STUDY ON REPRODUCTIVE BIOLOGY, CAPTIVE BREEDING, LARVAL REARING AND GROW-OUT OF GIANT SNAKEHEAD, CHANNA *MARULIUS* (HAMILTON, 1822)

SUMMARY

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SUMMARY

The 'Giant snakehead' is one of the important native species which has been in great demand not only in India but all over the south-east Asia and USA due to several of its qualities. Geographically the species is distributed in Pakistan, India, SriLanka, Bangladesh, Nepal, Burma, Thailand and China and has been established in inland waters of North America due to introductions. It inhabits large lakes and rivers; prefers deep, clear stretches of water with sandy or rocky bottom, swamps, marshes and rice fields and reported to attain maximum length of 180 cm and weight up to 30 kg. The species is very tasty at platter and considered a favourite sport fish as can be caught with ladle or spoon. It is also considered to have many medicinal properties and has been prioritized as an important fish species for diversification in aquaculture. Therefore, attempts have been made to understand its biology (including reproductive) in order to develop protocols for captive breeding, larval rearing and grow-outs.

The biological data on mean LWR, a, b and log w values, ponderal index (K) and coefficient of determination (R^2) in the present study indicated that the species strictly followed LeCren's Cube law with 'b' values of 3 in all the length intervals. The log w value (0.4868) was found lowest for smallest length group (1-10 cm), which subsequently increased to 1.3767 in length group 11-20 cm, 2.1551 in length group 21-30 cm, 2.4871 in length group 31-40 cm and 2.7584 in length group 41-50 cm. A significant drop in log w value was observed in higher length groups of 51-60 cm and 61-70 cm in comparison to small length groups with respective log w values of 2.1982 and 2.2768. K value of 0.92 in length group of 1-10 cm suggest that at this size, plumpness in the fish is highest which was found to reduce to 0.73 in length group 11-20 cm, 0.78 in length group 21-30 cm, 0.69 in length group 31-40 cm, 0.66 in length interval 41-50 cm, 0.58 in length interval 51-60 cm and 0.70 in length group 61-70 cm. The values of Coefficient of determination (R^2) were found to follow similar trend as that of K values showing negatively allometric growth in this species i.e. K less than 1. Highest R^2 value of 0.86 in length group of 1-10 cm suggest that at small size, the fish

followed strong LWR relationship in comparison to larger size groups with R^2 values of 0.68 in length group 11-20 cm, 0.76 in length group 21-30 cm, 0.51 in length group 31-40 cm, 0.67 in length interval 41-50 cm, 0.67 in length interval 51-60 cm and 0.6 in length group 61-70 cm. The summary of the statistical analysis for 24 morphometric variable of this species of size range 3.22 cm to 19.10 cm were found to differ >30% for all the parameters of the study when compared with the total length. The highest CV was observed for caudal fin length (71.43%) followed by head depth (51.50%), dorsal fin length (50.44%), pre-orbital length (49.47%), standard length (49.26%), forked length (48.10%) and upper jaw length (47.79%). The lowest value of CV was observed for dorsal fin spine length (32.42%), followed by head width (36.61%), pre-pectoral length (38.51%), eye diameter (38.56%) and caudal fin height (38.98%). The analysis on 5 different meristic variables (fins) suggested a relatively higher variability with the anal fin rays (18.80%) followed by pectoral fin rays (15.69%), dorsal fin rays (12.15%), caudal fin rays (8.98%) and pelvic fin rays (8.92%), which was observed 2.59%, 6.70%, 2.22%, 6.02% and 9.25% for the same parameters.

Morphological sex determination in *C. marulius* is difficult both during spawning and non-spawning seasons. Therefore, the fishes were examined for sex determination both during spawning and non-spawning seasons. The females were found to have either no distance or little distance between the tail end margin of pectoral fin and the first rosette of the lateral line. Further, there is comparatively very little distance between the vent and the start point of anal fin. These two points were very well observed even during non breeding period. During spawning season, the belly was found slightly swollen below the base of pectoral fins but this character was only pronounced in a good fecund fishes. The females have round vent and during spawning season, slightly fleshy and deep red. The males were found to have larger distance between the tail end of the pectoral margin and the first rosette of lateral line in comparison to females and this character exists in both immature and mature specimens and during spawning as well non spawning seasons. Another character which could be observed both during spawning and non spawning season is larger

distance between the vent and the start point of anal fin. A good mature male was found to exude transparent milt from the vent when pressure is applied on the abdomen.

The length and weight of the fishes used for the assessment of GSI was 49.4 cm to 81.8 cm and weight 0.8 kg to 3.5 kg in case of females and 51.4 cm to 95.04 cm and weight 0.8 kg to 4.9 kg in case of males. The mean value of GSI was lowest in January (0.184 ± 0.010), which showed gradual rise in February (0.340 ± 0.051) and March (0.705 ± 0.199) months and reached maximum in April (2.556 ± 0.233) in female fishes. The mean value of GSI in case of males were the lowest both in January and February months (0.038 ± 0.029 and 0.037 ± 0.032), which showed gradual rise in March (0.043 ± 0.011) and reaching maximum in April (0.080 ± 0.009). The testes of *C. marulius* were minute paired lobular structure, situated in the peritoneal cavity and suspended on either side of the mid-line by a mesovarium. At initial phase of development, the testes remain attached completely over the ventral mesovarium and with advancement of maturity the cranial part was found to invade both side of the alimentary canal. An entirely different methodology was used for the extraction of the testes unlike carps and catfishes. The histological study of ovarian development in the fish samples collected during February to April 2015 indicated five developmental stages of oocytes all through the study period and thus revealed that the ovarian development in this species is asynchronous and this species spawn many times during a prolonged breeding season. Generally four different stages i.e. immature, prespawning, spawning and post spawning (spent) of the testicular development were identified based upon the histological variations.

The captive breeding trials were undertaken in three sets of systems i.e. in earthen ponds, cement tanks and FRP tanks. Out of 8 sets arranged in pond conditions, spawning occurred in 5 sets. Only one female spawned in all the cases and females given hormonal injections of both 1.0 $ml.kg^{-1}$ bw and 1.5 $ml.kg^{-1}$ bw equally gave more or less the same spawning response. All the females spawned within 12-24 hours of giving hormonal injection. The females laid eggs in the form of an egg mass

surrounding between the aquatic macro-vegetation so that they remain in intact condition. Both fertilization and hatching rates were observed over 90% in all the spawned fishes. The water quality analysed for both ponds were found to range temperature 28.6 - 32.2 ^{o}C, pH 7.9 - 8.5, TDS 310 - 340 mg.L^{-}1 and was in the normal range. A total of 4 sets spawned out of 8 arranged for induced breeding in the cement tanks. None of the set in FRP tank responded though a good amount of mating response was observed in the brooders.

The fertilized eggs were round, transluscent, pale yellow, pelagic, non-adhesive and had a diameter of 1.79$\pm$0.05 mm. They were unique in having single large round oil globule of dia 1.1$\pm$0.1 mm, almost two-third size of the yolk and immersed in the golden yellow yolk having a dia of 1.25$\pm$0.1 mm and both were surrounded within a space bounded by the vitelline membrane. The embryo hatched in 29.00$\pm$1.00 pfh at 26$\pm$1 ^{o}C. A just hatched larva was translucent, dull brown in colour and has well defined yolk. The yolk-sac was completely absorbed in 73.00$\pm$0.30 phh or total 102.00$\pm$0.30 pfh. At this stage, the larva reached a length of 6.56 mm and swim freely with well developed mouth and all fins.

The larval rearing trial was conducted in triplicate set with six variable diets in 18 FRP tanks of 1125 litre (size 1.5 x 1.0 x 0.75 m). The highest mortality was observed in the second week of the experiment which slowed down in the subsequent weeks but continued till the completion of the experiment. The survival was significantly higher (p<0.05) with feeds E (60% CP, 88.3%) and F (54% CP, 85.0%) in comparison to feeds A (30% CP, 46.6%), B (36% CP, 46.6%), C (42% CP, 46.6%) and D (48% CP, 53.3%). A linear relationship existed between net biomass production, SGR and per day weight gain from feed A-F containing low to high levels of protein. The FCR was found very high and variable in treatments A to D, whereas it was in the acceptable range in treatments E (3.64) and F (3.26). The values of 'R^{2}' and 'W' for all the treatments were found more or less the same which revealed that all the surviving fishes were in good shape of health. The fishes in all the treatments follow Fulton's condition factor where values of 'b' were

observed higher than 3. 14 revealed that there were significant variations (p<0.05) in protein levels of carcasses of fishes fed different diets. The protein deposition in tissue was found directly proportional to the available protein in the test diets. The highest level of protein (666.3 $g.kg^{-1}$) was observed in the tissue of fishes fed diet F (CP 600 $g.kg^{-1}$) followed respectively 631.3 $g.kg^{-1}$, 627.6 $g.kg^{-1}$, 583.3 $g.kg^{-1}$, 576.9 $g.kg^{-1}$ and 560.9 $g.kg^{-1}$ with diets E (CP 540 $g.kg^{-1}$), D (CP 480 $g.kg^{-1}$), C (CP 420 $g.kg^{-1}$), B (CP 360 $g.kg^{-1}$) and A (CP 300 $g.kg^{-1}$).

The grow-out of *C. marulius* was taken up in a cement tank of dimension 14.2m x 10.3m x 1.2m (LxWxH) in which the test fish of length 4.11±0.042 cm and weight 4.05±0.059 g numbering 244 were stocked after manuring and proper acclimatization. The survival was found low in small size fish but gradually improved and stabilized from November onwards when they attained a mean length of 15.1±0.19 cm and weight 26.96±1.30. Though gross survival of only 22.54% was observed under 13 months culture period but majority of losses was only up to October. The loss in survival could be linked mainly to the cannibalism behavior as the numbers of shooters recorded in July were the highest resulting in net lowest survival of 63.93%. As the culture progresses and fish started relishing the formulated diet, the number of shooters also subsequently reduced and no shooter was recorded from December onwards resulting in stabilizing of net surviving rate to over 90% in the subsequent months. The weight-length data indicated that both of them tend to increase gradually and reached from a mere weight and length of 4.05±0.59 g and 4.11±0.042 cm in June 2013 to 117.68±10.43 g and 23.36±0.71 cm in June 2014. A strong correlation (R^2) existed between WLR all through the culture period. The 'K' values were found both size and season dependent. Small fishes (4.11±0.042 cm) in comparison to large fishes (23.36±0.71 cm) observed respective 'K' values of 5.173 and 0.9259. The analysis of regression expressed that both small (2.61 to 2.91 cm) and large groups (12.63 to 23.36 cm) observed allometric growth in 'b', though it was negative in previous case, and positive in the later. The value of 'b' was found to increase with increase in weight/age. In 13-months culture

period, the fry of *C. marulius* attained a length of 23.36±0.71 cm and weight of 117.68 g from that of 4.11±0.042 cm and 4.05±0.59 g respectively giving a net production of 5.48 kg (375.34 kg/ha/yr) at a gross survival of only 22.54%. Though the production was low but considering that the experiment was taken up in a small cement tank, where growth is always likely to suffer, there is need to take up similar study in larger earthen ponds with higher stocking densities along with the versatile method of grading the shooters. It is, therefore, concluded that *C. marulius* could be successfully weaned on artificial diet for a commercial farming. The weaning on artificial diet not only gradually stopped cannibalism but also provided comparatively higher survival and better production in comparison to culture on the models of predator-prey system or extraneous feeding with fish and animals meat. More and elaborate such studies are required for the development of commercial protocols in future studies.