

THE SPECIES COMPOSITION OF ROTIFERS IN THREE HYDROELECTRIC RESERVOIRS OF WESTERN HIGHLANDS, CENTRAL VIETNAM

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ABSTRACT

The rotifer fauna in three hydroelectric reservoirs of western highlands, central Vietnam were studied. Among a total of 63 identified species and subspecies, belonging to 23 genera in 15 families, *Brachionidae* was the most diverse family with 15 taxa recorded (23.81%) followed by *Lecanidae* (14 taxa, 22.22%), and *Synchaetidae* (8 taxa, 12.7%). Species accumulation curve and species richness estimators suggested a relatively high level of biodiversity of rotifera assemblages in the studied area. Besides, results on species composition of rotifera community in this study were compared to those of other freshwater bodies in Vietnam using Jaccard similarity index. In particular, the highest similarity was found between reservoirs in western highlands and Phu Ninh lake, Quang Nam Province while the largest difference in species composition was observed between western highlands and Bau Thiem lake, Thua Thien Hue Province.

Keywords: Rotifera, species richness, zooplankton, Western highlands.

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INTRODUCTION

Rotifers have universal distribution and account for a large proportion of zooplankton in water bodies, playing a substantial part in the functioning of ecosystems. These animals contribute considerably to the biodiversity of water bodies in the tropical and equatorial climate zones (Dussart et al., 1984).

The phylum Rotifera comprises about 2030 known species classified in three main groups, the marine Seisonida (3 species) the Monogononta (1570 species) and the unique, exclusively parthenogenetic Bdelloidea with 461 clonal species (Segers, 2007). In Vietnam, the first record of rotifera was reported by Shirota (1966) with 72 species in freshwater and 6 species in saline water. Dang et al. (1980) identified 52 species of rotifers in freshwater bodies in Northern Vietnam. Studies after that recorded 65 species in central Vietnam (Zhdanova, 2011) and 49 species in Southern Vietnam (Dang, 2012). Most notably, recent studies conducted by Trinh-Dang et al. (2019a, 2019b, 2015, 2013) documented 100 new records to Vietnam's rotifer fauna and five new species to science.

These results indicate a high potential of rotifer diversity in Vietnam.

Western highlands comprising five provinces, Kon Tum, Gia Lai, Dak Lak, Dak Nong and Lam Dong, is one of three sub-regions in central Vietnam. The region is mostly covered by forests which retain many water bodies with diverse biological resources. In order to explore the biodiversity Western Highlands as well as to contribute deeper knowledge about rotifera communities in Vietnam, a study on species composition of rotifers in three hydroelectric reservoirs, which currently play an important role in supplying water and hydroelectric power for human consumption as well as agricultural and industrial activities, was conducted.

MATERIALS AND METHODS

Three hydroelectric reservoirs located on the border between Dak Lak Province and Dak Nong Province, namely Serepok, Buon Kuop, and Buon Tua Srah, were investigated in September 2016, (Fig. 1). These reservoirs are positioned in The Serepok river basin, a 400 km tributary of the Mekong river with a total basin area of approximately 30.100 km².

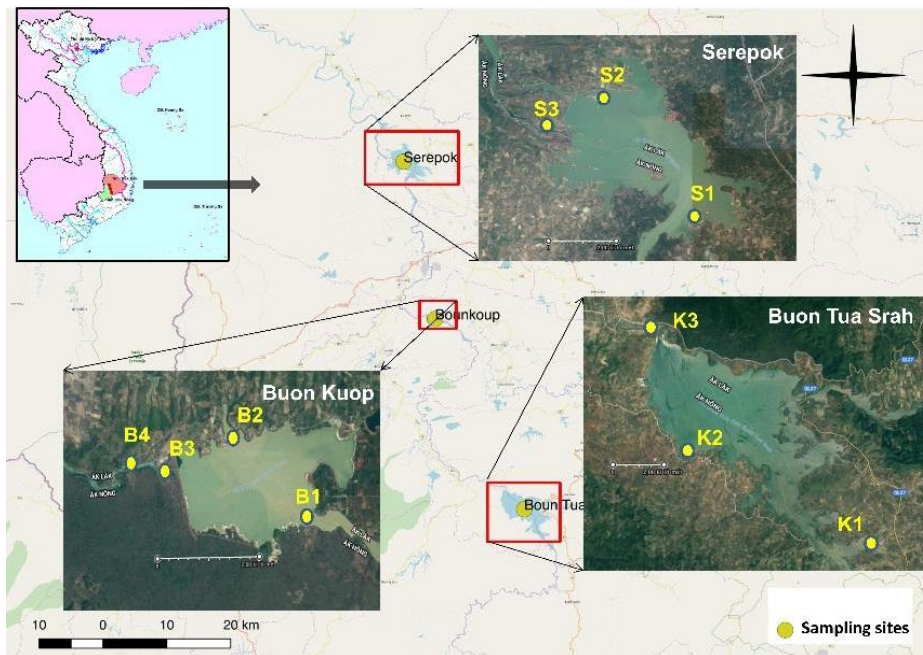


Figure 1. Schematic map of the study area

Zooplankton was studied in the littoral zone of reservoirs. Qualitative samples of rotifers were collected using a 50 µm mesh size cast-net and immediately preserved in 4% formaldehyde. Rotifer specimens were sorted and examined using a Hund (H600) compound microscope equipped with a camera. The trophi of rotifers were examined by adding a drop of commercial sodium-hypochlorite (NaOCl) to dissolve and isolate the hard trophi parts. Identification was based

on taxonomy and nomenclature of the rotifers as in Segers (2007). The species accumulator, species richness estimators and similarity index were calculated using the vegan package (Oksanen et al., 2013) in R (Team, 2013). Of these, Jackknife 2 and Chao 2 estimators were selected to estimate the expected diversity of rotifer in reservoirs (Trinh-Dang et al., 2019b). $Q_{B/T}$ index was used to evaluate the nature of eutrophic conditions:

$$Q_{B/T} = \frac{\text{No. of } Brachionus \text{ sp.}}{\text{No. of } Trichocerca \text{ sp.}} \text{ (Sládeček, 1983)}$$

RESULTS AND DISCUSSION

A total of 63 species and subspecies of 23 genera belonging to 15 families were identified in the studied area. Checklist is

provided in Table 1. Of these, Brachionidae was the most diverse family with 15 taxa recorded (23.81%) followed by Lecanidae (14 taxa, 22.22%), Synchaetidae (8 taxa, 12.7%) and Trichocercidae (7 taxa, 11.11%) (Fig. 2).

Table 1. Checklist of rotifer species of the studied reservoirs

No.	Taxon	Reservoir		
		(1)	(2)	(3)
Collotheceidae				
1	<i>Collotheca ornata</i> (Ehrenberg, 1830)	+	+	+
Conochilidae				
2	<i>Conochilus dossuarius</i> Hudson, 1885	+	+	+
3	<i>Conochilus unicornis</i> Rousselet, 1892	+	+	+
Flosculariidae				
4	<i>Floscularia bifida</i> Segers, 1997			+
Hexarthridae				
5	<i>Hexarthra mira</i> (Hudson, 1871)	+	+	+
Testudinellidae				
6	<i>Testudinella patina</i> (Hermann, 1783)	+	+	+
Trochosphaeridae				
7	<i>Filinia camasecla</i> Myers, 1938	+		
8	<i>Filinia longiseta</i> (Ehrenberg, 1834)	+		
9	<i>Filinia opoliensis</i> (Zacharias, 1898)	+	+	+
Asplanchnidae				
10	<i>Asplanchna priodonta</i> Gosse, 1850	+	+	+
Brachionidae				
11	<i>Anuraeopsis coelata</i> Beauchamp, 1932		+	
12	<i>Anuraeopsis fissa</i> (Gosse, 1851)	+	+	+
13	<i>Anuraeopsis navicula</i> Rousselet, 1911	+		+

14	<i>Brachionus angularis</i> Gosse, 1851	+	+	+
15	<i>Brachionus caudatus</i> Barrois & Daday, 1894	+		+
16	<i>Brachionus dichotomus</i> Shephard, 1911		+	+
17	<i>Brachionus falcatus</i> Zacharias, 1898	+		
18	<i>Brachionus forficula</i> Wierzejski, 1891	+	+	+
19	<i>Brachionus quadridentatus</i> Hermann, 1783		+	+
20	<i>Keratella cochlearis</i> (Gosse, 1851)		+	+
21	<i>Keratella cochlearis cochlearis</i> (Gosse, 1851)	+		
22	<i>Keratella lenzi</i> Hauer, 1953		+	+
23	<i>Keratella tropica</i> (Apstein, 1907)	+	+	+
24	<i>Plationus patulus</i> (Müller, 1786)	+	+	+
25	<i>Platyias quadricornis</i> (Ehrenberg, 1832)		+	+
Gastropodidae				
26	<i>Ascomorpha ecaudis</i> Perty, 1850	+	+	+
27	<i>Ascomorpha ovalis</i> (Bergendal, 1892)	+	+	+
Lecanidae				
28	<i>Lecane arcula</i> Harring, 1914	+		+
29	<i>Lecane bulla</i> (Gosse, 1851)	+	+	+
30	<i>Lecane closterocerca</i> (Schmarda, 1859)		+	+
31	<i>Lecane crepida</i> Harring, 1914		+	+
32	<i>Lecane curvicornis</i> (Murray, 1913)		+	
33	<i>Lecane hamata</i> (Stokes, 1896)		+	+
34	<i>Lecane hornemanni</i> (Ehrenberg, 1834)	+	+	+
35	<i>Lecane leontina</i> (Turner, 1892)		+	+
36	<i>Lecane luna</i> (Müller, 1776)		+	+
37	<i>Lecane lunaris</i> (Ehrenberg, 1832)		+	+
38	<i>Lecane papuana</i> (Murray, 1913)		+	+
39	<i>Lecane quadridentata</i> (Ehrenberg, 1830)		+	+
40	<i>Lecane rhenana</i> Hauer, 1929		+	+
41	<i>Lecane signifera</i> (Jennings, 1896)		+	+
Lepadellidae				
42	<i>Colurella uncinata bicuspidata</i> (Ehrenberg, 1830)		+	+
43	<i>Lepadella ehrenbergii</i> (Perty, 1850)	+	+	+
44	<i>Lepadella ovalis</i> (Müller, 1786)		+	+
45	<i>Lepadella patella</i> (Müller, 1773)		+	+
Notommatidae				
46	<i>Cephalodella</i> sp.		+	+
Synchaetidae				
47	<i>Ploesoma asiaticum</i> Trinh Dang, Segers & Sanoamuang, 2013		+	
48	<i>Ploesoma hudsoni</i> (Imhof, 189)	+	+	+
49	<i>Ploesoma lenticulare</i> Herrick, 1885		+	+
50	<i>Ploesoma</i> sp.	+	+	
51	<i>Polyarthra dolichoptera</i> Idelson, 1925	+	+	+
52	<i>Polyarthra vulgaris</i> Carlin, 1943	+	+	+

53	<i>Synchaeta</i> sp.		+	+
54	<i>Synchaeta stylata</i> Wierzejski, 1893	+	+	+
Trichocerca				
55	<i>Trichocerca capucina</i> (Wierzejski & Zacharias, 1893)	+	+	+
56	<i>Trichocerca chattoni</i> (Beauchamp, 1907)		+	+
57	<i>Trichocerca cylindrica</i> (Imhof, 1891)	+	+	+
58	<i>Trichocerca dixonnuttalli</i> (Jennings, 1903)		+	+
59	<i>Trichocerca flagellata</i> Hauer, 1937	+		+
60	<i>Trichocerca pusilla</i> (Jennings, 1903)		+	+
61	<i>Trichocerca similis</i> (Wierzejski, 1893)		+	+
Trichotriidae				
62	<i>Macrochaetus collinsii</i> (Gosse, 1867)	+	+	+
63	<i>Trichotria tetractis caudata</i> (Lucks, 1909)		+	+

Note: (+) species present; (1) Serepok; (2) Buon Kuop; (3) Buon Tua Srah.

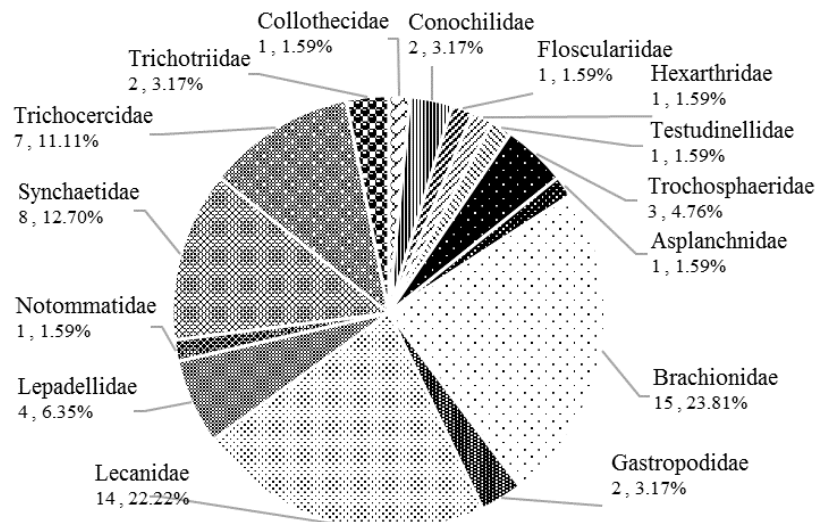


Figure 2. Composition of Rotifera community at family level in the studied reservoirs

One typical feature of the tropical rotifer fauna in southeast Asia is the prevalence of the families Brachionidae, Lecanidae, and Trichocercidae in terms of the number of species. In the pelagic zone, the family Brachionidae is prevalent while Lecanidae tends to dominate the littoral part (Dussart et al., 1984; Segers, 2001).

Regarding the number of recorded species in each reservoir, 34 taxa were found in Serepok reservoir, being lowest among the three investigated aquatic bodies, accounting for 53.97% total identified species in this area. Buon Kuop reservoir and Buon Tua Srah

reservoir shared similar values with 54 and 55 species respectively (equivalent to 85.71% and 87.3%) (Table 2).

The species composition of rotifers in the studied area in the western highlands (63 taxa belonging to 23 genera and 15 families) was quite similar to those of reservoirs in Khanh Hoa Province (Zhdanova, 2011) and Phu Ninh lake (Trinh-Dang et al., 2019b), where 61 - 65 taxa belonging to 15 families of rotifers were reported with the dominance of 2 families, *Brachionidae* and *Lecanidae*. This is possibly due to the similarities in geographical features and environmental characteristics. The species

richness of the in this study was lower compared to those in some other freshwater bodies, such as Bau Thiem lake (89 taxa), Thuy Tien lake (82 taxa) in Thua Thien Hue Province, central Vietnam (Trinh-Dang et al., 2015, 2013) and Kud-thing lake (183 taxa) in

Nong Khai Province, northeast Thailand (Sanoamuang and Savatentalinton, 2001). However, in comparison with freshwater bodies in southern Vietnam, with total taxa of 49 (Phan and Le, 2012), found a higher level of species richness was found in this study.

Table 2. Taxon of rotifer species in each study reservoirs

Reservoir	Order	Family	Genus	Species	Percentage
Serepok	3	13	18	34	53.97
Buon Kuop	3	13	22	54	85.71
Buon Tua Srah	3	14	23	55	87.3
Total	3	15	23	63	100

To assess the biodiversity of these reservoirs, the species accumulator and species richness estimators were constructed using the rarefaction method and fitted with a logarithmic model. The result showed that the average number of species at each studied site was relatively high (about 36 species/sample).

Besides, the number of species increased with the sample size following the equation $y = 36.35 + 13.01\log(x)$ ($R^2 = 0.93$). Based on the estimators, the species richness of rotifers in reservoirs might be between 63–65 taxa (according to the Chao 2, Jackknife 2 and Bootstrap indices) (Figure 3).

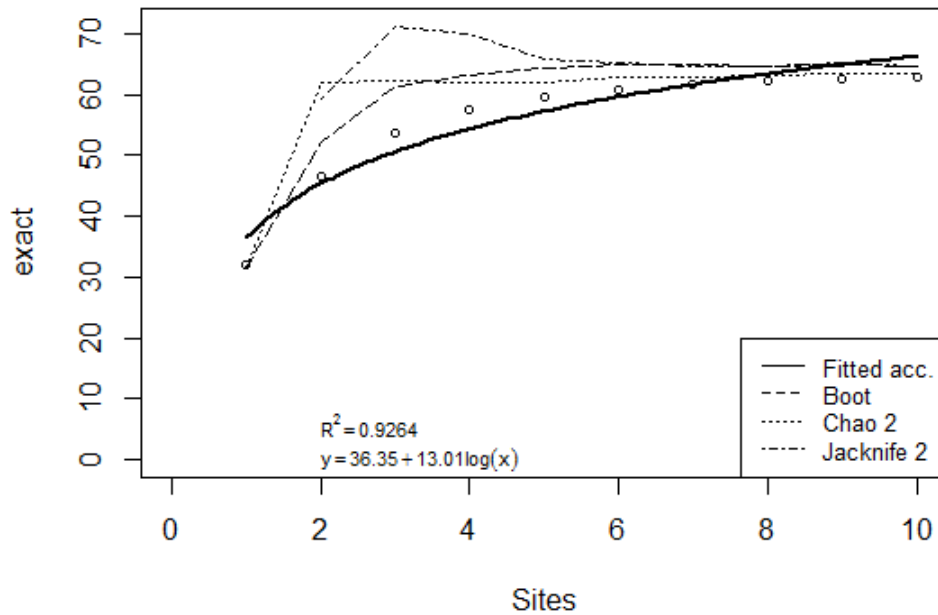


Figure 3. Species accumulator of species richness at study sites, with fitted curve and estimator curves

Jaccard's similarity index was calculated in order to investigate the similarities between rotifera communities among three reservoirs of Western highlands (Table 3). The highest value of similarity index was

found between Buon Kuop reservoir and Buon Tua Srah reservoir (similarity index = 0.85) while Serepok reservoir was quite different from the rest (similarity index < 0.5).

Table 3. The similarity index of rotifer communities among sites

Sites	(1)	(2)	(3)
Serepok (1)	1		
Buon Kuop (2)	0.40		
Buon Tua Srah (3)	0.47	0.85	1

Table 4. The similarity index of the rotifer communities among areas

Sites	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Khanh Hoa Province (1)	1							
Southern Vietnam (2)	0.34							
Nhur Y River (3)	0.37	0.31						
Thuy Tien Lake (4)	0.24	0.19	0.33					
Bau Thiem Lake (5)	0.09	0.08	0.11	0.24				
Phu Ninh Lake (6)	0.32	0.31	0.29	0.32	0.17			
Ly Son Island (7)	0.19	0.12	0.2	0.17	0.11	0.15		
Western Highlands (8)	0.41	0.32	0.37	0.45	0.19	0.46	0.22	1

Moreover, the similarities on the species composition of the rotifera community in this study was compared to those of other freshwater bodies in Vietnam (Table 4). Results fluctuated in the range of 0.19–0.46, demonstrating low to intermediate similarities. In particular, the highest similarity was found between the reservoirs in western highlands and Phu Ninh lake, a mesotrophic habitat located in northern Quang Nam Province (Trinh-Dang et al., 2019b) with a value of 0.46, followed by Thuy Tien lake in Hue (Trinh-Dang et al., 2013) and reservoirs in Khanh Hoa Province (Zhdanova, 2011) with values of 0.45 and 0.41 respectively. The largest difference in species composition was observed between this studied area and Bau Thiem lake, an oligotrophic habitat in Thua Thien Hue Province (Trinh-Dang et al., 2015) with dissimilarity index of 0.81, followed by water bodies in Ly Son island (Vo et al., 2019) with dissimilarity index of 0.78 (Table 4). These differences may be due to the difference of water body characteristics. In general, reservoirs in western highlands are oligotrophic habitats, indicated by $Q_{B/T}$ index values < 1 except Serepok reservoir (mesotrophic - $Q_{B/T}$ index = 1.3). According to on-field observations, aquaculture activities at Serepok reservoir has risen rapidly in recent years, which may cause the decline of

biodiversity. Therefore, it is necessary to conduct further studies on water quality and biodiversity of this lake in order to develop appropriate management strategies.

CONCLUSION

In summary, a total of 63 species and subspecies representing 23 genera in 15 families were reported. Of these, the Brachionidae is the most diverse family with 15 taxa recorded (23.81%) followed by Lecanidae (14 taxa, 22.22%), and Synchaetidae (8 taxa, 12.7%). The number of species increased with the sample size, following the equation $y = 36.35 + 13.01\log(x)$ ($R^2 = 0.93$). In comparison to other areas of Vietnam, the recorded faunal composition of western highlands was relatively similar (with similarity index value ranging from 0.19 to 0.46). In particular, the highest similarity was found between western highlands and Phu Ninh lake. The largest difference in species composition was observed between western highlands and Bau Thiem lake.

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