Sains Malaysiana 44(9)(2015): 1217–1222

A Review on *Sperata aor* (Hamilton, 1822), a Popular Food Fish of Indian Subcontinent

(Kajian ke atas *Sperata aor* (Hamilton, 1822), Ikan Makanan Popular dari Subbenua India)

SANDIPAN GUPTA*

ABSTRACT

Sperata aor *is a freshwater catfish of Bagridae family which is distributed throughout Indian subcontinent including India, Bangladesh, Pakistan, Nepal and Myanmar. It is a popular food fish due to its good taste and high nutritional value. Recently it has also made its entry in domestic ornamental fish markets of India and has been reported to have moderate export price too. Earlier, few works on different aspects of its morphology and biology have been carried out but no consolidated review is available on these aspects. Therefore, the current work was done to sum up all available information on these aspects to fill the information gap that will be beneficial to its future fishery. Considering all available information, knowledge on food and feeding habit of this fish species is satisfactory, except detail information on spatial variation of its breeding periodicity, proper information on other aspects are still lacking. No work has been conducted to examine its captive culture potential or for induced breeding. Further work should be done to explore its future fishery.*

Keywords: Breeding biology; feeding habit; fishery; morphology; Sperata aor

ABSTRAK

Sperata aor *adalah ikan keli air tawar daripada keluarga Bagridae tertabur di sepanjang subbenua India termasuk India, Bangladesh, Pakistan, Nepal dan Myanmar. Ia adalah ikan makanan popular kerana khasiatnya yang tinggi dan baik rasanya. Baru-baru ini ia juga telah menjadi ikan hiasan dalam pasaran tempatan di India dan telah dilaporkan mempunyai nilai harga eksport yang sederhana. Sebelum ini, beberapa kajian ke atas aspek morfologi dan biologi yang berbeza telah dijalankan tetapi tiada kajian keseluruhan ke atas aspek-aspek ini. Oleh itu, kajian ini telah dijalankan untuk menyatukan semua maklumat yang ada pada aspek-aspek ini untuk mengisi jurang maklumat yang dapat memberi manfaat kepada industri perikanan pada masa hadapan. Memandangkan semua maklumat yang ada, pengetahuan mengenai makanan dan tabiat pemakanan spesies ikan ini adalah memuaskan, kecuali maklumat terperinci tentang variasi reruang kala pembiakan yang masih kurang. Tiada kajian dijalankan untuk mengkaji potensi budaya kawalan atau untuk pembiakan teraruh. Kajian lanjutan perlu dilakukan untuk meneroka perikanan ini pada masa hadapan.*

Kata kunci: Biologi pembiakan; morfologi; perikanan; Sperata aor*; tabiat pemakanan*

INTRODUCTION

Long-whiskered catfish *Sperata aor* (Hamilton, 1822), is commonly known as a commercially important freshwater catfish of India, Bangladesh, Pakistan, Nepal and Myanmar (Azadi et al. 1992; Chondar 1999; Day 1878; Ferraris Jr. & Runge 1999; Ramakrishniah 1992; Talwar & Jhingran 1991; Tripathi 1996). Though in general it is mostly riverine in habitat, it also inhabits ponds, lakes, tanks, channels and reservoirs. This species has a high range of tolerance for temperature and salinity (Chondar 1999). Adults and juveniles are bottom and marginal dwellers; fry inhabit the shallow marginal area of rivers and marginal pits connecting the river through channels; larvae live in the nests formed among rocks or soft muddy beds of stream, rivers and large tanks (Chondar 1999). It has been considered as one of the most admired edible fishes due to low number of intramuscular bones (Chondar 1999; Talwar & Jhingran 1991) and high nutritional value with good protein content (Chondar 1999; Khawja 1966). Recently it has made its entry in domestic ornamental fish market of India (Gupta & Banerjee 2012) and has been reported to be exported from India as indigenous ornamental fish with moderate export price (Gupta & Banerjee 2014; Jayalal & Ramachandran 2012). Earlier, a number of works has been carried out on different aspects of its morphology, feeding and breeding biology but so far no consolidated report is available on these aspects of this species. So with this view, the current work was conducted to note down all those previously documented information to fill the gap that will be beneficial for its future fishery and management.

TAXONOMIC DESCRIPTION AND MORPHOLOGY

Sperata aor is a member of Bagridae family under order Siluriformes and class Actinopterygii (Figure 1). Earlier, Day (1878) documented the morphological characters of this catfish species in details; after that Chondar (1999), Ferraris Jr. and Runge (1999) and Talwar and Jhingran

(1991) added more information on this aspect. It is the compilation of the earlier documented morphological characters of *S. aor*: body is graceful, elongated and slender; body depth at dorsal fin origin is only slightly greater than that anterior to adipose fin origin, more posteriorly tapering gradually. Its depth is 4 to 5.2 times in standard length. Ventral surface of head and body is flat to anal fin base. Body is compressed and triangular in cross section across abdomen; compressed and ovoid across caudal region. Caudal peduncle is narrow. Skin is smooth, devoid of any scale. Lateral line is complete, midlateral in position. Head elongated; progressively depressed anteriorly. In lateral view, the profile of head is acutely triangular, with ventral surface of head nearly horizontal. Width of the head is 3/5 of its length; its upper surface is covered with thin skin, bones readily visible, ornamented with fine, irregular and radial grooves. Occipital process does not extend half-way to the basal bone of the dorsal, whilst an intermediate interneural shield exists which is usually wider than the occipital process. The width of this bone is subject to great variations, thus in some old specimens it is only twice as long as broad, whilst in others and in some immature it is four times as long as wide. The longitudinal furrow on the head extends to the base of the occipital process. Gill opening is wide, extending from exposed surface of post-temporal to beyond isthmus. Gill membranes are free from and not attached across isthmus. Branchiostegal rays are 12 or 13 in number. Snout is long and depressed; lateral margins slightly convergent anteriorly; snout margin is distinctly rounded with fleshy upper lip extending anteriorly beyond upper jaw; mouth sub-terminal, the width of the gape being equal from 2/5 to 3/7 of the length of the head; the cleft does not extend half way to the orbit.

Oral teeth small, sharply pointed, in irregular rows on all tooth-bearing surfaces; premaxillary tooth band is rounded, of equal width throughout; dentary tooth band is much narrower than premaxillary band at symphysis, tapering laterally; palatal tooth patch unpaired, continuous across midline, smoothly arched along anterior margin, tapering laterally to point extending posteriorly well past level of premaxillary band, band width narrower than premaxillary band at midline, widening laterally and then tapering to sharp point posterolaterally. Eyes are transversely oval. Barbels four pairs in total; maxillary barbels long, slender, without medial membrane, tip of barbel extends at least to caudal peduncle and often past tip of caudal fin rays; nasal barbels slender, extend past anterior margin of orbit and sometimes to its posterior margin; inner mandibular barbels originate close to midline, thicker and longer than nasal barbels, extend to level of posterior margin of orbit; outer mandibular barbels originate about one-half of eye diameter posterolateral of inner mandibular barbels, thicker and longer than inner mandibular barbels, extend past pectoral fin origin.

Dorsal fin is located above middle of the body; its margin is straight; this fin is with spinelet, spine and 7 branched rays; spine is long, straight and comparatively robust; anterior and lateral spine margins of small specimens smooth, with fine serrations on distal half of posterior edge; in large individuals anterior and lateral margin of spine granular, posterior serrations less prominent; tip of the adpressed spine reaches past adipose fin origin. The adipose dorsal fin commences above the last third or end of the ventral fin and its base equals about that of the rayed fin or even a little more; adipose fin margin is slightly convex for entire length; posterior end is deeply incised; the extent of the interspace between the dorsal fin and adipose dorsal fin equals half the length of that of the rayed dorsal fin. Pectoral fin is as long as the head excluding the snout and reaches 4/7 of the distance to the pelvic fin; it is with stout spine, sharply pointed at tip; anterior spine margin smooth while posterior spine margin with moderately strong serrations along entire length; pectoral fin margin is straight anteriorly but convex posteriorly; pectoral fin with 11 or 12 branched rays. Pelvic fins arise below the last dorsal fin rays and do not reach the anal fin; pelvic fin margin is slightly convex; pelvic fin with 1 unbranched and 5 branched fin rays. Anal fin originates opposite to middle of the adipose dorsal fin; fin margin is straight and with 3 or 4 unbranched and 8-10 branched fin rays. Caudal fin is deeply forked; lobes pointed, its upper lobe is longer with its tip bending downwardly. Body colour is bluish-leaden superiorly, gradually fading to whitish on flanks and belly; fins are yellowish, stained with dark externally in both the dorsal and caudal fins; a black spot about equal to the diameter of the eye is present on the adipose dorsal fin on its posterior and inferior portion.

FIGURE 1. Fresh specimen of *Sperata aor*

In adult stage, *S. aor* is almost alike with *Sperata seenghala*, but *S. aor* is chiefly distinguishable from *S. seenghala* by few characters as follows: *Sperata aor* snout is rounded; maxillary barbels long, extend to or even beyond the base of the caudal fin; interneural shield approximately as long as supraoccipital spine; pectoral fin rays 10 or 11 in number; orbit extends across the middle of length of head; gill rakers are typically 19 or 20 in number. In *S. seenghala*, snout is distinctly truncated; maxillary barbels extend no further than to middle of body; interneural shield longer than supraoccipital spine; pectoral fin rays 8 or 9 in number; orbit entirely in anterior half of head; gill rakers are typically 13 to 15 in number (Ferraris Jr. & Runge 1999).

Maximum Length and Growth Pattern

Day (1878) and Misra (1959) reported maximum length of 182.8 cm for *S. aor* while Talwar and Jhingran (1991) and Tripathi (1996) documented the length 180 cm. Job et al. (1955) enlisted 4 feet (122 cm) as the maximum length for *S. aor* in the commercial catch of Mahanadi River and Rahman (2005) reported 94 cm for the same in his collected samples from Bangladesh.

In studying the length-weight relationship, Saigal (1982) reported isometric growth pattern of *S. aor* in their studied specimens which was later supported by Azadi et al. (1992) and Sani et al. (2010). Later, allometric growth pattern was documented for this fish species. Khan et al. (2011) reported negative allometric growth pattern while Kumar et al. (2014) documented positive allometric growth pattern for *S. aor*.

Food and Feeding Habit

A good number of workers had studied the food and feeding habit of *S. aor* and they concluded the carnivorous feeding habit with piscivorous and predaceous nature of the adults (Azadi et al. 1992; Ghosh & Chakrabarti 2013; Raj 1962; Ramakrishniah 1992; Ranganathan & Radha 1966; Saigal 1964; Sinha & Chakrabarti 1986) except Agarwal and Tyagi (1969) who described *S. aor* as an omnivorous fish mainly feeds on worms and tender parts of the aquatic plants. Saigal (1964) reported that adult of *S. aor* mainly feeds on teleosts in the bottom and insects in the bottom and column waters. He reported teleosts to form the main part (58.7%) of the diet followed by insects (27.73%), crustaceans (8.21%) and plant matter and detritus (5.36%). Several fish species (*Aspidoparia morar*, *Oxygaster* sp., *Colisa fasciata*, *Gudusia chapra*, *Eutropiichthys vacha*, *Pama pama*, *Ailia coila*, *Gagata cenia*, *Nemacheilus botia*, *Rita rita*, *Setipinna phasa*, *Mastacembelus armatus*, *Puntius ticto*, *Gonialosa manmina*, *Glossogobius giuris*, *Chanda nama*, *Osteobrama cotio cotio*, *Mystus seenghala* and *Hilsa ilisha*) have been commonly documented in its gut content together with nymphs and larvae of Odonata, Diptera, Mecoptera, Trichoptera and Coleoptera. *Palaemon lamarrei* and *Leander styliferus* mainly have been enlisted as the crustacean food along with prawns and crabs (*Varuna* sp.). Apart from fish, the presence of may fly nymphs, mollucs and oligochaetes in the diet of *S. aor* was documented by Ranganathan and Radha (1966); and rotifers, diatoms and copepods on availability in the ecosystem were also reported by them. Azadi et al. (1992) reported it as a bottom-feeding carnivorous fish with the presence of several fish species such as *Glossogobius giuris*, *Ailia coila*, *Puntius sophore*, *Puntius ticto*, *Amblypharyngodon mola*, *Chanda ranga*, *Gudusia chapra*, *Corica soborna* and *Mastacembelus pancalus*, fish remains (scales, bones, eyes, fin rays and partly digested bodies), insects (dragonfly nymphs and chironomid larvae), bivalve molluscs (*Bellamya bengalensis* and *Thiara tuberculata*), crustaceans (*Macrobrachium lamarrei*), plant matter (parts of leaves, stems of higher plants, dried grass leaves and aquatic weeds), debris (decayed organic matter) and miscellaneous items (partly digested food materials mainly fish flesh, sand and mud) in the gut of *S. aor* collected by them. Ramakrishniah (1992) also reported the bottom feeding habit of *S. aor* - teleosts (*Glossogobius giuris*, *Osteobrama cotio*, *Oxygaster phulo*, *Oxygaster clupeoides* and *Barilius evezarxdi*), prawns (*Macrobrachium lamarrei*), molluscs (*Melanoides*, *Vivipera*), insects (nymphs of Odonata and larvae of Diptera) and organic detritus were found abundantly in its gut. Incidence of cannibalism in *S. aor* had been reported by Ramakrishniah (1992) and Saigal (1964).

Early fry stage has been reported to consume zooplankton (Chondar 1999); while advanced fry stage (23-26 mm) has been documented to consume small carp, *Puntius* sp., *Mugil* sp., clupeids and beetle larvae (Karamchandani 1957). Juveniles are mainly insectivorous, bottom and marginal feeder; consuming Coleoptera larvae (*Elmis*, *Cybister* and *Dytiscus*), Diptera larvae (*Culex*, *Chironomid*, *Dixia* and *Eristalis*), Odonata nymph (*Aeschina*, *Cordula* and *Mesothemis*) and water bug (*Corixa* and *Ranatra*); and also teleosts (*Aspidoparia morar*, *Oxygaster bacaila*, *Osteobrama cotio*, *Ailia coila*, *Gagata cenia*, *Eutropiichthys vacha*, *Setipinna phasa*, *Gonialosa manmina*, *Gudusia chapra*, *Chanda* sp. and *Puntius* sp.), crustacean (shrimp, prawn, small crabs and ostracods), plant matter and detritus (Saigal 1964). Change of diet from insectivorous in juveniles to piscivorous-cum-insectivorous in adults has been reported to be largely complete by the time the fish having reached a length of 300 mm or above (Saigal 1964). Recently Ghosh and Chakrabarti (2013) reported the importance of olfactory sense of this fish species in detection of food.

Sexual Dimorphism, Sex Ratio, Size and Age At First Maturity

Saigal (1964) and Sathyanesan (1962) reported that sex for *S. aor* beyond 300 mm in length can be differentiated externally by the presence of a papillary out-growth. This out-growth is present just above the urino-genital pore in male, but absent in female. On the contrary, Ramakrishniah

(1992) reported the presence of genital papilla in both the sexes from specimens collected at Nagarjunasagar reservoir.

Ramakrishniah (1992) and Saigal (1964) also reported female dominance in population of *S. aor* while Azadi et al. (1992) reported male dominance (except during pre-spawning period) in their studied sample.

Saigal (1964) reported that the minimum size at maturity for *S. aor* is 84 cm. Ramakrishniah (1992) documented 57.3 cm as length at first maturity for *S. aor* and he also reported *S. aor* used to get matured at the age of 4 years.

Gonadal Maturity Stages and Fecundity

Saigal (1964) documented seven gonadal maturity stages in *S. aor* based on macroscopic and microscopic scales - immature, intermediate, early maturing, late maturing, advanced maturing, ripe and spent. Saigal (1964) also reported the fecundity of *S. aor* varying at 45000-122500 in one spawning with maximum of 227050-612385 considering five spawning bursts in a season while Ranganathan and Radha (1966) documented fecundity range of 21490-38400 from Bhabanisagar reservoir. Azadi et al. (1992) documented fecundity range of 12560-48635 for *S. aor* from Kaptai reservoir, Bangladesh. Positive correlation of fecundity with body length, body weight and ovary weight was reported by Azadi et al. (1992) and Saigal (1964).

Breeding Periodicity and Spawning Type

The breeding season of *S. aor* has been reported to vary in different regions of India. June to July has been reported as breeding season in Punjab waters (Khan 1924) while April to May in Cauvery River (Raj 1940) and September to December in Tungabhadra River above Sunkesula anicut (Chacko & Kuriyan 1948). Saigal (1964) reported March to August as breeding season with spawning peaks in April and June in Ganga River for *S. aor* while February to May has been documented as breeding season for this fish species in Bhavanisagar reservoir (Ranganathan & Radha 1966) and April to October in Nagarjunasagar reservoir (Ramakrishniah 1992). Azadi et al. (1992) reported April to July as breeding season for *S. aor* in Kaptai reservoir, Bangladesh. This spatial variation of breeding season has been attributed to some important factors like temperature, day length, water current and sandy bed (Ranganathan & Radha 1966; Saigal 1982). Sathyanesan (1962) reported variation in spawning season in respect to early or late availability of the inducing factors. High water temperature, sluggish water current and sandy bed has been documented as important factors for spawning of *S. aor* in the Ganga (Saigal 1982). Ranganathan and Radha (1966) documented some important hydrological characters of the breeding environment of *S. aor* in the Bhabanisagar reservoir like gentle water flow of 300-400 cusecs, bright sunrise and cool breeze, optimum temperature range of 25.2-27°C, transparency 30 cm, alkalinity carbonate 1.5-3.0 ppm, bicarbonate 4.7-92.4 ppm, pH7.4-8.1, dissolved oxygen 6.0-7.4 mg/L, silicate 2.0-7.4, phosphate and carbonate nil and chloride 8-27 ppm. Saigal (1964) documented fractional spawning nature of *S. aor*, which was later supported by Ranganathan and Radha (1966) and Ramakrishniah (1992).

Parental Care

Phenomenon of parental care in *S. aor* was reported by Raj (1962, 1940) and Ranganathan and Radha (1966). In natural condition, it builds nest among pebbles or in the mud pits on river bed. The breeding pair used to prepare a simple type of nest by excavating pits in the clayey and sandy exposed mud flats of the river behind a projecting slab or shelf of rock to protect the young from the current. The pits are saucer-shaped (45 cm diameter × 15 cm depth). A number of pits are littered with the 600-700 m length of spawning grounds. The white secretion (scum) exuding from the inflamed ventral surface of the male parent is eaten by the hatchlings; this secretion is proteinaceous in nature (Raj 1940).

Fishery

Sperata aor is an important species of bagrids contributing to the commercial fishery of all the major river systems in India (Ramakrishniah 1992). It constitutes major components of the fishery in the middle and lower stretches of Ganga mostly during the late winter and early summer. Its fishery is also stable in river Yamuna. Saigal (1982) reported an estimated annual catch of *S. aor* during 1958-1969 averaged at 545.58 t and 367.74 t, respectively, for the Ganga and Yamuna rivers. It also constitutes a major fishery in the rivers and reservoirs of the Cauvery river system. It also forms an important fishery of Bhabanisagar reservoir, anticipating annual catch of 75-100 t (Ranganathan & Radha 1966).

Azadi et al. (1992) reported popularity of seine net (popularly called as tengra jal) with 150-300 m length, 5-10 m vertical depth and permissible mesh size of 7.5-18 cm for capture of *S. aor* in Kaptai reservoir, Bangladesh. Siddiq et al. (2013) documented the use of fash Jal (a kind of gill net) and different types of long line like maita daun, chara barshi and zomka barshi to catch *S. aor* in Meghna river estuary, Chandpur region, Bangladesh. The 'chir' fishing is a common traditional method popular among the local fishermen of the Hosangabad area along the Narmada river. The 'uduvalaus', a bottom set net also being used to catch *S. aor* from reservoir ecosystem (Ranganathan & Radha 1966).

Conclusion

According to the earlier documented work, it is quite clear that fair information is available on food and feeding habit of *S. aor,* except Agarwal and Tyagi (1969); all other

workers have documented its carnivorous, piscivorous and predaceous feeding habit. Information on stage wise variation in food preference is important for captive culture of any fish species. This particular information is available for this fish species. Change of food habit from insectivorous to piscivorous-cum-insectivorous in juveniles to adults has also been properly reported. In overall information available on food and feeding habit of this fish species is quite satisfactory. However, still stage wise and age wise studies on mouth morphology and architecture, mucosal surface of the alimentary canal and enzymatic study of the alimentary canal should be done to put support to the already existed basic information. No such information is available on change of feeding activity if any with breeding season for this fish species which to be studied definitely. Regarding the information available on different aspects of reproductive biology, except proper documentation on spatial variation in breeding periodicity, not much information is available on other aspects like sex-ratio, size at first maturity and fecundity. Spatial variation in breeding periodicity has been reported for *S. aor* and different factors like temperature, day length, water current, sandy bed and hydrological parameters have been attributed for such variation. Information so far available on sex-ratio is quite contradictory. Ramakrishniah (1992) and Saigal (1964) reported female dominance while Azadi et al. (1992) have reported male dominance in *S. aor* population. Therefore, detail work is needed to get firm conclusion in this aspect. Information available on size at first maturity is also scanty as that of fecundity. Fecundity ranges reported by Azadi et al. (1992) and Ranganathan and Radha (1966) have high difference in respect to the information provided by Saigal (1964). Therefore, further study is also needed for these aspects. This fish species is much hardy in nature and it can tolerate great extent of odd environmental condition when a few carps will survive (Chondar 1999). So it can be a good species to culture in captivity. Until now fishery of *S. aor* mainly depends on capture from nature. For fishery, however, captive culture is needed which until now has not been tried at all. Therefore, proper study should be conducted to gather important information needed for its captive culture to explore its future fishery.

REFERENCES

Agarwal, V.P. & Tyagi, A.P. 1969. Food and feeding habits and the alimentary canal of freshwater fishes of Muzzaffarnagar. *Agra University Journal of Research, (Science)* 18(1): 15-28.

Azadi, M.A., Islam, M.A. & Paul, J.G. 1992. Biology and fishery of the catfish, *Mystus aor*, in the Kaptai Reservoir, Bangladesh. In *Reservoir Fisheries of Asia*, edited by de Silva, S.S. *Proceedings of the 2nd Asian Reservoir Fisheries Workshop*, Hangzhou, People's Republic of China, 15-19 October 1990. pp. 125-140.

Chacko, P.I. & Kuriyan, G.K. 1948. A survey of the fisheries of the Tungabhadra River. *Proceedings of Indian Academy of Science* 28(5): 166-176.

Chondar, S.L. 1999. *Biology of Finfish and Shellfish*. India: SCSC Publishers. pp. 272-280.

Day, F. 1878. *The Fishes of India Being a Natural History of the Fishes Known to Inhabit the Seas and Fresh Waters of India, Burma and Ceylon*. London: William Dowson and Sons. p. 778.

Ferraris Jr., C.J. & Runge, K.E. 1999. Revision of the South Asian Bagrid catfish genus *Sperata*, with the description of a new species from Myanmar. *Proceedings of the California Academy of Sciences* 51(10): 397-424.

Ghosh, S.K. & Chakrabarti, P. 2013. Architectural pattern of different cells lining the olfactory epithelium of long-whiskered catfish, *Sperata aor* (Hamilton). *Mesopotamian Journal of Marine Science* 28(1): 69-80.

Gupta, S. & Banerjee, S. 2014. *Indigenous Ornamental Fish Trade of West Bengal*. New Delhi: Narendra Publishing House. p. 63.

Gupta, S. & Banerjee, S. 2012. Indigenous ornamental fish: A new boon in ornamental fish trade of West Bengal. *Fishing Chimes* 32(1): 130-134.

Jayalal, L. & Ramachandran, A. 2012. Export trend of Indian ornamental fish industry. *Agriculture and Biology Journal of North America* 3(11): 439-451.

Job, T.J., David, A. & Das, K.N. 1955. Fish and fisheries of the Mahanadi in relation to the Hirakund dam. *Indian Journal of Fisheries* 2(1): 1-40.

Karamchandani, S.J. 1957. On the occurrence of associates of carp fry in the fry-collection nets and the destructive role played by predatory fish. *Indian Journal of Fisheries* 4(1): 47-61.

Khan, H.M. 1924. Observation on the breeding habits of some freshwater fishes in Punjab. *Journal of Bombay Natural History Society* 29: 958-962.

Khan, S., Khan, M.A., Miyan, K. & Mubark, M. 2011. Length-weight relationships for nine freshwater teleosts collected from river Ganga. *International Journal of Zoological Research* 7(6): 401-405.

Khawaja, D.K. 1966. Biochemical composition of the muscles of some freshwater fishes during the prematurity phase. *Fisheries Technology* 3(2): 94-102.

Kumar, R., Yadav, S.S. & Tripathi, M. 2014. Studies on length-weight relationship of seven commercially important freshwater fish species of Gomti River, Lucknow (U.P.) India. *International Journal of Fisheries and Aquatic Studies* 1(3): 1-3.

Misra, K.S. 1959. An aid to the identification of the common commercial fishes of India and Pakistan. *Records of the Indian Museum* 57: 156-157.

Rahman, A.K.A. 2005. *Freshwater Fishes of Bangladesh*. Zoological Society of Bangladesh, Dhaka, Bangladesh. p. 263.

Raj, B.S. 1962. The extraordinary breeding habits of the catfish *Mystus aor* (Ham) and *Mystus seenghala* (Sykes). *Proceedings of the National Institute of Sciences, India* 28B(3): 193-200.

Raj, B.S. 1940. The extraordinary breeding habits of the catfish *Aoria* (*Macrones*) *aor* (Ham. Buch.) and *A.* (*Macrones*) *seenghala* (Sykes). *Proceedings of 27th Indian Science Congress (Madras)*, Part III Abstract 156.

Ramakrishniah, M. 1992. Studies on the breeding and feeding biology of *Mystus aor* (Hamilton) of Nagarjunasagar Reservoir. *Proceedings of the National Academy of Sciences, India* 62 (B) III: 357-364.

Ranganathan, V. & Radha, N.V. 1966. Biology and fisheries of *Mystus* (*Osteobagrus*) *aor* (Sykes) in the Bhabanisagar reservoir. *Madras Journal of Fisheries* 2: 11-14.

Saigal, B.N. 1982. Biology and fishery of *Mystus* (*Osteobagrus*) *aor* (Hamilton) and *Mystus* (*Osteobagrus*) *seenghala* (Sykes) with a review of the taxonomic status of the genus *Mystus scopoli*. PhD. Thesis, University of Calcutta, Calcutta, p. 389 (Unpublished).

Saigal, B.N. 1964. Studies on the fishery and biology of the commercial catfishes of the Ganga River system. II. Maturity, spawning and food of *Mystus* (*Osteobagrus*) *aor* (Hamilton). *Indian Journal of Fisheries* 11A(1): 1-44.

Sani, R., Gupta, B.K., Sarkar, U.K., Pandey, A., Dubey, V.K. & Singh, L.W. 2010. Length-weight relationships of 14 Indian freshwater fish species from the Betwa (Yamuna River tributary) and Gomti (Ganga River tributary) rivers. *Journal of Applied Ichthyology* 26(3): 456-459.

Sathyanesan, A.G. 1962. The ovarian cycle in the catfish *Mystus seenghala* (Sykes). *Proceedings of the National Academy of Sciences, India* 28B(6): 497-506.

Siddiq, M.A., Saha, D., Rahman, M. & Hossain, M.B. 2013. Fishing gears of the Meghna river estuary of Chandpur region, Bangladesh. *Trends in Fisheries Research* 2(1): 1-8.

Sinha, G.M. & Chakrabarti, P. 1986. Scanning electron microscopic studies on the mucosa of the digestive tract in *Mystus aor* (Hamilton). *Proceedings of Indian National Science Academy* B52(2): 267-273.

Talwar, P.K. & Jhingran, A.G. 1991. *Inland Fishes of India and Adjacent Countries*. 1st Ed. New Delhi, Bombay and Calcutta: Oxford and IBH Publishing Co. Pvt. Ltd. p. 1063.

Tripathi, S.D. 1996. Present status of breeding and culture of catfishes in south Asia. In *The Biology and Culture of Catfishes,* edited by Legendre, M. & Proteau, J.P. *Aquatic Living Resources* 9(Hors Serie.): 219-228.

Central Inland Fisheries Research Institute (ICAR)
Barrackpore, Kolkata-700120
India

*Corresponding author; email: sandipangupta2007@gmail.com

Received: 26 November 2014
Accepted: 28 April 2015