

STUDIES ON CILIATES OF THE FAMILY ANCISTROCOMIDAE  
CHATTON AND LWOFF (ORDER HOLOTRICHA,  
SUBORDER THIGMOTRICHA)

IV. HETEROCINETA JANICKII JAROCKI, HETEROCINETA  
GONIIBASIDIS SP. NOV., HETEROCINETA FLUMINI-  
COLAE SP. NOV., AND ENERTHECOMA  
PROPERANS JAROCKI

EUGENE N. KOZLOFF

*Lewis and Clark College, Portland, Oregon*

INTRODUCTION

The genus *Heterocineta* was established by Mavrodiadi (1923) for a ciliate which he named *Heterocineta anodontae*, and which he had formerly believed to represent a gregariniform stage in the development of *Conchophthirus anodontae* (Ehrenberg). Unaware of the fact that Mavrodiadi had abandoned his earlier conception and applied the name *Heterocineta anodontae* to this ciliate, Jarocki and Raabe (1932) described the same species, from *Anodonta cygnea* (L.) and *Unio pictorum* L., as *Hypocomatophora unionidarum*. Jarocki later (1934) pointed out that *Hypocomatophora unionidarum* was a synonym of *Heterocineta anodontae*.

In his papers of 1934 and 1935 Jarocki described seven additional species of the genus *Heterocineta* ectoparasitic on fresh water gastropods: *H. janickii*, from *Physa fontinalis* (L.); *H. lwoffii*, from *Viviparus fasciatus* Müller; *H. chattoni*, from *Radix ovata* (Drap.); *H. krzysiki*, from *Bithynia tentaculata* (L.); *H. maziarskii*, from *Coretus corneus* (L.); *H. turi*, from *Tropidiscus planorbis* (L.) and *Spiralina vortex* (L.); and *H. siedleckii*, from *Acroloxus lacustris* (L.). In 1945 I described as *Heterocineta phoronopsidis* a ciliate from the tentacles of *Phoronopsis viridis* Hilton. This species is the only representative of the genus thus far described which is not a parasite of fresh water molluscs or of the annelid commensal *Chaetogaster limnaei* von Baer when the latter is associated with infected snails.

On the fresh water prosobranch snails *Goniobasis plicifera silicula* (Gould) and *Fluminicola virens* (Lea) I have found two new species of *Heterocineta* which will be described herein as *H. goniobasidis* sp. nov. and *H. fluminicolae* sp. nov. I have also studied a species of *Heterocineta* from *Physa cooperi* Tryon which agrees with the original description of *H. janickii*. It seems advisable, for comparative purposes, and in view of the fact that Jarocki's description of *H. janickii* is not accompanied by illustrations, to include an account of the morphology of this form in the present paper.

The genus *Enerthecoma* was proposed by Jarocki (1935) for a single species, *E. properans*, parasitic on the gills of *Viviparus fasciatus*. Although the original description of this species is quite adequate, it is not supplemented by illustrations, and the second installment of Jarocki's "Studies on ciliates from fresh-water molluscs," in which figures of *E. properans* and several other ciliates were to be pub-

lished, has not come to my attention. A ciliate which I have found to infest *Viviparus malleatus* (Reeve) apparently is identical with *E. properans*. This ciliate will be described and illustrated here.

HETEROCINETA JANICKII JAROCKI

(Figure 1; Plate I, Fig. 1)

The body is elongated and flattened dorso-ventrally. The anterior end is attenuated, bent ventrally, and deflected slightly toward the left. The anterior one-half of the left margin is not quite so rounded as the right margin and typically is nearly straight or weakly indented. The body is widest a short distance behind the middle and rounded posteriorly. The ciliary system, to be described presently, is disposed on a shallow concavity occupying the anterior two-thirds of the ventral surface; the dorsal surface and that part of the ventral surface posterior to the ciliary area are convex. Twenty living individuals from *Physa cooperi* ranged in length from 25  $\mu$  to 32  $\mu$ , in width from 12  $\mu$  to 15  $\mu$ , and in thickness from 10  $\mu$  to 12  $\mu$ ,

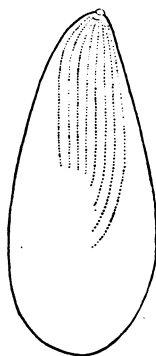


FIGURE 1. *Heterocineta janickii* Jarocki. Distribution of ciliary rows, somewhat diagrammatic.<sup>1</sup> Ventral aspect.

averaging about 30  $\mu$  by 14  $\mu$  by 11  $\mu$ . The specimens of *H. janickii* from *Physa fontinalis* which were studied by Jarocki ranged in length from 23  $\mu$  to 32  $\mu$ , in width from 12  $\mu$  to 17  $\mu$ , and in thickness from 10  $\mu$  to 13  $\mu$ .

The anterior end of the body is provided with a short contractile suctorial tentacle which enables the ciliate to attach itself to the epithelial cells of the host and to feed upon their contents. When fully extended the tentacle is about 3  $\mu$  to 4  $\mu$  (according to Jarocki about 4.5  $\mu$ ) in length. The internal tubular canal continuous with the tentacle is directed at first dorsally and then ventrally and obliquely toward the right side, and in specimens stained with iron hematoxylin can usually be traced for about one-half the length of the body.

The ciliary system consists of eight longitudinal rows originating close to the base of the suctorial tentacle. The first four rows from the right side are approximately one-half the length of the body. The remaining four rows become increasingly longer and terminate one behind the other a little to the left of the midline.

<sup>1</sup> The text figures illustrating this paper are based on camera lucida drawings of specimens impregnated with silver nitrate by Klein's method.

The longest row is about two-thirds the length of the body. The cilia are about  $6\mu$  to  $7\mu$  (according to Jarocki about  $5\mu$  to  $7\mu$ ) in length. While attached to the skin of the host the parasites are as a rule almost immobile, their cilia exhibiting only a feeble motion. When dissociated from the host *Heterocineta janickii* swim sluggishly, usually rotating on its longitudinal axis and tracing wide arcs with its attenuated anterior end.

The cytoplasm is colorless and contains numerous small refractile granules in addition to food inclusions. One or more large food vacuoles are present in the posterior part of the body behind the macronucleus. The contractile vacuole is situated near the middle of the body and opens to the exterior on the ventral surface. I have observed no permanent opening in the pellicle.

The macronucleus is typically sausage-shaped and is located near the middle of the body or somewhat posterior to the middle. As seen in dorsal or ventral view the longitudinal axis of the macronucleus is placed obliquely to the longitudinal axis of the body. As seen in lateral view, the anterior end of the macronucleus is directed dorsally, while the posterior end is directed ventrally. In fixed and stained preparations the chromatin appears to be more or less homogeneous. In ten individuals fixed in Schaudinn's fluid and stained by the Feulgen reaction the macronucleus ranged in length from  $7\mu$  to  $11\mu$  and in width from  $4\mu$  to  $5\mu$ .

The micronucleus is ovoid or spherical and is situated near the dorsal surface anterior to or to one side of the macronucleus. In most fixed and stained specimens the chromatin is homogeneous, although in some it appears to be concentrated in peripheral granules. In ten individuals fixed in Schaudinn's fluid and stained with iron hematoxylin the size of the micronucleus ranged from  $1.4\mu$  by  $1.4\mu$  to  $1.6\mu$  by  $2\mu$ .

*Heterocineta janickii* was present in very small numbers on the tentacles, mantle and margins of the foot of most of the specimens of *Physa cooperi* which I collected in a stream near Mt. Eden, California. The degree of infestation increased rapidly on snails kept in laboratory aquaria for a period of six weeks.

#### *Heterocineta janickii* Jarocki

Diagnosis: Length  $25\mu$ – $32\mu$  (according to Jarocki  $23\mu$ – $32\mu$ ), average about  $30\mu$ ; width  $12\mu$ – $15\mu$  (according to Jarocki  $12\mu$ – $17\mu$ ), average about  $14\mu$ ; thickness  $10\mu$ – $12\mu$  (according to Jarocki  $10\mu$ – $13\mu$ ), average about  $11\mu$ . The ciliary system consists of eight rows originating close to the base of the suckorial tentacles. The first four rows from the right are about one-half the length of the body, while the remaining four rows become progressively longer and terminate one behind the other a little to the left of the midline. The longest row is about two-thirds the length of the body. Parasitic on the epithelium of the tentacles, mantle, and foot of *Physa fontinalis* (L.) (Warsaw [Jarocki]) and *Physa cooperi* Tryon (Mt. Eden, California).

#### HETEROCINETA GONIOBASIDIS SP. NOV.

(Figure 2; Plate I, Figs. 2, 3)

The body is elongated and flattened dorso-ventrally. The anterior end is attenuated, bent ventrally, and deflected slightly toward the left. The anterior one-half of the left margin is not so rounded as the right margin and typically is nearly

straight or weakly indented. The body is widest at the middle or a short distance anterior to the middle. The ciliary system is disposed on a shallow concavity occupying the anterior two-thirds of the ventral surface; the dorsal surface and that part of the ventral surface posterior to the ciliary area are convex. Twenty-five living specimens taken at random ranged in length from  $36\ \mu$  to  $48\ \mu$ , in width from  $15\ \mu$  to  $20\ \mu$ , and in thickness from  $11\ \mu$  to  $14\ \mu$ , averaging about  $43\ \mu$  by  $18\ \mu$  by  $13\ \mu$ .

The anterior end is provided with a contractile suctorial tentacle continuous with an internal tubular canal. The nature of the canal is very similar to that of other members of the genus. It is directed at first dorsally and then ventrally and obliquely toward the right side of the body. It can be traced in most fixed specimens stained with iron hematoxylin for about one-half to two-thirds of the length of the body.

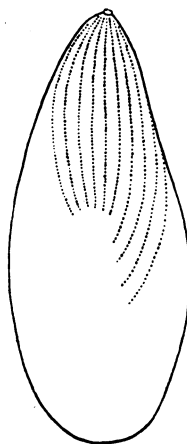


FIGURE 2. *Heterocineta goniobasidis* sp. nov. Distribution of ciliary rows, somewhat diagrammatic. Ventral aspect.

The cilia of *H. goniobasidis* are about  $9\ \mu$  long. Those of the anterior part of the ciliary system are markedly thigmotactic. The ciliary system consists of ten longitudinal rows. The first six rows are approximately the same length, being about one-half the length of the body, although on careful examination the first row is seen to originate some distance posterior to the level of origin of the other five rows. The seventh, eighth, ninth, and tenth rows originate progressively more posteriorly and become increasingly longer, terminating one behind the other a little to the left of the midline. The longest row is two-thirds to three-fourths the length of the body. The last one or two rows usually originate on the left margin and curve ventrally as they extend backward. The cilia of the distal portions of the longer rows are nearly always practically motionless and directed posteriorly. When dissociated from the host the ciliate swims sluggishly and erratically, rotating on its longitudinal axis.

The cytoplasm is colorless and contains numerous refractile granules of a lipoid substance in addition to food inclusions. There are usually one or two large food vacuoles in the posterior part of the body behind the macronucleus. The contractile vacuole is central and opens to the exterior on the ventral surface.

The macronucleus is situated in the middle portion of the body. It is elongated and typically somewhat narrower at its anterior end than at its posterior end. As seen in dorsal or ventral aspect, the longitudinal axis of the macronucleus is placed obliquely to the longitudinal axis of the body. As seen in lateral view, the anterior end of the macronucleus is directed dorsally, while the posterior end is directed ventrally. In ten individuals fixed in Schaudinn's fluid and stained with iron hematoxylin the macronucleus ranged in length from  $10\mu$  to  $13.5\mu$  and in width from  $4\mu$  to  $5.5\mu$ .

The spherical or ovoid micronucleus is very difficult to distinguish in the living ciliates. It is usually situated near the dorsal surface a short distance anterior to the macronucleus. In fixed and stained preparations the micronucleus is vesicular, the chromatin being concentrated along the periphery. In ten individuals fixed in Schaudinn's fluid and stained with iron hematoxylin the micronucleus ranged in size from  $1.2\mu$  by  $1.5\mu$  to  $1.5\mu$  by  $1.7\mu$ .

*Heterocineta goniobasidis* was found to be present on the epithelium of the gills and mantle of a small percentage of the specimens of *Goniobasis plicifera silicula* which I collected in Crystal Springs Creek, in Portland, Oregon. The degree of infestation on freshly collected snails was very low, but increased during the four weeks the specimens were kept in laboratory aquaria.

*Heterocineta goniobasidis* sp. nov.

Diagnosis: Length  $36\mu$ – $48\mu$ , average about  $43\mu$ ; width  $15\mu$ – $20\mu$ , average about  $18\mu$ ; thickness  $11\mu$ – $14\mu$ , average about  $13\mu$ . The ciliary system is composed of ten rows. The first six rows from the right side are about one-half the length of the body and, with the exception of the first row, originate close to the base of the suctorial tentacle. The remaining rows originate progressively more posteriorly and become increasingly longer, terminating one behind the other a little to the left of the midline. The longest row is two-thirds to three-fourths the length of the body. Parasitic on the gills and mantle of *Goniobasis plicifera silicula* (Gould) (Portland, Oregon). Syntypes are in the collection of the author.

#### HETEROCINETA FLUMINICOLAE SP. NOV.

(Figure 3; Plate I, Fig. 4)

The body is elongated and flattened dorso-ventrally. The anterior end is attenuated, bent ventrally, and deflected slightly toward the left. The anterior part

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#### EXPLANATION OF PLATE I

All figures except Figure 2 have been prepared with the aid of a camera lucida.

FIGURE 1. *Heterocineta janickii* Jarocki. Ventral aspect. Schaudinn's fixative-iron hematoxylin.  $\times 1,720$ .

FIGURE 2. *Heterocineta goniobasidis* sp. nov. Lateral aspect from left side, from life.

FIGURE 3. *Heterocineta goniobasidis* sp. nov. Ventral aspect. Schaudinn's fixative-iron hematoxylin.  $\times 1,720$ .

FIGURE 4. *Heterocineta fluminicola* sp. nov. Ventral aspect. Schaudinn's fixative-iron hematoxylin.  $\times 1,720$ .

FIGURE 5. *Enerthecoma properans* Jarocki. Macro- and micronuclei from three specimens. Schaudinn's fixative-Feulgen reaction.  $\times 1,720$ .

FIGURE 6. *Enerthecoma properans* Jarocki. Ventral aspect. Schaudinn's fixative-iron hematoxylin.  $\times 1,720$ .

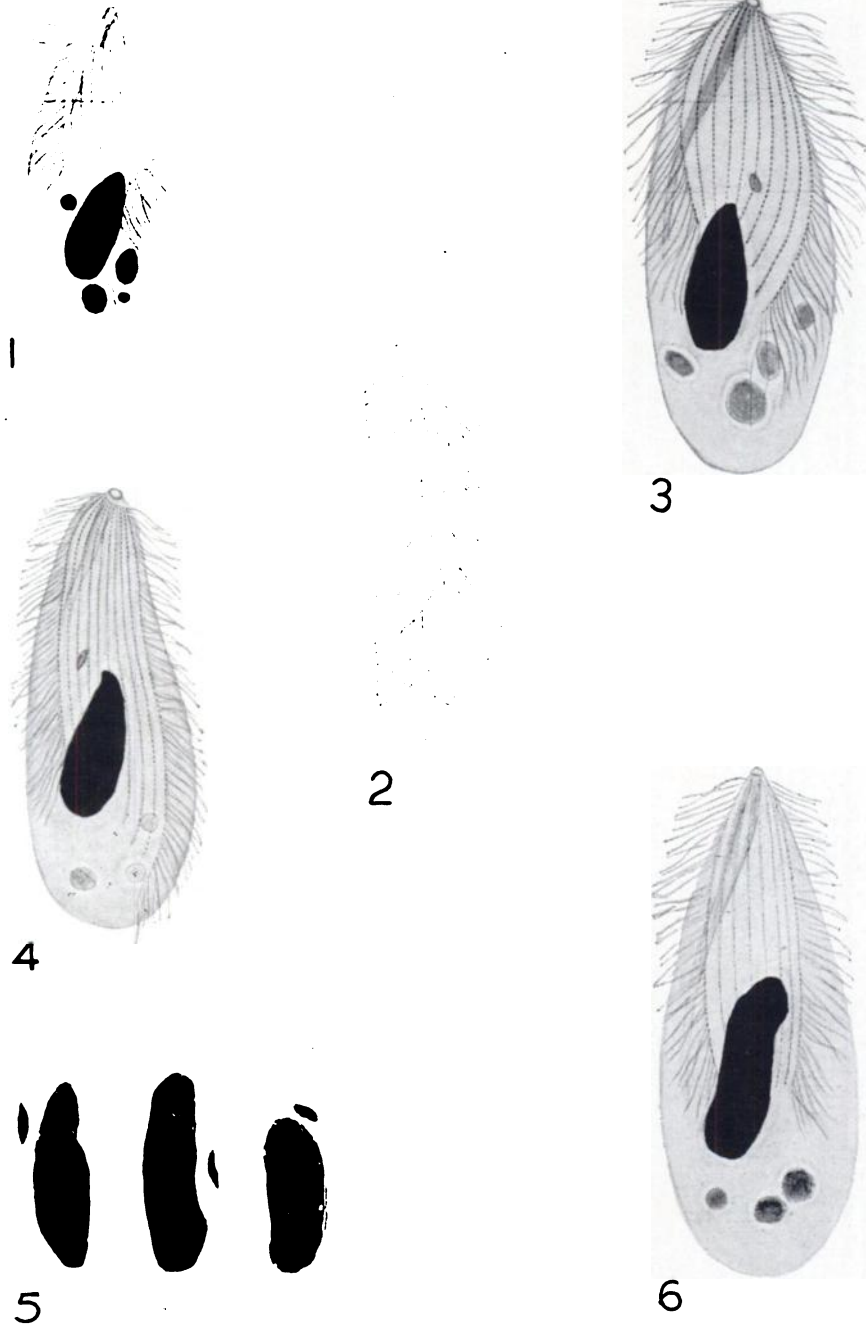


PLATE I

of the left margin is not so rounded as the right margin and typically is weakly indented. The body is widest a short distance behind the middle and rounded posteriorly. The ciliary system is disposed on a shallow concavity occupying the major portion of the ventral surface; the dorsal surface and that part of the ventral surface posterior to the ciliary area are convex. Twenty-five living individuals taken at random ranged in length from  $30\ \mu$  to  $36\ \mu$ , in width from  $13\ \mu$  to  $17\ \mu$  and in thickness from  $10\ \mu$  to  $12\ \mu$ , averaging about  $33\ \mu$  by  $15\ \mu$  by  $11\ \mu$ .

The anterior end is provided with a contractile suctorial tentacle continuous with an internal tubular canal. The canal is directed at first ventrally and then obliquely toward the right side of the body. It can be traced in most fixed specimens stained with iron hematoxylin for about one-half the length of the body.

The cilia of *H. fluminicola* are about  $6\ \mu$  or  $7\ \mu$  long. Those of the anterior part of the ciliary system are strongly thigmotactic. The ciliary system consists of ten longitudinal rows. The first row on the right side of the ciliary complex origi-

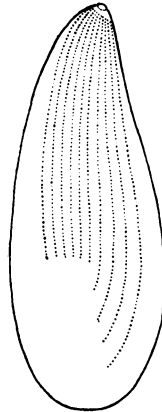


FIGURE 3. *Heterocineta fluminicola* sp. nov. Distribution of ciliary rows, somewhat diagrammatic. Ventral aspect.

nates close to the base of the suctorial tentacle; each of the remaining rows originates progressively more posteriorly. The first six rows from the right side are approximately the same length, being about two-thirds the length of the body. The last four rows become increasingly longer and incurved in such a way that they terminate one behind the other not far to the left of the midline. The longest row usually extends almost to the posterior end of the body. The cilia of the distal portions of these longer rows are usually directed posteriorly. When the ciliate is dissociated from the host it swims erratically, rotating on its longitudinal axis and tracing wide arcs with its anterior end.

The cytoplasm is colorless and contains numerous small refractile granules or a lipid substance in addition to food inclusions. One or more large food vacuoles are usually present in the posterior part of the body behind the macronucleus. The contractile vacuole is central and opens to the exterior on the ventral surface. We have not observed a permanent opening in the pellicle.

The sausage-shaped macronucleus is situated dorsally a short distance behind the middle of the body with its longitudinal axis placed obliquely to the longitudinal

axis of the body. In fixed and stained preparations the chromatin appears to be more or less homogeneous. In ten individuals fixed in Schaudinn's fluid and stained with iron hematoxylin the macronucleus ranged in length from  $7.4\ \mu$  to  $10\ \mu$  and in width from  $3.9\ \mu$  to  $4.4\ \mu$ .

The micronucleus is round, fusiform, or ovoid, and is usually placed dorsally near the middle of the body anterior to or to one side of the macronucleus. In fixed and stained specimens the chromatin is seen to be concentrated primarily along the periphery. In ten individuals fixed in Schaudinn's fluid and stained with iron hematoxylin the micronucleus ranged in size from  $1.5\ \mu$  by  $1.2\ \mu$  to  $1.7\ \mu$  by  $1.5\ \mu$ .

*Heterocineta fluminicola* was present in small numbers on the epithelium of the gills and the edge of the mantle of nearly all specimens of *Fluminicola virens* which I collected in Crystal Springs Creek in Portland, Oregon.

*Heterocineta fluminicola* sp. nov.

Diagnosis: Length  $30\ \mu$ – $36\ \mu$ , average about  $33\ \mu$ ; width  $13\ \mu$ – $17\ \mu$ , average about  $15\ \mu$ ; thickness  $10\ \mu$ – $12\ \mu$ , average about  $11\ \mu$ . The ciliary system is composed of ten rows originating progressively more posteriorly from the right side to the left. The first six rows from the right side are about two-thirds the length of the body. The remaining four rows become increasingly longer and terminate one behind the other a little to the left of the midline. The longest row extends almost to the posterior end of the body. Parasitic on the gills and mantle of *Fluminicola virens* (Lea) (Portland, Oregon). Syntypes are in the collection of the author.

ENERTHECOMA PROPERANS JAROCKI

(Figure 4; Plate I, Figs. 5, 6)

The body is elongated, nearly symmetrical as seen in dorsal or ventral view, attenuated anteriorly, and flattened dorso-ventrally. The anterior end is bent ventrally and deflected inconspicuously toward the left. The ciliary system is disposed on a narrow, relatively flat area occupying the anterior two-thirds of the ventral surface; the dorsal surface and that part of the ventral surface posterior to the ciliary area are convex. The body is widest at a point about two-thirds the distance from the anterior end to the posterior end. Twenty-five living individuals taken at random from *Viviparus malleatus* ranged in length from  $32\ \mu$  to  $56\ \mu$ , in width from  $13\ \mu$  to  $21\ \mu$ , and in thickness from  $10\ \mu$  to  $13\ \mu$ , averaging about  $44\ \mu$  by  $18\ \mu$  by  $11.5\ \mu$ . Specimens from *Viviparus fasciatus* which were measured by Jarocki ranged in length from  $33\ \mu$  to  $60\ \mu$ , in width from  $15\ \mu$  to  $22\ \mu$ , and in thickness from  $10\ \mu$  to  $13\ \mu$ .

The contractile suckorial tentacle is continuous with an internal tubular canal which is directed at first dorsally and then ventrally and obliquely toward the right side of the body. In specimens stained with iron hematoxylin the canal can usually be traced for about two-thirds or three-fourths the length of the body.

The ciliary system is composed of eight approximately equal rows about two-thirds the length of the body. These rows originate close to the base of the suckorial tentacle. The first five rows from the right side are usually a little more widely spaced than the last three rows. This was noted also by Jarocki, who stated that the ciliary system was separated into two complexes by an "inconsiderable eminence stretching from the base of the tentacle to the end of the system," which



segregated the five rows on the right from the three rows on the left. This eminence was evident on many of the living specimens which I examined but is never conspicuous. The cilia of *E. properans* are about  $9\mu$  in length and exhibit a feeble undulatory motion while the parasites are attached to the epithelium of the gills of the host. When dissociated from the host the ciliates swim slow and erratically, usually rotating on their longitudinal axes.

The cytoplasm is colorless and contains numerous small refractile granules of a lipoid substance in addition to food inclusions. One or more larger food vacuoles are usually present in the posterior part of the body. The contractile vacuole is situated a short distance behind the middle of the body and opens to the exterior on the ventral surface. I have not detected a permanent opening in the pellicle.

The macronucleus is typically sausage-shaped and is situated in the posterior half of the body with its longitudinal axis placed obliquely to the longitudinal axis

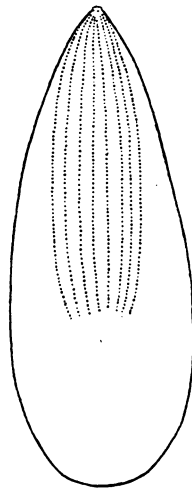


FIGURE 4. *Enerthecoma properans* Jarocki. Distribution of ciliary rows, somewhat diagrammatic. Ventral aspect.

of the body. In specimens stained with iron hematoxylin the chromatin appears to be more or less homogeneous, but in preparations stained by the Feulgen reaction it appears to be organized into a dense reticulum enclosing vacuole-like clear spaces of varying size. In ten individuals fixed in Schaudinn's fluid and stained by the Feulgen reaction the macronucleus ranged in length from  $10\mu$  to  $19\mu$  and in width from  $4\mu$  to  $7\mu$ .

The micronucleus is situated anterior to or to one side of the macronucleus. In most of the individuals of *E. properans* which I examined, the micronucleus is elongated and more or less fusiform. I have observed very few specimens to have a round micronucleus such as that described by Jarocki. The micronucleus does not stain readily with iron hematoxylin and it is possible that Jarocki may have mistaken food inclusions for micronuclei. In specimens stained by the Feulgen reaction the chromatin of the micronucleus appears to be concentrated in peripheral granules or strands. In ten individuals fixed in Schaudinn's solution and stained

by the Feulgen reaction the micronucleus ranged in size from  $0.8\ \mu$  by  $2.3\ \mu$  to  $1\ \mu$  by  $3.8\ \mu$ .

*Enerthecoma properans* was abundant on the gills of nearly all specimens of *Viviparus malleatus* which I collected in Stow Lake, San Francisco, California, and in Evans Lake, Riverside, California. It is undoubtedly a common parasite of this introduced snail wherever the latter has become established.

*Enerthecoma properans Jarocki*

Diagnosis: Length  $32\ \mu$ – $56\ \mu$  (according to Jarocki  $33\ \mu$ – $60\ \mu$ ), average about  $44\ \mu$ ; width  $13\ \mu$ – $21\ \mu$  (according to Jarocki  $15\ \mu$ – $22\ \mu$ ), average about  $18\ \mu$ ; thickness  $10\ \mu$ – $13\ \mu$ , average about  $11.5\ \mu$ . The ciliary system is composed of eight approximately equal rows about two-thirds the length of the body which originate close to the base of the suckorial tentacle and occupy a narrow, relatively flat area on the ventral surface. The first five rows from the right are more widely-spaced than the remaining three rows, and in living specimens appear to be segregated from the latter by an inconspicuous longitudinal eminence. The macronucleus is elongated; the micronucleus is typically elongated and more or less fusiform (according to Jarocki, spherical). Parasitic on the gills of *Viviparus fasciatus* Müller (Warsaw [Jarocki]) and *Viviparus malleatus* (Reeve) (San Francisco, California; Riverside, California).

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