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Osteological Features of Pelvic Girdle and Pelvic Fin in Cyprinid Fishes from Northern Western Ghats, India

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Abstract: Osteology of pelvic girdle was studied in fishes of family Cyprinidae from Northern Western Ghats, India. Osteology from members of Subfamily- Labeoninae- tribe Garrini, Subfamily Smiliogastrinae, Family Danionidae, Family- Danionidae- Subfamily Danioninae and Family Danionidae- Subfamily Rasbora was studied. Cleared and stained specimens were observed for variations in pelvic girdle and pelvic fins.

Keywords: Cyprinidae, Osteology, Pelvic girdle, Pelvic fin, Variations

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Introduction

The family Cyprinidae is the most diverse family of freshwater fishes in the world, with at least 3006 species (Nelson *et al.*, 2016). Morphological investigations provide valuable insight into the diversity and evolution of cyprinid fishes. The higher-level relationships of Cypriniformes have been incompletely resolved by earlier morphological studies as they were based on study of too few species and study of too few osteological characters. Howes (1981) attempted to resolve the phylogenetic position of *Ctenopharyngodon* and *Hypophthalmichthys* based on 22 morphological characters. Sawada (1982) has studied cladistic relationships and

zoogeography in members of Cobitoidea based on osteological features. Mabee *et al.* (2011) have studied the phylogenetic relationships between 53 cypriniform species based on 62 morphological characters. Conway and Mayden (2007) based on gill arch osteology have attempted to resolve the position of *Psilorhynchus sucatio* and *P. balitora*. Nelson (1969) has studied skeleton of gill arches in some tropical freshwater fishes.

Saxena and Chandy (1966) have studied osteology of pelvic girdle and fins in various genera of hill stream cyprinid fishes. Mehta and Tandon (1984) have studied the osteology of Weberian apparatus, pelvic and pectoral girdles

and caudal skeleton in Indian cyprinid fishes with their application in systematics. Shantakumar and Vishwanath (2006) have studied interrelationships within genus *Puntius* species from Manipour region of India. Vishwanath and Shantakumar (2007) have studied osteology of genus *Osteobrama* species from Northeast India. Shangningam and Vishwanath (2012) have observed vertebral counts in *Garra namyaensis* from Manipur region. Pethiyagoda *et al.* (2012) have studied osteology of *Puntius* and *Systemus*. Katwate *et al.* (2013) have studied osteology of *Pethia setnai*. Raghavan *et al.* (2013) have studied osteology of new genus *Sahyadria*. Katwate *et al.* (2014) have studied osteology of *Pethia longicauda*. Katwate *et al.* (2016) have observed osteology of a new species *Pethia sanjaymoluri*. Yadav *et al.* (2018) have studied osteology of caudal skeleton of some cyprinid fishes from Northeast India. Arunkumar *et al.* (2018) have studied the osteological characters of *Puntius* species from 6 different river systems of southern Western Ghats.

The present study attempted to study pelvic girdle and pelvic fin osteology within members of Subfamily- Labeoninae-tribe – Garrini (*Garra mullya*), Subfamily- Smiliogastrinae (*Puntius mahecola*, *Puntius sahyadriensis*, *Rohtee ogilbii* and *Systemus sarana*), Family- Danionidae (*Barilius barna*, *Barilius bendelisis* and *Salmophasia balookee*), Family- Danionidae Subfamily – Danioninae (*Devariao aequipinatus*) and Family- Danionidae- Subfamily-Rasborinae (*Rasbora daniconius* and *Rasbora labiosa*).

Materials and Methods

Members of Subfamily Labeoninae; tribe Garrini (*Garra mullya*), Subfamily Smiliogastrinae (*Puntius mahecola*, *Puntius sahyadriensis*, *Rohtee ogilbii* and *Systemus sarana*), Family Danionidae (*Barilius barna*, *Barilius bendelisis* and *Salmophasia balookee*), Family Danionidae; Subfamily Danioninae (*Devariao aequipinatus*), Family Danionidae; Subfamily Rasborinae (*Rasbora daniconius* and *Rasbora labiosa*) were collected from local market or wild from Lonavala, Karjat,

Patan, Pune, Bhor, and Malvan and were preserved in 4% buffered formalin or absolute alcohol. These preserved specimens were identified and were cleared and stained using Alcian Blue and Alizarin red as per protocol by Taylor and Van Dyke (1985) with some modifications. These cleared specimens were stored in 100% glycerol with thymol crystals for final preservation.

Olympus SZX stereo microscope was used for observation of these cleared and stained specimens. Photography was done and illustrations or drawings were made for further studies using Adobe Photoshop CC. Osteological nomenclature follows Conway (2011).

Results and Discussion

The pelvic girdle consists of a flat, elongated Basipterygium supporting branched and unbranched pelvic fin rays. Anteriorly Basipterygium bears internal and external processes. Basipterygium is the principal bone in pelvic girdle which is narrow anteriorly and gradually broadening posteriorly till it reaches first unbranched ray. Posterior to unbranched fin ray it again decreases gradually and terminates in ischiatic process. There are three pelvic radials which are either ossified or cartilaginous and either triangular or rectangular in shape. The lateral most pelvic radial 1 is slightly rectangular and larger than pelvic radial 2 which is little, smaller. The medial most pelvic radial 3 is triangular extending posteriorly towards midline. A small spindle like bone termed pelvic splint by (Gosline, 1961) is located anterodorsal to the first unbranched pelvic fin ray. Triangular heads of fin rays articulate with posterior edge of basipterygium and pelvic radials. These heads are oriented posteromedially. Triangular head of the first unbranched pelvic fin is biggest which gradually becomes smaller in size for medial fin rays.

The pelvic girdle of taxa under study are mostly similar in general form (Figs. 1, 2). However, they differ in number of fin rays, shape

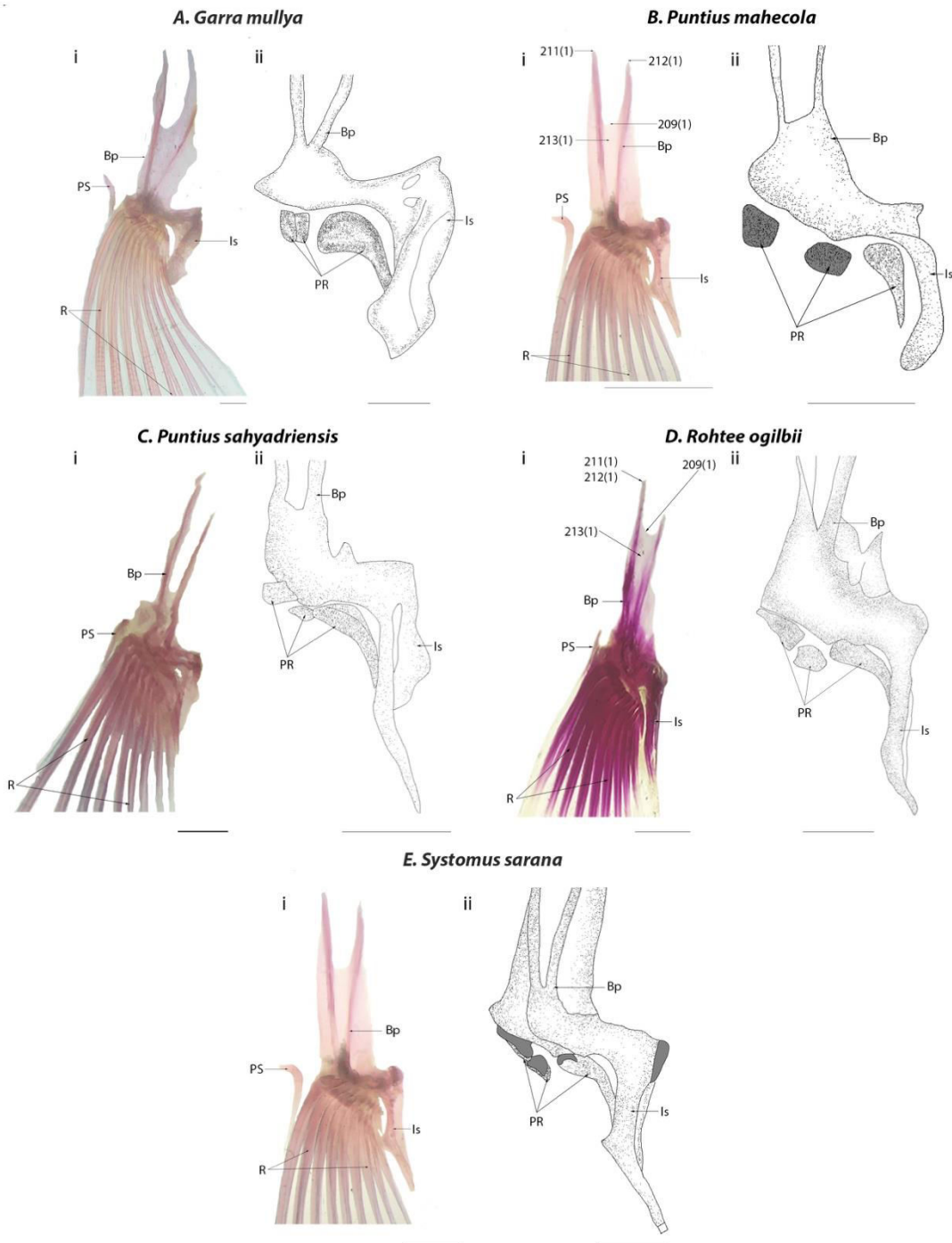


Fig. 1: Pelvic fin skeleton of Subfamily Labeoninae; tribe Garrini (A) *Garra mullya*) and Subfamily Smiliogastrinae (B) *Puntius mahecola*; (C) *Puntius sahyadriensis*; (D) *Rohtee ogilbii*; (E) *Systomus sarana*), in ventral view (i) and diagrammatic illustration of pelvic radials and ischiac process (ii). Anterior to top. Bp, basipterygium; Is, ischiac process; PS, pelvic splint; PR, pelvic radial; R, pelvic fin ray. Scale corresponds to 1 mm.

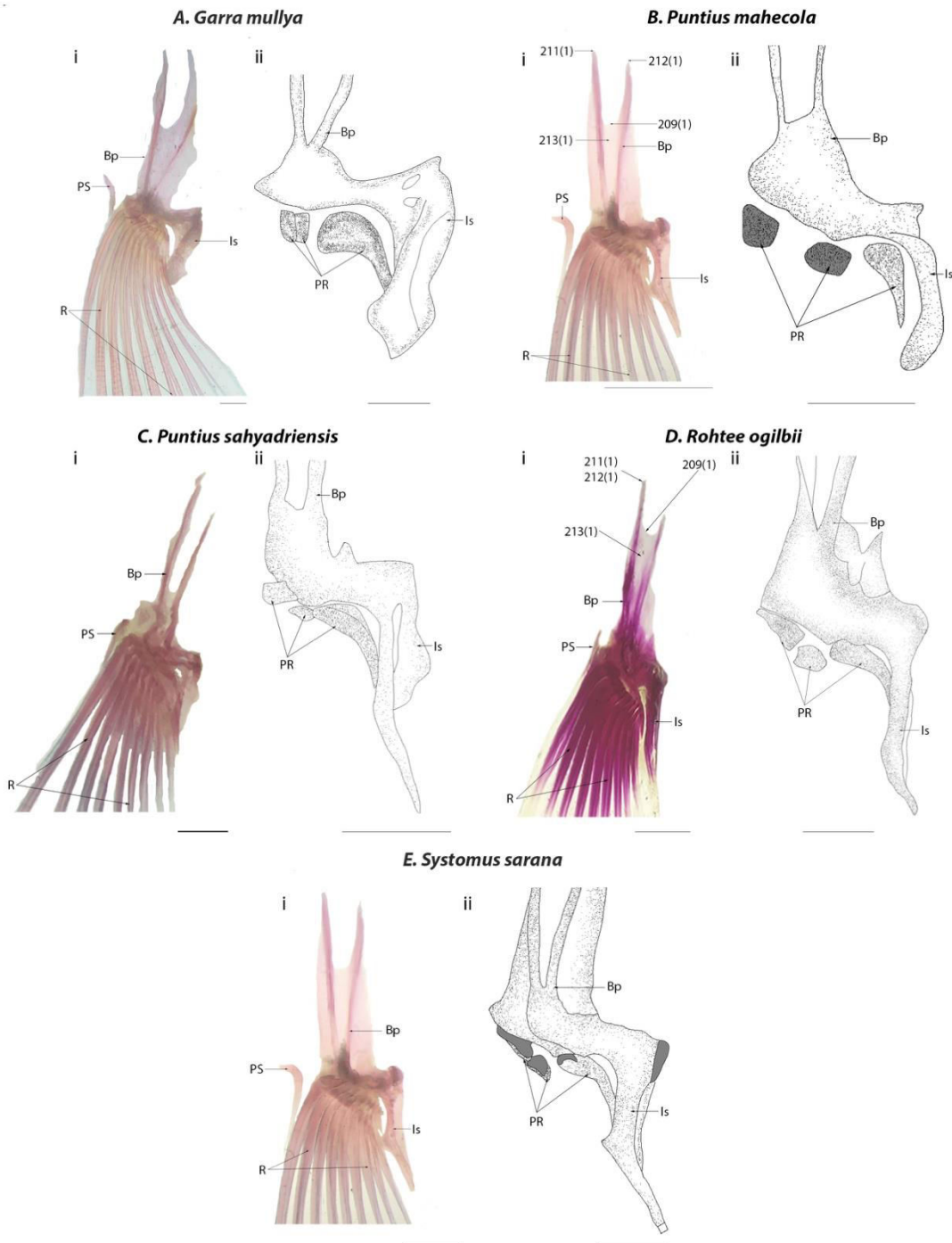


Fig. 2: Pelvic fin skeleton of Family Danionidae; Subfamily Danioninae (A) *Barilius barna*; (B) *Barilius bendelisis*; (C) *Salmophasia balookee*; (D) *Devario aequipinatus* and Subfamily-Rasborinae; (E) *Amblypharyngodon mola*; (F) *Rasbora daniconius*; (G) *Rasbora labiosa*, in ventral view (i) and diagrammatic illustration of pelvic radials and ischiac process (ii). Anterior to top. Bp, basipterygium; Is, ischiac process; PS, pelvic splint; PR, pelvic radial; R, pelvic fin ray. Scale corresponds to 1 mm.

of Basipterygium, ischiac process, shape and nature of pelvic radials and arrangement of pelvic radials.

In Subfamily- Labeoninae-tribe – Garrini, *Garra mullya*, the internal processes of two halves firmly meeting anteriorly at the midline. The ischiatic process bears irregular openings towards the lateral parts of Basipterygium. Of the three pelvic radials, the lateral most pelvic radial 1 and pelvic radial 2 are rectangular and of similar size. The medial most pelvic radial 3 is triangular extending posteriorly towards midline. Pelvic radial 1 and pelvic radial 2 slightly overlap on their lateral surfaces (Fig. 1 A).

In Family- Smiliogastrinae, *Puntius mahecola* roughly rectangular pelvic radial 1 and 2 are present while pelvic radial 3 is triangular (Fig. 1B). *P. sahyadriensis* shows roughly rectangular pelvic radial 1 and pelvic radial 2 and 3 are triangular (Fig. 1C). In *Rohtee ogilbii* pelvic radial 1 is triangular, pelvic radial 2 is rectangular while pelvic radial 3 is triangular (Fig. 1D). In *Systomus sarana*, all three pelvic radials are triangular. These pelvic radials show some cartilaginous parts also (Fig. 1E).

In Family- Danionidae, *Barilius barna*, pelvic radial 1 and 2 are roughly rectangular while pelvic radial 3 is triangular and slightly curved (Fig. 2A). In *B. bendelisis* pelvic radial 1 is triangular, pelvic radial 2 is rectangular while pelvic radial 3 is triangular and slightly curved. Posterior tip of pelvic radial 3 is extended a bit (Fig. 2B). In *Salmophasia balooke* pelvic radial 1 is triangular, pelvic radial 2 is rectangular while pelvic radial 3 is 'L' shaped, whose base is broad. Pelvic radial 2 is small compared to pelvic radial 1 (Fig. 2C). In *Devario aequipinatus* pelvic radial 1 and 2 are roughly rectangular. Pelvic radial 1 is slightly larger than pelvic radial 2. Pelvic radial 3 is 'L' shaped (Fig. 2D). In *Amblypharyngodon mola* pelvic radial 1 is triangular, pelvic radial 2 is rectangular while pelvic radial 3 is 'L' shaped.

Pelvic radial 1 and pelvic radial 2 slightly overlap on their lateral surfaces (Fig. 2E).

In subfamily Rasborinae, *Rasbora daniconius* and *R. labiosa*, pelvic radial 1 is triangular, pelvic radial 2 is rectangular and elongated while pelvic radial 3 is triangular. In *R. daniconius*, there are some cartilaginous parts on radials while in *R. labiosa* pelvic radial 2 is completely cartilaginous (Figs. 2F, G).

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