Forms of *Ceratium hirundinella* (O. F. Müller) Schrank in Lakes and Ponds of Indiana

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The algal genus, *Ceratium*, a dinoflagellate, is generally thought to contain four freshwater species. One of these, *C. hirundinella*, an open-water plankter, is the only species to have been found thus far in Indiana. This motile, unicellular alga has a state-wide distribution, or nearly so, in lakes and ponds, and there are herbarium specimens representing thirty-nine counties of a possible forty-eight from which we have plankton collections. The thirty-nine counties are located in the upper three-fourths of the state.

This study was begun recently in order to determine how many forms of *C. hirundinella* could be satisfactorily identified in our herbarium specimens, and to check the reliability of recently published descriptions of the forms. Several years ago, a thorough review was made of our plankton collections from about 300 lakes and ponds in order to note all the species of algae regardless of their individual abundance in the collection. It soon became apparent that *C. hirundinella* possesses infinite morphological variability and yet, could be arranged in groups sufficiently alike to warrant form epithets.

In Plate I are outline drawings of the four freshwater species of *Ceratium*. Fig. 1, *C. hirundinella* (O. F. Müller) Schrank (after Entz),

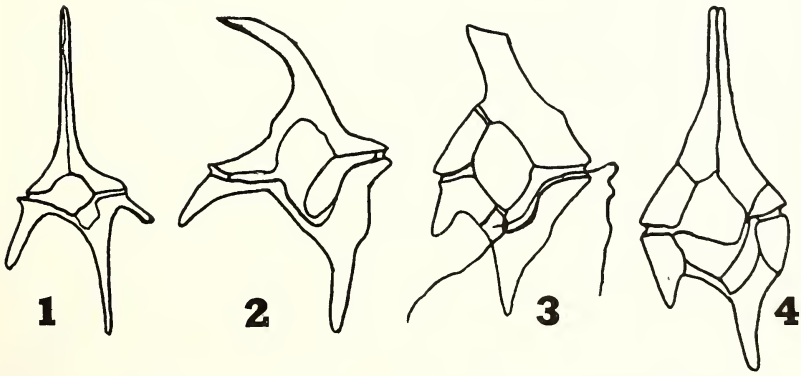

Plate I. Fig. 1. *Ceratium hirundinella* (O. F. Müller) Schrank. Fig. 2. *Ceratium carolinianum* (Bailey) Jorgensen (after Schilling). Fig. 3. *Ceratium cornutum* (Ehrenb.) Claparde & Lachman (after Schilling). Fig. 4. *Ceratium brachyceros* v. Daday (after Entz).

the only one found in Indiana to date, normally is composed of from 3 to 4 horns. The apical horn, which may be bent, is open at the tip, whereas, the others are closed. The cells vary from 100 to 350 microns in length. The width is about 40 to 55 microns. Fig. 2, *C. carolinianum* (Bailey) Jorgensen (after Schilling), a 3-horned species, is chiefly characterized by its bent and pointed apical cell. The length varies from 125 to 156

microns and the width from 70 to 105 microns. Fig. 3, *C. cornutum* (Ehrenb.) Claparede & Lachman (after Schilling), a 3-horned species, possesses a short, bent and truncated apical horn. The length varies from 95 to 150 microns and the width from 60 to 85 microns. Two flagella are shown here, one partly obscured by lying in the transverse furrow. Fig. 4, *C. brachyceros* v. Daday (after Entz), another definitely 3-horned species, and purely tropical (reported only from Africa and Asia) has an apical horn which is always straight. The length of the cells varies from 125-160 microns and the width from 40 to 55 microns.

These algae have fairly heavy reticulate ornamented walls and consist of 15 articulated plates, some of which are continued in horns. The epi- and hypovalves are separated by a transverse furrow or groove. Two flagella emerge from a flagellum plate on the ventral side of the cell. One of these is usually partially hidden in the transverse furrow.

C. hirundinella and *C. brachyceros* are open-water or free floating species. *C. carolinianum* and *C. cornutum* are generally shore species and often found intermingled with other water plants, namely, Chara and Lemna, but occasionally, they may be found in the open-water zone. Apparently, they are rare in the United States; however, both have been reported from Illinois.

Plate II portrays the four forms of *C. hirundinella* as found in Indiana. Fig. 1, f. *brachyceros* (v. Daday) Ostenfeld, a 3-horned plant,

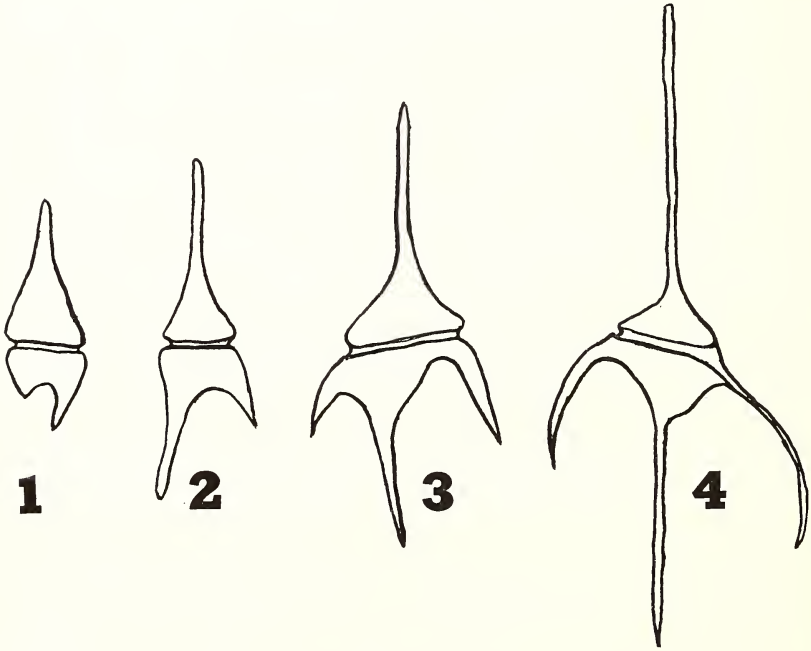

Plate II. Forms of *Ceratium hirundinella* (O. F. Müller) Schrank found in Indiana: Fig. 1, f. *brachyceros* (v. Daday) Ostenfeld; Fig. 2, f. *furcoides* (Entz) Schröder; Fig. 3, f. *robustum* (Amberg.) Bachman; Fig. 4, f. *piburgense* (Zdb.) Bachman.

is the smallest of the four forms, averaging 100 microns in length. The hypovalve, composed of two barely evident horns, is exceedingly short, and the epivalve narrows gradually to the apex. This form has been reported found chiefly in streams and rivers by Samuel Eddy. We have it in collections from Geist Reservoir and Lake Freeman whose water sources are mainly Fall Creek and Tippecanoe River respectively. The pH of the Geist Reservoir water ranges from 7.7 to 8.0 and this approaches the alkalinity of our northern Indiana lakes of glacial origin. However, this form has not been found in any of our lakes of the latter type. Morphologically, this form resembles very closely the species, *C. brachyceros.* Representative specimens in the writer's herbarium are numbered *1064,* 2524 (used for drawing), *2555* and *2603.*

Plate II, Fig. 2, f. *furcoides* (Entz) Schröder, intermediate in size (average—160 microns in length) has been found chiefly in gravel pits and small ponds. The horns are usually as shown here, but may be slightly curved and the antapicals converging instead of diverging. Representative specimens in the writer's herbarium are numbered **2560** (used for drawing) and *2656.*

Plate II, Figs. 3 and 4, forms *robustum* (Amberg.) Bachman and *piburgense* (Zdb.) Bachman respectively, both 4-horned, are primarily inhabitants of lakes of glacial origin here, e.g. Wawasee and Maxinkuckee. Each may be the only form present in a collection, but usually both are found together. Even though f. *piburgense* is shown by Huber-Pestalozzi (1) as having straight antapical horns, the name is used here for cells with two or three long, sickle-shaped antapical horns in the sense used by Bachman in 1911. Although he included both sickle-shaped and straight horns for the form, the Indiana forms seem to be all sickle-shaped, belonging otherwise to this category. Representative specimens in the writer's herbarium are numbered *2180, 2816;* and **D. G. Frey** (used for drawing), Round Lake, Steuben County. Form *robustum* has divergent antapical horns, but one of the three may be slightly curved. Representative specimens in the writer's herbarium are numbered *1013, 2465, 2519* and **2539** (used for drawing). The average length of f. *robustum* is about 200 microns, whereas f. *piburgense* is about 280 microns. These forms are found in more lakes than the first two and f. *robustum* is perhaps the most common of all.

Summary

1. There are four forms of *C. hirundinella* easily recognized in lakes and ponds of Indiana.

2. The criteria used for separation of the forms are the number and shape of horns and the total length of the cells.

3. In Indiana, forms *brachyceros* and *furcoides* are more often found in gravel pits and variously sized artificial lakes and ponds. Forms *robustum* and *piburgense* are more often found in lakes of glacial origin.

Literature Cited

1. HUBER-PESTALOZZI, G. 1950. Das Phytoplankton des Süsswassers. Die Binnengewasser 16 (3). *Ceratium,* pp. 260-283, Plate LXI.