

Descriptive osteology of fishes referred to the genus *Rasboroides* Brittan (Teleostei: Cyprinidae)

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ABSTRACT: Owing to the spectacular colouration, fish species of the genus *Rasboroides* have a substantial economic value in the aquarium trade of the world. All the species of *Rasboroides* categorized as threatened fishes. The studies revealed that some species of the genus *Rasboroides* are having a stable population in the South-western wet zone of Sri Lanka. Osteology of these important species was studied and the findings further support the recently described or re-described species within the genus. One of the important characters of the genus is danionin notch which was only observed in *R. pallidus*. This character is always observed in related Cyprinid genera *Devario*. The presence of danionin notch in *R. pallidus* is mystifying since it is independently found in two different tribes of subfamily Danioninae. Further studies ought to reveal the status of this character within the Danioninae.

Keywords: Danionin notch, dentary, ornamental fish, *Rasboroides pallidus*

INTRODUCTION

Sri Lanka possesses a highly diverse endemic fauna and flora (Myers *et al.*, 2000) and is a reservoir of unique evolutionary history (Bossuyt *et al.*, 2004). During the British rule of the island, several large scale-taxonomic studies on the fishes of Sri Lanka have been carried out. However, the aspects of osteology, ethology and ecology of fishes are handful in Sri Lanka (Costa and Fernando, 1967; De Silva *et al.*, 1977; Kortmulder, 1986; Moyle and Senanayake, 1984; Wickramanayake, 1990). Recently, De Silva *et al.* (2015) made a comprehensive compilation on freshwater fishes, where almost all reported fishes to date have been included. But that compilation too lacks the aspects of biology and osteology of fish.

Rasboroides vaterifloris (*Rasbora vaterifloris*) was originally reported in Gilimale, Sabaragamuwa Province of Sri Lanka (Deraniyagala, 1930). Brittan (1972) was the first reviser, who recognized the uniqueness of *Rasbora vaterifloris* and placed in subgenus, *Rasbora* (*Rasboroides*). Kottelat and Vidthayanon (1993) recognized the validity of the subgenus *Rasboroides* and resurrected to generic rank. Batuwita *et al.* (2013) resolved the

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identity of subdivision of *R. vaterifloris* by recognizing four different species (Deraniyagala, 1958). Previous study of Batuwita *et al.* (2013) on the genera *Horadandia* and *Rasboroides* discusses about a few characters of cranium, suspensorium, and 5th gill arch. Hence, this study discusses descriptive osteology of all congeners of genera *Rasboroides*.

METHODOLOGY

Meristic data of specimens were obtained following Batuwita *et al.* (2013) and staining and clearing procedure, a slightly modified method of Taylor and Van Dyke (1985) were adopted. Osteological terminology followed Fang (2003). Cleared and stained specimens were denoted as c&s.

RESULTS AND DISCUSSION

Rasboroides vaterifloris (Deraniyagala, 1930)

Figures 1A, 2A and Table 1 provide the osteological description of *R. vaterifloris*.

Materials examined. WHT 9701, 1 specimen, 25.5 mm SL (c&s); Sri Lanka: Ratnapura District: Kalu River basin, Induru stream: Induruwa Forest Reserve, near Gilimale: 06°45' N 80°26' E; WHT 9702, 1 specimen, 25.6 mm SL (c&s); Sri Lanka: Ratnapura District: Kalu River basin, Adona Stream: Parakaduwa; 06°49' N, 80°18' E.

Description. Infraorbitals with sensory canals; outer margin of 3rd infraorbital with downward extension; anterior dorsal extension of the maxilla slightly overlaps the premaxilla dorsally; dorsal boarder of operculum even; dorsal outline of lower jaw with a shallow concavity next to symphyseal knob; before the coronoid process of dentary a shallow concavity; superior border of anguloarticular elevated, convex; danionin notch absent; broad coronoid process on dentary; frantoparietal fontanelle present. Abdominal vertebrae12–13; caudal vertebrae16–17; total vertebrae29. Ventral view of the shape of supracleithrum, L-shaped; anterior outline of horizontal limb of cleithrum in ventral view convex; absence of a foramen on anterior wall of horizontal limb of cleithrum; coracoid foramen well-developed; basipterygium broad, not deeply notched. Basihyal with two lateral processes, apophysis narrow; absence of Rasborin process on 4th epibranchial; pharyngeal teeth rows 3 (3,4,5–5,4,3); pharyngeal teeth with terminal grooves; posterior lateral border of 5th ceratobranchial deeply notched; uroneural is absent from pleurostyle; parahypural and first hypural fused posteriorly; six hypurals present.

Rasboroides nigromarginatus (Meinken, 1957)

Figures 1B, 2B and Table 1 provide the osteological description of *R. nigromarginatus*.

Material Examined. WHT 578, 1 specimen, 29.0 mm SL (c&s); Sri Lanka: Kalutara District: Kalu River basin: Atweltota, 06°33' N 80°17'E.

Description. Infraorbitals with sensory canals; outer margin of 3rd infraorbital with downward extension; 4th infraorbital greatly reduced; 5th infraorbital absent; anterior dorsal extension of the maxilla slightly overlaps the premaxilla dorsally; outline shape of tip of the

ascending process of the premaxilla straight; dorsal boarder of operculum with a deep indentation; dorsal outline of lower jaw with a concavity next to symphyseal knob; no concavity before the coronoid process of dentary; superior border of anguloarticular not elevated, truncate; danionin notch absent; narrow coronoid process of dentary; frantoparietal fontanelle present. Abdominal vertebrae 12; caudal vertebrae 16; total vertebrae 28. Ventral view of the shape of supracleithrum: L-shaped; anterior outline of horizontal limb of cleithrum in ventral view convex; absence of a foramen on anterior wall of horizontal limb of cleithrum; coracoid foramen well-developed. Basipterygium broad, not deeply notched; basihyal with two lateral processes, apophysis wide; absence of Rasborin process on 4th epibranchial; pharyngeal teeth in 3 rows (3,4,5–5,4,3); pharyngeal teeth with terminal grooves; no notch on posterior lateral border of 5th ceratobranchial; uroneural is absent from pleurostyle; parahypural and first hypural fused posteriorly; six hypurals present.

***Rasboroides pallidus* Deraniyagala, 1958**

Figures 1C, 2C and Table 1 provide the osteological description of *R. pallidus*.

Materials Examined. WHT 11055, 1 specimen, 23.5 mm SL (c&s); Kalutara District: Kalu River basin: Yagirala, 06°22' N 80°10' E; WHT 11101, 1 specimen, 17.7 mm; WHT 11113, 1 specimen, 20.0 mm SL (c&s); Galle District: Gin River basin: Kombala-Kottawa forest reserve, 06°06' N 80°20' E.

Description. Infraorbitals with sensory canals; 1st and 3rd infraorbitals greatly enlarged; outer margin of 3rd infraorbital with downward extension; 4th infraorbital greatly reduced; 5th infraorbital absent; anterior dorsal extension of the maxilla slightly overlaps the premaxilla dorsally; outline shape of tip of the ascending process of the premaxilla straight; dorsal boarder of operculum slightly convex; dorsal outline of lower jaw with a concavity next to symphyseal knob; a shallow depression before the coronoid process of dentary; a broad coronoid process of dentary; superior border of anguloarticular convex, elevated; danionin notch present; frantoparietal fontanelle present. Abdominal vertebrae 11–12; caudal vertebrae 16–17; total vertebrae 28–29. Ventral view of the shape of supracleithrum L-shaped; anterior outline of horizontal limb of cleithrum in ventral view straight; absence of a foramen on anterior wall of horizontal limb of cleithrum; coracoid foramen well-developed. Basipterygium narrow, deeply notched; absence of hypohyal process on the basihyal, apophysis wide; absence of Rasborin process on 4th epibranchial; pharyngeal teeth in 3 rows (3,4,5–5,4,3); pharyngeal teeth with terminal grooves; no notch on posterior lateral border of 5th ceratobranchial; uroneural is absent from pleurostyle; parahypural and first hypural fused posteriorly; six hypurals present.

***Rasboroides rohani* Batuwita, De Silva & Edirisinghe, 2013**

Figures 1D, 2D and Table 1 provide the osteological description of *R. rohani*.

Material Examined. WHT 9714, 2 specimens, 25.6–29.5 mm SL (c&s): Sri Lanka: Ratnapura District: Walawe River basin, Rakwana Ganga tributary: Suriyakanda, 06°26'59" N 80°37'10" E, 980 m above sea level.

Description. Infraorbitals with sensory canals; outer margin of 3rd infraorbital without downward extension; 4th infraorbital greatly reduced; 5th infraorbital absent; anterior dorsal extension of the maxilla slightly overlaps the premaxilla dorsally; outline shape of tip of the ascending process of the premaxilla concave; dorsal boarder of operculum without a deep indentation; dorsal outline of lower jaw with a shallow concavity next to symphyseal knob; shallow concavity before the coronoid process of dentary; superior border of anguloarticular

straight; danionin notch absent; broad coronoid process of dentary; frontoparietal fontanelle present. Abdominal vertebrae 12–13; caudal vertebrae 17; total vertebrae 29–30. Ventral view of supracleithrum L-shaped; anterior outline of horizontal limb of cleithrum in ventral view convex; absence of a foramen on anterior wall of horizontal limb of cleithrum; coracoid foramen absent; basipterygium narrow, deeply notched; basihyal with two lateral processes, apophysis wide; absence of Rasborin process on 4th epibranchial; pharyngeal teeth in 3 rows (2,4,5–5,4,2); pharyngeal teeth with terminal grooves; no notch on posterior lateral border of 5th ceratobranchial; uroneural is absent from pleurostyle; parahypural and first hypural fused posteriorly; six hypurals present.

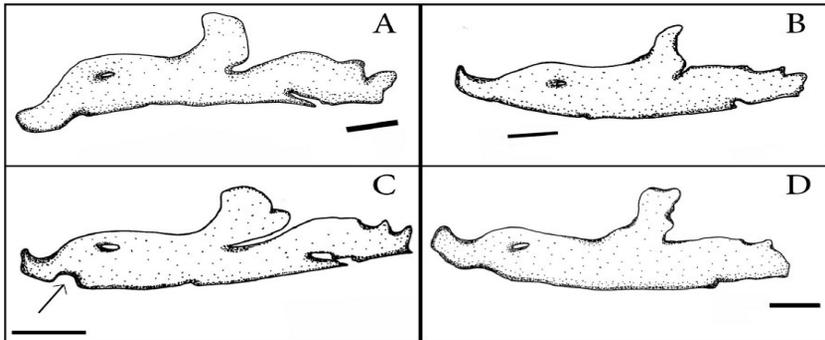


Figure 1. Lateral view of dentary of, *Rasboroides vaterifloris* (A); *R. nigromarginatus* (B); *R. pallidus* (C); *R. rohani* (D), respectively. Arrow head points danionin notch of *R. pallidus*. Scale bar 0.5 mm.

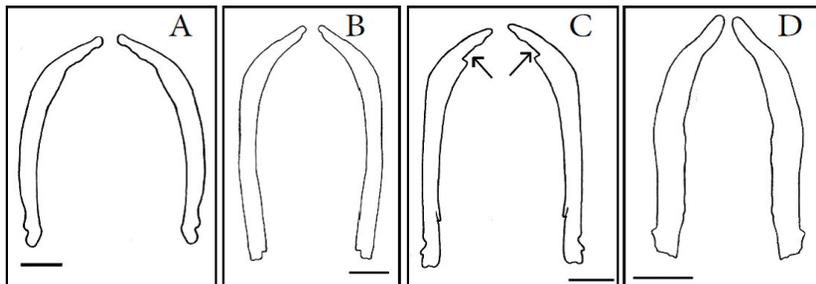


Fig. 2. Ventral view of dentary of, *Rasboroides vaterifloris* (A); *R. nigromarginatus* (B); *R. pallidus* (C); *R. rohani* (D), respectively. Arrow head points danionin notch of *R. pallidus*. Scale bar 1.0 mm.

Table 1. Pectoral and pelvic girdle characters of, *Rasboroides vaterifloris*, *R. nigromarginatus*; *R. pallidus* and *R. rohani*.

Character	<i>R. vaterifloris</i>	<i>R. nigromarginatus</i>	<i>R. pallidus</i>	<i>R. rohani</i>
Anterior boarder of cleithrum in ventral view	Convex	Convex	Straight	Convex
Coracoid foramen	Present	Present	Absent	Absent
Basipterygium	Moderately notched	Moderately notched	Moderately notched	Deeply notched

Osteology of *Rasboroides* species examined in this study showed pronounced differences among the species based on their morphology of cranium and suspensorium, dentary (Figures 1, 2), hyoid arch, basihyal, pectoral and pelvic girdles (Table 1). Pectoral and pelvic girdles have distinct differences among species. Morphology of dentary showed distinctly separable characters within the congeners and the consistency of these characters further supports the identity of four discrete species within the *Rasboroides*.

Kottelat and Witte (1993) placed *Rasbora axelrodi* Brittan, 1976 in the monotypic genus *Sundadanio* and considered it to be a member of the danionine lineage because it had a danionin notch in the dentary. However, Fang (2003) stated, that she did not observe a danionin notch in *S. axelrodi* (in 10 specimens). This describes intraspecific variations and/or presence of additional species in the genus (Conway *et al.*, 2011).

We examined about eight specimens (c&s) from the genus *Rasboroides* from Sri Lanka; only all *R. pallidus* (3 specimens) have the danionin notch (Figures 1C, 2C). However, the presence of shallow depression in *R. vaterifloris* (Figure 2A) has to be verified by further studies. Based on an on-going study of *Devario*, danionin notch appears to be a well-defined in all the Sri Lankan species (Batuwita *et al.*, pers. comm.). Fang (2003) also concluded that danionin notch is not a Danionin (s. l.) synapomorphy.

CONCLUSIONS

The findings of this study confirm the species recognition based on morphology and morphometry by the previous study of Batuwita *et al.* (2013). The results further revealed that one of the important characters of subfamily Danioninae, the danionin notch occurs also within the *Rasboroides*, suggesting that danionin notch is not a Danionin (s. l.) synapomorphy as mentioned by Fang (2003).

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