

## Ecology And Systematics of Brachionus Rotifers in Fresh Water Ponds of Vizianagaram, A.P.



### Environmental Science

**KEYWORDS :** Brachionus, Ecology, Monogononts, Planktons, Rotifers, Trophic nature

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### ABSTRACT

*Any tiny drop of water from among the fresh water bodies across the globe certainly contain several small and big living entities- of which few are free living pelagic animalcules, called planktons. The primary consumers in an aquatic ecosystem constitute as baseline in the food chain, major pulse of which are the zooplanktons belonging to micro-invertebrates. Among the zooplanktons, the species belonging to Monogonont rotifers of order Ploima especially that of genus Brachionus are unique for their versatile shape, size and ecology. Most of them are supposed to be cosmopolitan in distribution and indicators of specific trophic nature of a given aquatic ecosystem. They are used as bioassay in most of the studies related to qualitative assessment to determine the water quality. The ecology, systematics, morpho-pysiological changes, seasonal dynamics and practices related to bio-indication by Brachionus rotifers was reinvestigated in present study.*

### Introduction

Any small drop of water collected from any small or big fresh water body across the globe shall definitely contain tiny microscopic animalcules having a ciliated upper wheel like rotating structure, the corona; encapsulated in a casket like 'Lorica' and a masticating pharynx like 'mastax'; popularly called 'wheel animalcules' or Rotifers.

Limnobiological studies related to fresh water ponds of northern Andhra Pradesh are comparatively scanty than rest of the India. The rotifers serve as one of the most useful link in the food chain of aquatic ecosystem. Among the rotifers those belong to genus *Brachionus* are specific in their ecology and behavior. They not only abundant in their species composition but also rich in growing population. They exhibit a cosmopolitan distribution, polymorphism, cyclomorphosis and overall best indicators of trophic nature of a given aquatic ecosystem.

### Area of investigation

Present work was done on five perennial fresh water bodies in the city of Vizianagaram in the south state of Andhra Pradesh, India that lies in between the latitude 18°6'42" N and longitude of 83°24'29" E. The first one called 'Pedda Cheruvu' literally means the "Big pond" (referred as pond-I), the second 'Ayya Koneru' (pond-II), the third a sewage storage pond (pond-III), a water reservoir (pond-IV) and the last a polluted municipal ditch (pond-V). Water samples were collected weekly once from all these ponds for qualitative and quantitative assessments between May 2008 to April 2010.

### Sampling

For plankton analysis water samples were collected by dipping wide plankton net of mesh size of 45 microns just below the surface of water in open condition. Part of the sample was treated with 5-10% formaldehyde for future observations and another part was treated with boiled water and then fixed in formalin. Hot water treatment gives satisfactory results as well as can fix the organism in its natural position which no other relaxing agent can do (Edmondson, 1959). For the observation of Mastax and Trophi specimens were treated with KOH (or also Sodium hypochlorite) and mounted in glycerin. A mild centrifugation of preserved water sample either cool or gentle hot can also bring good result.

### Quantitative analysis

For quantitative analysis, of plankton a sub-sample of one ml. was quickly drawn with a wide mouthed pipette resembling that of a stempel pipette and poured into a counting cell similar to that of Sedgwick rafter cell of one ml. capacity and all the organisms of the aliquot were counted. However, when there was

a bloom, counting was done only in selected squares in random from which total numbers per liter of water could be calculated. All the body calculations were made by using Occulometer taken in microns and graphics were made using Camera Lucida. The classification and the identification of *Rotifera* is done as given by Edmondson (1959) and that of Koste (1978).

### Systematic study of *Brachionus* rotifers

About Sixty (66) Rotifers were recorded in present investigation belonging to different orders and genera. Of these species 61 were obtained from pond-1, 45 were from pond-2, 35 species were obtained from pond-3, 12 from water reservoir while only 9 species were recorded from sewage ditch. The Monogonont species belonging to order Ploima of genera *Brachionus* are given below.

#### *Brachionus calyciflorus* Pallas

##### Description:

*Brachionus calyciflorus* showed great variation in shape and size and exhibit polymorphism. Ahlstrom (1940) states that this species was an exceedingly variable species especially in its true size, length of the occipital spines and the location of postero-lateral spines.

#### *B. calyciflorus* var. *dorcas forma spinosa* (Wierzejski)

##### Description:

Lorica was smooth. There were four anterior spines, two median and two lateral. Hence, it was identical to the above variety i.e., *dorcas* except in the presence of postero-lateral spines.

##### Measurements:

Total length: 128;  
maximum breadth: 80.

#### *B. calyciflorus* var. *hymani* Dhanapathi

##### Description:

Anterior dorsal margin with four broad based stout spines, medians slightly longer than the laterals. There were saw tooth like outward extensions from base of median occipital spines. Anterior ventral margin had a V-shaped sinus flanked by short spines. Two Postero-lateral spines were present.

##### Measurements:

Total length: 266;  
maximum breadth: 180;  
length of anterior median spine: 44;  
length of anterior lateral spine: 32;  
length of postero-lateral spine: 15.

It has earlier been reported by Dhanapathi (1974) from Andhra Pradesh.

***B. angularis* Goose****Description:**

Anterior dorsal margin with two median spines, divided by a U-shaped sinus.

The lateral and intermediate spines were absent.

**Measurements:**

Total length: 112; Maximum breadth: 80; Anterior margin: 56.

The Indian forms of this species were relatively small with a wide distribution. Specimens from different localities collected during different seasons show variation in their size, nature of the cuticular protuberances flanking the foot opening and in the anterior median spines.

It has earlier been recorded by Nayar (1968), Nayar and Nair (1969), Dhanapathi (1974), Sarma (1988) and Murugan (1993).

***B. budapestensis* Daday****Description:**

Four anterior projections, two medians and two marginals; the medians were longer than the marginals. Posterior projections were absent.

**Measurements:**

Total length: 104; Maximum breadth: 66;  
Length of medians: 18; Length of marginals: 10.

This species had been reported earlier by Arora (1963) from Nagpur and Sarma (1988) from Delhi and first reported from South India by Kameswara Rao (1977).

***B. calyciflorus* var. *dorcas* (Gosse)****Description:**

Lorica is smooth. There were four anterior spines, two median and two lateral.

The postero-lateral spines were absent. There were two short spines flanking the foot opening.

Measurements: Total length: 196;  
Maximum breadth: 144; Length of occipital spines: 36.

***B. calyciflorus* forma *anuraeformis* Brehm****Description:**

Lorica was soft, smooth and stippled. The two lateral margins of the lorica were almost parallel exhibiting a barrel shape. The four anterior spines were almost equal in length. Two postero-lateral spines were present.

**Measurements:**

Length of lorica: 112; Maximum breadth of lorica: 94;  
Anterior margin: 78.

***B. calyciflorus* var. *brycei* P. de Beauchamp****Description:**

Lorica was more or less oblong in shape and smooth. The anterior dorsal margin of the lorica bears 4 spines, two medians and two marginal, medians being slightly longer than the marginal. In addition to these the anterior ventral margin bears two more spines which are rudimentary. Posterior spines were absent.

Measurements: Total length: 104; Maximum breadth: 62.

It had earlier been reported by Arora (1966) from Nagpur, Sharma (1979) from West Bengal and Sarma (1991) from Delhi.

***B. longipes* Anderson****Description:**

Six occipital spines were present. The foot of this species was of extraordinary length. In living specimens the foot was often extended so as to be three times as long as lorica. Viewed dorsally the edge of the lorica appeared round and the spines bordering the orifice of the foot could not be seen, except through the shell. The ventral view showed that these spines were placed further forward than the dorsal extremity of the lorica. The pectoral ridge rose considerably and had 4 undulations; the two middle ones were slightly notched.

Measurements: Total length: 225;  
maximum breadth: 195; Anterior margin: 128.

This was first reported by Rao (1977) from South India.

***B. calyciflorus* var. *Pala* (Ehrenberg)****Description:**

It was identical with the forma *anuraei* forms except for the absence of the postero-lateral spines.

Measurements: Total length: 86; Maximum breadth: 54.  
These specimens resemble those from Nagpur reported by Arora (1966).

***Genus Brachionus forficula* Wierzeiski****Description:**

*Brachionus forficula* was a quite variable species. The variation of the posterior spines was highly extensive in the specimens collected from the same place. There was knee-like swelling at the inner side of the posterior spines near their base. However, they may be lacking in such reduced forms as in the formae *urawaensis* and *minor*. The reduced forms of *B. forficula* have close affinities to *caudatus*, *aculeatus* and even to *angularis*.

***B. forficula* forma *typicus urawaensis* Sudzuki****Description:**

There were four anterior spines, two marginal and two median. The former was being longer than the later. The posterior spines were very long, curved inwards and each bearing a knee-like swelling on its inner margin.

**Measurements:**

Total length: 230; Breadth of anterior margin: 60;  
Maximum breadth: 112; Length of lorica: 94;  
Posterior spine: 98.

***B. forficula* forma *asymmetricus* Sudzuki****Description:**

These were comparatively smaller in size. Body length ranges 62-112 $\mu$ . Posterior spines: right 3-6 and left 3-24. The two posterior spines were unequal. This species was being reported for the first time from India by Chandra Mohan and Kameswar Rao (1977).

***B. forficula* forma *volgensis* Sudzuki****Description:**

The posterior spines were parallel and comparatively shorter than those of forma *typicus urawaensis*. The knee-like swellings were absent.

**Measurements:**

Total length: 196; Length of lorica: 100;  
Maximum breadth: 66; Breadth of anterior margin: 86;  
Posterior spines: 46.

***B. falcatus* Zacharias var. *lyratus* Lammermann****Description:**

There were six anterior projections which were of unequal length. The marginal were slightly longer than the medians while the intermediate projections were very long and curved ventrally at their distal ends.

**Measurements:**

Total length: 340; Intermediate spines: 76;  
 Posterior spines: 150; Maximum Breadth: 130;  
 Length f Lorica: 156;

***B.urceolaris* O.F.Muller****Description:**

Lorica was broader than long. Anterior marginal spines were two. Body broad and flat.

**Measurements:**

Total length:132; Maximum breadth:100; Anterior margins:80  
 It was earlier been reported by Arora (1963), Nayar(1968) and Dhanapathi (1974).

***B.bidentata* Anderson****Description:**

Lorica was ornamented with dorsal, ventral and basal plates. Six Occipital spines were present of which the marginals and intermediates were of equal length. The posterior spines were very small and those bounding the foot were large contain rounded papillae rather than the spines.

**Measurements:**

Total length: 158; Anterior spine: 18;  
 Breadth of anterior margin: 68; Maximum Breadth: 90;

***B.quadridentata* Hermann var.*melheni* (Barrois and Daday)****Description:**

Lorica broader than long. Six anterior spines- two marginal, two median and two intermediate; the median was comparatively longer than the others. Lorica stippled. There were two posterior spines which were smaller in size.

**Measurements:**

Total length:208; Maximumbreadth:148;  
 Posterior spine:48; Anterior laterals:20;  
 Anterior margins:92; Median spines:28.

Ahlstrom (1940) claimed it to be the most commonly occurring species.

It was earlier been reported by Arora(1963), Nayar(1968) and Dhanapathi (1974).

***B.caudatus* Barrois and Daday****Description:**

Lorica appeared distinct. There were four anterior projections, two dorsal and two marginal which were almost equal in length. There were two posterior spines which were long and slightly curved inwards.

**Measurements:**

Total length: 298; Length of lorica: 180;  
 Maximum breadth: 144; Breadth of anterior margin: 80;  
 Posterior spines: 86.

***B. diversicornis* (Daday)****Description:**

Four anterior projections of which the two medians were shorter than the laterals.

The right posterior spine was considerably longer than the left.

**Measurements:**

Total length: 196; length of lorica: 142;  
 Anterior lateral spines: 24; posterior spines: 9, 42;  
 Maximum breadth: 98.

***B. patulus* O.F.Muller****Description:**

The specimen was synonymised by Wulfert, 1965 as *Platyas patulus*. Occipital margin with six spines, the median slightly larger than the others. Ventral margin with four spines. Postero-lateral spine longer than median spine. The forms agree with the description given by Ahlstrom (1940).

**Measurements:**

Total length: 236; Maximum breadth: 148.

It was reported by Arora (1966), Nayar and Nair (1969) and Dhanapathi (1974) from different fresh water ponds of India.

**Ecology and special features****Morpho-physiological changes**

Morphological and Physiological modifications those occur according to seasonal variations collectively called Cyclomorphosis. Most of the aquatic zooplanktons especially that of copepods exhibit this phenomenon extensively. The *Brachionus* rotifers too demonstrate such phenomenon that has been studied extensively in temperate regions. During present investigation seasonal morphological changes in particular to change in shape and size of lorica, anterior and posterior spines and other such ornamentations related to that of *B. calyciflorus* and *B. caudatus* was studied elaborately.

In all these ponds, the maximum size of the lorica was observed for both the species of *Brachionus* during the period of high temperature. With the decrease in the temperature, there was a corresponding decrease in the length of the lorica and increase in the length of postero-lateral spine in case of *B.calyciflorus*, on the other hand in *B.caudatus* with the increasing temperature, there was a corresponding increase in the lengths of lorica and posterior spines. *B. calyciflorus* was typical for its polymorphic forms and specialized spiny outgrowths. It had been observed that the species of *Brachionus* examined from pond-I was larger, healthy and spinous in comparison to those brought and examined from other ponds. It was pragmatic that the deposition of domestic sewage, predators and rich phytoplankton growth in the pond may responsible for such growth.

Herbivorous rotifers ate particles less than 10  $\mu$ , with large rotifers taking large particles. *Asplanchna* a predaceous rotifer used to eat particles between 50 to 250 $\mu$  long having more liking to eat less grown or non-spined *Brachionus* sp. (150-900 $\mu$  long) than one that was with long spine within the same population. The length of spine in *Brachionus* sp. not only depended upon the length of lorica but also the composition of crustacean and copepod zoo-planktons in the ecosystem. After a fresh spell of monsoon, the production of phytoplankton went on increasing. The *malleate* or *malleo-ramate mastax* of herbivores rotifers such as *Brachionus* and *Keratella* which were specialized to capture such nano planktons, while the *incudate* tropharynx of *Asplanchna* are specialized for capturing small rotifers. This suggests that *prey of the right size but wrong shape is never accepted in predation*. Hence, a spine or any such thing at the right place at right time makes the prey unsuitable to its predator (Dodson 1974).

The proximal causes for cyclomorphosis can be mooted with the environmental conditions those change within no time, with the changing climate. A relatively low temperature, turbulence in the presence of light, the effects of photo-periodism, female principle and predation are some of the prime reasons for the morphometric changes in rotifers. Turbidity appears to be also an important factor influencing the reproduction and abundance of both the species. *B.calyciflorus* was observed in abundance when the turbidity was low. Another important factor which was observed in the present observation was dissolved oxygen.

With the increase in the dissolved oxygen content there was a corresponding increase in the abundance of *Brachionus* species. It may be concluded finally that no single factor is accountable for this seasonal polymorphism and morphological behavior but a combination of many factors like temperature, turbidity and hydrogen ion (pH) concentration, dissolved oxygen and feeding behavior, etc. are responsible for these variations, which might act in a cumulative manner.

#### Indicators of trophic nature

Rotifers are a common component of freshwater zooplankton communities. Species of the genus *Brachionus* are sensitive to changes in the water quality. Consequently their use as standard bioassay organisms has been universally recognized (APHA, 1998). Information on the acute toxicity tests of lead (Pb) on *Brachionus* is available in literature (Snell & Janssen, 1995, Legaspi & Rico 2001). Species belonging to *Brachionus*, especially *B. calyciflorus* can withstand heavy concentration of chemicals. Pejler, B. & Berzins, B., (1994) designated that presence of *Brachionus angularis*, *B. quadridentatus*, *B. urceolaris*, and *B. calyciflorus* as indicators of eutrophy.

The ecology of a rotifer directly or indirectly indicates the ecology of the habitat it is living. Similarly, the Plankton distributions in these ponds too vary as per the growing level of pollution. However, the only thing i.e., interesting, is nothing but the restriction in species diversity. Indeed only, few were dominating during these periods. Devetter (2003) had the opinion that '*the physical and chemical natures of clean water vary a great deal and hence it becomes difficult to declare water healthy merely on the basis of chemical analysis. A simple chemical constituent never acts independently as a limiting factor but it is the interaction of many factors that constitute an environment. The studies on the biological indicators are therefore more dependable in the assessment of water quality.*' In the present investigation it was clearly understood that bioassay along with the chemical analysis is also essential to determine the actual nature of water-to discriminate whether potable or not (Pattnaik, 2014).

#### Dormancy

Dormancy is a pattern or phenomenon exhibited by several species to overcome and withstand certain environmental conditions for brief period. Indeed it is a type of adaptation to escape from some adverse situation or rather a style of safeguarding its own race from extinction. The term '**Dormancy**' includes both *diapause* and *quiescence*. Diapause is initiated in response to a variety of stimuli (population density, temperature and photo-period) that are directly or indirectly predictive of environmental deterioration i.e., terminated by the return of favorable conditions. The Monogonont and Bdelloidean, rotifers reproduce parthenogenetically and live in unstable habitats.

During the investigation period the microscopic features of various Monogonont eggs were studied. Eggs were collected by a care handling with Micropipettes and preserved in separate glass vials with glycerol and alcohol. The presences of mictic eggs or resting eggs which undergo parthenogenesis in certain rotifers, for most of them remain virgin due to lack of a male partner are characteristics of rotifers which carry these eggs for most of the seasons in a year. Most monogonont rotifers are short-lived and complete their life cycle in 8-14 days, on average, at 22°C (Pattnaik, 2014). Thus, the short life-span of these rotifers sometimes either or include a winter or a dry season, and their environment hence is limited.

#### Seasonal dynamics

The abundance of zooplanktons has a direct relation with the hydrography, physico-chemical factors and availability of phytoplankton. Rotifers also are no exception to this principle. Biotic factors such as quality and quantity of food, interference

competition, predation and ecological conditions induce rotifer communities favoring one species over another. They are more susceptible to the environmental changes due to their small size and permeable integument. The temperature and pH tend to be positively related to species diversity while conductivity and salinity tend to be negatively related (Athibai et al., 2007, Pattnaik, 2014).

Most of the planktonic rotifers appeared to have potentially cosmopolitan in distribution. Tropical fresh water fauna greatly resembles the European forms especially as regards Rotifera (Pejler, 1998, Wallace and Snell, 2001). The species like *B. angularis*, *B. calyciflorus*, *B. quadridentata*, *B. urceolaris*, are cosmopolitan in distribution (May and Hare, 2005). Presence of *B. calyciflorus*, *B. quadridentata* in most of the Ethiopian and African lakes confirmed that both these species are cosmopolitan in nature (Pattnaik, B.S.R., 2014).

Rotifers showed a major pulse in all the ponds in summer months of April through July in Delhi (Sarma, 1988). May and Hare (2005) have the opinion that in tropical waters rotifers show a summer maximum. But from the present studies it is clear that rotifers show two maxima, one in summer and the other in winter. The species composition of the rotifers from the present ponds was the simultaneous occurrence of two or more species of the same genus in a single collection. For instance it was seen that *Brachionus* was represented by more than two species, even up to five species, in many samples, and it was the only genus, observed to have such a species composition. The different species of *Brachionus* that have entered into such species composition were *B. angularis*, *B. calyciflorus*, *B. forficula*, *B. caudatus* and *B. bidentata*.

All these Species are very hardy forms and have a wide distribution. The abundance of profundal organisms in general and that of insect larvae in particular has a direct correlation with the abundance of plankton fauna (Subba Rao, 1985), respecting the prey-predator relationship. The *Brachionus* rotifers dominated over other groups in all the ponds, the Ctenoid and Cyclopoid Copepods come next and the Cladocerans at the last in all these ponds.

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