Kleinere Mitteilungen.

Studies on the plates of the fresh-water *Ceratium*, the so-called *Ceratium hirundinella*.

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(With 4 figures in the text.)

Aside from the girdle which is made up of the cingular zone of plates, the thecae of all the members of the *Dinoflagellate* genus *Ceratium* are made up of four series or zones of plates. In the epitheca, or anterior to the girdle, there are two zones of plates, the apical and the precingular zones. These are separated from each other by the apical-precingular suture. In the hypotheca, or posterior to the girdle, there are also two zones, the postcingular and the antapical ones. These latter two zones are separated from each other by the postcingular-antapical suture. In the vast amount of literature that has accumulated on the morphology and taxonomy of this genus comparatively little deals with critical analyses of the plate relationships of these various zones. Enough has been written, however, to establish quite well the fact that there is a fundamental unity with regard to the plate arrangements in all the various groups of *Ceratium*. All authors are in agreement that there are the four zones of plates as indicated above. However, there is considerable disagreement in the literature with regard to

the number of plates in the several series or zones. This is especially true of the first two above-mentioned zones, those in the epitheca or the apical and precingular zones. Should such differences exist it would seem that radical departures from the pattern in existing members of the genus would furnish a possible basis for alterations in generic status.

The present paper deals only with the apical series of plates in the so-called *Ceratium hirundinella*, a species to be shown by KOFOID and HURST (MSS) in a forthcoming report to be misnamed. This form is a fresh-water one. Most descriptions of plate relationships in *Ceratium* have been given for marine material. All the marine forms that have been critically examined show the same number of plates in the theca and, with but minor variations, the same pattern (KOFOID, 1907, et al.). We find in the fresh-water form that we are examining no radical departure from the same plan. The fact that the so-called *Ceratium hirundinella* is a fresh-water species at first led us to suppose that it might differ from marine ones, but our examinations have not revealed such a difference in the number of plates in the apical series.

KOFOID (1907, Figs. 1 and 2) shows four apical plates in *Ceratium furca*, a marine species that belongs to the same subgenus (*Biceratium*) to which the so-called *Ceratium hirundinella* has been ascribed. He also shows four apical plates in all the other subgenera. The arrangement of these apical plates of *Ceratium furca* are shown in Figures D and E herein which are modified from KOFOID (1907). A midventral suture separates the first and fourth plates of this apical series. Ventro-lateral sutures separate the first and second and the third and fourth plates respectively. As a consequence the apical horn is composed of two ventral plates and two dorsal plates. The two ventral plates are more narrow than the two dorsal ones. A further thing to be noted in these figures is that the suture that separates the apical and precingular zones is roughly subparallel to the girdle and does not touch the girdle at any point. JÖRGENSEN'S (1911, Pl. 1 Figs. 1 and 2) figures of these plates in *Ceratium tripos*, also a marine form, show essentially the same condition. His statement (p. 3) is to the effect that there are four such plates.

In the so-called *Ceratium hirundinella*, LINDEMANN (1928, Figs. 78 A, 78 B and 78 C) shows four apical plates arranged in the same way as noted above for *Ceratium furca* and *Ceratium tripos*. These figures of *Ceratium hirundinella* do not show a marked difference in width

between the two dorsal and the two ventral plates. They do show, however, the apical-precingular suture as roughly subparallel to

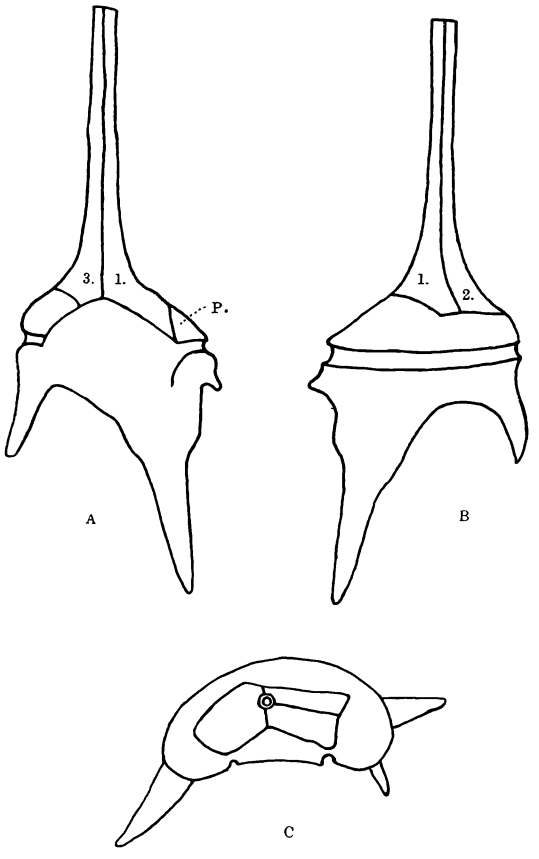

Fig. 1. *Ceratium hirundinella* modified from Entz (1927). Apical plates are numbered 1, 2 and 3. First precingular plate marked P. A Ventral surface; B Dorsal surface; C Apical view. This latter figure seems to have been drawn with reversed symmetry.

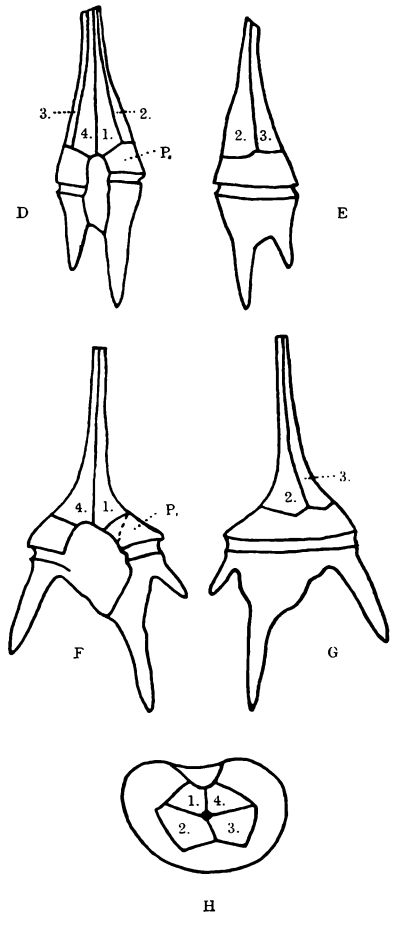

Fig. 2. *Ceratium furca* modified from Kofoid (1907). Apical plates numbered 1, 2, 3 and 4. First precingular plate marked P. D Ventral surface; E Dorsal surface. 350:1. *Ceratium hirundinella* modified from Lindemann (1928). Apical plates numbered as above. First precingular plate as above. F Ventral surface; G Dorsal surface; H Apical view.

the girdle. In his Figure 78 A, Lindemann (1928), by a dotted line, suggests a condition that is fully figured by Entz (1927).

LINDEMANN'S (1928) Figure 78 C gives an apical view of the plate arrangement of *Ceratium hirundinella.* These apical plates are here

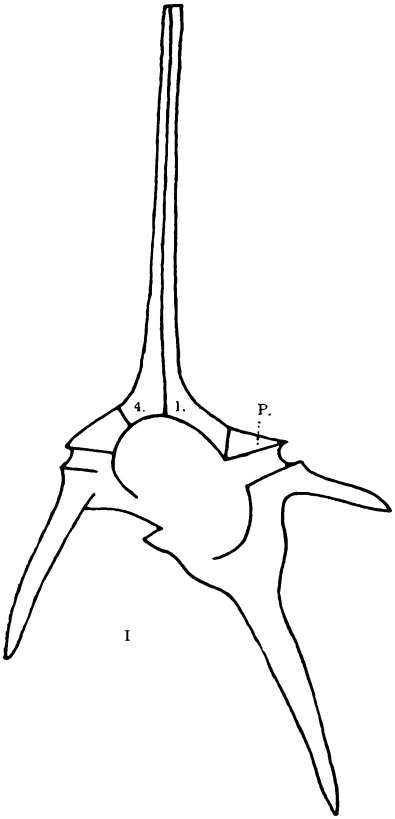

Fig. 3. *Ceratium hirundinella* showing two ventral apical plates (1, 4) with base of first apical plate (1) reaching along sulcus to region of flagellar pore. First precingular plate (P) does not touch sulcus. 640 : 1.

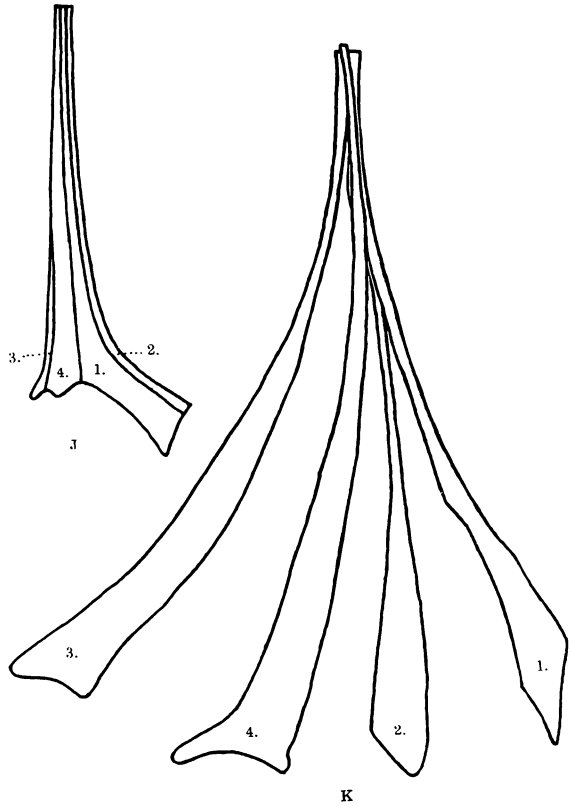

Fig. 4. *Ceratium hirundinella.* J Lateral apical sutures visible from ventral aspect. Apical plates numbered 1, 2, 3 and 4. 640 : 1. K Four apical plates (1, 2, 3 and 4) in separated condition. Figure does not give good idea of individual shapes due to different angles, levels and possible warping and bending. 1040 : 1.

seen to be four in number and arranged one in each quadrant of the apical horn. This figure shows that the two ventral plates are not as broad as the two dorsal ones, a condition not apparent in LINDEMANN'S other two figures (Figs. 78 A and 78 B). LINDEMANN'S figures are partially reproduced herein (Figs. F, G and H).

Contrary to the above, Entz (1927, Figs. 1, 2 and 27 d) figures three plates in the apical series of the so-called *Ceratium hirundinella* (Figs. A, B and C herein). He figures the first apical plate as forming the left half of the apical horn, the second apical plate as forming the posterior right quarter of this horn and the third plate as forming the anterior right quarter. In Entz's figure (his Fig. 2, Fig. B herein) the apical-precingular suture is dorsally roughly subparallel to the girdle but ventrally (his Fig. 1, Fig. A herein) the first apical plate has its right basal border lying along the sulcus entirely to the region of the flagellar pore at the proximal end of the girdle. This condition is suggested by the dotted line in Lindemann's (1928) Figure 78 A. In other words, the basal part of the first apical plate, as figured by Entz (1927), enroaches on the region of the precingular zone as figured by Kofoid (1907) and Jörgensen (1911). In the figures of these latter two authors, the first precingular plate also has its right margin bordering on the sulcus.

In a form quite similar in every way to the one Entz (1927) and Lindemann (1928) call *Ceratium hirundinella* we find that there are four apical plates. We have amply confirmed this observation over a period of three months of study on this one species. These apical plates are quite difficult to demonstrate and require time and patience in order to resolve them completely. In order to separate these plates we have used a trade-marked preparation called "Clorox", a bleaching and deodorizing fluid. Without the use of such a fluid it is almost impossible to trace the sutures between the apical plates. At best, without such aid, it is often not possible to trace the more prominent ventral apical suture completely. This suture is the most easily seen of all of them. With the aid of the above-mentioned chlorine compound, the apical horn at first usually separates into three plates. However, under continued observation the third plate always splits into two. In this latter splitting the intercalary cement is clearly seem to come out of the suture as minute particles.

As stated above, Entz (1927, Fig. 1, Fig. A herein) shows the acute tip of the basal part of the first apical plate as reaching to the flagellar pore. By so-doing it enroaches on the zone of the precingular series. Our observations seem to confirm this character of this plate. We have repeatedly seen it in this condition. We have never seen the first precingular plate bordering on the sulcus. If a suture that would permit this latter exists it certainly defies

detection. This first precingular plate, separated from the first apical plate by the here strongly oblique apical-precingular suture, approaches the sulcus no closer than to have its posterior right corner at the flagellar pore. These conditions are quite clearly shown in Figure I which is a camera lucida drawing.

In our material we have seen ample indications that the two ventral apical plates are somewhat more narrow than the two dorsal ones. Of course this character is subject to considerable variation and in some individuals the lateral apical sutures are all but invisible before they are parted when the theca is viewed ventrally. Figure J shows the ventral arrangement of the plates of the apical horn and shows the lateral apical sutures quite clearly. The right lateral apical suture is visible only basally when viewed in full ventral aspect. Figure K is a camera lucida drawing of the four apical plates of one individual in fully separated condition. They still remain loosely attached at the apical end. It is impossible from the figure to get an accurate idea of the individual shapes of these plates since in the original preparation they lie at different angles and project to different dephts in the mounting medium. Possibly some of these plates are seen more or less in face view, others much from the edge; some warping and bending may also have occurred.

No definite order of plate separation has been determined by us. At first we suspected that such might be the case but we were unable to confirm this. Usually, though, the first apical plate comes away with the second one attached to it and splits into two as the solvent action of the chlorine compound continues. The other sutures may part in any order except that in nearly all cases the ventral one seems to go first.

Accurate observations upon material such as the above-described are attended with many difficulties. Too much or too little of the chlorine compound will give faulty results. In the one case no separation of the sutures will result; in the other case the entire theca will be dissolved. Varations in individuals cause great degrees of variation in suture separation.

In a later communication we hope to set forth the plate pattern of the entire theca of the so-called *Ceratium hirundinella* in-so-far as our material permits us to make it out.

Summary.

In the so-called *Ceratium hirundinella,* a fresh-water species, there are four apical plates. The two ventral apical plates are somewhat narrower than the two dorsal ones. Basally the tip of the first apical plate reaches to the flagellar pore and for this reason the first precingular plate does not touch the sulcus.

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