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# Annual Population Dynamics of Copepods and its Correlation with Water Parameters in Fish Ponds of Ludhiana District, Punjab

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## Abstract

Zooplankton are the important part of aquatic food chain and the nutritious food for fish. Some zooplankton like cyclopoid copepods are the voracious predators of earlier instar mosquito larvae. In present study, copepod density as well as physico-chemical parameters like temperature, transparency, pH, electrical conductivity, total dissolved solids, dissolved oxygen, alkalinity and total hardness were recorded from selected three fish ponds of Ludhiana district of Punjab (India) from January-December 2014. Results showed the maximum copepod density (copepods $L^{-1}$) during March at GADVASU (2740.68 $L^{-1}$) and during April at Pandori (1231.60 $L^{-1}$) and Galib Kalan (2779.63 $L^{-1}$) fish ponds. From the collected zooplankton pool, annual count showed high population of mature copepods in comparison to immature one (including nauplii and copepodids) and from the mature population, cyclopoids were the predominant (60 to 79.33%) type of copepods found in the selected fish ponds. A significant negative correlation ($r = -.603$ at $p<0.05$) was observed between the copepod population and temperature at GADVASU fish pond and other two fish ponds, this relation was statistically non-significant. While rest of the studied water parameters showed statistically non-significant correlation with copepod population. The temperature favourable for high population of copepods was found to range from 20-27°C.

Key words : Cyclopoids, physico-chemical parameters, predators, temperature, zooplankton, pH

## INTRODUCTION

Zooplankton play a vital role as primary consumer of aquatic food chain which in turn influence the productivity of fresh water ecosystem. They occupy an intermediate position in the food web and mediate the transfer of energy from lower to higher trophic levels [1]. Being heterotrophic in nature, they play a key role in cycling of organic materials in an aquatic ecosystem [2]. Rotifers, cladocerans, copepods and ostracods constitute the major groups of zooplankton. Zooplankton communities are typically diverse and due to short life cycle, they are highly sensitive to environmental variation [3]. The quality of water in terms of physico-chemical and biological characteristics in the reservoir offers the most favourable conditions for the existence of zooplankton as well as other biota which constitute essential components of the food chain [4]. As a major element in aquatic biota, the zooplankton community often exhibits dramatic changes in response to the physico-chemical properties of the aquatic environment. They are susceptible to the variations in a wide number of aquatic parameters like temperature, pH, dissolved oxygen, total alkalinity and free $CO_2$ and water depth [5].

Copepods are dominant members of zooplankton community in freshwater and brackishwater. Main suborders of copepods found in freshwater are calanoids, harpacticoids and cyclopoids. Some authors [6] have reported large population of copepods in commercial fish ponds in comparison to other standing water bodies. Copepods have a complex life cycle with six naupliar, five copepodid stages and then adult [7]. As a consequence, ontogenetic development encompasses a large range of body sizes and concomitant changes in diet and predator vulnerability [8]. They are natural feeders of mosquito larvae and larvae juveniles of many finfish and crustaceans. It is generally believed that copepods can meet the nutritional requirement of fish larvae [9]. Beside their importance as fish food, the specific type of copepods i.e. cyclopoids are also good predators of mosquito larvae which are responsible to spread different deadliest diseases like malaria, dengue and chickungunia [10]. The aim was to study the seasonal variation of copepod population and to determine the effect of physico-chemical factors on their population under the local environmental conditions of the fish ponds of Ludhiana district, Punjab (India).

## MATERIALS AND METHODS

Three fish ponds selected to conduct the present study were; fish pond at Guru Angad Dev Veterinary and Animal Sciences University (GADVASU), Ludhiana, at village Pandori (24.1 km away from Ludhiana city) and village Galib Kalan (51.0 km away from Ludhiana city). All ponds were clear and properly maintained for the commercial production of fish. The regular monitoring of copepods in fish ponds was carried out at monthly intervals from January to December 2014. Water samples were collected during morning hours between 8 to 10 am. Zooplankton net having mesh size 60 µm was used for collections of copepods from fish ponds. Water was sieved at 5 sites /fish pond (approx.50L i.e 10L/site) through zooplankton net. Filtered zooplankton were fixed and preserved in 5ml of 5% formalin. For counting copepod population, sample was concentrate upto 30 ml by keeping it over night. Copepods were identified upto order level with identification keys given by different authors [11, 12]. Their number was counted manually with Sedgewick Rafter Counting cell [13] under binocular light microscope by taking 1 ml of concentrated sample in three replicates. Then calculation was done by the following formula:

$$\text{Number of Copepods/ml} = \frac{C \times 1000}{A \times D \times F}$$

Where, C = Number of organisms counted in 'n' field view, A= Area of field (1.369 $mm^2$), D = Depth (1 mm), F = Number of fields observed

$$\text{Number of Copepods /L} = \frac{M \times v}{V}$$

Where, M = Number of Copepods/ ml, v= Vol. of concentrated sample, V= Volume of filtered water

Water temperature and secchi disk transparency (SDT) were recorded at the spot using centigrade thermometer and sechhi disk respectively. Other physico-chemical parameters like electrical conductivity (EC), total dissolved solids (TDS), pH, dissolved oxygen (DO), alkalinity and total hardness (TH) were analysed with ELICO water analyzer from the water samples collected separately from all the selected fish ponds. To establish correlation between copepod population and physico-chemical parameters, data was analyzed by using correlation coefficient. SPSS statistical software version 16 was employed.

## RESULTS

Total population count of copepods recorded at monthly intervals throughout the year from three fish ponds at Ludhiana showed their low count in the January month, followed by a rise in February to March or April. The copepod density (copepods $L^{-1}$) reached its maximum level (2740.68 $L^{-1}$) during March at GADVASU fish pond and during April at Pandori (1231.60 $L^{-1}$) and Galib Kalan (2779.63 $L^{-1}$) fish ponds (Fig. 1). Data analysis showed that total annual population count was found to have more number of mature copepods (64.60 to 75.50%) as compared to that of immature one (including nauplii and copepodids ) at all the fish ponds (Fig. 2). The mature copepods identified on their morphological features were found to belong to two orders viz. calanoida and cyclopoida. Cyclopoids showed their prevalence

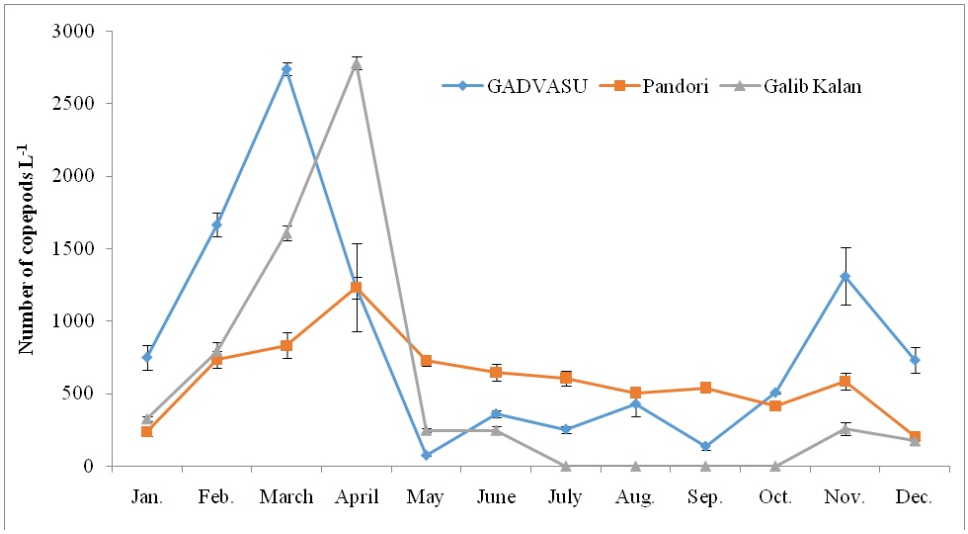
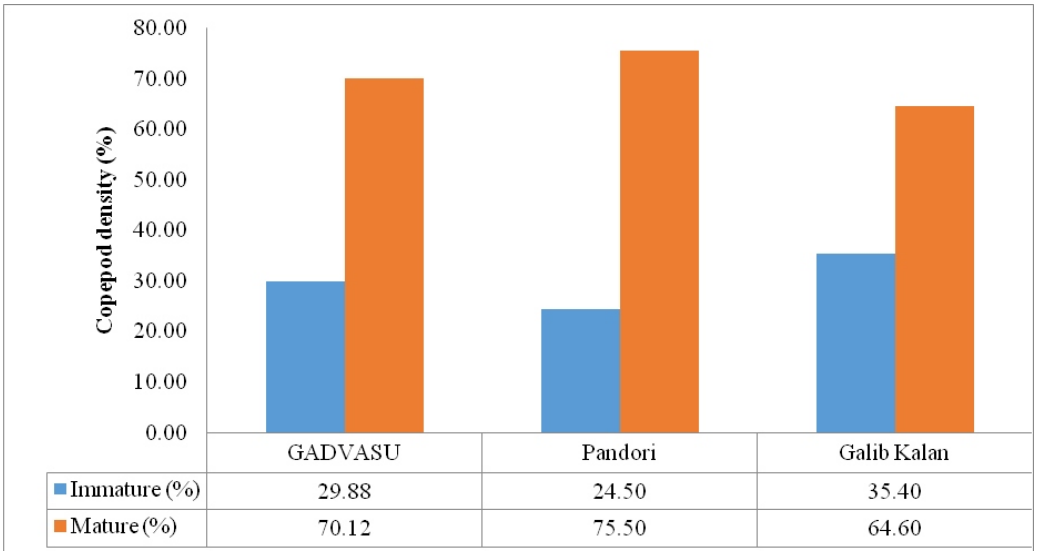



**Fig. 1 :** Annual population dynamics of copepod density at selected fish ponds of Ludhiana district




| | GADVASU | Pandori | Galib Kalan |
|---|---|---|---|
| Immature (%) | 29.88 | 24.50 | 35.40 |
| Mature (%) | 70.12 | 75.50 | 64.60 |

**Fig. 2 :** Annual population density of mature and immature copepods at selected ponds of Ludhiana district

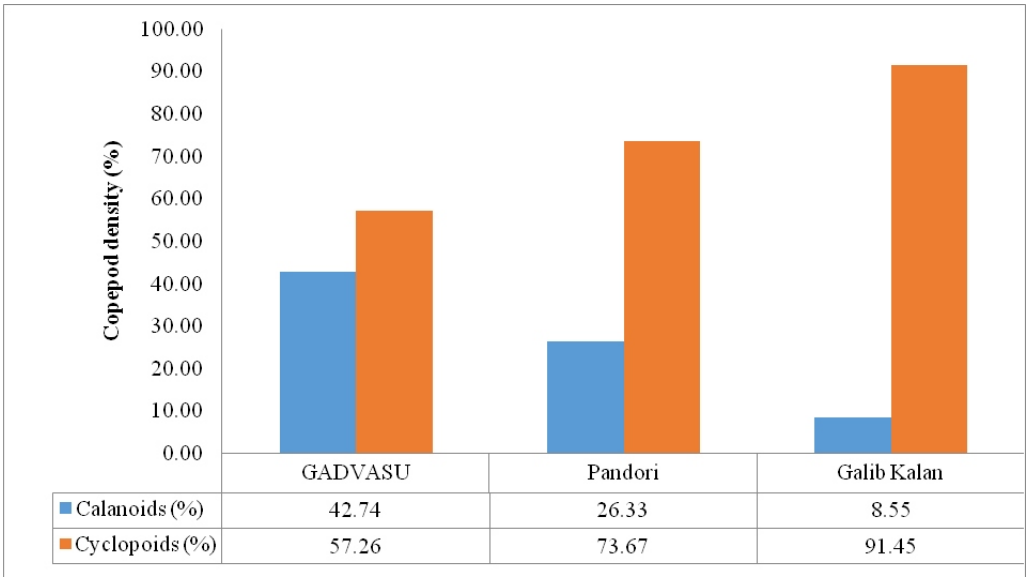



**Fig. 3 :** Annual copepod density (%) of calanoid and cyclopoid copepods at selected fish ponds of Ludhiana district

**Table 1:** Correlation of various physico-chemical parameters of water with copepod population at selected fish ponds of Ludhiana district.

| Water parameters | Correlation coefficient (r) | | |
|---|---|---|---|
| | GADVASU | Pandori | Galib Kalan |
| Temperature | -.637* | .575 | -.184 |
| Transparency | .068 | .177 | .094 |
| pH | -.258 | -.010 | -.079 |
| Electrical Conductivity | .241 | .175 | .397 |
| Total Dissolved Solids | -.088 | .133 | .366 |
| Dissolved Oxygen | .124 | -.528 | -.327 |
| Alkalinity | .010 | .130 | .444 |
| Total hardness | -.055 | .296 | .417 |

*Correlation is significant at the 0.05 level (2-tailed)

with variation in their density ranging from 57.26 to 91.45 %, whereas calanoids were found to be lesser in number at all sites (ranging from 8.55 to 42.74 %) as shown in figure 3. Some selected physico-chemical parameters of water at three fish ponds were studied and then correlated with copepods as shown in table 1. Water temperature was found to range from 15 to 35°C at all three sites throughout the year. In GADVASU and Galib Kalan fish ponds, a negative correlation (r = -0.637 and -0.184 respectively) of temperature with copepod population was found, which was significant at 0.05 level at GADVASU. Whereas in Pandori fish pond temperature showed non-significant positive correlation with copepod count (r =.575) as shown in table 1. In the present study, transparency was found to be positively correlated with copepod count at selected fish ponds with value of r =.068 at GADVASU, r =0 .177 at Pandori and .094 at Galib Kalan (Table 1). pH ranged from 7.42 - 9.20 at GADVASU fish pond, 7.20 - 9.20 at Pandori fish pond and 7.43-9.20 at Galib Kalan fish pond. In all fish ponds, correlation of pH with copepod population was negatively correlated, with correlation coefficient r = - 0.258 at GADVASU, r= - 0.079 at Pandori and r = - 0.010 at Galib Kalan fish ponds. Electrical conductivity was positively correlated with copepod density with value r = 0.241 at GADVASU, r =0.175 at Pandori and r = 0.397 at Galib Kalan fish ponds as shown in table 1. Total dissolved solids showed positive correlation at Pandori (r =0.133) and Galib Kalan (r =.366), where as negative correlation at GADVASU fish ponds (r =-0.088) (Table I). Dissolved oxygen was negatively correlated with copepod count at Pandori (r =-0.528) and Galib Kalan (r =-0.327), and positively at GADVASU (r =0.124). Alkalinity was non significantly positively correlated with copepod count at all fish ponds with values of r=0.010 at GADVASU, r =0.130 at Pandori and r =0.444 at Galib Kalan fish ponds. Total hardness was found to be negatively correlated with copepod population at GADVASU (r = -0.055) and positvely correlated at Pandori (r = 0.296) and Galib Kalan (r =0.417) fish ponds (Table 1).

## DISCUSSION

In the present study, copepod count showed highest peak in the months of March and April at all selected fish ponds, however in the month of November another small peak in the copepod population was observed followed by a decline in December (Fig. 1). Some authors [14] found two peaks of zooplankton one in August and another in February and others [15] reported that the zooplankton showed two peaks, one in May and another in October in Halti beel. Population density of copepods in a particular aquatic body depends on a number of physico-chemical factors. During this study the analysis of various factors like water temperature, secchi disk transparency, pH, electrical conductivity, total dissolved solids, dissolved oxygen, alkalinity and total hardness was carried out from selected fish ponds at monthly intervals throughout the year which showed their non-significant correlation with the copepods count, except water temperature (Table 1). Temperature is one of the essential and changeable environmental factor, since it influences the growth and distribution of flora and fauna. Copepods are very sensitive towards change in temperature and the results of present study indicated that their optimum/moderate count was recorded when the water temperature was found to range from 20-27°C at all the three fish ponds (20-27°C at GADVASU, 23-26 °C at Pandori and 22-27°C at Galib Kalan). It means that the optimum suitable range of temperature for copepod production lies between 20-27°C and this temperature is generally found during the months of March and April. Water temperature ranging between 13.5-32°C is reported suitable for development of the plankton organisms. Similar observations for zooplankton were made by different scientists [16,17, 18]. Therefore, copepod production density was reported to be low during the winter months having very low temperature (Jan. and Dec.) and also low during the summer months having very high temperature (May to October). The temperature during February was 19°C, which is also favorable for the production of copepods, but their number was found to be low during this time, it may be due to the fact that copepods try to adapt a change from very low temperature in January month to moderate temperature during the month of February. Another twisting point in temperature is in the month of November (19-20°C), which is also favourable for copepod production, but it also showed less copepod count because of very high temperature during its proceeding month (October) and very low temperature during the proceeding month (December). This may be the reason for the appearance of small peak in population count during the month of November at all the fish ponds (Fig. 1). In literature the available reports are mostly targeted on the population dynamics of zooplankton (rarely on copepods) and their seasonal abundance. Researchers have reported a general trend of high zooplankton growth during summer and less during winter season [19, 20, 21]. Only available report showing the differential data of zooplankton and copepod population, indicates variable trend in population dynamics of zooplankton and copepods, as the number of zooplankton was found low in rainy season (July-October) and high in winter (November-February) followed by summer (March -April), whereas copepods were reported highest in the summer season and lowest in winter season [4], which also supported our results of present study. Other water parameter i.e water pH was found to be alkaline in nature throughout the year at all sites and according to some authors [22, 23] the pH range between 6.0 and 8.5 indicates medium productive nature, more than 8.5 highly productive and less than 6.0 low productive nature of a reservoir.

Besides water parameters, other factors like food availability, dormancy and predation heavily influence the mating behavior and variations in population dynamics of copepods [24, 25]. In the present study, all the three selected ponds were being used for commercial fish production. Therefore, the organic fertilizers like cow dung, poultry manure and inorganic fertilizers were used regularly in these ponds to increase the production of phytoplankton and zooplankton. Ponds treated with a combination of inorganic and organic fertilizers gave a moderate production of both phytoplankton and zooplankton [26]. Bhanot *et al.* [27] have reported that organic fertilizers, especially poultry manure treated ponds, gave a high production of zooplankton, since it contains more N and P, which play a vital role for plankton production [28]. In Galib Kalan pond, fertilizers were not added after the month of June, which may be one of the factors for the decline of copepod population in this pond. In fish ponds, fish number and their predatory activity may also be responsible for the reduction in zooplankton count, because zooplankton especially copepods serve as major food for the fish than other zooplankton and animal larvae [17]. To avoid predation copepods may undergo diapause phase [25]. Some copepod species show variation in diapausing period, even in nearby located water bodies [29]. Variation found in the population density of copepods in the present study at selected three fish ponds, thus may be due to the effect of many factors as discussed above.

From total copepod count, mature copepods predominate over immature one throughout the year at all the three fish ponds. This may be due to the fact that immature copepods (nauplii and copepodids) take very less time to achieve maturity and mature one stay for a long period in the aquatic habitat [30]. Two orders viz. calanoida and cyclopoida were identified from collected water samples, in which cyclopoids predominate. Kocher *et al.* [6] have also observed the predominance of cyclopoids (55%), over calanoids (43%) and harpacticoids (1%) in the water samples collected from fish ponds of three districts of Punjab. Occurrence and predominance of cyclopoids among copepods in the fish ponds of Ludhiana, Punjab (India) highlights the significance of this study, as the cyclopoids are known to act as potential predators of mosquito larvae. Literature reveals that large sized cyclopoids are voracious feeders of mosquito larvae [7, 31, 32] thus can be utilized for the eco-friendly control of mosquitoes and mosquito born diseases.

## CONCLUSION

Water samples collected annually at monthly intervals from fish ponds of Ludhiana district, Punjab showed highest copepod population count during March and April months with more number of mature copepods in comparison to the immature ones. The present study indicated correlation of copepod density with temperature and favorable limit was found to lie between 20-27°C, while rest of the tested water parameters showed no significant effect on their population.

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## REFERENCES

1. Ahmad U, Parveen S, Khan AA, Kabir HA, Mola HRA, Ganai AH. Zooplankton population in relation to physico-

chemical factors of a sewage fed pond of Aligarh (UP), India. *Biol. Med.* 2011:*3:336-341*.

2. Gupta MC, Sharma LL. *Trophic status and zooplankton of Amarchand reserviour, Udaipur, Rajasthan.* 2007.C.P. 02: NSL.

3. Sharma MS, Sharma V, Malara H. *Biodiversity of zooplankton in relation to different types of aquatic pollution.* 2007. C.P. 46. NSL.

4. Bera A, Dutta TK, Patra BC, Sar UK, Korai AL. Correlation study on zooplankton availability and physico-chemical parameters of Kangsabati Reservoir, West Bengal, India. *Int. Res. J Environ. Sci.* 2014:3:2832.

5. Jhingran VG. Fish and Fisheries of India. Delhi: Hindustan Publishing Corporation. 1985.p. 727.

6. Kocher DK, Jamwal S, Kansal M, Bakshi DK. Coexistence of copepods and mosquito larvae in different standing water bodies of Punjab, India. Scholars Acad. J. Biosci. 2014: 2:640-642.

7. Marten GG, Nguyen M, Mason BJ, Ngo G. Natural control of *Culex quinquefasciatus* larvae in residential ditches by the copepod *Macrocyclops albidus*. J. Vector Ecol. 2000: 25:7-15.

8. Santer B. Influences of food type and concentration on the development of *Eudiaptomus gracilis* and implications for interactions between calanoid and cyclopoid copepods. Archiv fur Hydrobiologie 1994:131:141159.

9. Evjemo JO, Reitan KI, Olsen Y. Copepods as live food organisms in the larval rearing of halibut larvae (*Hippoglossus hippoglossus* L.) with special emphasis on the nutritional value. Aquaculture 2003:227:191-210.

10. Marten GG. Dengue hemorrhagic fever, mosquitoes and copepods. Policy Stud. J. 2000: 9:131-142.

11. Battish SK. Freshwater Zooplankton of India. Oxford and IBH Publishing limited, New Delhi. 1992. p. 174-193.

12. Witty LM. Practical Guide to Identifying Freshwater Crustacean Zooplankton. 2nd ed. Cooperative Freshwater Ecology Unit. 2004. p. 25 -32.

13. Welch PS. Limnological Methods. Mc Graw-Hill Book Company. INC., New York, 1948. p. 381.

14. Patra RWR, Azadi MA. Ecological studies on the planktonic organisms of the Halda River. *Bangladesh J. Zool.* 1987:15:109-123.

15. Razzaque A, Hossain MS, Islam AKMS, Hossain MMM, Ehshan MA. Study on plankton population of Halti beel at Natore, Bangladesh. *Bangladesh J Aquacult.* 1995:17:19-23.

16. Bhuiyan JR, Gupta AA. comparative hydrobiological study of few ponds of Barak valley, Assam and their role as sustainable water resources. J. Environ. Biol. 2007:28: 799-802.

17. Park KS, Shin HW. Studies on phyto-and-zooplankton composition and its relation to fish productivity in a west coast fish pond ecosystem. J. Environ. Biol. 2007: 28:415-422.

18. Rajagopal T, Thangamani A, Sevarkodiyone SP, Sekar M, Archunan G. Zooplankton diversity and physico-chemical conditions in three perennial ponds of Virudhunagar district, Tamilnadu. *J Environ. Biol.* 2010:31:265272.

19. Trivedi RK, Gurung V, Das BK, Rout SK. Variations of plankton population of two hill streams of the Darjeeling District, West Bengal. Environ. Ecol. 2003:21: 50-53.

20. Krishnamoorthi A, Selvakumar S. Seasonal fluctuation of Zooplankton Community in relation to certain physico-chemical parameters of Veeranam Lake in Cuddalore District, Tamil Nadu. Int. J. Res. Environ. Sci. Tech. 2012:2: 22-26.

21. Bashar MR, Basak SS, Uddin KB, Islam AKMS, Mahmud Y. Seasonal variation of zooplankton population with reference to water quality of Kaptai Lake, *Bangladesh.* Bangladesh Res. Pub. J. 2015:11:127-133.

22. Kurbatova SA. Response of microcosm zooplankton to acitification. Biol. Bull., 2005:1:100-108.

23. Tanner CC, Craggs RJ, Sukias JP, Park JB. Comparison of maturation ponds and constructed wetlands as the find stage of an advanced pond system. *Water* Sci. Technol. 2005: 51: 307-334.

24. Varpe O, Christian J, Geraint T, Oyvind F. Early is better seasonal egg fitness and timing of reproduction in a zooplankton life- history model. Oikos. 2007:116:1331-1342.

25. Reid JW, Williamson CE. Copepoda. *In* Thorp, J. and Covich, A. (eds.) Ecology and Classification of North American Freshwater Invertebrates. Elsevier, New York. 2010. p. 829899.

26. Chakraborti NM. Effect of organic manure and inorganic fertilizers on productivity of a brackish water fish pond. Environ. Ecol. 1984:2(4): 271-277.

27. Bhanot K, Bashaer VS, Bhatacharaya M, Ayyappan S, Panil KS. Composted domestic refuse as manure in carp ponds. National symposium on New Horizon in fresh water Aquaculture, 23-25. Proceedings. 1991.p.163-165.

28. Dhawan A. Changes in the tissue composition and reproductive cycle in relation to feeding in major carp, *Chirrhina mrigal* (Ham.). Ph.D. thesis, PAU. Ludhiana, India, 1986.

29. Elgmork K. Variation in torpidity of diapause in freshwater cyclopoid copepods. *Hydrobiologia*. 1996:320: 63-70.

30. Marten GG, Reid JW. Cyclopod copepods. J. Am. Mosq. Control Assos. 2007:23:65-92.

31. Kumar R, Rao TR. Predation on mosquito larvae by *Mesocyclops thermocyclopoides* (Copepoda: Cyclopoda) in the presence of alternate prey. Int. Rev. Hydrobiol. 2003:88: 570-581.

32. Mittal PK, Dhiman RC, Adak T, Sharma VP. Laboratory evaluation of the biocontrol potential of *Mesocyclops thermocyclopoides* (Copepoda: Cyclopoida) against mosquito larvae. *Southeast Asian* J. Trop. Med. *Public Health.* 1997: 28:857-861.