Chapter 31
Rotifer Diversity in Iranian Waters: A Review

Reza Malekzadeh-Viayeh

Abstract Iran is the second largest country in the Middle East with a significant contribution to the regional and global biodiversity. While the country is considered as a home to a wide range of flora and fauna, much of its biological assets has not yet been apprehended. Rotifers, the members of phylum Rotifera, comprise some 2000 species of minute aquatic invertebrates. They have increasingly attracted efforts from the global taxonomists and limnologists not only due to their crucial role in aquatic food webs, but also for their growing applications in fundamental biological research and aquaculture industry. The oldest available records of Iranian rotifers date back to almost 70 years ago. Notwithstanding that the task to discover the aquatic invertebrates, such as rotifers, of all Iranian waters is far from complete, the last decade has witnessed an expanding quantity of research and publications on their diversity. In this chapter, a review of the surveys on phylum Rotifera in Iran has been provided, including a checklist of the identified rotifer taxa, based on almost all available data. A total of 366 rotifer species and subspecies of 69 genera under 27 families have so far been identified from Iranian waters, most of which (95%) belong to the subclass Monogononta and the remaining (18 species of 8 genera in 4 families) to Bdelloidea. Biogeography of the rotifers, a comparison of the regional rotifer diversity, and prospects for future studies have also been discussed.

Keywords Rotifers · Species diversity · Iranian waters

31.1 Introduction

Estimation of global biodiversity has increasingly been granted not only due to its intrinsic scientific value but also for the vital contribution it has to human well-being and food safety. Several examples of biodiversity applications in modern societies

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exist, including the use of natural products for pharmaceutical development or extraction of marine resources. In addition, biodiversity provides ecosystems' health by supporting their stability, functionality and sustainability. These healthy ecosystems can, in turn, facilitate various crucial functions, such as recycling of organic waste, carbon sequestration, oxygen production, protection of water quality, mitigation of the effects of pollutants, and improve human and animal health (Clark et al. 2014; Jowkar et al. 2016). While the diversity of several Iranian terrestrial animal and plant groups (Ghasemi et al. 2012; Farashi and Shariati-Najafabadi 2017), fishes (Coad 1998, 2006; Esmaeili et al. 2017), and aquatic macroinvertebrates (Sharifinia 2015; Gerami et al. 2016) has been documented, not much is known about microinvertebrate fauna of the country.

Rotifers (phylum Rotifera) are a group of microscopic and primary freshwater invertebrates that occur in almost all types of habitat, from large permanent lakes to small temporary puddles and interstitial and capillary waters (Segers 2008). They are the dominant zooplankton group in inland waters and play a major role in energy transfer and nutrient cycling (Malekzadeh-Viayeh and Špoljar 2012). Due to their short life cycles, rotifers react quickly to changes in environmental conditions. Hence, their species composition and abundance may be used as biological indicators reflecting the alterations in water quality (Gutkowska et al. 2013). Rotifers offer interesting challenges to developmental and cell biologists because of their remarkable combination of development and plasticity of forms in response to environmental variations. In addition, they present superb research materials for many problems of current interest to ecologists, including population dynamics and genetics, resource partitioning, and adaptation of form, function, and life history (Ruttner-Kolisko 1974). Rotifers have also been used as primary live foods in the aquaculture of a variety of fish and crustaceans (Lubzens et al. 1989), the demand for whom has gradually been increased with the flourishing aquaculture practices worldwide (Suantika et al. 2003).

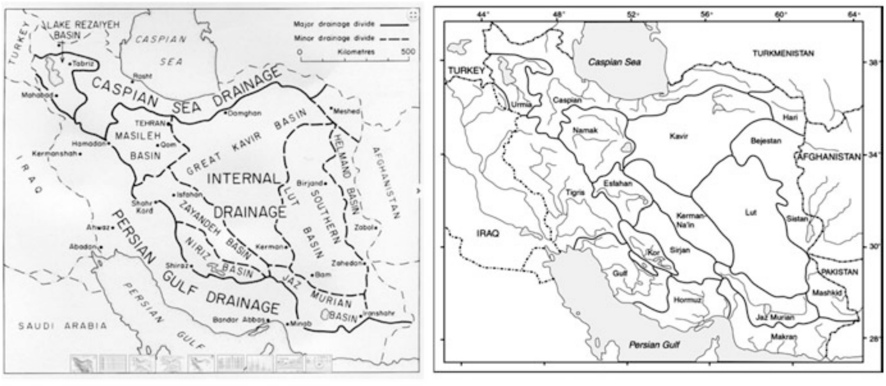
While rotifers have first been described in the 1600s, they have attracted much attention of the global naturalists since the twentieth century to disclose their diverse biological attributes. The expanded applications of rotifers in various scientific investigations as well as in biotechnology and aquaculture have promoted studies on their biodiversity, biogeography, ecology and conservation. Scientists have become more interested than ever to explore and describe rotifers from all over the world. This has led to the isolation and introduction of hundreds of these microinvertebrates from different continents (Murray 1913; de Ridder 1986; Shiel 1995; Pejler 1998; Modenutti 1998; Sarma 1999; Duggan et al. 2001; Jersabek 2003; Thorp and Covich 2009; Athibai et al. 2013; Kriska 2014), exceeding the number of described rotifer taxa to over 2000 (Smith 2001; Segers 2008), which is still undoubtedly much less than their actual number. The fact that new species are currently being discovered from various parts of the globe suggests that the taxonomic studies on rotifers are far from complete in spite of their 300-year-old history (Sarma 2006). Classically, three groups/subclasses are recognized within the phylum Rotifera: Monogononta, Bdelloidea and Seisonacea with 1570, 461 and 3 species, respectively, whereas molecular studies indicate that the exclusively endoparasitic Acanthocephala are also rotifers (Fontaneto et al. 2008). Among all other living organisms, rotifers are common in freshwater and marine habitats, but some species also live in such extreme environments as damp soil or on mosses (Fontaneto and De Smet 2015). Most species of the rotifers are cosmopolitan, but there also are biotope-specific or endemic taxa whose distribution is restricted to certain biogeography or ecological niche (Segers 2008). While rate of the rotifer endemism is still unclear, enhanced research efforts may find additional endemic taxa from different geographical areas (Segers and De Smet 2008).

In order to contribute to the knowledge of regional biodiversity, a review of the surveys on Iranian rotifers is herein provided which includes a first-ever and nearly-complete checklist of the identified rotifer taxa from the country using the available data. Biogeographical distribution of the reported rotifers, a comparison of the regional rotifer diversity, and general remarks on the performed investigations, flaws, and perspectives are discussed.

31.2 Geography, Climate and Hydrology of Iranian Plateau

Although the country presently known as 'Iran' is just part of the vast ancient Persian Empire territory, covering an area of about 1,648,000 km^2, it even now is one of the largest countries not only in the region but also on a global scale (*i.e.*, the second largest country in the Middle East and 18th in the world) (Jowkar et al. 2016; Rezaei et al. 2017). The country has a complex topography (Fallah et al. 2017), and more than half of its area is covered by mountains and deserts (Mirzaie-Nadowshan 2009). Iranian Plateau, encompassing Iran and parts of a number of neighboring countries, has an old formation history and connects to Mesopotamia to the west where the leading Elamite Civilization was established and was a historical start point for agriculture development by human (Derenko et al. 2013).

Iran is located between arid or continental climate zone of Central and West Asia and the Mediterranean climate zone, and, therefore, generally has a four-season climate influenced by the surrounding water basins, Caspian, Aral and Black seas in the north, Indian Ocean, Persian Gulf and Oman Sea in the south, Atlantic Ocean in the west, and Mediterranean Sea in northwest, as well as by mountain ranges, highlands and deserts. However, the main meteorological attributes, *e.g.*, length of the seasons, temperature, precipitation, humidity and air pressure, may differ greatly in different regions of the country (Ghorbani 2013; Fallah et al. 2017). Temperature can vary between −20 and +50 °C, while precipitation fluctuates from less than 50 mm to over 1000 mm per year (Madani et al. 2016). The Mediterranean climate governs large part of Iran, which is affected by changes in Westerly activities. Thus, except for the western parts and the northern coastal areas, Iran's climate is mainly arid and semi-arid (Fallah et al. 2017). About 75% of the total land area of Iran is dominated by arid or semi-arid climate with annual precipitation rates from ~350 mm to less than 50 mm (Kehl 2009). The average annual precipitation across the country is estimated to be near 250 mm, about one-third of the global annual precipitation (Mirzaie-Nadowshan 2009).



A B

Fig. 31.1 Described drainage basins for Iranian Plateau by Beaumont (1982) (**a**) and Coad (2006) (**b**)

Hydrologically, Iran is bound with massive bodies of water to its north (Caspian Sea) and south (Persian Gulf and Sea of Oman). With an estimated area of over 390,000 km^2, Caspian Sea is the largest landlocked waterbody in the globe with extended coasts in five countries of Iran, Russia, Kazakhstan, Turkmenistan and Azerbaijan. It once was a part of the ancient Tethys Sea, being completely isolated roughly 1 million year ago. However, it has retained a wealthy collection of fauna of marine origin that currently lives in its brackish water with salinities ranging from 10 to 13 ppt on average. Having its surface water located 22 m below the average sea level, Caspian Sea contains 40% of the world inland waters and its maximum depth is about 1000 m with a mean depth of 210 m. Some 130 rivers of various sizes drain into the sea, of which the northern rivers of Volga and Ural constitute the main (over 90%) water input (Birshtain et al. 1968; Kostianoy and Kosarev 2005; Asian Development Bank 2010; Jamshidi and Abu Bakar 2012). Persian Gulf and Sea of Oman are the only actual marine ecosystems in Iranian territory. Persian Gulf is a semi-closed projection of the Indian Ocean connecting to the oceanic waters through the Strait of Hormuz and Sea of Oman. It is located in one of the hottest regions in the world and is characterized by its harsh environmental conditions where the air temperature can rise to over 50 °C in summer, elevating the water salinity to 45 ppt (Moradi et al. 2014). Persian Gulf is surrounded by the Iranian shorelines in the north and those of several Arabic states in the south and southwest, which share the rich natural resources of the Gulf including its fauna and flora.

Iranian inland waters belong to several drainage basins whose number is defined to be up to 19 (Coad 1998, 2006). Beaumont (1982) specified 6 water basins for Iranian Plateau; among them, the largest is the Great Kavir (Kavir-e-Markazi) basin which covers about one-third of the total country area (Fig. 31.1). While the lakes in Iran have diverse formation history, many of them are the remnants of the Tethys Sea, parts of which turned into swamps and parts still exist. The most important existing lakes are Urmia (Orumieh/formerly, Rezāieh) Lake, Hāmoon, Qom Namak, Bakhtegān, Gāvkhooni, Jāzmooriān, Zarivār, Mahārloo, Parishān, and Tār. Most of the major Iranian rivers run in two principal basins: Caspian Sea and Persian Gulf basins. The main rivers flowing ultimately into the Caspian Sea (Aras, Sefid Rud, Chālus, Harāz, Sehezār, Bābol, Talār, Tajan, Gorgān, Atrak, Qarasoo, and Nekā) originate from the northern slopes of the Alborz Mountains. The Zāgros Mountains accommodate the main headsprings of the rivers running into the Persian Gulf and Oman sea watersheds. The major rivers of the latter basin are Arvand Rud, Gāmāsb, Kāroon, Jarrāhi, Zohreh, Dālaki, Mend, Shoor, Mināb, Mehrān and Naband (Sharifinia 2015). There also is a vastly-extended network of rivers in Iran, most of which are seasonally filled with water. Almost all water systems and resources are part of or in connection with the main water basins flowing eventually into the Caspian Sea in the north, Persian Gulf and Oman Sea in the south, and several confined basins in south, center, and east parts of the country (Ghorbani 2013). Iran shares several water basins with its neighboring countries. Based on a report by the Iranian Parliament Research Center, there are 89 rivers in Iran connected to the regional water drainages. Of these, 17 are shared with the adjacent countries, 4 are inflowing, and 68 are outflowing. Among the surrounding countries, Iraq has the highest topographic and hydrologic affinity with Iran and a number of 18 rivers are flowing into Iraq through the water basins in West Iran (http://rc.majlis.ir/en). The main transboundary rivers with considerable water flow through or into Iran are Aras, Āstārāchāy, Tajan (Tejen), Atrak, Sārisoo, Qarasoo, Zāb, Sirvān, Arvand Rud (Shatt al-Arab), Helmand (Hirmand), Harirud, Farāh and Khāsh. Ruttner-Kolisko (1980), based on their hydrological and chemical characteristics, classified Iranian inland waters in four categories: (1) exorheic rivers, reservoirs and swamps, (2) high alpine waters, (3) gradually–evaporating endorheic rivers and lakes, and (4) Astatic (unstable/temporary) desert springs and ponds.

Given that the climate of Iran has historically been regarded as semi-arid, the extended dry seasons in the country, chiefly in the last decade, have become a key concern. Drying lakes and rivers, declining groundwater levels, land subsidence, water quality deterioration, desertification, soil erosion, and dust and salt storms are the modern problems of a nation who was once one of the world's pioneers in sustainable water management (Madani et al. 2016). The annual precipitation is now less than the potential annual loss of water through evapotranspiration. Low precipitation and high evaporation rates, intense solar radiation and winds transferring the dry air masses, and mountain ranges, which prevent the transfer of moisture-laden air masses from Caspian and Mediterranean seas, are known as the main causes of the land dryness (Kehl 2009). These trends have more adverse effects when aquatic lives come into account. Several small to large lakes and rivers have been partly or completely dried out in the country. According to a recent study by the Iranian Parliament Research Center, 31 out of the 80 major Iranian lakes and wetlands, which are distinguished globally, have lost 60 to 100% of their water (http://rc.majlis.ir/en). Other than the global climate change, the state water mismanagement is blamed for its contribution to such losses (Madani et al. 2016). While impacts of the drought on larger residents of the inland water systems are noticeable, *e.g.*, mass mortality of fishes in Hāmoon Wetland in East and Zāyandeh-Rud River in Central

Iran, it is not clear to what extent the small aquatic invertebrates have been affected by this phenomenon.

31.3 A Biodiversity Hotspot

Iran contributes a significant share to the regional biological resources. Owing to its diverse geomorphological, topographical and climatic conditions, it is predictable that Iranian Plateau hosts a substantial blend of plant and animal taxa with high endemism rate. This is supported by the fact that the Plateau has historically acted as a bridge to connect three continents of Asia, Europe and Africa, resulting in its occupation by the European and Asian flora and fauna (Ghorbani 2013). Iran is located in the Palearctic realm at the crossroads of four biogeographical regions: the Euro-Siberian, the Irano-Touranian, the Nubo-Sindian and the Saharo-Arabian regions. The variety of landscapes arising from both this unique intersection of biogeographies and the physical and evolutionary processes operating across ecosystems and organisms have produced a diverse selection of flora and fauna. According to a recent estimation by the World Bank and Global Environment Facility, Iranian biodiversity has the highest economic value across Western Asia and the Middle East (Jowkar et al. 2016). The country's biodiversity hotspots are mostly distributed in north and west of Iran along the Alborz and Zāgros mountain ranges and are parts of the Irano-Anatolian biodiversity hotspot, which is designated as the 20th global hotspot region (Farashi and Shariati-Najafabadi 2017).

31.4 Rotifer Survey in Iran

Considering that scant records of field studies on Iranian water systems are available dating back to early and the mid-1800s (Marcet 1819; Abich 1856), Iranian Plateau remained relatively unexplored limnologically until the middle of the twentieth century. Heinz Löffler, a German limnologist, in a series of publications starting in 1949, described the environmental features of a number of Iranian water bodies and reported several fish, invertebrate and algal taxa, including 79 species and subspecies of rotifers from different locations in Iran: Hāmoon Lake in Sistān and Baluchestān Province, Lut Desert water basin in East Iran, Niriz (Bakhtegān) and Parishān Lakes in Fārs Province, Zāyandeh Rud water basin in Isfahān (Esfahān) Province, Zarivār Lake in Kurdistān (Kurdestān) Province, Urmia Lake in West Azarbaijān Province, and Anzali Wetland in Guilān (Gilān) Province (Löffler 1949/1950, 1953, 1961, 1981). His educational background and experience along with the adorable enthusiasm aided him to provide some of the exemplified technical and yet-valid reports with detailed characterization of the examined water bodies and many of the identified organisms. Over almost the same time period, an atlas of the Caspian Sea invertebrates, including the names and descriptions of 32 rotifer taxa, was published by Birshtain et al. (1968). They described the rotifers of the Caspian basin to be of three categories: (1) pre-estuarine, which accidentally enter into the coastal waters from the flowing rivers and are occasional members of the Caspian fauna, (2) euryhaline or eurybioant taxa, which are freshwater residents, but live in shallow, less saline coastal waters within the aquatic plants, and (3) stenohaline and less-frequently, euryhaline species living in saline waters. They also suggested that the number of rotifer taxa in the sea exceeds 300 species. While the reported taxa belonged to different parts of the sea and the exact sampling sites in the southern (Iranian) waters have not been delineated, they all are included in the list of Iranian rotifers collected in this review. The other pioneering studies on Iranian water systems were performed by two Austrian scientists, namely, Anton W. Ruttner and Agnes Ruttner-Kolisko. While their main focus seems to have been on investigating the geology and hydrology of some Iranian inland water basins (Ruttner-Kolisko 1966; Ruttner and Ruttner-Kolisko 1972, 1973), Ruttner-Kolisko (1980) reported the identification of about 100 rotifer species from Iranian salt lakes and desert pools by Löffler and herself. Although in her short article, she has briefly discussed on the ecological preferences of some rotifer species, she has not provided information on the identity of her rotifer inventories and their sampling locations. During the next two decades, no published report on Iranian rotifers was released. However, this does not necessarily imply that they have not been inspected by the native or overseas researchers. After a period of 'dormancy', research on the rotifers has been accelerated at the beginning of the twenty-first century, resulting in a surge in the publications by which a considerable number of Iranian rotifers were introduced. These accelerated efforts were mainly due to (1) a provoked general interest in Iranian biologists to investigate new and less-known subjects and present and publish their findings in international journals and communities, (2) the global trend of studying on more specific topics or group of organisms such as the phylum Rotifera, (3) a recent nationwide motivation to expand rotifer applications in aquaculture, and (4) the swift spread of Internet globally, which allowed the scientists to share their observations and experiences.

Anzali Wetland, an outstanding ecological heritage and one of the 25 Iranian wetlands of international importance (Ramsar Sites), and its adjacent water systems in Southern Caspian Sea are relatively extensively studied, mainly due to their proximity to one of the well-established fisheries research institute in the region. Most of these studies witnessed a considerably higher diversity and abundance of rotifers compared to the other zooplankton groups. Sabkara and Makaremi (2004) reported 50 genera of various zooplanktonic groups, including 26 rotifer genera, from Anzali Wetland. Later, they isolated 90 species of rotifers belonging to 36 genera from the wetland, of which 42 species of 13 genera were from the family Brachionidae (Sabkara and Makaremi 2009). Fallahi-Kaporchali et al. (2015) reported 30 rotifer genera from Anzali Wetland and the estuarine and coastal waters of Southern Caspian Sea. Fallahi and Sabkara (2015) noted that Rotifera was the most abundant zooplanktonic group in the wetland, comprising 31 out of the 60 identified genera of zooplanktons. However, the rotifers were not specified in their report. Golmarvi et al. (2017) reached a similar conclusion while studying the zooplankton of the wetland, noticing that out of the 61 zooplankton species, 30 belonged to the phylum Rotifera. Sabkara and Makaremi (2018) and Sabkara (2019) reported 89 species of 37 genera of rotifers from the wetland. In a recent survey, a total of 29 rotifer genera of 17 families have been identified from Anzali Wetland by Alavi et al. (2019). According to the latter study, Brachionidae and *Brachionus* were the most diverse rotifer taxa in the wetland, represented by 13 genera and 8 species, respectively. Rowshan-Tabari et al. (2003) investigated zooplanktons across the Iranian coastal line of the Caspian Sea at various depths, 10–100 m, and found Rotifera as the third most abundant zooplanktonic group (11%) after Cladocera (54%) and Copepoda (15%). Sabkara et al. (2006) investigated the zooplanktons of Kargānrud River flowing into the Caspian Sea and introduced *Keratella*, *Philodina*, *Synchaeta* and *Cephalodella* as the most abundant rotifer genera in the river comprising up to 17% of the total annual zooplankton abundance. Ghane-Sasansaraie (2007) by performing a physico-chemical and biological investigation on three major rivers in the Caspian Sea basin showed that rotifers from 11 genera were residing in the rivers. Khodaparast et al. (2012) recorded a total of 24 zooplankton species, including 9 rotifers, in the water column of three sampling sites at South Caspian Sea. Bagheri et al. (2013, 2014) reported the collective observations of their comprehensive study on zooplanktons of southwestern coast of the Caspian Sea during the years 1996–2010, in which 16 rotifer taxa were identified. Rowshan-Tabari et al. (2014) searched a broader area of the Southern Caspian coast for the zooplanktons, elapsing all three coastal provinces of Gilān, Māzandarān and Golestān. Of the 22 identified zooplankton species in their study, rotifers had the highest diversity (9 taxa) while were the second most abundant group after the copepods. According to their report, *Asplanchna priodonta* was the most abundant zooplankton in winter, reaching a density of over 3500 ind/m^3.

Studies on the rotifer diversity of other parts of the country have been sporadic. Sabkara and Makaremi (2003) investigated the zooplankton communities of Māku Dam Lake in Northwest Iran. They identified 17 rotifer taxa and found that Rotifera was the most abundant group in the lake, comprising two-third of the annual zooplankton population. Shayestehfar et al. (2008) introduced 13 rotifer taxa from Kor River in Fārs Province, South Iran. Mohammadzadeh et al. (2009) reported 10 rotifer genera from Amirkolāyeh Wetland in Northern Iran. Sabkara and Makaremi (2011) isolated 13 rotifer genera from Shoorābil Lake in Ardabil, Northwest Iran. Shayestehfar and Abdovis (2011) reported 6 rotifer species from a section of Kārun River running through Ahvāz City in Southwest Iran. They also observed rotifer population densities of up to 96 ind/l in the river. Jafari et al. (2011) conducted an ecological survey on Harāz River flowing in Māzandarān Province, North Iran, by which introduced 25 rotifer species with densities of 25–470 ind/m^3. Salavatian et al. (2011) identified 15 genera of zooplanktons, including 8 rotifer genera, while investigating Lār Dam Lake in Māzandarān Province. Papahn-Shooshtari et al. (2012) reported 4 families of Rotifera from Hoorolazim Wetlands, a complex of connected bodies of water on Iran-Iraq border. Sabkara and Makaremi (2013) documented the results of an earlier study on the zooplankton of Aras Dam Lake in Northwest Iran, in which 11 rotifer genera had been identified. The lake was also investigated by Mohsenpour-Azari (2017) who observed 19 rotifer taxa in its water. Farashi et al. (2014) found four rotifer genera, *Lecane*, *Brachionus*, *Trichocerca* and *Philodina*, in a cave stream, a tributary of the Dez River, in Lorestān Province, West Iran. The cave ecosystem was characterized by low water transparency, plankton abundance and concentrations of nutrients, while rotifers were the most abundant zooplankton therein. Ansari (2013) and Abbasi (2016) identified 25 and 19 rotifer species, respectively, from Shāzand suburb near Arāk City, Central Iran. Ansari et al. (2013, 2014) performed morphological analyses to discriminate inter- and intrapopulation variations in the rotifers *Lepadella patella*, *Brachionus urceolaris* and *B. quadridentatus* from Arāk County. Fathi et al. (2015) reported the predominance of rotifers of the genera *Keratella*, *Monostyla* (*Lecane*) and *Polyarthra* with abundances from 9000 to over 150,000 ind/m^3 in Choghākhor Wetland in Chāhārmahāl and Bakhtiāri Province, Central Iran. They witnessed the existence of a total of 16 rotifer genera in the wetland. Mohammadi and Reihan-Reshteh (2015) reported 23 monogonont rotifers from Harāz and Darakeh Rivers and Chitgar (Persian Gulf Martyrs) artificial lake in Tehran Province. Bagheri et al. (2017) found 37 zooplanktonic groups in Chitgar Lake in Tehran City, capital of Iran, among which Rotifera was the most diverse one represented by 20 genera. The lake is fed by Kan River originating from Mount Tochāl in Alborz Mountain Range. In a later study, however, Bagheri et al. (2018) only observed 11 rotifer genera in Kan River. Salavatian et al. (2016) reported the zooplankton of Arasbārān Dam Lake in Northwest Iran, including a list of 19 identified rotifer genera. Sinaei et al. (2017) in their study on the plankton of Sarbāz River in East Iran reported the genus *Brachionus* as the only rotifer taxon detected in the river. Ebrahimi-Dorche et al. (2018) identified 4 rotifer genera among the planktons of Zāyandehrud Dam Lake in central Iran.

During the years 2008 to 2010, three research projects were designed and performed at *Artemia* and Aquaculture Research Institute of Urmia University aiming at the discovery of biodiversity, ecological preferences, phylogenetics and aquaculture potential of the Iranian rotifers. Extensive sampling effort was invested across more than 40 water bodies in two provinces of West Azarbaijān, in Northwest, and Hormozgān, in South of Iran, during four seasons. As a result, more than 110 planktonic and epiphytic rotifer species and subspecies belonging to 41 genera and 22 families, including 61 new records from Iran, were identified and reported in the final project report and several peer-reviewed publications (Malekzadeh-Viayeh 2010a, b; Khaleqsefat et al. 2011; Malekzadeh-Viayeh and Špoljar 2012; Malekzadeh-Viayeh et al. 2014; Mills et al. 2017). Phylum Rotifera was also a focus of research by Faculty of Science of Tehrān University, through which the diversity of the local rotifer fauna was further explored. Hakimzadeh-Khoei et al. (2011) and Kordbacheh and Rahimian (2012) recorded 115 and 113 rotifer taxa, respectively, from various freshwater systems in Tehrān Province and its neighboring areas. Reihan-Reshteh and Rahimian (2014) reported 66 rotifer species from four major rivers of Kārun (Kāroon), Karkhe, Dez and Jarrāhi-Maroon, Shādegān

Wetland, and a number of small-to-large natural or artificial ponds in Khuzestān (Khoozestān) Province. Shādegān Wetland was earlier investigated by Kholfe-Nilsaz (2009) who found that Rotifera, with 12 out of the 24 genera, was the most diverse zooplanktonic group in the wetland, and among the rotifers, *Brachionus* and *Asplanchna* were the most abundant genera.

Similar to other planktonic groups, rotifers have also been studied out of their natural habitats, in small artificial ponds and water reservoirs. Mahdizadeh et al. (2006) recorded 14 rotifer genera from the earthen fish pond in Gilān Province. They have also observed significantly higher abundances of the rotifers in different seasons compared to the other zooplankton groups. Kamali-Sansiqi et al. (2014) identified the members of eight rotifer genera of *Adineta*, *Asplanchna*, *Brachionus*, *Gastropus*, *Keratella*, *Philodina*, *Polyarthra* and *Rotaria* in the earthen fish ponds of Gonbad-e-Kāvus in Golestān Province, Northeast Iran. While at least part of the rotifer communities in fish ponds may have originated in a different geographical location (*e.g.*, they may have been transferred alive or as resting eggs by water, fish larvae or organic fertilizers), they are herein considered to belong to where they are found.

To provide a more thorough inventory of the Iranian rotifers, the native species used in laboratory experiments are also included in the inventory presented in this chapter. Ahmadifard (2007) studied growth and body compositions of *B. calyciflorus* isolated from Anzali Wetland after being fed with different algal species. Farhadian et al. (2015) performed laboratory culture experiments on *Euchlanis dilatata* isolated from Hannā Dammed Lake in Semirom, Isfahān, using diverse feed items. Seyyedi-Abalvan et al. (2015) examined the effects of different nickel concentrations on population growth of *B. calyciflorus* sampled from Chāh-Nimeh reservoirs in Zābol, East Iran. Rufchaie et al. (2015) fed Persian sturgeon (*Acipenser persicus*) with vitamin C-enriched *B. calyciflorus* of Anzali Wetland to compare the nutritional value of different live foods by measuring the growth indexes of the fish.

While zooplankton communities of the Persian Gulf and Sea of Oman have recently been under investigation, the priority has been granted to the estimation of diversity and abundance of macrozooplanktons (Fazeli et al. 2013; Farhadian and Pouladi 2014; Abedi et al. 2014; Abedi 2015; Mokhayer et al. 2017). Pouladi et al. (2013) observed *Brachionus* rotifers among the zooplankton of Helle River estuary where the river meets the Persian Gulf, albeit only in their spring sampling. Recently, Khafaeizadeh et al. (2017) isolated 12 planktonic rotifer species from Bahmanshir River and its estuary on the northwestern coast of the gulf. Apart from less than a handful of records, almost nothing is known about the Iranian marine rotifer fauna. The distribution of locations where Iranian rotifers have been found and reported from is shown in Fig. 31.2.

Nearly all studies on Iranian rotifers have been performed based solely on their morphology. To contribute to the universal efforts addressing the question of cryptic speciation and puzzling taxonomy in *Brachionus plicatilis* species complex, we analyzed 15 clonal cultures of the putative members of this complex sampled from different localities in Iran using both their morphological and genetic (cytochrome c oxidase subunit 1-*COI*-DNA fragment) attributes (Malekzadeh-Viayeh et al. 2014).

Fig. 31.2 Map of Iran and its provincial districts. Red solid squares are to show the number of reports on Iranian rotifers in each district/province. Solid circles provide a rough comparison of the number of rotifer taxa reported from each district, where each circle is representative of about five taxa

Morphological analyses, based on nine linear measurements of the lorica, discriminated the 9 *Brachionus* rotifer strains whose body dimensions were available (Fig. 31.3), and the molecular comparisons illustrated that the rotifers belonged to four distinct entities: *B. plicatilis* senso stricto, s.s., *Brachionus* 'Austria', *Brachionus* 'Tiscar' and a putative native Iranian form (Fig. 31.4). However, the subsequent study by Mills et al. (2017) employing a nuclear gene region, the internal transcribed spacer subunit 1 (ITS1), in addition to the mitochondrial *COI* gene fragment discovered that none of the *Brachionus* rotifers from Iran could be regarded as a distinct or endemic species, as they constructed sister groups with those from other parts of the world.

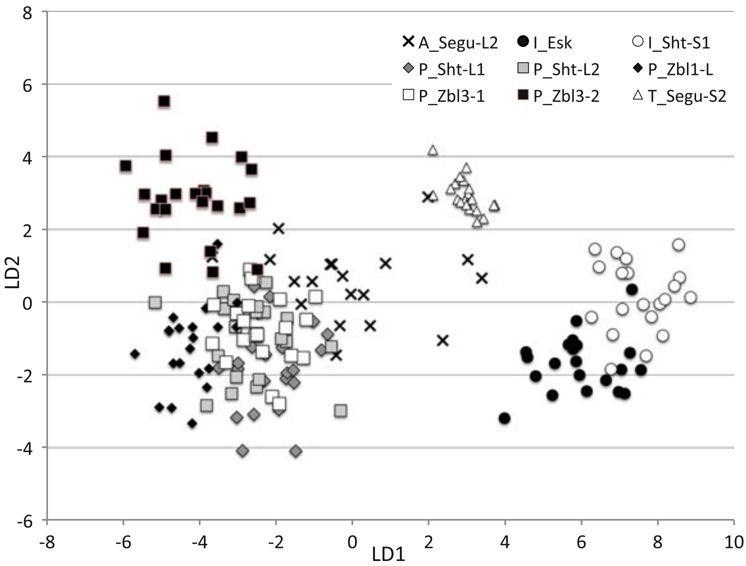


Fig. 31.3 The scatter plot resulted from a discrimination analysis based on the linear dimensions of nine *Brachionus* rotifer strains from Iran, denoted by different geometric shapes (Malekzadeh-Viayeh et al. 2014)

31.5 Notes on Iranian and Regional Rotifer Diversity

According to the existing literature, a total of 366 rotifer species and subspecies belonging to 69 genera and 27 families have so far been identified in Iranian waters. These exclude several rotifer taxa, which have been reported at genus or higher taxonomic levels. Regardless of sources of the records, all scientific and authority names were checked against the recently-updated global rotifer checklists and refined to omit the spelling errors and invalid taxa. A great majority of the rotifers (95.08%) belong to the subclass Monogononta, whereas 18 species (4.91%) representing 8 genera of 4 families are from the subclass Bdelloidea (Tables 31.1 and 31.2). The most diverse family is Brachionidae (58 species and subspecies, 15.85%), followed by Notommatidae (49 species and subspecies, 13.39%) and Lecanidae (44 species and subspecies, 12.02%). The families represented by the highest number of genera are Notommatidae (9 genera), Brachionidae (7 genera), and Euchlanidae, Flosculariidae and Philodinidae (5 genera each). *Lecane* is the most diverse genus (with 44 species and subspecies), followed by *Brachionus* (30 species and subspecies), *Cephalodella* (24 species and subspecies) and *Trichocerca* (23 species and subspecies). Several other rotifer families are present by only a single genus and species. The most widespread species with the highest distribution ranges are *Lecane lunaris* (found in 11 locations/water bodies), *Brachionus plicatilis* and *B. quadridentatus* (10 locations each), *L. bulla*, *L. luna* and *B. urceolaris* (9 locations each), and *B. calyciflorus*, *B. angularis*, *Keratella*

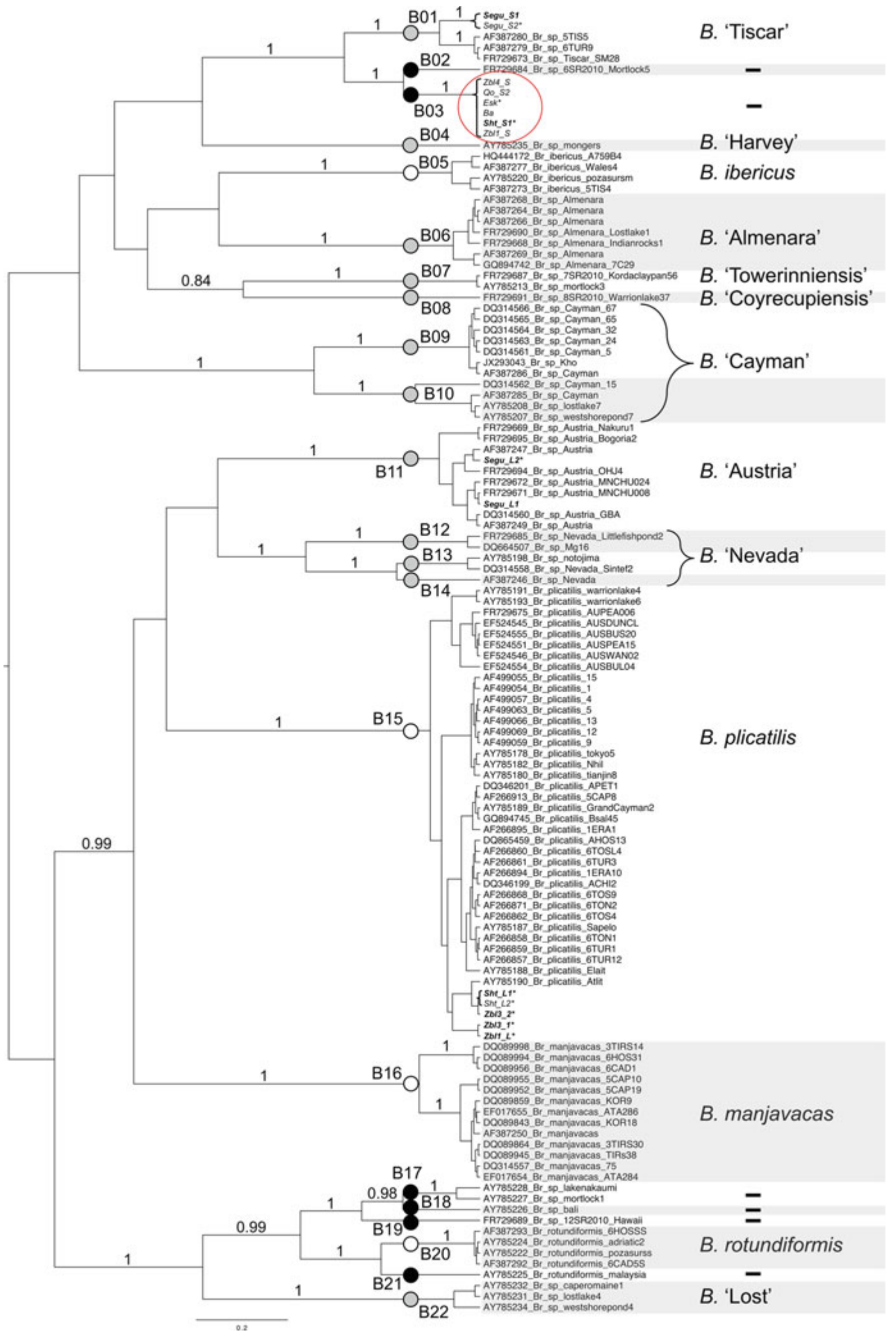


Fig. 31.4 Phylogenetic tree constructed based on the comparisons of the cytochrome c oxidize subunit 1 (*COI*) gene region of several members of the *Brachionus plicatilis* species complex from all over the world. The *Brachionus* rotifer strains from Iran made a distinct clade (shown in red circle) based on the *COI* phylogeny (Malekzadeh-Viayeh et al. 2014)

Table 31.1 Name and characteristics of the locations where the Iranian rotifers have been sampled from and their corresponding references

Site no.	Location/province	Climate	Position	Source
1	Caspian Sea	Humid continental	North	Birshtain et al. (1968), Rowshan-Tabari et al. (2003, 2014), Segers and De Smet (2008), Khodaparast et al. (2012), Bagheri et al. (2013, 2014), Fallahi-Kaporchali et al. (2015), Sabkara (2019), https://www.zin.ru
2	a. Anzali Wetland; Rivers in South Caspian Sea basin (b. Kargānrud, c. Haviq and d. Shafārud), e. Earthen fish ponds, and f. Amirkolāyeh Wetland, Gilān	Humid continental	North	Löffler (1961), Sabkara and Makaremi (2004, 2009, 2018), Sabkara et al. (2006), Mahdizadeh et al. (2006), Ghane-Sasansaraie 2007), Ahmadifard 2007), Mohammadzadeh et al. (2009), Fallahi-Kaporchali et al. (2015), Fallahi and Sabkara (2015), Rufchaie et al. (2015), Golmarvi et al. (2017), Sabkara (2019), Alavi et al. (2019)
3	a. Harāz River; b. Lār Dam Lake, Māzandarān	Humid continental	North	Jafari et al. (2011), Salavatian et al. (2011)
4	Golestān	Humid continental	North	Kamali-Sansiqi et al. (2014)
5	Tehrān	Moderate winters and hot summers, semi-arid steppe to alpine climate	North	Hakimzadeh-Khoei et al. (2011), Kordbacheh and Rahimian (2012), Mohammadi and Reihan-Reshteh (2015), Bagheri et al. (2017, 2018)
6	West Azarbaijān	Cool-temperate to cold/ Mediterranean, semi-arid	North-West	Löffler (1949, 1953, 1961), Sabkara and Makaremi (2003), Malekzadeh-Viayeh (2010a,b), Khaleqsefat et al. (2011), Malekzadeh-Viayeh and Špoljar (2012), Sabkara and Makaremi

(continued)

Table 31.1 (continued)

Site no.	Location/province	Climate	Position	Source
				(2013), Malekzadeh-Viayeh et al. (2014), Mohsenpour-Azari (2017)
7	Arasbārān Dam Lake, East Azarbaijān	Cool-temperate to cold/ semi-arid	North-west	Salavatian et al. (2016)
8	Shoorābil Lake, Ardabil	Cool-temperate to chilly/semi-arid	North-west	Sabkara and Makaremi (2011)
9	Zarivār Lake, Kurdestān	Moderate to cold, semi-arid to dry	West	Löffler 1961
10	Arāk and Shāzand Sub-urbs, Markazi	Moderate, with quite chilly summers and icy winters, desert, semi-desert, and moderate to cold mountainous	Center	Ansari (2013), Ansari et al. (2013), Abbasi (2016)
11	Dez River, Lorestān	Moderate to cold, subhumid continental	West	Farashi et al. (2014)
12	Khuzestān	Very hot to moderate and dry to semi-arid	South-West	Kholfe-Nilsaz (2009), Malekzadeh-Viayeh (2010a), Shayestehfar and Abdovis (2011), Papahn-Shooshtari et al. (2012), Reihan-Reshteh and Rahimian (2014), Khafaeizadeh et al. (2017)
13	Choghākhor Wetland, Chāhārmahāl and Bakhtiāry	Moderate to very cold and wet (rain and snow)	South-West	Fathi et al. (2015)
14	Zāyandeh Rud River basin; Gāvkhooni Wet-land; Hanna Dam Lake, Isfahān	Moderate, dry	Center	Löffler (1961), Farhadian et al. (2015), Ebrahimi-Dorche et al. (2018)
15	Bakhtegān and Parishān Lakes; Kor River, Fārs	Temperate, semi-arid	South-West	Löffler (1949, 1961, 1981), Shayestehfar et al. (2008)
16	Lut Desert water basin, Kermān	Hot and dry	South-East	Löffler (1961)
17	Hāmoon Lake; Sarbāz River, Sistān and Baluchestān	Hot to moderate, arid	South-East	Löffler (1961), Seyyedi-Abalvan et al. (2015), Sinaei et al. (2017)
18	Hormozgān	Very hot to moderate, humid-subtropical	South	Malekzadeh-Viayeh (2010a, b)

Table 31.2 Checklist of Iranian rotifers and their distribution across the country

Rotifer taxa	Location
Brachionidae Harring, 1838	
Brachionus angularis Gosse, 1851	1, 2a, 3a, 5, 6, 10, 12, 15
Brachionus angularis angularis Gosse, 1851	1
Brachionus angularis bidens Plate, 1886	1
Brachionus bidentatus Anderson, 1889	5, 6, 15
Brachionus calyciflorus Pallas, 1766	1, 2a, 3a, 5, 6, 12, 17, 18
Brachionus calyciflorus amphiceros Ehrenberg, 1838	1
Brachionus falcatus Zacharias, 1898	2a
Brachionus forficula Wierzejski, 1891	1
Brachionus budapestinensis Daday, 1885	1, 2a
Brachionus diversicornis Daday, 1883	1, 2a, 5, 12, 15
Brachionus bennini Leissling, 1924	6
Brachionus havanaensis Rousselet, 1911	12, 15
Brachionus leydigii Cohn, 1862	1, 5, 6, 12
Brachionus plicatilis Müller, 1786	1, 2a, 5, 6, 12, 14, 15, 16, 17, 18
Brachionus plicatilis plicatilis Müller, 1786	1, 12
Brachionus plicatilis decemcornis Fadeev, 1925	1
Brachionus asplanchnoidis Charin, 1947	6
Brachionus ‘Tiscar’	6
Brachionus quadridentatus Hermann, 1783	1, 2a, 3a, 5, 6, 10, 12, 15, 17, 18
Brachionus quadridentatus quadridentatus Hermann, 1783	1, 12
Brachionus rotundiformis Tschugunoff, 1921	1, 12
Brachionus cf. *rotundiformis*	12, 18
Brachionus nilsoni Ahlstrom, 1940	1, 6
Brachionus ibericus Ciros-Pérez, Gómez & Serra, 2001	18
Brachionus rubens Ehrenberg, 1838	2a, 5
Brachionus urceolaris Müller, 1773	1, 2a, 5, 6, 10, 12, 15, 17, 18
Brachionus urceolaris urceolaris Müller, 1773	12
Brachionus variabilis Hempel, 1896	2a, 5
Brachionus sericus Rousselet, 1907	12
Brachionus sp.	1, 2a, 2d, 2e, 4, 6, 7, 8, 11, 12, 13, 15
Keratella cochlearis (Gosse, 1851)	1, 2a, 5, 6, 10, 15
Keratella cochlearis cochlearis (Gosse, 1851)	8
Keratella tropica (Apstein, 1907)	1, 2a, 5, 6, 12, 15, 17, 18
Keratella lenzi Hauer, 1953	6
Keratella irregularis (Lauterborn, 1898)	6
Keratella procurva (Thorpe, 1891)	16, 17
Keratella quadrata (Müller, 1786)	1, 2a, 3a, 5, 6, 9, 15
Keratella quadrata quadrata (Müller, 1786)	12
Keratella tecta (Gosse, 1851)	6, 10, 12
Keratella f. *tecta*	6

(continued)

Table 31.2 (continued)

Rotifer taxa	Location
Keratella serrulata (Ehrenberg, 1838)	18
Keratella testudo (Ehrenberg, 1832)	17
Keratella valga (Ehrenberg, 1834)	1, 2a, 5, 12, 15
Keratella sp.	1, 2a, 2b, 2c, 2d, 2e, 3b, 4, 5, 6, 7, 8, 12, 13, 14
Notholca acuminata (Ehrenberg, 1832)	1, 2a, 3b, 5, 6, 9
Notholca labis Gosse, 1887	1, 5
Notholca salina Focke, 1961	6
Notholca salina salina Focke, 1961	12
Notholca squamula (Müller, 1786)	1, 2a, 5, 6, 9, 14, 15
Notholca striata (Müller, 1786)	5
Notholca psammarina Buchholz & Rühmann, 1956	5
Notholca foliacea (Ehrenberg, 1838)	3a
Notholca caudata Carlin, 1943	1, 6
Notholca cinetura Skorikov, 1914	1
Notholca sp.	2a, 6, 8, 13
Kellicottia longispina (Kellicott, 1879)	1, 3a, 7
Platyias quadricornis (Ehrenberg, 1832)v	1, 2a, 3a, 5, 6, 9, 12, 15
Platyias sp.	2a, 2f
Plationus patulus (Müller, 1786)	1, 2a
Anuraeopsis fissa (Gosse, 1851)	2a, 6
Anuraeopsis navicula Rousselet, 1911	2a
Anuraeopsis sp.	2a, 2e, 2f, 5, 7, 13
Notommatidae Hudson & Gosse, 1886	
Notommata aurita (Müller, 1786)	1, 5, 17
Notommata brachyota Ehrenberg, 1832	6
Notommata copeus Ehrenberg, 1834	1, 5, 12, 15
Notommata diasema Myers, 1936	6
Notommata glyphura Wulfert, 1935	5, 6
Notommata pygmaea Harring & Myers, 1922	6
Notommata tripus Ehrenberg, 1838	8
Notommata pseudocerberus de Beauchamp, 1908	1
Notommata sp.	2a, 6, 17
Cephalodella catellina (Müller, 1786)	2a, 5, 6, 12, 18
Cephalodella forficata (Ehrenberg, 1832)	6
Cephalodella physalis Myers, 1924	12
Cephalodella forficula (Ehrenberg, 1838)	1, 5, 6, 10, 12
Cephalodella gibba (Ehrenberg, 1830)	2a, 3a, 5, 6, 12, 18
Cephalodella gibboides Wulfert, 1951	6
Cephalodella gracilis (Ehrenberg, 1830)	10
Cephalodella gracilis gracilis (Ehrenberg, 1830)	6
Cephalodella inquilina Myers, 1924	8, 10
Cephalodella lepida Myers, 1934	6

(continued)

Table 31.2 (continued)

Rotifer taxa	Location
Cephalodella maior (Zavadovsky, 1926)	5, 12
Cephalodella misgurnus Wulfert, 1937	5
Cephalodella cf. *mus* Wulfert, 1956	6
Cephalodella obvia Donner, 1951	6
Cephalodella plicata Myers, 1924	5
Cephalodella stenroosi Wulfert, 1937	5, 6
Cephalodella sterea (Gosse, 1887)	6
Cephalodella tincaformis Koste, 1992	6
Cephalodella ventripes (Dixon-Nuttall, 1901)	2a, 5, 6
Cephalodella vittata Kutikova, 1985	6
Cephalodella anebodica Bērziņš, 1976	5
Cephalodella belone Myers, 1924	10
Cephalodella compressa Myers, 1924	10
Cephalodella pachyodon Wulfert, 1937	2a
Cephalodella sp.	2a, 2b, 2c, 2d, 2e, 3a, 5, 6, 7, 8, 9
Eosphora anthadis Harring & Myers, 1922	6
Eosphora cf. *anthadis*	12
Eosphora ehrenbergi Weber & Montet, 1918	6
Eosphora najas Ehrenberg, 1830	6, 12, 17
Eosphora therina Harring & Myers, 1922	18
Eothinia elongata (Ehrenberg, 1832)	6
Monommata actices Myers, 1930	5, 6
Monommata longiseta (Müller, 1786)	5
Monommata grandis Tessin, 1890	2a
Monommata sp.	2a, 5
Resticula melandocus (Gosse, 1887)	6, 12
Resticula nyssa Harring & Myers, 1924	6
Pleurotrocha atlantica Myers, 1936	12, 18
Pleurotrocha cf. *atlantica*	18
Pleurotrocha petromyzon Ehrenberg, 1830	5, 12
Pseudoharringia similis Fadeev, 1925	1
Taphrocampa annulosa Gosse, 1851	12
Drilophaga judayi Harring & Myers, 1922	10
Lecanidae Bartos, 1959	
Lecane aculeata (Jakubski, 1912)	2a, 12
Lecane bifastigata Hauer, 1938	12
Lecane bulla (Gosse, 1851)	1, 2a, 3a, 5, 6, 9, 14, 17, 18
Lecane bulla bulla (Gosse, 1851)	12
Lecane closterocerca (Schmarda, 1859)	1, 5, 6, 9, 10, 12
Lecane elsa Hauer, 1931	5
Lecane cf. *glypta* Harring & Myers, 1926	17
Lecane flexilis (Gosse, 1886)	2a, 6

(continued)

Table 31.2 (continued)

Rotifer taxa	Location
Lecane depressa (Bryce, 1891)	6
Lecane furcata (Murray, 1913)	5, 6, 9
Lecane grandis (Murray, 1913)	2a, 5, 12
Lecane hamata (Stokes, 1896)	1, 2a, 5, 6, 9, 12, 15
Lecane hastata (Murray, 1913)	6, 10, 18
Lecane inconspicua Segers & Dumont, 1993	8
Lecane lamellata (Daday, 1893)	5, 6, 12
Lecane leontina (Turner, 1892)	5
Lecane ludwigii (Eckstein, 1883)	1, 2a, 9
Lecane luna (Müller, 1776)	1, 2a, 5, 6, 9, 12, 14, 15, 17
Lecane lunaris (Ehrenberg, 1832)	1, 3a, 5, 6, 9, 10, 12, 14 15, 17, 18
Lecane nana (Murray, 1913)	5
Lecane obtusa (Murray, 1913)	5, 9, 15
Lecane opias (Harring & Myers, 1926)	5
Lecane arcuata (Bryce, 1891)	5
Lecane venusta Harring & Myers, 1926	5
Lecane papuana (Murray, 1913)	6, 12
Lecane plesia Myers, 1936	12
Lecane pumila (Rousselet, 1906)	6
Lecane punctata (Murray, 1913)	6, 12
Lecane pyriformis (Daday, 1905)	5, 10, 12
Lecane quadridentata (Ehrenberg, 1830)	1, 2a, 5, 6, 9, 14, 15
Lecane rhenana Hauer, 1929	1
Lecane scutata (Harring & Myers, 1926)	5, 12
Lecane stenroosi (Meissner, 1908)	1, 12, 15, 18
Lecane sympoda Hauer, 1929	5, 9
Lecane tenuiseta Harring, 1914	9
Lecane thalera (Harring & Myers, 1926)	2a, 6, 12, 15, 17, 18
Lecane curvicornis (Murray, 1913)	2a
Lecane cornuta (Müller, 1786)	1, 2a
Lecane crepida Harring, 1914	1
Lecane crenata (Harring, 1913)	1
Lecane ungulata (Gosse, 1887)	1, 12
Lecane broaensis Segers & Dumont, 1995	10
Lecane inermis (Bryce, 1892)	10
Lecane paradoxa (Steinecke, 1916)	10
Lecane sp.	1, 2a, 2c, 2e, 2f, 5, 6, 7, 11, 12, 13
Trichocercidae Harring, 1913	
Trichocerca cavia (Gosse, 1886)	6, 14, 15
Trichocerca caspica (Tschugunoff, 1921)	1, 2a
Trichocerca intermedia (Stenroos, 1898)	1
Trichocerca bicristata (Gosse, 1887)	1

(continued)

Table 31.2 (continued)

Rotifer taxa	Location
Trichocerca capucina (Wierzejski & Zacharias, 1893)	1
Trichocerca musculus (Hauer, 1936)	1
Trichocerca similis (Wierzejski, 1893)	1, 6, 10
Trichocerca tigris (Müller, 1786)	1, 2a
Trichocerca bidens (Lucks, 1912)	6
Trichocerca agnatha Wulfert, 1939	6
Trichocerca cylindrica (Imhof, 1891)	1, 5
Trichocerca elongata (Gosse, 1886)	1, 2a, 3a, 5, 6
Trichocerca heterodactyla (Tschugunoff, 1921)	1
Trichocerca longiseta (Schrank, 1802)	1, 2a, 5, 6, 9, 15
Trichocerca myersi (Hauer, 1931)	5
Trichocerca dixonnuttalli (Jennings, 1903)	9, 15
Trichocerca porcellus (Gosse, 1851)	2a, 5, 6, 12
Trichocerca pusilla (Jennings, 1903)	1, 2a, 5, 6, 9, 12, 15
Trichocerca rattus (Müller, 1776)	1, 2a, 6, 9, 15
Trichocerca stylata (Gosse, 1851)	1, 2a, 5, 16
Trichocerca tenuior (Gosse, 1886)	5
Trichocerca weberi (Jennings, 1903)	1, 6, 9, 15
Trichocerca obtusidens (Olofsson, 1918)	2a
Trichocerca sp.	1, 2a, 2d, 2e, 5, 6, 7, 8, 17
Lepadellidae Harring, 1913	
Lepadella acuminata (Ehrenberg, 1834)	1, 6, 10
Lepadella biloba Hauer, 1958	10
Lepadella (*Lepadella*) *biloba* Hauer, 1958	5
Lepadella (*Lepadella*) *costata* Wulfert, 1940	5
Lepadella heterostyla (Murray, 1913)	2a, 9, 15
Lepadella (*Lepadella*) *eurysterna* Myers, 1942	5
Lepadella ovalis (Müller, 1786)	1, 2a, 3a, 5, 6, 10
Lepadella (*Lepadella*) *ovalis* (Müller, 1786)	5
Lepadella patella (Müller, 1773)	1, 2a, 5, 6, 9, 10, 14, 15
Lepadella (*Lepadella*) *patella* (Müller, 1773)	5
Lepadella patella patella (Müller, 1786)	12
Lepadella cf. *discoidea* Segers, 1993	6
Lepadella (*Lepadella*) *punctata* Wulfert, 1939	5
Lepadella quadricarinata (Stenroos, 1898)	5, 12
Lepadella (*Lepadella*) *quadricarinata* (Stenroos, 1898)	5
Lepadella triptera (Ehrenberg, 1830)	1, 5, 6, 9, 15
Lepadella (*Lepadella*) *triptera* (Ehrenberg, 1830)	5
Lepadella neglecta Segers & Dumont, 1995	10
Lepadella (*Lepadella*) *apsida* Harring, 1916	2a
Lepadella (*Heterolepadella*) *ehrenbergii* (Perty, 1850)	2a
Lepadella (*Lepadella*) *hyalina* Smirnov, 1927	2a

(continued)

Table 31.2 (continued)

Rotifer taxa	Location
Lepadella sp.	2a, 2d, 2f, 5, 7, 8, 13
Colurella adriatica Ehrenberg, 1831	1, 2a, 3a, 5, 9, 12, 14, 15
Colurella colurus (Ehrenberg, 1830)	1, 5, 6, 10
Colurella obtusa (Gosse, 1886)	2a, 5, 6, 10
Colurella sanoamuangae Chittapun, Pholpunthin & Segers, 1999	12
Colurella uncinata (Müller, 1773)	1, 3a, 5, 6
Colurella uncinata bicuspidata (Ehrenberg, 1832)	6, 12
Colurella cf. *sinistra* Carlin, 1939	6
Colurella geophila Donner, 1951	2a
Colurella sp.	2a, 2c, 5, 6, 7
Squatinella lamellaris (Müller, 1786)	1, 2a, 12
Squatinella rostrum (Schmarda, 1846)	1, 2a, 5, 6, 9, 12, 15
Squatinella sp.	2a
Synchaetidae Hudson & Gosse, 1886	
Synchaeta cecilia Rousselet, 1902	1
Synchaeta cecilia f. *fusipes* Buchholz, 1954	1
Synchaeta grandis Zacharias, 1893	1
Synchaeta littoralis Rousselet, 1902	1, 6
Synchaeta tremula (Müller, 1786)	1, 6
Synchaeta neapolitana Rousselet, 1902	1
Synchaeta kitina Rousselet, 1902	1
Synchaeta longipes Gosse, 1887	1
Synchaeta baltica Ehrenberg, 1834	1
Synchaeta oblonga Ehrenberg, 1832	1, 2a, 5, 6
Synchaeta pectinata Ehrenberg, 1832	1, 2a, 5, 6, 9, 15, 17
Synchaeta stylata Wierzejski, 1893	1, 2a, 5
Synchaeta vorax Rousselet, 1902	1, 2a, 5
Synchaeta johanseni Harring, 1921	2a
Synchaeta sp.	1, 2a, 2b, 2d, 2e, 2f, 3b, 5, 6, 7, 8
Polyarthra dolichoptera Idelson, 1925	1, 2a, 3b, 5, 6
Polyarthra euryptera Wierzejski, 1891	1, 6
Polyarthra longiremis Carlin, 1943	1
Polyarthra luminosa Kutikova, 1962	1
Polyarthra remata Skorikov, 1896	1, 5, 6, 10
Polyarthra vulgaris Carlin, 1943	1, 2a, 3a, 5, 6, 9, 15, 17
Polyarthra major Burckhardt, 1900	1, 3a
Polyarthra minor Voigt, 1904	1, 6
Polyarthra sp.	2a, 2e, 4, 5, 6, 7, 8, 12, 13, 14
Ploesoma lenticulare Herrick, 1885	1
Ploesoma truncatum (Levander, 1894)	1
Ploesoma hudsoni (Imhof, 1891)	1
Ploesoma sp.	12

(continued)

Table 31.2 (continued)

Rotifer taxa	Location
Dicranophoridae Harring, 1913	
Dicranophorus forcipatus (Müller, 1786)	5, 6, 10
Dicranophorus luetkeni (Bergendal, 1892)	5
Dicranophorus epicharis Harring & Myers, 1928	6
Dicranophorus grandis (Ehrenberg, 1832)	1
Dicranophorus dolerus Harring & Myers, 1928	5
Dicranophorus sp.	2a
Dicranophoroides caudatus (Ehrenberg, 1834)	1, 5, 9, 12, 15
Encentrum uncinatum (Milne, 1886)	1, 3a
Encentrum saundersiae (Hudson, 1885)	2a, 6
Encentrum cf. *algente* Harring, 1921	6
Encentrum putorius Wulfert, 1936	12
Encentrum lutra Wulfert, 1936	5
Encentrum orthodactylum Wulfert, 1936	5
Encentrum cf. *putorius*	5
Encentrum ussuriensis De Smet & Chernyshev, 2006	10
Encentrum walterkostei Jersabek, 1994	10
Encentrum sp.	2a
Paradicranophorus hudsoni (Glascott, 1893)	1
Paradicranophorus aculeatus (Neizvestnova-Zhadina, 1935)	12
Aspelta angusta Harring & Myers, 1928	12
Hexarthridae Bartos, 1959	
Hexarthra fennica (Levander, 1892)	2a, 5, 6, 15, 16, 17
Hexarthra intermedia (Wiszniewski, 1929)	5, 9, 15, 17
Hexarthra mira (Hudson, 1871)	1, 2a, 5, 6, 9, 15, 17
Hexarthra oxyuris (Zernov, 1903)	1, 5
Hexarthra bulgarica (Wiszniewski, 1933)	6
Hexarthra jenkinae (de Beauchamp, 1932)	6
Hexarthra polyodonta (Hauer, 1957)	5
Hexarthra sp.	2a, 5, 6, 13
Asplanchnidae Eckstein, 1883	
Asplanchna brightwellii Gosse, 1850	1, 2a, 3b, 5, 6, 9, 12, 15
Asplanchna girodi Guerne, 1888	8
Asplanchna priodonta Gosse, 1850	1, 2a, 3a, 5, 6, 9, 12, 15
Asplanchna sieboldii (Leydig, 1854)	1, 6, 17
Asplanchna herricki Guerne, 1888	1
Asplanchna sp.	1, 2a, 2e, 2f, 4, 5, 6, 7, 8, 12, 13, 14
Asplanchnopus multiceps (Schrank, 1793)	1
Asplanchnopus sp.	1
Harringia rousseleti Beauchamp, 1911	15
Harringia eupoda (Gosse, 1887)	1
Euchlanidae Ehrenberg, 1838	

(continued)

Table 31.2 (continued)

Rotifer taxa	Location
Euchlanis dilatata Ehrenberg, 1832	1, 2a, 5, 6, 14, 16, 17, 18
Euchlanis dilatata dilatata Ehrenberg, 1832	12
Euchlanis incisa Carlin, 1939	1, 5
Euchlanis lyra Hudson, 1886	6, 12
Euchlanis parva Rousselet, 1892	9, 15, 18
Euchlanis pyriformis Gosse, 1851	1
Euchlanis calpidia (Myers, 1930)	1
Euchlanis alata Voronkov, 1912	1
Euchlanis arenosa Myers, 1936	1
Euchlanis deflexa (Gosse, 1851)	1, 3a
Euchlanis oropha Gosse, 1887	1
Euchlanis triquetra Ehrenberg, 1838	1
Euchlanis sp.	2d, 2f, 5, 12, 13
Beauchampiella eudactylota (Gosse, 1886)	1, 5, 15
Tripleuchlanis plicata (Levander, 1894)	1, 12
Dipleuchlanis propatula (Gosse, 1886)	1, 6
Diplois daviesiae Gosse, 1886	6
Flosculariidae Ehrenberg, 1838	
Ptygura furcillata (Kellicott, 1889)	5
Ptygura melicerta Ehrenberg, 1832	6
Ptygura tridorsicornis Summerfield-Wright, 1957	6
Sinantherina socialis (Linnaeus, 1758)	1
Sinantherina semibullata (Thorpe, 1893)	2a, 5
Sinantherina sp.	3a
Floscularia ringens (Linnaeus, 1758)	1, 5
Floscularia sp.	1
Lacinularia flosculosa (Müller, 1773)	1
Limnias melicerta Weisse, 1848	12, 15
Testudinellidae Harring, 1913	
Testudinella incisa (Ternetz, 1892)	5
Testudinella mucronata (Gosse, 1886)	5
Testudinella parva (Ternetz, 1892)	5
Testudinella patina (Hermann, 1783)	1, 2a, 5, 6, 9, 14, 15, 17
Testudinella truncata (Gosse, 1886)	2a
Testudinella sp.	2f
Pompholyx complanata Gosse, 1851	1
Pompholyx sulcata Hudson, 1885	1, 2a
Pompholyx sp.	2a, 5, 7, 8, 13
Mytilinidae Harring, 1913	
Mytilina mucronata (Müller, 1773)	1, 2a, 6, 9, 15
Mytilina ventralis (Ehrenberg, 1830)	1, 2a, 6, 9, 15
Mytilina ventralis brevispina (Ehrenberg, 1830)	9, 12, 14, 18

(continued)

Table 31.2 (continued)

Rotifer taxa	Location
Mytilina sp.	2a
Lophocharis oxysternon (Gosse, 1851)	1, 2a, 12
Lophocharis salpina (Ehrenberg, 1834)	3a, 5, 6, 9, 12, 18
Lophocharis naias Wulfert, 1942	5
Trichotriidae Harring, 1913	
Trichotria pocillum (Müller, 1776)	1, 2a, 5, 6, 12
Trichotria tetractis (Ehrenberg, 1830)	1, 2a, 3a, 5, 6, 9, 15
Trichotria tetractis similis (Stenroos, 1898)	5, 12, 18
Trichotria curta (Skorikov, 1914)	1
Macrochaetus altamirai (Arévalo, 1918)	12, 17
Macrochaetus collinsii (Gosse, 1867)	12
Macrochaetus subquadratus Perty, 1850	2a
Macrochaetus sp.	1, 2f, 5
Wolga spinifera (Western, 1894)	1
Trochosphaeridae Harring, 1913	
Filinia limnetica (Zacharias, 1893)	1, 5
Filinia brachiata (Rousselet, 1901)	6
Filinia longiseta (Ehrenberg, 1834)	1, 2a, 6, 15, 16, 17
Filinia terminalis (Plate, 1886)	1, 5, 6
Filinia cornuta (Weisse, 1847)	2a
Filinia sp.	1, 2a, 2e, 5, 6, 7, 8, 13
Collothecidae Harring, 1913	
Collotheca libera (Zacharias, 1894)	1
Collotheca campanulata (Dobie, 1849)	1, 2a
Collotheca mutabilis (Hudson, 1885)	1
Collotheca atrochoides (Wierzejski, 1893)	1
Collotheca heptabrachiata (Schoch, 1869)	5
Collotheca ornata (Ehrenberg, 1832)	1, 5, 6
Collotheca pelagica (Rousselet, 1893)	1, 5
Collotheca coronetta (Cubitt, 1869)	2a
Collotheca sp.	3b, 5, 7, 9, 13
Stephanoceros fimbriatus (Goldfusz, 1820)	1, 5
Proalidae Harring & Myers, 1924	
Proales reinhardti (Ehrenberg, 1834)	1
Proales minima (Montet, 1915)	5
Proales theodora (Gosse, 1887)	5, 12
Proales fallaciosa Wulfert, 1937	10
Proales decipiens (Ehrenberg, 1832)	2a
Proales sp.	2a
Conochilidae Harring, 1913	
Conochilus (*Conochiloides*) *dossuarius* Hudson, 1885	5
Conochilus hippocrepis (Schrank, 1803)	1

(continued)

Table 31.2 (continued)

Rotifer taxa	Location
Conochilus (*Conochilus*) *hippocrepis* (Schrank, 1803)	5
Conochilus unicornis Rousselet, 1892	1, 9, 17
Conochilus (*Conochiloides*) *coenobasis* (Skorikov, 1914)	1
Conochilus (*Conochiloides*) sp.	13
Epiphanidae Harring, 1913	
Epiphanes senta (Müller, 1773)	1, 5, 6, 10
Epiphanes brachionus (Ehrenberg, 1837)	2a
Epiphanes sp.	1, 2e
Proalides tentaculatus de Beauchamp, 1907	2a, 6
Proalides sp.	2a, 7, 8
Rhinoglena frontalis Ehrenberg, 1853	2a
Rhinoglena sp.	2a
Scaridiidae Manfredi, 1927	
Scaridium longicaudum (Müller, 1786)	1, 2a, 3a, 5, 6, 14, 15
Scaridium sp.	2a, 7
Gastropodidae Harring, 1913	
Gastropus stylifer Imhof, 1891	1
Gastropus minor (Rousselet, 1892)	1, 6
Gastropus hyptopus (Ehrenberg, 1838)	2a
Gastropus sp.	4
Ascomorpha ecaudis Perty, 1850	3a
Ascomorpha agilis Zacharias, 1893	5
Ascomorpha sp.	2a, 2e, 3b, 5, 7, 12, 13, 14
Lindiidae Harring & Myers, 1924	
Lindia (*Lindia*) *truncata* (Jennings, 1894)	6, 18
Lindia (*Lindia*) *janickii* Wiszniewski, 1934	6, 18
Lindia (*Lindia*) *torulosa* Dujardin, 1841	12
Ituridae Sudzuki, 1964	
Itura aurita (Ehrenberg, 1830)	1, 6
Itura chamadis Harring & Myers, 1928	2a
Itura viridis (Stenroos, 1898)	2a
Philodinidae Ehrenberg, 1838	
Philodina roseola Ehrenberg, 1832	5, 6, 10, 12, 15, 18
Philodina erythrophthalma Ehrenberg, 1830	2a
Philodina citrina Ehrenberg, 1832	5, 6
Philodina megalotrocha Ehrenberg, 1832	6
Philodina sp.	1, 2a, 2b, 2d, 2e, 2f, 3b, 4, 5, 6, 7, 11
Rotaria tardigrada (Ehrenberg, 1830)	5
Rotaria neptunia (Ehrenberg, 1830)	2a, 5, 6, 16, 17
Rotaria neptunoida Harring, 1913	6
Rotaria macrura (Ehrenberg, 1832)	5
Rotaria rotatoria (Pallas, 1766)	5, 6, 18

(continued)

Table 31.2 (continued)

Rotifer taxa	Location
Rotaria socialis (Kellicott, 1888)	5
Rotaria citrina (Ehrenberg, 1838)	10
Rotaria sp.	2a, 2c, 2d, 2e, 4, 5, 7, 8, 12
Dissotrocha macrostyla (Ehrenberg, 1838)	5
Dissotrocha aculeata (Ehrenberg, 1832)	2a, 6
Embata laticeps (Murray, 1905)	5
Macrotrachela quadricornifera Milne, 1886	5
Habrotrochidae Bryce, 1910	
Habrotrocha constricta (Dujardin, 1841)	5
Habrotrocha sp.	6
Philodinavidae Harring, 1913	
Philodinavus paradoxus (Muray, 1905)	5
Adinetidae Hudson & Gosse, 1886	
Adineta vaga (Davis, 1873)	10
Adineta sp.	4, 6
Bdelloidea (unspecified taxa)	9, 14, 15, 17

The scientific names are updated according to the global rotifer checklist provided by Segers (2007), Rotifer World Catalog (http://rotifera.hausdernatur.at/), and World Register of Marine Species (WORMS) (http://www.marinespecies.org). For *Brachionus plicatilis* species complex, the names are adapted to the recent revisions by Mills et al. (2017). Based on such considerations, some of the reported taxa with invalid scientific names are excluded. Numbers refer to the locations described in Table 31.1

tropica, *Platyias quadricornis*, *Lepadella patella*, *Colurella adriatica*, *Polyarthra vulgaris*, *Asplanchna brightwellii*, *A. priodonta*, *Euchlanis dilatata* and *Testudinella patina* (8 locations each). A large number of recorded rotifers (203 species and subspecies and a number of those identified at genus level) were each found only once or in a single location or water body. These include 81 taxa observed only in Caspian Sea water basin, 44 in Tehrān and 43 in West Azarbaijān provinces. More studies are required to elucidate to what degree the distribution of Iranian rotifer fauna is geographic-specific or is related to the environmental or climatic conditions. The rotifers have been sampled from various aquatic ecosystems comprising the small and large rivers, lakes, wetlands, temporary and permanent lagoons, pools, sinkholes and artificial reservoirs. The largest investigated water body is the Caspian Sea. Considering that the rotifers of some water systems have been reported at genus or higher levels (*e.g.*, 10 rotifer genera from Amirkolāyeh Wetland—Mohammadzadeh et al. 2009, 12 genera from Shādegān Wetland—Kholfe-Nilsaz 2009, 13 genera from Shoorābil Lake—Sabkara and Makaremi 2011, 8 genera from Lār Dam Lake—Salavatian et al. 2011, 4 rotifer families from Hoorolazim Wetlands—Papahn-Shooshtari et al. 2012, 11 genera from Aras Dam Lake—Sabkara and Makaremi 2013, 16 genera from Choghākhor Wetland—Fathi et al. 2015, and 19 genera from Arasbārān Dam Lake—Salavatian et al. 2016), these bodies of water seem to have a wealth of rotifer diversity that may substantially increase the number of Iranian rotifers.

While the Iranian provinces have been formed based mainly on the administrative or cultural considerations, many of them represent specific geography and climate. On the other hand, there may be similar conditions in distinct provinces. Similarly, the natural watershed boundaries of the country coincide neither with the administrative divisions nor with the climatic zones. As a result, shaping a robust framework for species distribution and biogeography based on the provincial divisions cannot be reasonable. Notwithstanding this, the provincial borders are used in order to locate the study sites and to provide a rough comparison of the extent of the studies countrywide. With regard to this, the highest rotifer diversity (234 taxa) has so far been reported from the northern provinces of Gilān, Māzandarān and Golestān, situated in the water basin of the Caspian Sea. These are followed by Tehrān and West Azarbaijān as the next most-intensively-investigated provinces with the highest numbers of rotifers reported (164 and 151 taxa, respectively). Although a considerable amount of data has so far been gathered on Iranian rotifer diversity in some locations, a vast portion of the country has not yet been searched for these ubiquitous creatures; that is, rotifers have been reported from only 17 out of the 31 provinces in Iran. For eight provinces, only a single report is available and two of these reports are older than half a century (Table 31.1 and Fig. 31.2). The investigated areas are located in varying latitudes with diverse climatic conditions. However, as can be seen in Fig. 31.2, they are mostly distributed in northern and western parts of the country where moderate to cold weather and semidry to humid climatic conditions are dominant and the average annual precipitation is higher than that of the eastern and central areas. Thus, while higher rotifer records from some parts of the country are primarily a consequence of more study efforts, they also reflect the suitability of environmental conditions and availability of aquatic habitats for diversification and colonization of the rotifers in those territories. Not unexpectedly, the rotifer-rich regions coincide with the distribution of major biodiversity hotspots in Iran (Farashi and Shariati-Najafabadi 2017). Nevertheless, given that the intensity of studies has also been very different in the investigated locations, the current list of Iranian rotifer taxa is undoubtedly very incomplete.

As the country is located at the crossroad of various biogeographies with diverse climatic conditions (Jowkar et al. 2016), it is no surprise that the representatives of various biogeographies are present in the rotifer inventories from Iran. While vast majority of rotifer taxa observed in Iran are cosmopolitan in nature, the taxa reported exclusively from single biogeographies across the globe (Segers 2007) have also been found in Iranian waters. These include the Nearctic (*Aspelta chorista*, *Cephalodella ablusa*, *C. abstruse*, *C. angusta*, *C. asarcia*, *C. astricta*, *C. collactea*, *C. compressa*, *C. conjuncta*, *C. compressa*, *C. conjuncta*, *C. derbyi*, *C. dixonnuttalli*, *C. eunoma*, *C. montana*, *C. mucosa*, *Euchlanis arenosa* and *Notommata pygmaea*), Neotropical (*C. tincaformis*, *Lecane broaensis* and *Lepadella* (*Lepadella*) *neglecta*) and Palearctic (*Brachionus asplanchnoides*, *B. ibericus*, *C. gibboides*, *C. mus*, *C. vittata*, *Encentrum walterkostei*, *L. inconspicua*, *L. paradoxa*, *Lepadella* (*Lepadella*) *costata*, *Notholca cinetura*, *Paradicranophorus* *aculeatus*, *Pseudoharringia similis*, *Ptygura tridorsicornis*, *Synchaeta cecilia* and *Trichotria curta*) rotifers. Nevertheless, no exclusively Australian, Antarctic, African, or Oriental rotifers have so far been reported from Iran (Table 31.2). Reihan-Reshteh and Rahimian (2014) suggested that multi-original nature of several Iranian rotifers is a result of the existence of natural bridges in the region which has facilitated the cross of organisms between the biogeographies.

From a regional perspective, except for India and Turkey, studies on rotifer biodiversity of the neighboring countries have been rather occasional. Because several water basins extend into and are shared among the adjacent countries, it would be beneficial to review the history of regional studies and the resulting rotifer inventories. A very early study on the plankton of the northern Caspian Sea was carried out by Tschugunoff (1921) who identified 92 zooplankton species, including 42 rotifers. Salahova et al. (2014) reported 20 rotifer species from 6 sampling sites on the Caspian Sea coasts in Azerbaijan Republic. *Trichocerca* (4 species), *Brachionus* (4 species) and *Synchaeta* (3 species) were the most abundant genera. They also cited a preceding survey, according to which, about 190 mesoplankton species live in the Caspian Sea, and among these, some 82 are in southern part of the Sea, with Rotifera being the most diverse mesoplankton group. A list of 145 rotifer species from Caspian Sea basin has been provided by Caspian Sea Biodiversity Project and almost all of them are from the northern freshwaters, mainly the Volga River territory (https://www.zin.ru/projects/caspdiv/caspian). Several rotifer species sampled in the south Caspian Sea are also freshwater residents originating from the associated water bodies, such as Anzali Wetland (Bagheri et al. 2013). While such species as *Trichocerca caspica*, *Trichocerca* (*Diurella*) *heterodactyla* and *Keratella tropica* f. *taurocephala* are marked as endemic to Caspian Sea (Segers and De Smet 2008, https://www.zin.ru), questions are raised over their taxonomic validity and endemicity. For instance, *T. caspica* and *T. heterodactyla* are deemed to be the erroneous alternatives of *T. marina* and *T. dixonnutalli*, respectively (Dr. H. Segers pers.com). It is assumed that more efforts have been done by the former Soviet Union and Russian scientists to evaluate the Caspian biological resources. However, as many of them have not been publicized or reported in English, they cannot be accessed in the online literature or universal data banks. Notwithstanding that a substantial fraction of the Caspian Sea invertebrates are yet to be discovered, a decline in their diversity and density has been noted. Climate as well as the hydrological changes, environmental degradation, and the invasive species are regarded as the main causes of the alteration in zooplankton communities in the south Caspian Sea (Bagheri et al. 2013, 2014; Rowshan-Tabari et al. 2014). India is a rather well-studied country in the region for its rotifer fauna. The first report on Indian rotifers belongs to the year 1889 (Sinha 2014). Since then, several studies have been conducted on their diversity (*e.g.*, Dhanapathi 1974; Arora and Mehra 2003; Sharma and Sharma 2005, 2011; Siddiqi and Karuthapandi 2013; Sharma 2017), resulting in the discovery of more than 490 rotifer species; which represents India as the host for the highest rotifer diversity in South-West Asia (Sinha 2014). While the records of rotifers for as old as the year 1903 are available from Turkey, the new surge of research on its rotifer fauna started in the 1980s (Dumont and De Ridder 1987;

Bekleyen 2001; Kaya and Altındağ 2007a,b; Kaya et al. 2007; Bekleyen et al. 2011; Ustaoğlu et al. 2012). The current list of rotifers from Turkey comprises 417 taxa (Ustaoğlu 2015). Considering that these taxa are recorded in 263 published literature, which are far more than the published reports of Iranian rotifers, if a comparison of rotifer discovery per sampling effort would be reasonable, rotifer diversity in Iran may be relatively higher than that of Turkey. A survey of water bodies in several locations in Turkey during the years 1992–1999 led to the detection of only 71 rotifer species (Altındağ and Yiğit 2001). Özdemir Mis and Ustaoğlu (2017) isolated 63 rotifer taxa by studying 59 high-mountain lakes in Northeast Turkey. Interestingly, the four most diverse rotifer genera in Iran and Turkey are the same and despite the much higher total rotifer records for Turkey, the number of species of its first four genera is similar to those for their Iranian congeners (*i.e.*, *Lecane* with 51, *Cephalodella* with 29, *Trichocerca* with 27 and *Brachionus* with 20 species and subspecies) (Ustaoğlu 2015). A further notable point in comparisons of the rotifer diversity in Iran and Turkey is that a higher diversity of *Brachionus* rotifers has been observed in the former country. There was no record of Rotifera from Arabian Peninsula until the late twentieth century. Segers and Dumont (1993) identified 118 monogonont rotifers from five Arabian states in south Persian Gulf. Similar to that for Turkey, the three most specious rotifer genera in the Peninsula and Iran are the same. While geographical proximity might explain such similarities, despite the diverse climates in most Iranian territories, Arabian Peninsula has almost constant climatic conditions year-round with high temperature and evaporation rates and most likely, the aquatic habitats with higher water salinities. According to the discussion provided by Aloufi and Obuid-Allah (2014), in spite of a considerable body of studies taken place in Saudi Arabian waters, they support a rather low zooplankton, including rotifer, diversity. Research on the rotifers in Iraq started more recently. Rabee (2010) and Abd Al-Rezzaq et al. (2014) reported 32 and 128 rotifer taxa from Iraqi waters, respectively. Abdulwahab and Rabee (2015) found 65 rotifer taxa from the Tigris River. Ahmed and Ghazi (2014) and Hammadi et al. (2016) identified 26 and 99 rotifer species, respectively, from Shatt al-Arab, a conjoined river of Tigris and Euphrates flowing into the Persian Gulf. Rotifers have also been considered in some ecological studies in Iraq (Al-Saboonchi et al. 2012; Salman et al. 2014). The external and internal conflicts during the last two decades may have been a reason that only a limited part of Iraq has been limnologically investigated. Reihan-Reshteh and Rahimian (2014) found a high similarity between the rotifer fauna of Khuzestān Province, Southwest Iran, and those of the Arabian waters and considered it as a consequence of the geological events connecting South Iranian Plateau to Arabian Peninsula. Reports on rotifers from Pakistan are scant, but its rotifer diversity appears to be worth noticing (Baloch and Soomro 2004; Sahato and Lashari 2004; Sulehria and Malik 2013; Hussain et al. 2016). While a majority of reports on regional rotifer diversity have been published in domestic or mediocre journals and are not backed up by detailed illustrations or proof of the identifications, they can still reflect the existence of a wide variety of rotifers in this part of the world, which are worthy of being accounted in global biodiversity estimations. Regardless of extent of the studies, a brief comparison of the rotifer diversity in the Near- and Middle Eastern countries testifies the high species richness of the Iranian rotifer fauna. It should also be noted that despite the timely literature review to provide the most complete list of the rotifers, there might still exist more records under university theses or locally-provided project reports which have not been inseminated. Thus, the number of identified rotifer species from Iran could exceed the present counts.

Considering that there may be more studies underway on Iranian rotifers, based on the current data, only a small proportion of the country's area has been searched for the rotifers and many pristine areas exist which are yet to be studied (Fig. 31.2). Thus, Iran can be considered as a virgin source and a potential hotspot of rotifer biodiversity, and it is predictable that many more rotifer taxa would be discovered and introduced from the country and its conjugated water basins in the future. Furthermore, Iranian marine rotifers, *i.e.*, those living in Persian Gulf and Sea of Oman, are left to be investigated and identified, holding promise for the observation of higher and exclusive rotifer diversity.

Despite acceleration of the research on Iranian rotifers in recent years, several factors may have contributed to the overall scarcity of studies and information. They include the limited number of skilled scientists, as well as difficulties to inspect small-sized and highly diverse rotifer groups. These are more effective when the more complex forms are to be examined. For instance, bdelloid rotifers can, at present, be identified only while alive and need to be examined during feeding and creeping (Segers 2008). This might be a reason why not many of them are among the rotifers recorded from all over the world, including Iran. Furthermore, while a considerable share of the introduced taxa are reported at genus or higher levels, it is not clear whether all of those at species or subspecies level have been identified accurately, identified, as no complementary approach, *e.g.*, using electron microscopy and molecular techniques, has been applied to confirm the identities. Thus, although this review discloses a fairly high diversity of rotifers discovered from Iranian mainland waters, the number of recorded rotifer species should be considered with caution, as rotifer identification at species level is mostly confusing and for many rotifer species requires detailed infrastructural examination of body sections such as their trophi (Segers 2008), assessment of reproductive isolation (Snell 1989), and application of genetic markers (Fontaneto 2014); neither of which has been provided in the records of Iranian rotifers, except for few morphological and molecular studies (Malekzadeh-Viayeh 2010b; Kordbacheh and Rahimian 2012; Malekzadeh-Viayeh et al. 2014; Mills et al. 2017). Moreover, it has been proven that for many rotifer species, several cryptic taxa exist within a single species (Leasi and Norenburg 2014). Therefore, future investigations on rotifer diversity in Iran must be assisted by precise ultrastructural and molecular inspections to provide an actual estimation of the diversity. Further studies should also address the relationships between environmental variables and the rotifer diversity and the question of possible rotifer dispersal across the country naturally or by human, birds or other animal vectors, as well as the historical affinity of the rotifers from water basins of the neighboring countries through genetic analyses.

A notable obstacle for further rotifer surveys in Iran is the consistent long-term drought, which has impacted the country during the last decade, shrinking the large and completely drying the small water bodies. Rotifers are among the few animal entities that produce dormant/resting eggs during their life cycle. These eggs can retain their viability for several decades if embedded within the sediments in oxygen-free conditions (Hairston 1996; Brendonck and De Meester 2003). Maximum age of the hatchable zooplankton eggs is estimated to be 332 year (Hairston et al. 1995). Piscia et al. (2012) found that *B. calyciflorus* resting eggs as old as ca. 100 years were still viable. Thus, optimal rotifer survey for a more thorough recording of Iranian rotifer diversity may require recovery of the dormant eggs from the dried water-systems beds and their identification following the production of laboratory cultures.

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