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POPULATION STRUCTURE AND POLYMORPHISM OF *Ceriodaphnia cornuta* IN KOTMALE RESERVOIR

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Abstract

A study of zooplankton was carried out in Kotmale reservoir, from August 1990 to December 1991. Vertical and horizontal sampling was done once a month near the dam of the reservoir, between 1100 hours to 1200 hours. A closing type net with mesh size of 50μ m was used for collection of zooplankton.

Ceriodaphnia cornuta is a cosmopolitan species and the dominant form in the cladoceran community of Kotmale reservoir. It represented 98% of the whole population at certain months. Its population structure comprised nymphs and adults throughout the year.

Ceriodaphnia cornuta showed polymorphism. Two morphological forms were identified. One form (horned form) had a comparatively smaller body (size range of 0.30—0.45 mm) with spines on the head region & the other (unhorned form) with a larger body (size range of 0.48—0.84 mm) without bearing spines.

Abundance of morphological forms were different in 1990 and 1991.

The spined form predominated in the epilimnetic waters where fish predation was high and the other form was found at all depths. Existence of such morphological forms may be an adaptation to minimize selective predation by fish.

Key words: Population structure, Polymorphism *Ceriodaphnia cornuta* Kotmale reservoir.

1. Introduction

Kotmale reservoir is the uppermost reservoir in the Mahaweli reservoir system, constructed by damming of river Mahaweli, for the purpose of hydro-electric power generation. It is located at an elevation of 640—762m above sea level, with a geographical position of 7°03' to 7°05' N and 80°36' to 80°41'E.

It has a surface area of 6.5 km^2, maximum depth of 90m, maximum length and width of 6.8 km 1.11 km respectively.

According to the classification of Huchinson & Lōeffler (1956) it is an oligomictic type of a reservoir. Its physical and chemical characteristics revealed that the water temperature varying between 23.0—28.0° C, pH in the range of 5.1—8.3 the conductivity in the range of 30—65 μs/cm surface dissolved oxygen in the range of 5.0—6.8 mg/1 & total alkalinity ranging between 0.2-0.6 meq/1, during the investigation period. It has a fairly rich zooplankton & phytoplankton community.

According to Fernando (1980 a & b) the zooplankton present in Kotmale reservoir belongs to typically tropical limnetic species.

2. Materials and Methods

Vertical & horizontal sampling of zooplankton was done at station 1, where water level remained at a considerably higher level, even during droughts. Physical & chemical properties of the reservoir were studied at three major stations (stl, st2, st3,) and in seven sub stations (A-G) (Fig 1). Collections of zooplankton were made once a month for a period of one and half years (from Aug. 1990-Dec. 1991) between 11.00 am. to 12.00 noon using a closing type net with a diameter of 30 cm and mesh size of 50 μm.

In order to study vertical distribution, vertical sampling was done by filtering each 10 m column of (0-10) m, (10-20) m, (20-30) m water from the surface to bottom.

In order to stydy the abundance of zooplankton in surface layers, a horizontal tow net sample was taken. All these samples were concentrated by filtering through 50 μm net and fixed in 4-5%formalin solution and transported to the laboratory for further investigation.

Each vertical sample was diluted upto 100 ml & horizontal sample upto 150—200 ml. From each of the above samples, five sub samples were counted using a sedgewickrafter cell and a microscope. Micrometer eye piece was used for necessary measurements.

Ceriodaphnia population was determined by counting *Ceriodaphnia* present in all five sub samples.

To identify the size distribution, more than 85% of the individuals were counted. Length and width measurements of the individuals were taken. Presence of eggs or nymphs in the brood pouch were also noted.

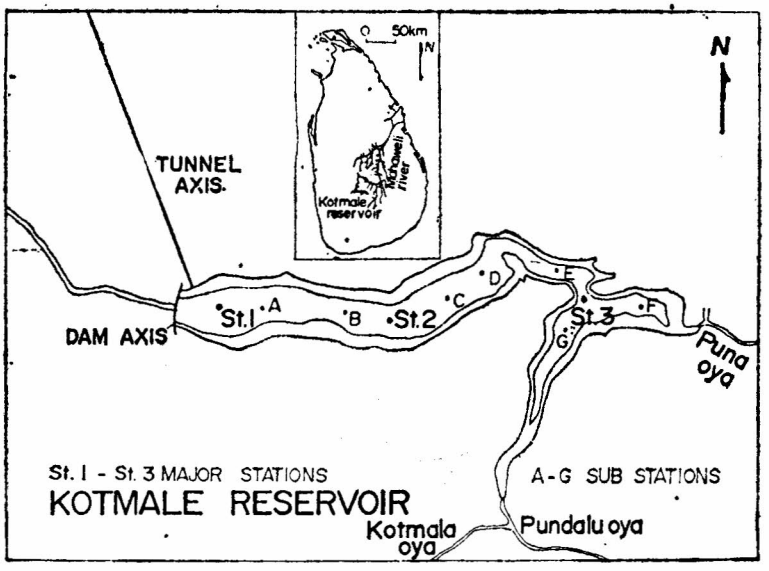

Fig. 1. Location of Kotmale reservoir and sampling stations

Morphological features of horned and unhorned forms were studied. These two forms were counted separately, in order to study their distribution and abundance.

The gut content analysis of fish (*Oreochromis mossambicus, Cyprinus carpio, Tor Khudree & Puntius sarana*) present in Kotmale reservoir was done in order to find out their prey items.

3. Results

The main taxonomic groups of zooplankton present in Kotmale reservoir are copepoda, cladocera and rotifera. Each group showed dominancy in different months. However, copepods showed the highest abundance in most of the months. Cladocerans were the second dominant group. The dominancy of each group was governed by several factors such as food availability, temperature and predation.

Among the ten species of cladocerans recorded in Kotmale reservoir, *Ceriodaphnia cornuta* is the most abundant. They were dominating through out the year, sometimes contributng 98% of the whole cladoceran community (Fig. 2).

Their percentage of abundance was never below 50% except in February in which another cladoceran; *Chydorus eurynotus* became dominant. Presence of high percentages, in *Ceriodaphnia cornuta* seem to be dependent mostly on food availability and reduced predation but less on the temperature. In

May, June and September comparatively high surface temperatures (26°C, 25° Cand 26.2°C respectively) were recorded while in November low temperature 24.2° C was recorded. However, independent of the temperature changes *Ceriodaphnia* population was high during those months.

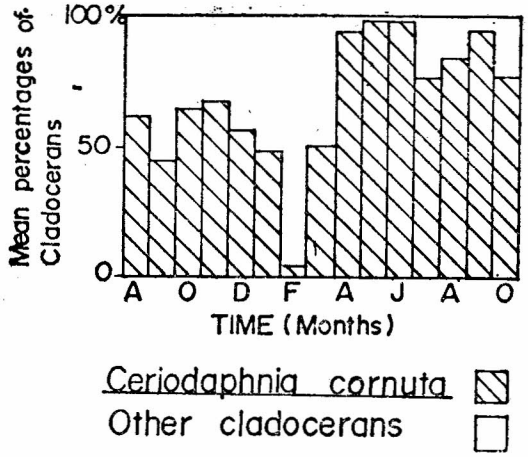

Fig. 2. Mean percentage of *Ceriodaphnia cornuta* with respect tc other cladocerans

The population structure of *Ceriodaphnia cornuta* comprised of individuals belonging to several size classes; 0.24—0.32 mm, 0.33—0.41 mm, 0.42—0.50 mm, 0.51—0.57 mm, 0.60—0.68 mm, 0.69—0.77 mm & 0.78—0.86 mm. Except for the first and the last size classes the individuals belonging to the other size classes were common. (Fig 3) Mainly the individuals, with body length, less than 0.48 mm, were dominating during most part of the year. Presence of eggs, nymphs & the smallest individuals (0.24—0.30mm) in low percentages may be due to invertebrate predation.

Asplanchna species, corethrid larva, water mites etc. may be the predators of eggs, nymphs & young stages of cladocerans. Gut content analysis of major fish types (*O. mossambicus* & *Puntius sarana*) of Kotmale reservoir showed predation on medium sized and large sized *Ceriodaphnia.* At certain times 90% of the gut contents of *O. mossambicus* were *Ceriodaphnia,* indicating heavy predation on their population.

In Kotmale reservoir *Ceriodaphnia cornuta* has shown two morphological forms (Fig. 4). Normally existing morph was bigger in size with more pigmentation, and referred to as the unhorned form. The other morph was less pigmented with tiny spines on the head region and with a smaller body. It was referred to as the horned form. The maximum body length of horned form was 0.45 mm while in unhorned form, the length reached upto 0.84 mm. Both forms could be identified easily from each other.

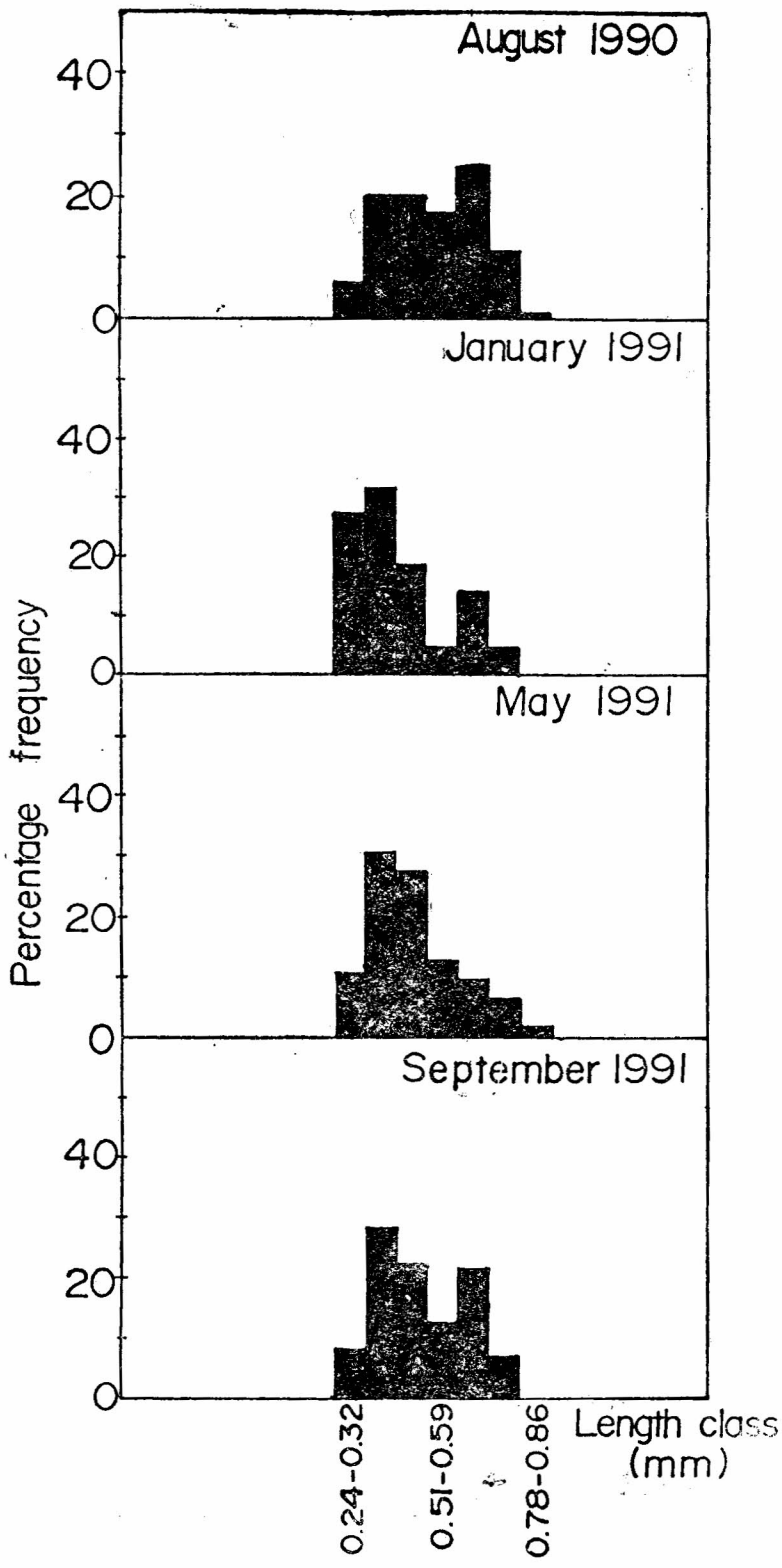

Fig. 3. Population structure of *Ceriodaphnia cornuta*

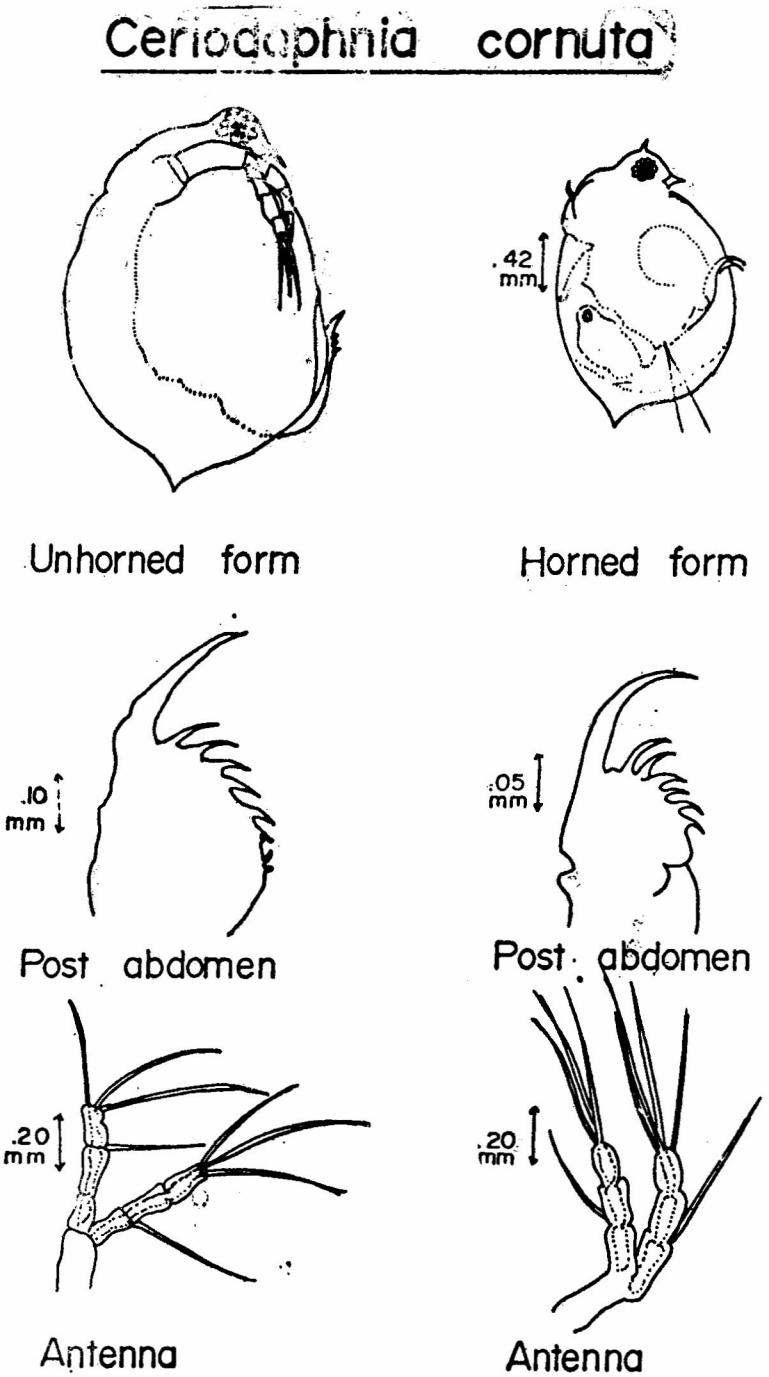

Fig. 4. Morphological forms of *Ceriodaphnia cornuta*

The horned form was first found in Kotmale reservoir, in March 1991, and continued to be present until the end of study period. During this period their population varied in numbers tremendously.

Increased population number of the horned form is correlated with the low water level in the drought season (Fig. 5).

This correlation implies that horned forms have appeared to reduce predation pressure on their community. As these morphological types were found during high temperatures in April and low temperatures in November, their populations seemed to be unaffected by temperature changes.

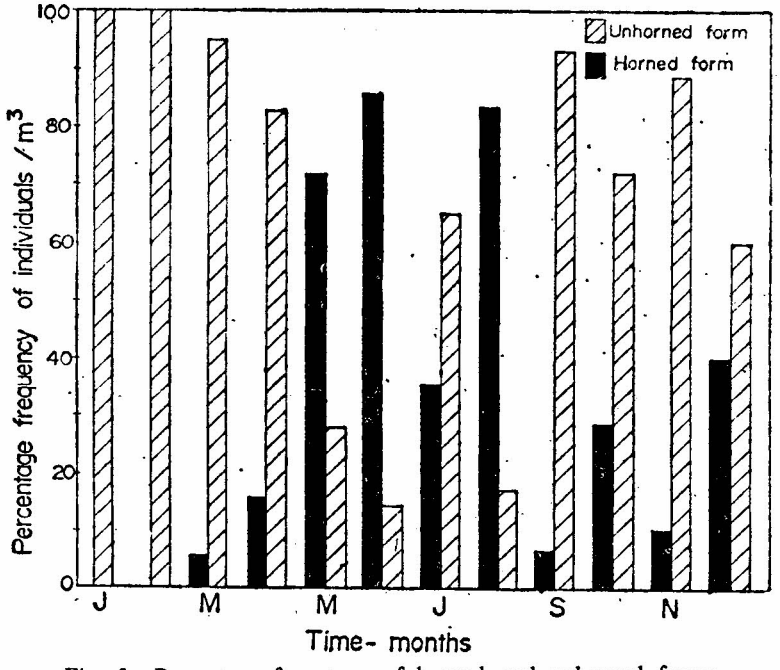

Fig. 5. Percentage frequeney of horned and unhorned forms

The vertical migration of both forms showed certain differences. A large percentage of horned forms were found at the epilimnetic waters where fish predation was high (Fig. 6). They were also found in deeper waters but in very low concentrations. However the unhorned forms were present from surface to bottom and a comparatively large percentage of them were occupying deeper waters. This shows that they were avoiding high predation by migrating to deeper waters. Through out the year it was noted that certain *Ceriodaphnia* were carrying eggs or nymphs in the brood pouch. This indicated that it was reproducing continuously. Maximum number of eggs and nymphs were observed in April, May, June September and October. The horned forms were observed with eggs in the brood pouch after they reached a body length of 0.33 mm or more while the unhorned forms were observed with eggs once they reached a body size of 0.57 mm or more, indicating that the horned forms reproduce early.

The maximum body size of the horned form was roughly 0.45 mm while the unhorned form reached upto 0.84 mm. It was noted that almost all the horned forms were females with brood pouches.

Some of them were carrying either one or two eggs or nymphs. The percentage of nymphs in the brood pouches were high compared to eggs, indicating that they reproduce rapidly by parthenogenesis to meet their losses by high production.

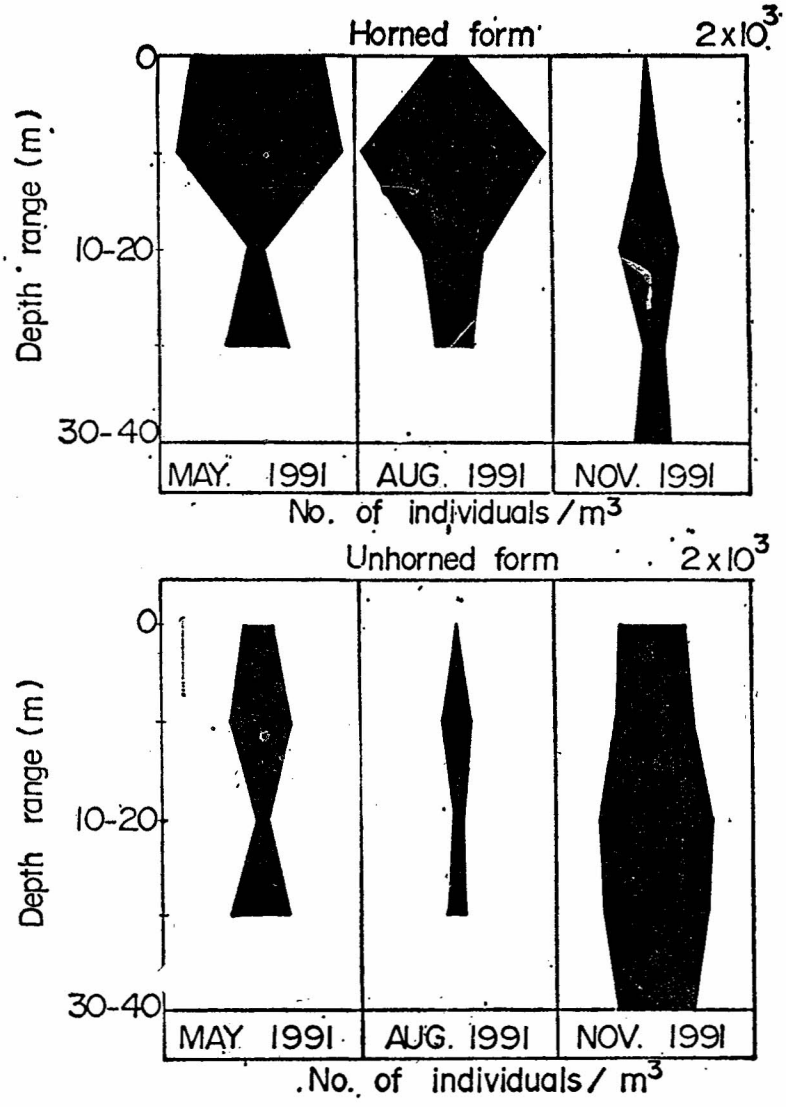

Fig. 6. Vertical migration of horned and unhorned forms

The other interesting feature noted in the horned form was that brood pouches of most individuals were empty during several sampling occasions (July, August, September and October). This showed that they have already released the eggs or nymphs in the brood pouches and are passing a time prior to the production of new eggs. This time duration may be long. With large empty brood pouches which looked like ephipia and guts pushed to one side they looked more transparent than the unhorned ones. Similar situation was observed in many unhorned forms as well. Since they showed this character for several months, it may be another feature to escape from visual observed predators. However *Ceriodaphnia* present in the samples in 1992 June, (when water level was very high) did not show this character, and their brood pouches were comparatively small and were with eggs, most of the time.

Higher reproductive abilities, formation of parthenogenetic eggs and nymphs, morphological changes and epiphia formation may be some of the adaptations of *Ceriodaphnia cornuta* for continuous dominancy in the cladoceran community.

4. Discussion

Zooplankton community in Kotmale reservoir is almost identical with that of Victoria reservoir (Piyasiri & Jayakody 1991) and the dominant taxonomic group during most of the months in both reservoirs were copepods.

Ceriodaphnia cornuta is a cosmotropical species, (Fernando 1980 a & b) and present in every habitat type (Rajapakse and Fernando 1982). It is the common and dominant cladoceran species in Victoria reservoir, (Piyasiri & Jayakody 1991) as well as in Kotmale reservoir.

The highest abundancy of *Ceriodaphnia cornuta* was recorded in warm months; late spring and summer in Tjeukemeer, (Vijeverberg 1980), May in Victoria (Piyasiri & Jayakody 1991). During this study the highest abundancy of *C. cornuta* was recorded in June in Kotmale reservoir.

Its population showed a sharp increase in September and November during which the temperatures were not high.

This indicates that its high population was independent of the temperature. *Ceriodaphnia* of all size classes were present through out the year indicating favourable conditions in the reservoir.

Zaret (1969, 1972 a & b) has recorded two morphological forms of *Ceriodaphina cornuta*, both forms had equal body sizes but one with tiny protruberances on the head region and a small eye and the other without any protruberances and with a bigger eye.

The morphological forms present in Kotmale reservoir were quite identifiable with two sizes of body, one horned and the other unhorned. The differences in eyes were not seen in the two morphs, but a slight difference in pigmentation was noticed. Zaret (1980) has shown in his lab experiments, that fish exhibited a greater electivity for the large eyed form, since it is clearly seen. The horned form of Kotmale reservoir may be avoiding size depending predators because they are more transparent and smaller bodied than the unhorned forms. Gut contents of *Oreochromis mossambicus* showed more of unhorned forms.

The empty, but unusually enlarged brood pouch could be also considered as a character to increase transparency of the body.

This may also contribute to escape from visual predators.

Zaret (1969) did not observe seasonal changes in the two morphs but spatial ones occured. Similar observations were recorded in Kotmale and the highest percentages of horned forms were observed when water level was low and predation was high. Horned forms were predominating in off shore areas of the lake where the fish predation was greater. Zaret 1969) In Kotmale reservoir they were abundant mostly in eplimnetic waters where fish predation was maximum. Zaret (1969) had recorded reproductive advantages of a shorter generation time and a greater number of viable eggs produced per female in unhorned form. The horned form of Kotmale reservoir started to reproduce early and almost all were females and a high percentage of them were carrying either one or two eggs or nymphs. This observation was not in accordance with the findings of Zaret (1969).

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