

A Checklist of Monogonont Rotifers (Rotifera: Monogononta) of Lake Ohrid, Republic of Macedonia

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Abstract: The study of the monogonont rotifers of Lake Ohrid revealed the presence of 73 species, representing 27 genera and 17 families. Sixty-one species were recorded in the littoral zone and only 12 species in the pelagic zone. The high number of species in the littoral habitats occurred due to the different life conditions in this zone, which allow greater habitat diversification. The highest number of species was observed in the genera *Lecane* (12 species), *Trichocerca* (11 species), and *Cephalodella* (6 species). Some of these species are among the most common rotifers, characteristic of the vegetated areas. The rotifers of Lake Ohrid have created taxonomically rich composition due to the wide variety of habitats they can inhabit.

Key words: Rotifera, distribution, littoral, pelagial, Lake Ohrid

Introduction

The rotifers (Rotifera), an important component of the littoral and limnetic invertebrate communities and an integral link in aquatic food-webs, comprise a modestly sized phylum of tiny, bilaterally symmetrical, eutelic metazoans, with rich and fascinating diversity. The phylum Rotifera contains two major groups: the heterogonic Monogononta and the exclusively parthenogenetic Bdelloidea. The monogononts (Monogononta) represent 1,571 species (SEGERS & DE SMET 2008), the majority of which are free-living freshwater taxa. They are ubiquitous, occurring in almost all types of freshwater habitats, and form a relatively diverse constituent of the fauna of stagnant freshwater ecosystems.

In the Republic of Macedonia, extensive field research has traditionally been carried out on the monogonont rotifers, as a part of the plankton community, in the pelagic zone (STANKOVIĆ 1931, KIEFER 1932/1933, KOZMIŃSKI 1935, SERAFIMOVA-HADZISHCE 1957, 1958, KOSTOSKI 1998). At the same time, the importance of littoral habitats has been overlooked and a comparatively smaller amount of studies have focused on the littoral rotifers. The

first detailed morpho-anatomical and ecological studies on the littoral rotifers in Lake Ohrid were carried out in 2000 (TASEVSKA 2002), thus, enriching the knowledge of the rotifer composition in the lake. Later, some comparative studies on pelagic and littoral rotifer communities were carried out (TASEVSKA et al. 2012a, b).

The aim of our study was to compile a list of the monogonont rotifers in Lake Ohrid based on data from field surveys in the pelagic zone and more extensively in the littoral zone, as well as published data.

Materials and Methods

Study area

Lake Ohrid (N41°02'19", E20°44'13") is the oldest lake in Europe and one of the oldest lakes in the world. Formed tectonically from 1.9 to 1.3 million years ago (WAGNER et al. 2017), the lake is situated in the Ohrid valley, at an altitude of 690 m a.s.l., in the south-western part of the Republic of Macedonia, bordering the Republic of Albania. It has a surface area of 358 km², a maximum depth of 288.7 m, a water

volume of 54.9 km³, and a shoreline length of 87.53 km (MATZINGER et al. 2007). The main characteristic of the ecosystem of Lake Ohrid is the scarcity of nutrients, and consequently, the low level of primary production in the lake. Its richness in biodiversity, and especially, in relict and endemic species, as a result of its high age, geographic isolation, and the stability of its ecological conditions, gives the lake global significance (SPIRKOVSKI et al. 2000).

Data collection and analysis

The study was based on monthly and seasonal collections conducted in 2000–2010, at one pelagic site and 16 different littoral sites distributed along the Macedonian shoreline of Lake Ohrid (Fig. 1). The littoral samples were collected with a dredge (with horizontal hauls on the bottom); the pelagic samples were collected with a 5-litre Ruttner sampler, filtered *in situ* through a sieve (45 µm mesh-size) and preserved with 4% formalin.

The taxonomic analysis of the collected rotifers was done under a compound microscope, considering the morphology of their body and the trophi, the latter extracted by adding a small volume of a sodium hypochlorite solution to dissolve the soft tissues. The identification of species was made according to identification guides of RUDESCU (1960), KUTIKOVA (1970), KOSTE (1978), BANCSI (1986), ŽIVKOVIĆ (1987), and SEGERS (1995).

Our collections were based on planktonic, semiplanktonic and benthic monogonont taxa, while the sampling of sessile and bdelloid rotifers was desired to update the species inventory. To compile the list of the monogonont rotifers we also used results from our previous studies (TASEVSKA 2002, 2010, TASEVSKA et al. 2003, 2004, 2008, 2012a, b). Information on distribution of the rotifer species was obtained from SEGERS (2007).

Results and Discussion

The rotifers of Lake Ohrid created taxonomically rich composition due to the wide variety of habitats they can inhabit. A total of 73 species, belonging to 27 genera and 17 families, were recorded during our study (Table 1). Sixty-one species occurred in the littoral zone and only 12 species in the pelagic zone. DUMONT & SEGERS (1996) have estimated that in the temperate regions a non-polluted lake with developed weedy littoral harbours about 150 species. The high number of species in the littoral is due to the greater influence of shoreline vegetation, which allows greater habitat diversification (GREEN 1972, KUCZYŃSKA-KIPPEN & NAGENGAST 2006, ŠPOLJAR et al. 2012, CHOI 2015).

The genus *Lecane* was dominant with 12 species (16.5%), followed by *Trichocerca* with 11 species (15%), and *Cephalodella* with six species (8%). *Lecane* and *Cephalodella* are considered among the most species-rich monogononts of biogeographical interest; they contain almost exclusively benthic-littoral or psammon-inhabiting species, with a majority inhabiting oligo- to mesotrophic, slightly acidic, soft waters (SEGERS 1995, 1996, 2008).

Some of the *Lecane* species in Lake Ohrid (e.g. *L. bulla*, *L. luna*, *L. closteroerca*, and *L. lunaris*) are among the most common widespread rotifers found in fresh waters in almost all neighbouring countries (ZARFDJIAN et al. 2000, MICHALOUDI & KOSTECKA 2004, KOZUHAROV 2007, OSTOJIĆ et al. 2012, SHUMKA 2014). One exception is *L. ivli* known from Lake Ohrid, waters in Serbia, from tap water in Budapest (Hungary) (SEGERS 1995), Italy (ROSSETTI et al. 2009), and from the Turkish part of the Tigris River catchment (BEKLEYEN et al. 2011). According to SEGERS (1996), the populations of *L. ivli* are centred in the Balkan region.

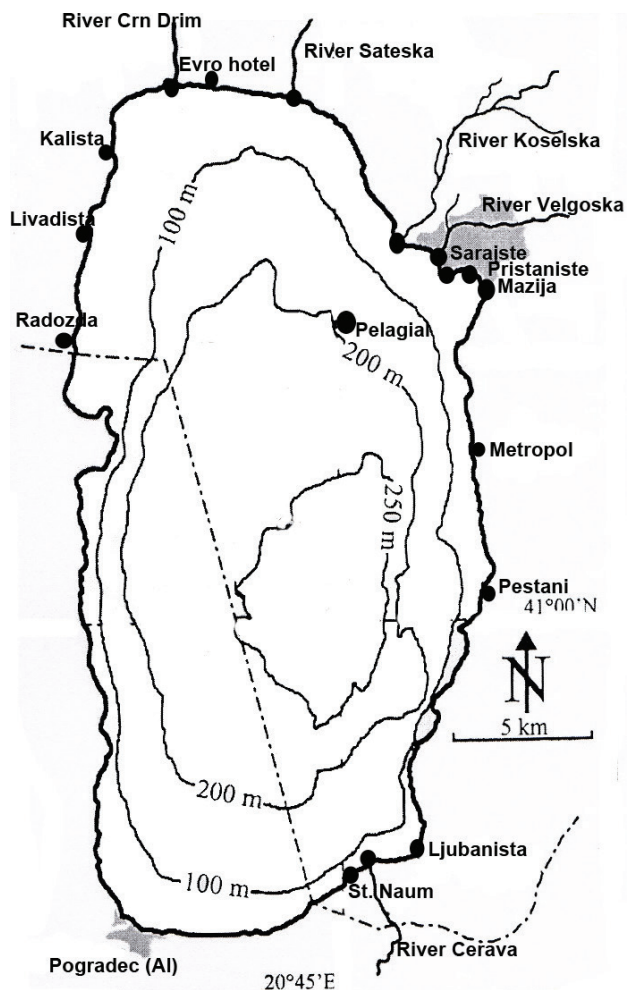


Fig. 1. Lake Ohrid and the sampling sites (black points)

Table 1. Systematic list of the monogonont rotifer species (Rotifera, Monogononta) recorded in Lake Ohrid. The reported distribution of each species is indicated: Pelagic zone: PEL – Pelagial; Littoral zone: RAD – Radozda, LIV – Livadista, KAL – Kalista, CD – River Crn Drim, EH – Evro Hotel, SAT – River Sateska, DAL – Daljan (River Koselska), GRA – Grasnica (River Velgoska), SAR – Saraiste, OD – Ohrid dock (Pristaniste), MAZ – Mazija, MET – Metropol, PES – Pestani, LJU – Ljubanista, CER – River Cerava, and SN – St. Naum

Taxa	Sites
Class Eurotatoria	
Subclass Monogononta	
Superorder Pseudotrocha	
Order Ploima	
Family Notommatidae	
<i>Notommata copeus</i> Ehrenberg, 1834	RAD, LIV, KAL, CD, EH, DAL, OD, MAZ, MET, LJU, SN
<i>Cephalodella eva</i> (Gosse, 1887)	SAT, DAL, GRA, SN
<i>Cephalodella gibba</i> (Ehrenberg, 1830)	RAD, LIV, KAL, CD, EH, SAT, DAL, GRA, SAR, OD, MAZ, MET, LJU, SN
<i>Cephalodella catellina</i> (Müller, 1786)	GRA, OD, MAZ, SN
<i>Cephalodella ventripes</i> (Dixon-Nuttall, 1901)	DAL, GRA, OD, MAZ
<i>Cephalodella forficula</i> (Ehrenberg, 1830)	EH, SAT, SAR, OD, MAZ
<i>Cephalodella tinca</i> var. <i>conspicua</i> Donner, 1950	RAD
Family Scaridiidae	
<i>Scaridium longicaudum</i> (Müller, 1786)	RAD, LIV, KAL, CD, OD, MAZ, PES, SN
Family Trichocercidae	
<i>Trichocerca weberi</i> (Jennings, 1903)	RAD, LIV, KAL, CD, EH, SAT, OD, SAR, MAZ, SN
<i>Trichocerca tenuior</i> (Gosse, 1886)	SAT, SAR, OD, MAZ, SN
<i>Trichocerca taurocephala</i> (Hauer, 1931)	SAT
<i>Trichocerca bidens</i> (Lucks, 1912)	RAD, EH, DAL, GRA, SAR, OD, MAZ
<i>Trichocerca bicristata</i> (Gosse, 1887)	RAD, LIV, KAL, CD, EH, GRA, SAR, OD, MAZ, PES, SN
<i>Trichocerca elongata</i> (Gosse, 1886)	RAD, GRA, SAR, OD, MAZ, SN
<i>Trichocerca rattus</i> (Müller, 1776)	DAL, GRA, SAR, OD, MAZ, SN
<i>Trichocerca rattus</i> f. <i>cristata</i> Harring, 1913	RAD, SAR, OD
<i>Trichocerca pusilla</i> (Jennings, 1903)	EH, GRA, MAZ, LJU, SN
<i>Trichocerca longiseta</i> (Schrank, 1802)	RAD, LIV, KAL, CD, EH, DAL, GRA, SAR, OD, MAZ, SN
<i>Trichocerca capucina</i> (Wierzejski & Zacharias, 1893)	PEL
Family Gastropodidae	
<i>Gastropus stylifer</i> Imhof, 1891	PEL
Family Synchaetidae	
<i>Synchaeta stylata</i> Wierzejski, 1893	PEL
<i>Polyarthra vulgaris</i> Carlin, 1943	PEL
<i>Polyarthra major</i> Burckhardt, 1900	PEL
<i>Ploesoma truncatum</i> (Levander, 1894)	PEL
Family Asplanchnidae	
<i>Asplanchna priodonta</i> Gosse, 1850	PEL
Family Dicranophoridae	
<i>Dicranophorus forcipatus</i> (Müller, 1786)	RAD, LIV, KAL, CD, EH, DAL, LJU, CER, SN
<i>Dicranophorus luetkeni</i> (Bergendal, 1892)	RAD, EH, SN
<i>Dicranophorus grandis</i> (Ehrenberg, 1832)	RAD, SAT, GRA, SAR, CER, SN
<i>Encentrum saundersiae</i> (Hudson, 1885)	EH, GRA, LJU, SN
Family Lecanidae	
<i>Lecane luna</i> (Müller, 1776)	RAD, LIV, KAL, CD, EH, GRA, SAR, OD, MAZ, SN
<i>Lecane flexilis</i> (Gosse, 1886)	RAD, LIV, KAL, SAR
<i>Lecane pusilla</i> Harring, 1914	RAD
<i>Lecane closteroerca</i> (Schmarda, 1859)	RAD, LIV, KAL, CD, EH, SAT, DAL, GRA, SAR, OD, MAZ, MET, CER
<i>Lecane hamata</i> (Stokes, 1896)	GRA, OD, MAZ, SN
<i>Lecane copeis</i> (Harring & Myers, 1926)	LJU, SN
<i>Lecane scutata</i> (Harring & Myers, 1926)	RAD
<i>Lecane ivli</i> (Wiszniewski, 1935)	SAT, MAZ, SN
<i>Lecane quadridentata</i> (Ehrenberg, 1830)	RAD, SN

Table 1. Continuation

Taxa	Sites
<i>Lecane lunaris</i> (Ehrenberg, 1832)	RAD, LIV, KAL, CD, EH, DAL, GRA, SAR, OD, MAZ, SN
<i>Lecane bulla</i> (Gosse, 1851)	RAD, LIV, KAL, EH, GRA, OD, MAZ, SN
<i>Lecane ludwigii</i> (Eckstein, 1883)	RAD
Family Trichotriidae	
<i>Trichotria pocillum</i> (Müller, 1776)	RAD, LIV, KAL, CD, EH, DAL, GRA, SAR, OD, MAZ, PES, SN
<i>Trichotria tetractis</i> (Ehrenberg, 1830)	RAD, KAL, CD, SAT, GRA, OD, MAZ, SN
Family Mytilinidae	
<i>Mytilina ventralis</i> var. <i>brevispina</i> (Ehrenberg, 1830)	RAD, LIV, KAL, CD, GRA, SAR, OD, MAZ, SN
<i>Mytilina ventralis ventralis</i> (Ehrenberg, 1830)	RAD, LIV, KAL, CD, EH, GRA, OD, MAZ, PES, SN
<i>Lophocharis oxysternon</i> (Gosse, 1851)	LIV, KAL, SN
Family Lepadellidae	
<i>Colurella obtusa</i> (Gosse, 1886)	GRA, OD, MAZ, LJU, SN
<i>Colurella adriatica</i> Ehrenberg, 1831	RAD, LIV, KAL, DAL, GRA, SAR, MAZ, SN
<i>Colurella colurus</i> (Ehrenberg, 1830)	KAL, SAT, DAL, GRA, SAR, OD, MAZ, SN
<i>Colurella uncinata bicuspidata</i> (Ehrenberg, 1830)	RAD, LIV, KAL, CD, EH, DAL, GRA, SAR, OD, MAZ, PES, SN
<i>Lepadella triptera</i> (Ehrenberg, 1832)	RAD, LIV, DAL, OD, MAZ, PES, SN
<i>Lepadella acuminata</i> (Ehrenberg, 1834)	RAD, GRA
<i>Lepadella ovalis</i> (Müller, 1786)	DAL, GRA, SAR, OD, MAZ, LJU, SN
<i>Lepadella patella</i> (Müller, 1773)	RAD, LIV, KAL, CD, EH, SAT, DAL, GRA, SAR, OD, MAZ, MET, PES, CER, SN
<i>Lepadella (Heterolepadella) ehrenbergii</i> (Perty, 1850)	RAD
Family Euchlanidae	
<i>Euchlanis incisa</i> Carlin, 1939	RAD, LIV, KAL, CD, SAR, OD, SN
<i>Euchlanis dilatata</i> Ehrenberg, 1832	RAD, LIV, KAL, CD, EH, SAT, DAL, GRA, SAR, OD, MAZ, MET, PES, LJU, CER, SN
<i>Euchlanis deflexa</i> Gosse, 1851	RAD, DAL, GRA, SAR, OD, MAZ, CER, SN
Family Brachionidae	
<i>Brachionus quadridentatus quadridentatus</i> Hermann, 1783	RAD, KAL, CD, EH, GRA, SAR, OD
<i>Platyas quadricornis</i> (Ehrenberg, 1832)	RAD, LIV, KAL, DAL, OD, MAZ, SN
<i>Keratella cochlearis cochlearis</i> (Gosse, 1851)	PEL
<i>Keratella quadrata</i> (Müller, 1786)	PEL
<i>Notholca squamula</i> (Müller, 1786)	RAD, LIV, EH, SAR, MAZ
<i>Notholca foliacea</i> (Ehrenberg, 1838)	LIV, MAZ, SN
<i>Notholca acuminata</i> (Ehrenberg, 1832)	LIV, KAL, GRA
<i>Kellicottia longispina</i> (Kellicott, 1879)	PEL
Superorder Gnesiotrocha	
Order Flosculariaceae	
Family Conochilidae	
<i>Conochilus hippocrepis</i> (Schränk, 1803)	PEL
Family Testudinellidae	
<i>Testudinella patina patina</i> (Hermann, 1783)	RAD, OD, MAZ, PES, SN
<i>Testudinella patina</i> f. <i>intermedia</i> (Anderson, 1889)	OD, SN
<i>Testudinella patina</i> f. <i>trilobata</i> (Anderson & Shephard, 1892)	RAD, LIV, KAL, CD, EH, GRA, OD, MAZ, SN
<i>Testudinella parva</i> (Ternetz, 1892)	RAD, EH, OD, MAZ, SN
Family Hexarthridae	
<i>Hexarthra mira</i> (Hudson, 1871)	EH, GRA, SN
Family Trochosphaeridae	
<i>Filinia terminalis</i> (Plate, 1886)	PEL

The majority of *Trichocerca* is considered widely distributed taxa (SEGERS 2003), characteristic of the vegetated areas, apart from *T. pusilla*, whose specimens are found in open water zone (TASEVSKA 2002, TASEVSKA et al. 2012). Of these cosmopolitan species, only *T. taurocephala* is restricted to the northern hemisphere (Palaeartic and Nearctic

biogeographical regions) (SEGERS 2007).

In general, the Lake Ohrid rotifer fauna is composed largely of widespread (94.5%), cosmopolitan species reported in the literature as littoral and/or benthic-periphytic. Future efforts on the understudied regions and taxonomic groups, preferably using modern, molecular tools, will

undoubtedly contribute to the study of rotifer diversity in Lake Ohrid and their role in ecosystem processes and functions.

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