Contributions to the rotifer fauna of Kerala (India) with two new records and remarks on some species

Anitha PS, Rani Mary George

Abstract
The present study reports on rotifer fauna from two low-saline backwaters namely Veli-Aakulam (latitude 8° 25’ – 8° 30’ N & longitudes 76° 55’ – 77° 00’ E) and Poonthura - Thiruvallam (latitude 8° 25’ – 8° 35’N & longitude 76° 50’ – 76° 58’ E) along the southern part of Kerala, India. The survey for rotifers was carried out from February 2000 to January 2001. A total of 42 species of rotifers belonging to 16 genera and 12 families are recorded. Of these, the family Brachionidae is represented by the highest number of 22 species followed by Lecanidae (5 species), Filinidae (4 species) and Mitilinidae (2 species). The rotifers, Brachionus dichotomus reductus (Koste & Shiel) and B. kostei (Shiel) are reported here for the first time from Indian waters while B. quadridentatus mirabilis (Daday), B. calyciflorus borgerti (Apstein), Mytilina crassipes (Luck), Filinia opolensis (Zacharias) and F. cornuta (Weisse) are reported for the first time from Kerala waters. The existence of B. forficula keralaiensis (Nayar & Nair) and B. rotundiformis (Tschugunoff) in Kerala waters is confirmed through the present study since they have been reported so far only from Kerala. Diagnostic features of some interesting species are also illustrated in the present account with remarks on their distribution in India.

Keywords: Rotifera, Kerala, Taxonomy, Brachionus, Kerala, Rotifer

Introduction
Taxonomic studies of rotifers from Kerala (India) are very scanty and are confined to freshwater habitats [1-3]. Studies on the estuarine rotifer fauna have received very little attention till date even though they constitute a predominant portion of zooplankton during certain seasons [4]. A total of 30 species of brackish water rotifers were reported from three estuaries of Kerala [5]. As the State is characterized by a number of lagoons and backwaters associated with estuaries, it is likely that many more species may be present than recorded. The present study is based on plankton samples collected from two brackishwater habitats (Veli-Aakulam & Poonthura-Thiruvallam) in the western part of Thiruvananthapuram coast, Kerala (India) in order to increase our knowledge in this group from the estuarine areas of Kerala. Forty-two species were identified and most of them belong to the order Plaemida. A list of species, varieties and forms, classified according to their families has been given. Some of these important taxa are briefly described and illustrated in this paper, with remarks on their distribution in India.

Material and Methods
Plankton samples were collected from Veli - Aakulam (latitude 8° 25’ – 8° 30’ N & longitudes 76° 55’ - 77° 00’ E) and Poonthura - Thiruvallam (latitude 8° 25’ – 8° 35’N & longitude 76° 50’ – 76° 58’ E) estuaries. The samples were collected by horizontal hauls using plankton net of 32 cm mouth diameter with a mesh size of 70μm. Samples were immediately preserved in 4% formaldehyde. The sorting and identification of rotifers were done with a stereo-dissecting microscope. All the illustrations given are camera Lucida drawings made with the aid of a compound microscope and the measurements are given in micrometers (μm). Rotifers were identified to species level using standard taxonomic references [6-8].

Results
A list of all the identified rotifers with varieties and forms from the samples is provided in list. Account of some taxonomically interesting taxa
Platyias leloupi: Gillard (Fig. 1)  
**Material:** Six parthenogenetic females were obtained from Poonthura and Thiruvallam.  
**P. leloupi** is the first report from Kerala. The specimens are identical with the description given by Koste & Shiel [9]. This taxon has been reported so far from West Bengal [10] and Delhi [11].  
**Measurements:** total length 352-429; maximum width 225-278; anterior spine 65-78; posterior spine 98-107

Brachionus angularis: Gosse (Fig. 2a-d)  
**Material:** Several parthenogenetic females were observed in the samples collected from all the stations.  
**B. angularis** has been reported from most of the states of India namely Rajasthan [12], Andhra Pradesh [13], West Bengal [14], Orissa [15], Tamil Nadu [16], Bihar [17] and Kerala [18].  
**Measurements:** total length 88-116; maximum width 76-96; median spines 7-11; egg size 67 x 47 (L x W). A few numbers are represented by the *f. aestivus* Skorikov (Fig. 2c,d). This form is characterized by the presence of highly reduced median spines, circular outline of lorica and the greatly converged caudal protuberance. The measurement of this small morph is: total length 80-84; maximum width 73-76; egg size 64 x 42. It is recorded for the first time from Kerala and second from India. This morph has been reported so far from Rajasthan [12].

Brachionus calyciflorus: Pallas (Fig. 3a-f)  
**Material:** Several ovigerous and non-ovigerous females were noted in the samples collected from all the stations.  
**B. calyciflorus** is one of the most common species and extremely variable in its size, length of occipital spines and, the presence and length of posterior spines. This taxon has wide spread distribution in India and been recorded from West Bengal [14, 15], Maharashtra [19] Kerala [1], Andhra Pradesh [13], Tamil Nadu [16], Bihar [17] and Kerala [18]. This species is represented by *f. typica* Koste (Fig. 3a), *f. heterospina* Saksena (Fig. 3b), *f. asymmetrica* Koste (Fig. 3c), *f. anuraeformis* Brehm (Fig. 3d), *f. amphiceros* Ehrenberg (Fig. 3e) and *f. dorcas* Gosse (Fig. 3f).

<table>
<thead>
<tr>
<th>Morphs</th>
<th>Total Length</th>
<th>Maximum width</th>
<th>Anterior Middle</th>
<th>Spines Lateral</th>
<th>Posterior Foot opening</th>
<th>Spines Lateral</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>f. typica</em></td>
<td>260</td>
<td>173</td>
<td>40</td>
<td>33</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td><em>f. heterospina</em></td>
<td>243</td>
<td>156</td>
<td>40</td>
<td>33</td>
<td>22</td>
<td>12/24</td>
</tr>
<tr>
<td><em>f. asymmetrica</em></td>
<td>277</td>
<td>190</td>
<td>40</td>
<td>33</td>
<td>22</td>
<td>12/24</td>
</tr>
<tr>
<td><em>f. anuraeformis</em></td>
<td>255</td>
<td>121</td>
<td>52</td>
<td>43</td>
<td>52</td>
<td>87</td>
</tr>
<tr>
<td><em>f. dorcas</em></td>
<td>381</td>
<td>242</td>
<td>121</td>
<td>69</td>
<td>52</td>
<td>-</td>
</tr>
</tbody>
</table>

Brachionus dichotomus reductus: Koste & Shiel (Fig. 4)  
**Material:** A total of 18 parthenogenetic females were collected from Poonthura and Thiruvallam.  
**Description of the female:** Lorica with long median anterior spines, which protrude as a ‘v’ shape; anterior lateral spines are absent; anterior sub-median spines are rudimentary, long caudal spines; lorica at the posterior end, overhanging the base of the foot opening.  
**Measurements:** total length 125-144; maximum width 76-113; antero-median spine 13-27; postero- median 36-47; Egg size 58 x 24. This is the first report of *Brachionus dichotomus reductus* from the Indian waters.

Brachionus forficula keralaiensis: Nayar & Nair (Fig. 5a, b)  
**Material:** Two parthenogenetic females from Poonthura station  
**Description of the female:** Lorica is firm and divided into dorsal and ventral plates; occipital margin with six spines, medians and laterals are almost equal in length or laterals slightly longer than medians; intermediate spines are highly reduced but invariably present in the examined materials; the pectoral margin is rigid, elevated with a wide ‘U’-shaped sinus, flanked with two pointed spines; lorica terminates posteriorly in a pair of stout sub-qual spines, which are widely separated at their bases.  
**Measurements:** total length 129-159; maximum width 73-91; antero-median spine 13-18; antero-intermediate spine 2-3; antero-lateral spine 18-22; posterior spine 34-49

*B. forficula keralaiensis* is originally established as a variety of *forficula* by Nayar & Nair [10] but in our observation it showed some distinct morphological difference to that of *Brachionus forficula*, and they are as follows:

- a) the presence of occipital intermediate spine, which is absent in *B. forficula*;  
- b) absence of internal swelling on the posterior spines, which is a characteristic feature for *forficula*; and  
- c) the pectoral margin (fig. 5a, b) of the present taxon is elevated towards the centre with a deeply notched sinus (‘U’-shaped), whereas the same for *forficula* has a shallow ‘U’ sinus to almost straight line (Sudzuki, 1964: 106, pl. 12, figs. 1-18; 1999: 48, pl. 31, figs.1-6, 49, pl. 32, fig. 1). According to Sudzuki [20] pectoral margin is also a significant morphological feature for the identification of a species. Therefore, the taxonomic validity of this rotifer needs a further confirmation that would facilitate the future reorganization of this taxon since it is reported so far only from Kerala.

Brachionus kostei: Shiel (Fig. 6a, b)  
**Material:** One parthenogenetic female from Thiruvallam station  
**Description of the female:** Six pointed occipital spines and two characteristic dorsally convoluted foot-opening spines; lorica stippled; pectoral margin is elevated and notched medially; the ventral plate with two cuticular ridges with granular borders.  
**Measurements:** total length 133; maximum width 89; antero-median spine 13; antero-intermediate spine 3; antero-lateral spine 13; posterior spine 13.

The present record is the first and fourth for this species from India and the world respectively. The species is observed from a single locality and also only one. The general morphology of the specimen from Kerala in the present study closely resembles that of Australian [21] and Thailand [22] specimens.
Brachionus quadridentatus mirabilis: Dayad (Fig. 7)
Material: Single female was collected from Poonthura station and is identical with the description given by Koste [7].
Measurements: total length 97-192; maximum width 117-185; antero-median spine 20-37; antero-intermediate spine 16-23; antero-lateral spine 27; postero-median spine 89; postero-lateral spine 129; greatest width - total length ratio 0.80-0.89.
B. quadridentatus mirabilis is the first report from Kerala and has been reported so far from West Bengal [14], Assam [23] and Bihar [17].
Koste [7] classified this rotifer as a subspecies of B. quadridentatus, but according to Sharma [14, 15, 23] it is a separate species. However, in our study we observed that this taxon has close resemblance with B. quadridentatus except in the relative length of the postero-lateral spine. Because of the close similarities between these two species, Koste’s opinion seems to be more applicable for this taxon than that of Sharma. One of the interesting observations on this species is its occurrence. The occurrence is very rare. Only one specimen was represented in the present collection.

Brachionus plicatilis: Müller (Fig. 8a, sssssb)
Material: Several parthenogenetic females were observed in the samples collected from all the stations and the specimens are identical with the description given by Koste [7] and subsequent authors [24].
Measurements: total length 171-277; maximum width 156-225; antero-median spine 20-43; antero-intermediate spine 9-34; antero-lateral spine 15-30; greatest width - total length ratio 0.81-0.91; egg size 98x 87 (Length x Width)

Filinia pejleri: Hutchinson (Fig. 11)
Material: Several females were obtained from Veli-Aakulam estuary. The specimens are well agreeing with the description given by several authors [7, 12]. This taxon is so far reported from West Bengal [23], Rajasthan [12] and Bihar [17].

Filinia longiseta: Zacharias (Fig. 12)
Material: A large number of specimens collected from Veli and -Aakulam stations.
The specimens are identical with the description given by Koste [7] and Koste & Shiel [8]. It has been reported earlier from Kerala [1-5], West Bengal [14] and Bihar [17].

Filinia opolensis: Zacharias (Fig. 13)
Material: A few numbers of this species was observed in the samples collected from Poonthura station and the specimens are well agreeing with the description given by Sharma [19]. It is the first report from Kerala and has been reported earlier from Maharashtra [19], Rajasthan [22] and West Bengal [14, 15].

Filinia cornuta: Weisse (Fig. 14)
Material: Numerous specimens were collected from Veli and Aakulam stations and the specimens are identical with the description given by Sarma [11]. It is the first record from Kerala. It has been recorded so far only from Delhi [11].

Comparative measurements of Filinia species is as follows

<table>
<thead>
<tr>
<th>Species</th>
<th>Body length</th>
<th>Maximum width</th>
<th>Dorsal bristles</th>
<th>Caudal bristles</th>
</tr>
</thead>
<tbody>
<tr>
<td>F. pejleri</td>
<td>84-87</td>
<td>34-38</td>
<td>314-355</td>
<td>298-312</td>
</tr>
<tr>
<td>F. longiseta</td>
<td>133-167</td>
<td>83-86</td>
<td>283-333</td>
<td>267-315</td>
</tr>
<tr>
<td>F. opolensis</td>
<td>168-176</td>
<td>69-73</td>
<td>421-436</td>
<td>412-422</td>
</tr>
<tr>
<td>F. cornuta</td>
<td>65-85</td>
<td>55-64</td>
<td>24-29</td>
<td>22-27</td>
</tr>
</tbody>
</table>

MONOGONONTA
Family: Epiphanidae
Epiphanes macrourus Barrois & Daday: A
Family: Brachionidae
Platyias quadracornis (Ehrenberg): A, P, T
*P. leloupi Gillard: P, T
Brachionus angularis Gosse: V, A, P, T
*f. aetius Skorikov: V, A
B. budapestinensis Daday: V, A
B. calyciflorus Pallas: V, A, P, T
f. typica Koste: V, A, P, T
*f. heterospina Saksena: V, A
f. asymmetrica Koste: V

Brachionus plicatilis has been reported so far from Andhra Pradesh [13], Tamil Nadu [16], Bihar [25], and Kerala [5, 26]. This rotifer is cosmopolitan and common in alkaline waters of India.

Brachionus rotundiformis: Tschugunoff (Fig. 9a-c)
Material: Five parthenogenetic females were observed in samples of Veli station.
Description of the female: Lorica small more rounded and not sharply separated into dorsal and ventral plates; occipital margin with small based acutely pointed spines; pectoral margin four-lobed, lateral ones roughly triangular; foot opening with sub square aperture ventrally and rather ovoid aperture dorsally.
Measurements: total length 98-156; maximum width 87-125; antero-median spine 11-22; antero-intermediate spine 9-13; antero-lateral spine 9-13; maximum width- total length ratio 0.80-0.89.

B. rotundiformis is a common halobiont rotifer observed along with B. plicatilis and it has been reported so far only from the estuaries and backwaters of Kerala [5, 26].

Keratella cochlearis: (Gosse) Fig. 10a-c
Material: Several females were observed in the samples collected from Poonthura and Thiruvallam. Our record is the first from Kerala. K. cochlearis has been recorded earlier from Andhra Pradesh [13]. This is also a variable species, the variability mainly on size of the spines and dorsal lorica pattern. This species is represented by f. recurvispina Jägerskiiöld (Fig. 9b) and f. tecta Lauterborn (Fig. 9c).
*f. dorcas* Gosse: V, T
*f. amuraeformis* Brehm: V, A, P
*f. forficula* Rudescu: V, A, T
*f. amphicerous* Ehrenberg: V, A, P, T
*f. monstruosa de Riddor: V
*B. calyciflorus borgerti* Apstein: V, A
*f. willeyi* Apstein: A
*f. brycei de Beauchamp: A
*B. caudatus Barrios & Daday: A, P, T
*f. majusculeus* Ahlstrom: A, T
*f. apsteini* Ahlstrom: T
*f. vulgatus Ahlstrom: T
*f. personatus Ahlstrom: T
**B. dichotomus reductus** Koste & Shiel: P, T
*B. forficula keralaiensis* Nayar & Nair: P, T
*B. falcatus* Zacharias: A, P, T
*f. lyratus Lemmerman: P, T
*f. hamatus Lemmerman: P T
*B. patulus* (Müller): A, T
**B. kostei Shiel: T
B. rubens Ehrenberg: T
B. urceolaris Müller: A, P, T
B. quadridentatus Hermann: A, P, T
*f. brevispina* Ehrenberg: T
*f. monospina* Saksema & Kulkarni: A, T
*f. divergens* Tschugunoff: T
*f. melhini Barrios &Daday: P, T
*f. curvata Tschugunoff: T
*B. quadridentatus mirabilis* Daday: T
*B. plicatilis* Müller: V, A, P, T
B. rotundiformis Tschugunoff: V
Keratella cochlearis (Gosse): P, T
*f. recurvispina* Jägerskiöld: P
*f. tecta Lauterborn: V, A, P, T
K. tropica (Apstein): V, A, P, T
*f. aspina* Fadeew: P, T
*f. asymmetrica* Barrios & Daday: P, T
Family: Euchlanidae
*Dipleuchlanis propatula* Gosse: A, P
*Mytilina ventralis* Ehrenberg: T
*M. crassipes* Lucks: T
Family: Trichotridae
*Trichotria tetractis* Ehrenberg: A, P, T
Family: Lepadellidae
*Lepadella crestata* Vasisht & Bathish: T
*L. ovalis* Müller: T
*L. patella* Müller: A, P, T
Family: Lecanidae
*Lecane leontina* (Turner): P, T
*L. ludwigi* (Eckstein): T
*L. luna* (Müller): T
*Monostyla quadridentata* (Ehrenberg): T
*M. bulla* (Gosse): V, A, P, T
Family: Notommatidae Hudson & Gosse
*Scaridium longicaudum* (Müller): A, T
Family: Synchaetidae (Hudson & Gosse)
*Polyarthra vulgaris* Carlin: V, A, P, T
Family: Asplanchnidae Eckstein
*Asplanchna brightwelli* Gosse: V, A, P, T
Family: Testudinellidae
*Testudinella patina* Hermann: A, P, T
Family: Hexarthridae
*Hexarthra intermedia* (Wierzejski): V, A, P, T

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**Family: Filiniidae**

*F. longiseta* (Zacharias): V, A, T
*F. pejleri* Hutchinson: V, A
*F. apolensis* (Zacharias): T
*F. cornuta* (Weisse): V, A

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**Fig. 1:** *Platyias leloupi* Gillard; Fig. 2a-c: *Brachionus angularis* Gosse; Fig. 2a: *B. angularis*; 2b-c: *B. angularis* f. aestivus Skorikov; Fig. 3a-e: *B. calyciflorus* Pallas: 3a: *f. typica* Koste; 3b: *f. heterospina* Saksema; 3c: *f. asymmetrica* Koste; 3d: *f. anuraeiformis* Brehm; 3e: *f. amphicerous* Ehrenberg; 3f: *f. dorcas* Gosse (Scale: 100µm)

**Fig. 4a-c:** *Brachionus dichotomus reductus* Koste & Shiel; 4a: female dorsal view; 4b: female ventral view; 4c: female with egg; Fig. 5a: *Brachionus forficula keralaiensis* Nayar & Nair; 5b: enlarged view of occipital spines and pectoral margin of *B. forficula keralaiensis*; Fig. 6a-b: *Brachionus kostei* Shiel; 6b: dorsal and ventral view of occipital region of *B. kostei*; Fig. 7: *Brachionus quadridentatus mirabilis* Daday (Scale: 100µm)
Discussion
Forty two rotifers belonging to 12 families and 16 genera are documented in the present account. According to Sharma [27], out of 310 rotifers belonging to 60 genera so far known from Indian waters, only 24 species have originally been described from Kerala, while Gopakumar [5] reported 30 species of rotifers from different estuarine habitats of Kerala. The present study raised the number of known species from this state to 42 as against 24 and 30 species reported by earlier workers. Cosmopolitan taxa comprise a dominant fraction (approximately 75%). The most diverse genus was Brachionus, which represented 15 species in the present study. The abundance of Brachionus species in tropical rotifer fauna has been pointed out by a number of workers [5, 26, 28, 29]. Thus, the abundance of Brachionus species in the present study is in accordance with the findings of workers cited above.

The most frequently encountered rotifers were Brachionus angularis, B. calyciflorus, B. plicatilis, B. falcatus, B. quadridentatus, Keratella cochlearis, Filinia longiseta and Asplanchna brightwelli. The rotifers such as B. dichotomus reductus and B. kostei are previously considered endemic to Australian waters [9] were observed in the present collection. The other reports of this species from outside Australia are only from Thailand [22, 30, 31]. A number of other rare species such as Brachionus quadridentatus mirabilis, B. forficula keralaiensis, B. rotundiformis, Filinia cornuta, F. opolensis and Lecane ludwigi are also added to the Kerala rotifer record. It is interesting to note that the distribution of B. rotundiformis and B. forficula keralaiensis in India has been reported so far only from the state of Kerala. Because of their restricted distribution in Indian waters, further study is needed on the distribution and occurrence of these taxa in different water bodies of India. The new and rare species records in the present study clearly illustrated that the rotifer records of Kerala requires an updating. A detailed survey on various water bodies of Kerala will increase the number of species and also provide more information about Kerala rotifer biogeography.

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