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DINOFLAGELLATA OF THE HAINAN REGION,
I. CERATIUM.

海南島雙鞭毛蟲, (一), 雙角蟲

By

DASHU NIE

倪達書



Zou jingsheng

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DINOFLAGELLATA OF THE HAINAN REGION

I. CERATIUM.

BY

DASHU NIE

INTRODUCTION

Ceratium is one of the largest genus of Dinoflagellates, widely distributed in boreal, temperate and tropical seas, with the exception of a few fresh-water forms. Although a number of species which have been reported by Wang and Nie ('32) and Wang ('36) from the Bay of Amoy and the Gulf of Pê-hai respectively, the genus has not been very much studied by the biologists in this country. The present report covers a number of species of this group, collected from various places of the Hainan Island (海南島), such as the Bays of Ching-lan (清瀾港), Shin-tsuen (新村港), San-yah (三亞港) and the Jiang-men district of Ya-shian (崖縣江門) by the writer during the Hainan Expedition jointly conducted by the Biological Laboratory of the Science Society of China; the National Research Institute of Biology, Academia Sinica; Fan Memorial Institute of Biology and Shan-tung University, in the year 1933-1934. In addition to those previously known, one species and two varieties are found to be new to science. The known species and varieties are described largely basing upon Jörgensen ('11) and all the figures are outlined with the aid of a camera lucida in order to make the sketches as accurate as possible. Thanks are due to Dr. Chia Chi Wang for his many helpful suggestions and criticism in preparing the manuscript.

Genus *Ceratium* SchrankI. Subgenus *Biceratium* (Vanhöffen) Gran

Section I. Candelabra

Ceratium candelabrum (Ehrb.) Stein 1883

(Fig. 1)

Peridinium candelabrum Ehrenberg 1859

Mid-body rather low, thick, robust, much shorter than broad. Epitheca obliquely conical, with concave lateral margins, but the left being more or less steeper than the right (angle $\varepsilon^* = 100^\circ - 110^\circ$), abruptly diminishing in size anteriorly and then drawn out into an apical horn, which is either straight or slightly bent. Hypotheca very low, especially at the right side, more or less triangular in outline, with its left margin slightly convex and contracted posteriorly. Post-margin obliquely straight or weakly arched, with $\angle^*$ being from $20^\circ - 25^\circ$. Two antapical horns often slightly divergent, occasionally parallel, each truncated at the free extremity; the left is about $1\frac{1}{4}$ to 2 times as long as the right. Transverse furrow moderately wide and gently undulated throughout; cingular lists well developed, generally furnished with radial ribs. Thecal wall

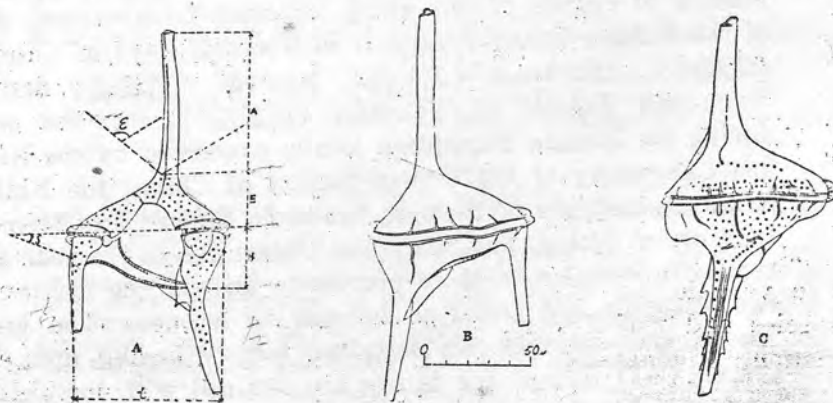


Fig. 1. *Ceratium candelabrum* (Ehrenberg). A, ventral view. B, dorsal view. C, lateral view.

*See Fig. 1a.

very rough, perforated with large pores, marked here and there by short wavy striae and sometimes also by large wing-like lists.

Dimension*: transdiameter, (t)=70-75 μ ; Length of the epitheca, (E)=27-30 μ ; Length of the hypotheca, (H)=30 μ ; Length of the apical horn, (A)=65-70 μ ; Length of the left antapical horn, (L)=50 μ ; Length of the right antapical horn, (R)=28-34 μ .

C. candelabrum is characterized by its low and much broad mid-body, the concavity of the lateral margins of epitheca, the more steep post-obliquity of the hypotheca and the strongly developed antapical horns. In the presently observed specimens, there is a delicate, small protubance at the ventral surface, very close to the post-cingular list of the left side. It appears as the vestige of the third antapical horn of *C. hirundinella*. Its presence is also indicated in Jörgensen's figure in his monograph ('11), but nothing is mentioned in his description.

As pointed out by Jörgensen ('11), this is a polymorphic species of the genus. It varies in different localities and also according to the different stages of growth. While the above description and figures A & B represent the more typical forms, figure C shows an old specimen which is strongly furnished with wavy striae and tooth-like lists along the margins of the antapicals and mid-body.

Individuals were frequently observed in the samples collected from the Bay of San-yah.

Ceratium candelabrum var. *dilatatum* (Gourret)

Jörgensen 1911

(Fig. 2)

C. Delatatum Gourret 1883

A large robust species with low and thick mid-body, much broader than long, relatively or absolutely broader than the type. Epitheca short cone-shaped, with its side-margins more or less straightly or slightly convex. Hypotheca exceed-

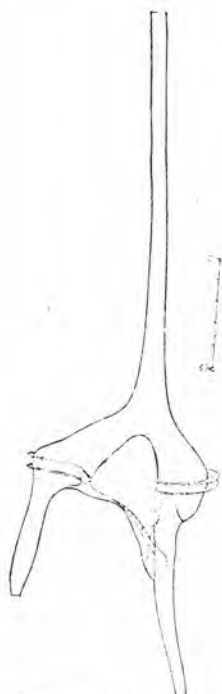


Fig. 2. Ventral view of *Ceratium candela-brum* var. *dilataum* (Gourret).

ingly low, especially at the right side, more or less triangular in outline, with its left side contracted posteriorly. Post-margin steep and strongly arched. Apical horn very long, erect or weakly curved at the center, usually of similar caliber throughout its length. Antapical horns often slightly longer and more divergent than the type, and also truncated at their free extremities. Transverse furrow, cingular lists and thecal wall resembling the type very closely.

Dimension: $t=80\mu$, $A=180\mu$, $L=65-70\mu$
 $R=50-55\mu$ $\angle\delta=25-30^\circ$

The variety differs from the type in that the body is much larger, the apical and antapical horns are relatively longer and the post-obliquity is much arched. Individuals were found in the samples collected from the Bay of Sanyah, but not so abundant as the type.

Section II Furciformia

Subsection 1. Eufurca

Ceratium furca (Ehrb.) Dujardin 1841

Feridinium furca Ehrenberg 1833

A medium-size species with moderately dorso-ventrally compressed mid-body. Epitheca triangular, gradually diminishing in size and then drawn out into a long or short opened apical horn. Antapical horns parallel or slightly divergent, the left one usually longer and sometimes about twice as long as the right, with tapering, and pointed tips.

In the cause of this study, it is found that, among the large number of the individuals of the species, there are cer-

tainly two distinct varieties as determined by Jörgensen in his monograph ('11). They are described in the following sections.

***Ceratium furca berghii* (Lemm.) Jörgensen 1911**

(Fig. 3)

C. furca var. *berghii* Lemmermann 1900

Epitheca narrowing more abruptly, angle of the two lateral margins relatively large, usually 40 degrees or more; upper narrowed portion or the apical horn nearly as long as or sometimes longer than the lower broadened part. Hypotheca shorter than the epitheca, with its lateral margins slightly contracted posteriorly. Post-indentation moderately steep. Antapical horns somewhat divergent, the left is usually larger in caliber and about twice longer than the right. Thecal wall perforated by minute clear pores and generally marked with linear striae.

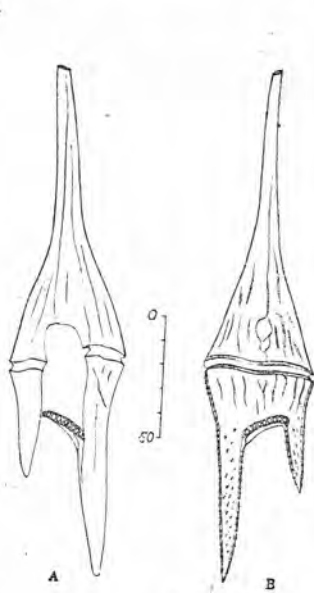


Fig. 3. *Ceratium furca berghii* (Lemmermann). A, ventral view. B, dorsal view.

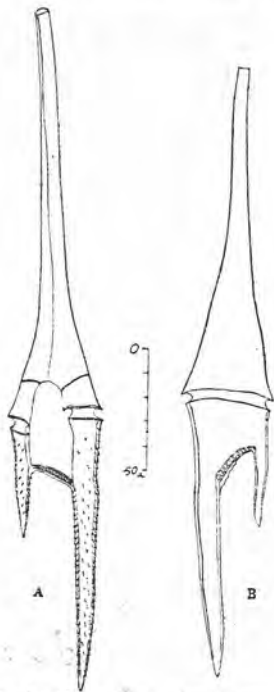


Fig. 4. *Ceratium furca eugrammum* (Ehrenberg). A, ventral view. B, dorsal view.

Dimension: $t=45$ (40-50) μ , $E+A=100-130\mu$
 $L=60$ (30-70) μ , $R=30$ (15-40) μ

Distribution: Ching-lan and Shin-tsuen

b). *Ceratium furca eugrammum* (Ehrb.) Jörgensen 1911

(Fig. 4)

Peridinium eurgammum Ehrenberg 1859

not *C. eugrammum* Kofoid 1907

Mid-body relatively small, always less than 40μ in trans-diameter. Epitheca narrowing gradually, with the angle of its lateral margins small and never exceeds 30 degrees; apical horn long or short, generally with erect and scarcely curved tip. Hypotheca less contracted between the girdle and the base of the antapicals; post indentation steep. Antapical horns usually parallel, the left is more than two times the length of the right. Thecal wall perforated by numerous minute pores and marked with linear striae, but less robust in habit.

Dimension: $t=37$ (34-40) μ $E+A=130-170\mu$
 $L=60-80\mu$ $R=25-30\mu$

Distribution: Shin-tsuen

Ceratium hircus Schröder 1909

(Fig. 5)

Body of moderate size, much longer than broad; transverse girdle slightly below the middle. Epitheca rather high, oblique conical, with its left side-margin more steeper than the right. Apical horn slender, erect, more distinctly delimited from the epitheca than that of the preceeding species. Hypotheca low, oblique, trapezoidal, with its both side-margins slightly concave. Antapicals about equal in length and similar in caliber throughout, relatively long and, in most cases, somewhat longer than the great transdiameter t ; the right horn instead of being in the same plane with the left, slightly bent to the ventral side; the left one paralleling, at first, with the right,

but then slightly bent to the outside (left) as it approaches the posterior extremity. Both horns ornamented with distinct tooth and large oblique pores, especially on their outside contour. Post-margin moderate sloping, with or without a large list at its left corner.

Dimension: $t=47.5$ ($44-52$) μ , $E+A=130-140\mu$,

$L=40-69\mu$,

$R=35-65\mu$.

Distribution: Ching-lan, Shin-tsuen, San-yah and Jiang-men.

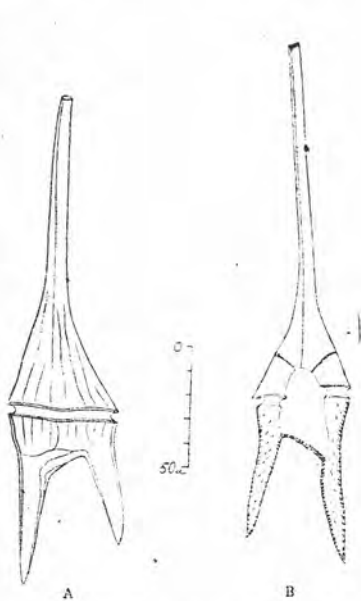


Fig. 5. *Ceratium hircus* Schröder. A, dorsal view. B, ventral view.

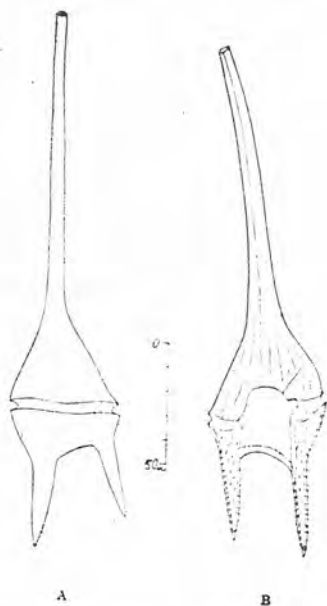


Fig. 6. *Ceratium hircus* var. *sinicum* var. nov. A, dorsal view. B, ventral view.

Individuals of this species were very abundantly found in the above mentioned localities. The distinct delimitation of the apical horn from the epitheca and the equal length of the two antapicals may be considered as the most important characteristics of the species.

Ceratium hircus var. *sinicum* var. nov.

(Fig. 6)

Mid-body of moderate size, robust, more or less fusiform in outline. Epitheca conical, with its lateral margins distinctly convex. Hypotheca slightly shorter than the epitheca, trapezoidal, with strongly convex left margin. Post-margin relatively narrow and very slight in obliquity as compared with the type. Apical horn greatly delimited from the epitheca, erect or slightly curved at its distal portion. Antapicals relatively short, usually a little shorter than the great transdiameter t , parallel or slightly divergent; the left being often a little longer than the right. Thecal wall robust, usually marked with longitudinal striae and distinct pores as the type. Tooth-like lists often present along the margins of the antapicals.

Dimension: $t=45-50\mu$, $E+A=150-160\mu$ $L=35-40\mu$, $R=30-35\mu$

This variety differs from the type in its fusiform mid-body, short antapical horns and narrow and less oblique post-margin. Individuals were commonly found in the samples collected from Jiang-man and Shin-tsuen.

Subsection 2. *Pentagona**Ceratium teres* Kofoed 1907

(Fig. 7)

Body of small size, broadly fusiform, greatly dorso-ventrally flattened. Epitheca triangular, with both lateral sides weakly convex; angle ϵ about 50° . Hypotheca strongly contracted posteriorly, trapezoidal; post-margin relatively wide and moderately oblique, with $\angle$ being about 20° . Apical horn distinctly delimited from the epitheca, long, slender and erect. Transverse girdle equatorial or nearly so, without well developed cingular list. Antapicals rather short, divergent, with both outside margins slightly bent or curved inwards at the middle; the left is usually about twice as long as the right. Thecal wall hyaline and structureless, appearing thicker on the mid-body than on the horns. Pores very faintly marked.

Dimension: $t=35-40\mu$, $E+A=130\mu$

$L=16\mu$ $R=8\mu$

Distribution: Not very abundantly in oceanic plankton off San-yah.

C. teres is one of the most defined and constant species in the genus. It is remarkable both in the form of the body and in the development of the antapical horns. The smooth thecal wall may be also considered as one of the important characteristics.

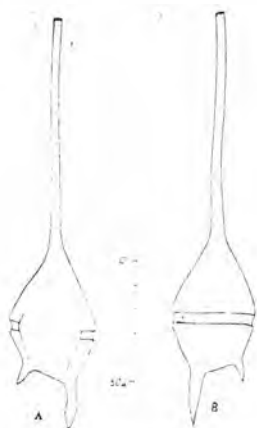


Fig. 7. *Ceratium teres* Kofoid. A, ventral view, B, dorsal view.

Ceratium kofoidi Jörgensen 1911

(Fig. 8)

C. eugrammum Kofoid 1907

Not *Peridinium eugrammum* Ehrb. 1873

A smallest species of the genus, with a relatively narrow mid-body. Transverse girdle moderately wide, situated a little below the middle portion of the mid-body. Epitheca triangular, with steep lateral margins. Apical horn long, slender, erect or weakly curved near the terminal end. Hypotheca broader than long, a little contracted posteriorly, with straight or slightly concave margins. Antapicals long, slender, parallel or slightly divergent; the left usually about twice as long as the right. Post-margin moderately sloping, with $\angle$ being about 30° [Jörgensen gives 15° ($14^\circ-20^\circ$) only]. Thecal wall rather thin, marked with linear striae and distinct pores.

Dimension: $t=25\mu$, $A=70-90\mu$

$L=34-38\mu$, $R=16-17\mu$.

C. kofoidi is closely related to *C. lineatum* on account of the form of the body and of the surface markings on the thecal

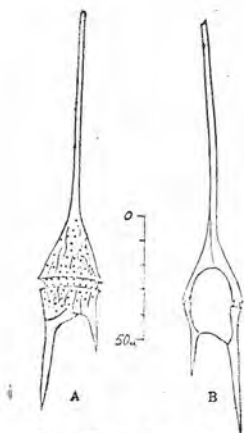


Fig. 8. *Ceratium kofoidi* Jörgensen. A, Dorsal view. B, ventral view.

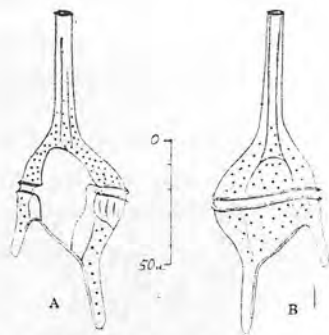


Fig. 9. *Ceratium ehrenbergi* Kofoid. A, ventral view. B, dorsal view.

wall. It differs from the latter in the size of the mid-body, and in the arrangement of antapical horns. *C. kofoidi* also differs from *C. teres* in its more robust habit, presence of striae, much straight side-margins of the epitheca and hypotheca and the absence of posterior contraction at the hypotheca.

Individuals were frequently observed in the samples collected from San-yah and Shin-tsuen.

Ceratium ehrenbergi Kofoid 1907

(Fig. 9)

Mid-body of moderate size, rounded in outline, dorso-ventrally compressed; somewhat convex at dorsal surface, concave at ventral surface. Epitheca rather oblique, with convex lateral margins, the right being much steeper than the left. Apical horn short and erect, often greatly delimited from the epitheca, arising more close to the right hand border than to the left. Hypotheca a little shorter than the epitheca, its left margin prominently contracted toward the base of the antapical horn. Antapicals short, often distinctly divergent, occasionally parallel, with rounded terminal extremity. Transverse girdle wide, with prominent lists somewhat anteriorly placed. Thecal wall thin, delicate, with sparse linear striae.

Dimension: $t=42-45\mu$, $E+H=52-55\mu$, $A=40-49\mu$

$L=20-26\mu$ $R=14-16\mu$ $\angle E = 90^\circ$.

This species was described by Kofoed from the west coast of Peru (9°S . 95°W . and 7°S . 101°W ., Albatros Exp., st. 4711 and 4719) in 1907. In his monograph, Jørgensen ('11), however, considered it as a degenerated form of the "*tripos*" group. As the individuals observed in the present study from San-yah and Shin-tsuen, exhibit some important features, similar to those originally described by Kofoed, the species in question is, here, considered as a valid one. It is not comparable with any species of the group of "*tripos*" and no sign of degeneration could be depicted.

The present specimens differ slightly from those of Kofoed in that they are relatively small in size, longer in apical and antapical horns and less robust in habit of the thecal wall.

This is a rare species and only few specimens have been observed in the samples collected from San-yah and Shin-tsuen.

II. Subgenus *Amphiceratium* (Vanhöffen) Gran

Ceratium pennatum Kofoed 1907

(Fig. 10)

Body variable in size, elongate fusiform, rather slender. Epitheca long, narrow, gradually diminishing in size anteriorly and then drawn out into a long apical horn. Apical horn rather long, either straight throughout its length or slightly bending towards the left aspect at its distal portion, where the wall at one side is often considerably thickened. Hypotheca slightly narrowing posteriorly, somewhat longer than broad. Left antapical horn long, rather straight at the anterior half, strongly but uniformly bending toward the left aspect posteriorly and the concave margin at the bending portion being also greatly thickened. Right antapical horn distinct, but very small and delicate. Transverse girdle below the middle; circular lists either poorly developed or entirely absent.

Dimension: $t=25-34\mu$ $E+A=240-306\mu$,

$L=200-280\mu$, $R=20-28\mu$.

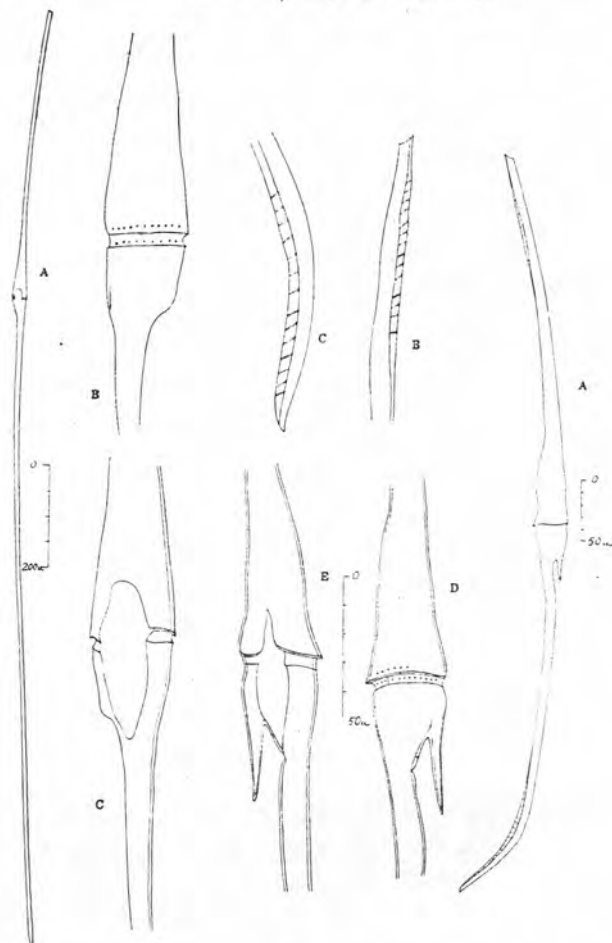


Fig. 11. *Ceratium extensum* (Gourret). A, ventral view. B, dorsal view of the mid-body. C, ventral view of the mid-body.

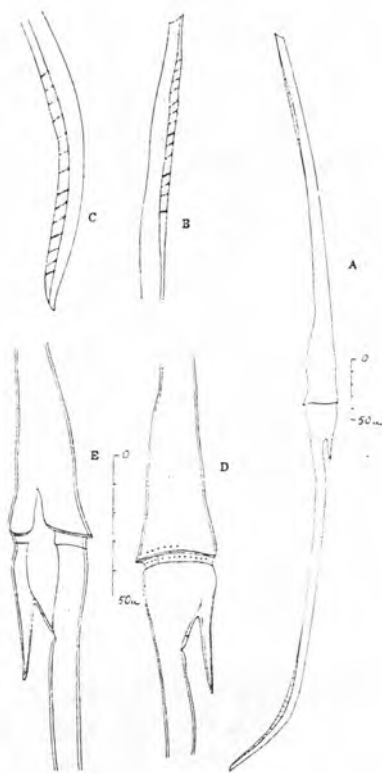


Fig. 10. *Ceratium pennatum* Kofoid. A, dorsal view. B, anterior portion of apical horn. C, posterior portion of the left antapical horn. D, dorsal view of the mid-body. E, ventral view of the mid-body.

Ceratium pennatum is characterized by its curved horns and greatly thickened wall at their concave surfaces. The

right antapical horn is very delicate but distinctly present. The epitheca greatly exceeds the hypotheca in size.

It should be noted, however, that the post cingular list of the transverse girdle which is always present in Kofoed's specimens, is total absent in the presently observed specimens.

Specimens were frequently observed in the samples collected from Ching-lan and Shan-tsuen.

Ceratium extensum (Gourret) Cleve 1901

(Fig. 11)

Ceratium furus var. *extensum* Gourret 1883

An exceedingly elongate linear species of the genus, with a slight expansion of the mid-body. Total length 45-50 transdiameters at the girdle. Epitheca with straight margins, tapering gradually from the girdle for a distance and then drawn out into a long apical horn. Hypotheca slightly contracted, short, about equal transdiameter in axial altitude. Left antapical horn linear, usually more than two times as long as the apical horn. Right antapical suppressed or wanting. Post-margin narrow; girdle narrow and with feeble lists.

Dimension: $t=28\mu$, $E+A=583\mu$, $L+H=1350\mu$

The morphological characters of the present animal agree practically in every detail to the descriptions given by Jørgensen ('11). It is known as the longest species of the genus. The species resembles, *C. strictum* (Okamura & Nishikawa) in certain extent, in spite of its great elongate body. However, it lacks entirely the right antapical horn which is possessed by *C. strictum*.

The occurrence of this species in San-yah is not very abundant.

Ceratium fusus (Ehrb.) Dujardin 1841

(Fig. 12)

Peridinium fusus Ehrenberg 1831

A moderate or small species, with very slender, elongate-fusiform body. Epitheca long, gradually narrowing anteriorly for a distance and then drawn out into a long apical horn.

Apical horn of uniform caliber or slightly diminishing in size at the free extremity, often weakly bending toward the dorsal aspect, occasionally straight throughout in some specimens. Hypotheca slightly contracted posteriorly, a little longer than broad. Left antapical horn usually very long, distinctly and uniformly bending toward the dorsal aspect, with distinctly scabrous or feebly serrated margins. Right antapical horn either entirely absent or reduced into a minute spur-like projection. Post-margin narrow; transverse girdle moderate, with distinct lists.

Dimension: $t=25-30\mu$, $E+A=240-250\mu$,
 $L=210-265\mu$.

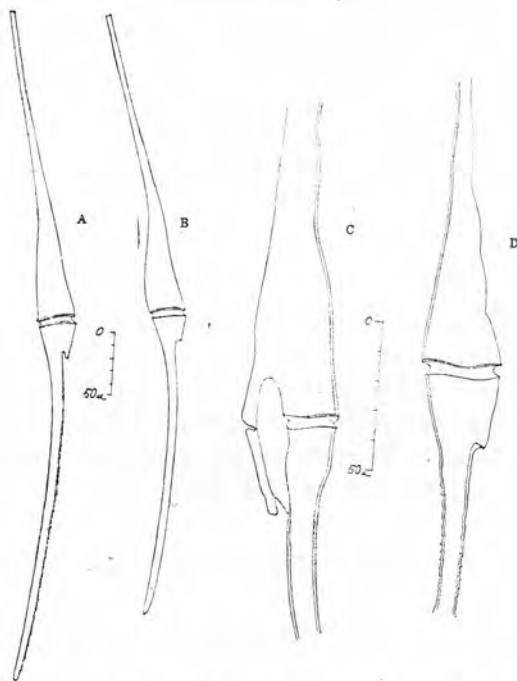


Fig. 12. *Ceratium fusus* (Ehrenberg). A and B, dorsal view. C, ventral view of the mid-body. D, dorsal view of the mid-body.

C. fusus varies very greatly in the form of the body, the length and curvature of horns and the degree of development

of the right antapical horn. In majority cases, the epitheca, together with its apical horn, is slightly longer than the hypotheca and its left antapical horn combined, but occasionally the reverse is also met with. Individuals were commonly found in the samples collected from various places of Hainan Island.

Ceratium fusus seta (Ehrb.) Jörgensen 1911

(Fig. 13)

Peridinium seta Ehrenberg 1859

Ceratium seta Kent 1880-'81

Body variable in size, elongate-fusiform, rather slender and delicate. Epitheca with more or less straight margins, tapering very gradually from the girdle to the base of apical horn. Apical horn thin, slender either of uniform caliber or slightly narrowed at its free extremity. Hypotheca gradually diminishing in size toward the base of antapical horns, usually longer than its greatest transdiameter. Left antapical horn rather long, straight, and smooth throughout its length. Right antapical horn usually absent, but occasionally represented by a minute spur or truncated stump. The posterior half of the entire body is always longer than the anterior half.



Fig. 13. Ventral view of *Ceratium fusus seta* (Ehrenberg).

Dimension: $t=16.5-22\mu$, $E+A=195-230\mu$

$L=230-235\mu$.

This species was originally described by Ehrenberg in 1859 as *Peridinium seta*, and later on, it was generally considered by other investigators as *Ceratium seta*. Stein ('83) maintained that the species in question is synonymous to *C. fusus*. In his monograph, Jörgensen ('11) described *C. seta* as a distinct sub-species of *C. fusus*, since it differs from the latter in that the transdiameter is much smaller and the lower half of the entire body is longer than the upper half. The writer is in agreement with Jörgensen's proposition. Individuals were commonly found in the samples collected from various places of Hainan.

III. Subgenus *Euceratium* Gran

Section 1. *Dens*

Ceratium dens Ostenfeld and Schmidt 1901

(Fig. 14)

Mid-body large, robust, a little broader than long. Epitheca oblique conical, rather low, usually twice as broad as high, with slightly convex or very steep left side margin and more convex right side margin. Apical horn rather long, stout, submedian, either uniform in caliber or slightly broadened at its base. Hypotheca somewhat as long as epitheca, with slightly convex or obliquely flattened post-margin. Left antapical horn very short, about $2/3$ of the greatest transdiameter, straight or slightly curved, with bluntly pointed antapex. Right antapical horn very long, usually as long as or twice the length of the apical, arising just below the transverse girdle, slightly curved for a short distance and then drawn out straightly with its pointed distal end greatly divergent to the apical. Transverse girdle well developed, oblique, marked with many longitudinal striae. Thecal wall rather thick, furnished with numerous irregular linear striae, two hyaline fins or lists usually present on the post-margin and on the left side of the hypotheca just below the transverse girdle respectively.

Dimension: $t=77-90\mu$, $E=1/2t$, $H>1/2t$,
 $A=110-150\mu$, $L=2/3t$, $R=A$ to $2A$,
 $\angle = 15^\circ$ $\beta^* = 180^\circ$ $\Delta^* = 90^\circ$

*See Fig. 15b.

Ceratium dens is characterized by its short left antapical horn and flattened or slightly convex post-margin. In addition to these, the robust habit of the thecal wall and the arrangement of the right antapical horn are also considered as important characteristics. Specimens isolated or in a chain were frequently observed from San-yah.

The right antapical horn of the specimens found from San-yah appears much longer than that described by Jörgensen ('11). It is usually twice as long as the apical and rarely shorter than the latter.

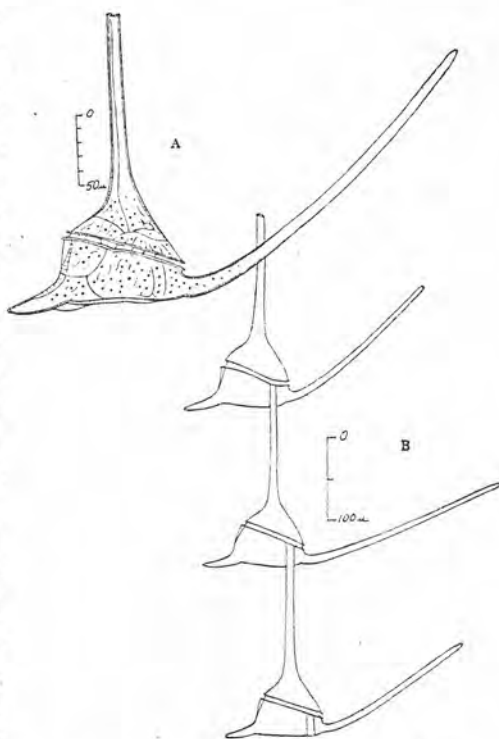


Fig. 14. *Ceratium dens* Ostenfeld and Schmidt. A, dorsal view. B, a chain of three individuals.

Section II. *Tripes* Pavillard

Subsection 1. *Eutripes*.

Ceratium pulchellum Schröder 1906

(Fig. 15)

Mid-body of medium size, somewhat longer than broad. Epitheca moderately high, about $\frac{3}{4}$ as long as broad, with steep or slightly convex left side and rather strongly convex right side margins. Apical horn very long, erect and rather strongly developed, usually of similar caliber throughout its length. Hypotheca longer than the epitheca, with slightly concave or rather straight left margin. Post-margin convex, usually pass-

ing over more uniformly from the left antapical and distinctly indented at the base of the right antapical. Antapical horn moderately short and less stout than the apical horn; the left one usually a little longer than the right, both bending gradually upward, with their pointed tips paralleling or somewhat divergent to the apical. Thecal wall delicate and structureless.

Dimension: $t=55-63\mu$, $A=190-240\mu$,

$L=120-160\mu$, $R=90-140\mu$.

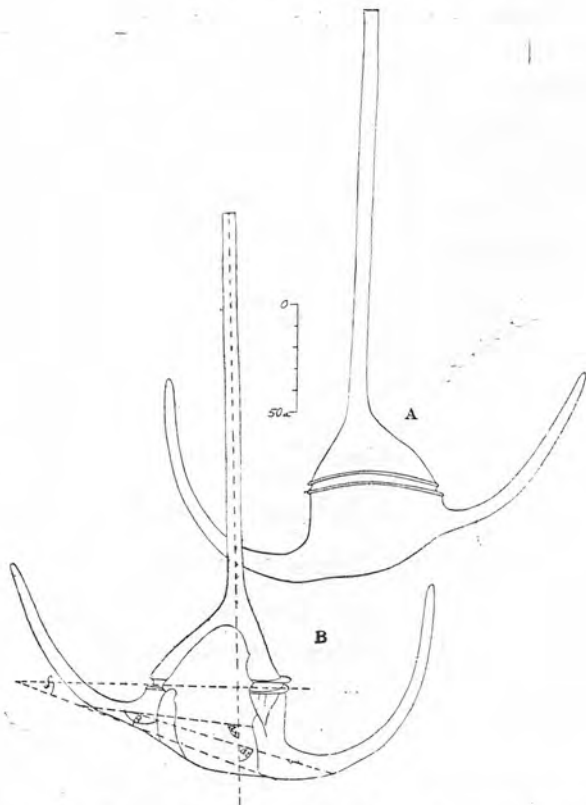


Fig. 15. *Ceratium pulchellum* Schröder. A, ventral view. B, dorsal view.

Ceratium pulchellum may be easily recognized by its tall mid-body, long apical horn, high hypotheca together with its straight left side margin and the structureless of the thecal

the left-hand border than to the right. Hypotheca high, with its left side margin straight and nearly parallel to the apical horn. Post-margin strongly convex or arched, antapical horns not setting off and less stouter than the apical. Right antapical horn exceedingly short, arising just below the transverse girdle and immediately bending upward subparalleling to the right side contour of the epitheca. Left antapical horn about two and a half times as long as the right, bending gradually upward from its base, with its pointed tip slightly divergent to the apical horn. Thecal wall hyaline, porulate, but otherwise structureless.

Dimension: $t=48-54\mu$, $E=2/3 t$, $H>E$, $A=245-260\mu$,
 $L=55-60\mu$, $R=20-25\mu$, $\angle =250^\circ$ $\angle =60^\circ$

Ceratium schröderi appears to be closely related to *C. pulchellum* in general outline of the body. However it differs from the latter mainly in (1) its small transdiameter of the mid-body (usually 10μ less than *C. pulchellum*), (2) the more convex of the post-margin and (3) the very short antapical horns.

In his monograph, Jörgensen ('11) considered the present species as a form of *C. pulchellum* which is not yet fully grown and its hypotheca somewhat undergoes a process of regeneration. The present animals are, however, very comparable to the figures of Jörgensen, showing some particular characteristics that may be well distinguished from *C. pulchellum*. No signs of regeneration could be perceptible. It is desirable to separate them from the latter species and, therefore, a new name is given.

Individuals of this species were occasionally found at San-yah.

***Ceratium tripos* (O. F. Müller) Nitzsch 1817**

(Fig. 17)

Cercaria tripos O. F. Müller 1777

Peridinium tripos Ehrenberg 1833

Mid-body of large size, slightly longer than broad. Epitheca rather low, usually more than twice as broad as long, with slightly convex left and strongly convex right margins. Hypotheca as long as or slightly longer than the epitheca, with its

left side margin more or less concave. Apical horn relatively long, more than twice the transdiameter in length, erect and usually broadened at its base. Antapicals short, the right one usually shorter than the left, both bending gradually upward till their pointed tips parallel or slightly divergent to the apical, but rarely convergent against the latter. Post-margin of the mid-body slightly convex, usually setting off from base of each antapical by a slight indentation, but less so from that of the left. Thecal wall very robust, marked with numerous longitudinal and anastomosing striae.

Dimension: $t=72-75\mu$, $A=190-200\mu$,
 $L=140-145\mu$, $R=100\mu$.

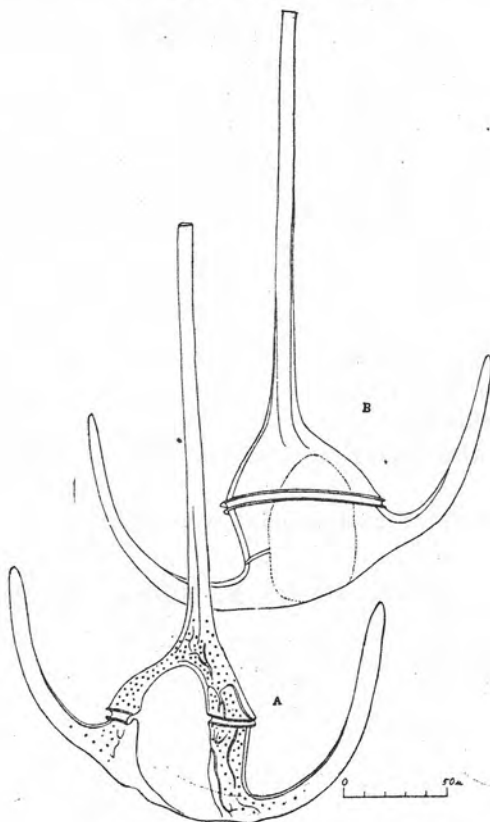


Fig. 17. *Ceratium tripos* (O. F. Müller).
A, ventral view. B, dorsal view.

Although *Ceratium tripos* is generally considered as a cosmopolitan species, the individuals of the typical form are not very abundant in coastal regions of China. So far it has not been record from the Gulf of Pe-hai (Wang '36) and the Bay of Amoy (Wang and Nie '32). The individuals collected from Shin-tsuen and Ching-lan were also presented in very small numbers.

***Ceratium tripos* var. *atlanticum* ostenfeld 1903**

This variety differs from the type in its large size of the mid-body, longer and wider spreading antapical horns. The measurements of the present specimens are quite identical to those recorded by Wang and Nie ('32) from Amoy.

***Ceratium brave* (Ostf. & Schm.) Schröder 1906**

(Fig. 18)

Ceratium tripos var. *brave* Ostenfeld & Schmidt 1901

Ceratium tripos var. *azoricum* Karsten 1906

Ceratium brave var. *curvulum* Jörgensen 1911

Ceratium schmidt, Wang & Nie 1932

Mid-body large, robust, slightly longer than broad. Epitheca a little less than twice as broad as long, with weakly convex left and strongly convex right margins. Apical horn very stout, either shorter or longer than the mid-body, usually broadened and slightly curved at the base. Hypotheca distinctly longer than the epitheca, with its post-margin uniformly con-

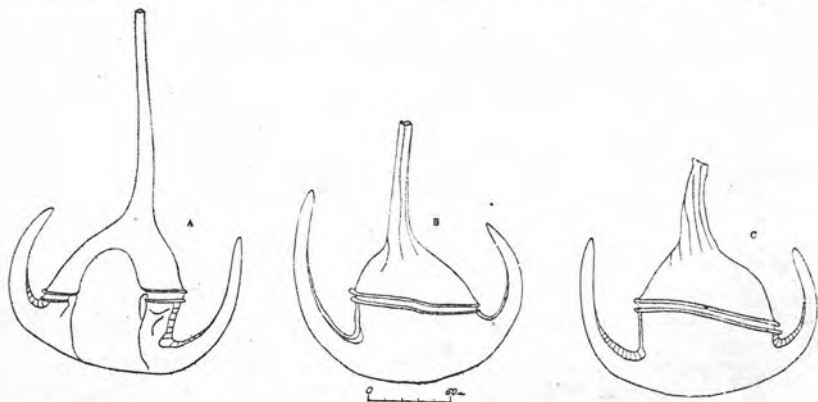


Fig. 18. *Ceratium brave* (Ostenfeld and Schmidt). A, ventral view, B and C, dorsal view,

vex. Antapical horns strongly developed, stout at the base, slightly longer than the mid-body. Left antapical usually a little longer than the right, bending gradually upward from the base till its distal extremity almost paralleling to the long axis of the apical. Right antapical bending more rapidly upward, with its distal portion slightly convergent to the apical. Thecal wall rather thick, porulate, usually furnished with many low and hyaline lists along the base of the apical horn.

Dimension: $t=80-90\mu$, $E=35-40\mu$, $H=50-52\mu$, $A=50-120\mu$
 $L=90-100\mu$, $R=70-80\mu$, $\beta=215-225$, $\angle a_o=$
110-110

Ceratium brave is characterized by its large and robust mid-body and short and stout antapical horns. The girdle or transverse furrow is relatively high and as a consequence, the epitheca is somewhat shorter than the hypotheca. Specimens were commonly observed from the surface collections at the stations of Shin-tsuen and San-yah.

It should be mentioned that the individuals observed from Shin-tsuen and San-yah vary greatly, especially in the form and size of the mid-body, the length of the apical horn and the form and direction of the antapical horns. When two extremes of variations are observed simultaneously, they might be mistaken as two different varieties or even species. After large numbers are examined and compared, a series of gradually deviations may be distinctly revealed. It seems that Jörgensen's ('11) new variety *C. brave* var. *curvulum* is evidently a intermediate form, and *C. schmidtii* reported by Wang and Nie ('32) is a long apical horned form of this species.

***Ceratium brave* var. *parallelum* (Schm.) Jörgensen 1911**

(Fig. 19)

Ceratium tripos var. *parallela* Schmidt 1901

Mid-body more or less smaller than the type, almost as long as broad. Apical horn long and relatively constant in length, about $1-1\frac{2}{3}$ as long as the body. Antapical horns regularly curved, often equal and balanced, widely spreading and much longer than the type. Post-margin less convex, usually

not setting off from the bases of the antapicals by any indentation, its curvature being continued without marked change in its radius with that of the antapicals till the latter attaining a direction parallel to the apical. A large and hyaline wing-like list is usually present at the base of the apical horn.

Dimension: $t=75-80\mu$, $E=35-40\mu$, $H=47-50\mu$, $A=85-140\mu$,
 $L=120-140\mu$, $R=120-145\mu$, $\beta=180-200^\circ$,
 $\angle a_e=90^\circ$.

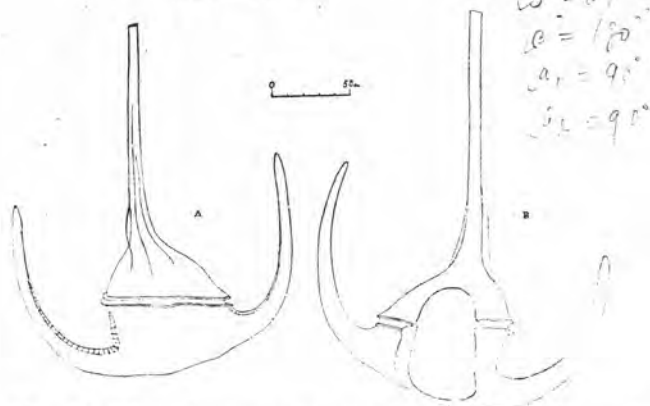


Fig. 19. *Ceratium brave* var. *parallelum* (Schmidt). A, dorsal view. B, ventral view.

This variety differs from the type in its relatively smaller size of the mid-body, longer and widely spreading antapical horns and less convex post-margin. Individuals of this species were very commonly found in the samples collected from various stations of Hainan, especially abundant at Shin-tsuen.

Ceratium declinatum Karsten 1907

(Fig. 20)

A small delicate species; mid-body dorso-ventral flattened, much longer than broad, with all three horns generally disposed in the same horizon. Epithea longer than hypotheca, with very steep left and strongly convex right margins; $\angle$ very acute ($10^\circ-15^\circ$). Apical horn long, straight, usually arising from the epithea near the left side. Hypotheca rather low, with its left side margin usually more or less straight. Post-

margin either uniformly convex or slightly flattened at the base of the right antapical horn. Antapicals distinctly dissimilar, with their distal portions parallel or slightly divergent to each other. Right antapical longer but slender than the left, much longer than the mid-body, bending gradually upward from its base with its median portion rectilineal and distal end slightly bented outward. Left antapical much stout, with its distal portion parallel or a little convergent to the apical horn. Transverse girdle slightly oblique, more distinct and wider at the left than at the right. Cingular lists not well developed, especially at the right half of the body. Thecal wall thin, structureless except perforated by minute clear pores.

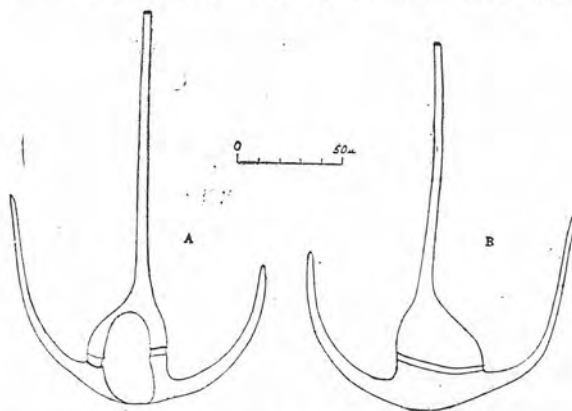


Fig. 20. *Ceratium declinatum* Karsten. A, ventral view. B, dorsal view.

Dimension: $t=35-42\mu$, $E=23-30\mu$, $H=20-23\mu$, $A=110-135\mu$,

$L=70-90\mu$, $R=92-105\mu$, $\angle > 180^\circ$,
 $\angle \alpha_e > 90^\circ$.

Ceratium declinatum is characterized by its small and delicate body and poorly developed cingular lists. The dorso-ventrally flattened mid-body, the horizontal disposition of the apical and antapical horns and the larger size of the epitheca than the hypotheca are also important characters of the species. Individuals were frequently found in the samples collected from San-yah.

Subsection 3. Gibber.

Ceratium gibberum f. *sinistrum* Gourret 1883

(Fig. 21)

For description, see Wang, 1936, p. 158.

This is a large species of robust habit, with all the horns greatly variable in length, curvature and direction. The individuals observed from Shin-tsuen, are mainly short apical horned varieties. The mid-body is more or less dorso-ventral depressed and both margins of the epitheca are unevenly convex. The girdle or transverse furrow is premedian and descending greatly towards the ventral side. The post-margin of the mid-body is strongly convex and not delimited from the bases of the antapicals by any indentation. The right antapical horn is not recurved at its distal end as described by Jörgensen ('11).

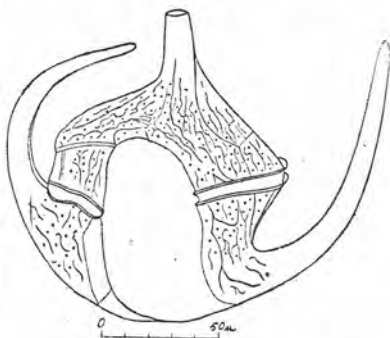


Fig. 21. Ventral view of *Ceratium gibberum* f. *sinistrum* Gourret.

Dimension: $t=93-100\mu$, $A=20-30\mu$
 $L=125\mu$, $R=100\mu$.

Ceratium schmidtii Jörgensen 1911*Ceratium curvicone* Schmidt 1901

(Fig. 22)

Mid-body of large size, rather delicate in habit, strongly-concaved at the ventral side. Epitheca tall, with left slightly and right strongly convex margins. Apical horn very long, erect but slightly bent and broadened at its base which is often marked with a short wing-like list. Hypotheca longer than the epitheca, with its left margin weakly concave. Post-margin convex, usually not setting off from the base of both antapicals by any indentation. Antapical horns very short, often shorter than the mid-body, greatly deflected toward the ventral side,

broadened at their base, bending upward abruptly with the least angles. Left antapical horn nearly straight, with its pointed tip almost parallel to the apical. Right antapical horn slightly bent at the base strongly recurved toward the dorsal aspect at the distal portion. Thecal wall moderate thick, porulate and sparsely marked with longitudinal striae.

Dimension: $t=74-47\mu$, $E=40-45\mu$, $H=50-55\mu$, $A=70-235\mu$,
 $L=62-73\mu$, $R=53-62\mu$, $\beta=215^{\circ}-235^{\circ}$,
 $\angle a_e=90^{\circ}-95^{\circ}$.

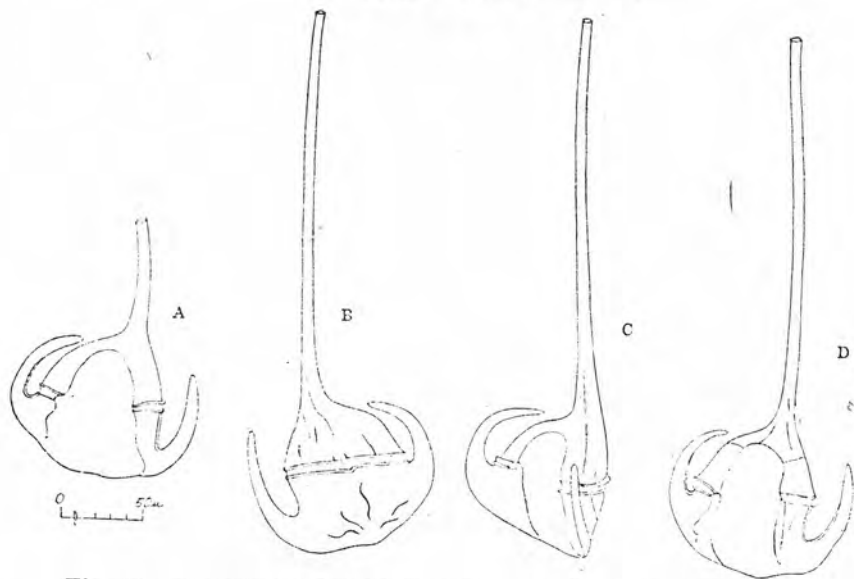


Fig. 22. *Ceratium schmidti* Jörgensen. A and D, ventral view, B, dorsal view. C, ventro-lateral view.

This species is mainly characterized by its mid-body which is greatly concaved ventrally and, as a consequence, the two antapical horns are also strongly deflected to the ventral aspect. In the most observed specimens, the apical horn is rather long and slightly bent and broadened at its base. Individuals with short apical horn are sometimes also met with. The antapicals are very peculiar, as they are distinctly shorter than the mid-body, and bending so suddenly upward that the distance between the mid-body and themselves are very short.

Specimens were frequently observed in the samples collected from San-yah.

Subsection 4. Lunulae

Ceratium lunulae Schimper in Chun 1900

(Fig. 23)

Ceratium arcuatum Okamura & Nishikaw 1904

Ceratium lunula f. *brachyceros* Jörgensen 1911

The presence of this species in the Chinese coastal region has been previously recorded by Wang and Nie ('32) from the Bay of Amoy. The specimens presently observed from the stations, Shin-tsuen and San-yah, are however, slightly different from those of Amoy. The mid-body is much larger in size and the side margin of the epitheca is but slightly convex or even straight. The antapicals are also much longer than the Amoy forms, and their curvatures are continued throughout without any marked change. Their distal ends, therefore, become convergent instead of divergent to each other as in the

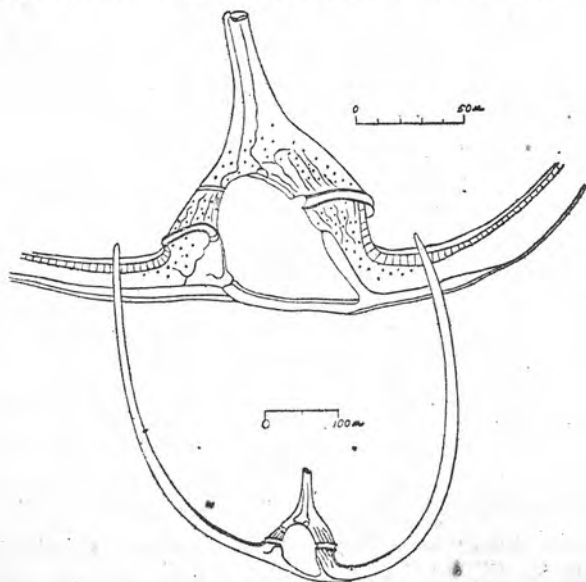


Fig. 23. Ventral view of *Ceratium lunula* Schimper.

case of Amoy forms. Chain formation is very common in this species.

Dimension: $t=90-94\mu$, $A+E+H=135-148\mu$,
 $L=355-520\mu$, $R=340-380\mu$.

Ceratium longium Karsten 1906

(Fig. 24)

Mid-body of large size, triangular in outline, about as long as broad. Epitheca somewhat oblique, with steep left and strongly convex right margins; $\angle$ about 75° . Apical horn

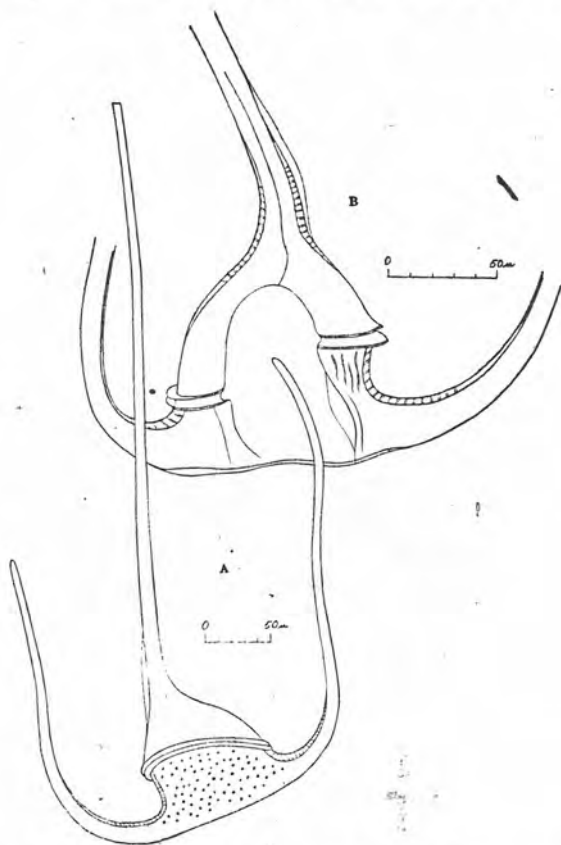


Fig. 24. *Ceratium longium* Karsten. A, dorsal view. B, ventral view of the mid-body.

exceedingly long, rather flexible, usually weakly undulated like the letter S, developed from the epitheca in a position more close to the left hand border. Hypotheca as long as or slightly longer than the epitheca, with oblique or somewhat concave left side margin. Antapical horns long, dissimilar, strongly deflected to the ventral side in their proximal region and as a consequence, they are seen from the dorso-ventral surface as approaching a cause of subparallel to the apical horn. Left antapical distinctly short and relatively straight as compared with the right, which is considerably undulated and usually curved inward at its distal end. Post-margin of the mid-body rather flattened or straight, not distinctly convex.

Dimension: $t=95\mu$, $A=445\mu$, $L=280\mu$, $R=340\mu$.

The present species resembles very closely to *C. karsteni* Pavillard. It differs from the latter in its exceedingly long apical horn, less divergent in length and great ventral deflection of the proximal regions of the antapical horns. The distance between the apical and antapical horns is narrower in the left side than in the right. In the present species, the post-margin of the mid-body is distinctly flattened or straight, while in *C. karsteni*, it is distinctly convex or even semicircular throughout. Like the case of *C. karsteni*, the basal portion of apical horn is usually furnished with a longitudinal band of wing-like list.

The occurrence of *C. longium* in the station San-yah is very rare, since only two specimens were observed during the middle part of september, 1934.

***Ceratium contortum* var. *saltans* (Schd.) Jörgensen 1911**

(Figs. 25-26)

Ceratium asltans B. Schröder 1906

Mid-body of large size, more or less rotund in outline. Epitheca rather oblique, with both side margins usually convex; the right being more convex and much longer than the left. Apical horn exceedingly long, developed from the epitheca in a position rather closer to the left side than to the right, broadened and very prominently curved near its base. Hypo-

theca as long as or slightly shorter than the epitheca, with its post-margin either evenly convex or slightly indented at the base of the right antapical horn.

Antapicals more or less equal in length, much shorter than the apical.

Left antapical horn uniformly bent upward, with its pointed distal end approximately parallel with or divergent to the apical horn.

Right antapical horn spreading laterally from the mid-body for a quiet distance and then bending suddenly upward with its pointed distal portion convergent against or sometimes obliquely crossing the apical.

The distal portion of the right antapical usually forms a right angle with its proximal portion.

Thecal wall thick, usually punctured with large pores; no striae and wing-like lists.

Dimension: $t=80-88\mu$, $A=450-470\mu$, $L=190-210\mu$

$R=220-230\mu$.

Ceratium contortum is characterized by its rotund mid-body, long apical and short and dissimilar antapical horns. The apical horn arises, as a rule, from the epitheca more close to the left-hand border and it is usually strongly curved at the basal portion. Variety *saltans* may be distinguished from the

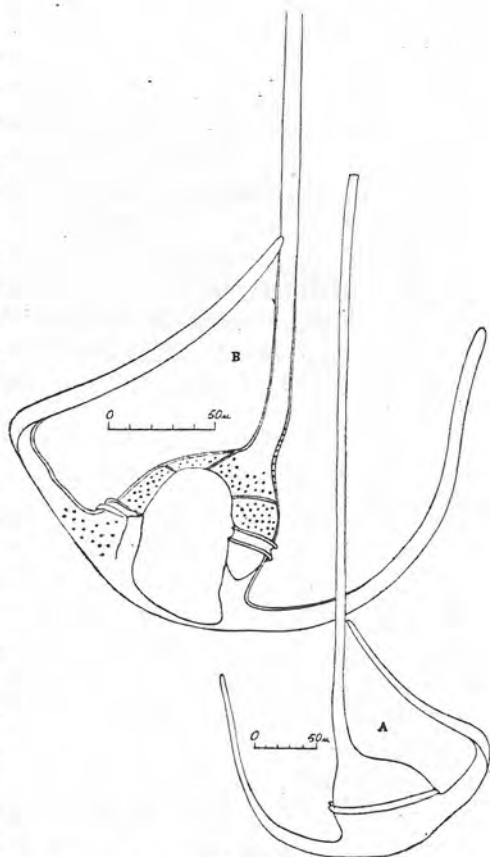


Fig. 25. *Ceratium contortum* var. *saltans* (Schröder). A, dorsal view. B, ventral view.

type by its exceedingly long apical horn and by the two ant-apical horns which are approximately equal in length. The variety also differs from the type in the curvature of the right antapical horn. As stated in above description, the right antapical horn spreads laterally from the mid-body for a quite

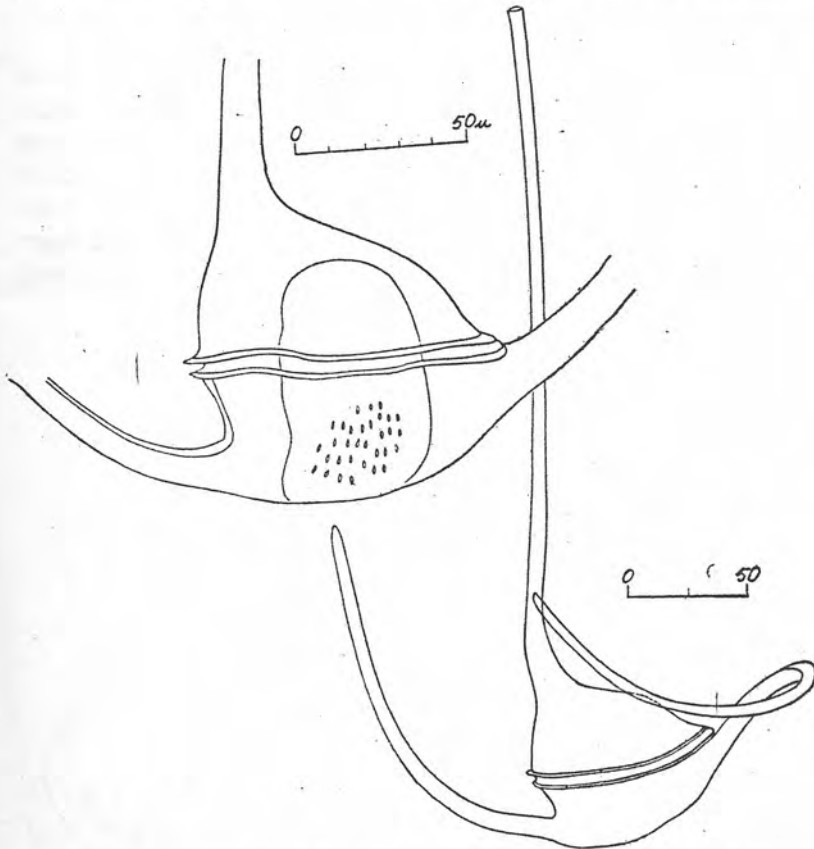


Fig. 26. Dorsal view of *Ceratium contortum* var. *saltans* (Schröder).

distance at first and then bend strongly upward to form a right angle with the proximal part. It should be noted that the curvature of the right antapical horn appears to vary very greatly, as in some cases (Fig. 26), it becomes spiral, forming a complete loop before the distal portion directs anteriorly.

Individuals were occasionally observed in the water samples collected from San-yah.

Section III *Palmatum*,

Ceratium palmatum var. *ramipes* (Cl.) Jörgensen 1911

(Fig. 27)

Ceratium ramipes Cleve 1900

Mid-body of medium size, about as long as broad. Epitheca wide, low and oblique, generally with unequal convex side margins; angle ε large, about 90° . Hypotheca as long as the epitheca, with its left side margin slightly concave or nearly straight. Post-margin often gently convex, setting off from the base of each antapical by a slightly indentation, but rather indistinct from that of the right. Apical horn very long, often slanting or deflected to the right at an angle about 25° , slightly broadened at the base and distinctly toothed on the left side border along the posterior third. Antapical horns well developed, about 2-3 times as long as the mid-body, spreading laterally from the mid-body for a short distance and then bending upward in a cause paralleling one to another, with their distal third separated into 4 to 8 finger-like processes. Right antapical about the same length as the left, but more deflected to the dorsal side and often convergent to the apical by an angle about 45° ; the left is divergent to the latter.

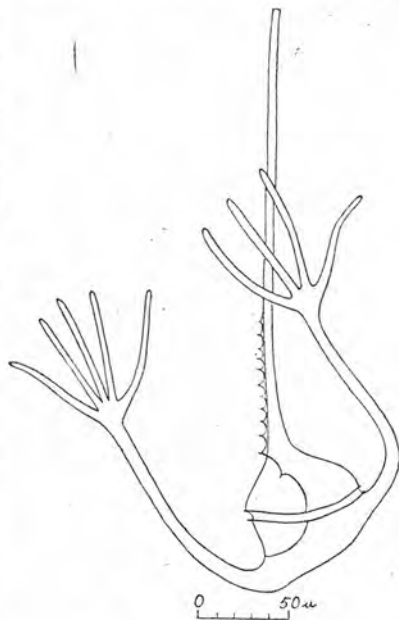


Fig. 27. Dorsal view of *Ceratium palmatum* var. *ramipes* (Cleve).

Dimension: $t=64\mu$, $E+H=t$, $A=245\mu$, $L=190\mu$,
 $R=L$, $\beta=180^\circ$, $\angle a_e=60^\circ$.

The variety differs from the type in that the finger-like processes of the antapical horns are arranged in the same plane and the distal end of each process is not inflated as the type. The curvature of right antapical horn is much wider than that of the type and its length usually equals to that of the left. Other characteristics are similar to the type.

Only few specimens were observed in a sample collected from San-yah.

Section IV Macroceros

Ceratium macroceros var. *hainanensis* var. nov.

(Fig. 28)

Mid-body of large size, thick, strongly convex at dorsal side, greatly concave at ventral side, often longer than broad.

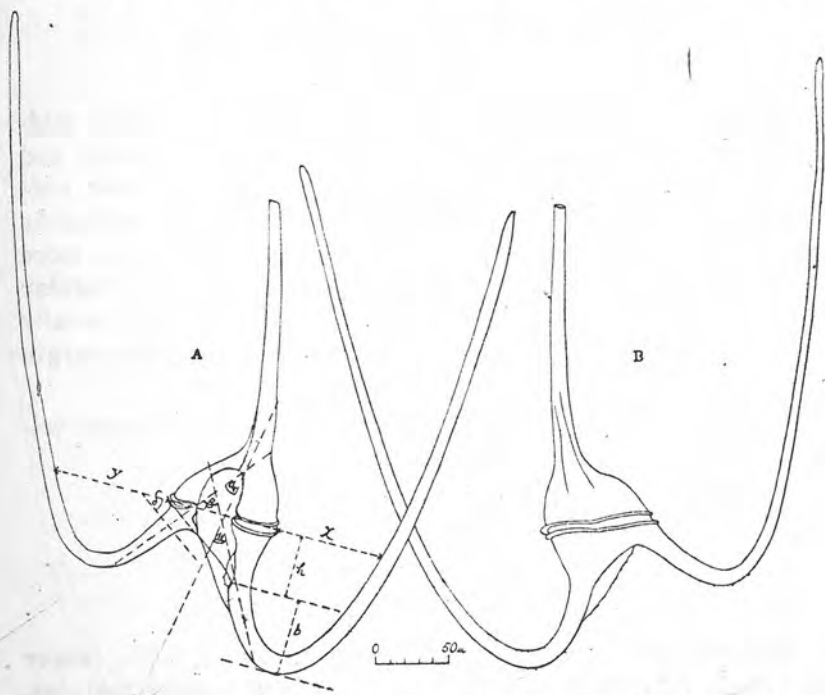


Fig. 28. *Ceratium macroceros* var. *hainanensis* var. nov. A, ventral view. B, dorsal view.

Epitheca slightly oblique, with convex side margins. Hypotheca as long as or slightly longer than the epitheca, with its left margin nearly straight or weakly concave. Post-indentation very deep, usually deeper than that of the type, sharply delimited from the base of antapical horns. Post-obliquity rather steep, with β from 35° - 38° . Apical horn relatively short, stout, often enlarged at its base and slightly bent to the right. Antapical horns divergently directed downward at first for a considerable distance with angle β from 65° - 70° , then rapidly bending upward with their ascending portions more or less subparallel to the apical and the distance between them (X and Y) being considerably narrower as compared with that of the type. Both antapicals are usually longer than the apical. Thecal wall less robust than that of the type; transverse girdle and cingular lists well developed.

Dimension: $t=64-70\mu$, $h^*=37-40\mu$, $b^*=1\frac{1}{3}-1\frac{1}{5}t$.

$X^*=1-1.5t$, $Y^*=X$

This new variety differs from the type in its large mid-body, steep post-obliquity, well developed transverse girdle and cingular lists, short but stout apical horn and narrower antapical angles. In the most observed specimens, the mid-body is relatively constant in form and size. The thecal wall is more delicate than that of the type, since no longitudinal or irregular striae is present. A hyaline and large wing-like list, usually with fine serrated border, is often present at the post-margin of the mid-body between the two antapical horns.

Individuals were frequently observed in the samples collected from Shin-tsuen.

Ceratum deflexum (Kofoid) Jørgensen 1911

(Fig. 29)

Ceratum macroceros deflexum Kofoid 1907

Mid-body of medium size, rather delicate, a little longer than broad. Epitheca oblique, low, with both convex margins. Hypotheca slightly longer than the epitheca, with its left margin almost straight or a little obliquely directed. Post-indentation

*See Fig. 28a.

tion very deep, sharply delimited from the base of antapical horns. Post-obliquity rather steep, with β from 25° - 30° . Apical horn long, submedian and erect. Antapical horns divergently directed downward at first for a quite distance, then deflected ventrally and finally, after passing their major flexures, bending upward in a course subparallel to the apical horn. Both antapicals are delicate, flexible and variable in curvature and sinuities. Transverse girdle and cingular list well developed; thecal wall hyaline and structureless.

Dimension: $t=57-62\mu$, $h=36-41\mu$, b slightly shorter than h ,

$A=100-450\mu$, $\angle a_o = 20^{\circ}-27^{\circ}$, $\beta = 45^{\circ}-70^{\circ}$,
 $X=.9-1.5t$, Y usually narrower than or equal to X .

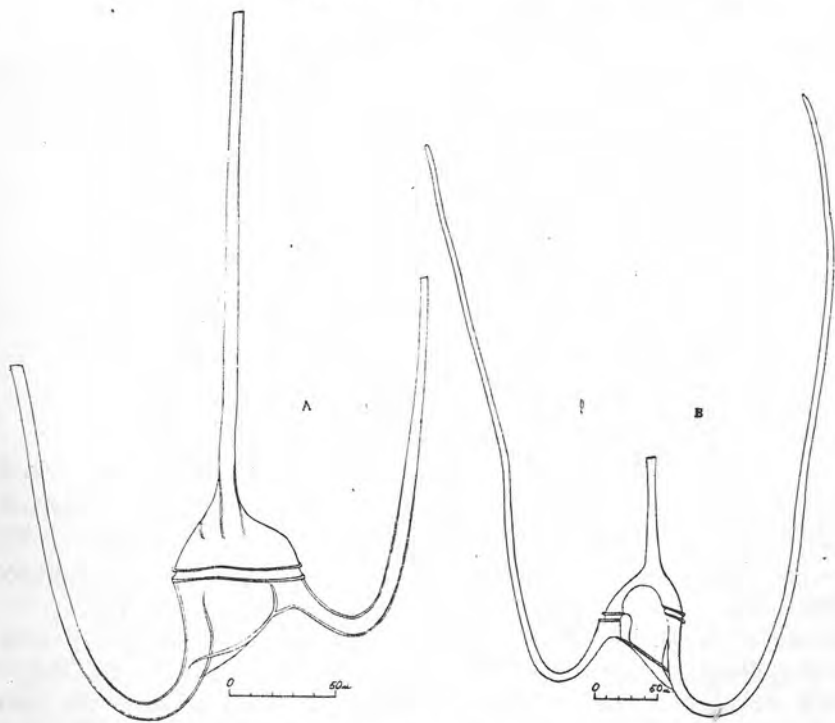


Fig. 29. *Ceratium deflexum* (Kofoid). A, dorsal view. B, ventral view.

This species differs from *Ceratium macroceros* and its subspecies in the marked ventral deflection of the proximal region of the antapicals. As a consequence, the antapicals, in dorso-ventral view, approach a cause subparallel to the apical horn and the distance between them is considerably shortened as compared with that in the case of *C. macroceros*.

Specimens were abundantly found in the samples collected from various stations of Hainan, especially at San-yah.

***Ceratium massiliense* (Gourret) Jörgensen 1911**

Ceratium tripos var. *massiliense* Gourret 1883

Ceratium tripos var. *macroceroides* Karsten 1906

Ceratium ostenfeldi Kofoid 1907

Specimens were found in great abundance from all surveyed places of Hainan. Morphologically, they agree practically in every detail with those recorded from Amoy by Wang and Nie ('32), except that they are relatively smaller in size, averaging about 79μ in transdiameter.

***Ceratium carriense* Gourret 1883**

(Fig. 30a)

Ceratium volans Pavillard 1905

Ceratium massiliense Pavillard 1907

Ceratium hundhausenii Schröder 1906

Mid-body of medium size, thick, robust in habit, somewhat longer than broad. Epithea oblique, generally with convex side margins. Hypotheca a little longer than the epithea, with its left side margin slightly concave. Post-indentation slightly deep, less abruptly delimited from the base of the right antapical than from that of the left, often with moderate fins. Post-obliquity rather steep, with $\angle = 30^\circ$. Antapical horns well developed, extraordinarily long, spreading laterally and anteriorly, with slight major flexures; the right forming an angle 75° - 90° and the left about 50° - 70° with the apical. Both antapical horns are approximately as long as the apical and

often serrated or toothed on the outer margin of the proximal portion. Transverse girdle and the cingular lists normally developed.

Dimension: $t=69\mu$, $h=43\mu$, $b>\frac{1}{3}<\frac{1}{2}t$, $A=700\mu$.

This species is characterized by its very long apical and antapical horns. The latter are widely spreading and greatly divergent one from another. They are attenuate distally and

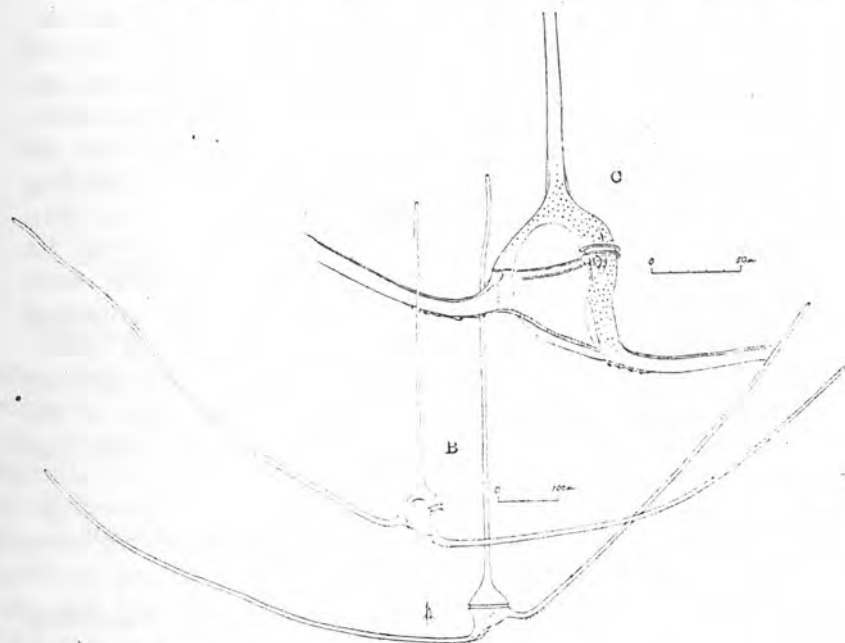


Fig. 30, A dorsal view of *Ceratium carriense* Gourret; B and C, Ventral view of *Ceratium carriense* var. *volans* f. *ceylanicum* (Schröder).

their tips are contracted or sometimes opened. The three horns are usually subequal in length. There are two wing-like bands or fins bordering the post-margin of the mid-body. One of them is long and relatively narrow, while the reverse is true for the other.

Specimens were occasionally found in the samples collected from San-yah.

Ceratium carriense var. *volans* f. *ceylanicum* (Schröd.)

Jørgensen 1911

Ceratium ceylanicum B. Schröder 1906

(Fig. 30b & c)

Mid-body closely resembling the type. Epitheca oblique, with its left side margin rather convex or somewhat bloated and its right side margin slightly convex. Hypotheca a little longer than the epitheca, with its left margin slightly convex. Post-indentation slight, but sharply delimited from the base of antapical horns, often ornamented with a fin. Antapicals extraordinarily long, slender usually much longer than the apical. Left antapical horn setting forth obliquely downward from the mid-body for a very short distance ($\angle a_c = 20^\circ - 30^\circ$), bending rapidly lateral to form a right angle with the apical, and then straightly extending out for a considerable distance with its distal portion gently curved upward. Right antapical horn spreading out like the left, except with a smaller antapical angle ($60^\circ - 80^\circ$) and its distal portion being slightly reflex downward. Tip of both antapicals contracted or obscurely open. Girdle or transverse furrow usually incomplete at the right side of the mid-body. Thecal wall often with irregular striae and large pores.

Dimension: $t = 72\mu$, $h = 54\mu$, $b = 1/3 h$, $A = 500\mu$,
 $L = 770\mu$, $R = 850\mu$, $\beta = 115^\circ$

This forma differs from the type in that the transverse girdle is usually incompletely developed at the right side of the mid-body and the distal portion of the right antapical horn is not curved upward, but slightly refracted posteriorly. It also differs from variety *volans* in the arrangement of the antapical horns, which are in the latter species horizontally spread out for a long distance before bending upward, with their ascending portions parallel to each other. Like the case of the type, the antapicals are usually serrated along the posterior margins of their basal parts.

Specimens were rarely found in the samples collected from San-yah.

Ceratum sumatranum (Karsten) Jörgensen 1911

(Figs. 31-32)

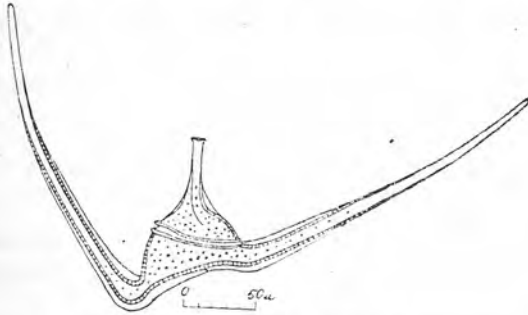
Ceratum tripus vultur var. *sumatranum* Karsten 1907

Fig. 31. Dorsal view of *Ceratium sumatranum* (Karsten).

Mid-body of large size, rather robust, more or less rectangular in outline, usually broader than long. Epithecæ exceedingly low, with rather unevenly convex margins; angle ϵ large, about 120° . Hypotheca twice as long as epithecæ, with distinctly convex left margin. Post-indentation slight, but very distinctly delimited from the base of the antapicals. Post-obliquity gently steep, with $\angle$ 28° - 30° . Apical horn short, nearly as long as the mid-body, developed from the epithecæ more close the right side margin than to the left, often enlarged at its base and furnished with long but low lists. Antapicals strongly developed, usually much longer than the apical, setting forth obliquely downward for a very short distance and then bending upward with abrupt flexures; the right forming an angle 50° - 60° and the left 30° - 40° with the apical. Tips of both antapicals contracted or obscurely open. Transverse girdle well developed, rather oblique, often with prominent lists. Thecal wall thick, robust, usually with irregular striae and large pores. Chain formation very common.

Dimension: $t=62$ - 65μ , $A=45$ - 65μ sometimes to 350μ ,
 $h=38$ - 40μ , $b=1/3h$, $\angle \epsilon=120^\circ$, $\angle \alpha=40^\circ$.

The species is mainly characterized by its robust and rectangular mid-body. The side margins of the epitheca are rather uneven. The girdle or transverse furrow is very oblique and relatively high in position and, as a result, the epitheca is much shorter than the hypotheca. The apical horn in the most observed individuals is about the same length as the mid-body, while, in the terminal member of the chain (fig. 32), it is much longer than that of the rest and usually bent to one

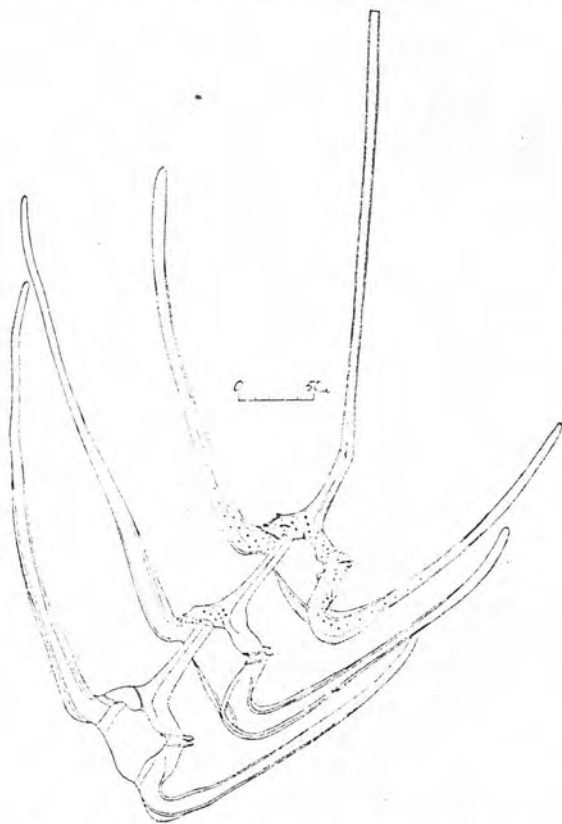


Fig. 32. A chain of *Ceratium sumatranum*.

side. The antapical horns are usually broadened at the base and become narrowing gradually as they approach the distal end. They are often slightly different in length; the right

being longer than the left. Long and narrow lists, which are sometimes serrated, are usually present on both sides of the antapicals. Chain formation is very common in this species and, in one case a chain was observed to be consisted of 24 individuals.

Individuals were found in great abundance in the samples collected from San-yah.

***Ceratium trichoceros* (Ehrb.) Kent 1880-1881**

(Fig. 33)

Peridinium trichoceros Ehrenberg 1860

Ceratium flagilliferum (in part) Cleve 1900

The occurrence of this species in the Chinese coastal region has been previously reported by Wang and Nie ('32) from Amoy. ^{Fig. 33} As the present specimens differ from those described by them, it seems necessarily to make some additional notes on certain peculiar characters.

Ceratium trichoceros is one of the smallest species of *macroceros* group. It is well defined by the rigid body, the wide-spreading major flexures of the antapicals (X usually

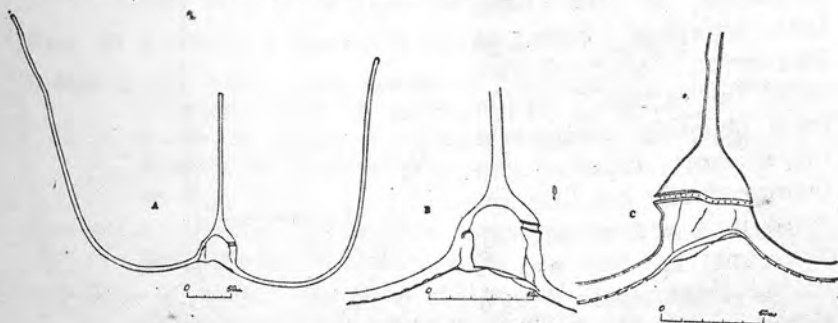


Fig. 33. *Ceratium trichoceros* (Ehrenberg). A and B, ventral view. C, dorsal view.

equal to 3 to $3\frac{1}{2}$ t according to Jörgensen's dimension) and the slender horns with opened tips. The three horns are sub-parallel and the antapicals are often distinctly serrated along their out margin toward the major flexures. Occasionally, the serrations are totally absent. The girdle or transverse furrow

and the cingular lists are not well developed, especially at the right half of the mid-body. The thecal wall is hyaline and structureless.

The occurrence of this species in Ching-lan, Shin-tsuen and San-yah is rather common.

Ceratium tenue (Ostf. & Sch.) Jörgensen 1911

(Fig. 34)

Ceratium tripos tenue Ostenfeld and Schmidt? 1901

Ceratium tripos patentissimum Karsten 1906

Mid-body of small size, delicate, almost as long as broad. Epitheca low, triangular, with somewhat straight or slightly convex lateral margins; angle ϵ of 80° . Hypotheca a little longer than the epitheca, with its left margin slightly concave. Post-indentation very slight, indistinctly delimited from the bases of antapicals, often with a well-developed fin. Post-obliquity moderately steep, with δ about 23° . Apical horn very long, median, erect throughout, slightly broadened at the base. Left antapical horn as long as or slightly shorter than the apical, setting forth obliquely posteriorly for a short distance and then gradually bending upward in a course slightly divergent to the apical. Right antapical horn almost as long as the left, setting forth laterally just beneath the transverse furrow for a short distance, then gradually bending upward, with its distal portion somewhat parallel to the apical. Tips of the antapicals usually contracted, often with a obscure terminal pore, thecal wall hyaline and structureless.

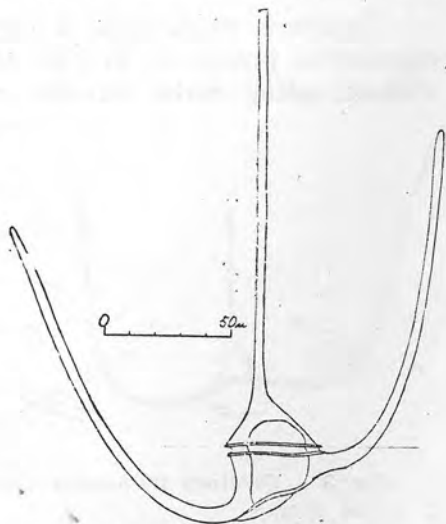


Fig. 34. Dorsal view of *Ceratium tenue* (Ostenfeld and Schmidt).

Dimension: $t=35-37\mu$, $A=150-170\mu$, $h=21\mu$, $b=1/3h$,
 $\beta=145^\circ$, $\angle a_e=50^\circ$, $X=1-1\frac{1}{4}t$, $Y=1/3t$.

Ceratium tenue is characterized by its small size, delicate habit, slight post-indentation and spreading antapicals with contracted but opened tips. It differs from *C. chavigar* in the less broadened shoulders, the smooth thecal wall and without-inflated tips of antapicals.

Individuals were only occasionally found in the surface collections made at San-yah.

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