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Rotifers in Lake Itasca

JUDY HELGEN*

ABSTRACT - Rotifers were collected from both the Littoral and Limnetic zones in Lake Itasca, Clearwater County, Minnesota, during two weeks in midsummer. In total, 82 species of rotifers were found, and 69 were identified to species. The littoral zone produced 67 species of rotifers, primarily associated with the aquatic macrophytes. While 35 species were collected in the limnetic zone, only 13 of them were restricted to that habitat. Species are listed by habitat and by type of plant on which they occurred.

Species diversity in *rotifers* can be great, with a typical alkaline lake holding up to 100 different species, and certain acid waters having 250 or more (Pennak, 1953). Although most species are cosmopolitan, there is latitudinal zonation in some of the planktonic *rotifers* in northern latitudes. At present, there are at least 20 species known only from the Americas (Green, 1972). In addition, Lake Baikal in Russia is known to have six endemic species of *rotifers*, and 17 which are not endemic there. Studies in Europe have been reported by Carlin (1943), Voight (1957), and Pejler (1957). In the United States Ahlstrom, Jennings, Haring, Myers and Edmondson have reported on *rotifers* at various times. *Rotifers* generally are thought to play only a minor role in secondary production in lakes, but there are now reports of some *rotifer*-dominated lakes (Larson, 1973; Schindler, 1972; Sorokin, 1972).

This report consists of a preliminary survey of the *rotifer* fauna of Lake Itasca, Minnesota, made from July 21 to August 2, 1974, from the University of Minnesota Field Biology Station at the lake. The calcareous till left by the glaciers has resulted in the larger lakes having high alkalinity, with a pH in surface waters commonly above 8.0 (Meyer and Brook, 1968), and a total alkalinity ranging over 3.0 meq acid/liter for Lake Itasca. Itasca has an extensive littoral area, which is the result of its shallow depth (median depth 5.5m) and an extensive shoreline of 21.9 km. That and its surface area of 441 hectares results in a shoreline development of 3.0.

Sampling sites are indicated on the map of Lake Itasca, Figure 1. Included are sites in the open water as well as in the littoral. Since the aim was to survey the kinds of species present in the lake and their habitats, the methods used were entirely qualitative. Plankton tows through the vegetated littoral area as well as the open water or limnetic zone were made, using a standard Turtox plankton net whose average pore size was 50 microns. Squeeze samples were taken from macrophytic plants and algae. In the limnetic zone various lake depths were sampled using a 2-liter Van Dorn water sampler, with 6 liters sampled at each level. In all, 60 samples were studied, the species being drawn and

measured alive with an ocular micrometer. The loricas of the *Keratella* spp. were best observed on specimens dissolved with dilute Chlorox, or cleared by bacterial degradation overnight. This permits observation of the distinct pattern of plates on the lorica. References used for the identifications are included in the bibliography. Particularly useful are the works by Edmondson (1959), Voight (1957, Haring and Myers (1921, 1924, 1926, 1927; and 1929), and Ahlstrom (1943). No comprehensive report on the *rotifers* of Minnesota was found, although some species are listed in zooplankton studies by Hellberg (1948) and Comita (1972).

Of the 82 species observed, 69 were identified to species. Of the total of 38 genera found, there were 22 genera with one species only, 10 genera with 2 species, 1 genus with 3 species (*Lepadella*), 1 with 4 (*Polyarthra*), 1 with 5 (*Keratella*), 1 with 6 species (*Monostyla*), and 2 with 10 species each, *Cephalodella* and *Trichocerca*. All the species and their habitats are listed in Table 1, and illustrated in Figures 2, 3, and 4. The limnetic species are listed in Table 2. Of those species, 35 were found in the limnetic zone and 29 were taken by plankton tows through the littoral area. In the littoral plant squeezes, 67 species were collected.

There was species overlap among the habitats; for instance, of the 35 species found in the limnetic zone, only 13 were found there; while 6 occurred also in the littoral area water, and the rest, 16, were collected in plant squeezes as well as in littoral and limnetic waters. This fits with Pejler's (1957) observation that in eutrophic waters in Sweden, species of the littoral zone may be found in the open water. In oligotrophic lakes, these same species may be confined to the littoral area. An example in Itasca would be the occurrence in the limnetic zone of *Rotaria* sp., which, although it can swim using its corona, is basically a creeping form.

Of the 67 species found in the littoral plant samples, 40 were only in the plant squeezes and were not found in the plankton tows. Of the plant-associated species, nine were found only there—*Polyarthra* euryptera and *Tylotrocha* monopus. It appears that the rotifers found in the littoral water are composed of those moving off the plants (9 species) plus those from the limnetic zone (6 species).

The greatest diversity of rotifers is associated with the aquatic macrophytes which included *Ceratophyllum demersum* L., *Potamogeton pectinatus*, *P. zosteriformis*, *Lemna trisulca*, *Chara* sp., *Najas flexilis*, *Zizania aquatica* *Nuphar* spp., *Nymphaea* sp., and *Cladophora* sp., *Chaetophora* sp.,

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Spirogyra sp., Gloeotricha sp. (epiphytic on Potamogeton sp.), and occasional small floating masses of mixed algae which contained Lyngbya sp., Gloeotricha sp., Gomphonema sp., Cymbella sp., Tabellaria sp., Navicula sp., Fragillaria sp., Closterium sp., Staurastrum sp., many ciliates and flagellates, and up to 11 species of rotifers per mass. Scirpus sp. stems had a poor fauna. The fauna of the plants are listed in Table 3. Although Edmondson (1944) found a poor fauna of sessile rotifers on Ceratophyllum sp., there is a substantial fauna when all types are considered. The growth of the colonial blue-green alga Gloeotricha sp. was extremely abundant on P. pectinatus, and Ptygura melicerta var. mucicola was found only within colonies of Gloeotricha sp. The association of this rotifer with Gloeotricha sp. has been noted by Edmondson (1944). Monostyla quadridentata may be associated with Ceratophyllum sp., as it was collected only from this plant, or from mixed plant squeezes containing large amounts of Ceratophyllum sp.

Certain species of rotifers occurred primarily near the bog shores, the West shore bog directly across from the Itasca Biology Station and the shore in Floating Bog Bay: Euchlanis dilatata, Monostyla bulla, M. furcata, Mytilina ventralis var. brevispina and var. macracantha, Trichotria pocillum, Lepadella erhenbergii, Diplois daviesae, and Scaridium longicaudum were more often found there. These species, except for those of Monostyla and Scaridium, were found by Pejler (1962) in benthic mud samples. On the bottom, the rotifers attach by the foot and swing around in the water.

The genus Trichocerca is noteworthy in that at least 10 species are present in the lake. The planktonic forms T. cylindrica and T. multicrinis were fairly common in the limnetic zone and, except for one specimen, were not found associated with the plants. With the exception of the rare species T. tigris which occurred only in the limnetic zone, the rest of the species were collected in plant samples. Members of the genus Trichocerca have a virgate mastax capable of piercing, pumping and swallowing, and are described as predatory (Pennak, 1953). Trichocerca cylindrica in Lake Itasca had a body length ranging from 367-399 microns, much larger than the 260-310 microns range reported by Jennings (1903), based on reports from the U.S. The maximum length of T. cylindrica in Canada is 866 microns (Chengalath and Fernando, 1973), in Itasca it was 714, and in more southern locations, it measures 680 microns maximum length. In Itasca, the average length of T. bicuspes was 252 microns, compared to Jennings' (1903) report of 120 microns. While the larger size of these two species does suggest a size increase to the north, lengths of the other rotifers in the study were well within the ranges given in species descriptions.

The 10 species of the genus Cephalodella occurred entirely in the littoral area in the plant samples. Two species, C. catellina and C. forficata, were observed as predators. Cephalodella catellina consumed a nematode twice its body length in less than 2 minutes, and C. forficata attached and killed a specimen of Ptygura. Pennak (1953) lists Cephalodella as omnivorous, as are members of the genera Filinia, Keratella, Lecane, Proales, Euchlanis, Epiphanes, and Brachionus. Predatory species are in Asplanchna, Dicranophorus, Ploesoma, Synchaeta, Trichocerca, Cupelopagus, Acyclus, and Atrochus. The saclike Asplanchna sp. was once seen with 13 Keratella sp. inside, and once with 6 Lecane sp., but typically, it contained 1 or 2 rotifers.

While Pejler finds Conochilus unicornis in oligotrophic water in Sweden, it was abundant in Lake Itasca, which is not oligotrophic. This colonial planktonic rotifer feeds on particles under 10 microns; Pejler suggests that it could exclude Keratella cochlearis which also uses small particle food (Pejler, 1957). In this survey, Conochilus unicornis was abundant while K. cochlearis was collected infrequently, but this is not direct evidence that competitive exclusion is taking place. There are other factors which could cause the midsummer crash of the K. cochlearis populations such as predation or negative exclusion of algae (see Edmondson, 1965). The dominant species of Keratella in Lake Itasca was Keratella crassa, a larger, more robust species, found only in North America. Table 4 shows a comparison of the average lengths. Keratella crassa is the deepest bodied of all the Keratellas, and can be recognized by its distinct pattern of 5 and 7-sided plates on the lorica (Ahlstrom, 1943).

Keratella cochlearis was found usually in the littoral tows and plant squeezes, and only once was collected in the limnetic zone. Keratella cochlearis is one of the most widely distributed and common rotifers, and a truly planktonic species. In samples taken both mid-lake and from the shore from several lakes, Pejler consistently found K. cochlearis only mid-lake (Pejler, 1957). It is interesting that, while the main population of K. cochlearis in Lake Itasca is probably in its midsummer crash, some individuals have survived in the littoral zone. On the other hand, K. crassa was commonly found in the limnetic zone. It was collected only once in a littoral tow, and once in a plant pour. This larger-bodied form may have an advantage over K. cochlearis in being able to consume larger food particles as well as avoid some size-selective predator. Perhaps Conochilus unicornis is effectively competitively excluding K. cochlearis, and the success of K. crassa in its presence is based on a ability to take larger food.

It has been suggested from a study of Severson Lake in Minnesota that the midge larva Chaoborus sp. may suppress K. cochlearis (Comita, 1972). Chaoborus was plentiful in Itasca, and it would be of interest to know if it preys more on K. cochlearis than on the larger K. crassa. Allan (1973) found that Chaoborus sp. preferred smaller cladocerans like Bosmina (330 microns) over the larger cladocerans and copepods (around 790 microns), and Dodson (1974) suggests that midge larvae prefer cladocerans. In view of this, it seems likely that K. crassa (206 microns) would be preyed upon as much as K. cochlearis (133 microns) unless predation continues to increase with decreasing size of prey.

No specimens of the common genus Brachionus were found, which supports Lindeman's (1939) statement that, although the genus is confined to alkaline water, it avoids lakes with a thermocline, and prefers shallow waters. In July, there were no specimens of Notholca, a genus restricted also to alkaline waters and characteristic of more northern areas. However, Notholca sp. was abundant in Lake Itasca in May, which points up the need to sample all year to know the entire fauna. On the basis of the relative lengths of the appendages, the species of Filinia in Lake Itasca is designated F. limnetica. The entire genus needs clarification. The specimen of Macrochaetus differs greatly from the 7 described species. It is probably a new species from Itasca, and needs description.

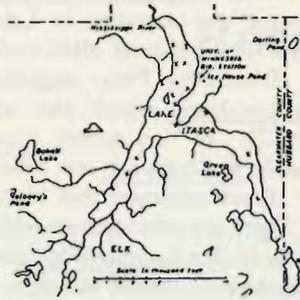
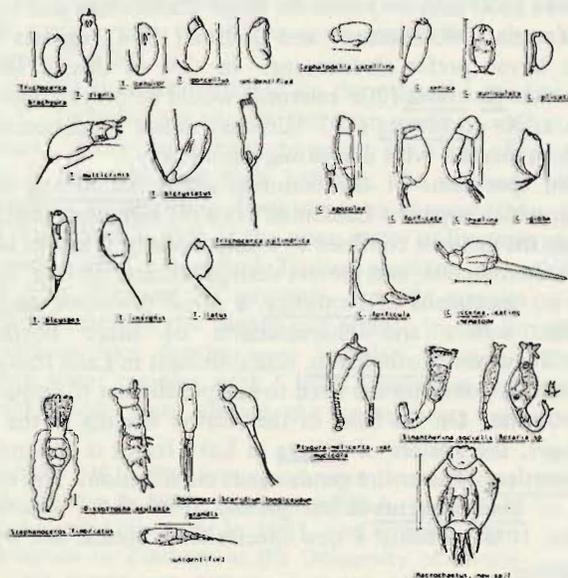


Figure 1

Lang's eutrophy indicators: *Brachionus* spp., *Trichocera capucina*, *Filina longiseta*.
 Carlin's eutrophy indicators: *Trichocera birostris*, *Euchlanis dilatata**, *Trichocerca porcellus**, the latter two euplanktonic.
 Thunmark's: *Brachionus angularis*, *T. cylindrica**, *T. pusilla*, *P. euryptera**, *Pompholyx sulcata**.
 Berzin's: *B. angularis* f. *angularis* and f. *bidens*, *B. quadridentatus* f. *quadridentatus*, *B. urceus*, *Keratella quadrata* f. *quadrata*, *Anuraeopsis fissa*, *T. capucina*, *T. pusilla*, *Pompholyx complanata*, *P. sulcata**, *Filinia longiseta*, *F. terminalis*.
 Lillieroth's: *B. angularis* f. *bidens*, f. *chelonis*, *B. calyciflorus* f. *calyciflorus*, f. *amphiceros*, *T. cylindrica**, *P. euryptera**, *Pompholyx sulcata**.
 Pejler's: *Brachionus angularis*, *Keratella quadrata**, *Pompholyx sulcata**. It should be noted that Carlin's designation of *Euchlanis dilatata* and *Trichocerca porcellus* as truly planktonic does not hold in Lake Itasca during the time of the study, since these two species were collected only in the littoral. From the above lists, it can be seen that, if the *Brachionus* species are removed, many of the other species occur in Lake Itasca. In addition, it is quite likely that further studies will reveal more species of the genus *Trichocerca*, since 10 species were collected in two weeks, and some remain unidentified.

Figure 2. Rotifers of Lake Itasca. Scale = 100 microns.



A later list given by Pejler (1964) included the following rotifers: *Proalides tentaculatus*, *Brachionus angularis*, *Anuraeopsis fissa*, *Trichocerca cylindrica**, *T. pusilla*, *Polyarthra euryptera**, *Pompholyx sulcata**, *Filinia longiseta*, *Trichocerca cylindrica*, however, have been found to be common in some oligotrophic lakes in Canada (Schindler and Noven, 1971) which points up further the need to study the habitats and ecology of rotifers in North America.

Future studies could include an elaboration of the seasonal abundance of the important species through the entire year, as well as predators and competitors for the same size food. *Chaoborus* predation needs more study. It might be informative to classify available food on the basis of particle size, relating this to determined sizes of food taken by the species studies, as well as filtering rates. Selective feeding would have to be determined in culture, perhaps using in situ culture in the lake. An interesting autecology study would be a search for seasonal selection of genotypes in one species of these rapidly reproducing organisms, for instance, a study of reproductive fitness of specimens taken from one or various habitats through the year.

Various authors have presented lists of species which are called indicators of eutrophic conditions. The variability in the following lists could be well caused by many kinds of lakes which fall under the term "eutrophic" and the ultimate individuality of each lake system. It would be more meaningful to categorize lakes on the basis of a limited number of factors, such as alkalinity, annual productivity of the algae, extent of the macrophyte beds, depth and dissolved oxygen in the bottom water. Then the species of *Brachionus*, for instance, could be classed as indicators of alkaline water as well as of water shallow enough not to have a thermocline. According to Pejler (1957), species which avoid highly eutrophic water are: *Ascomorpha ovalis*, *Asplanchna herrecki*, *Synchaeta grandis*, and *Ploeosoma hudsonij*. The following lists by European workers are taken from Pejler (1957). The species which are starred are found in Lake Itasca, which is just deep enough to have a thermocline and which, with much caution, might be considered a moderately eutrophic lake.

Figure 3. Rotifers of Lake Itasca. Scale = 100 microns.

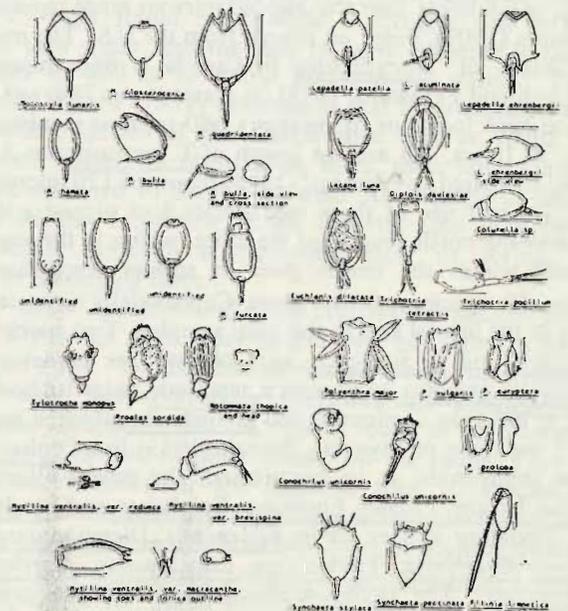


TABLE 2. Species of rotifers found in limnetic water and not usually in plant samples. Those also found in the water of the littoral are starred.

Ascomorpha sp.	Macrochaetus,
*Asplanchna sp.	Ploesoma hudsonii
*Chromogaster testudo	Ploesoma truncatum
*Conochilus unicornis	Polyarthra major
Filinia sp.	Polyarthra vulgaris
*Filinia limnetica	Pompholyx sulcata
Gastropus hyptopus	Synchaeta pectinata
Gastropus stylifer	*Synchaeta stylata
Kellicottia longispina	*Trichocerca cylindrica
**Keratella crassa	**Trichocerca multicrinis
Keratella gracilentia	Trichocerca tigris

** *Keratella crassa* and *Trichocerca multicrinis* were common in the limnetic zone. They were found infrequently in the plant samples.

TABLE 3. Rotifer fauna of the plant samples from Lake Itasca. (Total number of species in parentheses).

Potamogeton pectinatus (16)	Ceratophyllum demersum (14)	Nuphar sp. (14)
Cephalodella apocolea	Colurella sp.	Cephalodella sp.
C. catellina	Lepadella patella	Colurella sp.
C. plicata	L. ehrenbergii	Filinia sp.
C. xenica	Monommata grandis	Keratella cochlearis
Euchlanis triquetra	Monostyla closterocerca	Lecane sp.
K. cochlearis	M. hamata	Lepadella ehrenbergii
Lecane luna	M. lunaris	L. patella
Lepadella sp.	M. quadridentata	Monostyla closterocerca
Monostyla lunaris	Philodina sp.	Philodina sp.
Mytilina ventralis var. brevispina	Platylas patulus	Platylas patulus
Philodina sp.	Proales sordida	Rotaria sp.
Polyarthra proloba	Rotaria sp.	Testudinella patina
Rotaria sp.	Testudinella patina	Trichocerca brachyura
Scaridium longicaudum	Trichocerca brachyura	T. porcellus
Trichocerca brachyura		
Trichotria tetractis		
Chara (10)	Najas flexilis (10)	Lemna trisulca (10)

TABLE 3 Continued

Cephalodella catellina	Cephalodella forficata	Cephalodella sp.
Colurella sp.	Dissotrocha aculeata	Colurella sp.
Enentrum or	Lecane luna	Lecane luna
Lepadella sp.	Monostyla quadridentata	Lepadella patella
Monostyla closterocerca	Ptygura sp.	L. ehrenbergii
Notommata thopica	Rotaria sp.	Monostyla closterocerca
Philodena sp.	Sinantherina socialis	Philodina sp.
Pleurotrocha petromyzen	Stephanoceros fimbriatus	Rotaria sp.
	Testudinella patina	Testudinella patina
	Trichocerca latus	
Filamentous algae: Cladophora, Spirogyra, Chaetophora, Gloeotricha (16)	Mixed plant samples (21)	Mixed plant samples, bog shores (20)
Cephalodella	Cephalodella catellina	Cephalodella hyalina
C. auriculata	Colurella sp.	Colurella sp.
C. catellina	Keratella cochlearis	Diplois daviesiae
C. forficata	Lecane luna	Keratella crassa
C. gibba	Lepadella sp.	K. earlinae
Colurella sp.	Monostyla lunaris	Lecane curvicornis
Dissotrocha macrostyla	Mytilina ventralis, var.	Lepadella ehrenbergii
Keratella quadrata	redunda	L. patella
Lepadella patella	Notommata thopica	Monostyla bulla
Monostyla sp.	Philodina sp.	M. lunaris
Monostyla hamata	Platylas patulus	M. quadridentata
M. quadridentata	Rotaria	M. furcata
Philodina sp.	Scaridium longicaudum	Mytilina ventralis, var. brevispina
Platylas patulus	Sinantherina socialis	
Polyarthra sp.	Testudinella patina	Mytilina ventralis, var. macracantha
Ptygura melicerta, var. mucicola	Trichocerca bicrustatus	
Rotaria sp.	Trichocerca bicipes	Philodina sp.
	Trichocerca latus	Platylas patulus
	Trichocerca multicrinis	Rotaria sp.
	Trichocerca porcellus	Scaridium longicaudum
	Trichocerca tenuior	Testudinella patina
	Wierzejskiella sp.	Trichotria pocillum

TABLE 4. Average Lengths of *K. crassa* and *K. cochlearis*, in microns.

	Itasca specimens		Wisconsin (Ahlstrom, 1943)	
	Total Length	Body Length	Total Length	Body Length
<i>K. crassa</i>	206	119	212-7	118-131
<i>K. cochlearis</i>	133	78	120-193	53-64

TABLE 1, Rotifers in Lake Itasca, by habitat.

SPECIES	LIMNETIC	LITTORAL	LITTORAL	NEAR BOG	SPECIES	LIMNETIC	LITTORAL	LITTORAL	NEAR BOG
	WATERS	WATERS	PLANTS	SHORE		WATERS	WATERS	PLANTS	SHORE
Ascomorpha sp.	*				Lepadella ehrenbergii Perty			*	*
Asplanchna sp.	*	*		*	Lepadella patella Muller			*	*
Cephalodella spp.			*		Macrochaetus, new sp. *				
Cephalodella apocolea Myers			*		Monommata grandis Tessin			*	
Cephalodella auriculata Muller			*		Monostyla spp.		*	*	*
Cephalodella catellina Muller			*	*	Monostyla bulla Gosse			*	*
Cephalodella forficata Ehrenberg			*	*	Monostyla closterocera Schmarda			*	
Cephalodella forficula Ehrenberg			*		Monostyla furcata Murray (?)			*	*
Cephalodella gibba Ehrenberg			*		Monostyla hamata Stokes			*	*
Cephalodella hyalina Myers (?)			*	*	Monostyla lunaris Ehrenberg		*	*	*
Cephalodella plicata Myers			*		Monostyla quadridentata Ehrenberg	*	*	*	*
Cephalodella sterea Gosse			*		Mytilina ventralis var. brevispina Ehrenberg			*	*
Cephalodella xenica Myers			*		Mytilina ventralis var. macracantha Gosse			*	*
Chromogaster sp.	*	*			Mytilina ventralis var. redunca (?)			*	
Colurella spp.		*	*	*	Notommata thopica Harring and Myers			*	
Conochilus unicornis Rousselet	*	*			Philodina spp.			*	*
Conochilus unicornis Rousselet	*	*			Platylas patulus Muller		*	*	*
Diplois daviesiae Gosse	*	*	*	*	Pleurotrocha petromyzen Ehrenberg	*		*	
Dissotrocha aculeata Ehrenberg			*		Ploesoma hudsonii Imhof	*		*	*
Dissotrocha macrostyla Ehrenberg			*		Ploesoma truncatum Levander	*		*	*
Encentrum or Myersinella sp.			*		Polyarthra sp.	*	*	*	*
Euchlanis sp.		*			Polyarthra euryptera Wierzejski		*	*	*
Euchlanis dilatata Ehrenberg			*	*	Polyarthra major Burckhardt	*		*	*
Euchlanis triquetra Ehrenberg		*	*	*	Polyarthra proloba Wulfert	*	*	*	*
Filinia sp.	*	*	*		Polyarthra vulgaris Carlin	*		*	*
Filinia limnetica Zacharias	*	*			Pompholyx sulcata Hudson	*		*	*
Gastropus hytopus	*				Proales sordida Gosse			*	*
Gastropus stylifer Imhof	*				Ptygura sp.			*	*
Kellicottia longispina Kellicott	*				Ptygura melicerta var. mucicola Kellicott			*	*
Keratella cochlearis Gosse	*	*	*		Rotaria spp.	*	*	*	*
Keratella crassa Ahlstrom	*	*	*	*	Scaridium longicaudum Muller			*	*
Keratella earlinae Ahlstrom	*	*	*	*	Sinatherina socialis Linne		*	*	*
Keratella gracilentia Ahlstrom	*				Stephanoceros fimbriatus Goldfuss			*	
Keratella quadrata Muller	*		*	*	Synchaeta pectinata Ehrenberg	*		*	*
Lecane spp.	*		*	*	Synchaeta stylata Wierzejski	*	*	*	*
Lecane curvicornis Murray			*	*	Testudinella patina Hermann	*	*	*	*
Lecane luna Muller		*	*	*					
Lepadella spp.	*		*	*					
Lepadella acuminata Ehrenberg		*	*	*					

TABLE 1. Continued

SPECIES	LIMNETIC LITTORAL LITTORAL NEAR BOG			
	WATERS	WATERS	PLANTS	SHORE
Trichocerca spp.	*		*	*
Trichocerca bicrustatus Gosse			*	
Trichocerca bicuspes Pel			*	
Trichocerca brachyura Gosse			*	
Trichocerca cylindrica Imhof	*	*		
Trichocerca insignis Herrick			*	
Trichocerca latus Jennings			*	*
Trichocerca multicrinis Kellicott	*	*	*	
Trichocerca porcellus Gosse			*	
Trichocerca tenuior Gosse			*	
Trichocerca tigris Muller	*			
Trichotria pocillum Muller			*	*
Trichotria tetractis Ehrenberg			*	
Tylotrocha monopus Jennings		*		

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