PART I (4)

MASS CULTURE OF
ROTIFER, COPEPODS AND CLADOCERAN
Mass culture and production of the zooplankton to provide live food is indispensable for many crustacean and fish larvae. A perusal of the literature on aquaculture reveals a growing concern on the urgent need for research on live food organisms suitable for mass culture (Iveleva, 1969; Kinne, 1970; Omari, 1973). Great strides have been made in recent years on the mass production of *Artemia* which serves as an ideal prepacked larval food (Kinne, 1977; Sorgeloos, 1981). Besides, other important zooplankters such as rotifers, copepods and cladocerans are also used for shellfish and finfish larvae (Alikunhi *et al.*, 1955; Theilacker and McMaster, 1971; James and Al-Khars, 1984; James and Thirunavukkarasu, 1986). Among rotifers the most widely cultivated species is the *B. plicatilis*, which acts as an excellent food source for the predatory species. The mass culture of *B. plicatilis* was carried out using various feeds which included live, inert and mixed diets (Farukawa and Hidaka, 1973; Hirayama and Nakamura, 1976; Hirata, 1979; Gatescupe and Luquet, 1981; James *et al.*, 1983; Al-Khars *et al.*, 1986).
Copepods are universally accepted food by crustaceans and fishes. Hence mass culture of these organisms assumes an added importance in the intensive aquaculture practices involving rearing of larval stages of crustaceans and fishes. Several workers have attempted to culture different species of copepods on a large scale. However, the technology for the mass culture and production of copepods for aquaculture has not yet been fully established on a global basis.

Earlier works of Jacobs (1961), Mullin and Brooks (1967) and Kahan (1979) reveal only small scale experimental cultures of copepods. Zillioux (1969) was the first to describe a continuous culture system for planktonic copepods using synthetic seawater in 100 litre capacity tanks. The harpacticoid copepods, *Tigriopus japonicus*, *Niteora spinipes*, *Leophaete setosa*, *Euterpina acutifrons*, *Tisbe holothuriae* were cultured on mass scale by several workers (Nassogne, 1970; Kitajima, 1973; Abraham and Gopalan, 1975; Gopalan, 1977; Goswami, 1977; Kahan, 1981).

Several freshwater species of zooplankters such as *Chirocephalus* and cladocerans were also tried as larval feed. Among these species of *Daphnia* and *Moina* received considerable attention as feed for shellfish and finfish larvae. The experimental mass culture of freshwater zooplankton was carried out earlier using different feeds (Conklin and Provasoli, 1977; Nandy et al., 1977; Ventura and Enderez, 1980; DePauw et al., 1981).
The present experiment was carried out to develop the mass culture of zooplankters viz., rotifer (*B. plicatilis*), harpacticoid copepod (*N. orientalis*), calanoid copepod (*P. annandalei*), cyclopoid copepod (*Oithona sp.*) and cladoceran (*C. cornuta*) under laboratory conditions.

RESULTS

Results indicated that all the zooplankters showed a steady increase in population density with their preferable feeds. The rotifers multiplied rapidly attaining a maximum density of 403 individuals ml$^{-1}$ in 7 days (Fig. 16). The number of rotifers started increasing from the 1st day (43 individuals ml$^{-1}$) to 3rd day (227 individuals ml$^{-1}$). A little fluctuation was found between 4th and 6th days, whereas on the 7th day, the number attained its peak.

Figure 17, shows that all the three species of copepods attained maximum density on the 40th day. The population density of harpacticoid copepod increased from 226 to 3,957 individuals litre$^{-1}$, between 5th and 20th day, but only on 25th day the population decreased (2,758 individuals litre$^{-1}$) and then onwards a remarkable progress was seen till 40th day, attaining 8,326 individuals litre$^{-1}$ and subsequently the culture showed decreasing trend. Whereas in the case
of calanoid copepod the population fluctuated between 10th (538 individuals litre\(^{-1}\)) and 15th day (462 individuals litre\(^{-1}\)) and again the population increased till 25th day (4,382 individuals litre\(^{-1}\)) and decreased to 3,090 individuals litre\(^{-1}\) on the 30th day. The population density then onwards reached its maximum of 7,238 individuals litre\(^{-1}\) till the 40th day. On the 45th day, the population showed a decreasing trend.

In the case of cyclopoid copepod, the population density fluctuated throughout the study period, but maximum peak of 4,526 individuals litre\(^{-1}\) was obtained on the 40th day and later on, the population showed the decreasing trend. The multiplication rate of cladocerans, increased steadily and attained peak density of 13,100 individuals litre\(^{-1}\) on the 8th day (Fig. 18).

**DISCUSSION**

The rotifers attained maximum population with a mean of 422 individuals ml\(^{-1}\) using algae, *G. trochioides* as feed which is considerably lower than that was found by Hirata (1979) who obtained 530 individuals of rotifer ml\(^{-1}\) using *Chlorella* as feed. Hirayama and Nakamura (1976) have also obtained higher rotifer density of 434 individuals ml\(^{-1}\).
using the same algal species as feed. However, in the present experiment the yield obtained was higher than that of Gatesoupe and Robin (1981) who obtained 210 individuals ml\(^{-1}\) using commercial single cell proteins such as *Spirulina*, *Chlorella* and methanol grown yeast for feeding rotifers. Using marine yeast, James *et al.* (1983) have reported a maximum density of about 500 rotifers ml\(^{-1}\) which is higher than that of the present results. Furukawa and Hidaka (1973) reported a population density of <1000 rotifers ml\(^{-1}\) using marine yeast. The corresponding population density of >1000 rotifers ml\(^{-1}\) observed in this investigation could be due to the frequent harvest made during the observation period.

Hirayama and Watanabe (1973) have found that the marine yeast as a single diet for *B. plicatilis* has resulted in substantially lower reproductive rates than on a diet of *Chlorella* alone. It is generally known that mixed diets of algae and yeast produced greater population densities. James *et al.* (1987) reported that the *Chlorella* with a combination of marine yeast, yielded maximum of 671 rotifers ml\(^{-1}\).

In the present investigation, among the copepods, the harpacticoid copepod, *N. orientalis* attained maximum density. Calanoid copepod, *P. annandalei* gave multiplication rate
little lesser than that of harpacticoid copepod, while
cyclopoid copepod, Oithona sp. recorded still lesser rate
of multiplication. All the three species of copepods have
reached maximum population density on the 40th day. Goswami,
(1977) reported that harpacticoid copepod, Iophonaws setosa
attained a maximum density of 11,250 individuals litre$^{-1}$
in 45 days using detritus as sole feed. Similarly Gopalain
(1977) while studying experimental mass culture of
harpacticoid copepod, N.spinipes stated that the copepods
fed with Chlorella sp. gained maximum density of 9,750
individuals litre$^{-1}$ on 35 day, but as the culture days
increased to 56 days, the copepods fed with shrimp head
meal attained maximum of 11,100 individuals litre$^{-1}$. By
using vegetables such as carrot and lettuce, Tisba holothuriae
attained a population of 300 individuals ml$^{-1}$ (Kahan, 1981).
However, James and Thompson (1986) have observed that mean
daily production of calanoid copepod, P.anrandalei varied
between 68,513 and 2,00,000 litre$^{-1}$. Generally the
multiplication rates of cyclopoid copepod is lesser
than that of the calanoid and harpacticoid copepods.
James and Al-Khars (1984) while reporting the mass culture of
cyclopoid copepod, Apocyclus borneensis using Chlorella
as feed recorded a maximum density of 4,400 individuals
litre$^{-1}$ on 46th day. In the present instance also the
population density of cyclopoid copepod, Oithona sp. attained
the peak (4,526 individuals litre$^{-1}$) on the 40th day, whereas
the density dwindled on the 45th day (3,629 individuals litre$^{-1}$).

It was observed that the cladoceran, *C. cornuta* which fed voraciously on baker's yeast had a steady raise in population attaining maximum (13,100 individuals litre$^{-1}$) on 8th day. Nandy et al. (1977) experimenting on mass culture of cladoceran, *Daphnia lumholtsi* under three different feed conditions, suggested that the cladoceran fed with brewer's yeast attained a maximum population density of 12,650 to 15,000 individuals litre$^{-1}$, whereas less production was seen when feeding on *Chlorella vulgaris* and a mixed diet of *Chlorella* and poultry manure. By using chicken manure, Ventura and Snderes (1980) have developed cladoceran, *Moina* sp. culture upto a density of 500 - 1000 individuals litre$^{-1}$.

It can be summarised that all the zooplankters under review except cladoceran, *C. cornuta* have shown fluctuation in population density within the culture periods due to the frequent harvests made during the observation period.
Fig 16 Mass culture of *B. plicatilis*
Fig 17 Mass culture of copepods (N. orientalis, P. annandalei, Oithona sp.)
Fig 18 Mass culture of *C. cornuta*

**Graph:**
- **Y-axis:** C. cornuta number per 20ml
- **X-axis:** Culture days
- Points indicating growth over 8 days from 0 to 280 C. cornuta per 20ml.