

Review

Rotifer Species Diversity in Mexico: An Updated Checklist

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Abstract: A review of the Mexican rotifer species diversity is presented here. To date, 402 species of rotifers have been recorded from Mexico, besides a few infraspecific taxa such as subspecies and varieties. The rotifers from Mexico represent 27 families and 75 genera. Molecular analysis showed about 20 cryptic taxa from species complexes. The genera *Lecane*, *Trichocerca*, *Brachionus*, *Lepadella*, *Cephalodella*, *Keratella*, *Ptygura*, and *Notommata* accounted for more than 50% of all species recorded from the Mexican territory. The diversity of rotifers from the different states of Mexico was highly heterogeneous. Only five federal entities (the State of Mexico, Michoacán, Veracruz, Mexico City, Aguascalientes, and Quintana Roo) had more than 100 species. Extrapolation of rotifer species recorded from Mexico indicated the possible occurrence of more than 600 species in Mexican water bodies, hence more sampling effort is needed. In the current review, we also comment on the importance of seasonal sampling in enhancing the species richness and detecting exotic rotifer taxa in Mexico.

Keywords: rotifera; distribution; checklist; taxonomy



check for updates

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1. Introduction

Taxonomical studies involving species richness provide information on the global patterns of species distribution and are helpful to detect changes associated with climate or global trade. For example, in Mexico, the number of exotic and thus invasive species has been steadily increasing during the last two decades [1,2]. The existence of taxonomic checklists is helpful to confirm this.

Mexico is one of the megadiverse countries and accounts for about 10% of the world's biodiversity [3]. Despite well-classified geographical regions of Mexico [4], the description of the distribution of different groups of animal species is still fragmentary, especially with reference to invertebrates, including rotifers. Freshwater zooplanktonic groups are mainly composed of ciliates, rotifers, cladocerans, and copepods. Rotifers, being important trophic links in aquatic ecosystems, have been the focus of basic research, such as taxonomy and autecology, and applied aspects, such as ecotoxicology, aquaculture, and water quality indicators [5].

Studies on the rotifer species richness in Mexico have been steadily gaining importance during the last 25 years. Earlier studies were mainly sporadic and, at times, biased, with a limnological perspective [6]. Species checklists of rotifers from the Mexican territory are available only for selected regions. For example, information about the distribution of rotifers exists for the State of Mexico, Aguascalientes, Michoacán, Mexico City, and a few regions of the Yucatan Peninsula [7–13]. However, larger parts of the Mexican territory still lack such information. The first national checklist of rotifers from Mexico was produced during the late 1990s [14]. Since then, considerable progress has been made on the distribution of rotifers in different regions, although no attempts have been made to update the checklist.

Numerous models and computer programs are available to predict the possible number of species in a region or nation based on species accumulation and rarefaction curves, the presence or absence of given taxa, etc. For example, for understanding the state of biodiversity, models such as ICE, Chao 2, Jackknife, and Bootstrap are traditionally used to obtain species estimates for different groups of organisms [15]. Significant errors may still occur if the published reports of species are not corrected or weak data with large sampling gaps are used. In Mexico, the National Commission for the Knowledge and Use of Biodiversity (Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, CONABIO) contains data on the biodiversity of different groups of organisms, yet information on patterns of distribution of groups such as rotifers within its territorial jurisdiction are limited.

This work aimed to provide a comprehensive list of rotifer species recorded and document their distributional patterns from different regions of Mexico.

2. Materials and Methods

A bibliographic review of rotifer diversity studies from Mexico was conducted using the standard databases in the Web of Science using the search words “rotifer*”, “Mexic*” and “diversity” during the entire period available in each database (retrieved during May 2021). The records were then consulted in the full text, and we checked each work for the records of rotifer species. We also consulted works from other non-indexed journals but avoided contributions that contained only genus-level descriptions for rotifers. The data were sorted out into Excel files according to the geographical entities of Mexico. In addition, the documents available from CONABIO were also considered. For species nomenclature, we followed standard works on Rotifera [16,17]. The checklist provided here does not contain a listing of the infraspecific taxa. Therefore, only species were enumerated. However, infraspecific taxa were reported in the checklist without assigning an additional number.

Due to the increased accessibility of molecular tools in the study of systematics of rotifers, several cryptic taxa of commonly distributed species within genera such as *Brachionus*, *Keratella*, *Asplanchna*, and *Lecane* have been documented. However, cryptic species without formal description were not included in the checklist, although references to such studies are made in a separate table. When a known species was already reported from Mexico (e.g., *Philodina roseola*), the same taxon with *conferatur* status (e.g., *Philodina* cf. *roseola*) was not numbered. However, if a taxon was reported only with *conferatur*, it was considered for numbering (e.g., *Notholca* cf. *liepeterseni*). Further, taxa that have been identified as having potential species status but not described are not included here, for example, *Brachionus* sp. “Mexico” [18] and *Hexarthra* n. sp. [19]. In addition, as far as possible, we used published reports of species. When necessary, we checked the species identifications based on the illustrations provided in the articles with those from standard literature [20–23]. Yet, some taxa with species *inquirenda* status (e.g., *Polyarthra trigla*) were retained as such pending further studies. The species checklist was not arranged based on phylogeny of Rotifera. Rotifer families were arranged alphabetically, and within each family and genus, the species were all in alphabetic order. This facilitated reporting new records in future research.

A nonparametric analysis of species richness of Rotifera reported from Mexico was performed using the updated checklist. Models/computer simulations based on Chao 2, Jackknife 2, and Bootstrap were performed using EstimatesS 9 [24]. From the diversity estimators, we derived the efficiency percentage of each estimator with the following formula:

$$\frac{S_{observed}}{S_{estimated}} \times 10$$

3. Results

Mexico has 31 states and a capital, Mexico City. The total number of rotifer species reported from Mexico was 402, besides a few infraspecific taxa such as subspecies and

varieties. The list of consulted works is available in Supplementary 1 with coordinates for each federal entity obtained from the Mexican National Institute of Statistics and Geography (INEGI). The database, created using published works from Mexican Rotifera, is presented in Supplementary 2. Rotifers from Mexico represented 27 families and 75 genera (Table 1). Only eight genera, viz., *Lecane*, *Trichocerca*, *Brachionus*, *Cephalodella*, *Lepadella*, *Keratella*, *Ptygura*, and *Notommata*, of rotifers had more than 50% of the total species recorded from the Mexican territory. Each of these genera had at least 10 species, while the remaining genera had less than 10 species each. Of the 15 species recorded with *conferatur* status, 11 were from Chihuahua and Quintana Roo. To date, molecular analysis has revealed the existence of 17 taxa as species complexes consisting of cryptic species (Table 2).

Table 1. Checklist of rotifer species recorded from Mexico.

Subclass: Bdelloidea Hudson, 1884	
Order: Adinetida Melone & Ricci, 1995	
Family: Adinetidae Hudson & Gosse, 1886	
1	<i>Adineta vaga</i> (Davis, 1873)
Order: Philodinida Melone & Ricci 1995	
Family: Philodinidae Ehrenberg, 1838	
2	<i>Dissotrocha aculeata</i> (Ehrenberg, 1830)
3	<i>Macrotrachela sonorensis</i> Örstan, 1995
4	<i>Philodina acuticornis</i> Murray, 1902
5	<i>Philodina megalotrocha</i> Ehrenberg, 1832
6	<i>Philodina roseola</i> Ehrenberg, 1832
	<i>Philodina</i> cf. <i>roseola</i> Ehrenberg, 1832
7	<i>Pleuretra africana</i> Murray, 1911
8	<i>Rotaria citrina</i> (Ehrenberg, 1838)
9	<i>Rotaria elongata</i> (Weber, 1888)
10	<i>Rotaria magnacalcarata</i> (Parsons, 1892)
11	<i>Rotaria neptunia</i> (Ehrenberg, 1830)
12	<i>Rotaria rotatoria</i> (Pallas, 1766)
Subclass: Monogononta Plate, 1889	
Order: Collothecacea Haring, 1913	
Family: Atrochidae Haring, 1913	
13	<i>Atrochus tentaculatus</i> Wierzejski, 1893
14	<i>Cupelopagis vorax</i> (Leidy, 1857)
Family: Collothecidae Haring, 1913	
15	<i>Collothecha ambigua</i> (Hudson, 1883)
16	<i>Collothecha campanulata</i> (Dobie, 1849)
17	<i>Collothecha coronetta</i> (Cubitt, 1869)
18	<i>Collothecha crateriformis</i> Offord, 1934
19	<i>Collothecha ornata</i> (Ehrenberg, 1832)
20	<i>Collothecha pelagica</i> (Rousselet, 1893)
21	<i>Collothecha riverai</i> Vilaclara & Sládeček, 1989
22	<i>Collothecha tenuilobata</i> (Anderson, 1889)
23	<i>Collothecha trilobata</i> (Collins, 1872)
24	<i>Stephanoceros millsii</i> (Kellicott, 1885)
Order: Flosculariacea Haring, 1913	
Family: Conochilidae Haring, 1913	
25	<i>Conochilus coenobasis</i> (Skorikov, 1914)
26	<i>Conochilus dossuarius</i> Hudson, 1885
27	<i>Conochilus hippocrepis</i> (Schrank, 1803)
28	<i>Conochilus natans</i> (Seligo, 1900)
29	<i>Conochilus unicornis</i> Rousselet, 1892
Family: Flosculariidae Ehrenberg, 1838	
30	<i>Beauchampia crucigere</i> (Dutrochet, 1812)
31	<i>Floscularia melicerta</i> (Ehrenberg, 1832)
32	<i>Limnias ceratophylli</i> Schrank, 1803
33	<i>Limnias melicerta</i> Weisse, 1848
34	<i>Octotrocha speciosa</i> Thorpe, 1893

Table 1. Cont.

35	<i>Ptygura beauchampi</i> Edmondson, 1940
36	<i>Ptygura brachiata</i> (Hudson, 1886)
37	<i>Ptygura brevis</i> (Rousselet, 1893)
38	<i>Ptygura crystallina</i> (Ehrenberg, 1834)
39	<i>Ptygura furcillata</i> (Kellicott, 1889)
40	<i>Ptygura libera</i> Myers, 1934
41	<i>Ptygura</i> cf. <i>linguata</i> Edmondson, 1939
42	<i>Ptygura longicornis</i> (Davis, 1867)
43	<i>Ptygura melicerta</i> Ehrenberg, 1832
44	<i>Ptygura pedunculata</i> Edmondson, 1939
45	<i>Ptygura tacita</i> Edmondson, 1940
46	<i>Ptygura tridorsicornis</i> Summerfiel-Wright, 1957
47	<i>Ptygura velata</i> (Gosse, 1851)
48	<i>Sinantherina ariprepes</i> Edmondson, 1939
49	<i>Sinantherina semibullata</i> (Thorpe, 1893)
50	<i>Sinantherina socialis</i> (Linnaeus, 1758)
Family: Hexarthridae Bartoš, 1959	
51	<i>Hexarthra fennica</i> (Levander, 1892)
52	<i>Hexarthra intermedia</i> (Wiszniewski, 1929) <i>Hexarthra intermedia</i> f. <i>braziliensis</i> Hauer, 1953
53	<i>Hexarthra jenkiniae</i> (de Beauchamp, 1932)
54	<i>Hexarthra mira</i> (Hudson, 1871)
55	<i>Hexarthra oxyuris</i> (Sernov, 1903)
56	<i>Hexarthra polyodonta</i> (Hauer, 1957)
Family: Testudinellidae Haring, 1913	
57	<i>Pompholyx complanata</i> Gosse, 1851
58	<i>Pompholyx sulcata</i> Hudson, 1885
59	<i>Testudinella caeca</i> (Parsons, 1892)
60	<i>Testudinella emarginula</i> (Stenroos, 1898)
61	<i>Testudinella incisa</i> (Ternetz, 1892)
62	<i>Testudinella mucronata</i> (Gosse, 1886)
63	<i>Testudinella parva</i> (Ternetz, 1892)
64	<i>Testudinella patina</i> (Hermann, 1783)
65	<i>Testudinella reflexa</i> (Gosse, 1887)
Family: Trochosphaeridae Haring, 1913	
66	<i>Filinia brachiata</i> (Rousselet, 1901)
67	<i>Filinia cornuta</i> (Weisse, 1847)
68	<i>Filinia longiseta</i> (Ehrenberg, 1834)
69	<i>Filinia opoliensis</i> (Zacharias, 1898)
70	<i>Filinia pejleri</i> Hutchinson, 1964
71	<i>Filinia saltator</i> (Gosse, 1886)
72	<i>Filinia terminalis</i> (Plate, 1886)
73	<i>Horaella thomassoni</i> Koste, 1973
74	<i>Trochosphaera aequatorialis</i> Semper, 1872
Order: Ploima Hudson & Gosse, 1886	
Family: Asplanchnidae Eckstein, 1883	
75	<i>Asplanchna brightwellii</i> Gosse, 1850
76	<i>Asplanchna girodi</i> de Guerne, 1888
77	<i>Asplanchna herrickii</i> de Guerne, 1888
78	<i>Asplanchna intermedia</i> Hudson, 1886
79	<i>Asplanchna priodonta</i> Gosse, 1850
80	<i>Asplanchna sieboldii</i> (Leydig, 1854)
81	<i>Asplanchna silvestrii</i> Daday, 1902
82	<i>Asplanchnopus multiceps</i> (Schrank, 1793)
Family: Brachionidae Ehrenberg, 1838	
83	<i>Anuraeopsis fissa</i> Gosse, 1851
84	<i>Anuraeopsis quadriantennata</i> (Koste, 1974)
85	<i>Brachionus ahlstromi</i> Lindeman, 1939
86	<i>Brachionus angularis</i> Gosse, 1851

Table 1. Cont.

87	<i>Brachionus araceliae</i> Silva-Briano, Galván-De la Rosa, Pérez-Legaspi & Rico-Martínez, 2007
88	<i>Brachionus bidentatus</i> Anderson, 1889
89	<i>Brachionus budapestinensis</i> Daday, 1885
90	<i>Brachionus calyciflorus</i> Pallas, 1766
	<i>Brachionus calyciflorus calyciflorus</i> Pallas, 1766
91	<i>Brachionus caudatus</i> Barrois & Daday, 1894
92	<i>Brachionus dimidiatus</i> Bryce, 1931
93	<i>Brachionus dolabratus</i> Haring, 1914
94	<i>Brachionus durgae</i> Dhanapathi, 1974
95	<i>Brachionus falcatus</i> Zacharias, 1898
96	<i>Brachionus forficula</i> Wierzejski, 1891
97	<i>Brachionus havanaensis</i> Rousselet, 1911
98	<i>Brachionus josefinae</i> Silva-Briano & Segers, 1992
99	<i>Brachionus leydigii</i> Cohn, 1862
100	<i>Brachionus paranguensis</i> Guerrero-Jiménez, Vannucchi, Silva-Briano, Adabache-Ortiz, Rico-Martínez, Roberts, Neilson & Elías-Gutiérrez, 2019
101	<i>Brachionus plicatilis</i> Müller, 1786
	<i>Brachionus plicatilis longicornis</i> Fadeev, 1925
102	<i>Brachionus pterodinoides</i> Rousselet, 1913
103	<i>Brachionus quadridentatus</i> Hermann, 1783
	<i>Brachionus quadridentatus quadridentatus</i> Herman, 1783
104	<i>Brachionus rotundiformis</i> Tschugunoff, 1921
105	<i>Brachionus rubens</i> Ehrenberg, 1838
106	<i>Brachionus urceolaris</i> Müller, 1773
107	<i>Brachionus variabilis</i> Hempel, 1896
108	<i>Kellicottia bostoniensis</i> (Rousselet, 1908)
109	<i>Kellicottia longispina</i> (Kellicott, 1879)
110	<i>Keratella americana</i> Carlin, 1943
111	<i>Keratella cochlearis</i> (Gosse, 1851)
	<i>Keratella cochlearis cochlearis</i> (Gosse, 1851)
112	<i>Keratella hiemalis</i> Carlin, 1943
113	<i>Keratella irregularis</i> (Lauterborn, 1898)
114	<i>Keratella lenzi</i> Hauer, 1953
115	<i>Keratella mexicana</i> Kutikova & Silva-Briano, 1995
116	<i>Keratella morenoi</i> Modenutti, Diéguez & Segers, 1998
117	<i>Keratella procurva</i> (Thorpe, 1891)
	<i>Keratella procurva robusta</i> Koste & Shiel, 1980
118	<i>Keratella quadrata</i> (Müller, 1786)
119	<i>Keratella serrulata</i> (Ehrenberg, 1838)
120	<i>Keratella taurocephala</i> Myers, 1938
121	<i>Keratella tecta</i> (Gosse, 1851)
122	<i>Keratella ticinensis</i> (Callerio, 1921)
123	<i>Keratella tropica</i> (Apstein, 1907)
124	<i>Keratella valga</i> (Ehrenberg, 1834)
125	<i>Notholca acuminata</i> (Ehrenberg, 1832)
126	<i>Notholca bipalium</i> (Müller, 1786)
127	<i>Notholca foliacea</i> (Ehrenberg, 1838)
128	<i>Notholca</i> cf. <i>liepeterseni</i> Godske Björklund, 1972
129	<i>Notholca squamula</i> (Müller, 1786)
130	<i>Notholca striata</i> (Müller, 1786)
131	<i>Plationus patulus</i> (Daday, 1905)
	<i>Plationus patulus macracanthus</i> (Müller, 1786)
132	<i>Plationus polyacanthus</i> (Ehrenberg, 1834)
133	<i>Platyias leloupi</i> Gillard, 1967
134	<i>Platyias quadricornis</i> (Ehrenberg, 1832)
	Family: Dicranophoridae Haring, 1913
135	<i>Aspelta angusta</i> Haring & Myers, 1928
136	<i>Aspelta curvidactyla</i> Bērziņš, 1949
137	<i>Aspelta lestes</i> Haring & Myers, 1928

Table 1. Cont.

138	<i>Dicranophoroides caudatus</i> (Ehrenberg, 1834)
139	<i>Dicranophoroides claviger</i> (Hauer, 1965)
140	<i>Dicranophorus epicharis</i> Harring & Myers, 1928
141	<i>Dicranophorus forcipatus</i> (Müller, 1786)
142	<i>Dicranophorus grandis</i> (Ehrenberg, 1832)
143	<i>Dicranophorus prionacis</i> Harring & Myers, 1928
144	<i>Dicranophorus robustus</i> Harring & Myers, 1928
145	<i>Encentrum</i> cf. <i>cruentum</i> Harring & Myers, 1928
146	<i>Encentrum saundersiae</i> (Hudson, 1885)
147	<i>Encentrum uncinatum</i> (Milne, 1886)
148	<i>Paradicranophorus sordidus</i> Donner, 1968
Family: Epiphanidae Harring, 1913	
149	<i>Cyrtonia tuba</i> (Ehrenberg, 1834)
150	<i>Epiphanes brachionus</i> (Ehrenberg, 1837)
151	<i>Epiphanes clavulata</i> (Ehrenberg, 1832)
152	<i>Epiphanes macroura</i> (Barrois & Daday, 1894)
153	<i>Epiphanes senta</i> (Müller, 1773)
154	<i>Proalides subtilis</i> Rodewald, 1940
155	<i>Proalides tentaculatus</i> de Beauchamp, 1907
Family: Euchlanidae Ehrenberg, 1838	
156	<i>Beauchampiella eudactylota</i> (Gosse, 1886)
157	<i>Dipleuchlanis elegans</i> (Wierzejski, 1893)
158	<i>Dipleuchlanis propatula</i> (Gosse, 1886)
159	<i>Euchlanis calpidia</i> Myers, 1930
160	<i>Euchlanis deflexa</i> (Gosse, 1851)
161	<i>Euchlanis dilatata</i> Ehrenberg, 1832
	<i>Euchlanis dilatata luksiana</i> Hauer, 1930
162	<i>Euchlanis incisa</i> Carlin, 1939
163	<i>Euchlanis lyra</i> Hudson, 1886
164	<i>Euchlanis</i> cf. <i>mikropous</i> Koch-Althaus, 1962
165	<i>Euchlanis oropha</i> Gosse, 1887
166	<i>Euchlanis pyriformis</i> Gosse, 1851
167	<i>Euchlanis triquetra</i> Ehrenberg, 1838
168	<i>Tripleuchlanis plicata</i> (Levander, 1894)
Family: Gastropodidae Harring, 1913	
169	<i>Ascomorpha ecaudis</i> Perty, 1850
170	<i>Ascomorpha ovalis</i> (Bergendal, 1892)
171	<i>Ascomorpha saltans</i> Bartsch, 1870
172	<i>Gastropus hyptopus</i> (Ehrenberg, 1838)
173	<i>Gastropus stylifer</i> (Imhof, 1891)
Family: Ituridae Sudzuki, 1964	
174	<i>Itura aurita</i> (Ehrenberg, 1830)
175	<i>Itura chamadis</i> Harring & Myers, 1928
176	<i>Itura myersi</i> Wulfert, 1935
Family: Lecanidae Remane, 1933	
177	<i>Lecane aculeata</i> (Jakubski, 1912)
178	<i>Lecane aeganea</i> Harring, 1914
179	<i>Lecane arcuata</i> (Bryce, 1891)
180	<i>Lecane arcula</i> Harring, 1914
181	<i>Lecane aspasia</i> Myers, 1917
182	<i>Lecane bifurca</i> (Bryce, 1892)
183	<i>Lecane bulla</i> (Gosse, 1851)
184	<i>Lecane candida</i> Harring & Myers, 1926
185	<i>Lecane clara</i> (Bryce, 1892)
186	<i>Lecane closterocerca</i> (Schmarda, 1859)
187	<i>Lecane cornuta</i> (Müller, 1786)
188	<i>Lecane crenata</i> (Harring, 1913)
189	<i>Lecane crepida</i> Harring, 1914
190	<i>Lecane curvicornis</i> (Murray, 1913)

Table 1. Cont.

191	<i>Lecane decipiens</i> (Murray, 1913)
192	<i>Lecane doryssa</i> Harring, 1914
193	<i>Lecane elasma</i> Harring & Myers, 1926
194	<i>Lecane elegans</i> Harring, 1914
195	<i>Lecane elsa</i> Hauer, 1931
196	<i>Lecane flexilis</i> (Gosse, 1886)
197	<i>Lecane furcata</i> (Murray, 1913)
198	<i>Lecane grandis</i> (Murray, 1913)
199	<i>Lecane haliclysta</i> Harring & Myers, 1926
200	<i>Lecane hamata</i> (Stokes, 1896)
201	<i>Lecane hastata</i> (Murray, 1913)
	<i>Lecane cf. hastata</i> (Murray, 1913)
202	<i>Lecane hornemanni</i> (Ehrenberg, 1834)
203	<i>Lecane inermis</i> (Bryce, 1892)
204	<i>Lecane inopinata</i> Harring & Myers, 1926
205	<i>Lecane latissima</i> Yamamoto, 1955
206	<i>Lecane leontina</i> (Turner, 1892)
207	<i>Lecane levistyla</i> (Olofsson, 1917)
208	<i>Lecane ludwigii</i> (Eckstein, 1883)
209	<i>Lecane luna</i> (Müller, 1776)
210	<i>Lecane lunaris</i> (Ehrenberg, 1832)
211	<i>Lecane margarethae</i> Segers, 1991
212	<i>Lecane monostyla</i> (Daday, 1897)
213	<i>Lecane nana</i> (Murray, 1913)
214	<i>Lecane nelsoni</i> Segers, 1994
215	<i>Lecane obtusa</i> (Murray, 1913)
216	<i>Lecane ohioensis</i> (Herrick, 1885)
217	<i>Lecane papuana</i> (Murray, 1913)
218	<i>Lecane perpusilla</i> (Hauer, 1929)
219	<i>Lecane pertica</i> Harring & Myers, 1926
220	<i>Lecane punctata</i> (Murray, 1913)
221	<i>Lecane pyriformis</i> (Daday, 1905)
222	<i>Lecane quadridentata</i> (Ehrenberg, 1830)
223	<i>Lecane rhenana</i> Hauer, 1929
224	<i>Lecane rhytida</i> Harring & Myers, 1926
225	<i>Lecane rugosa</i> (Harring, 1914)
226	<i>Lecane ruttneri</i> Hauer, 1938
227	<i>Lecane satyrus</i> Harring & Myers, 1926
228	<i>Lecane scutata</i> (Harring & Myers, 1926)
229	<i>Lecane signifera</i> (Jennings, 1896)
230	<i>Lecane sola</i> Hauer, 1936
231	<i>Lecane spinulifera</i> Edmondson, 1935
232	<i>Lecane stenroosi</i> (Meissner, 1908)
233	<i>Lecane stichaea</i> Harring, 1913
234	<i>Lecane stokesii</i> (Pell, 1890)
235	<i>Lecane subtilis</i> Harring & Myers, 1926
236	<i>Lecane subulata</i> (Harring & Myers, 1926)
237	<i>Lecane tenuiseta</i> Harring, 1914
238	<i>Lecane thalera</i> (Harring & Myers, 1926)
239	<i>Lecane thienemanni</i> (Hauer, 1938)
240	<i>Lecane uenoi</i> Yamamoto, 1951
241	<i>Lecane undulata</i> Hauer, 1938
242	<i>Lecane unguitata</i> (Fadeev, 1925)
243	<i>Lecane ungulata</i> (Gosse, 1887)
244	<i>Lecane venusta</i> Harring & Myers, 1926
245	<i>Lecane yatseni</i> Wei & Xu, 2010
	Family: Lepadellidae Harring, 1913
246	<i>Colurella adriatica</i> Ehrenberg, 1831
247	<i>Colurella colurus</i> (Ehrenberg, 1830)

Table 1. Cont.

248	<i>Colurella hindenburgi</i> Steinecke, 1917
249	<i>Colurella oblonga</i> Donner, 1943
250	<i>Colurella obtusa</i> (Gosse, 1886)
251	<i>Colurella uncinata</i> (Müller, 1773)
	<i>Colurella uncinata bicuspidata</i> (Ehrenberg, 1832)
252	<i>Lepadella acuminata</i> (Ehrenberg, 1834)
253	<i>Lepadella apsidea</i> Harring, 1916
254	<i>Lepadella astacicola</i> Hauer, 1926
255	<i>Lepadella benjamini</i> Harring, 1916
256	<i>Lepadella biloba</i> Hauer, 1958
257	<i>Lepadella</i> cf. <i>cornuta</i> Koste & Shiel, 1989
258	<i>Lepadella cristata</i> (Rousselet, 1893)
259	<i>Lepadella dactyliseta</i> (Stenroos, 1898)
260	<i>Lepadella discoidea</i> Segers, 1993
261	<i>Lepadella donneri</i> Koste, 1972
262	<i>Lepadella ehrenbergii</i> (Perty, 1850)
263	<i>Lepadella heterostyla</i> (Murray, 1913)
264	<i>Lepadella latusinus</i> (Hilgendorf, 1899)
265	<i>Lepadella ovalis</i> (Müller, 1786)
266	<i>Lepadella patella</i> (Müller, 1773)
	<i>Lepadella patella patella</i> (Müller, 1786)
267	<i>Lepadella punctata</i> Wulfert, 1939
268	<i>Lepadella quadricarinata</i> (Stenroos, 1898)
269	<i>Lepadella quinquecostata</i> (Lucks, 1912)
	<i>Lepadella quinquecostata quinquecostata</i> (Lucks, 1912)
270	<i>Lepadella rhomboides</i> (Gosse, 1886)
271	<i>Lepadella triba</i> Myers, 1934
272	<i>Lepadella triptera</i> (Ehrenberg, 1832)
273	<i>Squatinella lamellaris</i> (Müller, 1786)
Family: Lindiidae Harring & Myers, 1924	
274	<i>Lindia ecela</i> Myers, 1933
275	<i>Lindia tecusa</i> Harring & Myers, 1922
276	<i>Lindia torulosa</i> Dujardin, 1841
277	<i>Lindia truncata</i> (Jennings, 1894)
Family: Mytilinidae Harring, 1913	
278	<i>Lophocharis oxysternon</i> (Gosse, 1851)
279	<i>Lophocharis salpina</i> (Ehrenberg, 1834)
280	<i>Mytilina acanthophora</i> Hauer, 1938
281	<i>Mytilina bisulcata</i> (Lucks, 1912)
282	<i>Mytilina mucronata</i> (Müller, 1773)
	<i>Mytilina mucronata spinigera</i> (Ehrenberg, 1830)
283	<i>Mytilina ventralis</i> (Ehrenberg, 1830)
	<i>Mytilina ventralis brevispina</i> (Ehrenberg, 1830)
	<i>Mytilina ventralis ventralis</i> (Ehrenberg, 1830)
Family: Notommatidae Hudson & Gosse, 1886	
284	<i>Cephalodella apocolea</i> Myers, 1924
285	<i>Cephalodella calosa</i> Wulfert, 1956
286	<i>Cephalodella catellina</i> Müller, 1786
287	<i>Cephalodella exigua</i> (Gosse, 1886)
288	<i>Cephalodella forficula</i> (Ehrenberg, 1830)
289	<i>Cephalodella gibba</i> (Ehrenberg, 1830)
290	<i>Cephalodella gigantea</i> Remane, 1933
291	<i>Cephalodella globata</i> (Gosse, 1887)
292	<i>Cephalodella gracilis</i> (Ehrenberg, 1830)
293	<i>Cephalodella</i> cf. <i>graciosa</i> Wulfert, 1956
294	<i>Cephalodella hoodii</i> (Gosse, 1886)
295	<i>Cephalodella macrodactyla</i> (Stenroos, 1898)
296	<i>Cephalodella</i> cf. <i>marina</i> Myers, 1924
297	<i>Cephalodella megaloccephala</i> (Glascott, 1893)
298	<i>Cephalodella misgurnus</i> Wulfert, 1937

Table 1. Cont.

299	<i>Cephalodella panarista</i> Myers, 1924
300	<i>Cephalodella physalis</i> Myers, 1924
	<i>Cephalodella</i> cf. <i>physalis</i> Myers, 1924
301	<i>Cephalodella rotunda</i> Wulfert, 1937
302	<i>Cephalodella stenroosi</i> Wulfert, 1937
303	<i>Cephalodella sterea</i> (Gosse, 1887)
304	<i>Cephalodella tenuiseta</i> (Burn, 1890)
305	<i>Cephalodella ventripes</i> (Dixon-Nuttall, 1901)
306	<i>Enteroplea lacustris</i> Ehrenberg, 1830
307	<i>Eosphora anthadis</i> Harring & Myers, 1922
308	<i>Eosphora ehrenbergi</i> Weber & Montet, 1918
309	<i>Eosphora najas</i> Ehrenberg, 1830
310	<i>Eosphora thoa</i> Harring & Myers, 1830
311	<i>Eosphora thoides</i> Wulfert, 1935
312	<i>Eothinia carogaensis</i> Myers, 1937
313	<i>Eothinia elongata</i> (Ehrenberg, 1832)
314	<i>Monommata actices</i> Remane, 1933
315	<i>Monommata diaphora</i> Myers, 1930
316	<i>Notommata aurita</i> (Müller, 1786)
317	<i>Notommata cerberus</i> (Gosse, 1886)
318	<i>Notommata copeus</i> Ehrenberg, 1834
319	<i>Notommata cyrtopus</i> Gosse, 1886
320	<i>Notommata falcinella</i> Harring & Myers, 1922
321	<i>Notommata glyphura</i> Wulfert, 1935
322	<i>Notommata haueri</i> Wulfert, 1939
	<i>Notommata</i> cf. <i>haueri</i> Wulfert, 1939
323	<i>Notommata pachyura</i> (Gosse, 1886)
324	<i>Notommata saccigera</i> Ehrenberg, 1830
325	<i>Notommata tripus</i> Ehrenberg, 1838
326	<i>Pleurotrocha petromyzon</i> (Ehrenberg, 1830)
327	<i>Resticula gelida</i> (Harring & Myers, 1922)
328	<i>Resticula melandocus</i> (Gosse, 1887)
329	<i>Resticula nyssa</i> Harring & Myers, 1924
330	<i>Sphyrias lofauna</i> (Rousselet, 1910)
331	<i>Taphrocampa annulosa</i> Gosse, 1851
332	<i>Taphrocampa selenura</i> Gosse, 1887
	Family: Proalidae Harring & Myers, 1924
333	<i>Proales cognita</i> Myers, 1940
334	<i>Proales daphnicola</i> Thompson, 1892
335	<i>Proales decipiens</i> (Ehrenberg, 1832)
336	<i>Proales fallaciosa</i> Wulfert, 1937
337	<i>Proales globulifera</i> (Hauer, 1921)
338	<i>Proales sigmoidea</i> (Skorikov, 1896)
339	<i>Proales similis</i> de Beauchamp, 1907
340	<i>Proales sordida</i> Gosse, 1886
341	<i>Proales</i> cf. <i>wesenbergi</i> Wulfert, 1960
342	<i>Wulfertia ornata</i> Donner, 1943
	Family: Scaridiidae Manfredi, 1927
343	<i>Scaridium botsjani</i> Daems & Dumont, 1974
344	<i>Scaridium longicaudum</i> (Müller, 1786)
	Family: Synchaetidae Hudson & Gosse, 1886
345	<i>Ploesoma hudsoni</i> (Imhof, 1891)
346	<i>Polyarthra dolichoptera</i> Idelson, 1925
	<i>Polyarthra</i> cf. <i>dolichoptera</i> Idelson, 1925
347	<i>Polyarthra euryptera</i> Wierzejski, 1891
348	<i>Polyarthra longiremis</i> Carlin, 1943
349	<i>Polyarthra luminosa</i> Kutikova, 1962
350	<i>Polyarthra major</i> Burckhardt, 1900
351	<i>Polyarthra remata</i> Skorikov, 1896
352	<i>Polyarthra trigla</i> Ehrenberg, 1834 (species inquirenda)

Table 1. Cont.

353	<i>Polyarthra vulgaris</i> Carlin, 1943
354	<i>Synchaeta bicornis</i> Smith, 1904
355	<i>Synchaeta elsteri</i> Hauer, 1963
356	<i>Synchaeta hyperborea</i> Smirnov, 1932
357	<i>Synchaeta longipes</i> Gosse, 1887
358	<i>Synchaeta oblonga</i> Ehrenberg, 1832
359	<i>Synchaeta pectinata</i> Ehrenberg, 1832
360	<i>Synchaeta stylata</i> Wierzejski, 1893
361	<i>Synchaeta tremula</i> (Müller, 1786)
362	<i>Synchaeta tremuloida</i> Pourriot, 1965
Family: Tetrasiphonidae Haring & Myers, 1924	
363	<i>Tetrasiphon hydrocora</i> Ehrenberg, 1840
Family: Trichocercidae Haring, 1913	
364	<i>Ascomorphella volvocicola</i> (Plate, 1886)
365	<i>Trichocerca bicristata</i> (Gosse, 1887)
366	<i>Trichocerca bidens</i> (Lucks, 1912)
367	<i>Trichocerca brachyura</i> (Gosse, 1851)
368	<i>Trichocerca braziliensis</i> (Murray, 1913)
369	<i>Trichocerca capucina</i> (Wierzejski & Zacharias, 1893)
370	<i>Trichocerca collaris</i> (Rousselet, 1896)
371	<i>Trichocerca cylindrica</i> (Imhof, 1891)
372	<i>Trichocerca dixonnuttalli</i> (Jennings, 1903)
373	<i>Trichocerca elongata</i> (Gosse, 1886)
374	<i>Trichocerca iernis</i> (Gosse, 1887)
375	<i>Trichocerca insignis</i> (Herrick, 1885)
376	<i>Trichocerca insulana</i> (Hauer, 1937)
377	<i>Trichocerca</i> cf. <i>intermedia</i> (Stenroos, 1898)
378	<i>Trichocerca longiseta</i> (Schrank, 1802)
379	<i>Trichocerca marina</i> (Daday, 1890)
380	<i>Trichocerca mollis</i> Edmondson, 1936
381	<i>Trichocerca mucosa</i> (Stokes, 1896)
382	<i>Trichocerca multigrinis</i> (Kellicott, 1897)
383	<i>Trichocerca musculus</i> (Hauer, 1937)
384	<i>Trichocerca porcellus</i> (Gosse, 1851)
385	<i>Trichocerca pusilla</i> (Jennings, 1903)
386	<i>Trichocerca rattus</i> (Müller, 1776)
387	<i>Trichocerca rosea</i> (Stenroos, 1898)
388	<i>Trichocerca rousseleti</i> (Voigt, 1902)
389	<i>Trichocerca ruttneri</i> Donner, 1953
390	<i>Trichocerca similis</i> (Wierzejski, 1893)
391	<i>Trichocerca stylata</i> (Gosse, 1851)
392	<i>Trichocerca tenuior</i> (Gosse, 1886)
393	<i>Trichocerca tigris</i> (Müller, 1786)
394	<i>Trichocerca vernalis</i> (Hauer, 1936)
395	<i>Trichocerca weberi</i> (Jennings, 1903)
Family: Trichotriidae Haring, 1913	
396	<i>Macrochaetus collinsii</i> (Gosse, 1867)
397	<i>Macrochaetus longipes</i> Myers, 1934
398	<i>Macrochaetus sericus</i> (Thorpe, 1893)
399	<i>Macrochaetus subquadratus</i> (Perty, 1850)
400	<i>Trichotria pocillum</i> (Müller, 1776)
401	<i>Trichotria tetractis</i> (Ehrenberg, 1830)
402	<i>Wolga spinifera</i> (Western, 1894)

Table 2. Some species complexes and cryptic species of rotifers reported from Mexico.

Species Complex	Reference
<i>Ascomorpha ovalis</i>	[25]
<i>Asplanchna brightwellii</i>	[26]
<i>Asplanchna girodi</i>	[27]
<i>Brachionus calyciflorus</i>	[25]
<i>Brachionus plicatilis</i>	[18,28]
<i>Brachionus quadridentatus</i>	[25]
<i>Euchlanis dilatata</i>	[29]
<i>Keratella cochlearis</i>	[25]
<i>Lecane bulla</i>	[30]
<i>Lecane cornuta</i>	[25]
<i>Lecane crepida</i>	[25]
<i>Lecane curvicornis</i>	[25]
<i>Lecane hastata</i>	[25]
<i>Lecane lunaris</i>	[25]
<i>Mytilina ventralis</i>	[25]
<i>Platygaster quadricornis</i>	[25]
<i>Testudinella patina</i>	[25]

The faunal diversity of rotifers from the different states of the country was highly heterogeneous. Only five federal entities (the State of Mexico, Michoacán, Veracruz, Mexico City, and Quintana Roo) had more than 100 species. The total number of genera per state followed the same trend of species richness (Table 3). Thus, seven federal entities (the State of Mexico, Michoacán, Veracruz, Mexico City, Quintana Roo, Aguascalientes, and Chihuahua) had more than 30 genera.

Table 3. Number of genera and species of rotifers reported from different States of Mexico. The states are represented by bold numbers. 1: Aguascalientes, 2: Campeche, 3: Chiapas, 4: Chihuahua, 5: Colima, 6: Guanajuato, 7: Guerrero, 8: Hidalgo, 9: Jalisco, 10: Mexico City, 11: Michoacan, 12: Morelos, 13: Nayarit, 14: Oaxaca, 15: Puebla, 16: Quintana Roo, 17: San Luis Potosi, 18: Sinaloa, 19: Sonora, 20: State of Mexico, 21: Tabasco, 22: Tlaxcala, 23: Veracruz, 24: Yucatán, 25: Zacatecas. Other states do not have published records of rotifers, and these were not included.

Species/States	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
<i>Adineta</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0
<i>Anuraeopsis</i>	1	0	0	1	0	0	1	0	1	1	1	1	0	0	1	1	1	0	0	2	1	0	1	0	1
<i>Ascomorpha</i>	3	0	0	1	0	2	0	0	0	1	1	0	0	0	0	2	0	1	0	3	1	0	3	0	0
<i>Ascomorphella</i>	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
<i>Aspelta</i>	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	1	0	0
<i>Asplanchna</i>	5	0	1	0	0	2	2	0	1	4	3	1	0	0	0	0	0	0	0	6	2	0	4	0	1
<i>Asplanchnopus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0
<i>Atrachus</i>	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Beauchampia</i>	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Beauchampiella</i>	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	1	0	0
<i>Brachionus</i>	14	4	5	5	0	4	11	6	2	13	14	8	0	0	0	8	2	0	0	11	9	1	17	0	12
<i>Cephalodella</i>	2	0	0	12	0	0	2	0	0	4	8	3	0	0	0	3	0	0	0	14	0	0	9	0	0
<i>Collotheca</i>	1	0	0	2	0	0	0	0	0	5	2	0	0	0	0	1	1	0	0	2	0	0	0	0	0
<i>Colurella</i>	0	0	0	4	0	0	0	0	0	3	2	2	1	0	0	3	0	0	0	4	0	0	5	0	0
<i>Conochilus</i>	4	0	0	0	0	0	1	0	1	1	4	0	0	0	0	0	0	0	0	4	0	0	2	0	1
<i>Cupelopagis</i>	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0
<i>Cyrtonia</i>	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Dicranophoroides</i>	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	1	0	0	0	1	0	0	2	0	0
<i>Dicranophorus</i>	0	0	0	2	0	0	1	0	0	2	1	2	1	0	0	3	0	0	0	4	0	1	3	0	0
<i>Dipleuchlanis</i>	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	1	0	0	0	2	0	0	1	0	0
<i>Encentrum</i>	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0
<i>Enteroplea</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0
<i>Eosphora</i>	0	0	0	1	0	0	1	0	0	1	1	1	0	0	0	1	0	0	0	3	1	0	2	0	0
<i>Eothenia</i>	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0
<i>Epiphanes</i>	1	0	0	0	0	0	1	0	0	2	2	0	0	0	0	1	0	0	0	2	1	0	2	0	0
<i>Euchlanis</i>	2	0	0	3	0	1	1	2	0	5	2	1	0	0	0	2	1	0	0	6	1	2	4	0	0
<i>Filinia</i>	4	0	2	3	0	2	3	0	1	4	3	1	0	0	0	1	0	0	0	5	1	1	2	0	3
<i>Floscularia</i>	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Gastropus</i>	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0
<i>Hexarthra</i>	2	0	1	2	0	2	1	0	1	2	1	1	0	0	1	1	0	0	0	3	0	0	2	0	0
<i>Horaeella</i>	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0
<i>Itura</i>	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0	1	0	0	0	3	0	0	1	0	0
<i>Kellicottia</i>	2	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1
<i>Keratella</i>	10	0	3	3	0	4	3	5	2	5	11	3	0	0	0	3	0	0	0	10	3	4	5	1	5
<i>Lecane</i>	10	13	2	21	3	0	15	3	0	29	29	21	17	0	0	40	6	1	0	34	4	2	39	0	11
<i>Lepadella</i>	2	0	0	5	1	1	1	4	0	6	11	5	1	0	0	9	0	2	0	11	0	2	5	0	1
<i>Limnias</i>	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Lindia</i>	0	0	0	0	0	0	0	0	0	1	2	1	1	0	0	1	0	0	0	2	0	0	2	0	0
<i>Lophocharis</i>	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	1	0	0	0	2	0	0	1	0	0
<i>Macrochaetus</i>	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	3	0	0	0	1	0	0	1	0	0
<i>Monommata</i>	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1	0	0	0	0	0
<i>Mytilina</i>	1	0	0	1	0	0	0	0	0	3	3	1	1	0	0	3	0	0	0	4	0	0	4	0	0
<i>Notholca</i>	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0
<i>Notommata</i>	0	0	0	2	0	0	1	0	0	1	4	0	3	0	0	3	0	0	0	7	0	0	2	0	0
<i>Octotrocha</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
<i>Paradicranophorus</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Philodina</i>	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0

Table 3. Cont.

Species/States	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
<i>Platyonus</i>	2	1	1	1	0	1	0	1	0	1	1	0	0	0	0	1	0	0	0	2	0	0	1	0	1
<i>Platyias</i>	1	0	1	1	0	1	1	1	0	2	1	1	1	0	0	1	0	0	0	2	1	0	1	0	1
<i>Pleuretra</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Pleurotrocha</i>	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	1	1	0	0
<i>Ploesoma</i>	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Polyarthra</i>	5	0	1	2	0	2	2	1	3	3	4	1	0	0	0	1	2	0	0	6	0	1	1	0	0
<i>Pompholyx</i>	1	0	0	0	1	0	1	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0
<i>Proales</i>	1	0	0	5	0	0	0	0	0	2	1	1	0	0	0	2	0	0	0	3	0	0	1	0	0
<i>Proalides</i>	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
<i>Ptygura</i>	0	0	0	2	0	0	0	0	0	8	0	0	0	0	0	3	0	0	0	3	0	0	0	0	0
<i>Resticula</i>	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	1	0	0	1	0	0
<i>Roturia</i>	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	1	0	0
<i>Scaridium</i>	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	1	0	0	1	0	0
<i>Simantherina</i>	0	0	0	0	0	0	0	0	0	3	2	0	0	0	0	1	0	0	0	2	0	1	1	0	0
<i>Sphyras</i>	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Squatinaella</i>	0	0	0	0	0	0	1	0	1	1	1	0	0	0	0	1	0	0	0	1	0	0	1	0	0
<i>Stephanoceros</i>	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Synchaeta</i>	4	0	1	2	0	0	0	0	1	3	4	1	0	0	0	2	0	0	0	3	4	1	1	0	0
<i>Taphrocampa</i>	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	2	0	1	1	0	0
<i>Testudinella</i>	1	1	1	1	0	0	1	0	0	3	5	2	1	0	0	4	0	0	0	6	0	1	3	0	0
<i>Tetrasiphon</i>	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Trichoerca</i>	7	0	0	2	0	1	3	0	0	15	12	4	2	0	0	8	0	1	0	23	6	2	10	0	1
<i>Trichotria</i>	2	0	0	1	0	0	1	0	0	2	2	1	0	0	0	0	0	0	2	0	1	2	0	0	2
<i>Triplichaelis</i>	0	0	0	1	0	0	0	0	0	1	1	0	1	0	0	1	0	0	0	1	0	0	1	0	0
<i>Trochosphaera</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
<i>Wolga</i>	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Wulferia</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Seasonally collected samples offered a higher number of species than those collected sporadically. Data on the species richness of rotifers collected seasonally from selected water bodies are presented in Table 4.

Table 4. The number of rotifer species reported from selected waterbodies through seasonal sampling.

Waterbody	Total Species	Reference
Valle de Bravo Reservoir (State of Mexico)	50	[31]
Madín reservoir (State of Mexico)	28	[32]
Llano reservoir (State of Mexico)	84	[33]
Iturbide reservoir (State of Mexico)	55	[34]
Lake Zumpango (State of Mexico)	33	[35]
Chimaliapan wetland (State of Mexico)	75	[36]
Lake Xochimilco (Mexico City)	81	[37]
Lake Cantera Oriente (Mexico City)	68	[38]
Benito Juárez Reservoir (Mexico City)	80	[39]
River Antigua (Veracruz State)	125	[40]
Amacuzac River Basin (State of Morelos)	65	[41]
Valerio Trujano Reservoir (Guerrero State)	64	[42]

Biogeographic distribution of selected species recorded from Nearctic and Neotropical regions of Mexico showed some of them to be out of known range based on global patterns. More than 20 taxa distributed in Palearctic region were reported from Nearctic or Neotropical regions (Table 5).

Table 5. Out of known range distribution of Rotifera recorded from Mexico. The known range from different geographical regions was based on [16], and for the national biogeographic provinces, Ref. [4] was followed. Afr: Afrotropical region; Ant: Antarctic region; Aus: Australian region; Nea: Nearctic region; Neo: Neotropical region; Ori: Oriental region; Pac: Pacific region and Pal: Palearctic region.

Species and Distribution	Records from Mexico
<i>Adineta vaga</i> : Afr, Pal	Quintana Roo and Tlaxcala: Neo
<i>Atrochus tentaculatus</i> : Aus, Pal, Ori	Mexico City: Nea
<i>Collotheca crateriformis</i> : Pal	Chihuahua: Nea
<i>Colurella colurus</i> : Pal	State of Mexico and Chihuahua: Nea; Veracruz and Quintana Roo: Neo
<i>Colurella oblonga</i> : Pal	Veracruz: Neo
<i>Dicranophorus forcipatus</i> : Pal	State of Mexico, Michoacán, Mexico City, Chihuahua and Tlaxcala: Nea; Morelos, Veracruz, Quintana Roo, Guerrero and Nayarit: Neo
<i>Epiphanes brachionus</i> : Pal	Mexico City: Nea; Guerrero: Neo
<i>Horaella thomassoni</i> : Neo	State of Mexico, Michoacán and Aguascalientes: Nea
<i>Keratella procurva robusta</i> : Aus	State of Mexico, Michoacán and Aguascalientes: Nea and Tabasco: Neo
<i>Lecane unguitata</i> : Afr, Aus, Ori, Pal	State of Mexico, Michoacán and Mexico City: Nea, Quintana Roo and Veracruz: Neo
<i>Lecane yatseni</i> : Ori	Veracruz: Neo
<i>Lepadella discoidea</i> : Afr, Aus, Ori	State of Mexico: Nea
<i>Lepadella punctata</i> : Ori, Pal	State of Mexico: Nea
<i>Mytilina mucronata spinigera</i> : Pal	Aguascalientes: Nea
<i>Mytilina ventralis</i> : Afr, Pac, Pal	State of Mexico, Mexico City, Morelos, Michoacán: Nea; Veracruz, Quintana Roo and Nayarit: Neo
<i>Notholca acuminata</i> : Afr, Pal	Chihuahua: Nea
<i>Notommata haueri</i> : Pal	Chihuahua: Nea
<i>Paradicranophorus sordidus</i> : Ant, Pal	Chihuahua: Nea
<i>Philodina acuticornis</i> : Pal	Chihuahua: Nea
<i>Plationus polyacanthus</i> : Pal	State of Mexico and Aguascalientes: Nea
<i>Proales globulifera</i> : Pal	State of Mexico: Nea
<i>Ptygura brevis</i> : Aus, Pal	Chihuahua deserts: Nea
<i>Ptygura tridorsicornis</i> : Pal	State of Mexico: Nea
<i>Sphyrias lofauna</i> : Afr, Pac	Michoacán: Nea
<i>Squatinella lamellaris</i> : Pac, Pal	State of Mexico, Michoacán and Mexico City: Nea; Veracruz y Quintana Roo: Neo
<i>Synchaeta elsteri</i> : Pal	Michoacán: Nea
<i>Synchaeta hyperborea</i> : Pal	Tabasco: Neo
<i>Synchaeta tremuloida</i> : Pal	Jalisco: Nea

Different estimators of species diversity indicated the asymptote in all cases (Figure 1). The efficiency percentage of species estimates varied between 62% and 86% (Chao 2 and Bootstrap, respectively). In addition, these estimators indicated that the potential richness of rotifers from Mexico could be from 450 to 600 species.

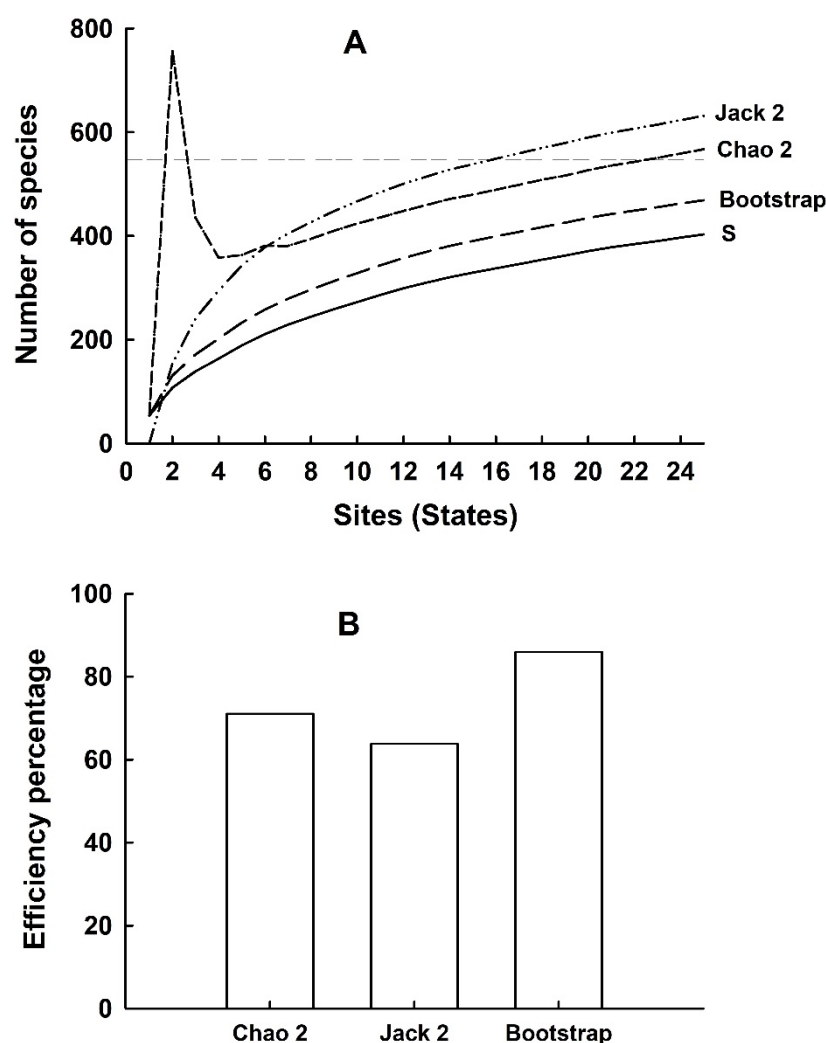


Figure 1. Diversity estimators (A) and efficiency percentage (B) using Jack 2, Chao 2, and Bootstrap methods.

4. Discussion

Taxonomical studies on Mexican rotifers date back more than 100 years. However, increased awareness of their role in limnological studies began only during the last 25 years. Figure 2 shows some of the interesting rotifer species from Mexico. Conventional limnological investigations in Mexico included rotifers as part of plankton [6], yet rarely quantified their abundances. One of the earliest studies on the seasonal variations of freshwater rotifers showed just seven rotifer taxa [43]. Thereafter, many studies on the seasonal variations of rotifers have been carried out from different water bodies such as ponds, lakes, reservoirs, and rivers. For certain freshwater ecosystems, zooplankton sampling was carried out for many years, for example, in the Valle de Bravo reservoir [44]. Long-term studies of riverine plankton are rare in Mexico, although the country has more than 200 rivers. Seasonal studies from River Antigua in the State of Veracruz have revealed 125 species REF. The importance of seasonal studies in understanding the rotifer species richness began receiving considerable attention after it became clear that certain exotic taxa appear only in certain months of the year. For example, *Notholca* cf. *liepeterseni* and *Lecane yatseni* have been recorded in River Antigua, Veracruz sporadically [40], although these species are native to the Scandinavian region and China, respectively.

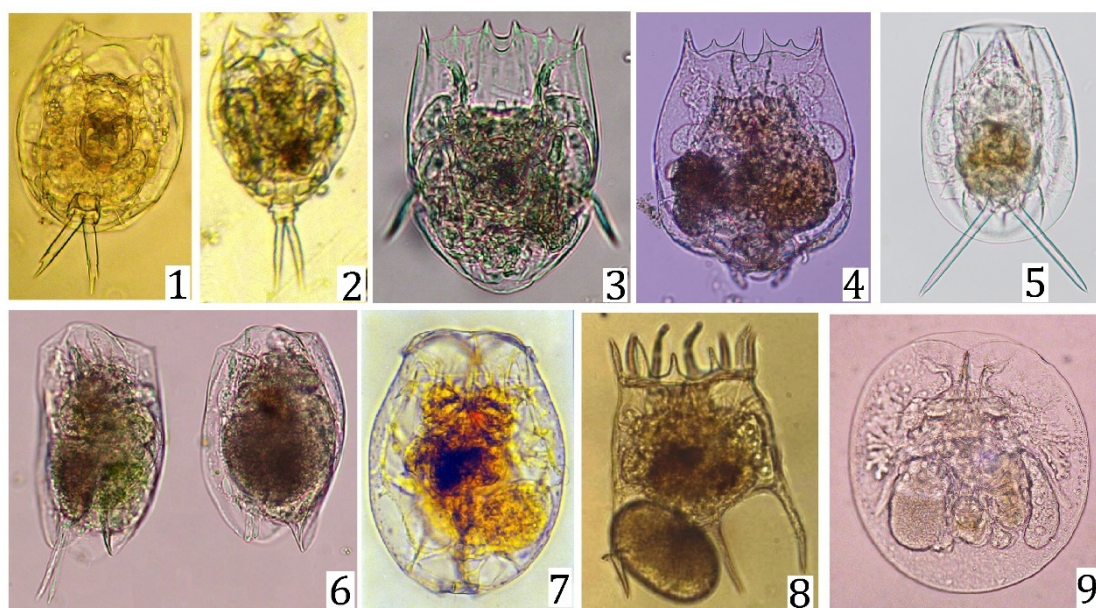


Figure 2. Some interesting rotifers from Mexico. (1) *Lecane yatseni*, (2) *Lecane rhytida*, (3) *Notholca* cf. *liepetterseni*, (4) *Brachionus bidentatus*, (5) *Dipleuchlanis propatula*; (6) *Euchlanis* cf. *mikropous*, (7) *Brachionus dimidiatus*, (8) *Platyonus patulus macracanthus* and (9) *Testudinella patina*. All photos from authors' previous works.

The first comprehensive list of Mexican rotifers was documented about 3 decades ago and contained 283 species [14]. Since then, many studies on Mexican freshwaters have reported the presence of 120 additional rotifer taxa. This, however, does not include close to 20 cryptic taxa, which require formal description. From the mean of species estimators, it appears that there is a possibility of encountering more than 600 species in Mexico. This may be a sub-estimation of the actual reality, since it is based on the diversity of rotifers which have been well studied only in 5–7 of the 32 federal entities in the country. This number is not unreasonable if one considers the numerous habitats that exist in Mexico which confer it a megadiverse status (CONABIO), as well as the existence of cryptic taxa within Rotifera. For example, the *Brachionus plicatilis* complex has as many as 15 cryptic species [45]. Several species complexes have already been reported in Mexico [25,28–30]. The geographic location of Mexico (as a corridor between South and North America) [46] also supports the possible occurrence of diverse rotifer species in different federal entities. This is further evidenced by the poor sampling in certain regions, especially in states such as Baja California, Durango, and Coahuila. Mexico has 70 large lakes (area: 1000 to 10,000 hectares), 14,000 reservoirs (85% with <10 hectares), and >200 rivers [6]. The rotifer species list presented in this work was based on only a handful of waterbodies and many more are yet to be studied.

Desert temporary ponds, rivers, and marine ecosystems have great potential for enhancing the species richness of rotifers to the Mexican fauna. For example, ephemeral waterbodies from the desert states in Mexico have yielded more than 100 rotifer species [47]. Yet, many temporary water bodies in Mexico have not been sampled even once. Rotifer fauna in riverine habitats have been rarely studied, although the species richness in these aquatic systems is high [40]. Mexico is bestowed with 9330 km of coastline. Yet, knowledge on the marine rotifers from Mexico is more fragmentary than inland saline waters [48]. For example, seasonal sampling efforts from the brackish water ecosystem in the State of Tabasco showed the presence of more than 35 rotifer species [49]. Of the three classes of rotifers, Bdelloidea, Monogononta, and Seisonacea, the last is represented by two marine genera, *Seison* and *Paraseison*. *Seison* is epizoic on the crustacean genus *Nebalia* but has not been so far reported from marine waters of Mexico, although *Nebalia* occurs in these waters [50]. Therefore, further studies on marine rotifers may be oriented for identifying *Seison* from *Nebalia*.

An aspect often overlooked in taxonomic studies is the culture of rotifer species, which is important for many reasons. The first is that, when studying the molecular taxonomy of predatory taxa, prey in the stomach contents may interfere with the analysis [26]. The second reason is that culturing species may reveal the presence of different phenotypes from the same genotype as observed in the case of *Euchlanis* cf. *mikropous* [51]. Third, some descriptions are vague and incomplete. For example, culturing a rare taxon with appearance of *Collotheca monoceros* [52] resolved the issue, showing that it was a regeneration by *Stephanoceros millsii*. Fourth, cryptic species have different life histories which cannot be identified from fixed samples [53]. Finally, for certain analysis of taxonomic characters such as measurements of trophi on SEM, culturing is needed to obtain sufficient quantity for the description of size range [54].

The occurrence of some rotifer species known from the geographic regions such as the Palearctic, Afrotropical, and Oriental were reported from Nearctic region and Neotropical regions of Mexico. For example, *Lecane yatseni*, typical to the Oriental region, was recorded from Mexico. Similarly, *Sphyrrias lofauna*, common to Afrotropical and Pacific regions, was documented from Nearctic region of Mexico [14]. This suggests not only extensive sampling, but also distributional aspects, including the possible roles that global climatic changes and trade involving aquatic species play a role in the dispersion of rotifers.

5. Conclusions

A taxonomic survey of rotifers so far has revealed the occurrence of about 400 species of rotifers from Mexico. Many Mexican states still do not have formal rotifer checklists. Only a few states in Mexico have some information on the diversity of rotifers. Yet, the species richness reported in this work is based on only a few selected water bodies. Species estimators have predicted the possible occurrence of about 600 rotifer species within the Mexican territory. Thus, further studies are still needed to understand rotifer diversity in Mexico.

Supplementary Materials: The following are available online at <https://www.mdpi.com/article/10.3390/d13070291/s1>, supplementary 1. List of consulted works for works on rotifer taxonomy and supplementary 2. Database compiled by the authors on the occurrence of different rotifer species from Mexico.

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