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Lecanid rotifers (Rotifera: Monogononta: Lecanidae) from Iran

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Abstract: Rotifer diversity was investigated in 26 bodies of water in northwest Iran. Thirteen species of Lecanidae were identified, 6 of which are new records for Iran. The new records include *Lecane flexilis* (Gosse 1886), *L. hamata* (Stokes 1896), *L. hastata* (Murray 1913), *L. lamellata* (Daday 1893), *L. papuana* (Murray 1913), and *L. punctata* (Murray 1913). Drawings are provided, and both the seasonal and spatial distributions of the identified taxa are discussed. A brief comparison is made between the present study's results and those reported from Turkey.

Key words: Rotifera, Lecanidae, Iran

Introduction

The Lecanidae constitutes a group of common fresh and saline-water monogonont rotifers. The family's single genus, *Lecane*, with about 200 species, is considered among the most species-rich monogononts (Segers, 1994, 1995, 2008). *Lecane* are of biogeographical interest and, in particular, abound in littoral habitats (Segers, 1996). They are diagnosed by the structure of the foot and of the trophary in the female; however, the structure of the trophary has not or has rarely been used in taxonomic studies of the genus (Segers, 1995). The key features of lecanids are the shape of the lorica, the contour of the anterior margin of the lorica, and the shape of the foot and toes (Arora, 1965). The problem with their identification emerges from their great diversity, intra-species variability, and size plasticity, even within a single taxon (Segers et al., 1992).

Lecane is among the best-represented genera in Southeast Asia (Segers, 2001). In the Middle East the most intensive work has been performed in Turkey (Ustaoğlu, 2004). As with most aquatic invertebrates, research on Iranian rotifers has not been adequate. A list of 16 Lecanidae species reported earlier from Iran is shown in Table 1. Löffler (1961) was probably the first to report rotifer taxa from Iran, including 15 species of *Lecane*. Since then, for a long period of time no significant studies were conducted.

Hakimzadeh (2007) reported some rotifer taxa, including 6 species of Lecanidae, from 51 sites near Tehran; 1 of these species was not recorded earlier. In an atlas of Caspian Sea invertebrates some rotifers, excluding lecanids, are noted (Birshtain et al., 1968). There are also a few publications and research reports containing lists of rotifers in the country (e.g. Mohammadian, 2005); however, most species have

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Table 1. List of the rotifers species of the family Lecanidae previously reported from Iran.

Species	Site	* Source
<i>Lecane bulla</i> (Gosse 1851)	Lake Hamoon, Caspian Sea and Persian Gulf basins, West and Northwest Iran Tehran vicinity	Löffler, 1961 Hakimzadeh, 2007
<i>L. luna</i> (Muller 1776)	Lake Hamoon, Caspian Sea and Persian Gulf basins, West and Northwest Iran Tehran vicinity	Löffler, 1961 Hakimzadeh, 2007
<i>L. lunaris</i> (Ehrenberg 1832)	Lake Hamoon, Persian Gulf basin, West and Northwest Iran Tehran vicinity	Löffler, 1961 Hakimzadeh, 2007
<i>L. thalera</i> (Harring and Myers 1926)	Lake Hamoon, Persian Gulf basin and Fars province (Southwest Iran)	Löffler, 1961
<i>L. closterocerca</i> (Schmarda 1859)	Persian Gulf basin, West and Northwest Iran, Kurdistan and West Azarbaijan Tehran vicinity	Löffler, 1961 Hakimzadeh, 2007
<i>L. furcata</i> (Murray 1913)	Qezel ozan River basin, North West Iran Tehran vicinity	Löffler, 1961 Hakimzadeh, 2007
<i>L. nana</i> (Murray 1913)	Tehran vicinity	Hakimzadeh, 2007
<i>L. glypta</i> (Harring and Myers 1926)	Lake Hamoon	Löffler, 1961
<i>Lecane cf. glypta</i> (Harring & Myers 1926)	Lake Hamoon	Löffler, 1961
<i>L. stenroosi</i> (Meissner 1776)	Persian Gulf basin, Central Iran	Löffler, 1961
<i>L. quadridentata</i> (Ehrb1832)	Central, West and Northwest Iran	Löffler, 1961
<i>L. ludwigi</i> (Eckstein 1883)	Kurdistan, West Iran	Löffler, 1961
<i>L. sympoda</i> (Hauer 1929)	Kurdistan, West Iran	Löffler, 1961
<i>L. tenuiseta</i> (Harring 1914)	Qezel ozan River basin, Northwest Iran	Löffler, 1961
<i>L. cf. obtusa</i> (Harring and Myers 1926)	Qezel ozan River basin, Northwest Iran	Löffler, 1961
<i>L. hamata</i> (Stokes 1890)	Qezel ozan River basin, Northwest Iran	Löffler, 1961

* Source could include more national reports or abstracts in which more species may be reported. However, for scientific validity only the 2 most reliable ones are referred to.

not been characterized in detail and published reports never contain leading illustrations, and therefore may not be fully reliable. As a result, there is an obvious scarcity of information on Iranian rotifer diversity.

As part of an attempt to improve our knowledge on the diversity of rotifers in Iran, herein we report and illustrate all the species of the family Lecanidae that were found during our survey of Iranian water bodies. Both the spatial and temporal distributions of the species are also discussed.

Materials and methods

Twenty-six lagoons, permanent ponds, temporary pools, and flowing waters in the province of West Azerbaijan were sampled. The province is located in northwestern Iran and covers an average area of 39,487 km². It lies at latitudes 35°58'–39°46'N and longitudes 44°3'–47°23'E. The climate is largely influenced by the rain-laden winds of the Atlantic Ocean and the Mediterranean Sea. Cold northern winds affect the region during winter and cause heavy snowfall. According to existing meteorological records, local temperature varies seasonally within the province. Average annual temperature ranges from 9.4 to 11.6 °C. Based on the same data, the highest temperature recorded was 34 °C in July, while the temperature may drop to as low as –16 °C in January. The sampling sites cover almost all major bodies of water in the area and have a standard distributional pattern, including different geographic zones within the province (Figure 1).

Sampling was carried out seasonally from October 2007 to October 2008. Planktonic specimens were collected by filtering the littoral waters through a fine-mesh (30–50 µm) plankton net. Epiphytic rotifers were isolated by rinsing the collected aquatic plants and algae on the net. Rotifer resting eggs were isolated from the collected surface sediments, especially during periods of drought or freezing, using the sucrose floatation technique recommended by Scott Mills (pers. com.). We made a saturated solution by mixing and stirring an equal proportion of sugar and tap water. Approximately 500 g of the sediment was added to an adequate volume of the solution and disturbed for several minutes, followed by overnight settlement for complete floatation of the deposited

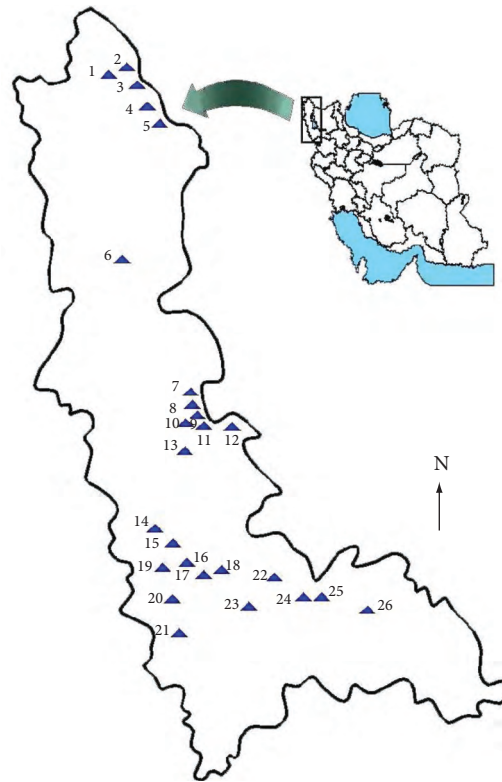


Figure 1. Map of Iran and the position of sampling sites (numbered triangles) in the northwest of the country.

1. Aghgul; 2. Shatloo; 3. Bohlolkandi; 4. Shahid Kazemi; 5. Haajjamaal; 6. Shahrakezarean; 7–11. Zambil (1–5); 12. Eskeleh; 13. Golemarz; 14. Gardeshaaneh; 15. Bijanabad; 16. Ghezenabad; 17. Khanlar; 18. Cheshmehgul; 19. Alkabad; 20. Kaniqaraniaqa; 21. Kanimotor; 22. Seyrangul; 23. Usefkandi; 24. Qoobighazi; 25. Kanibrazan; 26. Qoobibabaali

cysts. The supernatant, including the floating materials, was rinsed through a column filter that emptied into a 50-µm mesh. The resting eggs were hatched, as described by Garcia-Roger et al. (2006), with some modifications. Briefly, the eggs were transferred to a petri dish containing water with a salinity of 8–10 parts per thousand (ppt) and subsequently incubated at 25 °C under continuous light to facilitate hatching.

For each sampling occasion, the physico-chemical parameters of the water, such as temperature, salinity, and pH, were also measured using precision instruments. Initial examination of live animals was accomplished by differentiating rotifers from other

entities using a stereomicroscope. Plant materials were examined for the presence of sessile rotifers. Detailed inspection of the rotifers was performed by observing them under a dissection microscope. Drawings were made using a camera lucida. Taxonomic identification was performed according to Koste (1978) and Segers (1995).

The identified taxa isolated from the water column were designated as planktonic, and those isolated from aquatic vegetation were designated as epiphytic. The remaining individuals that were identified after they were recovered from the resting eggs were designated as hatched.

Results

The sampled sites had salinity between 0 and 26 ppt. Water temperature ranged from 1 to 32.5 °C, and pH ranged from 7.5 to 10. In total, 13 Lecanidae species were identified, 6 of which are reported for the first time from Iran (Table 2 and Figure 2). Five species (38.4 %) were exclusively epiphytic, while 1 species was found only in plankton samples; 5 species were found in the 2 groups. Hatching the resting eggs obtained from sediments facilitated the observation of 6 species, including 2 not observed in the water or plant samples.

L. closteroerca had the widest distribution and was observed at 8 of the 26 sites. Two species, *L. bulla* and *L. luna*, were isolated from 7 sites, while 7 species were isolated from 1 site each and did not coexist with any congener. Of the 26 sites, 9 (site numbers 2, 5, 9, 10, 11, 16, 17, 20, and 21) included only 1 species each, while site number 23 hosted 5 species of the family. Regarding the seasonal distribution of the taxa, spring was the most speciose season, with a total of 12 species. Only 5 species were observed in autumn. Nonetheless, as mentioned earlier, this seasonal comparison was incomplete due to a summer drought and a winter frost at many of the sites. Live specimens of *L. closteroerca* and *L. luna* were sampled in all seasons. Four species, *L. hamata*, *L. flexilis*, *L. hastata*, and *L. papuana*, were each observed in only 1 season.

Discussion

Although almost none of the available reports on Iranian rotifers include sufficient descriptions and illustrations, we consider them to be valid. Regarding all earlier works, our findings include 6 new records. Three species reported in the present study, *L. bulla*, *L. luna*, and *L. lunaris*, were previously reported from the same geographic region by Löffler (1961). Segers (1996), in his review of the biogeography and distribution pattern of

Table 2. The identified species of genus *Lecane* and their collection sites. Occurrence of species in each of the 3 putative categories, epiphytic, planktonic and from hatched cysts is shown by +. Numbers correspond to the sampling sites listed in Figure 1. Asterisks mark new records from Iran.

Species	Epiphytic	Planktonic	Hatched	Sites
<i>L. bulla</i> (Gosse, 1851)	+	+	+	11, 13, 14, 17, 18, 22, 23
<i>L. closteroerca</i> (Schmarda, 1853)	+	+	-	13, 14, 16, 18, 19, 21, 23, 25
* <i>L. flexilis</i> (Gosse, 1886)	+	-	-	18
<i>L. furcata</i> (Murray, 1913)	-	+	-	19
* <i>L. hamata</i> (Stokes, 1896)	+	-	-	14
* <i>L. hastata</i> (Murray, 1913)	+	+	+	26
* <i>L. lamellata</i> (Daday, 1893)	+	+	+	2, 8, 9, 10, 22, 26
<i>L. luna</i> (Müller, 1776)	+	+	+	5, 13, 18, 20, 22, 23, 25
<i>L. lunaris</i> (Ehrenberg, 1832)	+	-	-	14, 23
* <i>L. papuana</i> (Murray, 1913)	+	-	-	14
* <i>L. punctata</i> (Murray, 1913)	-	-	+	8
<i>L. quadridentata</i> (Ehrenberg, 1832)	+	-	-	13, 23
<i>L. thalera</i> (Harring & Myers, 1926)	-	-	+	22, 26

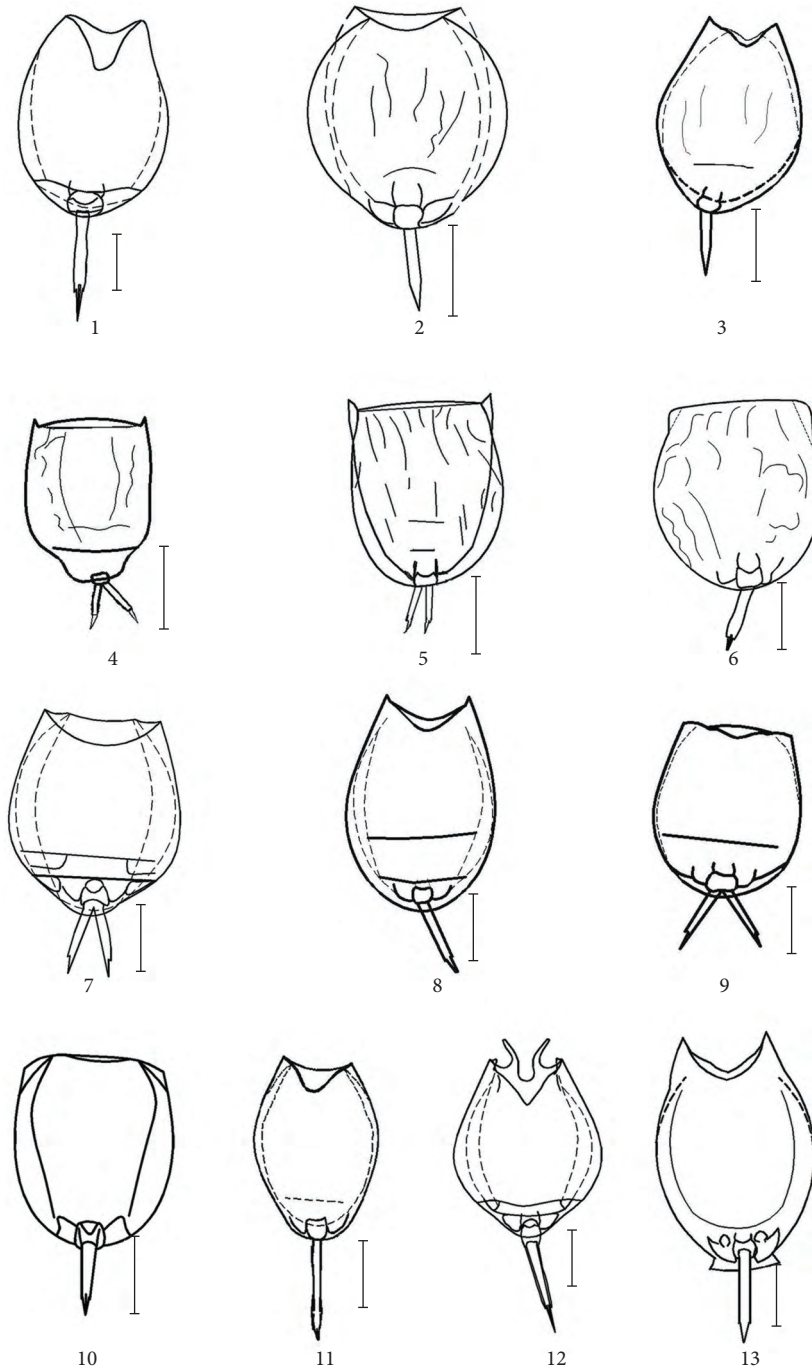


Figure 2. 1. *Lecane bulla*; 2. *L. closterocerca*; 3. *L. hamata*; 4. *L. hastata*; 5. *L. flexilis*; 6. *L. furcata*; 7. *L. luna*; 8. *L. thalera*; 9. *L. papuana*; 10. *L. punctata*; 11. *L. lunaris*; 12. *L. quadridentata*; 13. *L. lamellata*. Scale bar, 50 μm .

Lecane, categorized all its described taxa into 4 distinct groups. Accordingly, among the 13 identified rotifers, 8 species, *L. bulla*, *L. closterocerca*, *L. flexilis*, *L. furcata*, *L. hamata*, *L. luna*, *L. lunaris*, and *L. quadridentata*, are

cosmopolitan, i.e. from the group with worldwide distribution. Three species, *L. hastata*, *L. punctata*, and *L. papuana* are tropicopolitan, i.e. are distributed in tropical and subtropical regions.

Six species, *Lecane flexilis*, *L. hamata*, *L. hastata*, *L. furcata*, *L. papuana*, and *L. punctata* are rare taxa, and all were found at only 1 site, and with the exception of *L. furcata* all were observed in only 1 season. *L. bulla*, *L. closteroerca*, *L. lamellata*, and *L. luna* were distributed over several geographical areas, from north to south of the province. *L. bulla* and *L. luna* are 2 of the most common and most eurytopic species of the genus *Lecane* (Segers, 1995), and were sampled from waters with salinity ranging from 0 to 10 ppt. *L. luna* was found in all seasons and in a broad range of water temperature (1-30 °C), while live specimens of *L. bulla* were observed only in spring and summer in waters with temperatures between 24 and 33 °C. *L. papuana*, which is considered a warm-stenotherm taxon (Segers, 1995), was sampled from a fresh semi-lotic water body with a temperature of 30 °C. Most of the recorded species were sampled from freshwater environments with salinity ranging from 0 to 3 ppt; however, *L. hastata* was sampled from brackish water with a salinity of 10 ppt. *L. lamellate* and *L. closteroerca* were isolated from sites with variable salinity; the former was observed at salinity of 0.5-26 ppt, the latter at 0-10 ppt. These species occurred in all seasons, with varying water temperatures of 2.5-29.5 °C. The occurrence of *L. lamellate* in freshwater is notable, as Segers (1995) reported this taxon as a saline water rotifer. All specimens of *L. thalera* were identified after their collected resting eggs hatched, and no live animal was observed from the samplings. *L. punctata* was also identified following laboratory hatching of its eggs isolated from a frozen pool. *L. flexilis* and *L. hastata* were taxa of temperate waters and were found only in summer and spring, respectively, when the water temperature was 20-22 °C. While *L. hamata* was found only in summer in warm water (28 °C), *L. hastata* was found in both saline and freshwater, and *L. hamata* was introduced as a eurytopic taxon (Segers, 1995). *L. lamellata* and *L. papuana* exhibited eurythermy and were found in waters with temperatures ranging from 3 to 30 °C.

The identified lecanids exhibited tolerance to alkaline waters, as in most sampled waters the pH was more than 8. The species with the highest tolerance were *L. flexilis* and *L. lamellate*, which occurred in waters with a pH of 10. Lecanids are primarily

considered littoral-periphytic rotifers (Segers et al., 1992); however, several species were observed as free-swimming or planktonic taxa in the present study. It is also worth mentioning that we excluded a species suspected to be *L. pumila* from our list, as its identity was not fully confirmed by the experts we consulted due to the lack of suitable micrographs of its only specimen. If we had been able to definitely determine *L. pumila* our finding would have been of great importance, as this is a rare taxon worldwide (Hendrik Segers, pers. com.).

Because of geographic proximity, a comparison was made between the obtained data and those of Turkish rotifers reported to date. With a considerable number of publications available on the rotifer fauna of Turkey (Dumont and De Ridder, 1987; Segers et al., 1992; Ustaoglu, 2004; Kaya and Altindağ, 2007, 2009) and recent interest in Iranian rotifers, such comparison can contribute to the establishment of a databank of faunistics and biogeography of the local rotifer fauna, especially in consideration of the relevance of the area as a contact zone between the Palaearctic and Oriental regions. There is an apparent lack of data on the rotifer fauna from the other adjacent nations. Investigation of the Turkish rotifer fauna apparently began much earlier than the first report of Iranian rotifers was published by Löffler (1961). According to a review by Dumont and De Ridder (1987) on the history of studies on Rotifera from Turkey, some of the areas in east Anatolia adjacent to Iran, e.g. Van Lake, have been investigated for their rotifers; however, most attention has been focused on western and central Turkey. Lecanids are circumsubtropical taxa (Dumont and De Ridder, 1987); thus, not surprisingly, they significantly contributed to the list of rotifers from Turkey (see Ustaoglu, 2004) and in some regions of Iran in the present study (the complete list will be published soon). The geographical affinity of the 2 countries may be a reason for some of the similar findings on *Lecane* diversity and distribution. For instance, *L. bulla*, *L. closteroerca*, and *L. luna*, which are taxa with widespread distribution in Turkish waters (Dumont and De Ridder, 1987; Segers et al., 1992), also had the highest distribution in the investigated sites in the present study (Table 2). Similarly, *L. papuana* and *L. quadridentata* were among the rare taxa in both

Turkish waters and in the present study; however, *L. lamellate*, which is a rare species in Turkey, was recorded from several sites in the present study. In contrast to the results from the 2 countries, *L. quadridentata* was introduced as a eurytopic and cosmopolitan taxon (Segers, 1995). Furthermore, *L. thalera* has not been recorded from Turkey.

An interesting finding by Segers et al. (1992) is the variability in the body size of Lecanid species from different geographical areas. This may serve as a topic for further comparison of paratypes of each rotifer species from different regions. Although a comparison between the rotifer fauna of the 2 countries was not

within the scope of the present study, our results call for more comprehensive faunistic analysis involving the spatial or climatic significance of the identified rotifer taxa and their origin.

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