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Effect of Different Live Feed on Growth and Survival of Striped Murrel ***Channa striatus*** larvae

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Özet***: Farklı canlı yemlerin Çizgili Yılanbaş (***Channa striatus***) larvalarında büyüme ve yaşam oranı üzerine etkisi.*** Çizgili yılanbaş (*Channa striatus*)'ın Hindistan'da yüksek pazar değeri ve talebi bulunan akuakültüre uygun bir tatlısu balık türüdür. Ancak üretiminin artırılması için larval büyütme tekniklerinin geliştirilmesi gereklidir. Bu türe ait larvalar büyüme ve yaşam oranlarının ölçülmesi için plankton, chironomus larvası ve sivrisinek larvası gibi farklı besinler ile 28 gün boyunca beslendikleri bir deney gerçekleştirilmiştir. Deney süresince, adı geçen besinler balık larvalarına iki günde bir verilmiştir ve balıkların kendilerine sunulan tüm besin gruplarını kabul ettikleri gözlenmiştir. Çalışmada sivrisinek larvası ile beslenen grubun önemli ölçüde yüksek bir değerde (%96.66) yaşam oranına sahip olduğu, bunu chironomus larvası (%90) ve plankton (%86.66) ile beslenen grupların izlediği kaydedilmiştir. Spesifik gelişim oranıda (SGR) sivrisinek larvası ile beslenen grupta diğerlerine nazaran önemli derecede yüksek (%4.906) bulunmuş, bunu chironomus (%4.44) grubunun izlediği ve en düşük SGR değerine de (%3.621) plankton ile beslenen grupta rastlanmıştır. Benzer bir şekilde en yüksek yüzde ağırlık kazanımı (%2327) sivrisinek larvası ile beslenen, en düşük performans ise plankton ile beslenen grupta gözlenmiştir. C. striatus larvalarının beslenmesinde test edilen tüm canlı yem grupları arasında sivrisinek larvalarının en iyi gelişim değerlerini ortaya koyduğu ve bunu chironomus ve planktonun izlediği bulunmuştur. Bu çalışma *C. striatus*'un erken larvasının yapay koşullarda yüksek gelişim ve yaşama oranına sahip şekilde büyütülebildiğini göstermiştir. Bununla birlikte, larval besleme teknikleri bu türün ticari olarak üretilmesi için daha geliştirilmelidir.

Anahtar Kelimeler: *Channa striatus*, canlı yem, büyüme ve yaşam oranı, larval besleme.

Abstract: The striped murrel, *Channa striatus* is one among the highly priced, demanded and good cultivar freshwater fish species in India for which the development of larval rearing techniques are needed for large scale culture. An experiment was conducted to evaluate the growth and survival of larvae of this species fed with different live feed viz; plankton, chironomus larvae and mosquito larvae for 28 days. During the experimental period the fish were fed to satiation twice a day. In the present study, the fish accepted all types of feeds offered. The study revealed that significantly higher survival rate (96.66 %) was recorded in mosquito larvae fed groups followed by chironomus larvae (90 %) and plankton (86.66) respectively. Significantly the specific growth rate (SGR) was higher in larvae fed on live mosquito (4.906 %) followed by chironomus (4.44%) whereas minimum SGR (3.621%) was observed in plankton fed groups. Similarly highest percentage weight gain (2327 %) was also observed in mosquito larvae fed groups and least performance recorded in plankton fed groups. Among all the live feed tested for larvae of *C. striatus* mosquito larvae was found to produce the best growth results followed by chironomus and plankton. The present study showed that early larvae of *C. striatus* could be reared in captive conditions for attaining higher growth and survival. However the larval rearing techniques have to be improved further for commercial farming of this species.

Key Words: *Channa striatus*, live feed, growth and survival, larval rearing.

Introduction

The striped murrel, *Channa striatus*, is a native freshwater fish of tropical Africa and Asia (Ng and Lim 1990). Murrels are commercially cultured in Thailand, Philippines, Vietnam, and Cambodia (Wee 1982). It is one among the highly-prized freshwater, air-breathing fishes and hence have a good culture potential. The fish is well known for its taste, high nutritive value, recuperative and medicinal qualities (Khanna 1978). It has fine white flesh without any intra-muscular bones and is believed to contain recuperative and strength-giving substances, and is therefore especially given to elderly people and those in convalescences (Ling, 1977). Yaakob and Ali (1992) also noted the importance of snakehead for hastening the healing of wounds and internal injuries due to the presence of certain fatty acids such as *prostaglandin* and *thromboxin*. Hence, this species is gaining prominence as a cultured freshwater fish for medicinal purposes in the Asian market. As they are hardy and capable of breathing the atmosphere air by their accessory respiratory organs, they are suitable for profitable culture in oxygen depleted water bodies such as swamps, marshes, oxidation ponds etc., where normal fish species may fail to survive. The candidate species can survive in harsh environments with low dissolved oxygen and high ammonia (Ng and Lim, 1990; Qin *et al*., 1997) and therefore are often cultured in grow out ponds at densities of 40 – 80 fish/m^2 with annual yields ranging from 7 – 156 tonnes ha^{-1} (Wee, 1982). Although, it is very popular and highly

demanded fish in India but the production of the larvae of this fish in hatcheries is a major problem at present. In India, the culture of this species is still not common due to the lack of larvae supply and knowledge of their feeding and breeding techniques. Further, the rearing of hatchlings, post larvae and fry of *C.striatus* is a complicated process unlike the raising of carp fry, which has been standardized to some extent.

Considerable literature exists for murrel on their bionomics (Alikunhi, 1957; Mookerjee, 1946; 1948) and reproductive strategy (Parameshwaran and Murugesan, 1976), breeding (Marimuthu *et al.,* 2001a) spawning behaviour (Marimuthu *et al.,* 2001b) but little is known about their food preferences and needs of their early life. Recently, the successful induced spawning and seed production of *C. striatus* using synthetic hormone Ovatide by Marimuthu *et al*. (2007) and embryonic and larval development by Marimuthu and Haniffa (2007) have been reported. But larval rearing is still considered as most critical and therefore, the development of rearing technology is essential for this commercially important fish species.

Success of larval rearing depends mainly on the availability of suitable diets that are readily consumed, efficiently digested and that provide the required nutrients to support higher growth and health. Studies so far revealed that fish larvae are in general physiologically immature with little or no capacity to produce certain hormones and digestive enzymes, and that they are dependent to a greater or lesser extent on exogenous sources (mother and / or live food) (Dabrowski, 1982, Lam, 1994). The most important live food organisms used in aquaculture larval rearing practices in many commercially important freshwater and marine fish species today are micro algae, rotifers (*Brachionus plicatilis*) and the brine shrimp (*Artemia spp*.) (Leger *et al*., 1986). Successful rearing of fish larvae using zooplankton has been reported in several fish species (Watanabe and Fujita, 1983). In larviculture, the use of artemia nauplii has increased production costs. For this reason, attempts have continued to find new food sources alternative to artemia and good results have been reported for some cultured fish species. Blood worms (Chironomus), tubifex have also been used successfully for catfish (*Silurus glanis*) larval rearing (Ronyai and Ruttkay, 1991). Artificial dry diets are the other alternative food sources for larviculture and it has been reported that some of the freshwater fish species can be exclusively reared on dry diets from the start of the exogenous feeding (Appelbaum and Van Damme, 1988 and Legendre *et al*., 1995). Although dry feeds have met the nutritional requirements of fish larvae and have been prepared in appropriate sizes with today's technology, the attractiveness and digestibility of these feeds for the larvae have not been improved completely (Kowen *et al*., 2001). Moreover, in the early larval stage, this low success of dry diets has been attributed to insufficient feed intake, digestion and absorption due to the absence of a functional digestive system. Further it has been shown that formulated compound diets do not provide optimal larval growth when used exclusively as larval food, especially during the early larval stages of cyprinids and catfish (Hogendoorn, 1980; Dabrowski, 1982). Hence the present study was designed to evaluate the different types of live feed, plankton, chironomus larvae, and mosquito larvae in terms of acceptability, growth and survival rate of larvae of striped murrel *Channa striatus* under laboratory conditions.

Materials and Methods

The larvae of *C. striatus* were obtained from captive bred broodstock by induced spawning technique (using 0.4 ml ovaprim kg/body weight) developed at CARE St. Xaviers college, Palayamkottai, India. Immediately after complete yolk sac absorption the larvae were fed on live mixed zooplankton, predominantly consisted of Copepods, Rotifers, and Cladocerans in rectangular cement tanks (1500 L) for the first 13 days before commencement of the experiment. The experiment commenced at day 15, post-hatching. Feeding trials conducted in 15 L capacity plastic troughs with three different live feeds namely plankton, chironomus larvae and mosquito larvae for a period of 28 days. There different treatments (feeding regimes) were applied in triplicates (3x3 = 9 plastic troughs). The larvae were then randomly distributed between troughs. The initial stocking density was 20 larvae per trough. Initial mean length and total weight of larvae at that time of commencement of the experiment was 3.9 ± 0.40 mm and 0.034± 0.001g, respectively. The chironomus larvae and mosquito larvae were collected from the local aquarium shop. Mixed zooplankton consists of Copepods, Rotifers, and Cladocerans were collected from the culture ponds of CARE just before feeding the larvae each day using plankton net. The test larvae were fed *ad libitum* twice a day at 10: 00 hr and 16: 00 hr. Feeding rate for all the diet types were not measured but given in excess (supra libitum). Satiations were determined based on visual observation of acceptance and refusal of feed. The fish wastes (unconsumed feed and excrement) from the bottom of the troughs were siphoned with a rubber pipe daily. Aeration was provided in each trough using aquarium aerators. Approximately two third portion of the water in each trough was exchanged daily before the first feed ration was given.

Water quality parameters like temperature, pH and dissolved oxygen were monitored weekly once. For determination of growth, weekly 10 larvae were randomly sampled from each trough, and each larva was placed in paper towel in order to absorb water and weighed in electronic balance to the nearest 0.01 g. The length was measured by measuring scale to the nearest 0.01 mm. Each time after taking length and weight measurements, the fishes were dipped with 1 ppm KMnO4 solution for 20 seconds and the larvae were carefully released back to their respective trough. The behavior of the fish larvae was also observed during the course of the experiment, especially during feeding. Dead larvae were removed and counted twice a day, simultaneously to water changes, to estimate the percentage of survival rate per 24 h. On the last day of the experiment, all the remaining

larvae were individually counted for the calculation of actual survival rate. Cannibalism was detected by visual observation daily. Survival rates were calculated by taking into account the remaining and discarded larvae. The specific growth rate (SGR) and weight gain (%) was calculated to determine the growth performance during the experimental period according to the following formula

Survival rate = N_o- N_t / N_o*100; where N_o - initial total number of larvae, and N_t - total number of larvae at the end of 28 days of experiment.

SGR= 100*(ln W^2- lnW^1)/T; where W^1 and W^2 are the initial and final weights of the larvae and T is the time in days)

Weight gain (%) = (Final weight - Initial weight/Initial weight)*100

All the growth parameters such as mean initial weight, initial length, final weight, final length, specific growth rates, weight gain and survival rates were subjected to one-way analysis of variance (ANOVA), followed by Duncan's Multiple Range to test significant difference among the feeding regimes. Differences were considered significant at $p<0.05$. All data were analyzed using SPSS (version 11.0) for windows software program for statistical analysis. Data are presented as treatment means ± SD.

Results

The growth performance of larvae of *C. striatus* fed with three different feeding regimes are presented in Table 1 and depicted in Fig. 1&2. All the feeding regimes tested in the present study, the *C. striatus* larvae were appeared to adapt easily to circular plastic troughs and accepted all the live feed. The larvae appeared healthy and they continuously moving up and down in the water column. Frequent surfacing activity was observed. During the whole experimental rearing period, the larvae of *C. striatus* showed very active and typical preying habit of swallowing feed with moving upward and downward directions. No cannibalistic and attacking behavior was noticed during the experimental period. The larvae became sluggish and appeared to take rest for some time in the water column after every meal. Visually no changes in larval behaviour for the larvae fed with three different live feed types. In the present study the larvae fed on mosquito larvae showed a rapid growth rate and attained the highest final length and weight as compared to those that were fed with chironomous larvae, and plankton (Table 1). Analysis of variance (ANOVA) revealed a significant effect of live feed on growth. Statistically no difference was observed in the initial mean weight and total length of larvae at the commencement of the experiment. The final mean length and mean weight showed highly significant difference ($p<0.001$) in mosquito fed larvae when compared to chironomous and plankton. Thus the final mean length and mean weight showed an increase in body length and weight in all treatment groups.

The Specific Growth Rate (SGR) was calculated to determine the growth performance during the experimental period and the results are shown in Table. 1. The best SGR value was observed in larvae fed with mosquito larvae showing a mean value of (4.906 ±0.042 %/day), followed by chironomus (4.44±0.036 %/ day) and plankton (3.621 ±0.038 %/day). Statistical analysis revealed that, significantly higher value of SGR was observed in larvae fed with mosquito fed groups when compared to the rest of the groups. Significantly the highest percentage weight gain was observed in mosquito larvae fed groups (2327.29±2.638) followed by chironomus (1692.47±5.105). The least percentage weight gain (932.85±4.488) was recorded in larvae fed with plankton. The mean survival rate of *C. striatus* larvae fed on three different diets during the experimental period varied from 96.55 to 86.66% on day 28. The results indicated significantly the maximum mean survival rate (96.55 %) was observed in mosquito followed by chironomous larvae (90 %) whereas low survival rate (86.66 %) was observed in plankton fed group.

With regard to water quality, in the present study, mean dissolved oxygen level in all the treatment was 5.2±0.12 mg/L, range of pH values from 6.8 -7.0 and water temperature 29°C to 30°C. All the parameters recorded were under the tolerance limit of fish and they did not exhibit any distress during the experimental period.

Discussion

Several authors have studied the effects of different nutritional diets on the growth and survival of different fish species (Mathavan, 1976; Degani and Horowitz Levanon, 1985; Wah Lam and Shephared, 1988; Khan and Jafri, 1994; Kim *et al*., 1996). However, very little information is available on the larval rearing and early nutritional requirements of *C. striatus.* In the present experiment three live feed sources mosquito larvae, chironomus larvae, plankton were tested to assess the growth performance and survival of *C. striatus* larvae. At each sampling time we sampled 10 larvae in each trough and extrapolated the results to the corresponding group. Measuring all fish larvae would not have provided much more accuracy but would have caused unnecessary stress to the stocks. The highest growth performance of *C. striatus* larvae was observed in larvae fed with mosquito larvae. Live mosquito larvae might have stimulated the feeding behavior of larvae of *C. striatus* and increased the acceptance. This could have improved the food intake of the larvae of mosquito fed group. Feed intake of fish depends on size of the prey and predator, quality, density, physical attractiveness and mode of presentation of food (James *et al*., 1993). The wriggling movements of large and nutritionally rich prey organisms such as chironomous larvae and *Culex pipiens* larvae minimize the temporal and energy cost of feeding and maximize growth in *Cyprinus carpio* (James *et al*., 1993). In larviculture, several factors are reported to influence feeding and growth such as stocking density, production system, type and size of rearing tanks, size of fish and quality and quantity of food (Mgaya and Mercer, 1995). In our experiment, no cannibalistic behavior of larvae and mortality by cannibalism was observed.

Table 1. Growth performance and survival of *Channa striatus* larvae fed with different live feeds for a period of 28 days

Growth parameters	***Diets***		
	Plankton	Chironomus larvae	Mosquito larvae
Initial mean length (mm)	14.06±0.01[a]	14.07±0.011[a]	14.05±0.01[a]
Initial mean weight (g)	0.035±0.001[a]	0.034±0.001[a]	0.035±0.001[a]
Final mean length (mm)	30.26±0.015[c]	40.7±0.1[b]	48.73±0.152[a]
Final mean weight (g)	0.361 ± 0.015[c]	0.613 ± 0.004[b]	0.827 ± 0.001[a]
SGR (%/day)	3.621 ±0.038[c]	4.44±0.036[b]	4.906 ±0.042[a]
Weight gain (%)	932.85±4.488[c]	1692.47±5.105[b]	2327.29±2.638[a]
Survival rate (%)	86.66±5.773[a]	90.0±10[a]	96.66±5.77[a]

The mean values having different superscripts in the same row are significantly different at P<0.05% level.

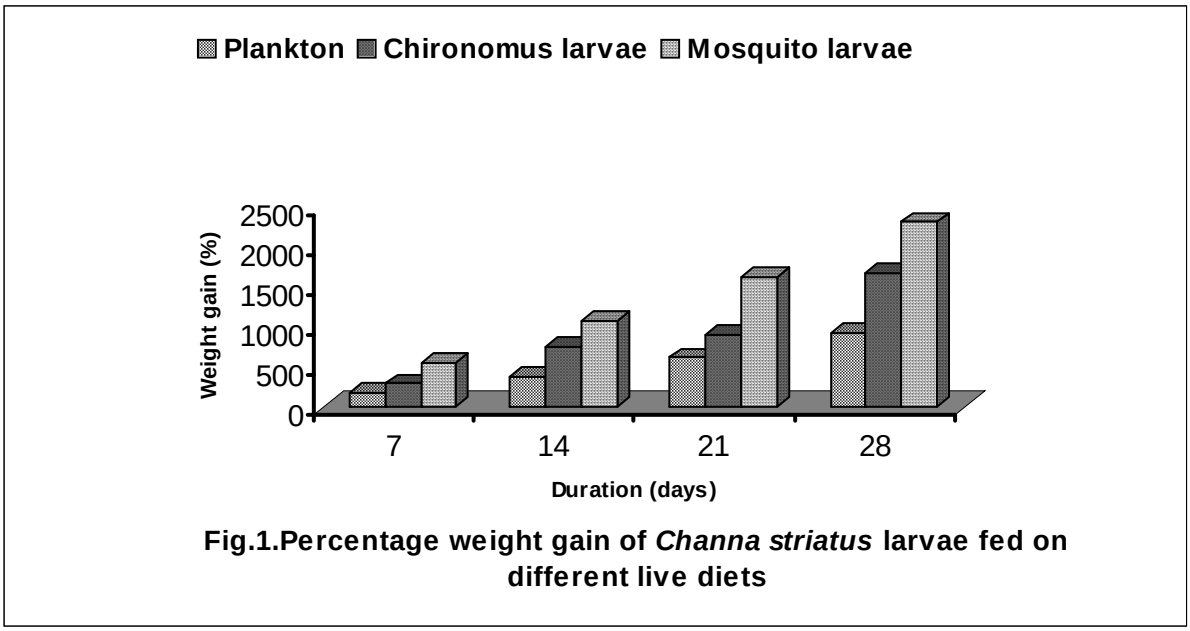

Fig.1.Percentage weight gain of *Channa striatus* larvae fed on different live diets

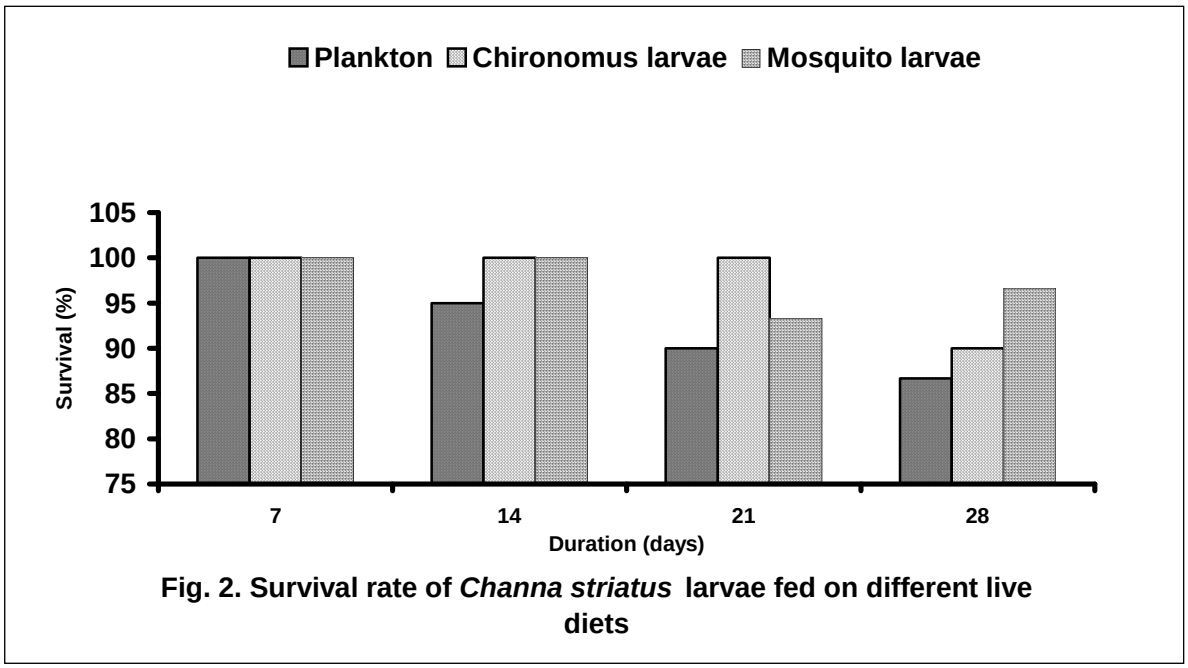

Fig. 2. Survival rate of *Channa striatus* larvae fed on different live diets

Larvae fed on plankton and chironomus had comparatively lower growth than those fed on mosquito larvae. Steffens (1960) reported that chironomid larvae are one of the most significant live food sources of pikeperch. In another studies by Shim, (1988) reported that, carps fed with chironomus gained more weight and growth. According to Fluchter (1982), the different larval stages have specific nutritional requirements. Several workers have reported successful rearing of fish larvae using live zooplankton for several species (Watanabe and Fujita, 1983). Among the various species of zooplankton, *Cladocerans* is known to be suitable as an initial feed for *Chanos chanos* (Villegas, 1990) and *Clarias macrocephalus* (Fermin and Boliver, 1991). Larval rearing of European catfish (*Silurus glanis*) fed with chironomus and tubifex, have been successfully carried out by Ronyai and Ruttkay (1990). It has also been reported that some freshwater fish species were exclusively reared on artificial diets from the beginning of exogenous feeding (Appelbaum and Van Damme, 1988; Charlon *et al*., 1986; Legendre *et al*., 1995). Degani (1991) found that juvenile *Trichogaster trichopterus* fed with live feed grew faster than those fed on formulated feed because of the palatability, high consumption rate and chemical composition of live feed organisms.

It is known that fish species are used successfully in biological control of mosquito larvae. A number of studies have been conducted to control mosquito larvae using different larvivorous fish species like *Gambusia affinis* and *Poecilia reticulata*, (Menon and Rajagopalan, 1978; Gupta *et al*., 1992; Kant *et al*., 1993). It was interesting to note that in the present study mosquito larvae served as an excellent diet for rearing larvae of *C. striatus.* The candidate species can be considered as one of the alternate bio control fish species eradicate mosquito in the aquatic environments.

In the present study, a higher mean survival (96.66 %) was observed in larvae fed with mosquito while lowest survival rate (86.66 %) was observed in plankton fed groups. Giri *et al*. (2003) observed that, highest survival of *Wallago attu* larvae fed on live zooplankton and dry feed compared to live zooplankton alone. The highest mortality and poorest growth were observed in fish fed with plankton. In nature, the slow-growing individuals are mainly planktonivorous, and the fast-growing ones are mainly piscivorous (van Densen and Vijverberg 1982). These results are similar to those reported by Zakes and Szczerbowski (1995), who attained much lower weights and lengths in pikeperch fed zooplankton *ad libitum* than in pikeperch reared on an artificial diet. In the present study, mosquito larvae proved to be an excellent feed for larval rearing of *Channa striatus.*

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References

Alikunhi, K.H. 1953. Notes on the bionomics breeding and growth of the murrel, *Ophiocephalus striatus* (Bloch). Proc. Indian Acad. Sci. 38:10-20.

Appelbaum, S., P. Van Damme. 1988. The feasibility of using exclusively artificial dry feed for the rearing of Israeli *Clarias gariepinus* (Burchell, 1822) larvae and fry. J. Appl. Ichthyol. 4:105–110.

Charlon, N., H. Durante, A.M. Escaffre, P. Bergot. 1986. Alimentation artificielle des larves de carpe (*Cyprinus carpio* L.). Aquaculture. 54:83–88.

Dabrowski, K. 1982. Proteolytic enzyme activity decline in starving fish alevins and larvae. Environmental Biology of Fish. 7: 73-76.

Degani, G., 1991. The effect of diet, population density and temperature on growth of larvae and juvenile *Trichogaster trichopterus* (Bloch and Schneider 1901). J. Aqua. Trop. 6:135–141.

Degani, G.A., D. Horowitz Levanon.1985. Effects of protein level on impurities, diet, density, ammonia and DO level on growth of European eel, *Anguila anguila* (L). Aquaculture. 46:193–200.

Fermin, A.C., M.E.C. Bolivar. 1991. Larval rearing of the Philippine freshwater catfish, *Clarias macrocephalus* (Gunther) fed live zooplankton and artificial diet: a preliminary study. Bamidgeh. 43:87– 94.

Giri, S.S., S.K. Sahoo, B.B. Sahu, A.K. Sahu, S.N. Mohanty, S.Ayyappan. 2003. Larval survival and growth in *Wallago attu* (Bloch and Schneider): effects of light, photoperiod and feeding regimes. Aquaculture. 213:151–161.

Gupta, D.K., R.M. Bhatt, R.C. Sharma, A.S. Gautam, R. Kant. 1992. Intradomestic mosquito breeding sources and their management. Indian J. Malariol. 29:41–46.

Hogendoorn, H., 1980. Controlled propagation of the African catfish, *Clarias lazera* (C&V): III. Feeding and growth of fry. Aquaculture, 21: 233– 241.

James, R., J. Muthukrishnan, K. Sampath. 1993. Effects of food quality on temporal and energetics cost of feeding in *Cyprinus carpio* (Cyprinidae). J. Aquac. Trop. 8:47–53.

Kant, R., R.M. Bhatt, D.K. Gupta, R.C. Sharma, H.C. Srivastava, A.S. Gautam. 1993. Observations on mosquito breeding in wells and its control. Indian J. Malariol. 20: 215–220.

Khan, M.A., A.K. Jafri. 1994. Replacement of fish meal with soybean meal diets formulated for fingerling carp *Labeo rohita* (Ham). The Third Asian Fisheries Forum. 663–666 pp.

Khanna, S.S. 1978. An introduction to fishes. (Second Edition). Central Book Dept. Allahabad pp. 428.

Kim, J., K.C. Masses, R.W. Hardy.1996. Adult artemia as food for first feeding Coho salmon (*Oncorhynchus kisuteh*). Aquaculture. 144: 217–226.

Koven, W., Y. Barr, S. Lutsky, I. Ben-Atia, R. Weiss, M. Harel, P. Behrens, A. Tandler. 2001. The effect of dietary arachidonic acid (20:4n-6) on growth, survival and resistance to handling stress in gilthead seabream (*Sparus aurata*) larvae. Aquaculture.193:107– 122.

Lam, T.J. 1994. Hormonos and egg /Larval quality in fish. J World Aqua Soc. 25(1): 2-12.

Legendre, M., N. Kerdchuen, G. Corraze, P. Bergot. 1995. Larval rearing of an African catfish *Heterobranchus longifilis* (Teleostei, Clariidae): effect of dietary lipids on growth, survival and fatty acid composition of fry. Aquat. Living Resour. 8:355– 363.

Leger, P., D.A. Bengtson, K.L. Simpson, P. Sorgeloos.1986. The use and nutritional value of artemia as a food source. Oceanogr. Mar. Biol. Annu. Rev. 24: 521– 623.

Ling S.W., 1977. Snakehead, ophiocephalus spp culture. pp 60–6. *In*: S.W. Ling (ed). Aquaculture in Southeast Asia: A historical overview: University of Washington Press, Seattle.

Marimuthu, K and M.A. Haniffa. 2007. Embryonic and Larval Development of the Striped Snakehead *Channa striatus.* Taiwania. 52(1): 84-92.

Marimuthu, K, M.A. Haniffa, M. Muruganandam and A.J. Arockia Raj. 2001a. Low cost murrel seed production technique for fish farmer. Naga. 24 (1& 2): 21-22.

Marimuthu, K., M.A. Haniffa, A. Jesu Arockiaraj and M. Muruganandam. 2001b. Spawning and parental behavior in the induced bred murrels. Indian Journal of Fisheries. 48 (4): 409-411.

Marimuthu. K., D. Kumar and M. A. Haniffa., 2007. Induced Spawning and Seed Production of Striped Snakehead *Channa striatus* Using Ovatide. Journal of Applied Aquaculture. 19 (4):95-103.

Mathavan, S., 1976. Satiation time and predatory behavior of the Dragon Fly Nymph *Mesogomphus lineatus*. Hydrobiologia. 50: 55–64.

Menon, P.K.B., P.K. Rajagopalan. 1978. Control of mosquito breeding in wells by using *Gambusia affinis* and *Aplocheilus blochii* in Pondicherry town. Ind. J. Med. Res. 68, 927–933.

Mgaya, Y.D. and J.P. Mercer. 1995. The effects of size grading and stocking density on growth performance of juvenile abalone, *Haliotis tuberculata* Linn. Aquculture. 136: 297–312.

Mookerjee, H.K., D.N. Ganguly and M. Islam. 1946. On the composition of feed and their correlation with weight and length of the body in the development of *Ophiocephalus punctatus,* Bloch. Proc. Indian Sci. Congr. 33: pp. 15.

Mookerjee, H.K., D.N.Ganguly and R.N. Bhattacharya. 1948. On the bionomics breeding and development of *Ophiocephalus striatus* (Bloch) Proc. Zool. Soc. Bengal. 1(1): 58-64.

Ng, P.K. L. and K.K.P. Lim. 1990. Snakeheads (Pisces: Channidae): natural history biology and economic importance. In Essays in Zoology. Papers Commemorating the 40th Anniversary of the Department of Zoology (ed, by L.M. Chou & K.L.P. Ng). pp. 127-152. National University of Singapore, Singapore.

Parameshwaran, S. and V.K. Murugesan. 1976b. Observation on the hypophysation of Murrels (Ophiocephalidae). Hydrobiologia. 50 (1): 81-87.

Qin, J., A.W. Fast and A.T. Kal. 1997. Tolerance of snakehead *Channa striatus* to ammonia at different pH. J World Aqua Soc. 28: 87-90.

Ronyai, A., and A. Ruttkay1990. Growth and food utilization of wels fry (*Silurus glanis*) fed with tubifex. Aquacult. Hung. (Szarvas) VI, 193– 202.

Shim, K. F. 1988. By-product utilization in live food culture for tropical aquarium fish. In: Fish Nutrition Research in Asia. Proceedings of the Second Asian Fish Nutrition Network Meeting. 128: 42-47.

Steffens, W 1960. Ernahrung und Wachstum des jungen Zanders (*Lucioperca lucioperca*) in Teichen. Z Fisch N.F. 9:161–271.

Van Densen W.L.T. 1985. Piscivory and the development of bimodality in the size distribution of 0+pikeperch (*Stizostedion lucioperca* L.). J Appl Ichtyol. 3:119–131

Villegas, C.T., 1990. The effects on growth and survival of feeding water fleas (*Moina macrocopa*) and Rotifer (*Brachionus plicatilis*) to milkfish (*Chanos chanos* Forsskal) fry. Bamidgeh. 42:10–17.

Wah Lam, S., and K.L. Shephared. 1988. Some effects of natural food level and high protein supplement on the growth of carp. Aquaculture. 72:131–138.

Watanabe, T.C. and S. Fujita. 1983. Nutritional values of live organisms used in Japan for mass production of fish: a review. Aquaculture. 34: 115–143.

Wee, K.L 1982. The biology and culture of snakeheads, In: J.F. Muir and R.J. Roberts, (editors). Recent advances in aquaculture. Pages, 180-211. Westview Press, Boulder, Colorado, USA.

Yaakob W.A.A., and A.B. Ali. 1992: Simple method for backyard production of snake head *(Channa striata* Bloch) fry. Naga, 15: 2: 22-23.

Zakes, Z, and A. Szczerbowski. 1995. Characteristics of autumn fry of pikeperch (*Stizostedion lucioperca*) reared in a traditional way in pond and in controlled conditions. Arch Polish Fish 3:159–168.