Journal of Crop and Weed 6(2)19-25: (2010)

To investigate the technical and co-management aspects of mud eel (*Monopterus cuchia*) culture by ethnic (*Adivasi*) communities in the Northern Bangladesh

B. K. CHAKRABORTY, S. A AZAD, B. BORMON[1], M. AHMED[2] AND A.M.O. FARUQUE

Department of Fisheries, Bangladesh
[1]World Fish Center, Bangladesh
,[2]TARA, Bangladesh

ABSTRACT

The current study was undertaken to observe production potential of mud eel in participatory semi-intensive culture systems in Noukuchi rice field (treatment T_1), Sherpur and Gohalidew Ponds (treatment T_2), Netrokona with an area of 0.20 and 0.06 ha, respectively. The water bodies were stocked with cuchia fingerlings (95.96±3.21 and 95.45±4.02 g) at a density of 5187.ha^{-1} and 12866.ha^{-1}, respectively in treatment T_1 and T_2 for a period of 150 days. Rice field and pond habitat was improved by installing mud-compost hips, bamboo roots; plastic and bamboo-made hollow pipes, and aquatic vegetations. The fish were fed with 3% bw (1% dead fish, 1% dry fish, and 1% flesh of snails and bivalve) at every alternative day. In addition live carp fry was also added to the system at 15 days interval. In the rice fish system, the individual final weight was 310.63±17.59 g in 150 days of culture period. The average daily gain, specific growth rate, FCR and survival rate were 1.43±0.08, 0.79±0.23, 1.0±0.0 and 90.0±0.0, respectively. Comparatively, lower growth performance of M. cuchia was observed in Gohalidew (T_2). The mean differences of gross yield between two treatments was significant ($P<0.05$). The results of this study indicated that treatment T_1 showed significantly higher growth and lower yield (cuchia 1440.0±0.0, and native fish 1122.48±9.32 kg.ha^{-1}.150 days^{-1}) than treatment T_2. The physico-chemical factors were found to be suitable for mud eel culture. M. cuchia semi-intensive culture in rice field and ponds is a good proposition as an aquaculture technology to save the mud eel from declined and enhance the nutritional status and socio-economic improvement of the Adivasi people.

Key words: FCR, growth, participation, survival rate and yield.

Mud eel (*Monopterus cuchia*) is a delicate and potential resource for consumption and livelihood maintenance of Adivasi communities of Bangladesh. The *M. cuchia* is a fresh water air breathing, swamp mud eel is locally known as cuchia. It commonly occurs in the fresh water of Bangladesh, Pakistan, Northern and Northeastern India and Nepal (Jingran and Talwar, 1991). Once, indigenous *M. cuchia* was abundant throughout the Bangladesh, plenty in mud-holes in shallow ``beels" and `boro` paddy field particularly in old Sylhet, Mymensingh and Tangail Districts (Rahman, 1989). But now-a-days this fish is hardly found in the open water system. The IUCN, Bangladesh (2000) enlisted *M. cuchia* as vulnerable species in the country, because of rough water management policy for irrigation, over exploitation and various ecological changes in its natural habitat; this species is threatened now. Cuchia is an important fish for the livelihoods of *Adivasi* people in terms of both for home consumption and trade. However, the availability of the aquatic lives is drastically reduced over the years. Several factors contributed to this, while the main two factors are the destruction of natural habitat and over harvesting. The natural habitats of cuchia has been destroyed by variety of ways like horizontal expansion of agriculture and aquaculture, destructive hunting methods, use of chemical fertilizer and pesticide, infrastructure development etc. Pollution from domestic, industrial and agrochemicals wastes and run off have resulted in extinction of a considerable amount of aquatic biota in same stretches of the open water system (Diaster, 1990; Chakraborty and Nur, 2009). On the other hand, harvesting of cuchia is increased with the increase of population, which is further influenced by the international demand and trade of cuchia. Many of poor *Adivasi* people harvest and sell cuchia as a full-time or part-time profession.

In this background, increasing the production of cuchia through restoring and protecting natural habitats on sustainable harvesting may be a good option for improving livelihoods of *Adivasi* people. In addition, the mainstream of Bangladesh does not eat cuchia and considers cuchia production an advantage to the Adivasi people. Seeing the potential, the *Adivasi* Fisheries plans to increase production of cuchia in small suitable private owned resources involving poor *Adivasi* people along with owners in culturing cuchia and improvement of habitats. However, lack of knowledge and information on cuchia culture technique in such natural environments is found to be an important constrain. In addition, the community based management of those private resources for *Adivasi* communities is also underdeveloped. Therefore, this research .work proposed to develop a sustainable culture method of cuchia through habitat restoration with the *Adivasi* people of the northern part of Bangladesh.

Email :bborty@gmail.com

MATERIALS AND METHODS

Many open water bodies like Patharia beel, Chinakuri beel, Dhapara beel, Vorotpur beel, Dhola pani beel, and China kuria beel of Durgapur Upazilla in Netrokona; Noukuchi beel in Jhenaigati and Ullatar beel, Mongla Khali Nalitabari Upazilla in Sherpur were surveyed on the basis of biological point of view to identify for selecting the suitable culture area of cuchia. But there was no suitable open water area in Durgapur, Netrokona, So, on the basis of geographical, biological and socio-economical point of view, three *adivasi* community's ponds at Gohalidew, Durgapur and one rice field, Noukuchi beel in Jhenaigati were selected for the study of growth culture of cuchia. Harvesting and consumption of

fishes in previous year were collected by interviewing the neighbor villagers.

Study Area and Experimental Design

The research has been carried out at the Noukuchi rice field (beel), Noukuchi, Union of Kangsa, Jhenaigati, Sherpur with an area of 0.20 ha (Fig.1) and three ponds of Gohalidew, Birisiri, Durgapur, Netrokona with area of 0.06 ha (Fig. 2. a-c) respectively. The study area was designed rice field as a treatment T_1 and ponds as a treatment T_2. The experiment was conducted for a period of 150 days from June to October, 2009.

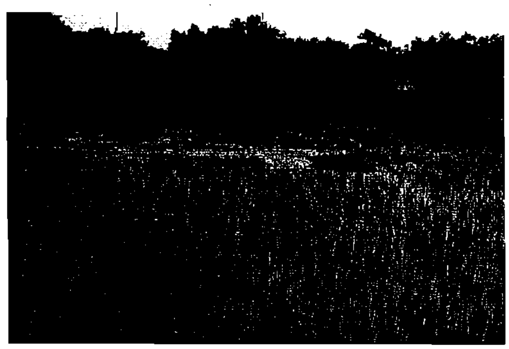

Fig. 1. Noukuchi Rice field

Fig. 2.a Pond of Chantu

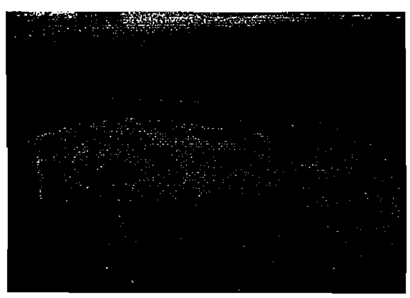

Fig. 2.b Pond of Bishaka

Fig. 2.c Pond of Denial

Habitat improvement

A safety shelter for cuchia was developed by installing bamboo root, plastic and bamboo-made hollow pipe, aquatic vegetation and necessary objects in the area of the habitat. This restricted shelter was marked by hoisting red flags. One or more mud-compost hip developed for natural shelter of cuchia in the suitable place of habitat by using firstly mud (10 cm), secondly, straw (10 cm), thirdly cow manure (10 cm) and lastly top layer were placed on a slope with one end. The size of the mud-compost hip was 2.0 m× 1.0 m ×1.0 m. To prevent the escaping of cuchia, net fencing was set up on the dyke of ponds and bamboo made bana was set up in the southern side of the rice field (beel).

Preparation

Quicklime ($CaCO_3$ @250 kg.ha^{-1}) was spread over the pond and dyke bottom and liming was done during the experimental period. Seven days subsequent to liming, the ponds were manured with organic manure (cowdung @ 2470 kg.ha^{-1}).

Stocking of fingerling

The fingerlings were collected from the Jinaigati and Birishiri cuchia market. The water bodies were stocked at a density of 5187 fingerlings.ha^{-1} and 12866 fingerlings.ha^{-1} with an initial weight of 95.96±3.21 and 95.45±4.02 g in the treatment T_1 and T_2 respectively. The catch statistics was maintained based on fortnightly sampling. The stocking densities were employed with three replicates in Durgapur ponds. The catch statistics was maintained based on fortnightly sampling. Before stocking, the total length and body weight of the fishes were recorded individually with the help of a measuring scale and a sensitive portable balance (Model HL 400 EX).

Feeding

In order to meet the increasing dietary demand, cuchia was fed with dead fish @ 1 %, dry fish @ 1 %, meat of snails and bivalve @ 1% alternative day and live fry of carp @ 5% body weight with an interval of 15 days for 150 days. Ration was adjusted by estimating the standing crop fortnightly.

Study of water quality parameters

Physico-chemical parameters of experimental area has been maintained fortnightly between 9.00 and 10.00 h. Water temperature was recorded using a Celsius thermometer and transparency was measured by using a Secchi disc of 20 cm diameter. Dissolved oxygen and pH were measured directly using a digital electronic oxygen meter (YSI Model 58) and an electronic pH meter (Jenway Model 3020). Total hardness and alkalinity were determined by titrimetric method (Clesceri *et al.*1989).

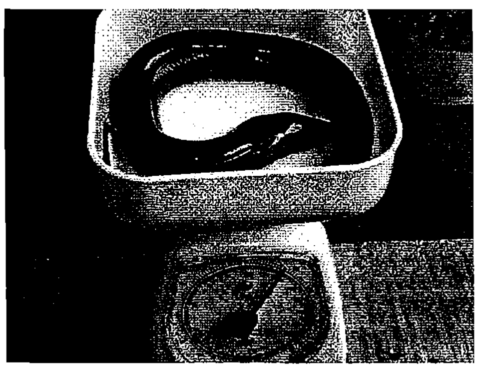

Fig. 3. Sampling method of cuchia.

Sampling of fish

M. cuchia was sampled fortnightly by using plastic and bamboo made pipe, and dorma jal. Length (cm) and weight (g) of the cuchia was measured (measuring scale and a portable sensitive balance Model HL 400 EX) separately to assess the growth condition of cuchia (Fig. 3).

Harvesting

After150 days cuchia were harvested from plastic and bamboo made pipe and own shelter earth hole by the help of hunter.

Statistical analysis

The data were statistically analyzed for Duncan's Multiple Range Test at 5% level of significance (Zar 1984) using Microsoft Excel software.

RESULTS AND DISCUSSION

Water quality parameters

The results of the physico-chemical parameters of the experiment is furnished in Table 1 which included temperature, transparency, pH, dissolve oxygen and alkalinity of water were found to be more and less in a normal range. It is evident from the Table 1 that the mean water temperature of the aquatic environments was not statistically significant ($P>0.05$). Mean Secchi disk transparency differed significantly ($P<0.05$), during 150 days study period. Higher values of transparency occurred during post monsoon and summer months due to reduced flow and relatively stable conditions of water. The pH value of the experimental beel did not differ significantly ($P>0.05$). A significant rise in pH during pre-monsoon; followed by a drop in winter was noted in two treatments. The mean dissolved oxygen (DO) of the surveyed experimental treatments did not differ significantly ($P>0.05$). But total alkalinity of the experimental treatments differed significantly ($P<0.05$).

Growth, feed utilization and production of fish

Fortnightly growths (length and weight) of *M. cuchia* were shown in Figs. 4 and 5. The increase in length and weight was the highest in Noukuchi rice field (T_1) followed by Gohalidew ponds(T_2). Growth and production parameters of *M. cuchia* were shown in Table 2. The initial length and weight of fingerlings of cuchia, stocked in both treatments were more or less same. The fish in rice field treatment showed the highest gain in both length and weight over Gohalidew ponds treatment, where

Table 1: Physico-chemical parameters of experimental two treatments

Parameters	Noukuchi rice field (T_1)	Gohalidew ponds (T_2)
Temperature (°C)	29.62±2.13 (26.60-31.5)	29.44±2.20 (26.42-31.80)
Transparency (cm)	18.48±2.09^b (14.80-20.50)	15.32±2.64^a (13.60-18.40)
Water depth (m)	0.74±1.22^a (0.40-1.05)	0.84±1.12^b (0.50-1.10)
pH	6.50±0.30 (5.50-7.20)	6.48±0.33 (5.88-7.40)
Dissolved oxygen (mg.l^{-1})	4.54±0.66 (3.64-5.62)	4.44±0.70(3.55-6.10)
Total alkalinity (mg.l^{-1})	32.57±8.87^b (22.40-34.20)	37.22±9.69^a (21.60-41.20)

Figures with different superscripts in the same row varied significantly (P<0.05). Figures in the parentheses indicate range.

Table 2: Growth performance, survival and production of *Monopterus cuchia* after 150 days of rearing.

Parameters	Noukuchi rice field	Gohalidew ponds
Initial length (cm)	43.39±5.06 (35.0-51.0)	46.13±3.26 (40.0-50.0)
Final length (cm)	60.30±0.71^{b} (59.00-60.60)	59.23±1.01 (57.80-60.20)
Initial weight (g)	95.96±3.21 (86.10-104.8)	95.45±4.02 (91.20-100.40)
Final weight (g)	310.63±17.59^{a} (294.0-338.80)	239.49±28.62^{b} (205.00-274.40)
Net weight gain (g)	214.67±0.98^{a} (198.8-220.44)	144.04±0.84^{b} (135.80-149.24)
Average daily gain(g)	1.43±0.08^{a} (1.34-148.22)	0.96±0.5^{b} (0.87-1.08)
Specific growth rate	0.79±0.23^{a} (0.40-0.51)	0.61±0.32^{b} (0.39-0.49)
Survival rate (%)	90.0±0.0^{a}	87.25±5.50^{b} (87.42-90.02)
FCR	1.0±0.0^{a}	1.46± 0.01^{b} (1.43-1.48)
Production.ha^{-1}.kg^{-1}		
Cuchia	1440.0±0.0^{b}	2681.5±24.55^{a}
Native and carp live species	1122.48±9.32^{a}	340.091±5.11^{b}
Total	2562.48±40.32^{a}	3021.59±15.96^{b}

Figures with different superscripts in the same row varied significantly (P<0.05). Figures in the parentheses indicate range.

stocking density of fingerlings was 5187 fingerlings.ha^{-1} in treatment T_1 and 12866 fingerlings.ha^{-1} in treatment T_2. However, the mean final length and weight of *M. cuchia* in two treatments were significantly different (P<0.05). The highest weight gain was in treatment T_1 and lowest in treatment

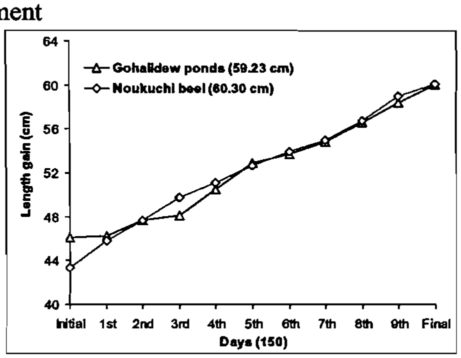

Fig. 4. Fortnightly gain in length (cm) of *M. cuchia* in two treatments.

T_2. SGR in treatment T_1 was significantly higher than treatment T_2 and was significantly different (P<0.05). FCR was significantly lower in treatment T_1 than treatment T_2. The highest survival rate was also observed in T_1 and the lowest in T_2.

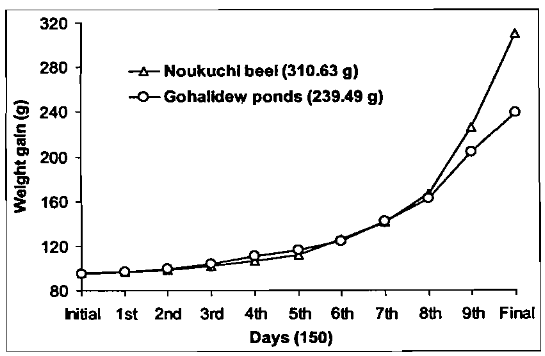

Fig. 5. Fortnightly gain in weight (g) of *M. cuchia* in two treatments

From an initial weight of 95.96±3.21g and 95.45±4.02 g, *M. cuchia* was found to attain the final

Table 3: Cost and benefits of mud eel (*Monopterus cuchia*) culture for a period of 150 days

Item	Amount TK•ha^{-1}•150 days^{-1}		Remarks
	Treatment T_1 (Tk)	Treatment T_2 (Tk)	
Return	259,200	402,225	Size variation: TK./kg/180; TK./kg/150
1.Cuchia			
2. Stocking and native Fish	224496	47612	Size variation: TK./kg/200; TK./kg/140
3. Vegetables	5,250	2,110	
4. Rice and straw	75,750	-	
Total return(TR)	**564,696**	**451,947**	
a. Variable cost:	88920	222300	
1. Price of fingerlings			
2. Feed 1(Tk. 40.00/kg)	57480	70640	
3. Compost hip	30552	32562	
4. Human labour cost (Tk. 100.00/day)	15000	15000	
5. Chemicals	1500	1500	
6. Miscellaneous	2418	3250	
Total Variable cost (TVC)	**195870**	**345252**	
b. Fixed cost :			Tk. 60/dec^{-1} according to MAEP, Mymensingh
1.Pond rental value	14820	14820	
Total fixed cost (TFC)	**14820**	**14820**	
Total cost (TC= TVC+TFC)	**210690**	**360072**	
Gross margin (GM= TR-TVC)	**368826^{a}**	**106695^{b}**	
Net return (TR-TC)	**354006^{a}**	**91275^{b}**	

1 US\$ =Tk. 70.00, MAEP= Mymensingh Aquaculture Extension Project; Figures with different superscripts in the same row varied significantly ($P<0.05$). Figures in the parenthesis indicate range.

weight of 310.63±17.59 g and 239.49±28.62 g, in treatments T_1 and T_2, respectively over a period of 150 days. Average daily gains were found to be 1.43±0.08 g and 0.96±0.5 g; SGR were 0.79±0.23 and 0.61±0.32 and Survival rate were 90.0±0.0 and 87.25±5.50% in treatments T_1 and T_2, respectively (Table 2). Significance difference was found in the value of ADG and SGR among different treatments ($P>0.05$). The yield of *M. cuchia* was recorded to be 1440.0±0.0 kg.ha.$^{-1}$.150 days^{-1} in treatment rice field and 2681.5±24.55 kg.ha.$^{-1}$.150 days^{-1} in treatment Gohalidew ponds. Total production was recorded 2562.48±40.32 kg.ha^{-1}.150 days^{-1} in treatment rice field and 3021.59±15.96 kg.ha.$^{-1}$.150 days^{-1} treatment Gohalidew ponds, respectively.

On the other hand, cost of production in treatment T_1 was consistently lower than those of treatment T_2. Highest net profit (in term of Bangladeshi Tk.ha^{-1} and one Bangladeshi TK= US\$ 0.0142) was obtained in treatment T_1 (368,826) followed by T_2 (106,695) (Table 3).

In this experiment, higher net benefits were obtained from rice field stocked with 5187 fingerlings.ha^{-1}. The higher market price of the large size of fishes in Noukuchi beel, substantially increased the net benefit compared to smaller size of fishes that produced in ponds with higher stocking densities. Overall, highest growth, survival and benefits of cuchia and native fishes were obtained in rice field(T_1). The net return were TK. 354,006/- and 91275/- kg.ha.$^{-1}$.150 days^{-1} in treatment T_1 and T_2,respectively (Table 3).

Formation of committee and Awareness meeting

Two local management committee was formed in Noukuchi and Gohalidew locations consisting 11 members (Representative of FFS-1, Pond owner-3 and Stake Holder-7) and 9 members (Matobar-1, Representative of FFS-1, Pond owner-3 and Stake Holder-4) from stakeholders through participatory discussion. The members of the committee were developed consensus on sharing of benefits, rules and regulations for resource management. Awareness meeting was arranged fortnightly by the implementing investigators at both the sites during study period.. Local *adivasi* community people was invited in those meetings including Farmers School (FS) representatives of World Fish-CARITAS and local NGO, like CARITAS, Local Headman of the *adivasi* community was informed in all the project activities during investigating period.

The present study was undertaken to observe production potential of mud eel in participatory semi-intensive culture systems in Noukuchi rice field (T_1), Sherpur and Gohalidew Ponds (T_2), Netrokona with an area of 0.20 and 0.06 ha, respectively. Growth rate of *M. cuchia* in terms of increase in body weight during experimental period was highest 310.63±17.59 g in treatment T_1 and 239.49±28.62 g in treatment T_2 to establish a compost hip for shelter of cuchia, which is very much similar study of Teng and chuna (1979). They used car tyres as a shelter for rearing of grouper *Epinephelus salmodes* and found highest gain.

Growth in terms of length, weight, weight gain and SGR of fingerlings of *M. cuchia* was significantly higher in T_1 where the stocking density was low compared to that of T_2 although same food was supplied in both the treatments at an equal ratio. The causes might include competition for food and habitat due to higher density of cuchia (Islam *et al.*, 2002; Rahman, 2003, Chakraborty *et al.*, 2008). It was observed during the winter that all the fish's burrowed in mud and PVC and bamboo made pipes for hibernation. Similar observation was reported by Nasar (1997) in *A. japonica, A. anguillia A. rostrata* and *A. cuchia*, respectively. Significantly higher survival rate (90%) was recorded in the treatment T_1, which was very much similar to the study of Teng and Chuna (1979), who reported survival rate of 93.8 to 99.1% with artificial hides.

The FCR values of T_1 are significantly lower than that T_2, which is supported by Islam 2002. De Silva and Davy (1992) stated that digestibility plays an important role in lowering the FCR value by efficient utilization of food. Digestibility, in turn, depends on daily feeding rate, frequency of feeding, and type of food used (Chiu *et al.*, 1987). However the lower FCR value in the present study indicates better food utilization efficiency, despite the values increased with increasing stocking densities. The reason for reduced survival rate in treatment T_2 was due to closed water body and higher stocking density of cuchia as well as competition for food and space in the experimental ponds. Similar results were obtained by Threpathi *et al.* (1979) and Chakraborty *et al.* (2003) for various carp and barb species. The highest production of fish was obtained in this study due to greater survival rate of the fish with artificial shelter (compost-mud hip) cuchia. But the production (1440.0±0.0 to 2681.5±24.55 kg/ha/150 days) of the present study was found better than that of Narejo *et al.* (2002) obtained 116.83 $kg.acre^{-1}.180\ days^{-1}$ in snake eel. Overall, highest growth and survival of cuchia was obtained at a density of 5,187 $fingerlings.ha^{-1}$. Growth of cuchia to a greater extent depended on the quality and quantity of food available. The results in the present experiment are very similar to those of Hossain (2001) and Chakraborty *et al.* (2008).

In this experiment, higher net benefits were obtained from treatment T_1 stocked with 5,187 $fingerlings.ha^{-1}$ than those from 12866 $fingerlings.ha^{-1}$. The higher market price of the larger size and weight of mud eel, stocking and native fish, straw and rice and vegetables produced in rice field, substantially increased the net benefit compared to Guhalidew ponds culture practice with aquatic habitat and higher stocking densities. The result in the present experiment is very similar to those of Munshi (1996); Vijayakumar *et al.* (1998), Usmani *et al.* (2003) and Chakraborty *et al.* (2008).

No significant differences in water temperature among different rice field and ponds were noted during the study period. Usui (1974) and Nasar (1997) reported an ideal temperature for proper feeding and growth of *M. cuchia* is between 20.0 to 35.0 oC and commented that the fish would not eat well bellow and above temperature. Usui (1974) reported that the below approximate 12 oC eels *A. japonica, A. anguillaand A. rostrata* do not feed and thus don't grow at all, hibernating and burrows in the mud. Brown (1957) and Nikolesky (1963) reported that temperature altered the rates of metabolic process and could be expected to have a considerable effect on the growth of poikilothermous animals. But the water temperature remained in desirable range in the experiment for favorable growth of the cuchia and other aquatic organisms which are supported the above findings. A transparency between 15.0 to 40.0 cm as appropriate for fish culture and the close variation in transparency might be due to depth of water, availability of the plankton population and rainfall (Boyd, 1979; Dewan 1973). pH values of the experimental water bodies was found to vary from 5.50.5 to 7.40 which is agreed well with the findings of Chakraborty et al. (2003). The dissolve oxygen was in acceptable range in the study period. Fluctuation of dissolve oxygen concentration might be attributed to photosynthetic activity and variation in the rate of oxygen consumption by fish and other aquatic organisms (Boyd, 1982). Alkalinity levels (21.60 to 41.20 $mg.l^{-1}$) indicate medium to higher level of productivity. Higher total alkalinity values might be due to higher amount of lime used during rice field and pond preparation (Boyd, 1982; Jhingran, 1991).
This suitable technology is helpful to prevent the fish from being extinct and this tasty fish will be available for the *Adivasi* communities and an opportunity to export the fish to earn foreign currency. Therefore, present study has been undertaken to develop a sustainable culture method of cuchia technology through habitat restoration with the tribal communities of the northern region of Bangladesh.

ACKNOWLEDGMENT

The authors gratefully acknowledge the financial support of World Fish Centre, Bangladesh. And are thankful to the department of Fisheries for kind support and cooperation.

REFERENCES

Boyd, C. E. 1979. *Water quality in warm water fish ponds*, Alabas Seed Agricultural Experiment station, Auburn, Alabama, USA. p 369.

Boyd, C.E. 1982. *Water Quality Management for Pond Fish Culture*. In: The physiology of fishes. Ed Brown, M. E. 1957. Academic Press, New York. p 36-400.

Brown, M.E. 1957. Experimental studies on growth. In: *The physiology of fishes*. (Ed. Brown, M. E.), Vol. I: Academic Press, New York, p 361-00.

Chakraborty, B.K., Miah, M.I., Mirza, M.J.A., Habib, M.A.B., 2003. Rearing and nursing of local sarpunti, *Puntius sarana* (Hamilton) at different stocking densities. *Pakistan J. Biol, Sci.*, **6**: 797-00.

Chakraborty, B.K. and Mirza, M.J.A. 2008. Growth and yield performance of Threatened Singi, *Heteropneustes fossilis* (Bloch) under semintensive aquaculture *J. Fish. Soc. Taiwan,* **35** :117-25.

Chakraborty, B. K. and. Nur. N. N. 2009. Study on aquatic biodiversity of Medha Beel in the Northern Bangladesh. *J Crop Weed*, India, **5** :4-11

Clesceri, L. S.; Greenberg, A. E and Trussell, R. R. 1989. *Standard Methods of the Examination of Water and Wastewater* (17th ed.). American Public Health Association, American Water Works Association and Water Pollution Control Federation, 1015 Washington D. C., USA 20036, p.10-203.

Chiu, Y.N., Sumagaysay, N.S., Sastrillo, M.G.S., 1987. Effect of feeding frequency and feeding rate on the growth and feed efficiency of milk fish, *Chanos chaqnos* (Forskal) Juveniles. *Asian Fish. Sci.* **1**: 27-31.

De Silva, S.S., Davy, F.B., 1992.*Fish nutrition research system in Asia*. *Asian Fish, Sci.*, **5**: 129-44.

Dewan, S. 1973. Investigation into the ecology of fishes of Mymensingh lake. *Ph.D. dissertion*. Bangladesh Agricultural University, Mymensingh, Bangladesh p 235.

Dister E. 1990. *Floodplain protection in Central Europe*. World Wildlife Found (WWF) Institute of Floodplains Ecology Visiting Card 31/90, Germany.

Hossain, Q.Z., 2001. Induced breeding of the fish *Cirrhinus reba* by pituitary gland extract and survival of spawn in nursery ponds. *J. Asiat. Soc. Bangladesh, Sci.,*. **27**: 205-13.

Islam, M.S., 2002. Evaluation of supplementary feeds for semiintensive pond culture of Mahaseer, *Tor putitora* (Hamilton). *Aquaculture*, **212**: 263-76.

IUCN. 2000. *Red book of threatened Fishes of Bangladesh*. IUCN - The World Conservation Union xii+p116

Jhingran, A. G. and P. K Talwar, 1991. *Inland fishes of India and adjacent countries*. Oxford and IBH Publishing Co. PVT. Ltd., New Delhi, India. 2 p; 541.

Jhingran, V.G. 1991. *Fish and Fisheries of India*, 3rd edn. Hindustan Publishing Corporation Delhi, India. p 727.

Munshi, J.S.D. 1996. *Ecology of Heteropneustes Fossilis, an Air-breathing Catfish of South-East Asia*. Narendra Publishing House, Delhi. p 174.

Narejo, N. T., M. M. Haque and S. M. Rahmatullah, 2002. Growth perpormance of snake eel, Pisodonophis boro (Hamilton).. *Bangla. J. Train. and Dev.* **15**: 23-29.

Nasar, S.S.T., 1997. *Backyard eel culture*: International Institute of Rural Reconstraction, Silang, Cavite, Philippines, 9: p 88.

Nikolsky, G. V., 1963. *The ecology of fishes* . Academic press Inc. London and New york, p. 17-19.

Rahman, M.A., 2003. Studies on the growth, survival and production of calbasu (*Labeo calbaus* Ham.) at different stocking densities in primary nursing. *Bull. Fac. Sci., Unv. Ryuyus, Jpn.* **76**: 245-55.

Teng, S. K. and T. E. Chuna 1979. Use of artificial hides to increase the stocking density and productio of estuary grouper, *Epinephelus salmoides Maxwell, reared in floating net cages. Aquaculture,* **16**:219-32.

Tripathi, S.D., Dutta, A., Sen Gupta, K.K., Pattra, S., 1979. High density rearing of rohu spawns in village ponds. In: Symp of Inland Aquacult. February 12-13, 1979. CIFRI. Barrack pore, p 14.

Usman Jafrim, N. A. K. and Khan, M. A. 2003. Nutrient digestibility studies in *Heteropneustes fossilis* (Bloch), *Clarias batrachus* (Linnaeus) and *Clarias gariepinus* (Burchell). *Aquaculture Res.*, **34**: 1365-2109.

Usui, A., 1974. *Eel culture*: Fishing news book limited, England p. 188

Vijayakumar, C., S. Sridhar and M.A. Haniffa. 1998. *Low cost breeding and hatching techniques for the catfish Heteropnuestes fossilius for small-scale farmers. NAGA,* **21**: 15-17.

Zar, J. H. 1984. *Biostatistics*. Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 718.