Arch. Hydrobiol.	120	4	481 – 493	Stuttgart, Februar 1991

Distributional Aspects of Rotifera in Central and South Chile

By Jenny M. Schmid-Araya, Lunz (Austria)[1]

With 4 figures and 2 tables in the text

Abstract

115 taxa of rotifers are recorded for 29 lakes Chilean lakes, among them 12 species are first time records in the country. 5 % of the taxa show a wide distribution between Central and South zones, while 14 % exhibit random occurrence. The majority of the species (81 %) are restricted to either Central or Southern regions. As a consequence, low taxonomic associations between lakes were observed, and it would imply that each lake has a relatively specific rotifer fauna.

Introduction

Rotifer species associations, in a given locality, seem to relate more to ecological factors, than biogeographical ones (Pejler 1957, Miracle 1976); although some cases of limited distribution have been reported (Brehm 1950, De Ridder 1981). These species associations could reflect a taxonomic spectrum, which could be characteristic in each type of water, a cause which probably has lead to take rotifer fauna as water quality indicators (Sladecek 1964, Gannon & Stemberger 1978, Vilaclara & Sladecek 1989).

Taxonomic research of the rotifer fauna in Chile was at first based in early expeditions to the country, where samples were obtained randomly in dispersed water bodies with few references to the locality (Daday 1902, Murray 1913, Hauer 1958). Later, Thomasson (1953, 1955 and 1963) and Löffler (1962), contributed lists of rotifer species in works orientated within a general limnological characterization of lakes in the South zone of Chile (32 ° 55′ S — 41 ° 05′ S). Since then, there have been occasional references to the group in general zooplankton investigations (Zuniga & Araya 1982, 1983; Campos et al. 1988), about the phenology of some species (Avendano & Saiz 1977, Soto et al. 1984), and general taxonomic features (Araya & Zuniga 1985).

The objective of this study is to deal with results of an investigation of the taxonomy and also, of the distribution of rotifers in Chilean water bodies along a latitudinal transect.

[1] Address of the author: Dr. Jenny M. Schmid-Araya, Biologische Station Lunz, A-3293 Lunz am See, Austria.

0003-9136/91/0120-0481 $ 3.25

Material and methods

The study compiles species records obtained for a total of 29 lakes, whose geographical situation in the country is shown in Table 1. The data were collected from different sources, as follows: a) previous taxonomic lists (mentioned in the introduction); b) qualitative samples obtained with a plankton net of 80 µm mesh size, throughout the water column; and c) quantitative samples obtained by vertical trawling with an Apstein type net (80 µm mesh size), or a Schindler sampler of 30 liters volume capacity. In the last two cases, samples were fixed in the field with 5 % formalin, drop to drop, to secure specimens in relaxed conditions. The index of affinity of Jaccard (Sj) (CARBONNEL 1973) was used to examine associations between lakes.

Results and discussion

A total of 115 taxa of rotifers (Class Monogononta) are recorded for Chile, among them 8 species and 4 forms are first time records in the country (Table 2).

Table 1. Geographical situation of the Chilean lakes analysed, and their respective species richness of rotifer fauna.

Lakes	Latitude	No. species
1. Catapilco	32°31′S – 71°17′W	8
2. La Laguna	32°39′S – 71°21′W	4
3. Del Inca	32°49′S – 70°51′W	9
4. Rungue	33°02′S – 70°56′W	11
5. El Plateado	33°04′S – 71°39′W	6
6. Penuelas	33°10′S – 71°29′W	26
7. Orozco	33°14′S – 71°26′W	16
8. Algarrobo	33°23′S – 71°39′W	10
9. El Peral	33°30′S – 71°36′W	14
10. El Yeso	33°39′S – 70°07′W	5
11. Aculeo	33°50′S – 70°54′W	6
12. Rapel	34°10′S – 71°29′W	16
13. Lanalhue	37°55′S – 73°18′W	14
14. Lleu-Lleu	38°09′S – 73°19′W	6
15. Huilipilun	39°08′S – 72°09′W	8
16. Villarrica	39°18′S – 72°05′W	26
17. Pichilafquen	39°18′S – 72°07′W	22
18. Quillehue	39°35′S – 71°33′W	10
19. Calafquen	39°32′S – 72°09′W	9
20. Pellaifa	39°36′S – 71°57′W	11
21. Panguipulli	39°43′S – 72°13′W	12
22. Rinihue	39°50′S – 72°20′W	8
23. Ranco	40°13′S – 72°23′W	11
24. Puyehue	40°40′S – 72°26′W	5
25. Rupanco	40°48′S – 72°25′W	7
26. Bonita	40°23′S – 72°19′W	6
27. Llanquihue	41°09′S – 72°47′W	18
28. Todos los Santos	41°05′S – 72°12′W	12
29. Antarctica pond	62°12′S – 58°55′W	1

Table 2. List of taxa of Rotifera recorded in Chilean lakes. (*) indicates first time record in the country; (1) cited by Koste & Jose de Paggi (1982); (2) cited by Thomasson (1963).

Class Monogononta

Order Ploimida

Fam. Epiphanidae
1. *Epiphanes brachionus* (Ehrb.)
2. *E. macrourus* (Barrois & Daday)

Fam. Brachionidae
3. *Brachionus angularis* Gosse
4. *B. calyciflorus calyciflorus* Pallas
5. *B. calyciflorus* f. *anuraeiformis* (Brehm)
6. *B. caudatus* f. *austrogenitus* Ahlstrom
7. *B. caudatus* f. *majusculus* Ahlstrom (*)
8. *B. bevanaensis* Rousselet
9. *B. patulus patulus* (O.F.M.)
10. *B. plicatilis* (O.F.M.) (*)
11. *B. quadridentatus quadridentatus* Herman
12. *Platyas quadricornis quadricornis* (Ehrb.)
13. *Keratella americana* Carlin
14. *K. cochlearis cochlearis* Gosse
15. *K. cochlearis* var. *tecta* f. *typica* Lauterborn
16. *K. ona* Boltovskoy & Urrejola
17. *K. thomassoni* Hauer
18. *K. tropica tropica* Apstein
19. *Notholca caudata* Carlin
20. *N. foliacea* (Ehrb.)
21. *N. labis labis* Gosse
22. *N. labis* f. *limnetica* Levander
23. *N. striata striata* (O.F.M.) (1)
24. *N. striata* var. *intermedia* Voronkov
25. *Kellicottia longispina longispina* (Kellicott) (1)
26. *Anuraeopsis fissa fissa* (Gosse)
27. *A. navicula* (Rousselet)

Fam. Euchlanidae
28. *Euchlanis dilatata dilatata* Ehrb.
29. *E. incisa incisa* Carlin
30. *E. meneta* Myers (1)
31. *E. triquetra* Ehrb.

Fam. Mytilinidae
32. *Mytilina ventralis* var. *brevispina* Ehrb. (*)
33. *M. ventralis* var. *macracantha* (Gosse) (*)
34. *Lophocharis naias naias* Wulfert
35. *L. salpina* (Ehrb.)

Fam. Trichotridae
36. *Trichotria pocillum* (O.F.M.)
37. *T. tetractis tetractis* (Ehrb.)
38. *Macrochaetus collinsi collinsi* (Gosse)
39. *M. sericus* (Thorpe)
40. *M. subquadratus* Perty

Fam. Colurellidae
41. *Colurella obtusa* (Gosse)
42. *C. uncinata* f. *bicuspidata* (Ehrb.)
43. *Lepadella* (s.str.) *acuminata acuminata* (Ehrb.) (1)
44. *L. cristata* (Rousselet)
45. *L. ovalis* (O.F.M.)
46. *L. patella patella* (O.F.M.)
47. *L. quinquecostata quinquecostata* Lucks
48. *L. rhomboides rhomboides* (Gosse) (1)
49. *L. triptera* Ehrb.

Fam. Lecanidae
50. *Lecane* (s.str.) *aculeata aculeata* (Jakubski) (1)
51. *L. aculeata* var. *arcula* (Harring) (1)
52. *L. flexilis* (Gosse)
53. *L. luna luna* (Muller)
54. *L. stichaea stichaea* Harring
55. *Lecane (M.) bulla bulla* (Gosse)
56. *L. closterocerca* (Schmarda)
57. *L. crypta* (2)
58. *L. furcata furcata* (Murray) (*)
59. *L. lunaris lunaris* (Ehrb.)
60. *L. lunaris crenata* (Harring)
61. *L. pyriformis* (Daday)
62. *L. quadridentata* (Ehrb.)
63. *L. subulata subulata* (H & M) (1)

Fam. Notommatidae
64. *Cephalodella gibba gibba* (Ehrb.)
65. *Monommata grandis* Tessin (1)
66. *Taphrocampa selenura* (Gosse)

Fam. Trichocercidae
67. *Trichocerca (Diurella) birostris* (Minkiewicz)
68. *T. dixon-nuttalli* Jennings
69. *T. inermis* (Linder)
70. *T. porcellus porcellus* (Gosse)
71. *T. ruttneri* (Donner)
72. *T. similis similis* (Wierzejski)
73. *T. tenuior* (Gosse)
74. *T. tigris* (O.F.M.) (*)
75. *T. weberi* Jennings
76. *Trichocerca* (s.str.) *elongata elongata* (Gosse) (*)
77. *T. jenningsi* Voigt (1)
78. *T. longiseta* (Schrank)
79. *T. pusilla* (Lauterborn)
80. *T. rattus* f. *carinata* (Ehrb.) (*)
81. *T. stylata* (Gosse)

Fam. Gastropodidae
82. *Gastropus minor* (Rousselet)
83. *G. stylifer* Imhof
84. *Ascomorpha ovalis* (Bergendal)

Fam. Synchaetidae
85. *Synchaeta lakowitziana* Lucks
86. *S. longipes* Gosse
87. *S. oblonga* Ehrb.
88. *S. pectinata* Ehrb.
89. *S. stylata* Wierzejski
90. *S. tremula* (O.F.M.) (1)
91. *Polyarthra dolichoptera dolichoptera* Idelson
92. *P. remata* (Skorikov)
93. *P. vulgaris vulgaris* Carlin

Fam. Asplanchnidae
94. *Asplanchna (A.) girodi* (De Guerne) (*)
95. *A. sieboldi* (Leydig)
96. *A. silvestris* (Daday)
97. *Asplanchnopus multiceps* (Schrank) (1)

Fam. Dicranophoridae
98. *Dicranophorus robustus robustus* H & M

Order Gnesiotrocha

Suborder Flosculariacea

Fam. Testudinellidae
99. *Testudinella patina patina* (Herman)
100. *T. patina* f. *trilobata* Anderson & Shephard (*)
101. *Pompholix complanata* Gosse
102. *P. sulcata* (Hudson)

Fam. Conochilidae
103. *Conochilus dossuarius dossuarius* (Hudson)
104. *C. natans* (Seligo)
105. *C. unicornis* (Rousselet)

Fam. Hexarthridae
106. *Hexarthra fennica* Levander
107. *H. intermedia intermedia* Wisniewski (*)
108. *H. oxyuris* (Sernov) (1)

Fam. Filiniidae
109. *Filinia longiseta longiseta* (Ehrb.)
110. *F. longiseta* var. *limnetica* (Zacharias) (1)
111. *F. terminalis* (Plate)

Fam. Trochosphaeridae
112. *Horaëlla brehmi* Donner (*)

Suborder Collothecacea

Fam. Collothecidae
113. *Collotheca libera* (Zacharias)
114. *C. mutabilis* (Hudson)
115. *C. pelagica pelagica* (Rousselet)

The order Ploimida is well represented with 13 families arranged in 26 genera, while the order Gnesiotrocha has only 6 families organized in 6 genera. The success of the order Ploimida, especially of the families Brachionidae, Trichocercidae and Lecanidae could be due to the presence of some tikoplanktonic genera, which in lakes of the Central zone have a high probability of occurrence, because of macrophyte abundances.

Remarks on new records in the country

Brachionus caudatus f. *majusculus* AHLSTROM, 1940 (Fig. 1 a)

The specimens, examined accordingly to AHLSTROM (1940), agreed with the description given for the form *provectus*, however due to well known variability of the group, the synonym after KOSTE (1978) was adopted. All individuals had only two median occipital spines developed, and the form appears mainly in Central zone reservoirs (Fig. 3). The form *majusculus* has also been detected in Argentina, Venezuela and Brazil (AHLSTROM 1940, KOSTE & JOSE DE PAGGI 1982), and this finding is a new record in Chile.

Lorica length 261 µm, width 123 µm; length of posterior spines 114 µm; distance between antero-lateral spines 88 µm.

Brachionus plicatilis (O.F.M., 1786) (Fig. 1 b)

This first time record in Chile, contributes to the knowledge of the cosmopolitan character of this taxa. Variation in the species is known in size, shape of the lorica and character of the anterior margins.

Lorica length 224 µm, width 136 µm; length of occipital spines 16—24—32 µm (lateral, intermediate, median); distance between antero-lateral spines 88 µm.

Mytilina ventralis (Figs. 1 c and d)

Two varieties of *M. ventralis* were found in Chile: var. *brevispina* (EHRB. 1832) and var. *macracantha* (GOSSE 1886). The specimens characteristics follow the descriptions made by KOSTE (1978) and STEMBERGER (1979); both varieties are present in different Chilean lakes. The var. *brevispina* is distributed in South America in Paraguay, while var. *macracantha* in Argentina, Venezuela and Brazil (KOSTE & JOSE DE PAGGI 1982). Lorica length of var. *brevispina* 195 µm and of var. *macracantha* 280 µm.

Lecane (Monostyla) furcata furcata (MURRAY, 1913) (Fig. 1 e)

The small specimens have the same appearance to the species described by HARRING & MYERS (1926), and were observed in sample sites with abundant macrophytes. Total length 100 µm; dorsal plate length 71 µm, width 75 µm; ventral plate length 73 µm, width 65 µm; length of toes 22 µm.

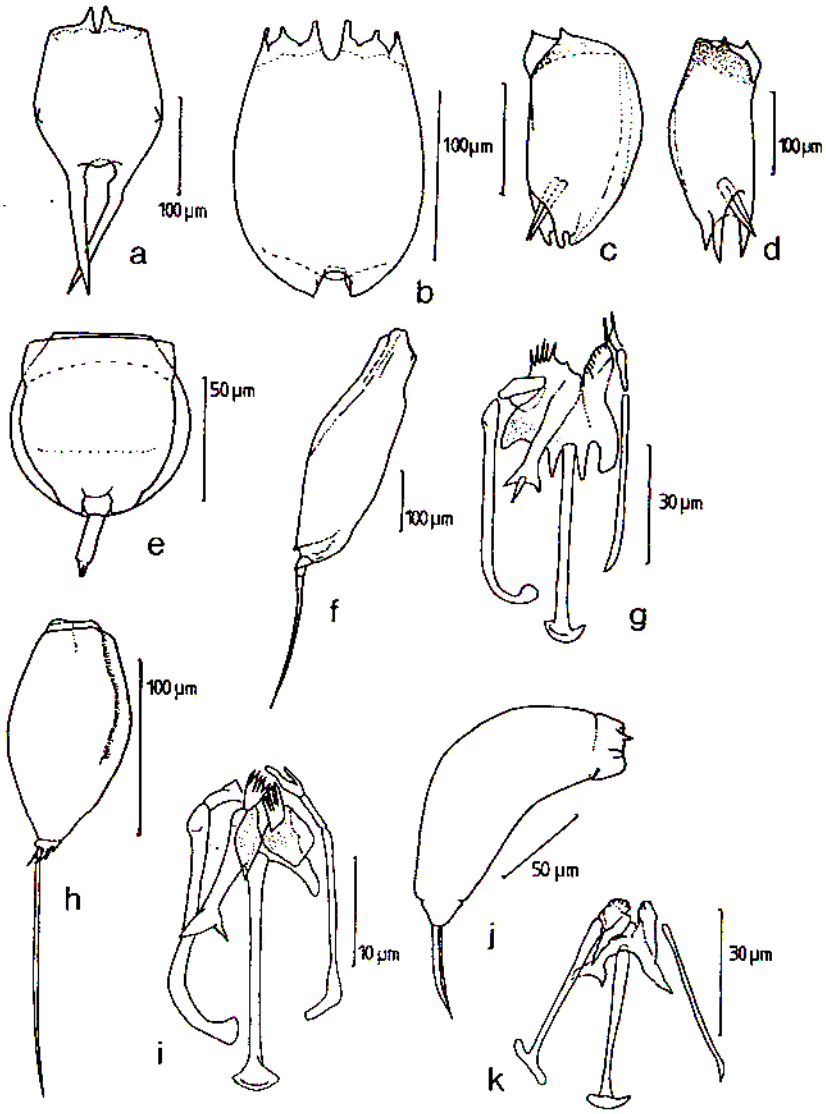

Fig. 1. Chilean rotifers: a) *Brachionus caudatus* f. *majusculus* AHLSTROM 1940, dorsal view. b) *B. plicatilis* O.F.M. 1786, dorsal view. c) *Mytilina ventralis* var. *brevispina* (EHRB. 1832), lateral view. d) *M. ventralis* var. *macracantha* (GOSSE 1886), lateral view. e) *Lecane (Monostyla) furcata furcata* (MURRAY 1913), ventral view. f) *Trichocerca* s.str. *elongata elongata* (GOSSE 1886). g) Trophy of *T. elongata elongata*. h) *T. rattus* f. *carinata* (EHRB. 1830). i) Trophy of *T. rattus* f. *carinata*. j) *Trichocerca (Diurella) tigris* (O.F.M. 1786). k) Trophy of *T. tigris*.

Trichocerca (s.str.) *elongata elongata* (Gosse, 1886) (Figs. 1 f and g)

The general body shape and trophy analysis coincided with the characterization given by Wulfert (1939). The species seem to be related to litoral areas, however only in one Central zone reservoir (Fig. 3).

Body length 420 μm; length of left toe 210 μm, length of right toe 40 μm.

Trichocerca (s.str.) *rattus* f. *carinata* (Ehrb., 1830) (Figs. 1 h and i)

The animals resembled the general description and trophy analysis made by Koste (1978), and were collected in the same site of *T. elongata elongata*. Body length 140 μm; toe length 130 μm; trophy 30 μm.

Trichocerca (Diurella) tigris (O.F.M., 1786) (Figs. 1 j and k)

Trophy analysis agreed with that given by Koch-Althaus (1962), and the species is restricted until now, in one Central zone pond (Fig. 3).

Body length 160 μm; toe length 50 μm; trophy 50 μm.

Asplanchna (Asplanchnella) girodi (De Guerne, 1888) (Fig. 2 a)

The taxa is present in several South American countries, while it is for the first time detected in Chile. The body shape is sacciform, with a body length of 500 μm and horse-shoe shaped vitellarium. The trophy revealed the absence of apophysis and inner tooth, both characteristic of this species.

Hexarthra intermedia intermedia Wiszniewsky, 1929 (Figs. 2 b, c and d)

In general the structure of the body and appendages agreed with the description of Bartos (1948). The asymmetric trophy was 6 toes and a length of 20 μm. The animals were found in Penuelas reservoir, during summer season and in low numbers (unpublished data). Body length 130 μm; ventral appendage 160 μm.

Horaëlla brehmi Donner, 1949 (Figs. 2 e and f)

The specimens, collected in Orozco and Algarrobo, have a similar body appearance and trophy to that described originally by Donner (1949). However, the individuals in Chile are smaller in size when compared to those in Koste (1978). Moreover, the examination of the trophy shows a similar shape in the manubrium and unci, accordingly to both mentioned authors, but the lower base of the rami and the alulae beside the fulcrum are asymmetric (Fig. 2 f). These features may evidence a deviation and would need further study to establish if it constitutes a form. Body length 250 μm, width 150 μm; trophy length 23 μm, width 28 μm; fulcrum 8 μm; longest tooth in the unci 11 μm; shortest tooth in the unci 9 μm.

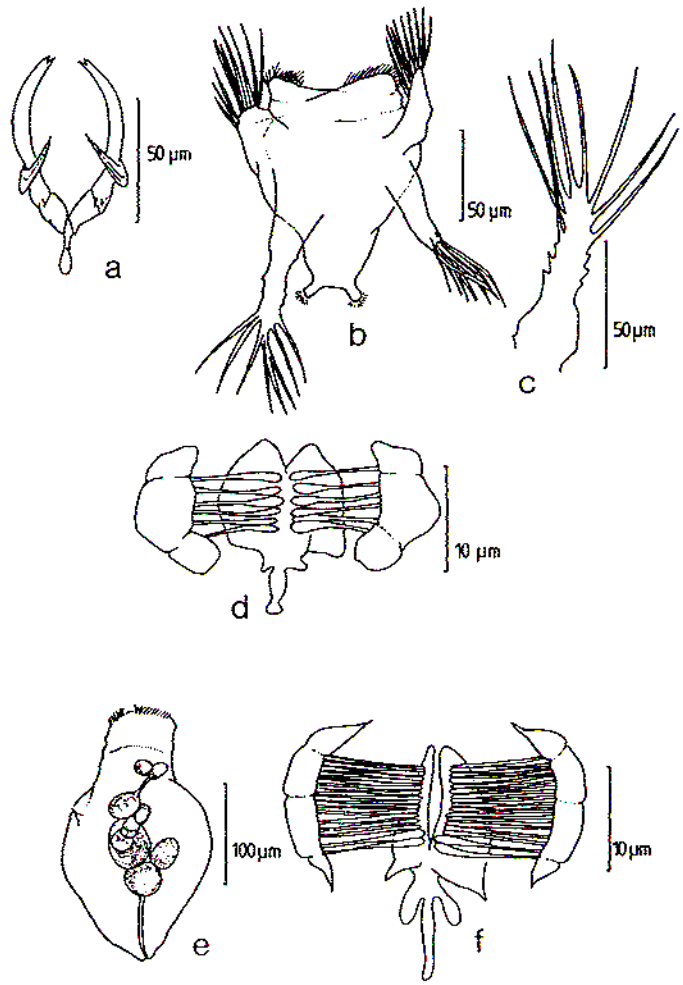

Fig. 2. Chilean rotifers: a) Trophy of *Asplanchna (Asplanchnella) girodi* (De Guerne 1888). b) *Hexarthra intermedia intermedia* Wiszniewski 1929. c) Ventral appendage of *H. intermedia intermedia*. d) Trophy of *H. intermedia intermedia*. e) *Horaëlla brehmi* Donner 1949. f) Trophy of *H. brehmi*.

Distributional aspects

The distribution pattern of Chilean Rotifera along a latitudinal transect from 31° 12′ S to 62° 12′ S is shown in Fig. 3. For a total of 101 taxa, whose locations in the country are specifically known, it is possible to distinguish four groups of species: a) with relatively regular and wide occurrence

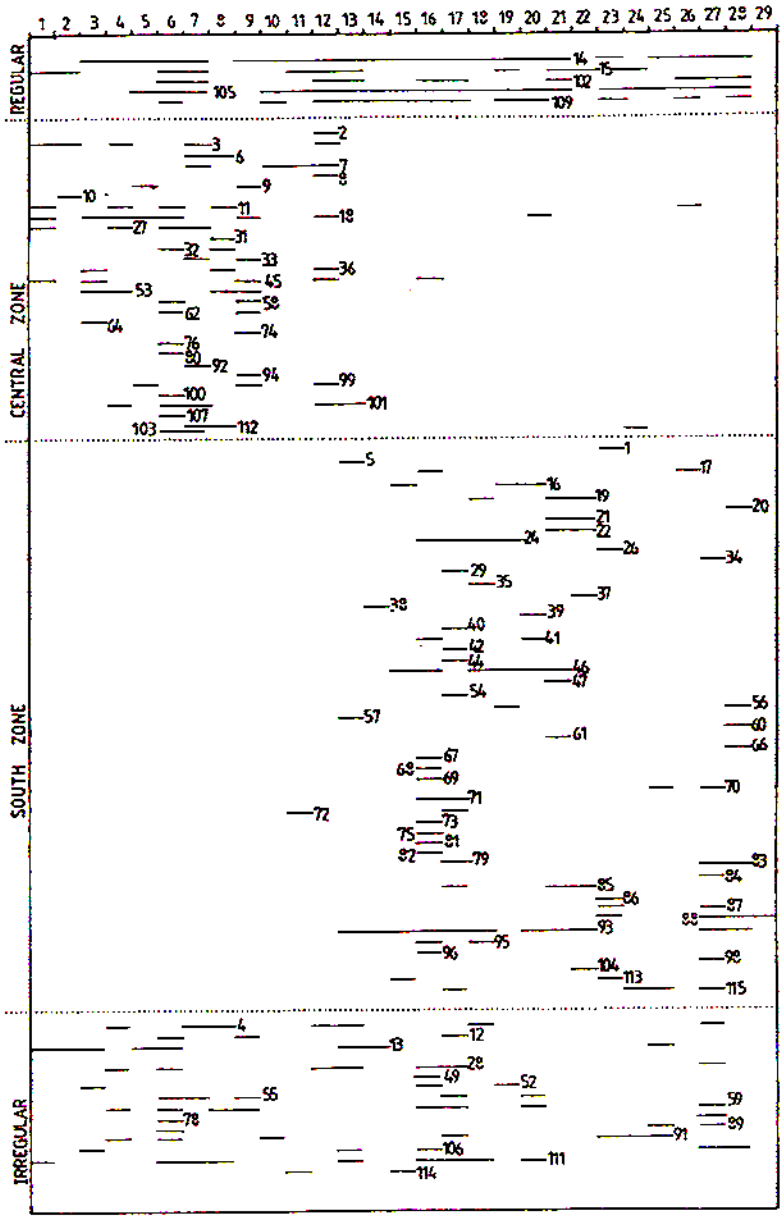

Fig. 3. The distribution of the rotifer fauna in Chile, arranged in a latitudinal transect from 32° to 62° S. The numbers in the upper-margin (1—29) correspond to lakes listed in Table 1. A total of 101 taxa, whose location could be known within the transect, are represented with a number accordingly to Table 2.

throughout the transect; b) with high frequency in the Central zone; c) mainly frequent towards the South and, d) with a random presence through this latitudinal transect.

Species with broad distribution belong to well-known cosmopolitans (*Keratella cochlearis* and *Conochilus unicornis*), or those which due to temperature tolerances can appear during summer in the epilimnion of southern lakes (*K. cochlearis* var. *tecta* f. *typica*, *Pompholix sulcata* and *Filinia longiseta longiseta*).

Within the group observed in the Central zone, several taxa are recognized as cosmotropicals. Among them, *Brachionus havanaensis* was the subject of discussion by De Ridder (1981), as a New World species and, also that its distribution in some places could be a consequence of man-made effect. In Chile, it was reported by Zuniga & Araya (1982) and Soto et al. (1984) in Rapel reservoir. According to these authors, the species appears in May, when temperature ranges from 16.8 °C to 17.1 °C and disappears after heavy rains, which cause floods in some areas of the lake. It is important to point out that, the presence of *B. havanaensis* in Chile is restricted to this reservoir.

Keratella tropica, a dominant also in sub-tropical climates (Ruttner-Kolisko 1974), is distributed between 32 ° 31′ S to 39 ° 43′ S in Chile. However, probably because of its similarities (Berzins 1955), it has been recorded as *Keratella valga* (Araya & Zuniga 1985). Another species, *Anuraeopsis navicula* is similarly limited to the Central zone, being characteristic of shallow reservoirs. It has been observed in high abundances, during Autumn, in Rungue reservoir at temperatures ranging from 18 °C to 21.5 °C (unpublished data).

Limited distribution towards the South is shown by species such as *K. ona*, *Polyarthra vulgaris*, *Collotheca libera* and *C. pelagica* among others, and the genera *Notholca* and *Synchaeta* (Fig. 3). Most of these taxa are: cold stenothermous, related to waters rich in oxygen or generally associated to oligotrophic conditions. These characteristics are found in these lakes from 39 ° S next to the Andes range (Campos 1984). The genera *Macrochaetus* and *Lophocharis* as well as the species *Asplanchna sieboldi* and *A. silvestris* were recorded in the South (Löffler 1962, Thomasson 1963), but since then, they have not re-occurred in the area.

Among taxa randomly distributed throughout the latitudinal transect, it is worth to mention *K. americana* (= *K. gracilenta*) endemic to the Nearctic and Neotropical regions (Brehm 1950, De Ridder 1981). The distribution of this species in Chile extends to lake Rupanco (40 ° 48′ S), which is situated in temperate South Chile. Other rotifers like *Polyarthra dolichoptera*, *Hexarthra fennica* and *Filinia terminalis* also show a random frequency of occurrence in the country, but it could be due to an occasional presence in high altitude lakes in the Central zone and at the same time in oligotrophic southern lakes. On the other hand, *Brachionus calyciflorus* has been observed in central reservoirs but, it was also found in three southern lakes: Lanalhue, Quillehue and Llanquihue

(LÖFFLER 1962, THOMASSON 1963); nevertheless, at least in the latter one, the species did not occur even after a year-cycle study (CAMPOS et al. 1988).

Lakes associations

The group formation shown in Fig. 3 would imply, as a consequence, a faunistic differentiation throughout the lakes in the latitudinal transect. Fig. 4, shows the taxonomic similarity between these water bodies, where it is possible to observe low values of association. The low similarity could be the result of the high number of taxa (81 %) with a limited distribution to either

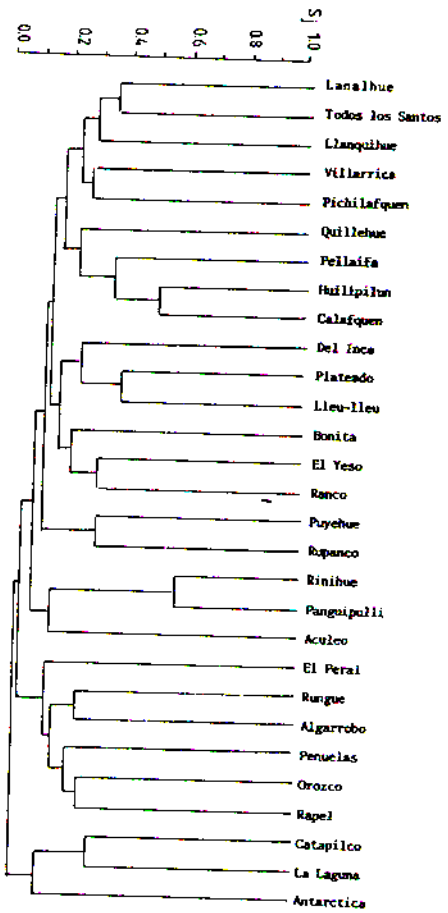

Fig. 4. Dendrogram of taxonomic similarity of the rotifer fauna (Sj), between 29 Chilean lakes.

(Löffler 1962, Thomasson 1963); nevertheless, at least in the latter one, the species did not occur even after a year-cycle study (Campos et al. 1988).

Lakes associations

The group formation shown in Fig. 3 would imply, as a consequence, a faunistic differentiation throughout the lakes in the latitudinal transect. Fig. 4, shows the taxonomic similarity between these water bodies, where it is possible to observe low values of association. The low similarity could be the result of the high number of taxa (81%) with a limited distribution to either

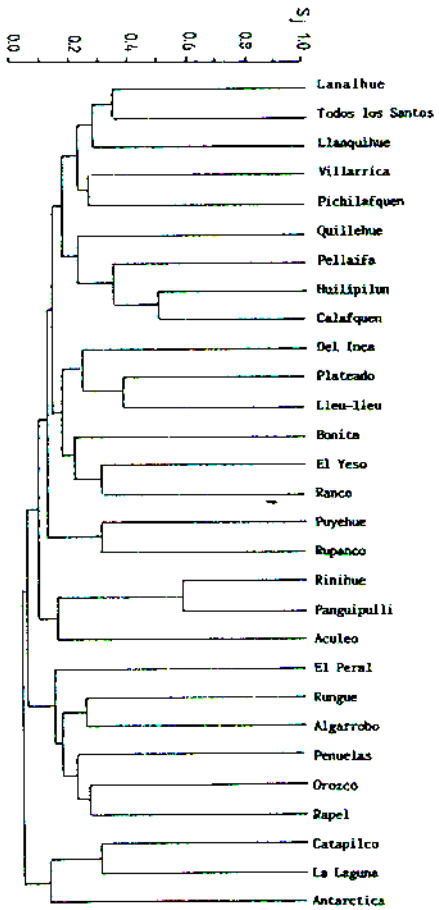

Fig. 4. Dendrogram of taxonomic similarity of the rotifer fauna (Sj), between 29 Chilean lakes.

Central or South regions; therefore indicating that some lakes have a characteristic rotifer fauna. Despite the low values, general tendencies of groups can be seen, as expected by associations within the same area or a mixture between different regions. In this last group, similarity of the rotifer fauna between high altitude lakes, such as Laguna del Inca and Yeso, and the South area could be predicted, because of general oligotrophic conditions. In addition, the inclusion of Aculeo and El Plateado in the same group could be explained due to the temperature regime, especially observed in the latter (Zuniga & Dominguez 1977).

With respect to the species richness, Penuelas, Villarrica and Pichilafquén show higher values when compared to the rest (Table 1). The total number of species found in Penuelas corresponds to a year-cycle study (unpublished data), and some rotifers have a tikoplanktonic character. The two other lakes, situated in the South, deviate from the general trend of low species richness shown by the rest of the oligotrophic lakes. Moreover, in Villarrica seven species of *Trichocerca*, recorded by previous authors, have not been observed again. Similarly, a total of 18 taxa could be listed in lake Llanquihue, but only 6 species were found after a one year study (Campos et al. 1988).

Generally, higher values of species richness in the Central zone could be due to the presence of both: truly planktonic and litoral species, together with occurrence of cosmotropical rotifers. Low species richness in the Central region are shown by high altitude lakes (Inca, Yeso) and also by Aculeo and Plateado, confirming the resemblance in the rotifer fauna in these lakes with those in the southern zone.

Acknowledgements

Thanks are due to Dr L. R. Zuniga (Universidad Catolica, Valparaiso, Chile) for constructive criticism of an earlier draft of this manuscript. Special thanks to Dr P. E. Schmid for valuable suggestions on the manuscript. This work was partly supported by project DGI 122.788/83 from Universidad Catolica de Valparaiso, Chile.

References

Ahlstrom, E. (1940): A revision of the Rotatorian genera *Brachionus* and *Platyas* with description of one new species and two new varieties. — Bull. Amer. Mus. Nat. Hist. 77: 143—184.

— (1943): A revision of the Rotatorian genera *Keratella* with description of three new species and five new varieties. — Bull. Amer. Mus. Nat. Hist. 80: 411—457.

Araya, J. M. & Zuniga, L. R. (1985): Manual taxonómico del zooplancton lacustre de Chile. — Bol. Inf. Limnol. Inst. Zool. Univ. Austral 8: 1—110.

Avendano, V. & Saiz, F. (1977): Taxocenosis de rotiferos limnéticos de la laguna El Plateado. — An. Mus. Hist. Nat. (Valpso) 10: 121—133.

Bartos, E. (1948): On the bohemian species of the genus *Pedalia* Barrois. — Hydrobiologia I: 63—77.

Berzins, B. (1955): Taxonomie und Verbreitung von *Keratella valga* und verwandten Formen. — Arz. Zool. Ser. 2, 8: 549—559.

Brehm, V. (1950): Apostillas zoogeograficas a varios trabajos del Prof. Gauthier, con un apéndice sobre las caracteristicas biogeograficas de algunos grupos de organismos dulceacuicolas. — P. Inst. Bio. Ar. I Tomo 7: 83—130.

Campos, H. (1984): Limnological study of Araucanian lakes (Chile). — Verh. Internat. Verein. Limnol. 22: 1319—1327.

Campos, H., Steffen, W., Agüero, G., Parra, O. & Zuniga, L. R. (1988): Limnological study of lake Llanquihue (Chile). Morphometry, physics, chemistry, plankton and primary productivity. — Arch. Hydrobiol. Suppl. 81: 37—67.

Carbonnel, G. (1973): L'analyse de groupe en paléoécologie et en biostratigraphie. — Arch. Sr. Geneve 26: 23—68.

Daday, E. (1902): Beiträge zur Kenntis der Süßwasser-Mikrofauna von Chile. — Termez, Fuzekt 25: 436—447.

Donner, J. (1949): *Horaëlla brehmi* nov. gen., nov. spec. — Hydrobiologia II: 134—140.

Gannon, J. E. & Stemberger, R. S. (1978): Zooplankton (especially crustacean and rotifers) as indicators of water quality. — Trans. Amer. Micros. Soc. 97: 16—35.

Harring, H. K. & Myers, F. J. (1926): The rotifer fauna of Wisconsin. III. A revision of the genera *Lecane* and *Monostyla*. — Trans. Acad. Wisconsin 22: 315—423.

Hauer, J. (1958): Beitrag zur Kenntnis südamerikanischer Rotatoria. — Beitr. natur. Forsch. Südwestdeutschland 17: 174—178.

Koch-Althaus, B. (1962): Beitrag zur Rotatorienfauna des Bodensees. — Limnologica 1: 93—110.

Koste, W. (1978): Rotatoria. Die Rädertiere Mitteleuropas. Ein Bestimmungswerk begr. von M. Voigt. Überordnung Monogononta. — I. Textband: 1—673, II Tafelband: 234 Tab., Gebrüder Borntraeger, Berlin, Stuttgart.

Koste, W. & Jose de Paggi, S. (1982): Rotifera of the Superorder Monogononta from Neotropis. — Gewässer und Abwässer 68/69: 71—102.

Löffler, H. (1962): Zur Systematik und Ökologie der chilenischen Süßwasserentomostraken. — Beitr. Neutrop. Fauna 2: 145—221.

Miracle, M. R. (1976): Distribución en el espacio y en el tiempo de las especies del zooplancton del lago Banyoles. — Icona Monografías 5: 1—270.

Murray, J. (1913): South American Rotifers. — J. Roy. Micr. Soc.: 229—236, 341—362, 449—454.

Pejler, B. (1957): On variation and evolution in planktonic Rotatoria. — Zool. Bidr. Uppsala 32: 1—66.

— (1977): General problems of rotifer taxonomy and global distribution. — Arch. Hydrobiol. 8: 212—220.

de Ridder, M. (1981): Some considerations on the geographical distribution of rotifers. — Hydrobiologia 85: 209—225.

Ruttner-Kolisko, A. (1974): Plankton rotifers: Biology and taxonomy. — Die Binnengewässer Suppl. 26: 1—146.

Sladecek, V. (1964): Zur Ermittlung des Indikations-Gewichtes in der Gewässeruntersuchung. — Arch. Hydrobiol. 60: 241—243.

Soto, D., Vila, I. & Villalobos, B. (1984): Temporal and spatial distribution of rotifera in a Chilean reservoir: A possible effect of impoundment hydrodynamics. — Hydrobiologia 114: 67—74.

Stemberger, R. S. (1979): A guide to rotifers of the Laurentian Great Lakes. Final Report. — U.S. Environmental Protection Agency, Cincinnati, Ohio: 1—185.

Thomasson, K. (1953): Studien über das südamerikanische Süßwasserplankton. 2. Zur Kenntnis des südamerikanischen Zooplanktons. — Ark. Zool. ser. 2, 6: 189—194.

— (1955): Studies on South American freshwater plankton. 3. Plankton from Tierra del Fuego and Valdivia. — Acta Horti Gotoburgensis 19: 193—225.

— (1963): Araucanian lakes. Plankton studies on North Patagonia. — Acta Phytogr. Suecica 47: 1—139.

Vilaclara, G. & Sladecek, V. (1989): Mexican rotifers as indicators of water quality with description of *Collotheca riverai*, n. sp. — Arch. Hydrobiol. 115: 257—263.

Wulfert, K. (1939): Rädertierefauna Deutschlands, IV. — Arch. Hydrobiol. 35: 563—624.

Zuniga, L. R. & Dominguez, P. (1977): Observaciones sobre el zooplancton de lagos chilenos. — An. Mus. Hist. Nat. (Valpso) 10: 107—120.

Zuniga, L. R. & Araya, J. M. (1982): Estructura y distribución espacial del zooplancton del embalse Rapel. — An. Mus. Hist. Nat. (Valpso) 15: 45—57.

— — (1983): Zooplancton del lago Ranco: Distribución espacial y temporal de la comunidad. — Arch. biol. Med. Exp. 16: 194.

Submitted: 8 March 1990; accepted: 28 October 1990.