



***Badis britzi*, a new percomorph fish (Teleostei: Badidae) from the Western Ghats of India**

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Abstract

Badis britzi, the first species of the genus endemic to southern India, is described from the Nagodi tributary of the west-flowing Sharavati River in Karnataka. It is distinguished from congeners by a combination of characters including a slender body, 21–24 pored lateral-line scales and a striking colour pattern consisting of 11 bars and a mosaic of black and red pigmentation on the side of the body including the end of caudal peduncle, and the absence of cleithral, opercular, or caudal-peduncle blotches, or an ocellus on the caudal-fin base. *Badis triocellus* Khyntiam & Sen is considered a junior synonym of *B. singenensis* Geetakumari & Kadu.

Key words: freshwater fish, Karnataka, Perciformes, Sharavati

Introduction

Percomorph fishes of the family Badidae currently comprise two genera: *Badis* (16 species) and *Dario* (six species), that are distributed in South and Southeast Asia, from southern and eastern India and Nepal, east to the Mekong drainage in Thailand and Laos (Kullander & Britz 2002; Britz & Kullander 2013; Eschmeyer 2014; Britz & Ali 2015). The first badid to be recorded from peninsular India was *Badis badis* (Hamilton, 1822) from the erstwhile Presidencies of Mumbai and Chennai (now mostly within Maharashtra and Tamil Nadu) (Day 1875–1878; Kullander & Britz 2002), the Godavari drainage (Karmakar & Datta 1998) and Chembarambakkam Lake near Chennai (Knight & Devi 2009). The fish recorded as *Badis dario* from Wayanad by Day (1875–1878) was recently shown to be a new species, *Dario urops*, by Britz *et al.* (2012). The recent discoveries of two unusual badids, namely *D. urops* Britz, Ali & Philip, and *D. huli* Britz & Ali, from west-flowing rivers in Karnataka (Britz *et al.* 2012, Britz & Ali 2015) has increased the number of species in this family in peninsular India to three.

During a recent survey of the Nagodi tributary of the west-flowing Sharavati River in Karnataka State, we discovered a species with a colour pattern strikingly different from any known species of Badidae, which we describe herein as *Badis britzi*.

Material and methods

Study site and sampling. Specimens of the new species were collected from the Nagodi tributary of the west-flowing Sharavati River, near the town of Nittur in Karnataka State, India. The series collected was limited to four individuals, three of which were fixed in 10% formalin and one in absolute ethanol. A specimen of *Badis badis* was also collected from Cauvery River near Mysore, Karnataka, India.

Morphology, morphometry and osteology. Measurements were taken point to point, using dial calipers, to the nearest 0.1 mm. Subunits of the body are presented as percent of standard length (SL), and subunits of the head as percent of head length (HL). Methods for morphometry follow Kullander & Britz (2002), with additional measurements including total length, dorsal-fin base length, anal-fin base length, caudal-peduncle least depth and caudal-peduncle length. Fin rays were counted for all the specimens under transmitted-light stereo-microscope. Description and numbering of the laterosensory system on the head follows Fig. 1 in Kullander & Britz (2002). The value in parentheses after a specific count represents the frequency of the count. Colour pattern terminology follows Kullander & Britz (2002). One of the paratypes, BNHS FWF 126, was cleared and stained for osteological study following the procedure described by Potthoff (1984).

Voucher specimens and museum abbreviations. Voucher specimens are deposited in the museum collections of the Bombay Natural History Society (BNHS), Mumbai; Wildlife Information Liaison Development (WILD) Society, Coimbatore; Western Regional Center of the Zoological Survey of India (ZSI-WRC), Pune. Other materials examined are in the museum collection of Conservation Research Group, St. Albert's College (CRG-SAC), Kochi, India.

Molecular information. Gill tissue was extracted from fresh specimens of the new species (WILD-15-PIS-141) and a specimen of *Badis badis* from Mysore, Cauvery, Karnataka (WILD-15-PIS-144). Tissue was preserved in absolute ethanol. DNA extraction and PCR amplification for the cytochrome oxidase subunit 1 (COI) gene sequences and sequencing protocols follow Ali *et al.* (2013). Sequences were analyzed by BLAST tool (Altschul *et al.* 1990). Sequences generated as part of the study are deposited in GenBank (accession numbers KP666031 and KP666032). Gene sequences were aligned using MUSCLE (Edgar 2004) and a molecular analysis was performed using the freeware MEGA 6 (Tamura *et al.* 2013). Genetic differences were calculated using P distances and the standard error of the estimate was calculated using bootstrap method for 1000 iterations.

Results

Badis britzi, new species

(Figs. 1–3)

Holotype. BNHS FWF 125, 32.7 mm SL, male; India: Karnataka: Nagodi tributary of the west-flowing Sharavati River, near the town of Nittur (13°54'58" N, 74°53'21"E, 594 m ASL); P. Kumkar, U. Katwate, R. Raghavan and N. Dahanukar, 30 June 2014.

Paratypes. WILD-15-PIS-140, 24.7mm SL, same data as holotype; BNHS FWF 126, 29.8 mm SL, same data as holotype (cleared and stained); ZSI-WRC P/4243, 32.2 mm SL, same data as holotype; WILD-15-PIS-141, 22.1 mm SL, same data as holotype (used for genetic analysis).

Diagnosis. *Badis britzi* shows a colour pattern that differs from all other species in the genus. It can be distinguished from all members of the *B. ruber* group (Kullander & Britz 2002, that includes *B. ruber*, *B. khwae* and *B. siamensis*) by absence of cleithral and caudal-peduncular blotches, from all members of the *B. assamensis* group (that includes *B. assamensis* and *B. blosyrus*) by absence of an opercular blotch and of two parallel rows of dark blotches and alternating dark and light stripes along the body, from all members of the *B. corycaeus* group (that includes *B. corycaeus*, *B. pyema* and *B. kyar*) by the absence of an ocellus on the caudal-fin base, from all members of the extended *B. badis* group (that includes *B. badis*, *B. chittagongis*, *B. ferrarisi*, *B. dibruensis*, *B. tuivaiei* and *B. kanabos*) by the absence of a cleithral blotch, and from *B. singenensis* by the absence of a conspicuous black blotch posterodorsally on the opercle, three distinct dark blotches on dorsal fin base and another distinct black blotch on the base of anal fin. Further, the new species also has a slender body (body depth less than 30% SL), which distinguishes it from all other congeners except *B. pyema* and *B. kyar*. Its colour pattern, which consists of 11 dark, clearly-defined bars, most closely resembles that of *B. kyar* and *B. juergenschmidtii*, from which it is distinguished by a greater head length (32.3–35.0% SL vs. 26.8–31.4% in *B. kyar* and 28.8–29.6% in *B. juergenschmidtii*), a longer snout (6.8–8.3% SL vs. 5.0–6.4% in *B. kyar*) and shorter dorsal-fin base (54.6–56.6%SL vs. 62.3–63.7% in *B. juergenschmidtii*).

Description. General appearance as in Figs. 1 and 2, morphometric data are provided in Table 1.

TABLE 1. Selected morphometric information of type series of *Badis britzi* (n=5, holotype BNHS FWF 125 and paratypes WILD-15-PIS-140, BNHS FWF 126, ZSI-WRC P/4243 and WILD-15-PIS-141).

Character	Holotype BNHS FWF 125	Mean (sd) (n=5)	Range (n=5)
Total length (mm)	39.3	34.4 (5.4)	27.4–39.3
Standard length (SL, mm)	32.7	28.3 (4.7)	22.1–32.7
% SL			
Head length (HL)	33.9	33.6 (1.0)	32.3–35.0
Snout length	6.8	7.3 (0.6)	6.8–8.3
Eye diameter	9.7	9.6 (0.7)	8.7–10.6
Interorbital width	8.3	7.9 (0.4)	7.5–8.3
Upper-jaw length	9.1	7.4 (1.1)	6.1–9.1
Lower-jaw length	10.1	9.3 (0.6)	8.4–10.1
Body depth	27.1	26.9 (1.0)	25.5–28.4
Pelvic fin-length	26.7	25.9 (0.7)	24.9–26.7
Pelvic to anal distance	27.6	30.6 (2.0)	27.6–32.8
Dorsal-fin base length	56.1	55.9 (0.8)	54.6–56.6
Anal-fin base length	17.5	17.9 (2.6)	16.2–22.5
Caudal-peduncle depth	15.4	14.7 (0.5)	14.2–15.4
Caudal-peduncle length	16.6	16.1 (0.7)	15.3–17.0
% HL			
Snout length	20.1	21.8 (1.5)	20.1–23.8
Eye diameter	28.5	28.5 (1.3)	27.1–30.4

Body elongate, its depth less than 30% SL, laterally compressed. Predorsal profile convex, sharply increasing from tip of snout to anterior border of dorsal fin, then gradually decreasing from first ray of dorsal fin to end of caudal peduncle. Ventral profile descending steeply until below posterior border of eye, then almost flat to origin of anal fin, ascending thereafter to base of caudal fin. Caudal peduncle only slightly attenuated posteriorly, its length slightly more than its depth (length to depth ratio 1.1–1.2).

Head slightly pointed with angle of snout slightly less than 90° in lateral view, snout length less than eye diameter. Eyes large, situated in anterior upper half of head. Interorbital distance less than eye diameter. Mouth terminal, lower jaw projecting beyond anterior margin of upper jaw. Angle of jaws situated at vertical through anterior third of eye. Opercular spine broadly triangular, with a single tip. Vomer, palatine and pharyngeal process of parasphenoid toothed. Basihyal teeth absent. Teeth on hypobranchial 3. Gill rakers simple. First gill arch with 7 outer and 8 inner rakers on ceratobranchial and 1 outer and 1 inner raker on epibranchial region; second gill arch with 7 outer and 6 inner rakers on ceratobranchial and 1 outer and 1 inner raker on epibranchial region; third gill arch with 7 outer and 4 inner gill rakers on ceratobranchial and 1 outer and no inner gill rakers on epibranchial region; fourth gill arch with 4 outer and 2 inner gill rakers on ceratobranchial and no rakers on the epibranchial region. Ceratobranchial 5 with numerous small teeth.

Scales ctenoid on sides, cycloid on dorsal surface of head. Predorsal scales 4 anterior to coronalis pore, 9 posteriorly, excluding the pored scale. Four rows of scales on cheek. Cephalic sensory-canal pores comprise dentary pores 4 (d1-d4), anguloarticular pores 2 (aa1-aa2), preopercular pores 6 (p1, p3-p7), nasal pores 2 (n1-n4), frontal pores 3 (f2-f4), coronalis opening (cor), infraorbital pores 4 (io1-io4), lachrymal pores 3 (l1-l3), posttemporal openings 2 (pt1-pt2), extrascapular openings 3 (ex1-ex3) and pterotic opening 1 (pt2-3). Lateral line distinct, incomplete, broken into upper anterior line and posterior lower lateral line. Upper, anterior line gradually sloping until below vertical from dorsal-fin origin, then parallel to dorsal profile almost up to end of dorsal-fin base, encompassing 21(2) or 22 (3) scales. Posterior, lower lateral line with 0 (1), 1 (2) and 2 (2) pored scales, posterior lateral-line pores, wherever present, separated from anterior pores by four rows of scales. Total lateral-

line scale counts 22/2 in holotype and 21/1, 22/1, 21/2 and 22/0 in paratypes. Scales in longitudinal series, including those on base of caudal fin, 26 (1), 27 (1) or 28 (3). Scales in transverse series $\frac{1}{2}$ 2/1/7. Circumpeduncular scales 16.



FIGURE 1. *Badis britzi*, holotype (BNHS FWF 125, 32.7mm SL).



FIGURE 2. *Badis britzi*, holotype in life, immediately after capture.

Vertebrae 15+13 (Fig. 3) in c&s specimen. Dorsal-fin rays XVII+9 (5). Anal-fin rays III+7 (5). Pectoral-fin rays 12 (1) or 13 (4). Pelvic-fin rays I+5 (5). Principal caudal-fin rays 7+7 (5). Procurrent caudal-fin rays 3+3 (5). Sheathing scales present along base of dorsal and anal fins.

Interradial membranes of spinous dorsal fin projecting as short fin lappets that do not extend much beyond tips of spines. Soft dorsal and anal fins with rounded tips, extending to base of caudal fin or slightly beyond. Pectoral-fin origin on vertical through first dorsal-fin spine, adpressed pectoral-fin reaching posteriorly to vertical through base of 9th or 10th dorsal-fin spine. Pelvic-fin with its origin on vertical through third dorsal-fin spine, adpressed

pelvic-fin reaching posteriorly to 13th or 14th dorsal-fin spine, stopping short of anal-fin base. Caudal fin subtruncate.



FIGURE 3. Cleared and stained specimen of *Badis britzi*, paratype (BNHS FWF 126, 29.8mm SL).

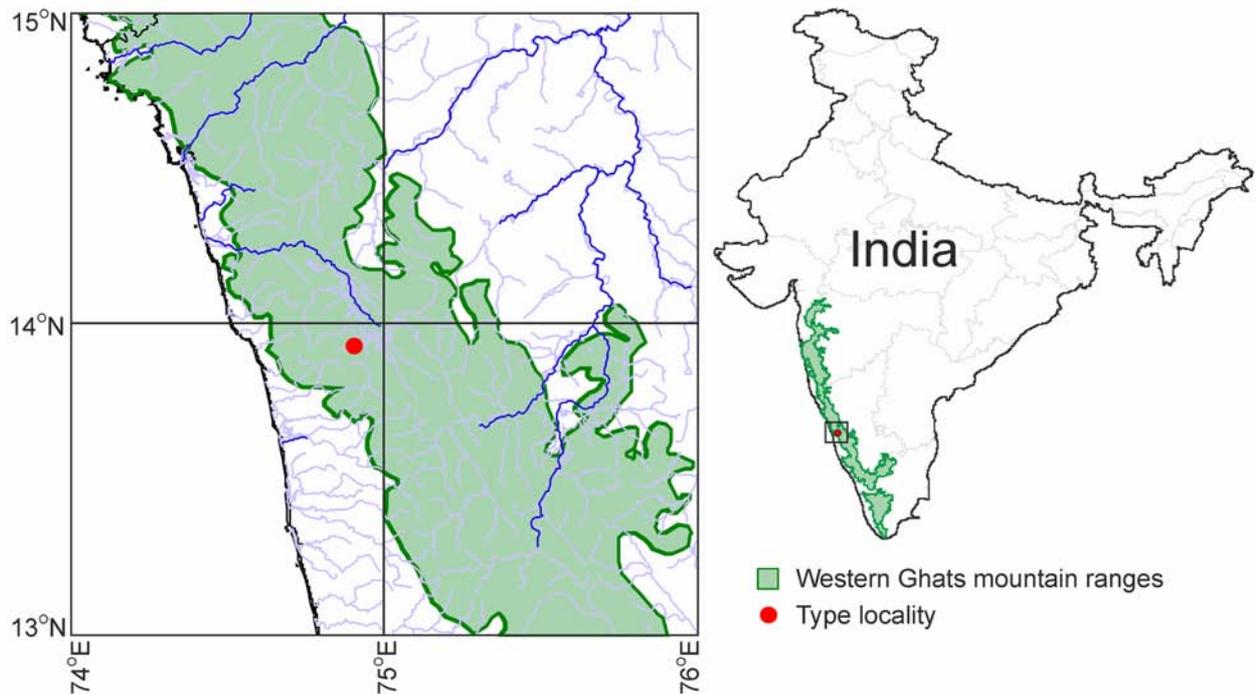


FIGURE 4 Type locality of *Badis britzi* in the west-flowing Sharavati River, Karnataka, India.

Coloration in life. General appearance as in Figure 2. Background colour beige to light brown, darker on dorsal than on ventral side, with several reddish and dark-brownish to black marks. Preorbital stripe dark brown. Postorbital stripe dark brown, extending obliquely from upper posterior margin of eye towards nape. No cleithral spot. A series of 11 irregular dark bars on lateral surface of body and tail base, consisting of a mosaic of dark-brown and red pigments. Caudal blotch absent, but end of caudal peduncle with a vertical black bar followed by a red vertical bar towards base of caudal fin. Pectoral fin translucent. Pelvic-fin outer rays with black interradial membrane, inner rays with red pigmentation. Anal fin dusky at base, with intermittent black and red pigments. Dorsal-fin base with dense aggregations of melanophores forming blotches along its base, mostly continuing from bands on lateral side of body. Seven such blotches on base of dorsal fin. Base of each dorsal-fin spine dusky, distal ends white. Dorsal fin membrane dusky at the base, followed distally by a band of red chromatophores. Base of dorsal-fin soft rays with melanophores and brown chromatophores, distal area mainly translucent, with occasional

red chromatophores. Caudal fin, translucent, without pigmentation except for a dark-brown and red band at its base.

Colour in preservative. Similar to coloration in life. Background body colour more uniform dark brown. Black bars more clearly visible posterior to anterior border of anal-fin base. Red melanophores less conspicuous. Coloration on caudal base less conspicuous.

Distribution. *Badis britzi* is currently known only from its type locality in the Nagodi tributary of the west-flowing Sharavati River, near the town of Nittur, Karnataka, India (Fig. 4).

Etymology. The species name honours Ralf Britz, Natural History Museum, London, for his contributions to the understanding of the systematics and evolution of badid fishes.

Habitat. The species was found in a slow-moving clear stream with riparian cover (Fig. 5), with gravel and pebbles as the major substrate. The species was found associated with marginal vegetation and submerged roots. Co-occurring fishes included *Barilius* sp., *Devario malabaricus*, *Danio rerio*, *Schistura nagodiensis*, *Haludaria fasciata*, *Dawkinsia arulius*, *Pethia* sp., *Channa gachua* and *Mastacembelus armatus*.

Genetic distance. *Badis britzi* (KP666031) has a significant genetic distance in COI gene (P distance = 16.7±1.6) from *Badis badis* (KP666032, collected from Mysore, Karnataka), the only other species within the genus that occurs in southern India.



FIGURE 5. Habitat at the type locality of *Badis britzi*: the Nagodi tributary of Sharavati River, Karnataka, India.

Discussion

Badis britzi brings the number of badid species known from India to 13. It is only the fourth species recorded from the rivers of the Western Ghats region and the first species of *Badis* found in a west-flowing river system in the subcontinent.

Badis britzi differs from *B. badis*, *B. ferrarisi* Kullander & Britz 2002, *B. chittagongis* Kullander & Britz 2002, *B. dibruensis* Geetakumari & Vishwanath 2010 and *B. kanabos* Kullander & Britz 2002 by the absence (vs. presence) of a dark blotch covering the superficial part of the cleithrum; from *B. khwae* Kullander & Britz 2002, *B. ruber* Schreitmüller 1923 and *B. siamensis* Klausowitz 1957 by the absence (vs. presence) of a dark blotch on the dorsolateral region of the caudal peduncle; from *B. assamensis* Ahl 1937 and *B. blosyrus* Kullander & Britz 2002

by the absence (vs. presence) of an opercular blotch and absence of a black blotch on the caudal-fin base; from *B. corycaeus* Kullander & Britz 2002 and *B. pyema* Kullander & Britz 2002 by the absence (vs. presence) of an ocellar marking on the caudal-fin base; and from *B. singenensis* Geetakumari & Kadu 2011 by the absence (vs. presence) of a black blotch on the soft rays of the dorsal and anal fins.

In terms of its colour pattern and a more slender body (body depth less than 30% SL), *B. britzi* somewhat resembles *B. kyar* Kullander & Britz 2002 and *B. juergenschmidtii* Schindler & Linke 2010, both distributed in Myanmar. While the caudal blotch is absent in *B. britzi*, there is a distinct caudal band, almost in the same position, in all three species. Further, the series of dorsal-fin blotches, a character that distinguishes the new species from all its other congeners, is similar to the colour pattern in *B. khwae* and *B. juergenschmidtii*. Nevertheless, *B. britzi* differs from *B. kyar* and *B. juergenschmidtii* by a greater head length (32.3–35.0% SL vs. 26.8–31.4% in *B. kyar* and 28.8–29.6% in *B. juergenschmidtii*), longer snout (6.8–8.3% SL vs. 5.0–6.4% in *B. kyar*) and shorter dorsal-fin base (54.6–56.6%SL vs. 62.3–63.7% in *B. juergenschmidtii*).

In the current study we have not included *Badis triocellus* Khyntiam & Sen 2013 for comparison because we do not consider it a valid species for the following reasons. *Badis triocellus*, claimed in its original description to be distinguished by the three distinct black blotches on its fins—two at each end of the dorsal fin and one on the anal fin (Khyntiam & Sen 2013)—in fact possesses the same colour pattern as *B. singenensis* (Geetakumari & Kadu 2011). Further, the type localities of the two species are close to each other, from two tributaries of the Bramhaputra river system, and there are no other characters to separate the two species. We note in passing that though *B. triocellus* becomes available from an issue of the *Records of the Zoological Survey of India* originally scheduled for the year 2011, the actual date of publication provided on the cover pages of the journal is August 2012; in fact, the issue was probably not available until 2013 (see Eschmeyer 2014). We therefore consider *B. triocellus* to be a junior synonym of *B. singenensis*.

Although Britz *et al.* (2012) and Britz & Ali (2015) placed the southern Indian species *D. urops* and *D. huli* in *Dario*, they suggested that the two species possess some characters that do not fit the original diagnosis of the genus by Kullander & Britz (2002). *Badis britzi* has a slender body (body depth 25.5–28.4% SL), which is similar to *D. urops* and *D. huli*, but like other *Badis* species, it possesses a well-developed lateral-line system with 21–24 pored scales on the body, which is reduced to 3–5 pored scales in *D. huli* and completely lacking in *D. urops*. *Badis britzi* is the first endemic species of *Badis* recorded from the Western Ghats of India. A specimen of *B. badis* collected from Mysore is genetically similar to those collected from north and north-east India, and might represent a case of introduction through the aquarium trade or fish stocking. The discovery of an endemic species of *Badis* from peninsular India, which is quite distinct from all its congeners, opens the door to interesting questions about its biogeographic affinities, which will be addressed in a forthcoming study.

The discovery of *Badis britzi* from a west-flowing river in the central Western Ghats also underlines the arguments of Dahanukar *et al.* (2011) that the state of knowledge of the ichthyofauna of this region is still poor. It suggests the need for more exploratory surveys and taxonomic studies as other interesting species await discovery in this exceptional hotspot of freshwater biodiversity.

Comparative material

Badis badis (n = 3): WILD-15-PIS-142 and 143; 34.8–35.0 mm SL, India: West Bengal: Ganga River near Kolkata, coll. R. Raghavan, U. Katwate and N. Dahanukar, 7 June 2014. WILD-15-PIS-144; 25.0 mm SL, India: Karnataka: Mysore, Cauvery River, col. Nikhil Sood, 1 May 2012.

Dario urops (n = 11): Holotype, CRG-SAC.2012.3.1, 23.8 mm SL, male; India: Karnataka: from a small unnamed stream, off the Barapole tributary of Valapattanam river, 12°0.310'N 75°53.408'E; 811 m asl.; R. Raghavan *et al.*, 30 Jan 2012; Paratypes, CRG-SAC.2012.3.2–11, 10, 17.1–23.6 mm SL, same data as holotype.

Dario huli (n = 4): Holotype, BNHS FWF 121, 23.7 mm SL; India: Karnataka: from a small unnamed stream between Balehalli and Agumbe, a tributary of the Tunga river, 13°30'44"N 75°08'44"E, 635 m asl; A. Ali *et al.*, 17 March 2014. Paratypes, BNHS 122–124, 3, 17.7–22.5 mm SL, same data as holotype.

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