Gastrotricha of Central Wisconsin

Joseph Luka Zakarija
Loyola University Chicago

GASTROTRICHA OF CENTRAL WISCONSIN

by

Joseph Luka Zakarija

A Thesis Submitted to the Faculty of the Graduate School

of Loyola University of Chicago in Partial Fulfillment

of the Requirements for the Degree of

Master of Science

April

1980

ACKNOWLEDGEMENTS.

I wish to extend my gratitude to the Facutly and Staff of our Biology Department, especially to Dr. Clyde E. Robbins for assistance in preparation of this manuscript; to Douglas Mack, Randy Scarpiniti, Jim Grieco, Tony Esposito, Kevin Johnson and Manfred Borges, Jr. for assistance in field collections; to Cristine Charlesworth for photographic advice; to Teofila Bator for preparation of illustrations; and especially to my wife, Marija, and my father, Mr. Ivan Zakarija, for their patience and encouragement during the completion of this manuscript.

VITA

The author, Joseph Luka Zakarija, is the son of Ivan John Zakarija. He was born June 26, 1955, in Berwyn, Illinois.

His elementary education was obtained in the Catholic schools of Chicago, Illinois, and secondary education at Loyola Academy, Wilmette, Illinois where he graduated in 1973.

In September, 1973, he entered Loyola University, and in January, 1978, received the degree of Bachelor of Science with a major in biology.

In September, 1979, he was granted an assistantship in biology at Loyola University, and became a member of the Croatian Academy of America.

Table of Contents.

Page

List of Illustrations.

List of Photographs.

I. Introduction

Gastrotricha are one of the most neglected groups of freshwater micrometazoans. Although studies from Europe have been the most comprehensive they are incomplete. Only scattered studies have been reported from Asia, Africa or South America. Australian studies are non-existent. In North America, studies are lacking from both Canada and Mexico. Comprehensive taxonomic and distributional reports in the United States have been performed in only two of the fifty states.

Joblot(1718) was the first investigator to report the existence of Gastrotricha. O.F. Muller(1773) gave a descriptive account of Gastrotricha, but classified them as Infursoria. Ehrenberg(1830) referred to them as Rotifera. Not until Metschnikoff(1864), was Gastrotricha recognized as distinct from Rotifera because of gastrotrich's ventral ciliation.

Zelinka(1889) laid the foundation of modern gastrotrich classification. His phylogenetic treatment was widely accepted until the work of Remane(1927a), which united the Gastrotricha with the Nemotoda, Kinorhyncha and Rotifera into the phylum Aschelminthes.

The major investigations of the twentieth century were performed by Europeans, the most outstanding of whom were: Greuter(1917), Grunspan(1908,1910), Voigt(1901,1902 1903,1904,1909) and Remane(1927a,1927b,1936). Remane's work marked the closing era of Gastrotricha study in Europe. Studies of Saito(1937), Naidu(1962) and Visvervara (1963,1964) have shown similarities among the Asian, European and North American fauna, thereby suggesting cosmopolitanism of species.

The work produced in the United States has continued to be taxonomic and distributional. The major studies were performed by: Stokes(1887a,1887b,1918), Packard(1936,1958a,1958b,1958c,1958f,1959,1960,1962), Davison(1938), Brunson(1947,1948,1949,1950,1963), the Krivaneks(1958a,1958b,1959,1960), Robbins(1963,1965,1966), Hawkes(1965), Horlick(1969) and Rossino(1979).

Rossino's 1979 study was the only one done in Wisconsin. The purpose of this survey is to extend the taxonomic and distributional record of the Gastrotricha of Central Wisconsin.

II. Phylogenetic Position of Gastrotricha

Descriptions of Gastrotricha are found in the works of some of the notable early zoologists. Ehrenberg (1830) seperated all Gastrotrichs into two genera on the basis of the texture of their cuticle. Ehrenberg proposed two genera; Ichthydium, those that possess a smooth cuticle; and Chaetonotus, those without a smooth cuticle. These generic names are still in use today.

However, Ehrenberg's system of classification soon became inadequate or new forms were discovered and other systems were developed. Classification systems were developed by Zelinka(1889), Daday(1905) and Cordero(1918), but these also proved inadequate as well as incomplete. Mola(1932) developed a complete system based upon the work of other authors, but not on new material.

Since the Gastrotricha show similarities to groups other than rotifers, Remane's(1927) Aschelminthes concept is widely accepted(Hyman-1951) and will be utilized throughout this paper. However some authors treat Gastrotricha as a seperate phylum.

Remane's system for freshwater Gastrotricha with some modification, is as follows:

Phylum-Aschelminthes

Class-Gastrotricha

Order-Macrodasyoidea- Remane, 1927

Genus-<u>Marinellina</u>-Ruttner-Kolisko 1955

Order-Chaetonotoidea- Remane, 1927

Family-Chaetonotidae-Zelinka, 1889

Genus-<u>Chaetonotus</u>-Ehrenberg, 1830

Genus-<u>Ichthydium</u>-Ehrenberg, 1830

Genus-<u>Lepidodermella</u>-Zelinka, 1889

Genus-<u>Aspidiophorus</u>-Voigt, 1902

Genus-<u>Heterolepidoderma</u>-Remane, 1927

Genus-<u>Polymerurus</u>-Remane, 1927

Genus-<u>Asperpellis</u>-Horlick, 1969

Family-Proichthydidae-Remane, 1936

Genus-<u>Proichthydium</u>-Cordero, 1918

Family-Dichaeturidae-Remane, 1936

Genus-<u>Dichaetura</u>-Lauterborn, 1913

Family-Neogosseidae-Remane, 1936

Genus-<u>Neogossea</u>-Remane, 1927

Genus-<u>Kijanebalola</u>-Beauchamp, 1932

Family-Dasydytidae-Remane, 1936

Genus-<u>Dasydytes</u>-Gosse, 1851

Genus-<u>Stylochaeta</u>-Hlava, 1904

The application of the species concept to parthenogenetic organisms such as Gastrotricha have been criticized by Dobzhansky(1951) and Mayr(1963). Their argument centers on the fact that Gastrotricha are not sexually reproducing which automatically excludes them from most definitions of species. Simpson(1961) argues that the species concept is valid in uniparental, as well as, biparental organisms because there is a formation of a gene pool. In addition there is a inhibition to the spread of genes to other populations and a community inheritance.

III. Definition of the Chaetonotoid Gastrotricha

Gastrotricha are characterized as having a pseudocoelomate body, somewhat vermiform and unsegmented, with an anus terminating far posterior to the mouth, and a cuticle of varying relative thickness. Chaetonotoidea is defined as a distinct order since it possesses adhesive glands and tubes, cilia in various and distinct arrangements, and a nemotode-type pharynx lacking trophi. Gastrotrichs do not possess corona or a segmented cuticle. They are also aquatic and microscopic, ranging from minute to 1.5mm in total length.

The members of the Order Chaetonotoidea are generally freshwater inhabitants with the exception of the Families Neodasyidae and Xenotrichuldae which are marine, and the Family Chaetonotidae which has a few marine members. With the exception of the marine genera, the Chaetonotids possess protonephridia and occur only as parthenogenic females in which no evidence of males exist in the population,however this has recently been debated by Weiss and Levy(1979).

Adhesive glands are usually present as a single posterior pair, but a few species lack the glands. Variations of the cuticular structure in the form of spines and scales are characteristic of the Chaetonotidae.

Macrodasyoidea are distinguished from the Chaetonotidae because all are marine with one known exception, Marinella flagellata Ruttner-Kolisko(1955) from the Ybbs River, Austria. They lack protonephridia, are hermaphroditic, and possess many lateral adhesive glands.

IV. Definition of the Chaetonotoid Characteristics Employed in Taxonomy.

A. Cuticular Structures.

Chaetonotoid Gastrotrichs are classified on the basis of the size, type and arrangement of the cuticular features because of their stability.

1. Spines- Classification of freshwater Gastrotricha is dependent upon the determination of the type, placement, attachment, and relative lengths of the spines that may be present. They may originate in the scales or may arise as direct outcroppings of the cuticle. Most Gastrotrichs possess fixed, rigid spines, only two known species possess moveable ones; Chaetonotus quintispinous and Chaetonotus trichodrymodes. Spines are measured from tip to scale(or cuticle) and any curvature is iqnored. Refer to Plate 2.

2. Scales- Members of the Family Chaetonotidae are the only freshwater Gastrotrichs known to possess scales. The four different types of scales are: scales bearing a spine, flat and unornamented scales, scales with a low median keel, or scales with a short stalk and broadened end plate. Refer to Plate 2.

3. Tactile Bristles- These are fine processes found in many species of Chaetonotoids. No sensory function has been demonstrated for these structures therefore the term may be misleading. The reliability of tactile bristles as a taxonomic tool has been questioned strongly by Robbins(1963). He has found that the presence of tactile bristles to be variable within a species. Robbins suggests that the tactile bristles may be lost in handling of the organisms, or are lost regularly under natural conditions, as in molting.

B. Body Form

The total body length, size and shape of the head, neck, trunk and caudal furca are important in classifying Chaetonotoids.

1. Head- Most freshwater Gastrotrichs possess either a one, three or five lobed head. The width of the head is the widest dimension anterior to the intestine. Another morphological characteristic of the head is the cephalic shield which is a thin sheet of cuticle extending from above the mouth posteriorly over the anterior part of the head. Presence or absence of a cephalic shield is significant in taxonomy at the species level.

2. Neck- This is the region of constriction posterior to the head and anterior to the intestine, the width is measured as the narrowest dimension between the head and intestine.

3. Trunk- This division of the body is the entire area posterior to the pharynx. The widest dimension of the trunk is taken as its width. Zelinka(1889) and Sacks(1953) report that the trunk is narrower than the head in newly hatched Gastrotrichs; also, the presence of a developing egg within the animal will enlarge the width of the trunk by as much as fifty percent.

4. Total Length- The total length is the dimension from the most anterior extent of the head to the tip of the caudal furca. Individuals within a species may vary as much as thirty percent. Other measurements remain more constant.

5. Caudal Furca- When present, the caudal furca is formed by a dichotomous branching of the posterior end of the body. An adhesive gland is usually found in each branch of the furca. The length of the caudal furca is measured from the point of branching at the midline to the tip. Refer to plate 2.

6.Pharynx- The pharynx is a muscular tube similar to that of the Nematode in form and histological structure(Remane,1936). The pharynx can be a straight cylinder;either possessing an anterior bulb, a posterior bulb or both, or it may be nearly round as in the Genus Kijanebalola.

7.Other Internal Features- The only internal features of noteworthy mention are the intestine and the cement glands of which neither organ appears to be distinct. The presence and number of refractive granules in the intestine have been used in taxonomic descriptions of certain species(Brunson,1950). However the nature of the granules is not clear. Robbins(1963) has observed that these granules are transitory features.

8.Ciliary Tracts- The ventral ciliation that is characteristic of the Gastrotricha consists of distinct ciliary tracts. Different Genera are characterized by different ciliary patterns. Chaetonotus has a continuous double row of cilia; Dasydytes has a double row of intermittent small patches; and Proichthydium has a single band across the ventral surface of the head only. Ciliary tracts are unknown for several species and genera.

The purpose of the ventral cilia is locomotion while the long tufts of cilia on the head are probably of a sensory nature(Robbins,1963). Because cilia beat in only one direction, Gastrotricha are unable to back up. They must go over or around an object.

9. Eggs- The freshwater Gastrotricha lay both summer and winter eggs. Summer eggs usually start developing upon being laid. Winter eggs will experience a period of dormancy before development starts; this allows the species to survive adverse conditions such as freezing or dessication. Winter eggs are covered with spines, papilla, or pits, in various patterns and have a thick shell. Summer eggs usually have a smooth membranous covering that is thin and fragile. Winter eggs have been observed for only a few species; however, with greater investigation they could become an important taxonomic characteristic.

V. Freshwater Gastrotricha of North America

Chaetonotus larus, Fernald(1883), was the first species of Gastrotricha reported from North America. In 1887, Stokes described eleven new species and redescribed ten species origanally described from Europe. Since Stoke's work, North American studies are widely scattered. The most notable works have been: Packard(1936,1958a,1958b,1958c, 1958d,1958e,1958f,1959,1960,1962) with nine redescribed species from Maine, New York, New Hampshire, and Virginia; Brunson(1947,1948,1949,1950,1963) with six redescribed and twelve new species from Michigan; Robbins(1963,1965,1966, 1973) with two new and ten redescribed species from Illinois; the Krivaneks(1958a,1958b,1959,1960) with two new species and two families from Louisiana not previously found in North America; Hawkes(1965) with seven redescribed species from North and South Carolina; Horlick(1969) with one new and fourteen redescribed species from Illinois; and Rossino(1979) with one new and four redescribed species from Wisconsin. Refer to Appendix 1 for detailed documentation.

VI. Area of Study.

The area of this study included Adams, Columbia and Marquette Counties in Central Wisconsin(refer to maps 1 and 2). A total of five collection sites were established. One collection site was in Marquette County, one in Columbia County and three in Adams County. Two of the collection sites; Parker Lake in Adams County, and the Baraboo River in Columbia County have specified names. The other three ponds are glacial relicts, and have no formal names, therefore, for the purpose of this paper, they will be designated Ponds A,B and C. Sites were sampled at random intervals.

Site 1- Parker Lake- T15N-R7E-S14-¼S.W.

This study was made on June 1,1979. Parker Lake is a small circular lake lying 40 feet below the surrounding terrain. The lake has no inlet or outlet, it is fed by an artesian well. The collection was made on the western edge of the lake, one hundred feet from rural road G. This end of the lake is shallow and is dominated by high grasses and cattails, and samples were obtained here. Two species of Gastrotrichs were found.

Site 2- Pond A- T15N-R7E-S23-¼N.E.

Collections from this site were made on June 1, 1979. Pond A is a kettle type pond lying 40 feet below the surrounding terrain. The pond resembles a bog because of the adjacent matted vegetation, and dark colored water. Vegetative material consists of decaying organic matter made up mostly of fallen Oak leaves. Samples were collected from the northern end of Pond A. Three species of Gastrotricha were obtained.

Site 3- Pond B- T15N-R7E-S15-¼S.E.

Collections were obtained on June 1, 1979. Pond B is a kettle type pond lying 40 feet below the surrounding terrain. Pond B is located within 500 feet from Wisconsin Route 82. The pond resembles a marsh, and abounds with aquatic grasses and duckweed. It is slightly oblong, and measures 100 feet at its longest point. Two species of gastrotrichs were found.

Site 4- Pond C- T15N-R8E-S9-¼S.W.

Collections were made on September 23,1979. Pond C is a small pond measuring approximately 100 feet in diameter, and is 20 feet above the surrounding terrain. An intermittent stream empties from the pond.

Cattails surround the pond, and aquatic grasses encircle the entire area. The samples were obtained from aquatic grasses because open water was not readily accessable. One species of gastrotrichs was obtained.

Site 5- Baraboo River-

This collection was performed on August 1, 1979. Samples were taken from the marshy area directly adjacent to the river. Aquatic grasses were the primary flora. One species of gastrotrich was obtained.

VII. Methods and Materials.

A. Collection

Areas of Central Wisconsin chosen as collection sites were never before investigated. Samples were taken from various freshwater aquatic situations such as lake, marsh, bog and running water. In the collection process samples of water, surface vegetation or detritus were taken with Nalgene 500ml plastic specimen containers. The surface vegetation was picked by hand and placed into the containers along with some water from the site. Cattails were cut into sections and added to water in the jars.

In the laboratory, the samples were divided; half were placed in controlled temperature room at 15-17 degrees Celsius for storage, the other half were brought into the laboratory and kept at room temperature with indirect and direct light. Gastrotricha were subcultured by taking 50-75ml of the original culture sample consisting of surface and bottom water, vegetation and detritus and combining this with 300-400ml of Bold's Basal Medium. Samples subcultured by this method produced Gastrotricha for nine months to a year.

B. Observations

Collections were observed daily in the laboratory with a Baush and Lomb(stereozoom 5) dissecting microscope. As Gastrotricha appeared they were removed individually from the samples using a mouth suction pipette, then individual water droplets were placed on microscope slides in order to isolate the one droplet containing the gastrotrich.

C. Preparation of Permanent Slides (Robbins,1963).

After successful isolation of a gastrotrich, it was fixed by inverting the slide over a two per-cent osmic acid solution(Brunson, 1950) for ten seconds. A drop of glycerine was placed in the droplet containing the fixed specimen. After this step, the water was allowed to evaporate until the animal was left in pure glycerine. Specimens could be kept in glycerine for an indefinite time in a dust free container. Excess glycerine was removed prior to permanent mounting with cotton-tip applicators.

Final mounting was accomplished by covering the glycerine droplet with glycerine jelly warmed to 45 degree Celsius(Pennak, 1953), and placing a coverslip of zero-grade thickness over the entire preparation.

D. Cuticular Observations.

Final observations and measurements were performed on the prepared slides with an American Optical binocular, compound microscope at 100X,250X,450X and 1000X total magnification. Cuticular observations were made by using varying magnifications and light intensities. Dimensions of the gastrotrich and its specific structures were measured and recorded. Individual scales were dislodged from the body by applying pressure to the coverslip with a blunt probe.

E. Photography.

Photographs were taken of the permanent slides using a American Optical Microscope. The film used was Panachromatic X-135-32ASA(Kodak). All photographs were developed and enlarged by the author.

VIII. Occurrence of Gastrotricha in Central Wisconsin.

The eight species of Gastrotricha described in this section were found in Adams, Columbia and Marquette Counties of Wisconsin; five are previously described and three are new species of which two will be identified only to the genus level. In each description attention is given to any variation which occurs between the original and subsequent descriptions of a species and members of that species identified elsewhere.

Following the description of each species are listed locus key, collection site, date of collection, water temperature, pH and substrate from which the collection was made.

1. *Chaetonotus acanthophorus* (Stokes,1887)

Description.

Total length, 140-150 microns; head width, 25 microns; pharynx length, 40-45 microns; trunk width, 30-35 microns; furca length, 20-25 microns; long spine length, 13-18 microns; short spine length, 5 microns; distinct five lobed head; spines of graduated length occuring from neck to trunk.

Discussion.

The animals found in this study were approximately the same as those previously recorded.

New Records.

Oxford Quadrangle, Wisc.

Pond B-T15N-R7E-S15-¼S.E.-duckweed,detritus.

pH-5.5-5.8.

Temperature-17 degrees Celsius.

2. <u>Chaetonotus</u> <u>machrochaetus</u> (Robbins,1963)

Description.

Total length,145-150 microns; head width, 25-30 microns; pharynx length, 40-45 microns; trunk width, 25-30 microns; furca length, 30-35 microns; indistinct lobed head; body lacks typical graduated chaetonotoid shape.

Discussion.

The animals found in this study were approximately the same size as that reported by Robbins,1963.

New Records.

Oxford Quadrangle, Wisc.

Pond A-T15N-R7E-S23-¼N.E.-detritus.

pH-5.2-5.5.

Temperature-18 degrees Celsius.

3. <u>Chaetonotus</u> <u>trichodrymodes</u> (Brunson,1950)

Description.

Total length, 110-120 microns; head width, 20-25 microns; pharynx length, 40-45 microns; trunk width, 20-25 microns; furca length, 20-25 microns; mid-dorsal trunk spines, 90-100 microns; five lobed head; trunk appears thinner than neck region.

Discussion.

Mid-dorsal trunk spines are 35-40% longer than that reported by Brunson,1950. All of these spines appear to arise from a central area located on the anterior section of the trunk on the dorsal surface.

New Records.

Oxford Quadrangle, Wisc.

Pond A-T15N-R7E-S23-¼N.E.-fallen Oak leaves.

pH-5.2-5.5.

Temperature-18 degrees Celsius.

4. Chaetonotus wisconsinensis n. sp.

Description.

Total length, 185-225 microns; head width, 35-43 microns; pharynx length, 65-90 microns; trunk width, 52-64 microns; furca length, 42-48 microns; dorsal trunk spines are placed in non-alternating rows of graduated lengths, 24-32 microns long and possess a pronounced keel, a total number of 80 have been observed; head is distinctly five lobed; one pair of ciliary tufts appear on the head; a cephalic shield is present; diameter of oral ring is 13 microns; each specimen possesses 5 distinct spines situated between the caudal furca, 4 having length of 25-28 microns and the medial one a length of 11 microns; spines are located on the lateral surface of the neck as a double row of 15-20 on each side with the length of 15-18 microns each; scales are present on trunk and neck region, those of the trunk are chevron shaped and have spines arising from them, those of the neck total 70-80 are circular have no spines and cover the entire neck region.

Discussion.

The lateral spines of the neck region and the absence of them on the dorsal surface is a characteristic never previously described for a Chaetonotus genus.

Chaetonotus wisconsinensis shows similarities to the recently discovered *Chaetonotus rafalskii*, Kisielewski, 1979 from Poland. The pattern of spination is similar except for that of the neck region, the scales of the *C. rafalskii* are triradiate while that of the *C. wisconsinensis* are not, and the dimensions of the furca are much larger on the *C. wisconsinensis* than the *C. rafalskii*.

New Records.

Oxford Quadrangle, Wisc.

Pond C-T15N-R8E-S9-¼S.W.-detritus.

pH-6.1-6.4.

Temperature-12.3-12.8 degrees Celsius.

5. Chaetonotus sp. A

Description.

Total length,112-144 microns; head width, 16-24 microns; pharynx length, 40-44 microns; trunk width, 18-21 microns; furca length, 23-24 microns; spine length, 16-17 microns; head three lobed; spines arise directly from the cuticle, no scales present; spines are of graduated length from neck to furca; furca has distinct outward curvation; cuticle is unusually thick; and head region is larger in dimension than the trunk.

Discussion.

This species does not conform exactly to descriptions of other chaetonotoids, but the characteristics are sufficently indistinct that further study is needed to determine speciation.

New Records.

Wisconsin Dells Quadrangle, Wisc.

Baraboo River-T12N-R9E-S28-¼N.W.-aquatic grasses.

pH-7.1-7.4.

Temperature-15.5-16.0 degrees Celsius.

6. Chaetonotus sp. B

Description.

Total length, 130-135 microns; head width, 25 microns; pharynx length, 40-50 microns; trunk width, 28 microns; furca length, 20 microns; spines of trunk, 25 microns; spines of neck, 15 microns; head single lobed; neck possesses 25-30 diamond shaped scales with spines.

Discussion.

The vast majority of chaetonotoids have spines of equal or graduated length from anterior to posterior, and this does not conform to typical pattern in that these spines are of varying lengths and placement. It was not identified to species level due to lack of specimens.

New Records.

Oxford Quadrangle, Wisc.

Parker Lake-T15N-R7E-S14-¼S.W.-detritus.

pH-7.0-7.4.

Temperature-15.5-16.0 degrees Celsius.

7. <u>Heterolepidoderma illinoiensis</u> (Robbins,1963)

Description.

Total length,124-126 microns; head width, 28 microns; pharynx length, 50-60 microns; trunk width,22-24 microns; furca length, 24 microns; head five-lobed; no spines present; elongated scales over entire length of the body; all scales have a low median keel; and a well defined cuticle.

Discussion.

The animals found in this study had furca lengths 40-50% smaller than those reported by Robbins,1963.

New Records.

Oxford Quadrangle, Wisc.

Parker Lake-T15N-R7E-S14-¼S.W.-cattails.

pH-7.0-7.4.

Temperature-15.5-16.0 degrees Celsius.

Pond B-T15N-R7E-S15-¼S.E.-aquatic grasses.

pH-5.5-5.8.

Temperature-17 degrees Celsius.

8. Lepidodermella squamatum (DuJardin,1841)

Description.

Total length, 190-200 microns; head width, 40-45 microns; pharynx length, 70-75 microns; trunk width, 50-60 microns; furca length, 40-50 microns; head distinctly five lobed; body distinctly scaled; and scales occuring in alternating rows which project posteriorly.

Discussion.

The animals in this study were much larger than those described by Rossino(1979), Robbins(1963) and Brunson(1950). Pregnant animals found in this study had a trunk width at least one-third larger than non-pregnant animals.

New Records.

Oxford Quadrangle, Wisc.

Pond A-T15N-R7E-S23-¼N.E.-detritus.

pH-5.2-5.5.

Temperature-18 degrees Celsius.

IX. Summary

1. The Chaetonotoid Gastrotricha are defined and characteristics used in their classification are discussed and evaluated.
2. The most inclusive system of classification of freshwater gastrotrichs is that of Remane(1936).
3. There has been little work done on the gastrotrichs in North America. A summary is given of all known North American species. All of the reported species are from the United States.
4. Methods and materials of collection, observation, mounting and photography of gastrotrichs are discussed.
5. Gastrotrichs that have been subcultured in the laboratory with Bold's Basal Medium have remained viable for nine months to a year.
6. Eight species of gastrotrichs are described from this study. Five of these species are previously described, but only one has been previously described from Wisconsin. Of the three remaining species, two are classified to the genus level only, and the third is identified as a new species, Chaetonotus wisconsinensis.

X. Literature Cited

Beauchamp, P.M. de. 1932. Scientific results of the Cambridge Expedition to East African lakes. Rotiferes et gastrotriches. J.Linnean Soc. 38:231-248.

Brunson, R.B. 1947. Gastrotricha of North America II. Four new species of Ichthydium from Michigan. Papers Mich. Acad. Sci. 33:59-62.

_______. 1950. An introduction to the taxonomy of the Gastrotricha with a study of eighteen species from Michigan. Trans. Am. Microscop. Soc. 69: 325-352.

_______. 1959. Gastrotricha. In W.T. Edmondson, (ed.), Fresh-Water Biology. John Wiley & Sons, Inc., New York, 406-419.

_______. 1963. Aspects of the natural history and ecology of the Gastrotricha. In E.C. Dougherty, (ed.), The lower metazoa. Univ. California Press, Berkeley and Los Angeles. pp. 473-478.

Bryce, D. 1926. Rotifera and Gastrotricha of Devil's Stump Lakes, North Dakota, J. Quekett Microscope Club, 15: 81-108.

Cordero, E.H. 1918. Notes sur les Gastrotrichs. Physis (Rev. Soc. Argentin. Ciencias Nat.) 4: 241-255.

Daday, E. 1905. Untersuchungen Uber die SusswasserMikrofauna Paraguays, Zoo-ology Bd. 18, Heft 14.

Davison, D.B. 1938. A new species of gastrotrichan- Chaetonotus robustus, new species. Am. Mus. Novitates 972:1-6.

Dobzhansky, T. 1951. Genetics and the Origin of Species. Columbia University Press, New York, pp. 273-275.

Ehrenberg, C.J. 1830. Organization, Systematik und Geographischen Verhaltnis der Infusionthierchen. Zwei Vortrage in der Akademie der Wissenschaften zu Berlin gehalten in den Jahren 1828 und 1830. Berlin. 108 p.

_________. 1838. Die Infusionsthierchen als vollkommene Organismen. Leipzig. pp. 386-390.

Fernald,C.H. 1883. Notes on Chaetonotus larus. Amer. Nat. 17: 1217-1220.

Goldberg,R.J. 1949. Notes on the biology of a common gastrotrich of the Chicago area, Lepidodermella squamatum(Dujardin). Trans. Ill. Acad. Sci. 42: 152-155.

Gosse,P. 1851. A catalogue of Rotifera found in Britain; with descriptions of five new genera and thirty new species. Ann. and Mag. Nat. Hist. 8(2nd Ser.): 197-203.

Greuter,A. 1917. Beitrage zur Systematik der Gastrotrichen in der Schweis. Rev. Suisse Zool. 25: 35-76.

Grunspan,T. 1910. Die Susswassergastrotrichen Europas. Eine Zusammenfassende Darstellung ihrer Anatomie, Biologie und Systematik. Ann. Biol. Lasustre 4:211-365.

Hatch,M.H. 1939. Notes on two species of Gastrotricha from Washington. Am. Midland Nat. The. 21: 257-258.

Hawkes,J.A.W. 1965. A Taxonomic Study of Gastrotrichs from the Southern Appalacian Mountain Region. M.A. Thesis. unpublished. Wake Forest College, Winston-Salem, North Carolina. p.57.

Hlava,S. 1904. Die systematische Stellung von Polyarthra fusiformis Spencer. Zool. Anz. 28: 331-336.

Horlick,R. 1969. The Gastrotricha of North-Eastern Illinois, M.A. Thesis, Loyola University, Chicago, Illinois. 147 pp.

Hyman,L.H. 1951. The Invertebrates: Acanthocephala, Aschelminthes and Entoprocta. McGraw-Hill Book Co., New York. pp. 151-170.

James,D.E.(ed.) 1974. Culturing Algae, Algae Media. Carolina Biological Supply Co., Burlington, North Carolina. p. 19.

Kisielewski,J. 1979. New and insufficiently known freshwater Gastrotricha from Poland. Annales Zoologici, Warszawa, Poland, vol.34, no.13: 417-421.

Krivanek,R.C. and J.O. Krivanek. 1958a. A new and a redescribed species of Neogossea(Gastrotricha) from Louisiana. Trans. Am. Microscop. Soc.77: 423-428.

________. 1958b. Taxonomic studies on the Gastrotricha of Louisiana.(Abstr.) Assoc. Southeastern Biol. Bull. 5(1): 12.

________. 1959. A new species of Stylochaeta(Gastrotricha) from Louisiana. Trans. Am. Microscop. Soc. 78: 77-81.

________. 1960. Gastrotricha of the New Orleans area. (Abstr.) Assoc. Southeastern Biol. Bull. 7(2): 32.

Lauterborn,R. 1913. Gastrotricha. Handw. Naturw. 4: 621-623.

__________. 1913. Gastrotricha. In Handwerter-buch d. Naturwissensch. Vol. 4. Jena.

Mayr,E. 1963. Animal species and evolution. The Balknap Press, Cambridge, Mass. pp. 27-29.

Metschnikoff,E. 1864. Uber einige wenig bekannte miedere Tierformen. Z. fur Wiss. Zool. 15: 450-463.

Mola,P. 1932. Gastrotricha della acque dolci italiane-Internat. Reveue Hydrobiology Hydrogi. vol. 26.

Muller,O.F. 1773. Vermium terrestrim et fluviatilium, seu animalium infusoriorum, helminthicorum et testaceorum, non marinorum, succinta historia. 1(1): 1-79.

______. 1786. Animalcula Infuroria Fluviatillia et Marina. pp. 124-125 and 215-216.

Naidu,K.V. 1962. Three species of Gastrotricha from fresh waters of Cuddapah, India. Ann. and Mag. Nat. Hist. 5(1): 1-4.

Packard,C.E. 1936. Observations on the Gastrotricha indigenous to New Hampshire. Trans. Am. Microscop. Soc. 55: 422-427.

_______. 1958a. Report on a gastrotrichan species from Ashland,Virginia. Virginia J. Sci.,The 9(2): 247-252.

Packard, C.E. 1958b. Studies on the Gastrotricha I. The genus Polymerurus. A. Introduction. Turtox News 34(12): 242-244.

_______. 1958c. Studies on the Gastrotricha I. The genus Polymerurus. B. Procedures, local observations and general recordings. Turtox News 35(2): 66-67.

_______. 1958d. Studies on the Gastrotricha I. The genus Polymerurus. C. Morphology, Turtox News 35(7): 154-157.

_______. 1958e. Studies on the Gastrotricha I. The genus Polymerurus. D. Physiology, Turtox News 35(12): 282-284.

_______. 1958f. Studies on the Gastrotricha I. The genus Polymerurus. G. Classification. Turtox News, 36(4): 114-116.

_______. 1959. Polymerurus nodicaudus Voigt from Ashland, Virginia. Turtox News, 37(6): 156.

_______. 1960. Gastrotricha from the Singapore Airport, Paya Lebar, locality. Turtox News, 38(12): 300-301.

_______. 1962. An Ichthydium, probably sulcatum of the Mountain Lake, Virginia area. Turtox News, 40(3): 82-84.

Pennak, R.W. 1953. Freshwater Invertebrates of the United States. Roland Press Co., New York, p.738.

Remane, A. 1927a. Beitrag zur Systematik der Susswasser-gastrotrichen. Zool. Jahrb. Abt. System. 53: 269-320.

______. 1936. Gastrotricha, p.242. In H.G. Bronns, (ed.) Klassen und Ordnungen des Tierreich. Leipzig. Band 4, Abt.2, Teil 2, Buch 1.

Robbins, C.E. 1963. Studies on the taxonomy and distribution of the Gastrotricha of Illinois. Ph.D. Thesis. Univ. of Illinois. 96 pp.

_______. 1965. Two new species of Gastrotricha(Aschelminthes from Illinois). Trans. Amer. Microscop. Soc. 84(2): 260-263.

_______. 1966. The Occurrence of Gastrotricha in Illinois. Trans. Amer. Microscop. Soc. 85(1): 165.

Rossino,G.J. 1979. Gastrotricha of Kettle Moraine State Park, M.S. Thesis, Loyola University, Chicago, Illinois 70 pp.

Ruttner-Kolisko,A. 1955. Rheomorpha neiswestnovae und Marinellina flagellata, zwei phylogenetisch interessante Wurmtypen aus dem Susswasserpsammon. Osterreich. Zool. Z. 6(½): 55-69.

Sacks,M. 1955. Observations on the embryology of an aquatic gastrotrich, Lepidodermella squamatum(Dujardin,1841). J. Morphol. 96(3): 473-495.

_____. 1964. Life history of an aquatic gastrotrich. Trans. Am. Microscop. Soc. 83(3): 358-362.

Saito,I. 1936. Neue und bekannte Gastrotrichen der Umgebungvon Hiroshima, Japan. Jour. Sci. Hiroshima Univ., Ser. B, Div. 1, 5: 245-265.

Simpson,G.G. 1961. Principles of Animal Taxonomy. Columbia University Press, New York. pp. 161-163.

Stokes,A.C. 1887a. Observations on a Chaetonotus. Microscope,The. 7: 1-9 and 33-43.

______. 1887b. Observations on a new Dasydytes and a new Chaetonotus. Microscope,The. 7: 261-265.

______. 1918. Aquatic microscopy for beginners. John Wiley and Sons, Inc., New York. 308 p.

Visvesvara,G. 1963. On some Gastrotricha from India with descriptions of two new species. Ann. and Mag. Nat. Hist. 6(67): 435-443.

__________. 1964. On some Gastrotricha of the genus Chaetonotus from India. Ann. and Mag. Nat. Hist. 7(76): 209-216.

Voigt,M. 1901. Mittheilungen aus der Biologischen Station zu Plon, Holstein. Uber einige bisher unbekannte Susswasserorganismen. Zool. Anz. 24: 191-195.

_____. 1902. Die Rotatorien und Gastrotrichen der Umgebung von Plon. Zool. Anz. 25(692): 673-681.

_____. 1904. Rotatorien und Gastrotrichen der Umgebung von Plon. Forschgber.aus der Biol. Sta.zu Plon. 11: 1-180.

Whitney,M. 1958. Gastrotricha. In P. Brohmer, P. Ehrmann, and G. Ulmer,(ed.), Die Tierwelt Mitteleuropas. Leipzig. Band 1, Lief 4a. pp.1-74.

Weiss,M.J. and Levy,D.P. 1979. Sperm in Parthenogenetic freshwater Gastrotricha. In D. Farner and W. Chavin (ed.), Science,AAAS. Washington, D.C. 205(4403): pp. 302-303.

Zelinka,C. 1889. Die Gastrotricha. Eine monographische Darstellung ihrer Anatomie, Biologie und Systematik. Z. Wiss. Zool. 49: 209-384.

XI. Appendix

A. The following table is a distribution list of the freshwater Gastrotricha of North America.

Species	State found	Authority	Date
Asperpellis concinnus	New Jersey	Stokes	1887
	New Hampshire	Packard	1936
	Illinois	Horlick	1969
A. sulcatum	New Jersey	Stokes	1887
	Michigan	Brunson	1956
	Michigan	Packard	1962
	Illinois	Horlick	1969
Aspidiophorus paradoxus	New Jersey	Davison	1938
	North Carolina	Hawkes	1965
	South Carolina	Hawkes	1965
Chaetonotus acanthodes	New Jersey	Stokes	1887
C. acanthophorus	New Jersey	Stokes	1887
	New Hampshire	Packard	1936
	Michigan	Brunson	1950
	Virginia	Packard	1958
	Illinois	Robbins	1963
	Illinois	Horlick	1969
C. aculeatus	Illinois	Robbins	1963
	Wisconsin	Rossino	1979
C. brevispinosus	New Jersey	Stokes	1887
	New Hampshire	Packard	1936
C. chuni	Washington	Hatch	1939
C. elegans	North Carolina	Hawkes	1965
	South Carolina	Hawkes	1965
C. enormis	New Jersey	Stokes	1887
C. formosus	New Jersey	Stokes	1887
	Michigan	Brunson	1950
	Illinois	Horlick	1969

Species	State found	Authority	Date
Chaetonotus gastrocyaneus	Michigan	Brunson	1950
	Illinois	Horlick	1969
C. larus	Maine	Fernald	1883
	New Jersey	Stokes	1887
	Illinois	Horlick	1969
C. longispinosus	New Jersey	Stokes	1887
	Illinois	Robbins	1963
	Illinois	Horlick	1969
C. loricatus	New Jersey	Stokes	1887
C. machrochaetus	Illinois	Robbins	1963
	North Carolina	Hawkes	1965
C. octonarius	New Jersey	Stokes	1887
	New Hampshire	Packard	1936
	Michigan	Brunson	1950
	Illinois	Robbins	1963
	Illinois	Horlick	1969
	Wisconsin	Rossino	1979
C. quintespinosus	Illinois	Robbins	1963
C. robustus	New York	Davison	1938
	New Jersey	Davison	1938
	Illinois	Horlick	1969
C. similis	New Jersey	Stokes	1887
	New Hampshire	Packard	1936
C. spinifer	New Jersey	Stokes	1887
C. spinosulus	New Jersey	Stokes	1887
	Illinois	Robbins	1963
	Illinois	Horlick	1969
C. succinctus	Virginia	Packard	1958
C. tachyneusticus	Michigan	Brunson	1948
	Wisconsin	Rossino	1979

Species	State found	Authority	Date
Chaetonotus trichodrymodes	Michigan	Brunson	1950
	Illinois	Robbins	1963
C. trichostichodes	Michigan	Brunson	1958
	Virginia	Packard	1958
C. vulgaris	Michigan	Brunson	1950
C. zelinkae	North Carolina	Hawkes	1965
	South Carolina	Hawkes	1965
Dasydytes ooeides	Michigan	Brunson	1950
D. saltitans	New Jersey	Stokes	1887
D. monile	Illinois	Horlick	1969
Heterolepidoderma gracile	Illinois	Robbins	1963
	Illinois	Horlick	1969
H. ocillatum	Illinois	Robbins	1963
H. illinoiensis	Illinois	Robbins	1963
Ichthydium auritum	Michigan	Brunson	1950
I. brachykolon	Michigan	Brunson	1947
I. leptum	Michigan	Brunson	1947
I. macropharyngistum	Michigan	Brunson	1947
I. minimum	Michigan	Brunson	1950
I. monolobum	Michigan	Brunson	1950
	North Carolina	Hawkes	1965
I. podura	New Jersey	Stokes	1887
	Illinois	Horlick	1969
Kijanebalola sp.	Louisiana	Krivanek	1960
Lepidodermella squamatum	Washington	Hatch	1939
	Illinois	Goldberg	1949
	Michigan	Brunson	1949
	Illinois	Sacks	1953
	Illinois	Robbins	1963
	North Carolina	Hawkes	1965
	South Carolina	Hawkes	1965

Species	State found	Authority	Date
Lepidodermella squamatum	Illinois	Horlick	1969
	Wisconsin	Rossino	1979
L. trilobum	Michigan	Brunson	1950
Neogossea fasiculata	Louisiana	Krivanek	1958
N. sexiseta	Louisiana	Krivanek	1958
Polymerurus callosus	Michigan	Brunson	1950
P. nodicaudus	North Dakota	Bryce	1924
	New Jersey	Davison	1938
P. rhomboides	New Jersey	Stokes	1887
	New Jersey	Davison	1938
	Pennsylvania	Whitney	1938
	Maine	Packard	1957
	Illinois	Horlick	1969
P. striatus	Wisconsin	Rossino	1979
Stylochaeta curvisetta	Louisiana	Krivanek	1959
S. fusiformis	New Jersey	Davison	1938
S. scirteticus	Michigan	Brunson	1950

Illustrated Plates

Plate 1

Abreviation	Definition
M..................	Mouth
CT.................	Ciliary Tuft
PHL................	Posterior Head Lobe
P..................	Pharynx
ATB................	Anterior Tactile Bristle
IN.................	Intestine
PTB................	Posterior Tactile Bristle
CF.................	Caudal Furca

Generalized structures of a common gastrotrich.

Plate 1

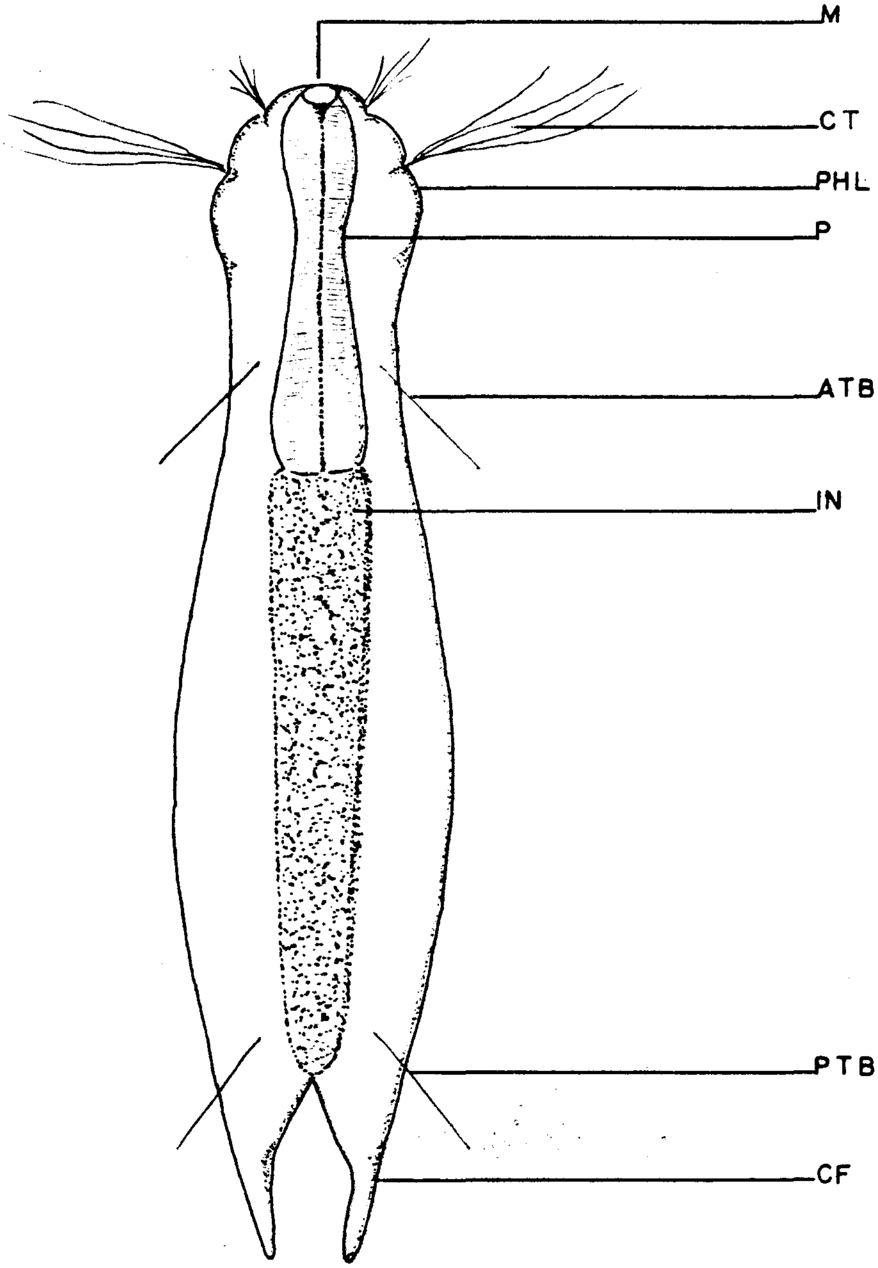


Plate 2

1. Spination of _Stylochaeta_.
2. Spination of _Dasydytes_.
3. Furca of _Polymerurus_.
4. Furca of _Chaetonotus chuni_.
5. Scale and spine from _Aspidiophorus_.
6. Scale and spine from _Chaetonotus_.

Plate 2

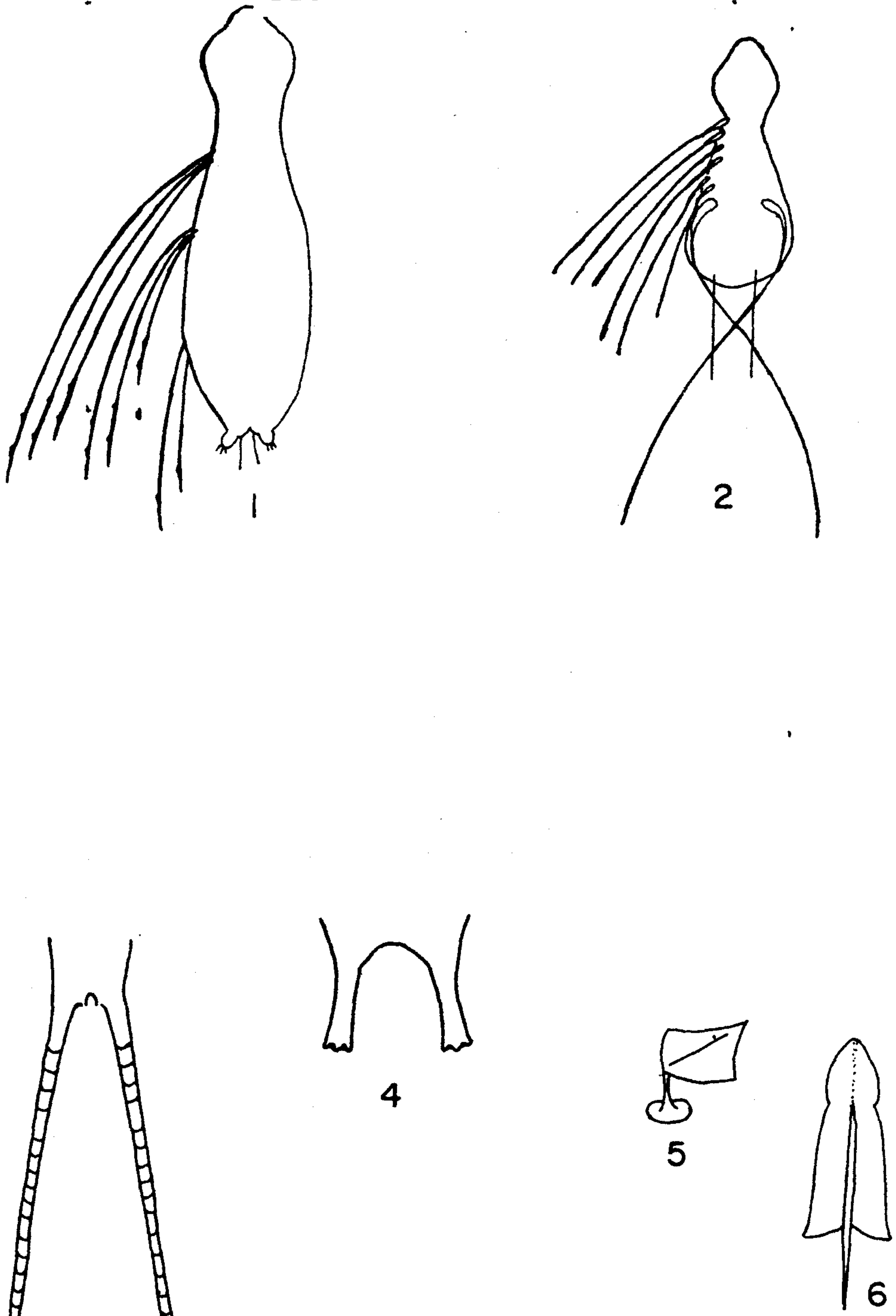


Plate 3

Chaetonotus acanthophorus

Dorsal view

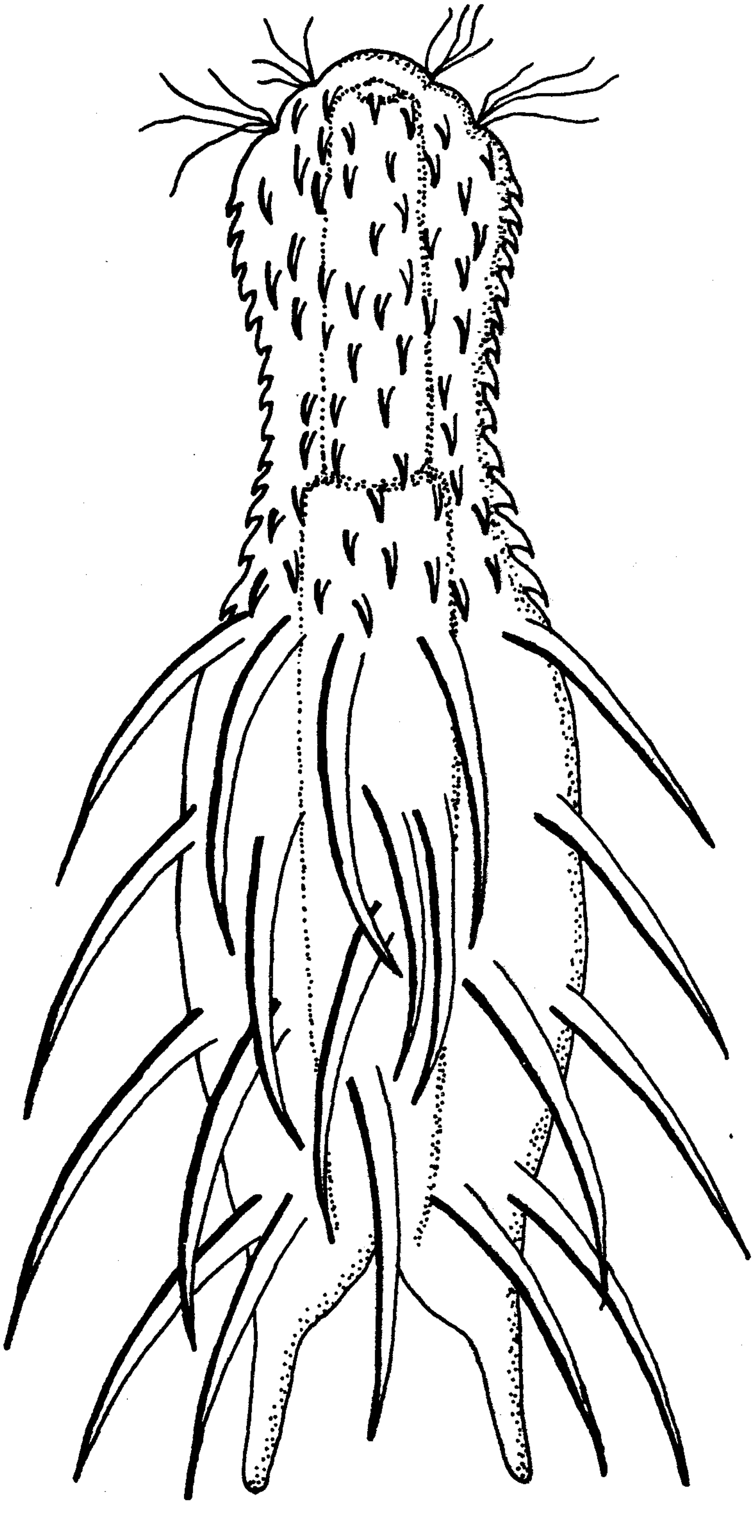


Plate 3

Plate 4

<u>Chaetonotus</u> <u>machrochaetus</u>

Dorsal view

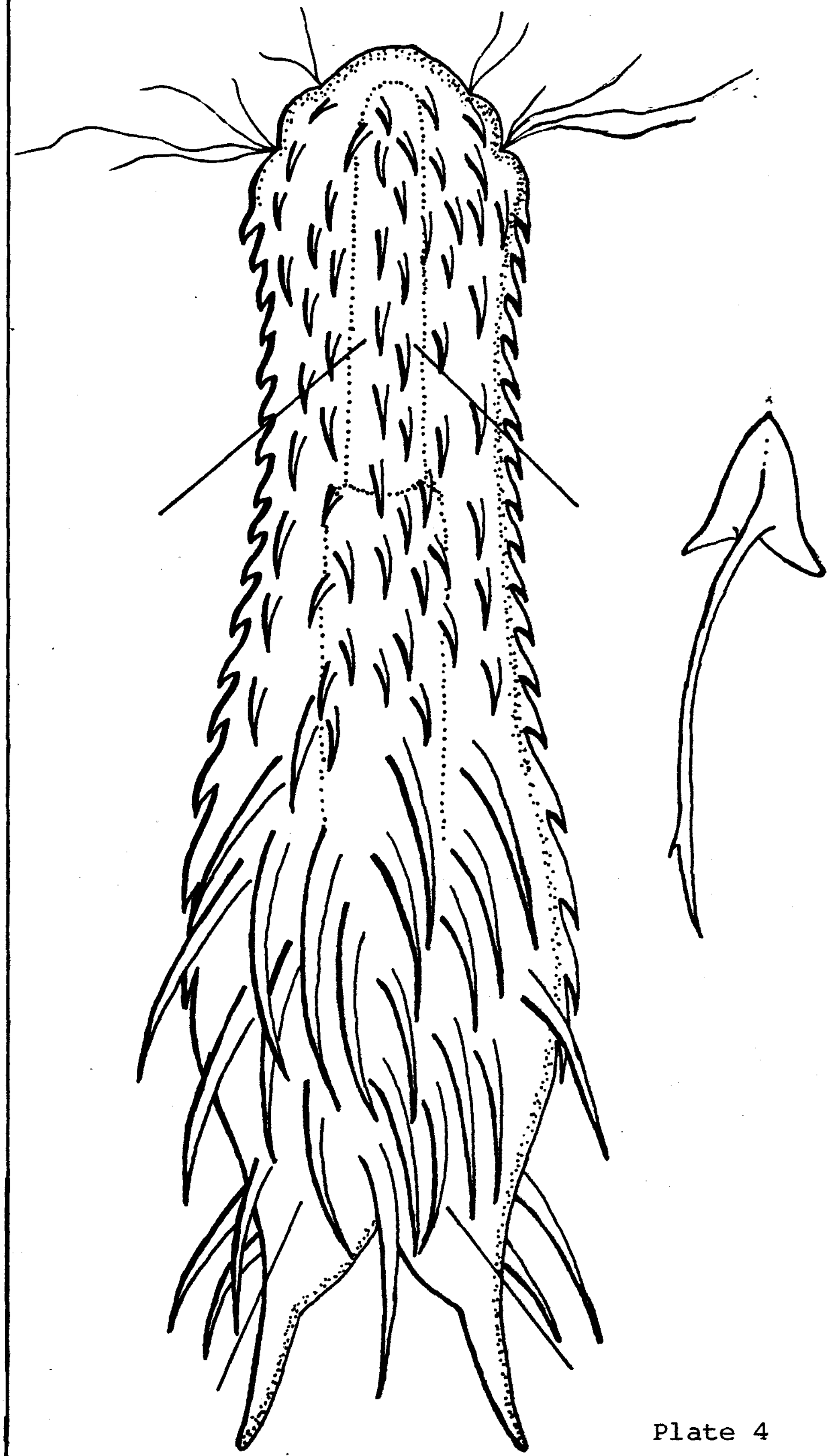


Plate 4

Plate 5

<u>Chaetonotus</u> <u>trichodrymodes</u>

Lateral view.

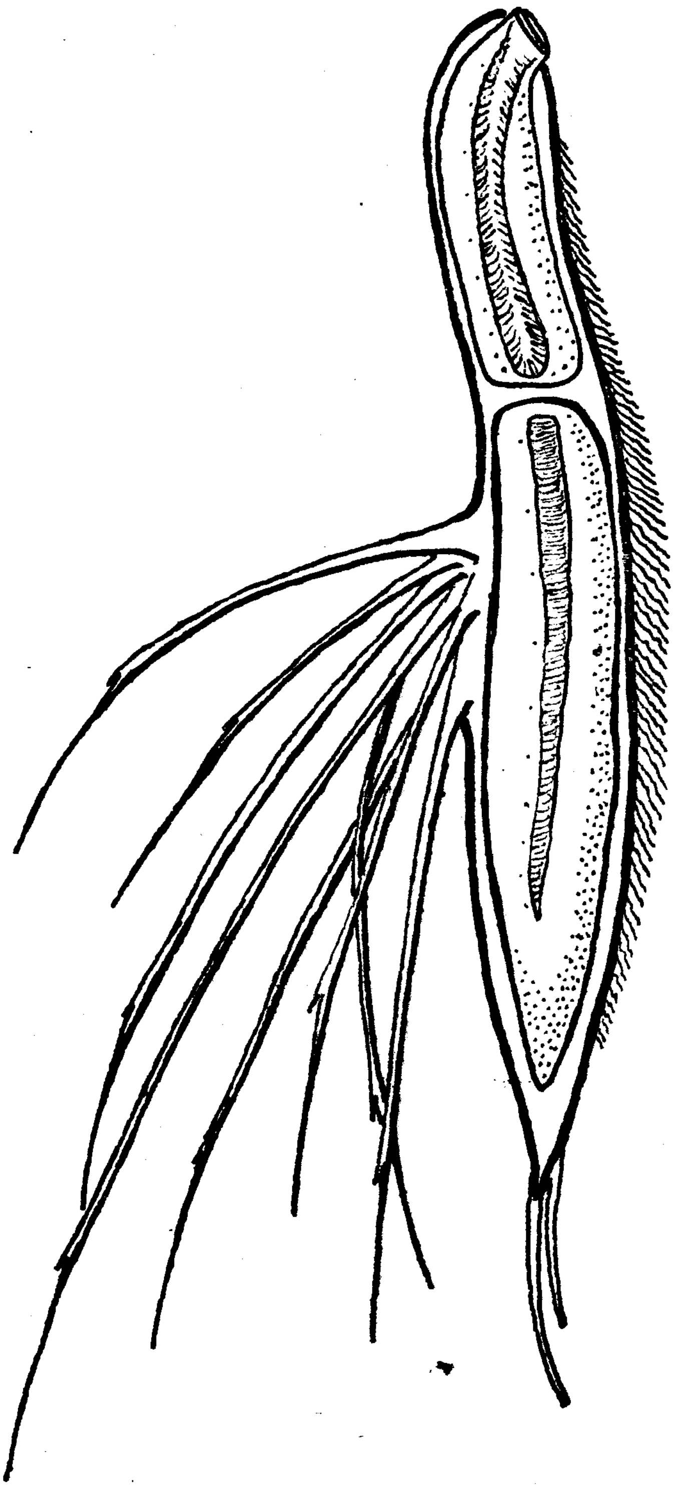


Plate 5

Plate 6

Chaetonotus *wisconsinensis*, n. sp.

Dorsal view.

Spine and scale.

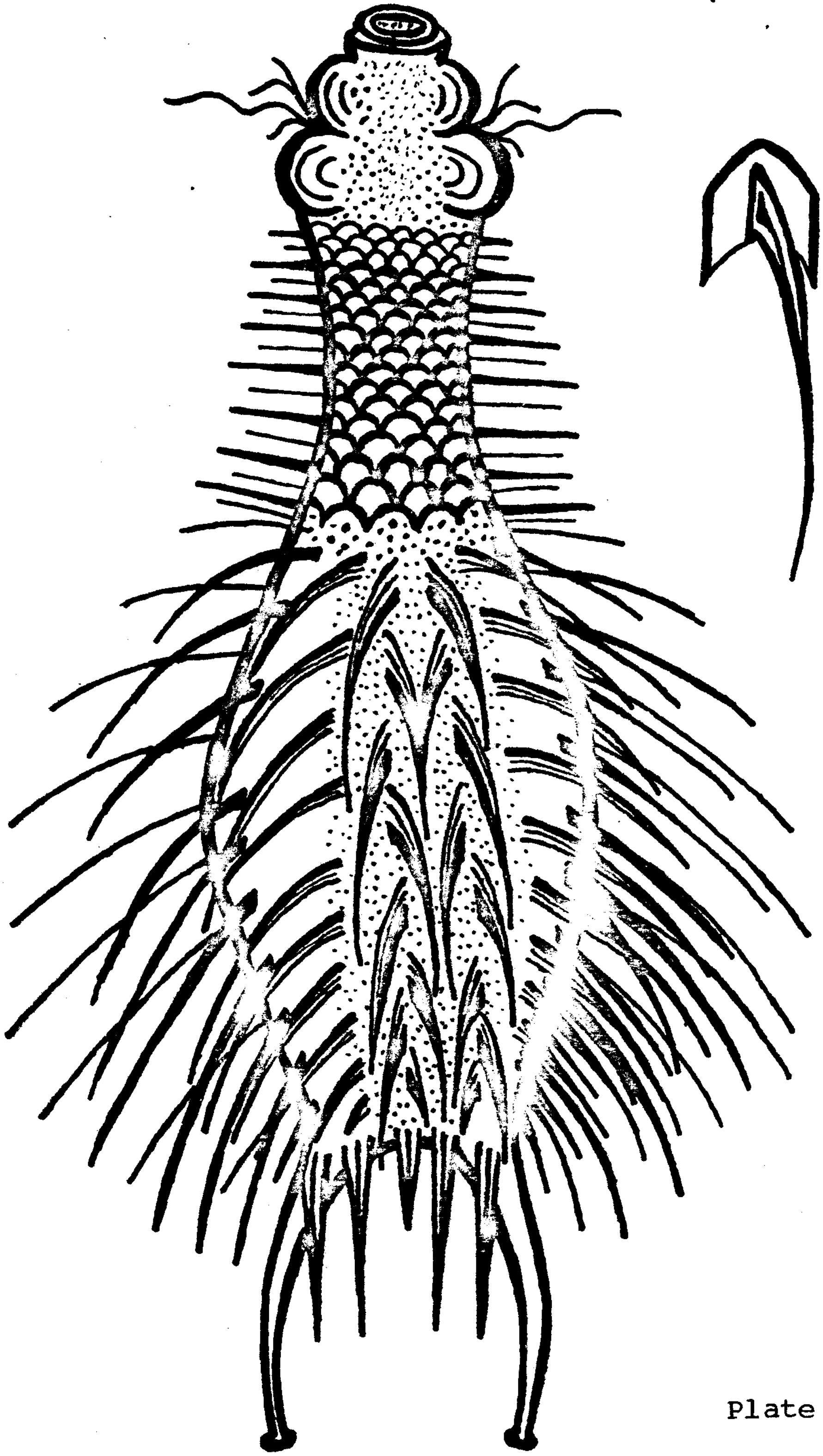


Plate 6

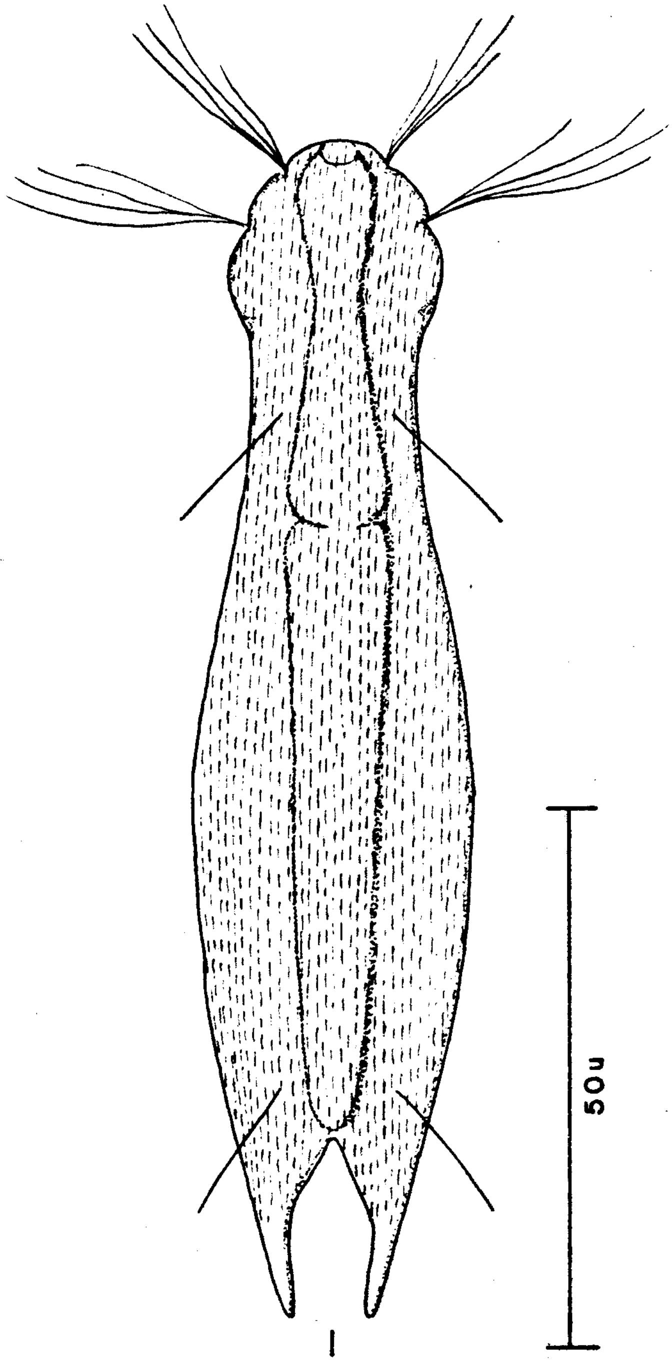
Plate 7

<u>Heterolepidoderma</u> <u>illinoiensis</u>

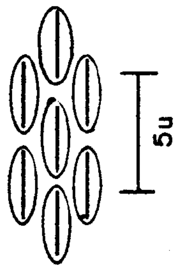
Dorsal view.

Scales.

Plate 7



1



2

Plate 8

Lepidodermella squamatum

Dorsal view.

Scales.

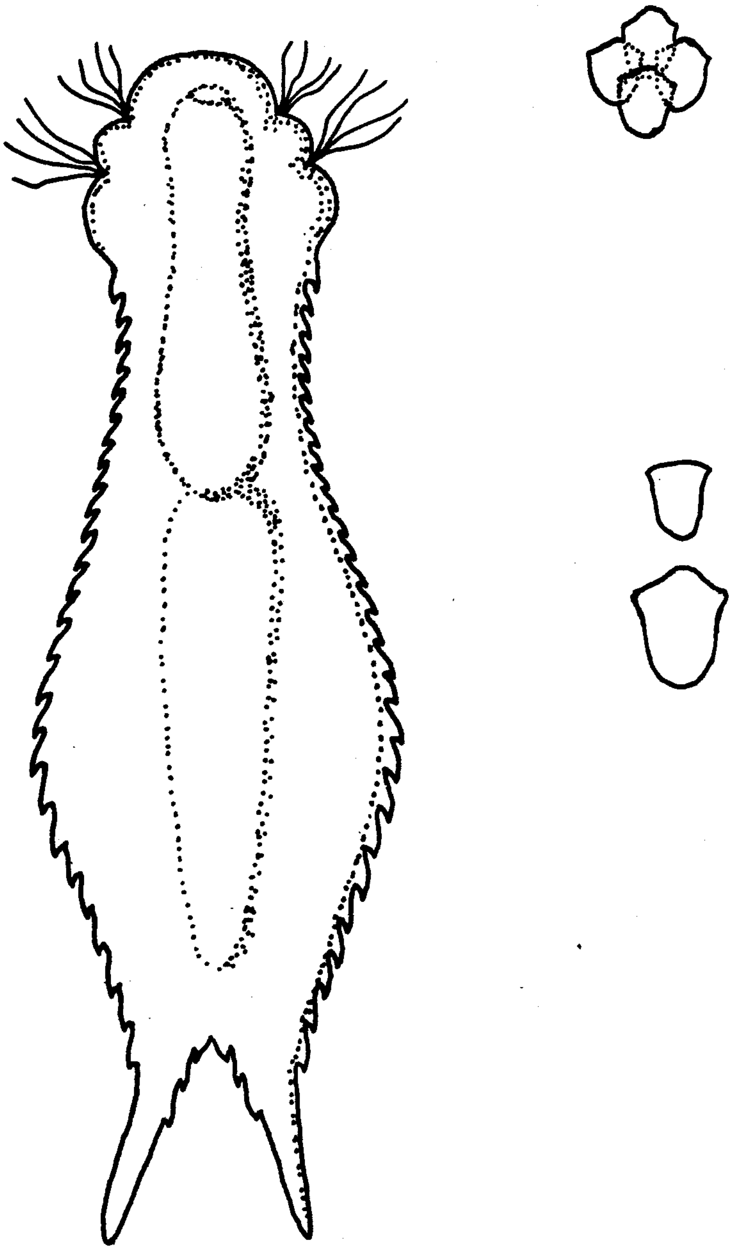


Plate 8

Photographic Plates

Plate A

Chaetonotus acanthophorus

Dorso-lateral view.

Magnification: 1000X.

Plate A

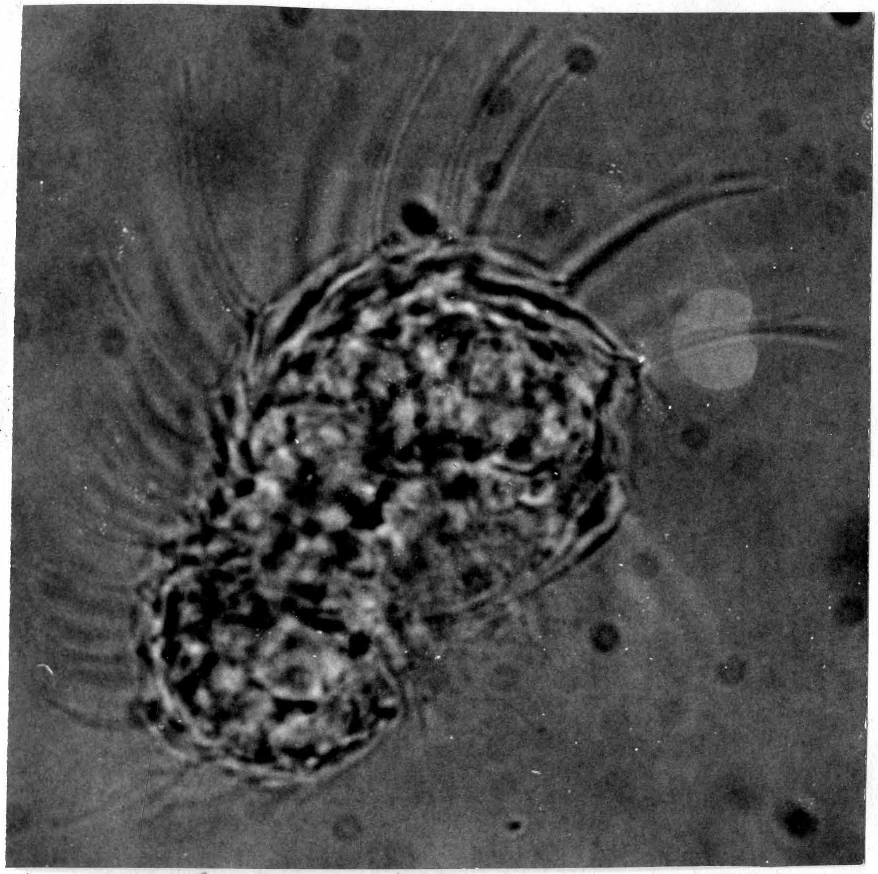


Plate B

<u>Chaetonotus machrochaetus</u>

Lateral view

Magnification: 1000X.

Plate B

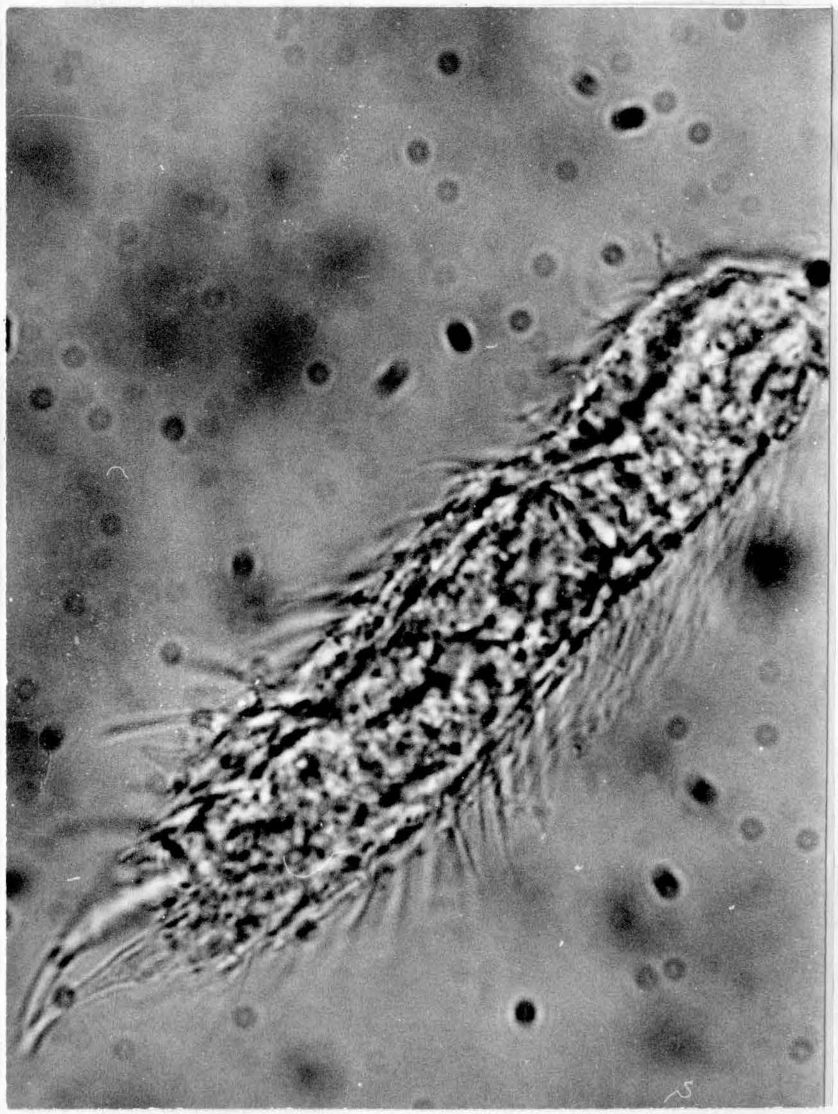


Plate C

Chaetonotus trichodrymodes

Lateral view.

Magnification: 1000X.

Plate C

Plate D

Chaetonotus wisconsinensis n. sp.

Dorsal view.

Magnification: 450X

Plate D

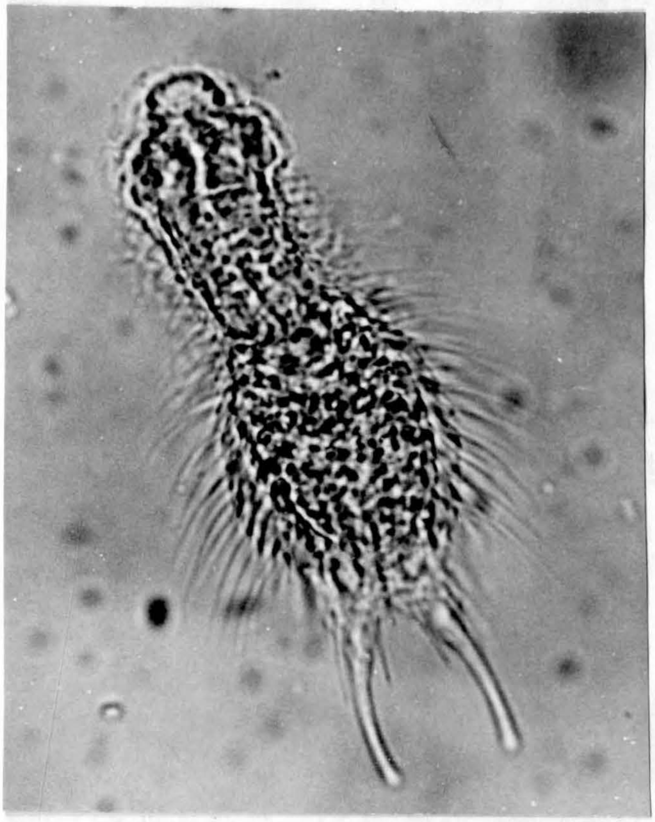


Plate E

Chaetonotus wisconsinensis n. sp.

Dorso-lateral view.

Magnification: 1000X

Plate E

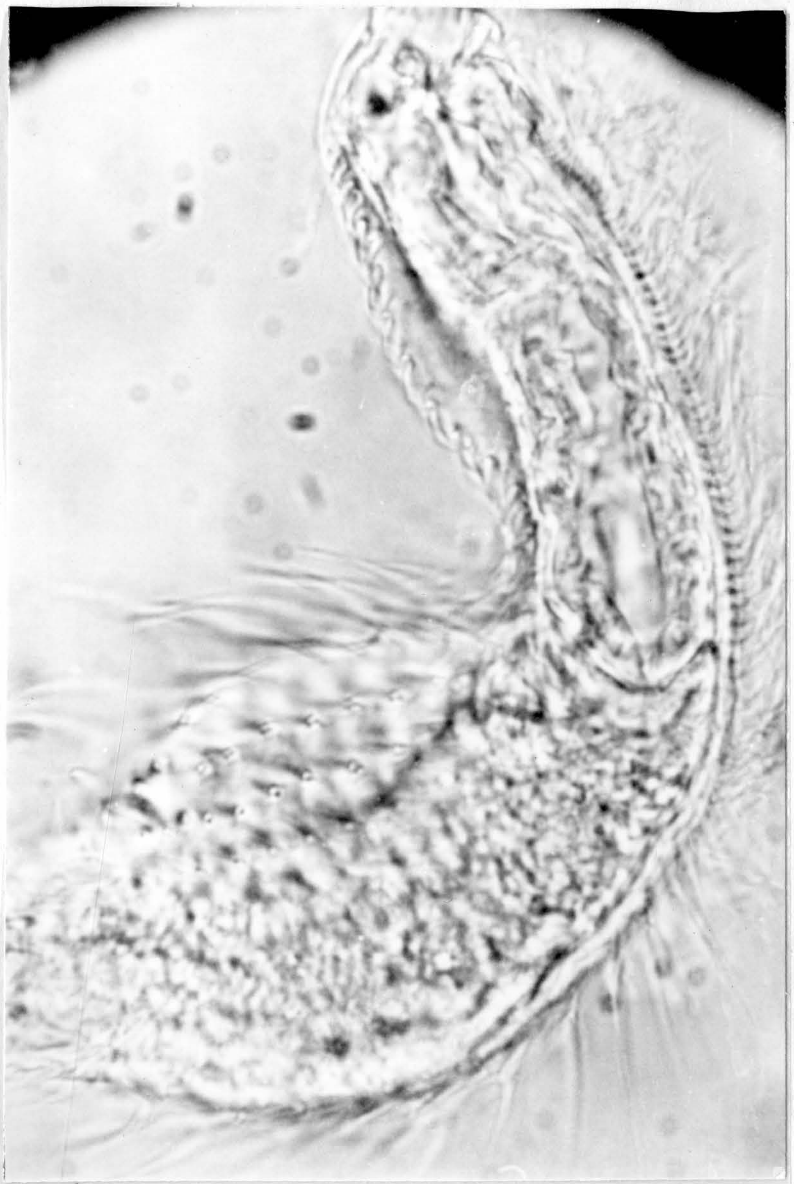


Plate F

Chaetonotus wisconsinensis n. sp.

Dorsal view- neck scales.

Magnification: 1000X

Plate F

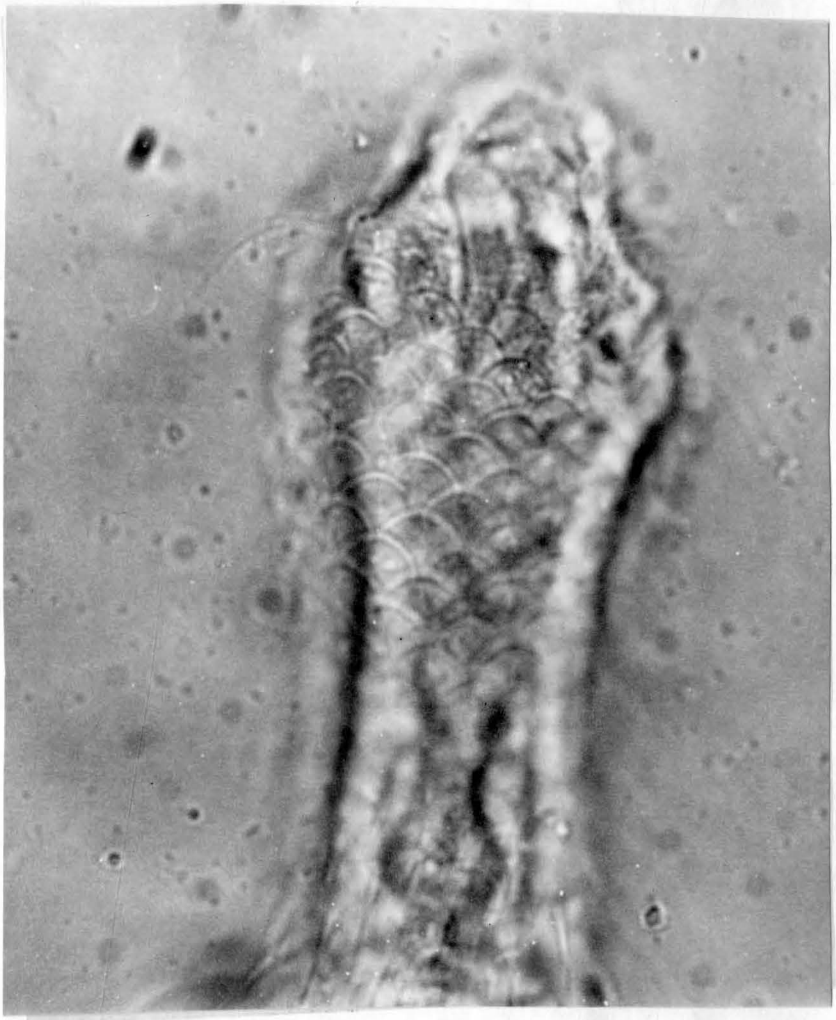


Plate G

Chaetonotus *wisconsinensis* n. sp.

Dorsal view-trunk spines.

Magnification: 1000X

Plate G

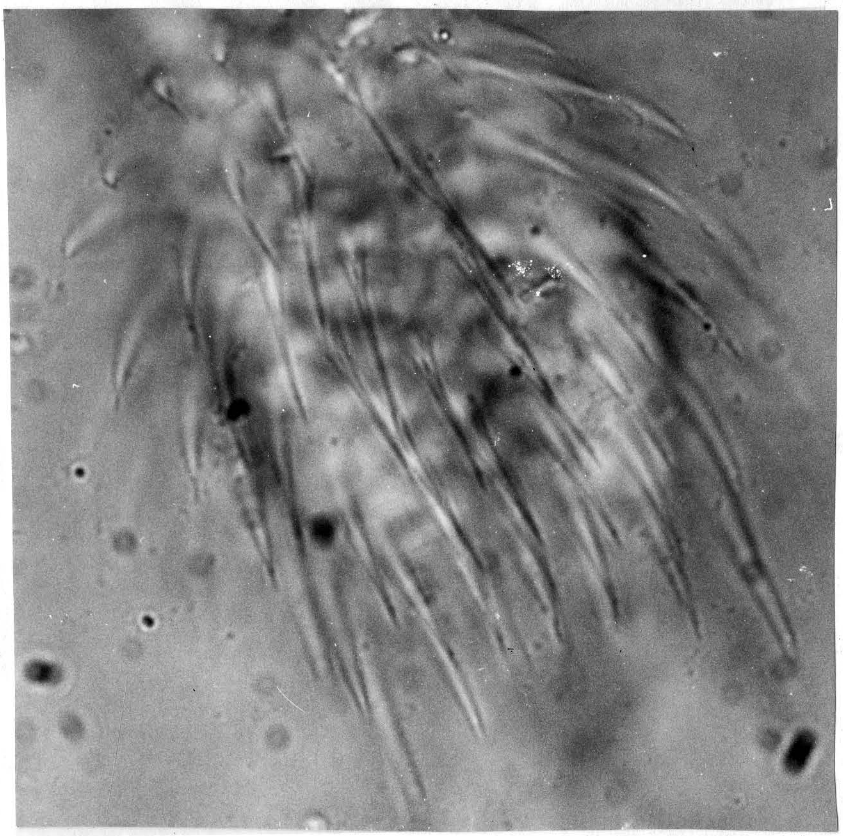


Plate H

Chaetonotus wisconsinensis n. sp.

Dorsal view-caudal furca.

Magnification: 1000X

Plate H

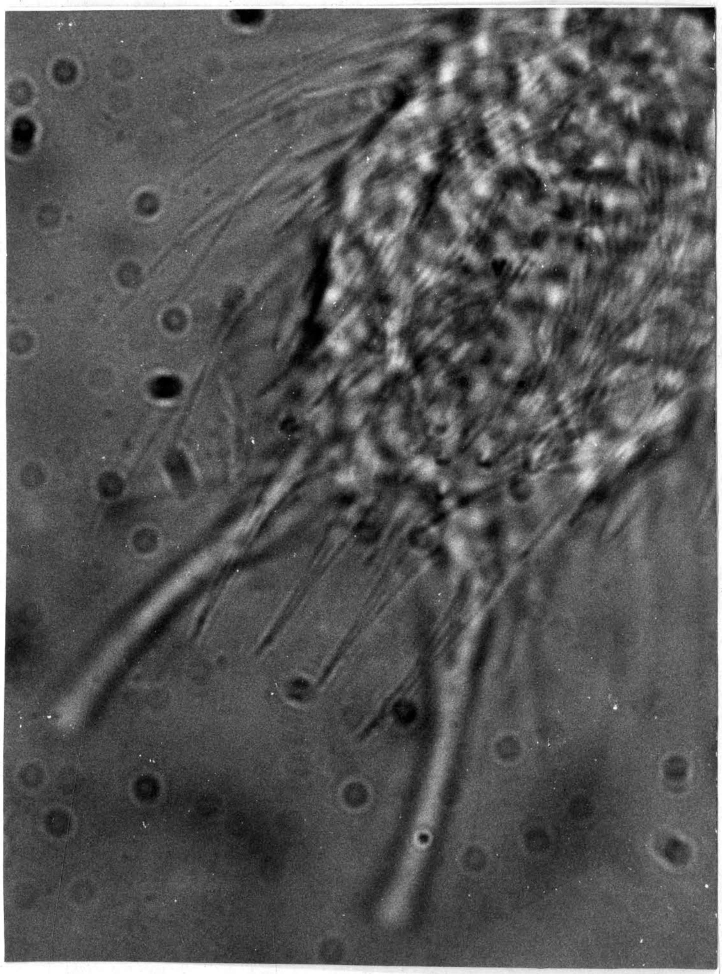


Plate I

Chaetonotus sp. A

Dorsal view.

Magnification: 1000X

Plate I

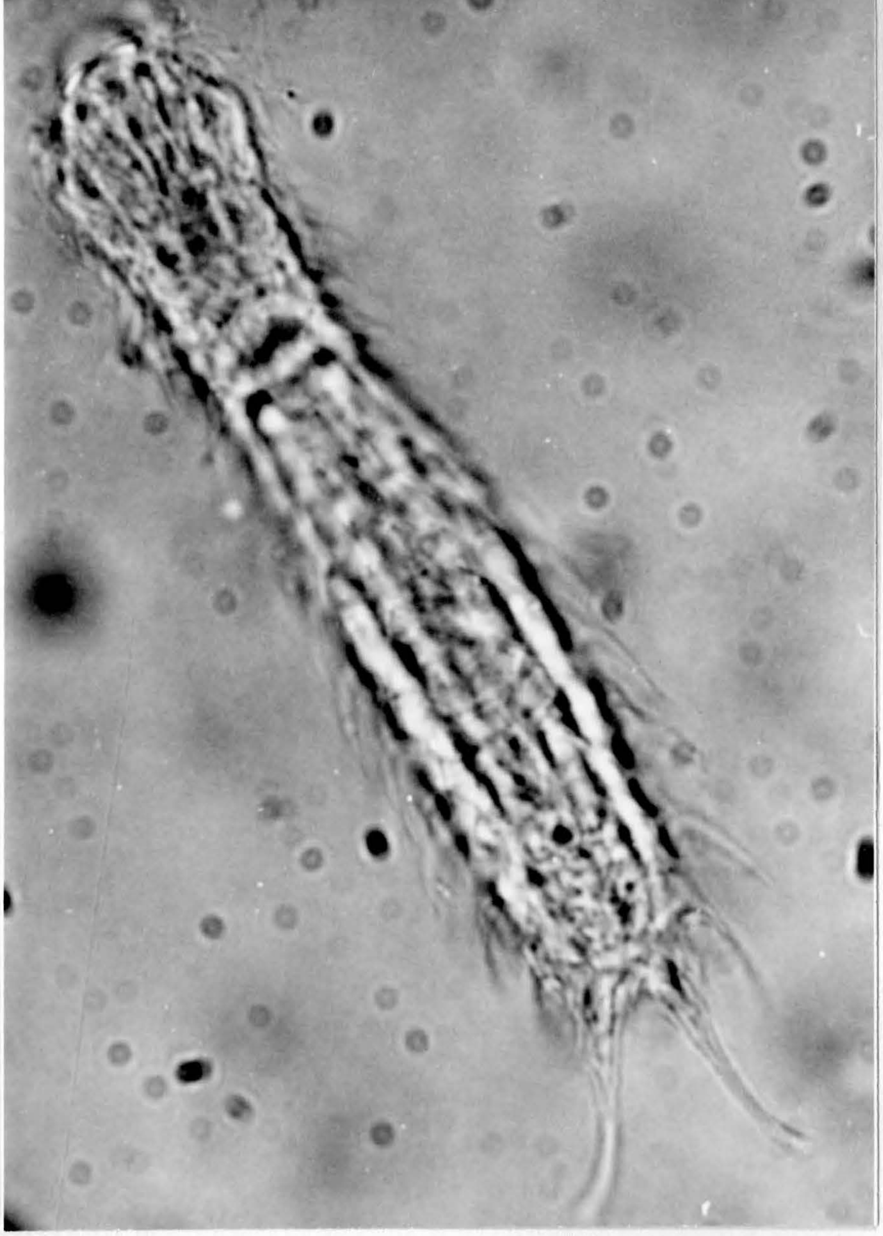


Plate J

Chaetonotus sp. B

Dorsal view.

Magnification: 1000X

Plate J

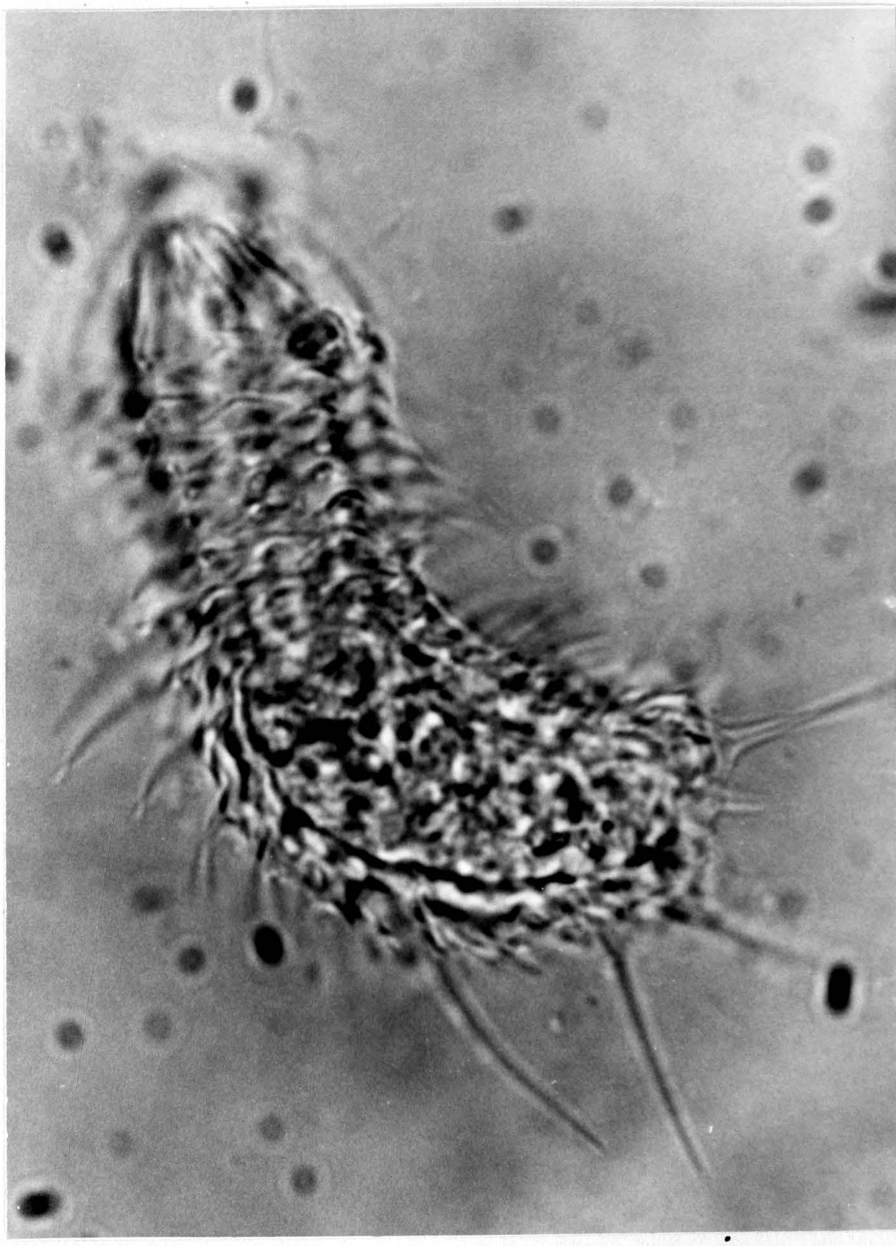


Plate K

Heterolepidoderma illinoiensis

Dorsal view.

Magnification: 1000X

Plate K

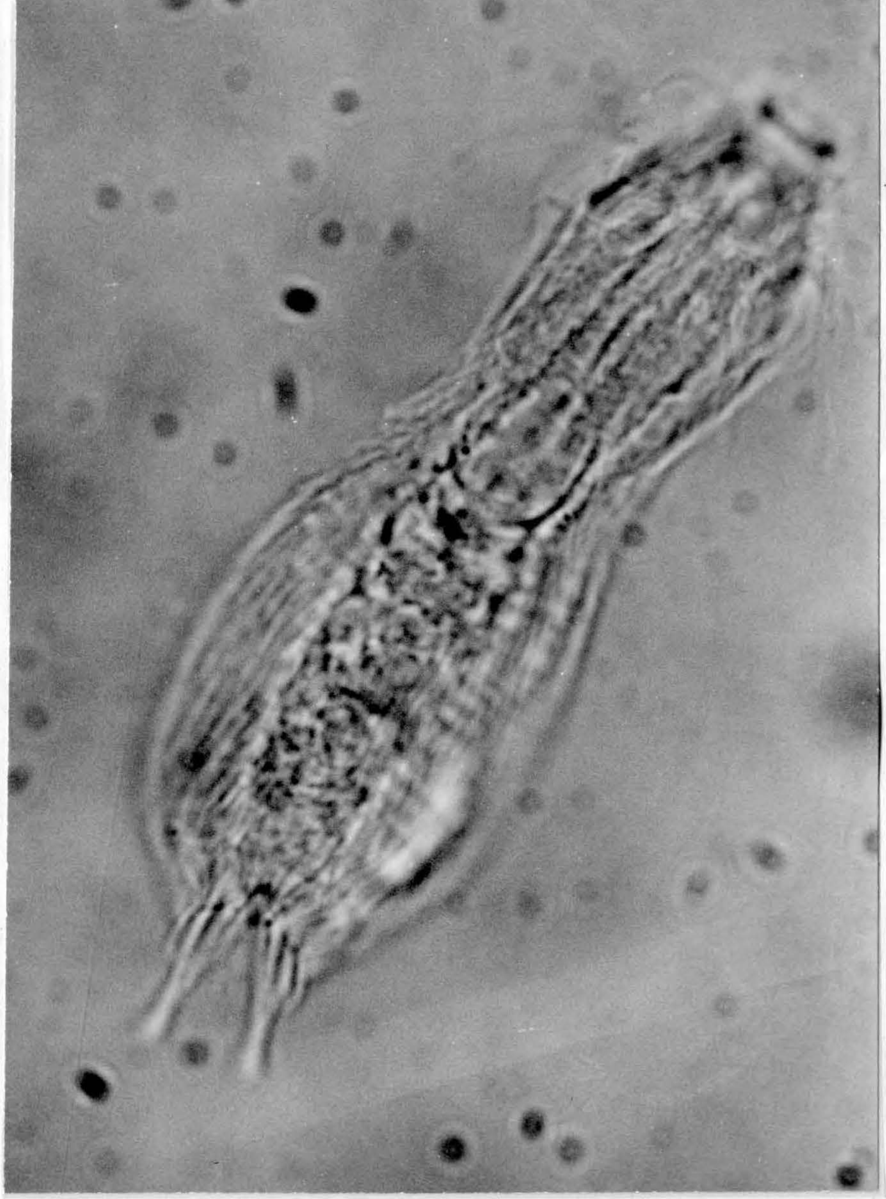


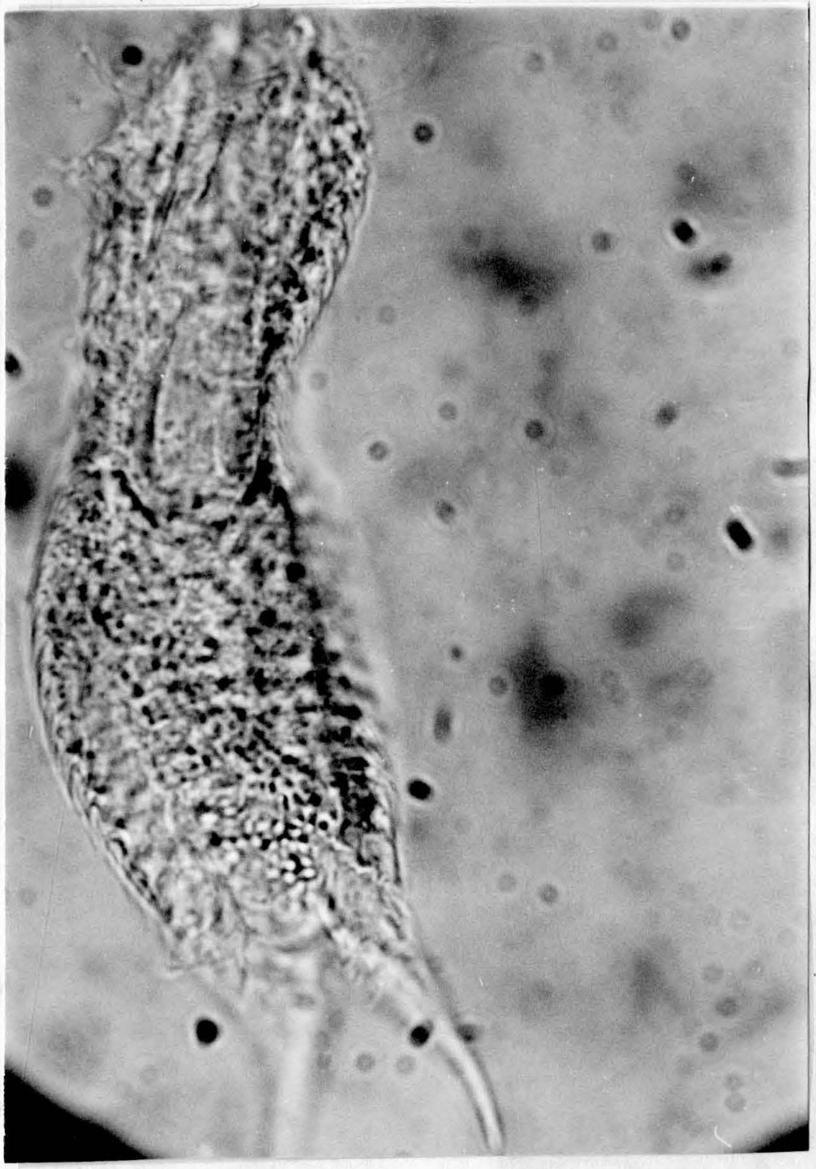
Plate L

Lepidodermella squamatum

Dorso-lateral view.

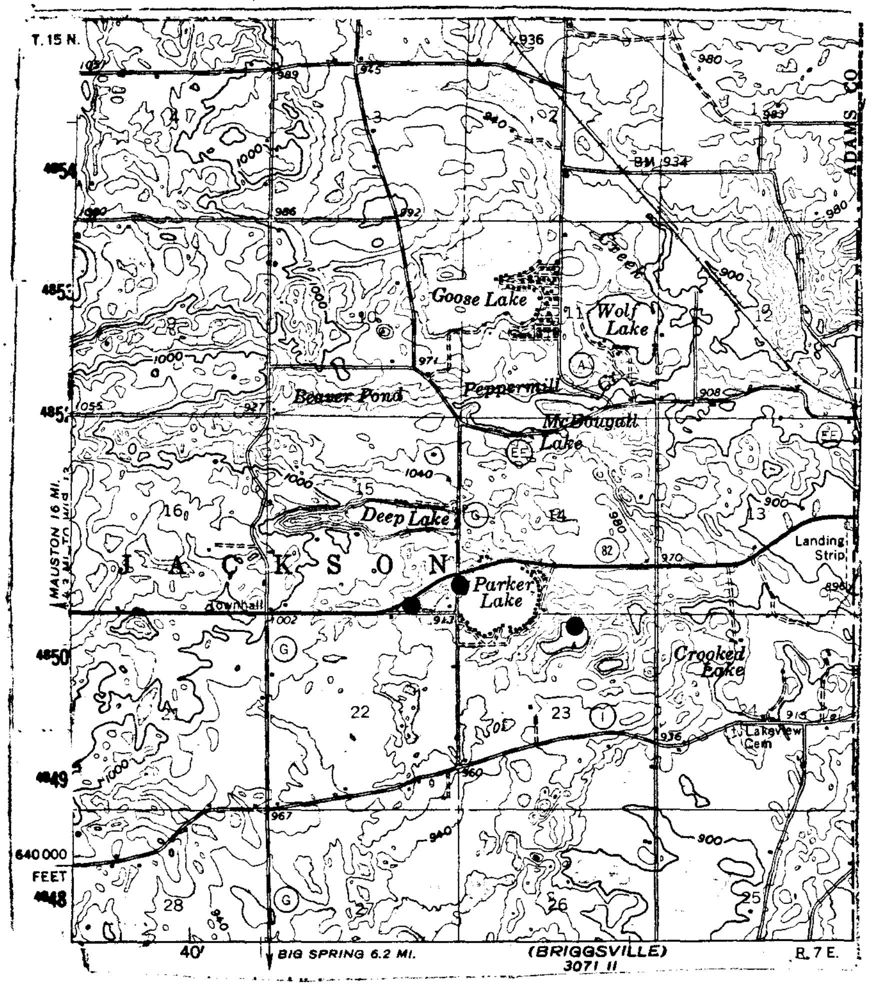
Magnification: 1000X

Plate L



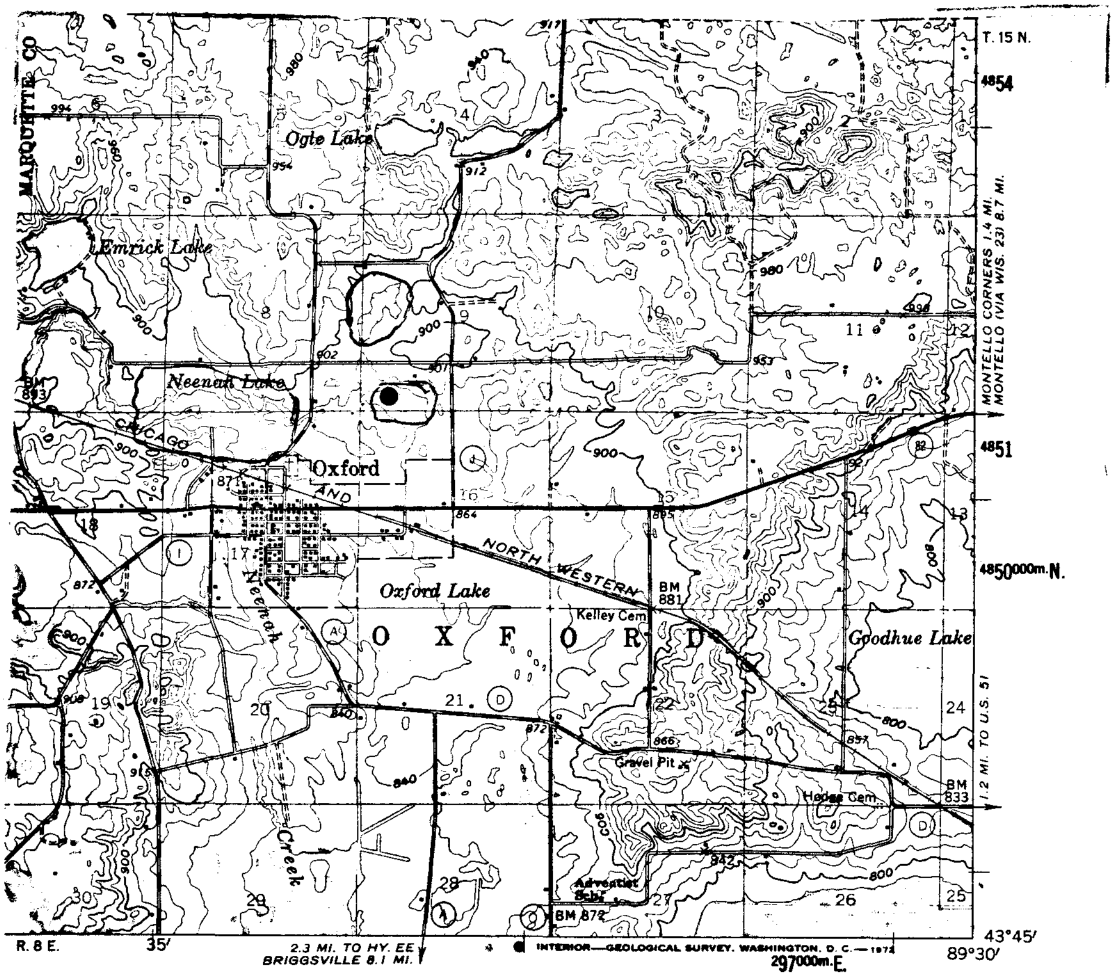
C. Maps.

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY



OXFORD QUADRANGLE
WISCONSIN

STATE OF WISCONSIN



(PORTAGE)
3171 III

ROAD CLASSIFICATION

Heavy-duty .... Light-duty ....

Medium-duty .... Unimproved dirt ....

State Route

QUADRANGLE LOCATION

OXFORD, WIS.

N4345—W8930/15

1961

SCALE 1:62500

1 ½ 0 1 2 3 4 MILES

1000 0 3000 6000 9000 12000 15000 18000 21000 FEET

1 .5 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

APPROVAL SHEET

The Thesis submitted by Joseph L. Zakarija
has been read and approved by the following committee:

Dr. Jan Savitz, Director
Associate Professor, Biology, Loyola

Dr. Edward Palincsar
Professor, Biology, Loyola

Dr. Clyde Robbins
Associate Professor, Biology, Loyola

The final copies have been examined by the director of the thesis and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the thesis is now given final approval by the Committee with reference to content and form.

The thesis is therefore accepted in partial fulfillment of the requirements for the degree of Master of Science.

4/11/80 Jan Savitz

Date Director's Signature