Asian Journal of Multidisciplinary Studies

ISSN: 2321-8819 (Online)
2348-7186 (Print)

Impact Factor: 0.92
Vol. 4, Issue 2, February 2016

Variations of Vertebral bones among freshwater *Puntius* (Teleostei: Cyprinidae) from Lower Anicut, Tamil Nadu

N.Rajasekaran and R.Sivakumar

[1]Ph.D Research Scholar,
Department of Zoology,Government Arts College (Autonomous),
Kumbakonam – 612 002.
[2]Assistant Professor,
Department of Zoology, Government Arts College (Autonomous),
Kumbakonam – 612 002.

***Abstract**: Freshwater is critical to human society and sustains all terrestrial and aquatic ecosystems. Worldwide, freshwater fishes are the most diverse of all vertebrate groups, but are also the most highly threatened through anthropogenic activities such as river management works, dam building, and land use change in the watersheds. Lower Anicut is one of the major fishing point in the Cauvery river system in Tamil Nadu which isselected for the present study. The taxonomic identification of Puntius species were made by osteologcial work of the vertebral bones isolation from Lower Anicut (Kollidam river), Tamil Nadu. The Kollidam river inhabits naturally ornamental and edible fishes like Puntius species. Four Puntius species were collected from this site. The specimens were preserved and stored in laboratory. Themorphological features (body colour, size and shape) and the meristic counts of all the Puntius species viz. Puntius sophore, Puntius filamentosus, Puntius sarana and Puntius ticto were recorded. Thereafter, the variation of vertebral bones among the Puntius groups were observed.*

Key words: Vertebral bones, *Puntius* species, Radiography and boiling method.

Introduction

Freshwater is critical to human society and sustains all terrestrial and aquatic ecosystems (Millennium Ecosystem Assessment 2005).Worldwide, freshwater fishes are the most diverse of all vertebrate groups, but are also the most highly threatened through anthropogenic activities such as river management works, dam building and land use change in the watersheds (Duncan & Lockwood 2001, Dudgeon *et al.* 2006, De Silva *et al.* 2007, Nel *et al.* 2009).

The total protected areas have been earmarked for extensive conservation of habitats and ecosystems. However, a review of the protected area network in India reveals a poor representation of freshwater fish biodiversity in that network. Recently, the Ministry of Environment and Forests, Government of India, has prepared National Biodiversity Action Plan to help conserving biological diversity in both terrestrial and aquatic ecosystems (MOEF 2008). India has very rich aquatic biodiversity spanning the country. In India there is about 2319 fish species that have so far been documented, of which about 838 fishes inhabit freshwaters (Lakra & Sarkar 2010).

Cypriniformes constitutes the largest order of freshwater fishes encompassing more than 3,000 extant species (Nelson 2006). The taxonomy of Cypriniformes has been the subject of a long debate since the 19th century. However, literature on comparative osteological studies ofCyprinidae is rare. The genus *Puntius* is the largest in number of species of all cyprinid genera in Asian tropics. Fishes of this genus occur throughout the region from Pakistan to Southern China, inhabiting various types of freshwater. The status of *Puntius* is obscure; the delimitation and nomenclatural validity of the genus have remained unsettled (Hora and Mukerji, 1934; Smith, 1945; Hoedeman, 1958; Myers, 1960).

Puntius is a complex genus, which exhibit high degree of variability in colour pattern, size, and habitat such as lake, ditches, pond, river and hill-stream. Kottelat (1999), described *Puntius* as a 'catchall' genus in which a large number of unrelated small barbs have been placed, however restricted to a very limited geographical area and without information on the limits of the genera Kullander and Fang (2005) mentioned that the obscure status of the group is owing to scantiness in the knowledge of its inter and intrageneric relationship. Numerous species *Puntius* occur in the Salween, Irrawady and Ganga drainages of the

Indian region. Some of them have very similar characters making it difficult to differentiate. Examination of species inhabiting these rivers is required to elucidate more clearly the lines of differentiation and dispersal of *Puntius* (Taki *et al.,* 1978).

The characteristic feature of the new genus *Puntius* was the absence of barbels. It became apparent later, however that within the new genus *Puntius* there were some species with barbels. Therefore, a great deal of uncertainty remains and *Barbus* and *Puntius* are both used as names for the genus. All previous Sri Lankan workers who studied the family Cyprinidae were primarily concerned with describing of new species (Deraniyaga1a, 1952: Munro, 1955: Mendis and fernando, 1962: Pethiyagoda, 1990).

Almost all the authors studied only colour patterns and meristics and ignored the internal anatomy and osteology which are very important in understanding the taxonomy and phylogeny of fishes. As the phylogenetic studies are the basis of Zoological Classification, attention was given to the osteology of Sri Lankan cyprinids with a view to resolve the identity and phylogeny of *Puntius.* The importance of osteology in the taxonomy of fishes is evident by the work carried out on other fishes by Norden (1961), Goslin (1965), Collette and Chao (1975), Tyler *et al.,* (1989), Frame *et al.*, (1978), Weitzman (1962) and Topp and Cole (l968). Osteological studies of some Cyprinids have been carried out by Wilimovesky and Weitzmann (1955), Harrington (1955) and Yousuf *et al.,* (1988).

The aim of present study is taxonomic identification of *Puntius* species by osteologcial work of the vertebral bones.

Materials and methods:

The KollidamRiver inhabits ornamental and edible fishes like *Puntius* species. The species were collected from Lower Anicut 11° 15'N latitude and 79° 30' E longitude (Figure1).

Puntius sophore, Puntius filamentosus, Puntius sarana, and *Puntius ticto* were collected from this site. The specimens were captured by cast net (2-4 cm squares size) and were brought to the laboratory in ice box. Specimens were mopped by filter paper to remove excess of water from their body surface, thereafter recorded the biometric characters. *Puntius* individuals were identified at species level following by Smith, *et al.,* 1945. Meristic characters were followed by Hubbs, *et al.,* 1964, Dwivedi, *et al.,* 1974, Jayaram,1984;1999.

The whole specimens were boiled in hot water at 5-10 minutes for 100-110°C; each side were mopped for 2 minutes and turned. The whole fish after cooking were chiled and placed on a dissecting tray, skeleton and pin bone were dissected out using needle and artery forceps, to remove tissue carefully of the bones.

Vertebral bone counts were obtained from radiographs also. The vertebral bones were counted fromend of the Weberian apparatus to caudal bones origin point of the all specimens. X-radiographs were made with a Philips MG-105 low voltage X-ray unit, and photographs obtained with a Caresteam 500 MAS T Mammography camera. Institutional abbreviations are as listed in Leviton *et al*., (1985) and Leviton and Gibbs (1988).

Results

Systematic position

1. **Kingdom** : Animalia
Phylum : Chordata
Class : Actinopterygii
Order : Cypriniformes
Family : Cyprinidae
Genus : *Puntius*
Species : *Puntius sophore* (Hamilton, 1822)
Common name : Pool barb
Vernacular name: Saanipodi (in Tamil)

2. **Kingdom** : Animalia
Phylum : Chordata
Class : Actinopterygii
Order : Cypriniformes
Family : Cyprinidae
Genus : *Puntius*
Species : *Puntius filamentosus* (Valenciennes, 1844)
Common name : Black-spot barb and Indian Tiger barb
Vernacular name : Chevalli, Macha-Kendai (in Tamil)

3. **Kingdom** : Animalia
Phylum : Chordata
Class : Actinopterygii
Order : Cypriniformes
Family : Cyprinidae
Genus : *Puntius*
Species : *Puntius sarana* (Hamilton, 1822)
Common name : Olive barb
Vernacular name: Panjalapodi (in Tamil)

4. **Kingdom** : Animalia
Phylum : Chordata
Class : Actinopterygii
Order : Cypriniformes
Family : Cyprinidae
Genus : *Puntius*
Species : *Puntius ticto* (Hamilton, 1822)
Common name : Two spot barb, Firefin barb and ticto barb
Vernacular name: Saanipodi (in Tamil)

Morphological characters:

***Puntius sophore*-** Body is elongated, deep and compressed. Concave type of anal and no barbels. Caudal fin deeply forked (Figure-2). Body colour with silver bright and bright reddish strip along entire mid body from snout to caudal fork in breeding season. Colour in life, beautiful silvery, black gray-green to brownish. Abdomen white colour and a deep black round blotch at base of caudal fin.

Puntius filamentosus- Body is elongated and lateral line are complete; Horizontal oval type of spot on the caudal peduncle. Concave type of anal and no barbels (Figure-3). Colour of caudal fin lobes tip side black colour formed. Colour in life at various stages distinctly different and adults uniformly silvery to greenish silvery.

***Puntius sarana* -** Body is elongated and lateral lines are complete; mouth moderate with sub-terminal; Barbels are two pairs, with reddish brown, rostral ones as long as orbit, maxillary pair much longer. Dorsal fin spine is serrated; Concave type of anal fin, (Figure-4). Colour in life, olive black, and flanks silvery with golden reflections. One black round spot located in caudal peduncle and another in operculum.

***Puntius ticto*-** Body is elongated. Mouth is terminal and small size; no barbels. Dorsal fin spine serrated. Lateral line origin and end of body located in two black round spots. First spot occurred in 3, 4 lateral line scales and another in 16, 17, 18 lateral line scales. Concave type of anal fin, (Figure-5). The black colour of the small bands spread in entire tip of the body scales and tip of the caudal fin.

Meristic characters:

The morphological characters were analyzed in four *Puntius* species. The number of black spots, position and their dorsal fin spine and rays were distinguishing character in these fishes.

***Puntius sophore*:** 2 spots were noted and first black spot located in centre of the caudal peduncle each side on the lateral line 20-23rd scales and another black spot located on 4-6 branched rays base of dorsal fin. Smooth type of dorsal fin spine.

Fin formula: D. 12 (III/9); A. 8-9 (III/5-6); V. 9(I/8); P. 14-15 (I/13-14); L.l.25-26.

***Puntius filamentosus*:** One black blotch was observed in 17-19th lateral line scale sides. Caudal fin 1-4thupper and lower lobe tip side red and black colour present. Dorsal fin spine serrated.

Fin formula: D. 12 (III/9); A. 9 (III/6); V. 10 (I/8-9); P. 14-15 (I/13-14); L.l.22-23.

***Puntius sarana*:** Noted on two black blotch and first blotch present in each sides of caudal peduncle. And another blotch present each side of operculum. Dorsal fin spine serrated.

Fin formula: D. 12 (III/8-9); A. 8-9 (III/5-6); V. 8(I/7); P. 14-17 (I/13-16); L.l.30-32.

***Puntius ticto*:** Noted 2 spots, the first spot located in operculum each side of 3-5th scales and 16 - 21stscales. Dorsal fin spine serrated. Incomplete lateral line.

Fin formula: D. 12 (III/9); A. 9-10 (III/6-7); V. 9(I/8); P. 13-14 (I/12-13); L.l.24-25.

Isolation of vertebral bones through boiling in Puntius species:

The numbers of vertebral bone by boiling in Puntius species were shown in Figure 6 and Table – 1.

The number of vertebral bone in Puntius sophore was 26 whereas in Puntius filamentosus the number of vertebral bones 27-28, Puntius sarana 32 and Puntius ticto 24.

Vertebral bone counts through Radiograph in Puntius species:

Vertebral bones of various species of Puntius by X – ray were shown in Figure 7 and Table 1.

Vertebral bone counts in Puntius sophore was 26 whereas in Puntius filamentosus 27-28, Puntius sarana 32 and Puntius ticto 24.

Vertebral bone counts are of great value in separating Puntius species which are superficially similar but little level variations. Vertebral counts also aid in identification of closely related taxonomic such as this species. The intra specific variation in vertebral counts must be known when using these characters to separate closely related taxonomic identification.

The taxonomic significance of the variation observed in the present study has to be assessed in relation to the available taxonomic information on the *Puntius* species. Observed osteological variations provide good evidences for intra-specific heterogeneity among *Puntius* species populations.

Discussion

The shape and structure of projecting processes of the vertebrae, term “apophyses” (Wake, 1979), can be of taxonomic significance. The size and shape of the apophyses were used as a taxonomic characters by Clothier (1950) and Clothier and Baxter in their keys to adult California fishes based on the vertebral column.

The number, morphology, and sequence of ossification of the vertebral column and associated bones of the vertebral centra and their appendages, of the neural and haemal spines, and of the ribs and intramuscular bones are useful as taxonomic aids and are of systematic importance. The manner of formation of vertebral centra,

arches, and ribs was described for herring by Manavala Ramanujam (1929).

Partial counts of vertebrae (or myomeres) are useful when applied to certain groups of fishes. Vertebrae (or myomeres) are one of the basic metric characters used in identification of larval fishes. Myomeres form in the embryo (Fowler, 1970) and are considered to be nearly, if not exactly; equivalent to the number of vertebrae. Possible exceptions to this generality have been suggested by Hempel and Blaxter (1961) and by Berry and Richards (1973). Myomeres may be difficult to count, particularly those near the skull of near the end of the caudal peduncle. When counting vertebrae, some authors (e.g., Berry and Richards 1973) include the ural bones (or urostyle) as a single unit irrespective of the number of constituent elements: other (e.g., Cohen and Nielsen, 1978) do not include ural bones in their counts. Vertebral counts are great value in taxonomical level separating of the species.

Gopalakrishnan *et al.,* (1970) have quoted that the fundamental similarities among animals are deep seated and the various internal structures show remarkable resemblance. Superficially, however, the animals look entirely unlike each other. Cain (1971) has ascertained that reliance on a single character will not only group together unrelated forms but may even get us into a position where we can produce no diagnosis at all. Hemalatha and Rajkumar (1996) have coined that the internal organs can be used to establish the taxonomic position of fishes. Considering these opinions, it may be presumed that the method of classification of fishes based entirely on the external characters, especially the fin-ray count, may not be accurate and so the study of internal structures as tools for establishing taxonomy should be given due consideration. The present study, thus, supports the conclusions of Popova (1970), Dzhumaliyev (1978) and Sujatha and Duttt (1985) regarding the validity of comparison of vertebrae for the classification of fishes.

The axial skeleton of *P. sarana* commonly consists of 36 vertebrae (Shanthakumar & Vishwanath, 2006) and the variation in vertebral number seems to be linked to the doubling of the neural spines in the preural caudal vertebrae. For instance, specimens from the rivers Nilwala, Walawe and Kirindi, which had less than 36 vertebrae, all showed doubling of the neural spines on preuralcentra. It is generally believed that the doubling process is a result of vertebral fusion or more correctly, non-separation during development (Kandler, 1932).

The number of vertebrae in fishes is fixed early in development, usually by the time of hatching (Gwyne, 1940; Garside, 1966), and believed to be influenced by physical, chemical and biological conditions of the water where eggs and larvae are laid and develop (Arratia, 1992). Vertebral fusion is known to be a common feature in other cyprinids as well (Eastman, 1980). The observed results are in agreement with the above interpretation, (Irfan & Suneetha Gunawickrama, 2011) and indicate that the vertebral number seems to be a powerful adjunct in studies of intra-specific variation in *P. sarana* fish. Similar complex vertebrae have been encountered in the preural region of variety of fishes (Kandler, 1932; Barrington, 1937; Ford, 1937; Buhan, 1972; Patterson and Rosen, 1977).

Sarana group is larged-sized fishes which differ from others in having comparatively less body colour markings, presence of two pairs of well-developed barbels, a pair of uroneurals on the dorsal tip of the urostyle, higher total vertebral counts than smaller species (35-36 Vs. 29-33). Mirza and Abdumssad (1982), reported higher vertebral counts in the *sarana* group to larger species (from 4 to 6) i.e., from *sophore* group to *sarana* group. The number of vertebrae is within certain limits often characteristic of a given species or at least genus (Harder, 1975). Bailey and Gosline (1955) reported certain differences in the vertebral counts between general and most subgenera and between many species within a subgenus.

The vertebral column of *Puntius sarana* generally consists of 36 vertebrae, out varied from 34 to 36, where the specimens from the rivers Gin, Kalu and Menik had36 vertebrae. Speciemens from Nilwala River and the Walawe River mostly had 34 vertebrae, while those from the Kirindi Oya commonly had 35 (Irfan *et al.,* 2011).

The *Puntius sarana* X-Ray analysis revealed that truncated body is due to vertebral fusion in 5th and 6th vertebrae and from 24th and 25th vertebrae. In aberrant fish, neutral and haemal spines were bifurcated and wavy. This aberration appears to be due to development error (Nisha Bhagat and Ravinder Kumar, 2014).

The present observation resulting in the placement of *Puntius sophore, Puntius flamentosus, Puntius sarana* and *Puntius ticto* under the species also supports the idea of Jayaram (1991) and Talwar and Jhingran (1992).

Acknowledgement

We thank the local fisherman for their cooperation in collection of specimens. The authors thanks to the principal, Government Arts College (Autonomous), Kumbakonam, for permitting research and the Department Head, for providing necessary facilities. We thanks UGC- RGNF, New Delhi, for providing the financial assistance to the present research.

REFERENCES:

Arratia, G. (1983). The caudal skeleton of ostariophysan *Journal of the National Science Foundation of Sri Lanka **39** (2),* **177**(2): 213-229.

Arratia, G. (1997). Basal teleosts and teleostean phylogeny. *Paleo Ichthyologica* **7**: 5-168.

Arratia, G. (1999). The monophyly of Teleostei and stemgroup teleosts. In: *Mesozoic Fishes 2: Systematics and Fossil Record* (eds. G. Arratia& H.P. Schultze), pp. 265-334.

Arratia, G. and H.P.Schultze, (1992). Reevaluation of the caudal skeleton of certain actinopterygian fishes III. Salmonidae. homologization of caudal skeletal structures. *Journal of Morphology* **214**(2): 187-249.

Barrington, E.J.W. (1937). The structure and development of the tail in the plaice (*Pleuronectes platessa*) and the cod (*Gadus morhua*). *Quarterly Journal of Microscopical Science* **79**: 447-469.

Berrry, F.H. and W.J.Richards, (1973). Characters useful to the study of larval and juvenile stages fish in Atlantic coast estuaries, p.48-65. Tech. Publ.1, Middle Atl. Coastal Fish *Cent., Natl. Mar. Fish. Serv.* NOAA, Highlands, NJ 0732.

Buhan, P.J. (1972). The comparative osteology of the caudal skeleton of some North American minnows (Cyprinidae). *American Midland Naturalist* **88**(2): 484-490.

Cain, A.J. (1971). Animal species and evolution. Hutchinson University, London, Hutchinson and Co.Ltd.178-202. Great Portland Street, London. VVI: 17-18.

Clothier, C.R. (1946). Vertebral variation with size in *Clevelandia ios*. Copeid.1946:113-116.

Clothier, C.R. (1950). A key to some southern California fishes based on vertebral characters Calif. Dep. Fish Game, *Fish Bull.* 79, 83 p.

Cohen, d. M., and 1. G. Nielsen,(1978). Guide to the Identification of genera of the fish order Ophidiiforme with a tentative classification of the Order. U.S. Dep. Commer., *NOA Tech. Rep. NMFS Circ.* 417, 72 p.

Collette, B.N. and L.N.Chao, (1975). Systematics and Morphology of the Bonitos (Santa) and their Relatives (*Scombridae sardini*), *Fish. Bull.* 73(3): 516-625.

Deraniyagala, P.E.P. (1952). A Coloured Atlas of Some Vertebrates from Ceylon. I Pisces. *Ceylon. Natl. Muse. Pub. Colombo.* pp.149.

De Silva, S.S., W. Abery Nigel and T.T.Nguyen Thury, (2007). Endemic freshwater finfish of Asia: distribution and conservation status. Divers. Distrib. 13: 172-184.

Dudgeon, D., A.H. Arthington, M.O. Gessner, Z. Kwabata, D.J. Knowler, C. Leveque, R.J. Naiman, A. Prieur- Richaed, D. Soto, M.L.J. Stiassny and C.A.Sullivan, (2006). Freshwater biodiversity: importance, threats, status and conservation challenges. Biol. Rev. 81: 163-182.

Duncan, J. and J.L. Lockwood, (2001). Extinction in a field of bullets: a search for the cause in the decline of the world's freshwater fishes. Biol. Cons. 102: 97-105.

Dwivedi, S. N. and M. R.Menezes, (1974). A note on the morphometry and ecology of *Brachirus orientalis* (Bloch and Schneider) in the estuaries of Goa. Geobios, 1: 80-83.

Dzhumaliyev, M.K. (1978). The morphology and trophic characteristics of the swim-bladder in some order of fish. Voor. Ikhtion. 17(2):284-291.

Eastman J.T. (1980). The caudal skeletons of catostomid fishes. *American Midland Naturalist* **103**(1): 133-148.

Eastman, J.T. and J.C.Underhill, (1973). Intra-specific variation in the pharyngeal tooth formulae of some cyprinid fishes. Copea, 1973(1): 45-53.

Ford, E. (1937). Vertebral variation in teleostean fishes. *Journal of the Marine Biological Association of United Kingdom* **22**(1):1-57.

Fowler, J.A. (1970). Control of vertebral number in teleosts- an embryological problem. *Quarterly Review of Biology* 45 (2):148-167

Frame, D.W., Andrews, T.J. and C.F. Cole, (1978). Osteology of the American Plaice *Hippoglossoides platessoides.* Post ilia, Number 173. Peabody Museum of Nati,Hist. Yale University, New Haven.

Garside, E.T. (1966). Developmental rate and vertebral number in Salmonids. *Journal of the Fisheries Research Board of Canada* **23**(10): 1537-1551.

Gopalakrishnan, T.S., Sambasivaih, Itta and Rao, A.R.Kamalakara, (1970). Principles of organic evolution. Peari publications, Madras: 20-40.

Goslin, W.A. (1965). Teleostean Phylogeny. Copeia 1965 no.2.

Gosline, W.A. (1961). Some osteological features of modern lower teleostean fishes. *Smithsonian Miscellaneous Collections* **142**(3): 1-42.

Gwyne A.M. (1940). The development of the vertebral column of the Pacific herring (*Clupea pallasii*). *Journal of the Fisheries Research Board of Canada* **5**:11-22.

Harder, W. (1975). Anatomy of fishes. Part 1. E. Schweizerbart sche Verlagsbuchhandlung. Stuttgart, 611pp.

Harrington, R.W. (1955). The Osteocranium of the American Cyprinid Fish *Notropis bifrenatus* with an annonated Synonymy of Teleost Skull Bones. Copeia 4: 267-289.

Hemalatha, K.K. and R.Rajkumar, (1996). Taxonomic relationship of air-bladder in six families of Cypriniformes (Teleostei). *J. Inland Fish. Soc. India*, 28(2):62-74.

Hoedeman, J.J. (1958). Rivulid fishes of the Antilles. Studies on the fauna of Curacao and other Caribbean Islands, 32, 112– 127.

Hora, S.L. and D.D. Mukerji, (1934). Notes on fishes in the Indian Museum. Records of the Indian Museum, xxiii. a collection of fishes from S. Shan states, Burma. Records of the Indian museum 36: 353-370. 1-3 figs.

Hubbs, C.L. and K.F. Lagler, (1964). Fishes of the Great Lakes Region. University of *Michigan Press, Ann Arbor, MI, USA,* 213pp.

Irfan, F.L. and K.B.Suneetha Gunawickrama,(2011). Osteological variation of the olive barb *Puntius sarana* (Cyprinidae) in Sri Lanka. *J. Natn. Sci. Foundation Sri Lanka*: 39(2): 121-128.

Jayaram, K.C., (1999). The freshwater fishes of the Indian region. Narendra publishing house, Delhi.

Jayaram, K.C., (1991). Revision of the genus *Puntius* (Hamilton) from the Indian Region (Pisces: Cypriniformes, Cyprinidae, Cypriniae). Records of the Zoological Survey of India, Occasional Paper 135: 1-178.

Kandler, R., (1932). Unsicherheitenbei Bestmmung der Wirbelzahlinfolge 'Verwachsungser scheinungen'. *Journal du Conseil International pour l'Exploration de la Mer***7**:373-385.

Kottelat, M., (1999). Nomenclature of the genera *Barbodsi, Cyclocheilichthys, Rasbora* and *Chonerhinos* (Teleostei: Cyprininae and Tetraodontidae), with comments on the definition of the first reviser. *Raffles Bulletin of Zoology* 47(2): 263-268.

Kullander, S.O. and F. Fang. (2005). Twonew species of *Puntius* from Northern Myanmar (Teleostei: Cyprininae). Copeia 2005 (2): 290-302.

Lakra, W.S. and U.K.Sarkar, (2010). NBFGR-Marching ahead in cataloguing and conserving fish genetic resources of India. Fishing Chimes 30: 102-107.

Leviton, A.E. & R.H., Jr.Gibbs, (1988). Standards in Herpetology and Ichthyology. Standard symbolic codes for institution resource collections in herpetology and ichthyology. Copeia 1988 (no. 1): 280-282.

Leviton, A.E., R.H. Gibbs, Jr., E. Heal and C.E. Dawson,(1985). Standards in herpetology and ichthyology: Part I. Standard symbolic codes for institutional resource collections in herpetology and ichthyology. Copeia 1985 (no. 3): 802-832.

Manavala Ramanujam.S.G., (1929). The study of the development of the vertebral column in teleosts. As shown in the life history of the herring. *Proc. Zool. Soc. Lond.* 1929: 365-414.

Mendis, A.S. and C.H. Fernando, (1962). A Guide to the Fresh Water Fauna of Ceylon. *Fish. Res. Stat. Ceylon. Bull.* No.12:pp.160.

Millennium Ecosystem Assessment (MEA), (2005). Ecosystems and Human Well-being: Desertification Synthesis. World Resources Institute, Washington, D.C., USA.

Ministry of Environment and Forests (MoEF), (2008). India. (Downloaded: May (2011), http://www.moef.nic.in/report/ report.html).

Mirza, M.R. and D. Abdumassad, (1982). A contribution to the fishes of the genus *Puntius* Hamilton-Buchanan (Pisces: Cyprinidae) from Pakistan. *Biologica*, 28 (1): 61-81.

Munro, I.S.R., (1955). The Marine and Freshwater Fishes of Ceylon, Dept. Exter,Aff, Canbara, 351 p.

Myers, G.S., (1960). Preface to any future classification of the cyprinid fishes of the genus *Barbus*. *Stanford Ichthyological, Bulletin*,7(4): 212-215.

Nel, J.L., D.J. Roux, R. Abell, P. Ashton, R.M. Cowling, J.V. Higgins, M. Thieme and J.H.Viers, (2009). Progress and challenges in freshwater conservation planning. *Aquatic Conserv: Mar. Freshw. Ecosyst.* 19: 474-485.

Nelson, J.S., (2006). Fishes of the world, 4th edition. John Wiley and Sons, Inc, New York, 601 pp.

Nisha Bhagat and Ravinder Kumar, (2014). Deformities in Some Fresh Water Fish of River Tawiin Jammu (J&K). An introduction Journal of life Sciences. *TheBioscan.*9 (3): 991-996.

Norden, R., (1961). Comparative Osteology of Representative Salmonid fishes with Particular Reference to the Grayling *(Thymallus arctieus)* and it's Phylogeny *J. Fish. Res. Bd. Canada*, 18: 179-791.

Patterson, C., (1968). The caudal skeleton in lower Liassic, *the National Science Foundation of Sri Lanka **39** (2) 128.*

Patterson, C., (1984). Family Chanidae and Other Teleostean Fishes as Living Fossils, Springer-Yer/ai. New~York. pp. 132-139.

Patterson, C., and D.E. Rosen, (1977). Review of Ichthyodectiform and other Mesozoic teleost fishes and the theory and practice of classifying fossils. *Bulletin of the American Museum of Natural History* 158 (2): 81-172.

Pethiyagoda, R., (1991). Freshwater Fishes of Sri Lanka. Wildlife Heritage Trustof Sri Lanka, Colombo. 361 p.

Popova, A.A., 1970. Variability of the swim-bladder in carp (*Cyprinus carpio* L.) from Kursk and Niva fish farms. *J. Ichthyol.,* 10(6): 844-849.

Ramaswami, L.S., (I 955). Skeleton of Cyprinoid fishes in relation to phylogenetic studies. The skull and Webarian apparatus in the subfamily Gobininae (Cyprindae) *Acta Zool.* (Stockholm) 36: 127-158.

RamshortVan, J.D., (1981). Aquarium Encyclopedia of Tropical Freshwater Fish. *HP Books Tucson U.S.A. pp.* 194-224.

Reagan, C.T., (1911). The Classification of fishes of the order Ostariophysi, Cyprinoidea Ann. Mag. *Nat. His. Ser.* & Vol. 8: 13-32.

Senanayake, F.R. and P.B.Moyle, (1982). Conservation of Fresh water Fishes ofSri Lanka. Bio. Conser. 22:181-195.

Shantahkumar. M. and W.Vishwanath, (2006). Inter-Relationship of *Puntius* Hamilton-Buchanan (Cyprinidae: Cyprininae) found in Manipur, India. Zoo Outreach organization; www.Zooprint. Org. ISSN 0973-2535. 21(6).

Smith, C.L. and R.M.Baily, (1961). Evolution of the Dorsal Fin Support of Perccid Fishes. *Papers of the Michigan Acadamy of Sci. Art and Letters.* XLVI: 345-363.

Sujatha, K. and S.Dutt, (1985). Shape of the swim-bladder in family Silaginidae (Pisces) and its Taxonomic value. Mahasagar, Bulletin of National Institute of Oceanography. 18(3): 429-431.

Taki, Y., A. Katesyama and T. Urushido, (1978). Comparative morphology and interspecific relationship of Cyprinid genus *Puntius.Japanese Journal of Ichthyology* 25 (1): 1-8.

Talwar, P.K. and A.G.Jhingran, (1991). Inland fishes of India and Adjacent Countries. Vol. 1. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, Bombay, Calcutta, 541pp.

Topp. R.W. and Cole, C.F. (1968). An Osteological Study of the Sciaenid Genus *Sciaenops gill* (Teleostei: Sciaenidae). *Bull. Mar. Sci.* 18(4): 902-945.

Tyler, J. C., Jonson, D. G. Izuminakamura andB.B. Collette, (1939). Morphology of *Luvarusim perialis* (Luvaridae), with a Phylogenetic Analysis of the Acanthuroid (pisces). Smithsonian Contributions to *Zoology*, Smithsonian Institute Press, Washington D.C.pp.78.

Wake, M.H. (Editor), (1979). Hyman's comparative vertebrae anatomy.3rd ed. *Univ. Chicago Press*, Chicago, 788.

Weitzman, S.H., (1962). The Osteology of *Brycon meeki.* A generalized Characid Fish with an Osteological Definition of the Family. *Stanford Ichthyological. Bul-8* (1): pp. 77.

Wilimovsky, N.J. and S.H.Weitzman, (1955). Guide to the Osteology of the Head, Pectoral Girdle and Webarian apparatus of the Common Carp *Cyprinus carpio* L. *Stanford Natural. History. Muse.* Mimeo. Report 21.

Yousuf, A.R., Pandit, A.K. and A.R. Kahn, (1988). Cranial Osteology of *Schizothoraichthys niger* (Heckel) (Cyprinidae, Schizothoracinae) *Indian J. Fish.* 35: 26-31.

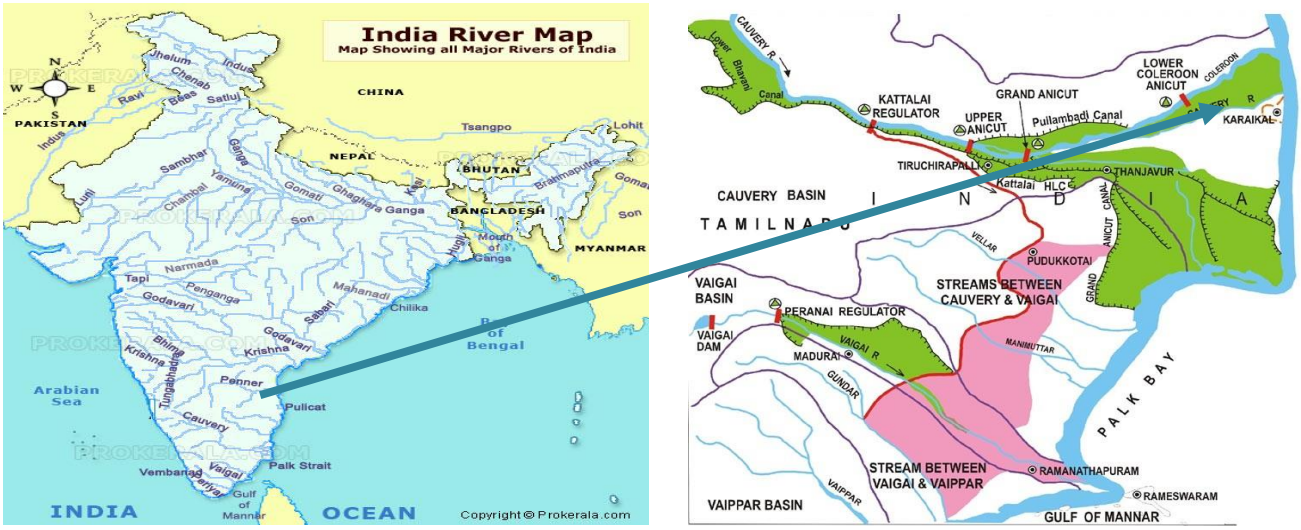

Fig.1 Study Area (Lower Anicut)

Fig: 2 *Puntius sophore*

Fig: 3 *Puntius filamentosus*

Fig: 4 *Puntius sarana*

Fig: 5 *Puntius ticto*

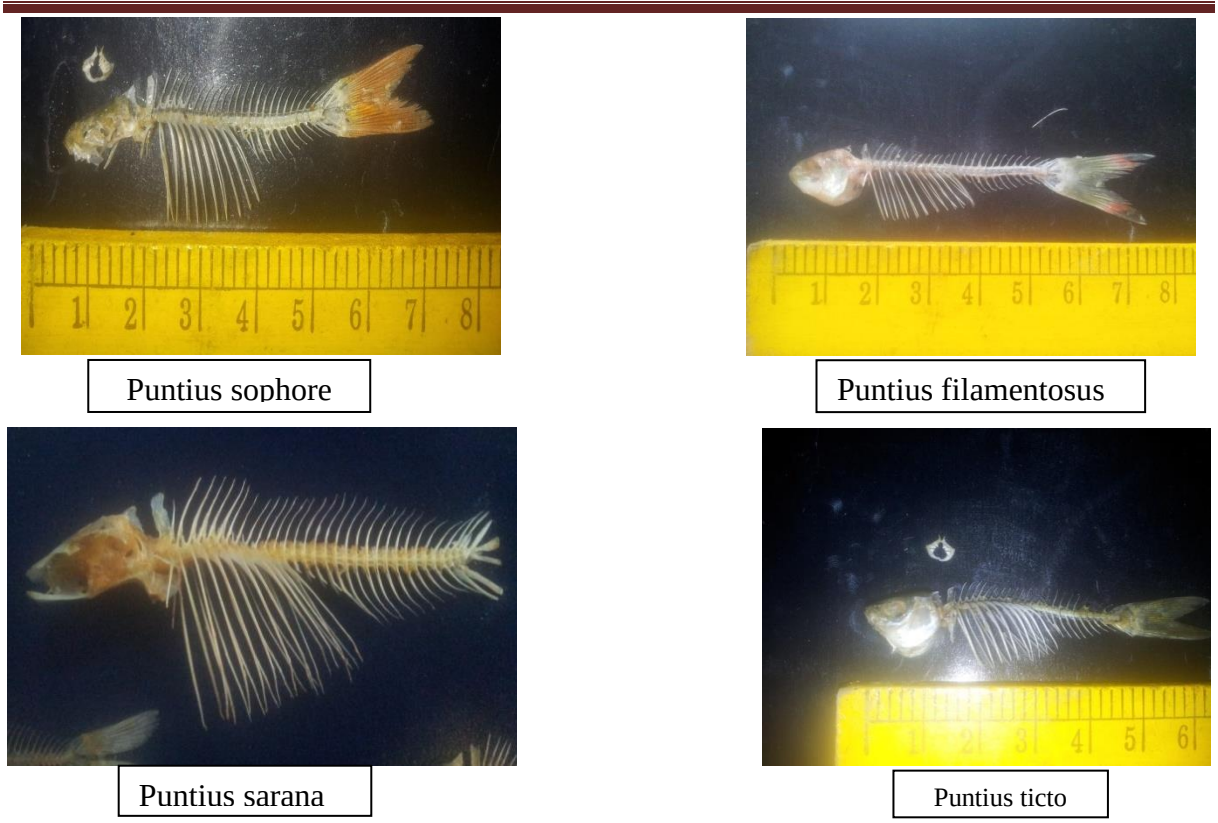

Fig. 6 Showing Vertebral bones in *Puntius* species by boiling

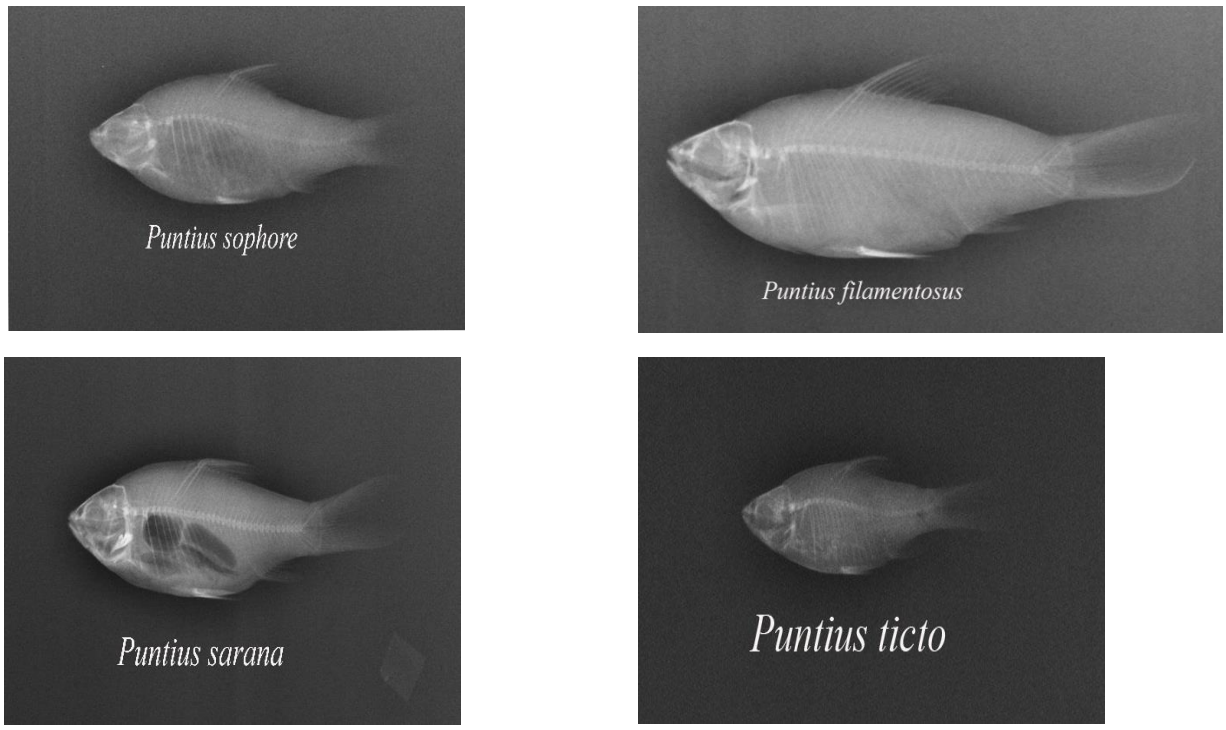

Fig. 7 Showing Vertebral bones in *Puntius* species by X-ray radiograph

Table. 1 Differentiation of Vertebral bones among *Puntius* Species through boiling and X-ray

Sl. No.	Meristic Character	*Puntius sophore*	*Puntius filamentosus*	*Puntius sarana*	*Puntius ticto*
1.	**Vertebral bones through boiling**	26	27-28	32	24
2.	**Vertebral bones through X - ray**	26	27-28	32	24