AN ASTOMATOUS CILIATE FOUND IN THE BODY CAVITY OF A COPEPOD COLLECTED FROM LAKE MICHIGAN

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This paper reports the discovery of a parasitic ciliate in various species of *Diaptomus* in the plankton of Lake Michigan. This parasite presents the characteristics of the genus *Perezella* Cépède, an astomatous ciliate, three species of which were described by Cépède in marine copepods belonging to the family Calanidae. So far as we know, no representative of this genus has been found in fresh water copepods.

The purpose of this work was to classify these parasitic infusorians and compare their characteristics with those of *Perezella*. Samples of plankton were collected approximately once a week during 1950 and 1951 for the purpose of studying planktonic organisms from the surface layer of Lake Michigan, near Mundelein College, Chicago.

Planktonic samples obtained in this way were fixed with formalin. When the parasitized copepods were found, special fixatives were used in order to facilitate their study. The material was fixed with stronger formalin solutions, with Schaudinn fixative, acetic alcohol, and sublimate acetic solution. Then the material was stained with Delafield-Harris hematoxylin and with Heidenhain hematoxylin with subsequent differentiation by acid alcohol in the case of Delafield, and with the usual decolorizing agents of Heidenhain's method. After differentiation then, the body of *Diaptomus* becomes so transparent that all details of the structure of the parasites can be observed. Whole mounts of infected *Diaptomus* were cleared with cedar oil and oil of cloves.

Only infusorians found in living specimens of *Diaptomus* were considered as true parasites and used as material for this work. This precaution was necessary because frequently cases of false parasitism were found which consisted of an invasion of the dead bodies of various planktonic cladocerans and copepods by a Colpidium which acted as a scavenger. The latter infusorian is fairly common in the Chicago region of Lake Michigan, and on several occasions pure cultures of it were obtained from infected crustaceans.

Before the finding of *Perezella* by Casimir Cépède in collaboration with Alfred Giard, only the genera *Anoplophrya* and *Collinia* among astomatous infusorians was reported from crustaceans (Gammarus and Asellus).

During a study of the plankton of the Straits of Dover, Cépède and Giard found two parasitic infusorians in the body cavity of the copepods of that region. One of these infusorians has a mouth and was named by Cépède, *Uronema rabaudi*. The other one was astomatous and

was named *Perezella pelagica*. The second parasite was found in a calanid, *Paracalanus parvus*.

Cépède, in a monograph published in 1909 (1), reported the observation in *Calanidae*, a marine family of copepods. He described *Perezella* as a small infusorian with a maximum length of 48 microns. It is ovoid or elliptic in contour and has a regularly curved body with a ventral concavity which is more pronounced in smaller individuals not filled with reserve food substances. The body is covered with cilia of the same length and density all over its surface.

The ectoplasm is described as a thin layer under the pellicle and seems to be structureless. The endoplasm is finely granular and contains reserve food inclusions such as droplets of fat and globules of different sizes, which, according to the iodine reaction, seem to be glycogenic in nature.

The macronucleus is relatively small and ovoid, of a compact type, and uniformly filled with small chromatin granules. The micronucleus, which is described by Cépède as rarely seen, is small, spherical, and sometimes found at a considerable distance from the macronucleus. The infusorian possesses one contractile vacuole close to its posterior end. No cytostome or any kind of buccal structure was observed.

Brief descriptions of the genus *Perezella* are also given by Doflein (3) and by Kudo (6). Both authors, however, simply give a resumé of Cépède's description.

Our specimens are practically the same as *Perezella pelagica* as described by Cépède. The parasitic infusorians were found in the body cavity and in the tissues of *Diaptomus* (Centropagidae Gnathostomata Copepoda). They not only invade the body proper, but also penetrate into the furca, the antennae, and the legs of the crustacean (figs. 1 & 2).

The infusorian is ovoid in form with the anterior portion narrowed so that its greatest diameter is approximately one-third of the way from the posterior end. The largest individuals, which are usually filled up with reserve food substances, become oval and sometimes almost spherical in shape. Their maximal length is smaller than the one indicated by Cépède, being about 35 microns, while the greatest diameter is from 20 to 25 microns.

The smaller individuals have a typically curved body with a deep ventral concavity (fig. 3). The larger ones, like those described by Cépède, do not show this characteristic (fig. 4).

The infusorians penetrating to the very end of the furcal ramifications sometimes form on their posterior end protoplasmic elongations, deeply penetrating into the caudal spines of *Diaptomus* (fig. 5).

As stated in Cépède's description, the ectoplasm is barely distinguishable under the pellicle. The rest of the body is finely granular endoplasm. The infusorians possess one contractile vacuole close to their rounded posterior end, sometimes placed slightly to one side (fig. 3).

The endoplasm of the larger individuals becomes filled with food inclusions which can be shown by their reaction to Sudan III or Lugol's solution to be of either a glycogenic or a fatty nature. In these individ-

PLATE I.

FIG. 1.—An infected specimen of *Diaptomus* drawn at low power. Numerous parasites can be observed, some penetrating into the antenna and the furca.

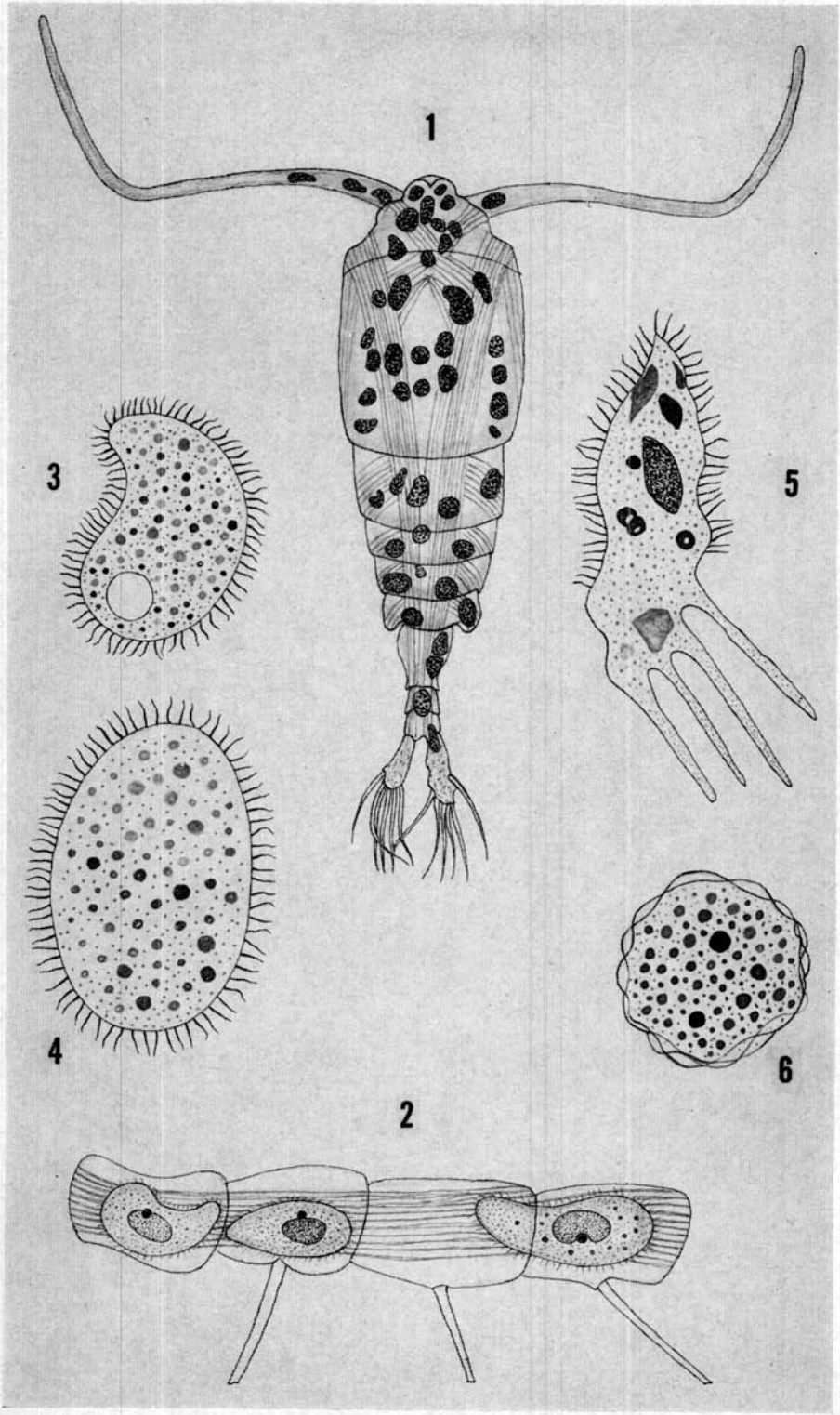
FIG. 2.—A portion of the antenna containing three small specimens of *Perezella*. Objective Zeiss D., ocular 10 x .

FIG. 3.—A typical small individual of *Perezella* showing a ventral concavity and a contractile vacuole in its posterior end. Zeiss immersion 1/12, ocular 10 x .

FIG. 4.—A large individual of *Perezella* full of food reserve substances.

FIG. 5.—A specimen of the parasite from the furca of *Diaptomus* showing the protoplasmic elongations (attaching organellae) which were introduced into the spines of the furca. Immersion 1/12, ocular 10 x.

FIG. 6.—A cyst of *Perezella* showing characteristic sculpturing of the membrane.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uals the quantity of food substances becomes so large that it is impossible to see their nuclear apparatus either in vivo or in stained preparations. In smaller individuals, which contain only a limited number of food inclusions or sometimes even are completely devoid of them, the nuclear apparatus can easily be observed. The macronucleus, either ovoid or somewhat irregular in shape, seems to be in general smaller than that of *Perezella pelagica.* The micronucleus, small and spherical, can easily be distinguished from the food inclusions by its peculiar coloring, which is much deeper than that of the food inclusions, and of a different shade. In most cases it lies close to the macronucleus or even inside a deep depression in it. However, cases were observed in which the micronucleus lies far away from the macronucleus. Multiple micronuclei are rare, but in one occasion as many as three were observed.

We had no opportunity to observe the reproduction of these parasitic infusorians or how they are transmitted. However, in one occasion cysts were observed (fig. 6). These are almost spherical in shape and present a typical sculpturing of the membrane which is not described by Cépède for the cysts of *Perezella pelagica.* It seems probable that such cysts are liberated from the body of *Diaptomus* after its death and then swallowed by other copepods. The infusorians probably come out of their cysts in the digestive tract, later making their way into the body cavity. However, further study of the life cycle of the parasite is necessary.

In conclusion, the above described infusorian is morphologically almost identical with *Perezella pelagica* Cépède with the following differences: its size; capacity to form protoplasmic elongations (attaching organellae) already described for the infusorians of the families *Haptophryidae* and *Intoshellinidae,* also astomates, but never before found in representatives of the *Anoplophryidae;* the peculiar sculpturing of the cysts; and above all, the habitat of its host. The latter, parasitized by *Perezella pelagica,* are different genera of marine copepods, *Calanidae,* while the host of the above described species of *Perezella* is a species of fresh water copepod, *Diaptomus.* This last circumstance was considered sufficient to term the *Perezella* here mentioned a different species.

Description and dimensions: an astomatous ciliate measuring from 24 to 37 microns in length and 20 to 25 microns in diameter; ovoid or elliptic in shape; ventral depression in small individuals; uniform covering of body with cilia; devoid of mouth; very thin ectoplasmic layer; one contractile vacuole in posterior end of the body; one compact, oval macronucleus; one or rarely several micronuclei; parasite of various species of *Diaptomus.*

Type and paratype: are selected from hundreds of infusorians found in several heavily infected specimens of *Diaptomus* of the plankton of the Chicago region of Lake Michigan, the slides of which are deposited in the biological collections of Mundelein College, Chicago, Illinois.

Classification:

Class: *Ciliata,* Perty, 1852,
Order: *Holotricha,* Stein, 1867,
Suborder: *Astomata,* Schewiakoff, 1896, emend. Cépède, 1907,

Family: *Perezellidae*, Cépède, (in *Anoplophryidae* Cépède, 1910),
Genus: *Perezella*, Cépède, 1910,
Species: *Perezella diaptomi*, Lehmann, 1951, new species,
Synonym: none.

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