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Seasonal Morphological Changes IN ROTIFERS

KEYWORDS: Morphometric changes, Zooplanktons, Rotifers, dinoflagellates, cladocerans, copepods, lorica, mastax, outer spines, parthenogenesis Oligotrophic, Physical factors

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ABSTRACT *The Morphological changes those occur in certain species of invertebrates in accordance to environmental condition are called Cyclomorphosis. The phenomenon has been noted in the dinoflagellates, rotifers, cladocerans and much strikingly in the copepods. The degree to which the Cyclomorphosis is developed within different populations of the same species is variable. Although the seasonal incidence of the change is clearly determined by environmental factors, there may also be certain other inherited diversity in different species to react to these factors.*

The seasonal changes of form in certain Rotifers is so striking that the summer and winter forms of the same species would certainly be supposed to represent different species by an observer, unacquainted with the facts. Although there is no significant change in the physiological processes in these planktons but great change in the morphology as well as existence of polymorphism is observed, rather for some extent it is true that the cyclomorphic changes do have some adaptive significance too. It involves the alternation of different morphological units in a species in accordance to the climatic as well as environmental changes. The total body size may increase, decrease or remain the same throughout the cycle, depending on the species. The change that occurs in the shape of Lorica, size and number of outer ornamentation like spines and the shape of mastax in accordance to body shape is remarkable. The polymorphic forms and the morphological changes in accordance to the environment in case of some of the Brachionus rotifers especially during their greatest period of diversity for a brief period is investigated in the present work.

Introduction

The Morphological change those occur in certain species of invertebrates in accordance to environmental conditions is called **Cyclomorphosis**. The term Cyclomorphosis was coined by **Lauterborn** (1904) but the actual concept came to lime light only after **Coker** (1939). Organisms that reproduce during most of the year by asexual or parthenogenesis methods appear to exhibit this phenomenon. The degree to which the Cyclomorphosis is developed within different populations of the same species is variable. Although the seasonal incidence of the change is clearly determined by environmental factors, there may also be inherited diversity in the capacities of different races of a species to react to these factors.

Rotifers are one such group of invertebrates found abundantly in any fresh water body throughout the globe. Popularly known as "the wheel animalcules", these are although small in number but large populations are found in a particular environment. Among the Rotifers the Monogonants, especially that of order Ploima having the genus Brachionus are unique for their polymorphic forms and exhibition of Cyclomorphosis. Cyclomorphosis in rotifera was described first by Weisenberg-lund (1926) and later by several workers like Beauchamp (1952), Gallagher (1957), Hutchinson (1967), Gilbert (1973), Dodson (1974) also by Indian contributors like Arora (1965), Nayar (1968) and Dhanapathi (1980).

Materials and Methods

Present work was carried out on two different perennial ponds in the city of Vizianagaram belonging to the state of Andhra Pradesh, India between May-2009 to April, 2011. Of these two ponds, one is Eutrophic (highly polluted, Pond-1) and the other Oligotrophic (semi clean Pond-2) since no municipal or domestic wastages is allowed to pass into this pond. Plankton samples were collected periodically (weekly once) from both pond-1 and pond-2. Species related to Brachionus are collected separately and measurements were being taken. Three species were only considered for investigation of which two are e.g., Brachionus calyciflorus and B.caudatus while the other one is Keratella cochlearis.

Water samples for hydrographical analysis were collected by dipping a 250 ml wide mouthed glass stopered or polythene bottle just below the surface of water in open condition. The water was immediately transported to the laboratory after replacing the stopper, for chemical analysis. For systematic study of planktons, samples were collected separately. The collected sample was divided generally into three parts. The first part was treated with 5% procaine hydrochloride and then fixed in Schaudinn's fixative. The second part was treated with 5-10% formaldehyde and third part was treated with boiled water and then fixed in formalin. When the organisms treated directly in formaldehyde, the soft parts contracted considerably leaving the clear outline of the Lorica, thus making the identification easy. Hot water treatment gives satisfactory results as well as can fix the organism in its natural position which no other relaxing agent can do. A large number of organisms were placed in a Petri dish somewhat less than half full (Edmondson,1959). An equal amount of boiling water was suddenly poured into the middle of the dish. This method worked well for basically free swimming organisms. The forms were stained in Haematoxylin and Alum carmine. Then they were mounted in pure glycerin and glycerin jelly. For the observation of Mastax, specimens were treated with KOH and forms so treated were mounted in a glycerin. Forms treated with sodium hypochlorite also gave good results.

Brachionus calyciflorus Pallas

Brachionus calyciflorus is an extremely variable species, the variability is pronounced in the size, length of posterolateral spines as well as occipital spines. Examination of all the data from the localities surveyed, the data from Big Pond (Pond-I) was found continuous enough to explain the phenomenon of Cyclomorphosis, in B.calyciflorus. Although this species was observed in the samples collected between April, 2009 and January, 2010, the continuous data could be obtained only from 7th October, 2009 to 9th January, 2010. On 23rd September, 2009 when the surface temperature was 32.4°C there were few forms of this species in the samples. On 7th October

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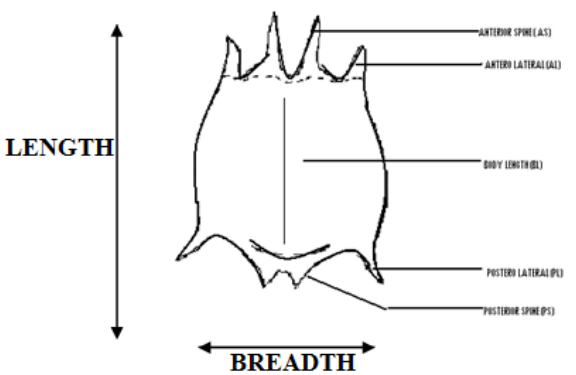
the number of specimen appeared a bit increased when the temperature was 28.5°C. The quantitative study of the rotifer revealed that there were two peak periods of abundance when the temperature was 21.0°C ON 26-11-09 and the second peak when it was 20.0°C ON 02-01-10. The rotifer stated disappearing from the samples when the temperature rose to 23.0°C on 16th January, 2010 and found very few on 23rd January 2010.During the period of occurrence of these species, the hydrogen-ion concentration (pH) fluctuated between 8 and 9 and turbidity between 11 and 72 ppm.

Polymorphic forms of B.calyciflorus

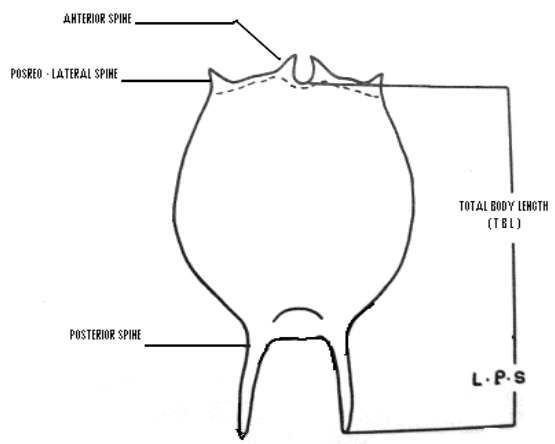
Morphological variations:
Measurements were taken for thirty specimens from each sample collected once in a week. Length of lorica (TBL), Maximum breadth (B) of lorica and the length of Postero-lateral spines (PLS) were measured and their mean values were given in table. The respective points used in making the measurements were shown in Graphs. The lengths of the lorica ranged from 230 to 328 microns while the breadth from 200 to 228 microns. In case of Postero-lateral spines the length of the right posterolateral spine which was more variable was taken. Its length ranged from 21 to 53 microns while the length of left posterolateral spine ranged from 23 to 50 microns.Thus we can conclude that the right spine is elongated than the left one.



The specimens with and those without posterolateral spines were almost equal in the samples of 7th and 14th October. The specimens without posetrolateral spines gradually decreased and they disappeared completely in the samples collected from 4th November to 18th December. Again few specimens without posterolateral spines had re- appeared on 25th December and continued till 9th of January 2010. In the earlier collections the specimens without posterolateral spines (var. dorcas) are larger in size than those with posterolateral spines (var. dorcas f. spinosa). In the samples from 4th November till 18th December only var. dorcas forma spinosa was present. But the lateral Collections showed an assemblage of varied forms (var. dorcas, var. pala and var. dorcas f. spinosa). Some specimens without posterolateral spines were found smaller than those with posterolateral spines in the collection during 25th December, 2009 to 9th January, 2010. Increase in the length of the postero-lateral spine (right) with the decrease in the size of the lorica has been observed.

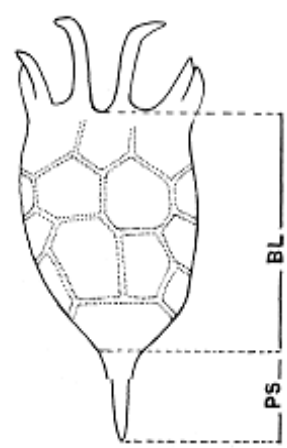
Brachionus caudatus Barrios and Daday
Although this species occurred for most part of the year in both the ponds but for morphological variances, samples were collected from Pond – 1 were taken for present study. Only the measurements of the population collected from 05th March to 21st May 2009 were only analyzed for drawing the following conclusions.

Morphological Variation
This rotifer showed a variation in length of posterior spines, arising on either side of the foot. The measurements were taken for twenty specimens from each weekly sample. The length of lorica (TBL), maximum breadth of lorica (B) and the length of each posterior spine (PS) were measured and the mean values were presented in the Table. The respective points used in the making the measurements were shown.



The lengths of Lorica ranged from 98 to 128 microns while the Breadth from 87 to 112 microns. The Posterior spines are almost equal except in very few. As the right one showed much variation, measurements of this spine were taken for illustration. Its length varied from 12 to 63 microns.With the increase in the temperature the length of lorica increased and there was also a corresponding increase in the length of spines. But the rate of increase in the length of posterior spine is greater than the rate of increase in the length of lorica.

Keratella cochlearis



A series of measurements were recorded on K. cochlearis within the same period as that of B. calcyflorus, including body length (BL), caudal spine length (CSL) and Breadth (B) and Total Body Length (TBL). The average daily temperature of the air is here taken and the averagecaudal spine length are plotted. This rotifer showed a variationin length of its caudal spines. The measurements were taken for twenty specimens from each weekly sample. The length of lorica (TBL), maximum breadth of lorica (B) and the length of Caudal spine (CSL) were measured and the mean values were presented

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in the Table. The respective points used in the making the measurements were shown. The lengths of Lorica ranged from 98 to 128 microns while the Breadth from 87 to 112 microns.The Caudal Spine Length was in between 54 to 9 6 microns in length.There was a gradual increase in Caudal Spine Length from November to February and decreased since then.

Conclusion

The proximal causes including Cyclomorphosis can be mooted with the environmental conditions those change within no time along with the climate. A relatively warm or warming temperature, turbulence presence of light, female principle and predation are some of the prime reasons. Exuberant forms of rotifers have been correlated with starvation for Brachionus or with dense food or cold water. Gilbert had the opinion that incase of Brachionus the abundance of Asplanchana (a predator) in the same locality also influence Cyclomorphosis. 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 both the species. Nayar (1956) was of the opinion that these physico-chemical factors may not have direct influence on the rotifer B.calyciflorus. This may be true to certain extent but in the present investigation it is clear that the occurrence of Cyclomorphosis is basically due to the physico-chemical changes in the environment.

In both these ponds the maximum size of the lorica was observed for all the species during the period of high temperature. In B.calyciflorus 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. But in B.caudatus with the increase in temperature, there was a corresponding increase in the length of lorica and length of posterior spines. Thus, the changes in temperature may indirectly affect the morphology of the animal as evidenced by the present observations. Finally it may be concluded that no single factor can account for this seasonal polymorphism but a combination of many factors like temperature, turbidity and hydrogen-ion (pH) Concentration, dissolved oxygen and feeding behavior, etc. are all responsible for these variations which might act in a cumulative manner.

Of the three species chosen for Cyclomorphosis, Brachionus is typical for its polymorphic forms and specialized spiny outgrowths. It was also noticed that the species of Brachious examined from pond-I were much large, healthy and spinous comparatively to the samples brought and examined from pond-II. One of the biggest reasons for such variance may be attributed in the form of domestic sewage pollution which is opened into the pond-I in large accounts.

The morphological stutures are also correlated with some of the predator rotifers such as Asplancha. In Keratella cochlearis the body is much enlarged during the winter season unlike Brachionus and Asplancha. The longest spine is found in the winter months of December and January while the shortest during the August. The availability of food also had a direct relation with the morphological changes. Herbivorous rotifers ate particles less than 10 microns (μ), with large rotifers taking large particles. Asplancha being a predaceous rotifer eats particles between 50 to 250μ long with better liking for non-spined Brachionus speicies than spined ones of the same genus. Hence, the development of spines in Brachionus attribute to some months of the year is not only related to environmental conditions but also on the types of predators such as Asplancha. The abundance of predators had a direct impact on the length and number of body spines. Keratella on the other hand is covered although externally by a well developed lorica yet it is an easy prey for number of predators of both rotifer and other groups.

After a fresh spell of monsoon, the distribution of phytoplankton is plenty. The malleate or malleo-ramate mastex of herbivorous rotifers such as Brachionus and Keratella is specialized to capture such nanno planktons, while the incudate trophy of Asplancha are specialized for capturing small rotifers. This suggests that prey of the right size but wrong shape is never accepted in predation, hence many be rejected after being caught. For example, the presence of long spines on B.calyciflorus does not affect the rate of collision with Asplancha but decreases the probability of being eaten once caught. Hence, a spine or any such thing at the right place at right time makes the prey unsuitable for predation. The abundance, size and population along with the external structures such as the lorica and spines in a rotifer has a direct relation with ecological condition, availability of food, presence of male individuals and especially with that of presence of predator. Studies on these three rotifers in deed is just a beginning in this regard.

TABLES

BODY DIMENSIONS OF B.calyciflorus (08-10-09 TO 21-01-10)

DATE	MEAN LENGTH OF LORICA	MEAN BREADTH OF LORICA	MEAN LENGTH OF POSTERIO LATERAL SPINES	
			RIGHT	LEFT
08-10-09	328	227	21	23
15-10-09	327	228	23	23
22-10-09	302	221	25	26
29-10-09	266	212	30	28
05-11-09	301	220	31	30
12-11-09	302	224	35	34
19-11-09	293	218	52	49
26-11-09	256	202	53	50
03-12-09	277	212	51	49
10-12-09	235	204	43	46
17-12-09	242	208	51	48
24-12-09	236	208	40	40
31-12-09	230	200	40	38
07-01-10	250	210	37	37
21-01-10	246	204	35	36

BODY DIMENSION OF B. caudatus (05-03-09 TO 21-05-09)

DATE	MEAN LENGTH OF LORICA	MEAN BREADTH OF LORICA	MEAN LENGTH OF POSTERIOR SPINES	
			RIGHT	LEFT
05-03-09	98	87	12	11
12-03-09	102	96	13	13
19-03-09	105	100	17	16
26-03-09	106	102	19	19
02-04-09	107	102	23	23
09-04-09	109	101	31	30
16-04-09	114	104	41	41
23-04-09	117	106	48	48
30-04-09	118	108	48	48
07-05-09	120	110	56	52

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14-05-09	124	116	59	56
21-05-09	128	122	63	60

VARIATION OF SPINE LENGTH IN K. cochlearis

DATE	NO.OF SPECIES	WATER TEMP.	SPINE LENGTH
08-10-09	35	30.0	54
15-10-09	36	28.5	57
22-10-09	32	28.5	64
29-10-09	35	27.5	71
05-11-09	07	25.5	74
12-11-09	21	27.5	87
19-11-09	21	25.0	89
26-11-09	04	24.5	85
03-12-09	36	23.4	93
10-12-09	36	22.5	94
17-12-09	33	21.2	96
24-12-09	30	22.0	91
31-12-09	26	22.0	90
07-01-10	36	20.6	96
21-01-10	36	21.8	94
28-01-10	36	23.0	88
04-02-10	22	25.7	65

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