JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Quantitative Analysis of Morphometric and Meristic Variations in *Heteropneustes fossilis*

[1]Akhand Pratap Singh and [2]C Vijayakumar

[1]Research scholar and [2]Professor

Department of zoology, St. Andrew's college, Gorakhpur, U.P., INDIA

Abstract:

Heteropneustes fossilis commonly known as Singhi, occurs in freshwater bodies like pools, tanks, lakes, stream and rivers of india. Its is an air-breathing fish containing pharyngeal lungs as accessory respiratory organs which enables it to tolerate low oxygenated and eutrophicated water bodies like Sarua lake Campiorganj, Gorakhpur, U.P.. There is no detailed study was made on morphometric biology of *Heteropneustes fossilis* directly from particular water body.

In the present study revealed morphometric characterstics of *H. fossilis* by using multi-linear dimensions from Sarua lake Campiorganj, Gorakhpur, U.P. India. A total 42 individuals of *Heteropneustes fossilis* were collected with the help of local fisherman by using different type of nets between September 2023 to March 2024. For each individual, total numbers of fin rays were counted with the help of magnifying glass. The body weigh were measured by using digital balance and various lengths were taken by using slide calipers to the nearest 0.01 gm and 0.01 cm accuracy respectively. The body weigh were ranged between 7.5 to 86.7 gm, and total length ranged from 109.0 To 130.1 mm. The fin formula of *Heteropneustes fossilis* is: dorsal, D.6-7; pectoral, Pc,1/7; pelvic, Pv. 6-7; anal, A.64-65; and caudal, C. 14-17. The findings of the current study can be very effective for identification and stock management of this particular species in the Sarua lake, Campiorganj, Gorakhpur, U.P., India.

Keyord: *Heteropneustes fossilis,* Morphometric, Meristic, Fin rays.

Introduction:

Species of *Heteropneustes fossilis* (Bloch, 1794) (Siluriformes: Heteropneustidae), The Asian stinging cat fishes, are commercially important freshwater fishes distributed through south Asian countries. The body of *Heteropneustes fossilis* is elongated, head depressed and covered with osseous plates and it has four pair of barbels. They are air breather due to the presence of a pair of accessory respiratory organ in the form of air sacs which are extending backword from the gill chamber. The dorsal fin is small and devoid of bony spines, the pectoral spine is strong internally serrated and the caudal fin is rounded (Nelson,2006).

The stinging catfish mostly found in rivers, lakes, muddy streams and marshland (Froese and Pauly 2018). These fishes are highly important commercially because of their nutritional quality (Saha and Guha, 1939; Alok et al, 1993), medicinal value (Jha and Rayamajhi, 2010) and low fat content (Rahman et al, 1982). They are important in research work due to the presence of accessory respiratory organs (Jha 2009).

Morphometric and meristic characteristics are accommodating for the acknowledgment and classification of species (Bagenal and Tesch, 1978; Jayaram, 1999; Hossain et al., 2016). In addition, morphometric characteristics play an imperative part in fisheries investigate, as they are utilized for comparing life history and morphological characteristics of population across districts (Hossain et al., 2013; Parvin et al., 2018; Khatun et al., 2019). The Asian stinging catfish, *Heteropneustes fossilis* (Bloch 1974, family Heteropneustidae) is a commercially imperative angle species in south Asia. This species is locally known as Shingi or Singhee (Rahman, 1989). It is broadly dispersed throughout the south and south-east Asian countries including Bangladesh, India, Laos, Myanmar, Nepal, Pakistan, Sri Lanka, and Thailand (Talwar and Jhingran, 1991). *Heteropneustes fossilis* is too found in Iran and Iraq (Coad, 1996; FAO, 1997). The species for the most part possesses lakes, ditches, swamps, and marshlands, but now and then inhabits muddy waterways (Froese and Pauly, 2018). Very small inquire about has been done on the morphometric and meristic characteristics

of this species on this angel in Gorakhpur, Uttar Pradesh. In any case, a few endeavors have been made to think about length-weight connections (LWRs) (Khan et al., 2012; Alam and Ferdaushy, 2015; Das et al., 2015; Hossain et al., 2017; Muhammad et al., 2017) of this fish species. Be that as it may, no considers cover morphometric (except LWR, Hossain et. al 2017) and meristic characteristics using the multi-linear measurements of *Heteropneustes fossilis* from the Sarua lake biological system of Uttar Pradesh. In this manner, the present study consider the morphometric and meristic characterstics of *Heteropneustes fossilis* .Its has not been included in IUCN red list (IUCN, 2004). Fairly common, but its population is declining day by day hence it is considered under threatened species (NBFGR Lucknow,2010). The major threats are such as over exploitation and habitat loss and degradation cause of habitat destruction and conversion, pollution, over-exploitation, impact of climatic change and exploration of dam in river systems.

Material and Methods:

Study area and sampling:

The current study was carried out in the Sarua lake Campiorganj (**Image 1),**(Lat. 27.0548740*N; Long. 83.2271232*E). A total of 48 individuals of *Heteropneusts fossilis* were occasionally collected from fishermen between September 2023 and March 2024. This fish is collected from the site with the help of local fisherman by using various customary fishing gears such as cast nets (mesh size: 1.0-2.0 cm), gill nets (mesh size: 1.5-2.5 cm), and square lift nets (mesh size: ~1.0 cm). The collected specimens were transported to the lab within a well oxygenated polythene bags and if few specimen were died they preserved with 10 % buffered formalin upon arrival in the laboratory situated in Department of zoology, St. Andrew's College, Gorakhpur.

Image2: Satellite map of Sarua lake, Campiorganj, Gorakhpur, INDIA

Instruments for measurement:

The total numbers of fin rays were counted using a magnifying glass. The total body weight (BW) of each individual was weighed using an electronic balance, whereas various and different linear dimensions (lengths) were taken by digital slide calipers to the nearest 0.01 gm and 0.01 cm accuracy, respectively.

Result:

Counts and measurements are from 42 specimens ranging from 109.0-130.1 mm total length. Body is slender, elongated, compressed, sub cylindrical up to the pelvic fin base and depth of the body at dorsal origin, 12.5-15.3 % SL. Head with moderate size and greatly depressed with the top and slides covered with osseous plates. Snout is flat, mouth small, terminal, transverse, upper jaw slightly longer. Eyes are small, lateral in anterior part of head and not visible from ventral surface.

The body is elongate, laterally compressed behind the pelvic-fin origin, and sub-cylindrical in the pre-pelvic area. The eye is lateral and has a free orbital edge, the nostrils are wide apart, and the mouth is small, terminal, and transverse. Two cephalic fontanels, the anterior being longer than the posterior. Anterior fontanel originates at the level of the anterior margin of the eye and extends to the

posterior boundary of the orbit or slightly behind; the posterior groove is placed on the occiput. The occipital spine is short and does not extend to the dorsal fin base, leaving a significant gap between the occipital process and the dorsal fin base.

Teeth villi create bands on the jaws. Barbels are four pairs, with the nasal extending one orbit diameter in front of the dorsal fin base and the tip of the pectoral fin; the maxillary barbell reaches the pelvic fin base and behind the dorsal fin base; and the outer and inner mandibles reach the pectoral fin tip. Gill aperture is broad, gill membrane is free from the isthmus, and there are seven branchiostegal rays. Air sac tube length, originating from the gill chamber and extending to one-half of the anal fin base. Dorsal fin is short and located in the anterior third of the body, in front of the ventral fin origin, and lacks a spine; pectoral fin has a strong spine, inner edge serrated, and outer edge granulated; pectoral fin does not extend to the pelvic fin, but does reach the anal fin. Anal fin is very long but not confluent with the caudal fin, with a short gap between these two. Caudal fin rounded. Skin smooth; muscle bands distinct on skin.

The head is broad and depressed with four pairs of barbels around the mouth. These barbels are sensory organs that help the fish navigate and locate food in murky waters. The elongated body shapes associated with higher water temperatures may reflect adaptations to more dynamic water environments, where streamlined bodies offer hydrodynamic advantages (Schluter, 2000). Conversely, more robust body shapes in cooler, sediment-rich environments could indicate adaptations for benthic living, where sturdier bodies help in navigating complex substrates and Blackish or dark brown above, lighter below while juvenile are reddish brown (**Figure,1-3 and Table,1)).**

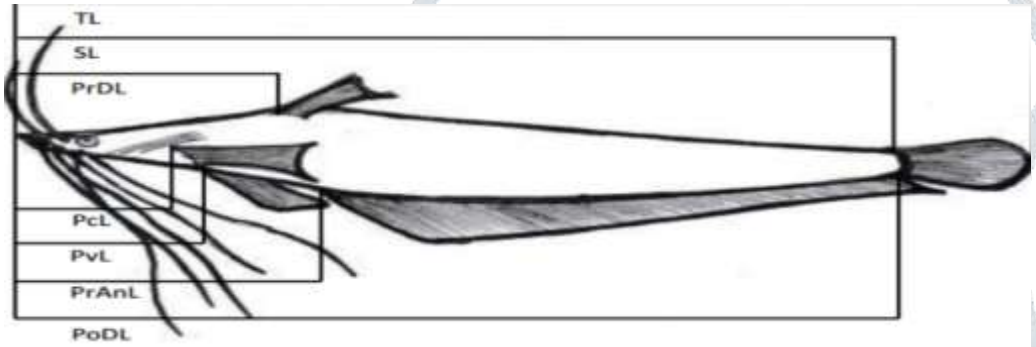

Figure 1. A photo of *Heteropneustes fossilis* where various lengths were indicated by line (Rahman et al, 2019)

Figure 2. *Heteropneustes fossilis*, a drawing in Bloch 1794

Figure 3. *Heteropneustes fossilis* collected from Sarua lake, Campiorganj, Gorakhpur, INDIA

Table 1. Morphometric measurements of the *Heteropneusts fossilis* (Bloch,1794) (n=42) captured from Sarua lake, Campierganj, Gorakhpur, INDIA

SN	Measurements	Minimum(mm)	Maximum((mm)	Mean	Standard deviation
1	Total length	109	130.1	117.4	7.4
2	Standard length	98.1	115.5	106.2	6.7
3	Pre-dorsal length	30.5	32.5	31.3	0.7
4	Pre-pectoral length	14.2	16.7	15.9	0.9
5	Pre-Pelvic Length	31.2	34.4	32.8	1.1
6	Pre-anal length	38.4	41.4	40.0	1.2
7	Post-dorsal length	66.2	72.4	68.9	2.7
8	Body weigh (gm)	7.5	86.7	42.6	1.3

Fins:

Dorsal fin rays, 6-7; anal fin rays 64-65; pelvic fin rays 6-7; pectoral fin rays 1st- 1, 2nd- 7 and Caudal fin rays 14-17. Dorsal fin short vertically inserted above tip of pectoral fin. Dorsal fin length, 9.8-11.9% SL. Pre dorsal length, 30.5-32.5% SL; post dorsal length, 66.2-72.4%SL. Pectoral fin long or short, pointed or rounded with strong spine, serrated along its inner edge and with few serrations at its anterior ends. Pectoral fin length,9.9-12.5% SL; Pelvic fin length, 7.5-9.8 %SL. Distance between pectoral insertion to anal origin, 23.4-26.5% SL; distance between pelvic insertion to anal region, 4.6.6%SL. Caudal fin is round. Anal fin long, separated by a distinct notch from the caudal fin. Caudal fin length is 11.3-14.6%SL (**Table, 2 and Figure, 4, 5, and 6).**

Table 2. Meristic of the *Heteropneusts fossilis* (Bloch,1794) (n=42) captured from Sarua lake, Campierganj, Gorakhpur, INDIA

SN	Meristic count	Minimum	Maximum
1	Dorsal fin rays	VI	VII
2	Anal fin rays	L X iv	L X v
3	Pelvic fin rays	vi	vii
4	Unbranched pectoral fin rays	I	I
5	Branched pectoral fin rays	VII	VII
6	Caudal fin rays	X IV	X VII

Figure 4. *Heteropneustes fossilis:* Pectoral fin

Figure 5. *Heteropneustes fossilis:* Pelvic fin

Figure 5. *Heteropneustes fossilis:* Caudal fin

Barbels:

Barbels 4 pairs, well developed, the maxillary extends beyond the pectoral fin(Table,3 and Figure, 7),

Table 3. Barbels of the *Heteropneusts fossilis* (Bloch,1794) (n=42) captured from Sarua lake, Campierganj, Gorakhpur, INDIA

SN	Barbels measurements	Minimum(mm)	Maximum(mm)	Mean	SD
1	Maxillary barbell length	190.2	228.0	208.5	16.5
2	Rostral barbell length	104.8	164.4	147.6	22.2
3	Outer mandibular barbel	164.4	221.7	195.2	18.6
4	Inner mandibular barbell	150.5	189.6	169.2	15.0

Figure 7. *Heteropneustes fossilis:* Dorsal view of head showing narrow and shallow cephalic fontanel and babels

Sexual diamorphism;

Sexual dimorphism in *Heteropneustes fossilis* is primarily observed in body size and reproductive organs. Males generally have a slimmer body compared to the broader, more robust females. Males often possess more pronounced pectoral fin spines, which are used during breeding displays and territorial defense (Frose et al; 2011).

Environmental Influences;

The regression analysis underscores the significant role of environmental factors in shaping the morphology of *Heteropneustes fossilis*. Variations in sediment type, for instance, could have influenced the development of different fin shapes and sizes, providing advantages for locomotion and stability in different substrate conditions. This finding aligns with previous studies that have demonstrated the impact of habitat on fish morphology (Langerhans & DeWitt, 2004)**.**

Discussion:

In the current investigation, all samples' meristic and morphological numbers differ. Similar findings were obtained for *Heteropneustes fossilis* (Shafi et. al; 1982). Meristic counts of Japanese charr, Salvelinus leukemogenic, differed significantly between river systems (the Naka and Tone rivers, central Japan) and Naka River tributaries (Ashinagasawa, Akasawa, Ushirosawa, and Moto-okashirasawa streams) (Nakamura; 2003). In this study, considerable morphological differences were discovered among *Heteropneustes fossilis* hatchery, Tanguarhaor, and Old Brahmaputra stocks. These phenotypic differences are attributable to habitat conditions, feeding tactics, and geographic location.

Similar findings were reported for Anchovy, Engraulis encrasicolus, in the Black, Aegean, and northeastern Mediterranean Seas (Turan et al; 2004b). Morphometric discrepancies between stocks are to be expected given their geographical separation and possible ancestry. Fish are extremely sensitive to environmental changes and can quickly adjust by modifying their morphology. Morphological features are well known for their considerable plasticity in response to changes in environmental variables such as food quantity and temperature (Allendorf et al; 1988, Swain et al; 1991, Wimberger; 1992).

In general, fish have greater morphological trait variability within and between populations than any other vertebrates, and they are more vulnerable to environmental morphological alterations (Allendorf et al; 1988, Wimberger et al; 1992). Fish exhibit a great degree of phenotypic flexibility. They quickly adapt by changing their physiology and behaviour to the surroundings. The findings of this study are important as early baseline information on *Heteropneustes fossilis* populations for future research. More study, particularly genetic studies and investigations into the effects of environmental conditions, is required to prevent *Heteropneustes fossilis*, an indigenous and commercially important aquaculture species, from extinction.

There is little information on the morphometric properties of *Heteropneustes fossilis* in Indian and other literature. However, the current study revealed the morphometric properties of *Heteropneustes fossilis* by employing different length measurements (TL, SL, PrDL, etc.). Using typical fishing gear, this study gathered specimens ranging in body size from tiny to large.

This study discovered 6-7 dorsal fin rays, 1/7 pectoral fin rays, 6-7 pelvic fin rays, 64-65 anal fin rays, and 14-17 caudal fin rays, which are quite similar to D. 7; V. 6; A. 70; C. 19 (Bhuiyan, 1964); D. 6-7; P1. 1/6-7; P2. 6; A. 62-70 (Rahman, 1989); and D. 7; P. 7; V. 6; A. 60-79; C. 19 (Shafi and Quddus, 2001). Morphometric and meristic features can provide important information for species identification.

In the current study, the highest length of *Heteropneustes fossilis* reported was 130.1 mm TL, which is shorter than the maximum known TL of 310 mm recorded in the Ganga River, India (Khan et al., 2012). Information on maximum length is required to determine population parameters such as asymptotic length and growth coefficient of fish, which is significant for fisheries resource planning and management (Hossain et al., 2012; Hossen et al., 2019; Hossain et al., 2019). The *Heteropneustes fossilis* data were obtained over a long period of time and are not typical of any specific season, thus they should be taken as mean-annual values for comparative purposes.

Conclusion:

This study's findings can help fish taxonomists, fishery managers, biologists, and conservationists develop early management strategies and regulations to sustain the species in wetlands and surrounding ecosystems.

Acknowledgments:

Author is highly grateful to Dr. M. Anto Claver, Department of zoology, St. Andrew's College, Gorakhpur and the Principal and secretaries of St. Andrew's college management for providing necessary laboratory facilities. I am also obliged to local fisherman of Sarua lake for their co-operation during entire survey period.

Conflicts of Interest:

The authors declare that there is no conflict of interest regarding the publication of the present paper.

References:

1. Alam MM and Ferdaushy MH. 2015. Length-length and length-weight relationships and condition factor of nine freshwater fish species of Nageshwari, Bangladesh. Int J Aqua Bio, 3: 149-154.
2. Allendorf FW, Phelps SR. Loss of genetic variation in hatchery stock of cutthroat trout. Trans Am Fish Soc 1988; 109:537-543.
3. Alok D, Krishnan T, Talwar GP,Garg LC. 1993. Induced spawning of catfish, Heteropneustes fossilis(Bloch), using D-Lys6 salmon gonadotropin-releasing hormone analog. Aquaculture 115: 159-167. DOI: 10.1016/0044-8486(93)90366-
4. .Bagenal JB and Tesch FW.1978. Methods for Assessment of Fish Production in Freshwaters. Blackwell Scientific publication, Oxford, p. 361
5. Bloch ME. 1794. Naturgeschichte de Aus ländischen Fische. Siebenter Theil, Morino, Berlin.
6. Coad BW. 1996. Exotic fish species in the Tigris-Euphratus basin. Zool Middle East, 13:71 -83
7. Das PW, Rahman K, Talukdar and Deka P. 2015. Length-weight relationship and relative condition factor of Heteropneustes fossilis (Bloch) of Deepar Beel, a Ramsar site of Assam, Indian J Appl Res,12: 1024-1027.
8. FAO, 1997. FAO database on introduced aquatic species. FAO Database on Introduced Aquatic Species, FAO, Rome.
9. Froese R and Pauly D. (Eds). 2018. Fish Base 2018, World Wide Web electronic publication. Available at: http://www.fishbase.org(accessed on 25Apri 2018).
10. Froese, R., &Pauly, D. (Eds.). (2011). *Heteropneustes fossilis* in Fish Base.
11. Hossain MY, Naser SMA, Bahkali AH, Yahya K, Hossen MA, Elgorban AM, Islam MM and Rahman MM. 2016. Life history traits of the flying barb *Esomus danricus* (Hamilton,1822) (Cyprinidae) in the Ganges River, northwestern Bangladesh. Pak J Zool, 48: 399-408.

12. Hossain MY, Hossen MA, Ahmed FZ, Hossain AM, Pramanik MNU, Paul AK, Nawer F, Khatun D, Haque N and Islam MA. 2017. Length–weight relationships of 12 indigenous fish species in the Gajner Beel floodplain (NW Bangladesh), J Appl Ichthyol,33: 842-845
13. Hossain MY, Rahman MM, Abdallah EM and Ohtomi J. 2013. Biometric relationships of the pool barb *Puntius sophore*(Hamilton 1822) (Cyprinidae) from three major rivers of Bangladesh. Sains Malays, 42: 1571–1580.
14. IUCN, 2005. The IUCN Red list of Threatened Species. Version 2005-1.
15. Jha BR. 2009. Fish Ecological Studies in Assessing Ecological Integrity of Rivers:Application in Rivers of Nepal. VDM Verlag Dr. Muller Aktiengesellschaft & Co. KG, Germany.
16. Jha BR, A Rayamajhi.2010. *Heteropneustes fossilis*. The IUCN Red List of Threatened Species. Version 2014.2. www.iucnredlist.org. (Accessed on 10 October, 2014).
17. Jayaram KC. 1999. The Freshwater Fishes of the Indian Region. Narendra Publishing House, Delhi. p. 551
18. Khan MA, Khan S and Miyan K. 2012. Length–weight relationship of giant snakehead, Channa marulius and stinging catfish, Heteropneustes fossilisfrom the River Ganga, India. J. Appl. Ichthyol,28:154–155.
19. Khatun D, Hossain MY, Rahman MA, Islam MA, Rahman O, Sharmin MS, Parvin MF, Haque ATU and Hossain MA. 2019. Life-history traits of the climbing perch Anabas testeudineus (Bloch, 1792) in a wetland ecosystem. Jordan J Biol Sci,12: 175-182.
20. Langerhans, R. B., & DeWitt, T. J. 2004. Shared and Unique Features of Evolutionary Diversification. American Naturalist, 164(3), 335-349.
21. Muhammad HZ, Iqbal Q, Bashir MA and Hanif. 2017. Length-weight relationship and condition factor of catfish species from Indus River, Pakistan, Punjab University J Zool, 32: 35 -38.
22. Nakamura T. 2003. Meristic and morphometric variations in fluvial Japanese charr between river systems and among tributaries of a river system. Environ Biol Fishes; 66:133-141.
23. NBFGR, 2010. The Threatened freshwater fishes of India.
24. Nelson JS. 2006. Fishes of the World. 4th Edition. John Wiley andSons, Hoboken, New Jersey.
25. Parvin MF, Hossain MY, Nawer F, Khatun D, Rahman M A, Islam M A, Rahman O and Sharmin MS. 2018. Morphometric and meristic characteristics of *Salmostoma bacaila* (Hamilton, 1822) (Cyprinidae) from the Ganges river, Northwestern Bangladesh. Jordan J Biol Sci,11: 533-536.
26. Rahman MA, Gheyasuddin S, Rashid MH, Chowdhury MFZ. 1982. Proximate composition and nutritive quality of freshwater fishes of Bangladesh. Bangladesh J. Fish 2(5): 37-43. DOI:10.4236/fns.2011.210145.
27. Rahman AKA. 1989. Freshwater Fishes of Bangladesh. Zoological Society of Bangladesh, Department of Zoology, University of Dhaka. p. 364.
28. Saha KC, Guha BC. 1939.Nutritional investigation of Bengal fish. Indian JMedRes26: 921-927.
29. Schluter, D. 2000. The Ecology of Adaptive Radiation. Oxford University Press.
30. Shafi M, Quddus MM. 1982. Bangladesh'er mathso sampad (in Bengali) Bangla,.
31. Swain DP, Ridell BE, Murray CB. 1991. Morphological differences between hatchery and wild populations of coho salmon (Oncorhynchus kisutch): environmental versus genetic origin. Can JFish Aquat Sci; 48:1783-1791.
32. Talwar PK, Jhingran AG.1991. Inland Fishes of India and Adjacent Countries. A.A Balkema, Rotterdam, p.541.
33. Turan C, Erguden D, Gurlek M, Basusta N, Turan F. 2004b Morphometric structuring of the anchovy (Engraulis encrasicolus L.) in the Black, Aegean and northeastern Mediterranean Seas. Turk J Vet Anim Sci; 28:865-871.
34. Wimberger PH. 1992. Plasticity of fish body shape - the effects of diet, development, family and age in two species of Geophagus (Pisces: Cichlidae). Biol J Linn Soc; 45:197-218.