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The fundamental niche of *Mesocyclops* species within the broad aquatic environmental framework at Ranchi Lake

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Abstract- For the study of the fundamental niche of *Mesocyclops* a common zooplankton species, *Mesocyclops leuckartii* (a cyclopoid copepod) was selected and then its fundamental niche was identified. The niche can only be conceptualized in freshwaters. Therefore for understanding the actual picture of the environmental conditions amoeba diagrams, defining the environmental parameters, of Ranchi Lake were created. Within the broad environmental framework, the three major parameters which define the fundamental niche of *Mesocyclops* are food resource, temperature and alkalinity. *Mesocyclops* population showed a significant negative correlation with the phytoplankton population. With increase in the *Mesocyclops* population there will be increased pressure on the food resource. Similarly, it showed a significant negative correlation with the temperature too. A decrease in the *Mesocyclops* population was observed below 16°C and an increase above 25°C. However, it showed a significant positive correlation with the alkalinity in the range of 200 - 250 mg L^{-1}. The area of the fundamental niche changes during an annual cycle with changes in the respective parameters. At Ranchi Lake it was found that the fundamental niche had its greatest area (niche relaxation) in the month of May and smallest (niche compression) in the month of July.

Key words: Niche, Niche Relaxation, Correlation, Amoeba, Copepod

INTRODUCTION

According to Hutchinson (1957) the environmental variables, both physical and biotic, affecting a species population are treated as a set of n-coordinates[1,2] where n equals to 22 (oxygen, temperature, pH, alkalinity, carbon dioxide, light intensity, conductivity, Total Dissolved Solids, salinity, chloride, hardness, calcium, Biological Oxygen Demand, Chemical Oxygen Demand, Dissolved Organic Matter, Total Organic Carbon/Total Inorganic Carbon, nitrate, sulphate, phosphate, silicate, N/P, chlorophyll as food resource and other conditions of existence). The range of these variables within which the species can survive and reproduce, then define an n-dimensional abstract volume or hyper volume, which have been termed as the fundamental niche. The objective of the present study was to identify the fundamental niche of the copepod, *Mesocyclops leuckartii* at Ranchi Lake, Ranchi.

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MATERIALS & METHODS

Ranchi Lake has an area of about 0.157 km^2 and a depth of about 6 meters (Fig 1). It is one of the oldest water bodies in the city. Samples were collected once each month for a period of two years and used for species identification and counting on a Sedgwick rafter cell at 10x magnification. An outline of the Ranchi Lake is shown in Fig 1. The estimation of chlorophyll was done by using

spectrophotometer at 630nm, 645nm and 665nm.[3] The measurement of water temperature was done by using a thermometer and alkalinity was measured by titrimetric method every months.

Niche is defined as "an n- dimensional hyper volume within which a species selects the most favourable or optimum combination of variables"[4]. However, an n-dimensional hyper volume can only be conceptualized. So, in order to present the actual picture of environmental conditions, an amoeba was created defining 22 aquatic parameters of Ranchi Lake (Fig 2).

RESULTS & DISCUSSION

Ranchi Lake has been monitored for the last 10 years with special emphasis and reference on the environmental conditions and biotic parameters especially the impact of the environmental conditions, on the plankton abundance and diversity[5]. The results of the present study are depicted in Fig 7 to 11. The Fig 2 presents an amoeba based on 22 water parameters and the niche structure it produces based on their combination. The values of the parameters have been converted to log values.

Till 2015 Ranchi Lake had a moderate diversity of zooplankton but, with the development of the concrete statue and increase of the subsidiary materials in the water body, the diversity has decreased considerably and now only a few species of crustaceans are found. Therefore, for the study of the fundamental niche a common zooplankton species *Mesocyclops leuckartii* was selected and then its fundamental niche was identified. *Mesocyclops* is a cyclopoid copepod. The females are about 1mm in length while the males are generally smaller, that is, about 0.6 mm in length (Fig 3a and 3b). The optimum temperature for the growth of this copepod is between 25°C to 30°C. The female clutch size consists of 70-75 eggs and these hatch to form the nauplius larva (Figs. 4 & 5).

Development of *Mesocyclops* consists of a series of 12 instars[6,7]. The first six instars are termed as naupliar instars while, the second six instars are copepodid instars, the last of which is the adult (Fig 6). *Mesocyclops leuckartii* matures in about 10.2 days and the mean longevity is 50.9 days. Apart from temperature, the two other factors affecting this particular plankton are food resource (algae) and alkalinity. Thus, the fundamental niche of *Mesocyclops* could be identified.

The fundamental niche of *Mesocyclops* can be defined on the basis of three parameters i.e., food, temperature and alkalinity.

Food:

Organisms are primarily dependent on their food source. *Mesocyclops* is omnivorous feeding on algae, insect larvae and dead organic matter[8,9]. However, their primary dependence is on available algae. In the present study *Mesocyclops* population indicated significant negative correlation with algal availability (exhibited by chlorophyll estimation). Since the increase in *Mesocyclops* population exerts an increased pressure on the food resource, the phytoplankton population decreases (Eq.1).

Log Δ *Mesocyclops* = -3.5407 log Δ chlorophyll + 0.7266 (r=-0.8132) Eq.1 (Fig. 7)

Temperature:

The optimal temperature for the growth and development of *Mesocyclops* is 15°C to 30°C[10,11]. At this temperature if alkalinity is favourable and food material is sufficient, there is optimum growth of *Mesocyclops*. At Ranchi Lake the water temperature varied from 16°C to 30°C. *Mesocyclops* showed good growth between 23ºC to 25ºC but decreased with increase in temperature beyond 25°C. A significant negative correlation was noted between *Mesocyclops* population and temperature as defined below in equation 2.

Log Δ *Mesocyclops* = -7.3611log Δ temperature - 0.0629 (r=- 0.8712) Eq.2 (Fig. 8)

Alkalinity:

The third factor controlling the fundamental niche of *Mesocyclops* is alkalinity[12]. The *Mesocyclops* population showed a significant positive correlation with alkalinity as represented by equation 3.

Log Δ Mesocyclops = -0.3075log Δ Alkalinity – 1.3071 (r= + 0.745) Eq.3 (Fig. 9)

Mesocyclops population showed a significant negative correlation with phytoplankton because with the increase in *Mesocyclops* population there was an increase in pressure on the food resource. Similarly, temperature has an impact on the development of *Mesocyclops*. A significant negative correlation was observed as evident by the decrease in *Mesocyclops* population below 16°C. Conversely, the *Mesocyclops* population showed an increase with increase in temperature above 25°C.

Alkalinity however exhibited a significant positive correlation with *Mesocyclops* population. An increase in alkalinity resulted in an increase in the population of copepod.

The area of the fundamental niche changes during an annual cycle with changes in the respective parameters (Fig 10). At Ranchi Lake it was found that the fundamental niche had its greatest area (niche relaxation) in the month of May and smallest (niche compression) in the month of July (Fig 10).

On the basis of the present results obtained for the three factors considered that is food, temperature and, alkalinity affecting this particular plankton the fundamental niche of *Mesocyclops* was identified (Fig 11).

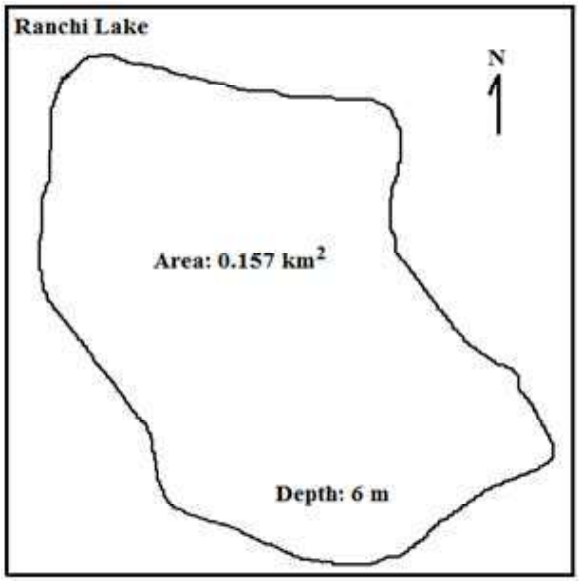

Fig 1: Outline of Ranchi lake

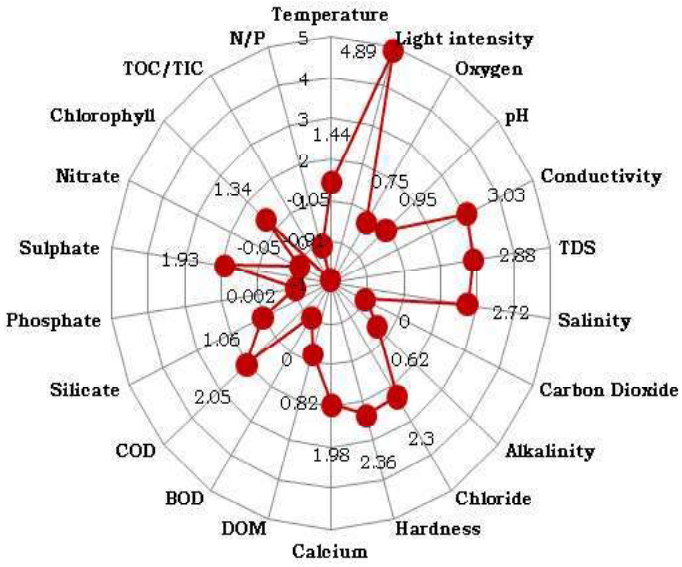

Fig 2: An amoeba based on 22 water parameters and the niche structure it produces based on their combination. The values of the parameters have been converted to log values.

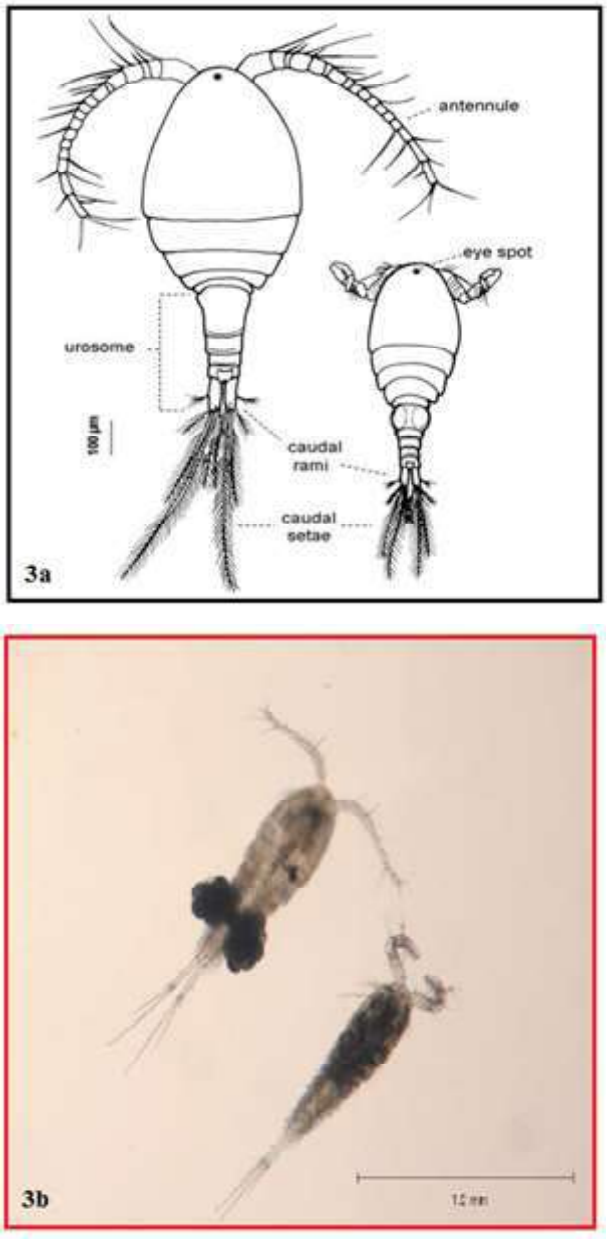

Fig 3a and 3b: A male and a female *Mesocyclops*

Fig 4: Liberation of eggs by female *Mesocyclops*

Fig 5: Nauplius larvae of *Mesocyclops*

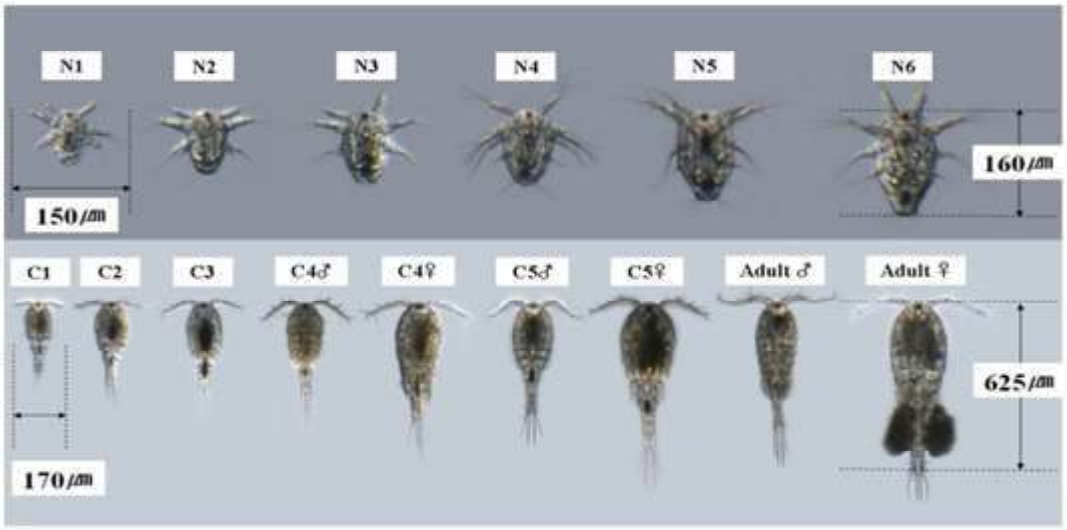

Fig 6: The developmental stages of *Mesocyclops* through six naupliar and six copepoidid stages.

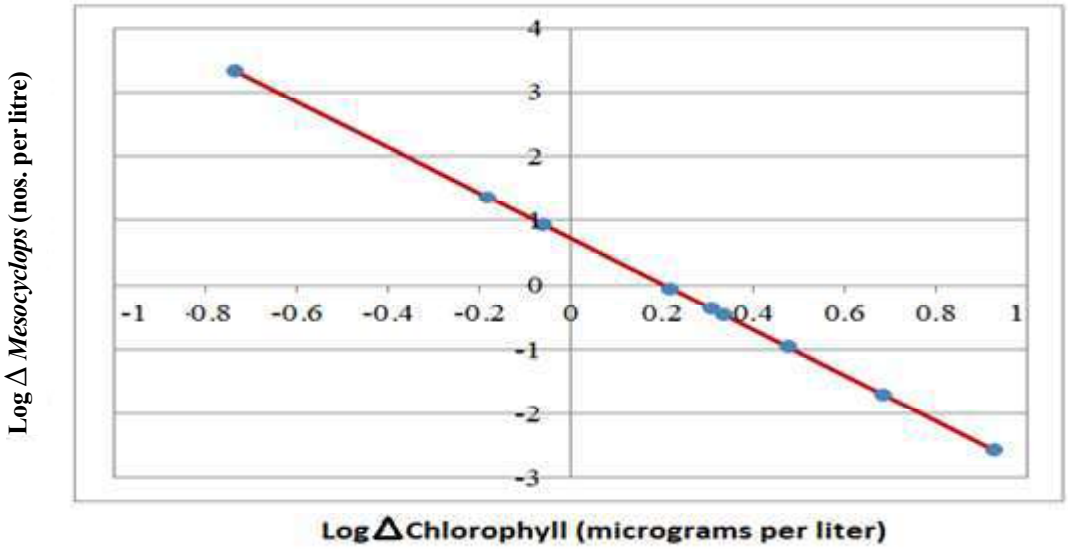

Fig 7: Correlation between *Mesocyclops* and amount of chlorophyll

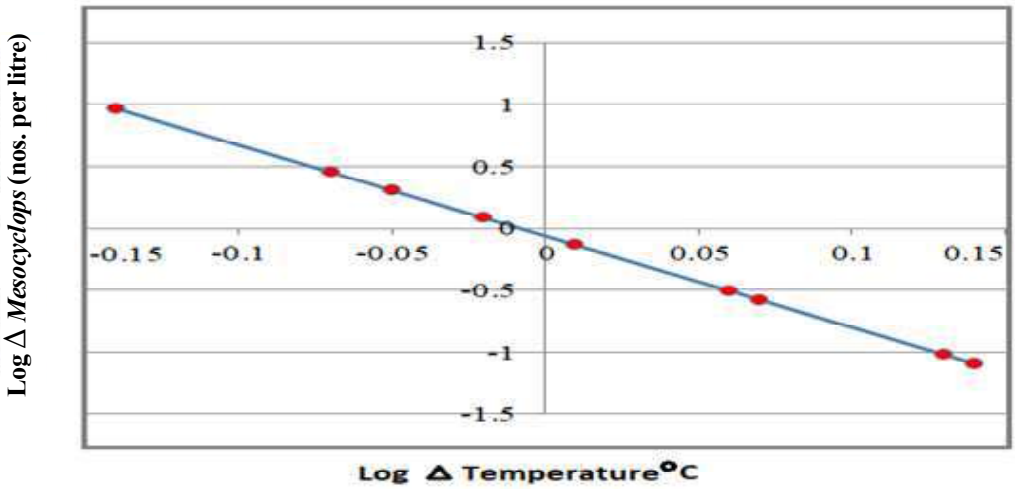

Fig 8: Correlation between *Mesocyclops* and temperature.

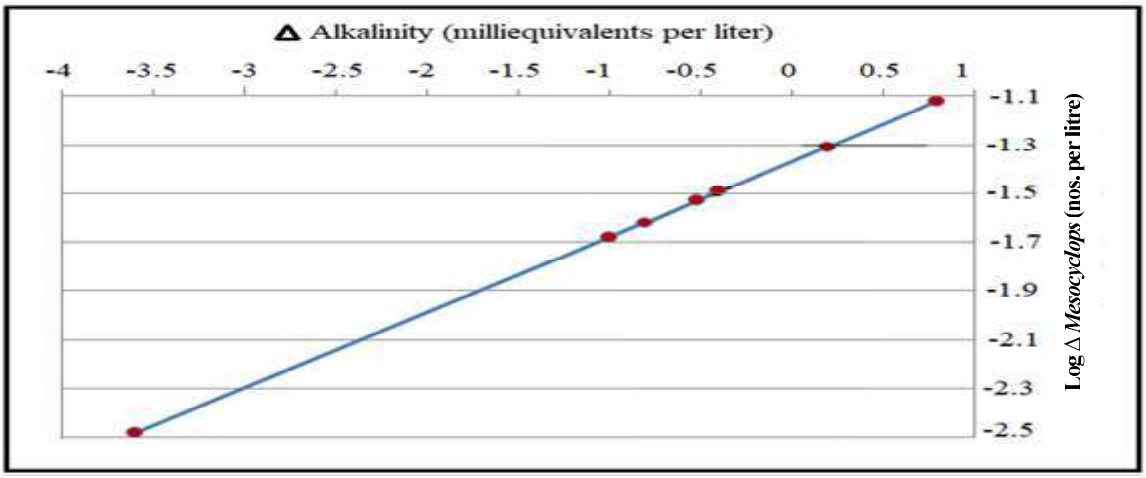

Fig 9: Correlation between *Mesocyclops* and alkalinity

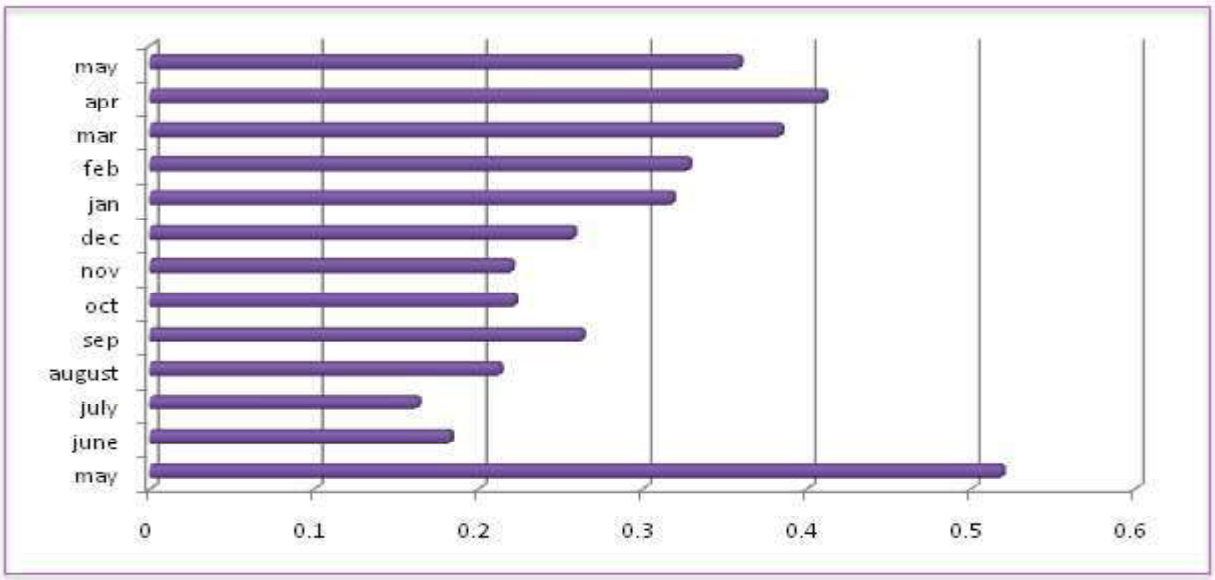

Fig 10: Graph showing the area of the fundamental niche in various months. The area is created by the parametric values of temperature, amount of chlorophyll and alkalinity.

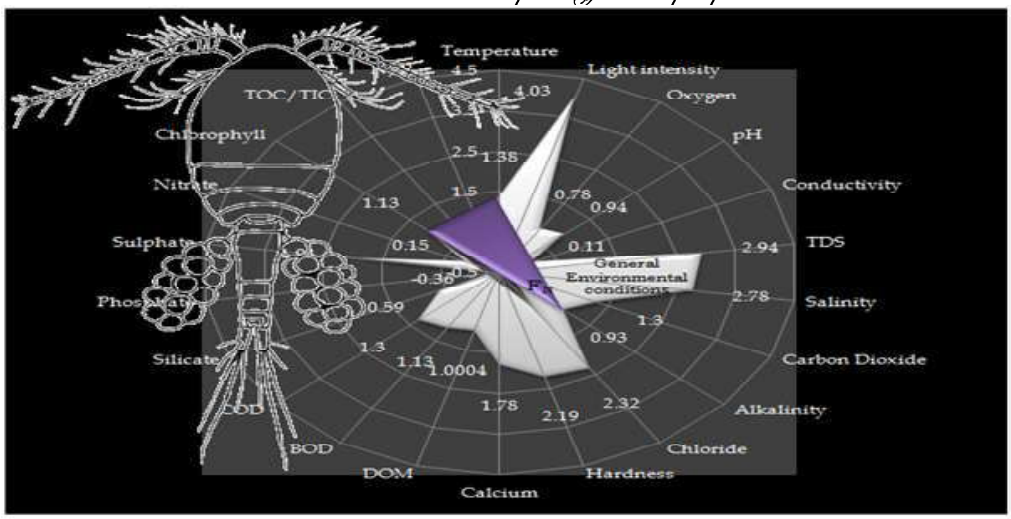

Fig 11: Graph showing the area of the fundamental niche in various months. The area is created by the parametric values of temperature, amount of chlorophyll and alkalinity.

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