

***Badis juergenschmidti* – a new species of the Indo-Burmese fish family Badidae (Teleostei: Perciformes) from Myanmar**

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> Abstract

Badis juergenschmidti sp. n. is described from south central Myanmar. The new species is easily distinguished from its congeners by the lack of conspicuous spots on posterodorsal corner of opercle and superficial part of cleithrum, caudal fin with contrasted white margin posterodorsally and posteroventrally in adult males. A new numbering standard for the vertical bar pattern is provided. Notes on habitat and reproductive behaviour of the herein described species are given.

> Kurzfassung

Badis juergenschmidti sp. n. wird aus dem südlichen Zentralmyanmar beschrieben. Die neue Art unterscheidet sich von den übrigen Arten der Gattung durch das Fehlen auffälliger Flecke im posterodorsalen Eck des Kiemendeckels und über dem Ansatz der Brustflosse sowie durch einen weiß gefärbten dorsalen und ventralen Saum der Schwanzflosse bei den adulten Männchen. Ein neuer Standard zur Benennung der vertikalen Balken auf den Körperseiten wird vorgestellt. Beobachtungen zum Habitat und dem Fortpflanzungsverhalten der Art werden mitgeteilt.

> Key words

Teleostei, Perciformes, Badidae, *Badis*, taxonomy, new species, Myanmar, bar pattern, habitat.

Introduction

The genus *Badis* BLEEKER, 1854 was revised in 2002 by KULLANDER & BRITZ; they described and re-described 12 valid *Badis* species. The recently published descriptions of *B. tuivaiei* VISHWANATH & SHANTA, 2004 and *B. dibruensis* GEETAKUMARI & VISHWANATH, 2010, both from India, lift the number of species to 14. The members of the genus are distributed from middle Mekong in the east to the Indus drainage in the west (KULLANDER & BRITZ, 2002). The centre of the species diversity of the genus lies in north-eastern India, Bangladesh and Myanmar.

During a field trip in Myanmar the second author was able to collect specimens of an unknown species of *Badis* near the famous Kyauktiyo Pagoda which is also well known as the ‘Golden Rock’.

Comparison with the other species of the genus from in- and outside Myanmar showed that the newly

collected material represents a new species. The purpose of this paper is to provide a formal description of this badid as *B. juergenschmidti*.

Material and Methods

Type specimens are preserved in 75 % ethanol. The holotype and adult paratypes are deposited in the fish collection of the Senckenberg Naturhistorische Sammlungen Dresden, Museum für Tierkunde (MTD F). Examined material of *B. juergenschmidti* is listed under species account.

Morphometrics and meristics have been taken following the methods described in KULLANDER & BRITZ

(2002). Measurements were made with an electronic digital calliper reading to the nearest tenth of a millimetre. All ratios are expressed as percentages of standard length (SL). Counts were made under a dissecting microscope; fin-ray counts were made with light transmitted through the fins. Figures in brackets after counts indicate the number of specimens examined with that particular condition. Data are given only for the measurements and meristics which are currently used in descriptions of new *Badis* species (e. g. KULLANDER & BRITZ, 2002; GEETAKUMARI & VISHWANATH, 2010). For comparisons data from previously described and re-described species (KULLANDER & BRITZ, 2002; VISHWANATH & SHANTA, 2004; GEETAKUMARI & VISHWANATH, 2010) were used.

Nomenclature of colour pattern (except for bar pattern) is according to KULLANDER & BRITZ (2002). Vertical bars are numbered from caudal fin base in an anterior direction (similar as introduced for South American cichlids by KULLANDER & SILFVERGRIP, 1991) as shown in Fig. 1. Bar 1, across base of caudal-fin (in some species split into three distinct spots); bar 2, across caudal peduncle (partly expressed as a prominent dark blotch on dorsolateral aspect of caudal peduncle in some species); bar 3, from posterior rays of dorsal fin to posterior anal-fin rays; bar 4, from posterior dorsal-fin spines to anterior part of anal fin; bar 5, from middle dorsal fin to anus; bar 6, across side above vent; bar 7, from anterior dorsal fin to slightly posterior of pelvic-fin base; bar 8, from slightly anterior of dorsal-fin base to posterior edge of gill cover. In the majority of *Badis* species bar 4 to 7 vertically split in an anterior and posterior part. These parts are indicated by an “a” for anterior and a “p” for posterior (e.g. “7a” = anterior part of the split bar 7). Terminology for lateralis system on head follows KULLANDER & BRITZ (2002).

Observations of reproductive behaviour and live colouration are based on specimens collected from the type locality which have been kept in aquaria (these specimens are not part of the type series).

Delimitation of species follows the approach of the population aggregation analysis (PAA) as described and discussed by DAVIS & NIXON (1992). PAA is the formal procedure of the traditional pragmatic methodology on morphological diagnostic differences (SITES & MARSHALL 2003). According to this method species are discriminated by fixed diagnostic characters or divergent character states (or on a unique combination of several such character states).

All photos of live specimens were taken under the same conditions, to provide an effective comparison of the hue of colours. The photos were illuminated with a flash light having a colour temperature of about 5600 Kelvin, without further influence of any other light source.

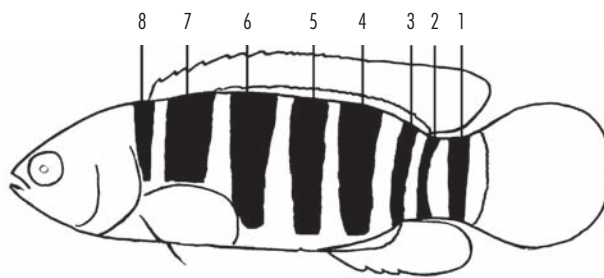


Fig. 1. Schematic representation of generalized bar pattern in males of *Badis juergenschmidti* (for explanation of numbers see material and methods).

The parameters of the water in the field were measured with the following instruments: WTW-Weilheim, Typ pH 320 with pH-electrode, SenTix 21 for the hydrogen ion concentration and water temperature and Sera (tolerance of 0.2 %) for the electrical conductivity.

Badis juergenschmidti sp. n.

Figs. 2–5, Table 1

Holotype. MTD F 32325, adult male, 34.6 mm SL, Myanmar, Ka Dat Chaung river, at Kammon Chaung village, about 8 km north west of Kyaiktiyo (17°24'22"N 97°04'20"E); leg. H. LINKE *et al.*, March 2010.

Paratypes. MTD F 32326–29, 4 ex, 18.8–30.6 mm SL, same data as given for the holotype.

Diagnosis. *Badis juergenschmidti* sp. n. is a comparatively slender species (body depth 29–31 % of SL). It differs from the remaining members of the genus by the combination of the following character states: (1) no conspicuous blotch on posterodorsal corner of opercle, (2) no conspicuous dark blotch covering superficial part of cleithrum, (3) bar 1 in adult males broad, not reduced to a single median blotch nor split into three separate blotches, (4) bar 2 without a distinct dark blotch on dorsolateral aspect of caudal peduncle, (5) caudal fin posterodorsally and posteroventrally with a contrasted white margin in adult males.

Description. Refer to Figures 2–3 for general appearance. Morphometric data of three type specimens (30.3–34.6 mm SL) are summarized in Table 1. Counts are given for 5 specimens (18.8–34.6 mm SL). Body comparatively elongate (body depth 30–32 % of SL) and laterally compressed. Snout round, moderately long. Head rounded in lateral aspect. Orbit situated in



Fig. 2. *Badis juergenschmidti* sp. n., holotype, male, MTD F 32325.



Fig. 3. *Badis juergenschmidti* sp. n., paratype, female, MTD F 32326.

anterior half of head and midaxis of body. Predorsal contour concave arched, in smaller specimens more straight; prepelvic straight, slightly concave. Dorsal-fin base almost straight. Caudal peduncle with straight dorsal and ventral edge, longer than deep (caudal peduncle length/caudal peduncle depth ≈ 0.75). Females smaller than males (largest measured female specimen is 30.3 mm SL versus 34.6 mm SL). Dentary pores 3, lacrymal pores 3. Predorsal scale 3–4 anterior to coronalis pore, 7–8 posteriorly. Scales in vertical row $1\frac{1}{2}$ above and 7 below lateral line. Scales in lateral row 26(2) or 27(3). Tubed scales in lateral line $21\frac{1}{4}$ (3), $22\frac{1}{4}$ (1) or $22\frac{1}{5}$ (1). Dorsal fin base densely scaled with 1–2 scale rows, anal fin base scaled with 2 rows. Caudal-fin base scaled. Soft dorsal and anal fin rounded, reaching slightly beyond caudal fin base. Caudal fin (length 28–32 % of SL) round or subtruncate in adult

males. Pectoral fin round (length 24.5–26.5 % of SL). Pelvic fin pointed (length 24–27 % of SL). Dorsal fin XVI.9(1) or XVII.9(4). Anal fin III.7(5). Pectoral fin 12(5).

Colouration in alcohol. Ground colour brown-reddish in adult males, light brownish in females. Dorsally darker, ventrally lighter. Prepelvic area and belly greyish-blue. Head sides grey, ventrally lighter. No conspicuous blotch on superficial part of cleithrum. No conspicuous blotch on posterodorsal corner of opercle. Preorbital stripe dark grey, continuous across lower jaw. Suborbital stripe straight. Supraorbital stripe dark, prominent in subadult specimens and females, less intensive in adult males. Opercular bar on anterior dorsal area of opercle, expressed as a dark blotch in adult males. Bars on body and head sides dark grey to

Tab. 1. Morphometric data of *Badis juergenschmidti*. Measurements of holotype (h) and two paratypes (p) in percent of standard length (except SL in mm); mean = arithmetic mean.

	male (h)	male (p)	female (p)	mean
Standard length	34.6	30.6	30.3	31.8
Head length	28.8	29.6	28.9	29.1
Snout length	6.2	6.5	6.9	6.6
Orbital diameter	9.2	9.6	9.3	9.4
Interorbital width	5.8	5.5	6.3	5.8
Upper jaw length	9.0	8.2	8.9	8.7
Lower jaw length	11.3	11.0	11.2	11.2
Body depth	29.8	31.9	30.7	30.8
Pelvic fin length	26.9	26.1	24.8	25.9
Pelvic to anal distance	36.0	38.4	39.9	38.1
Dorsal fin base length	63.7	62.3	62.7	62.9
Anal fin base length	18.3	16.9	17.3	17.5

blackish. Bar 1 prominent and straight; bar 2 straight or slight arched; bar 3 slightly oblique (ventral portion situated more anterior than dorsal portion), ventrally bar 2 and bar 3 are fused in some specimens; bar 4 straight, not vertically split; bar 5 broad, not vertically split, ventral parts of bar 4 and 5 are fused in some females and subadult specimens; bar 6 broad and straight, ventrally split into anterior and posterior parts in small specimens and females; bar 7 broadest bar, straight, in small specimens and females usually divided ventrally into two parts; bar 8 dorsally broader than ventrally. Bar pattern in females more variable than in males. Dorsal fin light grey with broad dark grey band slightly above scaly area, a white seam with blackish submarginal stripe. Soft portion with a grey arched band, otherwise hyaline. Anal fin hyaline with whitish seam and dark submarginal band. Caudal fin hyaline, posterodorsally and posteroventrally with a contrasted white margin and dark submarginal band; an additional dark arched vertical bar in anterior half. Pectoral fin hyaline or slightly dusky in posterior half. Pelvic fin dusky with dark margin and tip. In females dark markings less intensive than in males.

Colouration in life. Refer to Figures 4–5. Colours and pattern depend on the mood of the fish. Ground colour of subadult specimens mostly beige to light-brownish or pale yellowish. Dominant adult males reddish-brown.

Geographical distribution. So far only known from the type locality, the Ka Dat Chaung River, south eastern central Myanmar.

Ecological notes. The type locality is a small river with a width of about fifty meters during the rainy season. At the time of collecting, in March, it was the

dry season and the water was very shallow (about 20 to 30 cm). The current was slow. The river bed was characterized by boulders, pebbles and sand. Some parts are covered by a thin biofilm or detritus. The water was clear. Its temperature (at 9.30 in the morning) was 26.9 °C and the water was very soft (electric conductivity 6 µS). The pH-value measured was 6.4 pH. The only other species collected at that location was *Acanthocobitis zonalternans*; a very common loach in Myanmar.

Reproductive behaviour. Observations in captivity showed that *Badis juergenschmidti* is a cave brooder. After spawning the male takes care of the brood by himself. It does not allow the females to enter the cave afterwards. During the brood care it leaves the cave to eat something and to chase away intruders. After around 7 days the offspring leave the cave.

Etymology. The species epithet honours Dr. Jürgen SCHMIDT (Ruhmannsfelden, Germany) for his valuable contributions on the ethology and taxonomy of Southeast-Asian freshwater fishes.

Comparative notes. *Badis juergenschmidti* is distinguished from the other species of the genus by the lack of a dark spot on the superficial part of cleithrum (versus present in *B. ferrarisi*, *B. kanabos*, *B. badis*, *B. chittagongis*, *B. ruber*, *B. siamensis*, *B. khwae*, *B. dibruensis* and *B. tuivaiei*), bar 2 without a distinct blotch on dorsolateral aspect of caudal peduncle (versus present in *B. siamensis*, *B. khwae*, *B. ruber*), bar 1 in large preserved males broad and straight (versus bar 1 horizontally divided into three more or less clear separated blotches in *B. ruber*, *B. siamensis*, *B. blosyrus* and *B. assamensis*), bar 1 lacking a prominent median blotch (versus present in *B. badis*, *B. chittagongis*,



Fig. 4. Colouration in life of *Badis juergenschmidti* sp. n. (male) with reduced bar pattern.



Fig. 5. Colouration in life of *Badis juergenschmidti* sp. n. (male) showing bar pattern.

B. kanabos, *B. ferrarisi*, *B. corycaeus*, *B. dibruensis*, *B. tuivaiei* and *B. pyema*), bar 1 not curved (versus curved in *B. kyar*). It can furthermore be differentiated by the absence of a conspicuous blotch on the posterodorsal corner of the opercle (versus present in *B. assamensis* and *B. blosyrus*), no reduced number of lacrymal and dental pores (dental pores 3 and lacrymal pores 3 versus lacrymal pores 2 and dental pores 1–2 in *B. corycaeus* and *B. pyema*), presence of white margins on dorsal and ventral parts of caudal fin in males (versus no such pattern in *B. kanabos*, *B. badis*, *B. chittagongis*, *B. siamensis*, *B. dibruensis*, *B. tuivaiei*,

B. kyar, *B. corycaeus* and *B. pyema*), vertical bars on flank not emerging from blackish spots (versus valid for *B. ruber*, *B. siamensis*, *B. assamensis*, *B. blosyrus*, *B. corycaeus* and *B. pyema*).

Discussion

The family Badidae is comprised of the two genera *Badis* and *Dario* (see KULLANDER & BRITZ, 2002).



Fig. 6. Collecting site of *Badis juergenschmidti* sp. n. in Myanmar.

The species of *Badis* are easily separated from species of the genus *Dario* by the presence of tube-bearing scales in the lateral line (versus absence of bony tubes in *Dario*) and a shorter pelvic fin in males (pelvic fin not reaching beyond the anterior base of anal fin versus pelvic fin in males reaching beyond the anterior part of anal fin in *Dario*). Following these character sets *B. juergenschmidti* fits the genus *Badis*.

The species of the genus *Badis* resemble each other in sharing very similar (or even identical) morphometric data (KULLANDER & BRITZ, 2002). Hence, colour pattern is the major source for species delimitation within the genus (cf. KULLANDER & BRITZ, 2002; VISHWANATH & SHANTA, 2004; GEETAKUMARI & VISHWANATH, 2010). *Badis juergenschmidti* is also distinguished from the remaining species of the genus mainly by characteristics of its colour pattern (see diagnosis and comparative notes).

KULLANDER & BRITZ (2002) assigned the species of genus *Badis* based on external morphological characters and mainly on colour patterns to five species groups (viz. *B. assamensis* group, *B. badis* group, *B. corycaeus* group, *B. ruber* group, and *B. kyar*). This assemblage receives further support by the analyses of molecular data (RÜBER *et al.*, 2004). *Badis juergenschmidti*, however, does not fit any diagnostic characters or character states of these groups. Following the key to the species of Badidae provided by KULLANDER & BRITZ (2002), *B. juergenschmidti* keyed out along-

side *B. kyar*. *Badis juergenschmidti*, however, may be reliably differentiated from *B. kyar* by the characteristics mentioned above (see comparative notes) and by the bar pattern (bar 5, 6 and 7 not vertically split in adult males of *B. juergenschmidti* versus bar 5, 6 and 7 vertically split in male *B. kyar*; cf. KULLANDER & BRITZ, 2002). Although there are some similarities in key characters, we refrain from putting *B. juergenschmidti* into a putative *B. kyar* species group since there are remarkable differences between both species. Furthermore, no comprehensive phylogenetic analysis (which should be based on different kinds of character sets) of the genus is currently available.

The species of *Badis* feature a pattern of vertical dark bars (BARLOW, 1963; KULLANDER & BRITZ, 2002). Based on our preliminary observation of the development of the bar pattern based on ontogenetic series, we found a basic pattern and here provide a numbering system for it to facilitate describing and distinguishing species (see Fig. 1). There is a variation in the bar pattern among the species of *Badis* and even within a single specimen (the pattern differs slightly between left and right side). Nevertheless, the basic pattern is found in almost all Badidae species and the shape of the vertical bars providing an excellent tool for species or species group discrimination. There is only one species of *Badis* (*B. dibruensis*) which was recently described with the diagnostic character state of the absence of dark vertical bars on sides (GEETAKUMARI & VISHWANATH, 2010). However, it seems necessary to do more investigation on this subject because when looking at the type specimens, it may also be possible that the conclusion drawn by GEETAKUMARI & VISHWANATH (2010) is due to not well preserved specimens.

The basic bar pattern is also found in species of genus *Dario* (except for *D. dayingensis*; cf. KULLANDER & BRITZ, 2002). In contrast to *Badis*, where bars 4 to 7 are usually vertically split into an anterior and a posterior part, bars in *Dario* are not divided.

Live specimens of *Badis* do not show the bar pattern constantly. The pattern of dark markings and colouration depends on the mood of the fish and there is a great diversity of different patterns, each relating to a particular type of behaviour (BARLOW, 1963). Despite that, the colour pattern in live specimens also holds species specific elements. This is why it seems important to include colour photos of live specimens in a species description. The typical colouration of adult males of *B. juergenschmidti* is unique for its almost plain and bright reddish-brown to reddish flank (Fig. 4). However, the colouration of live specimens is not yet documented for every species. This is why we are only using characteristics of colour pattern and dark markings observable in preserved specimens in the diagnosis and comparative notes.



Fig. 7. Habitat (type locality) of *Badis juergenschmidti* sp. n.

Before the comprehensive revision of Badidae by KULLANDER & BRITZ (2002) was published, only 3 different species were recognized as valid within *Badis*. The revision revealed the large diversity of this genus. As pointed out and discussed by REIS (2004) such revisions are not only an inventory of the current knowledge, but also provide an important source for the discovery and description of additional species in subsequent studies. The herein described species, *B. juergenschmidti*, lifts the number of species taxa in the genus to 15. This, however, does not complete the picture of species richness in the genus *Badis*. We know of several forms which seem to be distinct from hitherto described species. These are often well-known both in the aquarium hobby and popular literature (see VAN DER VOORT, 2009), but lack of sufficient material prevents their formal description.

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