Pakistan J. Zool., vol. 37(3), pp. 181-185, 2005.

Effect of Temperature on Food, Growth and Survival Rate of Freshwater Mud Eel, *Monopterus cuchia* (Hamilton) During Aestivation Period

M. M. RAHMAN, N. T. NAREJO*, G. U. AHMED, M. R. BASHAR AND S. M. RAHMATULLAH
Department of Aquaculture, Bangladesh Agricultural University, Mymensingh-2202

Abstract.- The effect of temperature has been studied on feed intake, growth and survival rate of freshwater mud eel, *Monopterus cuchia* kept in four cemented cisterns with different shelters *viz.*, mud, PVC pipes and water hyacinth. The feed (dead small fish, kaski *Corica soborna*) was supplied once a day in the evening due to their nocturnal habit. The lowest average feeding rate (2.9g/Kg/day) was found at the lowest average temperature (14.4°C) and the highest average feeding rate (12g/kg/day) was found at the highest average temperature (27°C). The average food intake of each cistern was 266 g during December 2003 and January 2004. Nearly double amount (438 g) of food was taken during the month of February and March. The mean initial weight of mud eel was 82.4 ± 1.53 g and the mean final weight was 78.45 ± 0.92 g. No mortality was observed during the experimental period. No food was taken by the fish at or below the average temperature of 12°C.

Key words: Aestivation, *Monopterus cuchia*, mud eel.

INTRODUCTION

Temperature is one of the main metabolic activity regulatory factors that ultimately affect the growth, reproduction and behaviour of animals including fish. Effect of temperature on different animal behaviour has been studied by different researchers (Hutching, 1998; Conant and Collins, 1998; Petranka, 1998; Ultsch, 1973; Weber, 1944; Bicudo and Johansen, 1979; Delaney *et al*., 1974). During aestivation the water temperature goes down and the general activity of eel is consequently stopped. The eels just go down and bury themselves under the mud, rocks or in the substrate available to protect them and wait for the water to warm up, and when the food is more abundant (Narejo, 2003).

A freshwater mud eel or swamp eel, *Monopterus cuchia*, also known as Kuchia or Kucha belonging to the family Synbranchidae commonly occurs in the freshwater of Bangladesh, Pakistan and throughout India (Jhingran and Talwar, 1991). It is available in plenty throughout Bangladesh in mud holes, shallow beels and boro-paddy fields particularly in Sylhet, Mymensingh and Tangail Districts (Rahman, 1989). It has developed specialized pharyngeal pouches for bimodal gas exchange (Hughes and Munshi, 1973; Munshi, 1985). *M. cuchia* has remarkable ability to distend respiratory air sac for gas exchange (Mishra *et al*., 1977). It is a carnivorous nocturnal fish, and prefers small fish, worms and mulluscs. Kuchia spends the daytime hiding under crevices, stones, water hyacinth and soft mud (Nasar, 1997). Although tribal people and very few other Bangladesh is eat this fish, it is commercially important for export.

Since there is no information available on the food intake, growth and survival rate of these mud eels during aestivation period, the present study was initiated to observe the effect of temperature on intake of food, growth and survival rate of *M. cuchia* in the cemented cisterns during aestivation period.

MATERIALS AND METHODS

The experiment was conducted in the Department of Aquaculture, Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh for four months during December 2003 to March 2004. Live specimens of mud eel were collected from local fishermen of Mymensingh region, acclimatized for 15 days in cemented cisterns with water hyacinth to study the effect of temperature on

* Corresponding author (E-mail: nntariq@hotmail.com)
Present address: Department of Fresh Water Biology and Fisheries, University of Sindh, Jamshoro
0030-9923/2005/0003-0181 $ 8.00/0

food intake, growth and survival rate of mud eels. Four cemented cisterns of 1.25m^2 each were selected instead of mud ponds (Narejo *et al*., 2002b) for maintenance of fish. Four cisterns, 1/3rd of each were provided with soft mud (height of about 40.0 cm), 1/3 rd provided with water hyacinth and 1/3rd provided with PVC pipes (2.5 to 4.5 cm diameter, 10 pieces of pipes, each being 50 cm long were placed at the bottom of the cisterns). The depth of water was maintained at 15.0 cm, and was changed every alternate day to prevent the accumulation of growth inhibitory ammonia (Seymour, 1980). Ten mud eels of mean body weight 82.4 ± 1.53 g were reared in each cistern. Each cistern was supplied with dead small fish, kaski (*Corica soborna*). At the beginning feeds were supplied to each cistern once a day at 6.00 P.M. at the rate of 4% of the body weight. The quantity of feed was adjusted according to the left over feed found in the cistern the next day. The quantity of feed increased with the increase of fish demand as reported by Nasar (1997). It was noted that the eels preferred to eat at dusk as they are nocturnal in habit (Narejo, 2003). The unutilized feed was siphoned off everyday before next feeding and records were maintained. During the cleaning and feed supply the movement and behaviour of the experimental fish was observed. Temperature was recorded three times a day (8 AM; 1 PM and 6 PM) throughout the study period and average of three temperatures of a day was taken for calculation. Frequent sampling was avoided to minimize the disturbance to the experimental fish. For this reason measurement was taken at the end of the experimental period. The fish was weighed on a portable electronic balance (Model No. CT. 1200-S, USA) with the help of small plastic bucket. It was very difficult to handle the live eel, so, measurements of length were avoided. The growth rate was determined in terms of increase or decrease in mean body weight.

RESULTS

The lowest average feeding rate (2.9g/Kg/day) was found at the lowest average temperature (14.4°C) and the highest average feeding rate (12g/kg/day) was found at the highest average temperature (27°C). Lowest average food intake of each cistern was 266 g during the months of December 03 and January'04. Nearly double the amount (438 g) of food has been taken during the month of February and March'04. It was also observed that the feeding rate increased with the increasing temperature following the equation Y = 0.9252 × -11.466 (R^2 = 0.914) (Fig. 2) and the feeding rate decreased with the decreasing temperature following the equation Y = 0.1576 × + 1.3377 (R^2 = 0.1353) (Fig.1). The effect of different temperatures on feed intake of mud eels per kg body wt. of fish per day has been presented in Table I.

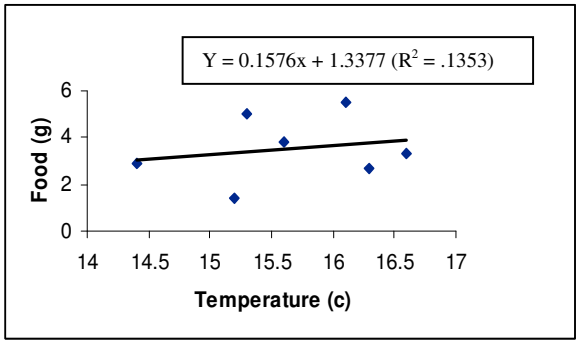

Fig 1. Correlation of food intake by the eel (*Monopterus cuchia*) with decreasing temperature.

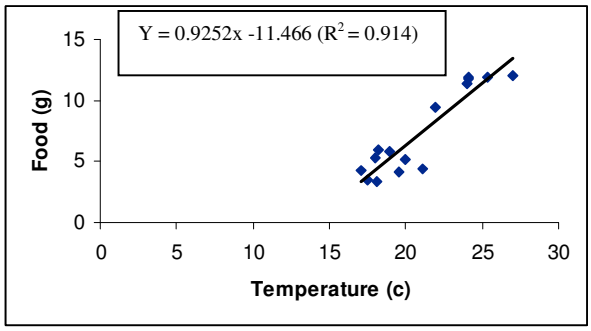

Fig 2. Correlation of food intake by the eel (*Monopterus cuchia*) with increasing temperature.

The mean initial weight of eels was 82.40±1.53 g and the mean final weight was 78.40±0.92 g. At the end of experiment the mean weight loss was 3.95±.061 g. The survival rates of fish during the experimental period was 100%. No disease was observed during the experimental period. It was also

noted that majority of the fish were burrowing inside the mud in one place, keeping the triangular snout out of mud and a few of them were also found together in a pipe, keeping the triangular snout out of pipes during the aestivation period. No fish were observed in the water hyacinth during that period. The fish took no food or very little food during the experimental period. The fish took no foods at the average temperature of 12°C.

Table I.- The effect of environmental temperature on feed intake per kg body per day of mud eel, (*Monopterus cuchia*) during aestivation period reared in the cemented cisterns of BAU, Mymensingh, Bangladesh

Sample No.	Time period (5 day intervals)	Average Temp. (°C)	Average food intake (g)/kg/day
1	01-12-03 – 05-12.03	21.1	4.40
2	06-12-03 – 10-12-03	19.6	4.10
3	11-12-03 – 15-12-03	18.1	3.40
4	16-12-03 – 20-12-03	16.6	3.30
5	21-12-03 – 25-12-03	18.9	5.80
6	26-12-03 – 30-12-03	15.3	5.00
7	31-12-03 – 04-01-04	14.4	2.90
8	05-01-04 – 09-01-04	15.2	1.40
9	10-01-04 – 15-01-04	16.3	2.70
10	16-01-04 – 20-01-04	17.5	3.50
11	21-01-04 – 25-01-04	18.2	6.00
12	26-01-04 – 30-01-04	16.1	5.52
13	31-01-04 – 04-02-04	15.6	3.78
14	05-02-04 – 09-02-04	17.1	4.32
15	10-02-04 – 14-02-04	18.0	5.28
16	15-02-04 – 19-02-04	20.0	5.12
17	20-02-04 – 24-02-04	21.9	9.48
18	25-02-04 – 29-02-04	24.0	11.36
19	01-03-04 – 05-03-04	24.1	11.84
20	06-03-04 – 10-03-04	24.1	11.80
21	11-03-04 – 15-03-04	25.3	11.84
22	16-03-04 – 20-03-04	27.0	12.00

DISCUSSION

In the present study it was observed that feed intake by the eel increased with the increasing temperature and it decreased with the decreasing temperature. It was also noted that all the fish burrowed inside the mud in one place, keeping the triangular snout out of mud. The fish in the PVC pipes were also found together in a pipe, keeping the triangular snout out of pipes. It might be the strategy of the fish to protect themselves from stress of low temperature during the winter months. Usui (1974) and Nasar (1997) reported similar observation in *Anguilla japonica*, *A. anguilla*, *A. rostrata*, and *M. cuchia.* Dunn (1983) reported that lungfish *Lepdosiren paradox* confined in a moist mud burrow survived several months during the dry season.

The average feed intake of each cistern was 266 g during the months of December 2003 and January 2004. It was near about half the amount from another two months (February and March 2004), 438 g. That is the increasing trend in food intake (near double) observed during the months from February and March 2004. It might be due to the optimum temperature (22 to 28°C). Johansen (1970) and Delaney *et al*. (1974) observed that air exposed fish are not able to take food, so they suffer starvation during such exposition. Usui (1974) reported similar results in *Anguilla japonica*, *A. anguilla* and *A. rostrata*, Chen (1976) in *A. japonica* and *A. anguilla,* Nasar (1997) in *M. cuchia* and Rashid *et al*. (1996) in *Pangasius sutchi.* No feed was taken by the experimental fish at the average temperature 12 °C and weight (g) loss for each (3.95 ± .061) was observed during the experimental period (aestivation). Gomes (1994) and Stievenart (1997) reported similar trend of weight loss (aestivation) in silk worm and giant African snails respectively during winter. Nasar (1997) reported an ideal temperature for proper feeding and growth of *M. cuchia* between 20 to 35°C and commented that the fish would not eat well below and above the temperature ranges. Usui (1974) reported that at 12°C eels like *Anguilla japonica*, *A. anguilla* and *A. rostrata* do not feed and thus do not grow at all. The above findings and temperature ranges are similar to the present study. Brown (1957) reported that temperature altered the rates of metabolic process and could be expected to have a considerable effect on the growth of poikilothermous animals. Nikolsky (1963) observed that metabolic rates were most closely connected with changes in temperature of the water. Long (1995) observed that fish adopted physiological, biochemical and behavioral strategies which decreased the metabolic rate and increased the anaerobic metabolism as well as changes in nitrogen metabolism by burrowing in the mud.

Ultsch (1973) and Weber (1944) observed that during aestivation, the aquatic salamanders (*Amphiuma means*, *Siren lacertina*) slow down their metabolism and live off on large fat reserves located in their tails. This adaptation allows them to live in both permanent and temporary bodies of water. In the present study the significantly highest survival rate (100%) was obtained. Teng and Chua (1979) in estuary grouper *Epinephelus salmoides*, Ali *et al*. (1999) in *Penaeus monodon* and Narejo *et al*. (2002b) in *Pisodonophis boro* reported similar survival rates of 99.1%, 99% and 90% respectively with shelter. Ling (2001) observed that Black mud fish (*Neochanna diversus*) reduced their metabolic rate by around 60% and remained mostly inactive throughout the period of aestivation.

ACKNOWLEDGEMENT

The authors are happy to acknowledge the financial support of the World Fish Center (ICLARM), Bangladesh for successful completion of the research project. The authors would thank Dr. Somen Dewan, Professor, Department of Fisheries Management, Bangladesh Agricultural University (BAU), Mymensingh for his help to smoothly run the research work in the cemented cistern adjacent to the Fisheries Faculty Building, BAU, Mymensingh.

REFERENCES

ALI, M.S., SHAFIQUZZOHA, A. F. M. AND AHMED, S.U., 1999. Effect of submerged aquatic vegetation on growth and survival of *Penaeus monodon* (Fab.). *Bangladesh J. Fish. Res.,* **3**: 145-149.

BICUDO, J.E.P.W. AND JOHANSEN, K., 1979. Respiratory gas exchange in the air breathing fish, *Synbranchus marmoratus*. *Environ. Biol. Fish.,* **4**: 55-64.

BROWN, M.F., 1957. *Physiology of fishes*. Academic Press Inc. Publishers. New York vol. 1, pp. 390-392.

CHEN, T. P., 1976. *Aquaculture practices in Taiwan*. Fishing News Books Limited. 1 Long Garden Walk, Farnham, Surrey, England. pp.163.

CONANT, R. AND COLLINS, J.T., 1998. *A field guide to reptiles and amphibians*. Houghton Mifflin Company, Boston.

DELANEY, R.G., LAHIRI, S. AND FISHERMAN, A.P., 1974. Aestivation of the African lungfish *Protopterus aethiopicus*, cardiovascular and respiratory functions. *J. exp. Biol.,* **61:**111-128.

DUNN, J.F., HOCHACHKA, P. W., GUPPY, M. AND DAVIDSON, W., 1983. Metabolic adjustments of diving and recovery in the African lungfish. *Am. J. Physiol*., **245**: 651-657.

GOMES, D.S.M.A., 1994. Hatchability of silkworm eggs, under variable estivation and hibernation conditions and chemical treatment with HCl during diapause. *Vet. Zootec.,* **6**: 147-159.

HUGHES, G. M. AND MUNSHI, J. S. D., 1973. Nature of air-breathing organs of the Indian fishes *Channa*, *Amphipnous*, *Clarias* and *Saccobranchus* as shown by electron microscopy. *J. Zool. Lond*., **170**: 245-270.

HUTCHING, G., 1998. *The natural world of New Zealand: an illustrared encyclopaedia of New Zealand's natural heritage*. Penguin Books (NZ) Ltd, Auckland.

JHINGRAN, A.G. AND TALWAR, P.K., 1991. *Inland fisheries of India and adjacent countries,* Vol. 1, Oxford and IBH publishing Co. Pvt. Calcutta. pp. 514.

JOHANSEN, K., 1970. *Air breathing fishes.* In: *Fish physiology* (eds. W.S. Hoar. and D.J. Randall), vol. IV, pp 361-411. Academic Press. New York.

LING, N., 2001. *New Zealand mud fishes*: *a guide*. Department of Conservation, University of Waikato, Wellington, Hamilton, New Zealand. 21pp.

LONG, J.A., 1995. *The rise of fishes*. In: *500 million years of evolution*. Johns Hopkins Univ. Press, Baltimore, 233 pp.

MISHRA, N., PANDEY, P.K. AND MUNSHI, J.S.D., 1977. Haematological parameters of an air- breathing mud eel, *Amphipnous cuchia* (Ham.) (Amphipnoidae; Pisces). *J. Fish Biol*., **10**: 567-573.

MITTAL, A.K. AND AGARWAL, S.K., 1977. Histochemistry of the unicellular glands in relation to their physiological significance in the epidermis of *Monopterus cuchia* (Synbranchiformes; Pisces). *J. Zool. Lond*., **182**: 429-439.

MITTAL, A.K., WHITEAR, M. AND AGARWAL, S. K., 1980. Structure and histochemistry of the epidermis of the fish *Monopterus cuchia*. *J. Zool. Lond*., **191**: 107-125.

MUNSHI, J. S.D., 1985. The structure, function and evolution of the accessory organs of air-breathing fishes of India. *In*: *Vertebrate morphology* (eds. Duncker and Fleischer), pp. 353-366. New York: Gustav Fischer.

NAREJO, N.T., 2003. *Comparative studies on the biology and culture of* Monopterus cuchia *and* Mastacembelus armatus *of Mymensingh region*. Ph.D. thesis, Department of Aquaculture, Bangladesh Agricultural University, Mymensingh, Bangladesh. 205 pp.

NAREJO, N.T., HAQUE, M.M. AND RAHMATULLAH, S.M., 2002b. Growth performances of snake eel, *Pisodonophis boro* (Hamilton) reared experimentally with different food items. *Bangladesh J. Train. Dev*., **15**: 221-225.

NASAR, S.S.T., 1997. *Backyard eel culture*: International Institute of Rural Reconstruction, Silag, Cavity, Philippines. 88 pp.

NIKOLSKY, G.V., 1963. *The ecology of fishes*. Academic Press, London and New York, 352 pp.

PETRANKA, J.W., 1998. *Salamanders of the United States and Canada*. Smithsonian Institution Press, Washington D.C.

RAHMAN, A.K.A., 1989. *Freshwater fishes of Bangladesh*. Zoological Society of Bangladseh, Univ. Dhaka 364 pp.

RASHID, M.H., RAHMATULLAH, S.M. AND AMIN, M.R., 1996. Preparation of low-cost feed for cage culture of pangus *Pangasius sutchi* (Fowler). *Bangladesh J. Fish*., **19**: 45-52.

SEYMOUR, E. A., 1980. The effects and control of algal blooms in fishponds. *Aquaculture,* **19**: 55-74.

SINGH, B.N., TOWHEED, M. A. AND MUNSHI, J. S. D., 1989. Respiratory adaptations in the larvae of *Monopterus cuchia* (Ham.). *J. Fish Biol.,* **34**: 637-638.

STIEVENART, C., 1997. Shell morphology, growth, reproduction and estivation of giant African snails. *Tropicultura,* **15**: 217-219.

TENG, S. T. AND CHUA, T. E., 1979. Use of artificial hides to increase the stocking density and production of estuary grouper *Epinephelus salmoides* (Maxwell), reared in floating net cages. *Aquaculture,* **16**: 219-232.

ULTSCH, G.R., 1973. Observations on the life history of *Siren lacertian. Herpetologica,* **29**: 304-305.

USUI, A., 1974. *Eel culture.* Fishing News Books Limited, England 188 pp.

WEBER, J. A., 1944. Observation on the life history of *Amphiuma means. Copeia,* **1944**: 6162.

(Received 19 August 2004, revised 22 February 2005)