Ceratium belone* (Figure 4), *Ceratium candelabrum* (Fig. 5) *Ceratium concilians* (Fig. 6), *Ceratium contortum* (Fig. 7), *Ceratium declinatum* var. *normale* (Fig. 8), *Ceratium dens* (Fig. 9), *Ceratium furca* (figs. 10-11), *Ceratium furca* var. *berghii* (Fig. 12), *Ceratium fusus* (Fig. 13).

**Dimension: length 220 -240 µm.**

**Local distribution: station Groguida.**

***Ceratium concilians* Jorgensen, Fig. 6**

Jørgensen, 1920: 72, fig. 69; Graham & Bronikovsky, 1944: 33, figs. 17h-i; Sournia, 1968: 449, fig. 74; Subrahmanyam, 1968: 45, figs. 74-75; Wood, 1968: 26, fig. 47; Steidinger & Williams, 1970: 44, pl. 6, fig. 15; Taylor, 1976: 81, pl. 19, fig. 186.

Body not rough, posterior contour more or less humpbacked towards left. Apical horn bent, convex towards left and dorsally. Right posterior horn uniformly bent from base towards the dorsal side of the body, distal portion often again somewhat bent in the direction of the apical horn.

**Dimension: length 80 -120 µm.**

**Local distribution: station Grau of Lahou.**

***Ceratium contortum* (Gourret) Cleve, Fig. 7**

Graham & Bronikovsky, 1944: 34, figs. 18d-n; Sournia, 1968: 441, figs. 67-70; Subrahmanyam, 1968: 44, figs. 69-71; Wood, 1968: 23, fig. 39; Steidinger & Williams, 1970: 44, pl. 6, figs. 16a, b; Taylor, 1976: 81, pl. 18, figs. 179-181; Balech, 1988: 145, pl. 62, fig. 4, pl. 63, fig. 2; Hernández-Becerril, 1988: 190, pl. 1, fig. 5; Licea *et al.*, 1995: 33, pl. 2, fig. 1; Steidinger & Tangen, 1997: 472, pl. 27; Okolodkov, 2010: 64, Pl. 4, Fig. 8; Pl. 5, Fig. 1; Pl. 8, Fig. 6; Pl. 11, Fig. 8; Pl. 12, Fig. 1).

Cell body subtriangular, with slightly convex posterior margin, lacking a notch between the antapical horns. Epitheca oblique on right, right contour strongly convex; apical horn twisted, S shaped; horns slender; antapicals unequal, right longer than left and twisted towards apical horn.

**Dimension: length 235-280 µm.**

**Local distribution: station Grau of Lahou.**

***Ceratium declinatum* (Karsten) Jørgensen, var. normale, Fig. 8**

Karsten, 1907: pl. 48, figs. 2a, b; Jørgensen, 1920: 66, figs. 63-65; Graham & Bronikovsky, 1944: 32, figs. 16q-t, 17a-c; López, 1966: fig. 32; Steidinger *et al.*, 1967: pl. 6, fig. b; Sournia, 1968: 438, fig. 66, pl. 2, fig. 8; Subrahmanyam, 1968: 54, figs. 98-101, pl. 4, fig. 20; Wood, 1968: 27, fig. 50; Steidinger & Williams, 1970: 45, pl. 7, fig. 18; Taylor, 1976: 82, pl. 16, figs. 163, 164, 166, 167; Licea *et al.*, 1995: 34; Steidinger & Tangen, 1997: 472, pl. 26.

Cell body delicate, subtriangular, longer than it is wide. Posterior margin of the cell is generally convex, almost flat near the right antapical horn. Epitheca is asymmetrically convex, much more on the right side than near the left one. Apical horn moderately long, slightly curved at its base and distally it is straight, strongly shifted to the left.

**Dimension: length 210-235 µm.**

**Local distribution : station Grau de Lahou**

**\**Ceratium dens* Ostenfeld & Schmidt, Fig. 9**

Karsten, 1907: pl. 48, figs. 8a, b; Sournia, 1968: 457, fig. 80; Subrahmanyam, 1968: 34, fig. 58, pl. 3, fig. 16;

Taylor, 1976: 68, pl. 17, fig. 172; Okolodkov, 2010 : 60, Pl. 3, Fig. 8; Pl. 9, Fig. 5- 6; Pl. 11, Fig. 2.

Cell body almost triangular, with slightly convex sides of the epitheca. Right antapical horn very short and bends laterally. Widest point adjacent to the antapical horns. Rather large, robust species of characteristic shape. Body somewhat broader than long. Epitheca low, half as long as broad. Apical horn well developed, rather uniformly broad, broadened at base. Hypotheca low, double as broad as long with proportionately slightly inclined posterior contour. Right horn bent round uniformly from the base divergent towards apical horn, long, somewhat narrower than both the other horns.

**Dimension: length 110-120 µm.**

**Local distribution: station Grau of Lahou**

***Ceratium furca* (Ehrenberg) Claparède & Lachmann, Figs. 10-11**

Paulsen, 1908: 90, fig. 122; Jørgensen, 1920: 17, figs. 7-12; Lebour, 1925: 145, pl. 30, fig. 3; Graham & Bronikovsky, 1944: 18, fig. 7; Kato, 1957: 12, pl. 3, figs. 4a, b; López, 1966: 371, figs. 6-7, 68, 72, 92, 93; Sournia, 1968: 395, figs. 18-20; Subrahmanyam, 1968: 20, figs. 21-29, pl. 2, figs. 7-12; Wood, 1968: 29, fig. 57; Steidinger & Williams, 1970: 45, pl. 7, figs. 20a, b; Taylor, 1976: 60, pl. 12, fig. 109; López, 1966: pl. 4, 5; Balech, 1988: 131, pl. 56, figs. 4-6; Licea *et al.*, 1995: 36, pl. 2, fig. 7; 2004: figs. 2, 8; Steidinger & Tangen, 1997: 472, pl. 25; Okolodkov, 2010: 55, Pl. 2, Fig. 6; Pl. 9, Fig. 2; Pl. 10, Fig. 9.

Body straight; epitheca tapering gradually into apical horn; hypotheca varying from parallel-sided to tapering from girdle; antapicals strong, unequal, usually straight, parallel to subparallel, may be toothed.

**Dimension: length 65-105 µm.**

**Local distribution: stations Grau of Lahou and Groguida.**

**\**Ceratium furca* var. *berghii* Lemmermann, Fig. 12**

Lopez, 1966: 23, fig. 6; Burns & Mitchell, 1980: 151, figs. 4, 5.

Cell resembles *Ceratium furca* to some extent. Antapicals usually parallel, but may be slightly divergent. Right antapical approximately half the length of the left. Apical horn curved, it is perhaps the most characteristic feature of this variety.

**Dimension: length 60-80 µm.**

**Local distribution: stations Grau of Lahou and Groguida.**

***Ceratium fusus* (Ehrenberg) Dujardin, Fig. 13**

Paulsen, 1908: 90, fig. 123; Lebour, 1925: 146, pl. 31, fig. 1; Graham & Bronikovsky, 1944: 25, figs. 11e, 13a-d; Kato, 1957: 13, pl. 3, figs. 5a-c, 6a, b; Margalef, 1961a: 81, figs. 26e-g; López, 1966: fig. 11; Sournia, 1968: 408, figs. 32-33; Subrahmanyam, 1968: 31, fig. 55, pl. 1, figs. 3-6; Wood, 1968: 29, fig. 58; Steidinger & Williams, 1970: 45, pl. 8, figs. 21a- b; Taylor, 1976: 66, pl. 13, figs. 129- 130,

136- 137; Balech, 1988: 132, pl. 54, figs. 5- 6, 8; Bérard-Therriault *et al.*, 1999: 164, pl. 83a; Okolodkov, 2010: 51, Pl. 1, Figs. 6- 7; Pl. 10, Fig. 4.

An elongated needle-shaped species. Medium to small species. Widest point adjacent to the girdle from which the epitheca long, gradually tapering to a cylindrical or gently tapering apical horn, usually slightly bent dorsally or straight; hypotheca tapering; left antapical long, slightly curved, rarely straight; right antapical rudimentary or absent.

**Dimension: length 230-460  $\mu\text{m}$ .**

**Local distribution: stations Grau of Lahou and Groguida.**

***Ceratium gibberum* Gourret, Fig. 14**

Paulsen, 1908: 75, fig. 98; Jørgensen, 1920: 70, figs. 67, 68; Lebour, 1925: 152, fig. 49; Graham & Bronikovsky, 1944: 33, figs. 17d-g; Kato, 1957: 16, pl. 5, fig. 17; López, 1966: fig. 23; Sournia, 1968: 446, figs. 73-74; Subrahmanyam, 1968: 46, figs. 76-78; Wood, 1968: 30, fig. 61; Steidinger & Williams, 1970: 45, pl. 8, fig. 22; Taylor, 1976: 84, pl.19, fig. 187; Licea *et al.*, 1995: 38, pl.18, fig. 7; Steidinger & Tangen, 1997: 472, pl. 27.

Cell body very robust, subpentagonal. Posterior margin of the cell is very convex and Resembles *C. concilians* but differs in its rugged structure. Body thick, slightly flattened. Epitheca low, left side contour almost straight, the right straight to strongly convex. Anterior horn at base more or less bent towards left, then straight, of varying length; base beset with protuberances which follow the margin and are often costate across. Hypotheca longer than epitheca with much inclined left side contour. Antapical contour strongly convex, more or less raised like a hump. Left posterior horn robust, uniformly arched. Right posterior horn shaped variously, right from the base strongly towards front and ventrally oriented.

**Dimension: length 180-200  $\mu\text{m}$ .**

**Local distribution: stations Grau of Lahou and Groguida.**

***Ceratium horridum* (Cleve) Gran, Fig. 15**

Ostenfeld, 1903: 584, figs. 136-139; Karsten, 1907: pl. 48, fig.16; Jørgensen, 1920: 96, figs. 86-92; Lebour, 1925: 155, pl. 34, fig.2; Graham & Bronikovsky,1944: 42, figs. 23i-l; Kato, 1957: 17, pl. 5, fig. 14; López, 1966: figs. 42-43; Sournia, 1968: 474, pl. 3, figs. 91-95; Subrahmanyam, 1968: 63, figs. 113-128; Wood, 1968: 32, fig. 65; Taylor, 1976: 71, pl. 20, fig. 202, pl. 21, figs. 203-208, 211-212; Balech, 1988: 148, pl. 65, figs-. 3-9; Licea *et al.*, 1995: 39, pl.3, figs. 3a-b, 4, pl. 18, fig. 11; Steidinger & Tangen, 1997: 474, pl. 28; Bérard-Therriault *et al.*, 1999: 164, pl. 83d.

Cell body relatively robust. Posterior margin of the cell oblique. Apical horn rather long, almost straight,

positioned centrally. Proximal parts of the antapical horns are directed laterally, lacking a notch between them; distally they bend continuously and are directed anteriorly, being slightly parallel to each other.

**Dimension: length 55-165  $\mu\text{m}$ .**

**Local distribution : station Grau of Lahou.**

***Ceratium inflatum* (Kofoid) Jørgensen, Fig. 16**

Jørgensen, 1920: 35, fig. 25; Graham & Bronikovsky, 1944: 23, figs. 11o-s; Kato, 1957: 14, pl. 3, fig.7; López, 1966: fig. 10; Sournia, 1968: 412, fig. 36; Subrahmanyam, 1968: 29, figs. 48-49; Steidinger & Williams, 1970: 46, pl. 10, fig. 25; Balech: 1988: 135, pl.55, figs.5-9; Steidinger & Tangen, 1997: 474, pl. 25; Okolodkov, 2010: 52, Pl. 1, Fig. 8; Pl. 10, Fig. 5.

Cells needle-shaped, long. Characterised by the slightly bent or almost straight apical horn which is considerably longer than the left posterior horn. Epitheca above all almost equally broad, then, rapidly narrowed into apical horn. Left antapical abruptly curved. Right horn very small, thin and pointed.

**Dimension: length 200-300 $\mu\text{m}$ .**

**Local distribution: stations Grau of Lahou and Groguida.**

***Ceratium lineatum* (Ehrenberg) Cleve, Fig. 17**

Sournia: 1968: 404, figs 25- 26; Wood, 1968: 34, fig 72; Balech: 1988: 130, 131, pl, 56, figs 10-13; Taylor, 1976; Steidinger & Tangen, 1997:475, pl.25.

A rather small and delicate member of the genus. Epitheca forming a more or less equilateral triangle with a sharp transition into a fairly long apical horn; hypotheca rather rectangular extended at the lower corners into two unequal antapical horns which are straight but diverge slightly.

**Dimension: length 74-120  $\mu\text{m}$ .**

**Local distribution: station Grau of Lahou.**

***Ceratium longirostrum* Gourret, Fig. 19**

Jørgensen, 1920: 37, figs. 26, 27; Graham & Bronikovsky, 1944: 24, figs. 11t-v; Silva, 1956: 57, pl. 7, fig. 10; López, 1966: fig. 15; Sournia,1968: 413, fig. 37; Subrahmanyam, 1968: 30, figs. 50-52; Wood, 1968: 35, fig. 75; Steidinger & Williams, 1970: 46, pl. 10, fig. 27; Taylor, 1976: 67, pl. 13, figs. 131a- b; Balech, 1988: 134, pl. 55, figs. 10-11; Licea *et al.*, 1995, 41, pl. 3, fig. 9; Okolodkov, 2010: 54, Pl. 2, Figs. 3-4; Pl. 10, Fig. 7.

Cells needle-shaped, very long. Epitheca tapers into a long apical horn and hypotheca tapers into a long left antapical horn. Apical and left antapical horn equal or subequal in length, apical horn being slightly curved and left antapical horn curved. A reduced right antapical horn may be present.



Figs. 14-21. *Ceratium gibberum* (Fig. 14), *Ceratium horridum* (Fig. 15), *Ceratium inflatum* (Fig. 16), *Ceratium lineatum* (Fig. 17), *Ceratium longirostrum* (Fig. 19), *Ceratium massiliense* (Fig. 21), *Ceratium pentagonum* (Fig. 18), *Ceratium praelongum* (Fig. 20).

**Dimension: length 270-380  $\mu$ m.**

**Local distribution: station Grau of Lahou.**

***Ceratium massiliense* (Gourret) Jørgensen, Fig. 21**

Jørgensen, 1920: 85, fig. 78-80; Graham & Bronikovsky, 1944: 38, figs. 22e-l; Kato, 1957: pl. 6, figs. 18, 20; Margalef, 1961a: 81, fig. 26h, pl. 6, 7, 10; López, 1966: fig. 51; Wood, 1968: 36, fig. 78; Sournia, 1968: 465, figs. 87-88; Subrahmanyam, 1968: 74, pl. 4, fig. 23, pl. 7, figs. 34, 35; Steidinger & Williams, 1970: 46, pl. 11, figs. 30a, b, pl. 12, figs. 30c-e; Taylor, 1976: 73, pl. 20, figs. 193-196; Balech, 1988: 147, pl. 64, figs. 2-3 & 5-6; Licea *et al.*, 1995: pl. 4, Steidinger & Tangen, 1997: 477, pl. 33.

Large, long-horned, very variable; body has a triangular configuration. Epitheca oblique; base contour slightly concave; apical straight horn much shorter than the two antapicals horns.

**Dimension: length 50-80  $\mu$ m.**

**Local distribution: station Grau of Lahou.**

***Ceratium pentagonum* Gourret, Fig. 18**

Jørgensen, 1920: 24, fig. 15-17; Graham & Bronikovsky, 1944: 20, figs. 10c, d, h-n; Kato, 1957: 13, pl. 4, fig. 9; Margalef, 1961a: 81, pl. 6; López, 1966: 367, figs. 5, 59, 63, 90, photo 1(3, 4); Sournia, 1968: 400, figs. 23-24; Subrahmanyam, 1968: 23, figs. 32-33; Wood, 1968: 37, figs. 82, 39; Steidinger & Williams, 1970: 47, pl. 12, fig. 31; Taylor, 1976: 62, pl. 12, figs. 111-113; Steidinger & Tangen, 1997: 477, pl. 26.

Mid-body pentagonal. Epitheca broadly triangular, the side margins forming an angle of about 60° at the apex. Apical horn very long and straight. Antapicals horns stout and moderately divergent and sharply pointed at tip. Left horn about twice as long as right.

**Dimension: length 210 µm.**

**Local distribution: station Grau of Lahou.**

***Ceratium praelongum* (Lemmermann) Kofoid ex Jörgensen, Fig. 20**

Jörgensen, 1920: 10, fig. 4; Graham & Bronnikovsky, 1944: 14, figs. 1a-d; Sourmia, 1968: 386, pl.1, fig.1; Subrahmanyam, 1968: 14, figs. 8-9; Wood, 1963b: fig.148; 1968:38, fig. 83; Taylor, 1976: 58, pl. 11, figs. 102- 103 ; Steidinger & Tangen, 1997: 477, pl. 25.

Margin in ventral view almost straight for about 2/3 length, then evenly rounded. Epitheca about twice the length of hypotheca. Hypotheca slightly narrowed with two tapered antapical horns.

**Dimension: length 241 µm.**

**Local distribution: station Grau of Lahou.**

**\**Ceratium pulchellum* Schroder, Fig. 22**

Jorgensen, 1920: 50, fig. 46; Graham & Bronnikovsky, 1944: 27, figs. 14 56-f; Subrahmanyam, 1968 : 33, fig.60.

Robust species; epitheca with steep left and very convex right side. Apical horn long and strong, slightly wider in middle, base of hypotheca strongly convex. Antapicals short, less stronger than apical. Right slightly diverging to apical, a reduced left antapical horn may be present.

**Dimension: length 142 µm.**

**Local distribution: station Grau of Lahou.**

***Ceratium schroeteri* Schroder, Fig. 23**

Jörgensen, 1920: 8, fig. 3 ; Subrahmanyam, 1968: 16, fig. 32; Wood, 1963b: 42, fig.150; Steidinger & Williams, 1970: 47, fig. 154; Taylor, 1976: 58,pl. 11, fig. 104.

A small species resembling *Ceratium digitatum*, but with less lateral expansion of the epitheca and less curvature of the antapicals than is found in that species. Epitheca broad, tapering a short distance from the apex to a short, scarcely delimited apical horn, slightly scoop-shaped and twisted to the left. Antapicals horns unequal. Right horn straight and tapering, left strongly curved dorsally and to the left, and the wall of its concave face is strongly thickened.

**Dimension: length 280 µm.**

**Local distribution: station Grau of Lahou.**

***Ceratium symmetricum* Pavillard, Fig. 24**

Karsten, 1907: pl. 48, figs. 7a, b; Graham & Bronnikovsky, 1944: 29, figs. 15h-l; López, 1966: figs. 29, 30; Sourmia, 1968: 432, figs. 55-57; Subrahmanyam, 1968: 51, figs. 89-92; Wood, 1968: 40, fig. 89; Steidinger & Williams, 1970: 47, pl. 13, fig. 34; Taylor, 1976: 87, pl. 15, figs. 152-154, 156; Balech, 1988: 143, pl. 61, figs. 7, 9; Licea *et al.*, 1995: 47, pl. 5, figs. 1- 2, pl. 20, fig. 3; Steidinger & Tangen, 1997: 478, pl. 28.

Cell body with convex sides, sometimes slightly inflated on the left side, with notably convex posterior margin, lacking a notch between the antapical horns, slightly longer than wide. Apical horn rather short and slightly curved, positioned centrally. Antapical horns relatively long, continuously curved and directed anteriorly, positioned at about equal distance from the cell body.

**Dimension: length 190-200 µm.**

**Local distribution: station Grau of Lahou.**

***Ceratium teres* Kofoid, Fig. 25**

Kofoid, 1907b: 308, fig. 34-36; Graham & Bronnikovsky, 1944:21, figs. 11b-d; López, 1966 : 371, figs. 8, 64, 91, photo 1(7); Sourmia, 1968: 405,fig. 28; Subrahmanyam, 1968: 24, figs. 34- 35; Wood, 1968: 40, fig. 90; Steidinger & Williams, 1970: 47, pl. 13, figs. 35a- b; Taylor, 1976: 63, pl. 12, fig. 110, pl.40, fig. 484; Balech, 1988: 131, pl. 56, fig. 7; Licea *et al.*, 1995: 47, pl. 5, fig. 3; 2004: fig. 5; Steidinger & Tangen, 1997: 478, pl. 26; Okolodkov, 2010: 58, Pl. 3, Fig. 4; Pl. 10, Fig. 12.

Cells with a body with straight or slightly convex sides and slender, delicate horns. Epitheca triangular, with well separated apical horn. Antapical horns short, left one about twice as long.

**Dimension: length 75-90 µm.**

**Local distribution: station Grau of Lahou.**

***Ceratium trichoceros* (Ehrenberg) Kofoid, Fig. 26**

Jörgensen 1920: 88, fig. 85; Graham & Bronnikovsky, 1944: 179, fig. 22b; Kato, 1957: 19, pl. 6, figs. 19a- b; Margalef, 1961a: 81, fig. 26i, pl. 6, 8, 10; López, 1966: figs. 44-45; Sourmia, 1968: 472, fig. 89; Subrahmanyam, 1968: 81, fig. 147, pl. 7, fig. 37; Wood, 1968: 40, fig. 91; Steidinger & Williams, 1970: 47, pl. 14, figs. 36a-c; Taylor, 1976: 75, pl. 12, fig. 117, pl. 21, fig. 210; Balech, 1988: 150, pl. 66, fig. 4; Licea *et al.*, 1995: 47, pl. 5, fig. 4; 2004: fig. 4; Steidinger & Tangen, 1997: 478, pl. 29; Okolodkov, 2010: 79, Pl. 7, Fig. 1; Pl. 13, Fig. 8.

Body small; epitheca rounded; horns thin and long; antapicals beginning almost parallel to girdle, then curved until they are parallel with apical horn and almost the same length forming a flat-bottomed U.

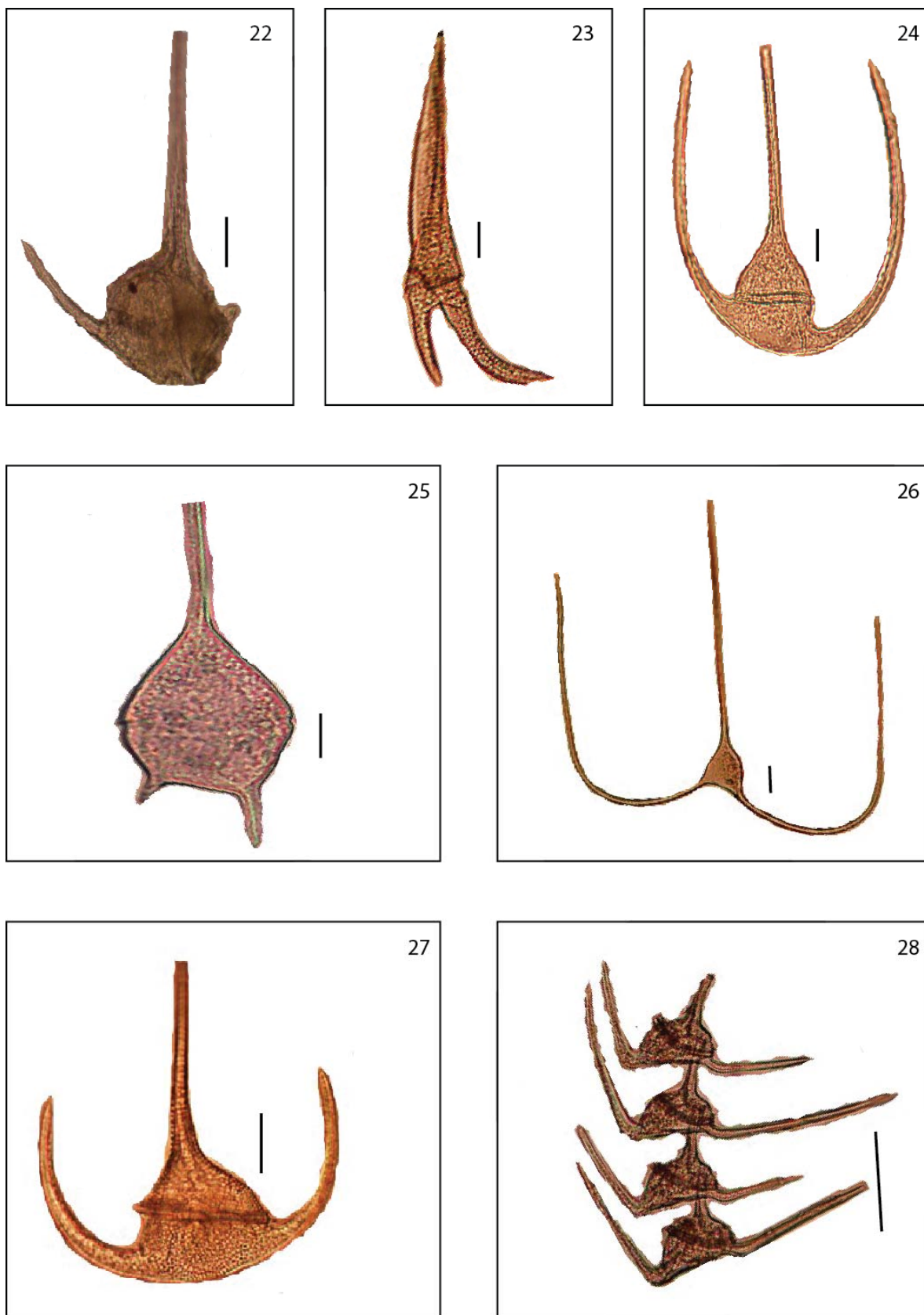
**Dimension: length 210-300 µm**

**Local distribution: stations Grau of Lahou and Groguida.**

***Ceratium tripos* (O. F. Müller) Nitzsch, Fig. 27**

Ostenfeld, 1903: 583, figs. 132-134; Paulsen, 1907: 21, figs. 30, 31; 1908: 77, figs. 102-107; Jörgensen, 1920: 46, figs. 33-39; Lebour, 1925: 148, figs. 32- 33; Graham & Bronnikovsky, 1944: 25, figs. 13e-n, 14b-f; Kato, 1957: 15, pl. 4, figs. 12a- b, 13a- b, Margalef, 1961a: 81, pl. 6, 7, fig. 26j, López, 1966: figs. 33-36; Subrahmanyam, 1968: 35, fig. 59, pl. 3, figs. 17, 18; Wood, 1968: 41, fig. 92; Steidinger & Williams, 1970: 47, pl. 15, fig. 40; Taylor, 197: 88, pl. 14, figs.147, 149-151, pl. 16, figs. 168-170; Balech, 1988: 138, pl. 58, figs. 1-7,pl. 59, figs. 1-6, pl. 60, figs. 1-2; Licea *et al.*, 1995: 48, pl. 5, figs. 5a, b, 7, pl. 20, fig. 4; Steidinger & Tangen, 1997: 478, pl. 26.

Body of cell stout, about as broad as it is long. Epitheca triangular leading sharply into a fairly long straight horn. Antapicals more or less continuous with slightly flattened base, then sharply curved forward, parallel to or making an acute angle with apical horn. Hypotheca slightly flattened at the posterior end.



Figs. 22-28. *Ceratium pulchellum* (Fig. 22), *Ceratium schroeteri* (Fig. 23), *Ceratium symmetricum* (Fig. 24), *Ceratium teres* (Fig. 25), *Ceratium trichoceros* (Fig. 26), *Ceratium tripos* (Fig. 27), *Ceratium vultur* var. *sumatranum* (Fig. 28).



**Dimension: length 110 µm.**

**Local distribution: stations Grau of Lahou and Groguida**

***Ceratium vultur* var. *sumatranum* (Karsten) Steemann Nielsen, Fig. 28**

Ostenfeld & Schmidt, 1901: 167, fig. 20; Karsten, 1907: pl. 48, figs. 13-15; Graham & Bronikovsky, 1944: 41, figs. 23a-h; Kato, 1957: 19, pl. 7, fig. 24; Sournia, 1968: 480, figs. 96-97; Subrahmanyam, 1968: 68, fig. 131; Wood, 1968: 41, fig. 94; Steidinger & Williams, 1970: 47, pl. 15, fig. 39; Taylor, 1976: 76, pl. 22, figs. 220-224, pl. 43, fig. 511; Licea *et al.*, 1995: pl. 5, fig. 8; Steidinger & Tangen, 1997: 482, pl. 6, 28.

Cell body very robust, somewhat trapezoidal. Apical horn in the anterior cell of the colony thicker and longer than those in other cells. Left antapical horn bends laterally-anteriorly, arising immediately behind the cingulum. Epitheca very low. Hypotheca double as long as epitheca with often slightly convex to about straight, rarely concave, at times slightly oblique left side contour.

**Dimension: length 40-50 µm.**

**Local distribution: station Grau de Lahou.**

### Conclusion

In all twenty seven species have been identified from the area of study. Reyssac (1970) reported only fifty seven species from the Atlantic Ocean, Couté and Iltis (1985) six from the Ebrié lagoon which are several times larger in area than the Grand Lahou's Shelf.

Overall, the genus *Ceratium* is as diverse as *Peridinium*, *Dinophysis* and other genera comprising many species, and is represented only by sixty three species in the entire world (Gomez, 2005). On the whole, the species composition of *Ceratium* in the Grand-Lahou lagoon is very similar to that in any well-studied tropical or subtropical region (Sournia, 1968; Subrahmanyam, 1968; Wood, 1968; Steidinger & Williams, 1970; Taylor, 1976). New records (*Ceratium arietinum*, *Ceratium dens*, *Ceratium furca* var. *Berghii* and *Ceratium pulchellum*) for the Côte d'Ivoire part of the Gulf of Guinea were mainly from an oceanographic station (station 2: Grau of Lahou) situated further from the coastline.

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(Received for publication 15 March 2012)