

Kayahschistura lokalayensis, a new genus and species of cave fish from Myanmar (Teleostei: Nemacheilidae)

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Abstract. *Kayahschistura lokalayensis*, new genus and species, is described from Lokalay Loku Gu Cave, Kayah State, Myanmar. It is related with species of the genera *Mustura*, *Pteronemacheilus*, *Physoschistura*, *Petruichthys* and *Rhyacoschistura*, but cannot be placed in any of the presently named genera. It is distinguished by the absence of colour pattern, the eye very regressed and at the bottom of a longitudinal slit, the presence of a suborbital flap, the forked caudal fin, the presence of a large posterior chamber of the air bladder in the abdominal cavity, and the modified pectoral-fin rays, especially the presence of numerous small tubercles on the dorsal surface of branched rays 1–3 and membranes between them.

Key words. Kayah State, biospeleology, loaches, Cobitoidei

INTRODUCTION

Nemacheilid loaches typically occur in fast flowing water of small streams and less often in other habitats such as large rivers and caves. The family has its greatest diversity in Southeast Asia from where about 260 species have been described; most are described and figured in Kottelat (1984, 1990a, 1998, 2000, 2001) and Freyhof & Serov (2001). In addition, new species and genera are still regularly described (e.g., Bohlen & Šlechtová, 2010, 2014; Ou et al., 2011; Plongsesthee et al., 2011, 2013; Kottelat, 2017b, c, e–h, 2019), especially in Myanmar (e.g., Bohlen & Šlechtová, 2010, 2013a, b, 2014; Chen & Neely, 2012; Kottelat, 2012a, 2017a, d, 2018; Bohlen et al., 2014, 2016).

Most nemacheilids inhabit small streams in hilly areas, with fast water and stone bottom, and they live, feed, and reproduce under stones. Because of these requirements and their small size, throughout their ranges some species have been able to enter caves and evolve cave-adapted forms. They have been recorded in caves in China, Vietnam, Laos, Thailand, Malaysia, Indonesia, India, Iran, Turkmenistan, Iraq, and Germany (e.g., Lan et al., 2013; Kottelat, 1988, 1990b, 2004, 2012b, c, 2013; Kottelat & Géry, 1989; Kottelat et al., 2007; Kottelat & Leisher, 2012; Freyhof et al., 2016; Behrmann-Godel et al., 2017). Until now, no cave species

has been reported from Myanmar, where biospeleological exploration is still in infancy.

During a visit of caves in karstic areas of western Kayah State, white fishes were observed in several caves by JG. During a fish survey in a nearby area, MK obtained a fish collected from one of the same caves. It was not preserved in an optimal way, but nevertheless it can be identified as an unnamed species, and the male sexual dimorphism allows to place it near some known, surface genera. The species is placed in a new genus and is described here as *Kayahschistura lokalayensis*.

This article is dedicated to the memory of Tony Whitten, friend and strong promoter of biodiversity exploration and conservation in Southeast Asia, a man with a great interest for cave and karst habitats.

MATERIAL AND METHODS

Since only one specimen is available and because of its fragile condition, it could not be dissected thoroughly and internal characters could not be examined in detail, especially the shape of the bony capsule of the anterior chamber of the air bladder.

Measurements and counts follow Kottelat (1990a) and Kottelat & Freyhof (2007). Last 2 branched dorsal and anal-fin rays articulating on a single pterygiophore are noted as “1½”. The holotype is deposited in Muséum d’Histoire Naturelle, Geneva (MHNG). Comparative data of species of the genus *Mustura* Kottelat, 2018 are from Kottelat (2018). Data on the other nemacheilid species are based on Kottelat (1990a, 2017a, 2018, 2019).

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***Kayahschistura*, new genus**

Type species. *Kayahschistura lokalayensis*, new species.

Diagnosis. See description of *K. lokalayensis*.

Etymology. Name based on Kayah State, where the type locality of the type species is located; and *Schistura* McClelland, 1838, a genus of nemacheilid loaches in which most South and Southeast Asian species had been placed. Gender: feminine.

***Kayahschistura lokalayensis*, new species**

(Fig. 1)

Holotype. MHNG 2782.033, 80.0 mm SL; Myanmar: Kayah State: Hpruso District: Maw Thi Do commune, Han Li village, Lokalay Loku Gu cave (also Myaug a San cave), 19.39115°N 97.02287°E.

Diagnosis. *Kayahschistura lokalayensis*, as many cave loaches, has a whitish body without any colour mark. The eye is very regressed and still visible at the bottom of a longitudinal slit. It is the first cave nemacheilid reported from Myanmar. It cannot be identified as any of the surface species presently known in the country, and cannot be placed in any known genus of the family. However, the presence of a suborbital flap, the forked caudal fin, and the modified pectoral fin suggest a relationship with species of *Mustura*, *Pteronemacheilus*, *Rhyacoschistura*, and *Physoschistura*. The pectoral fin of *K. lokalayensis* is distinguished in having the dorsal surface of branched rays 1–3 and the membranes in between these covered by densely set small tubercles forming a continuous patch, with rays 4–6 covered by narrower patches of less densely set tubercles (missing on membranes in between), a few tubercles on the lower surface of the unbranched ray and branched rays 1 and 2, and no membrane between branches of branched rays 1–3.

Description. See Fig. 1 for general appearance and Table 1 for morphometric data of holotype. Moderately elongate nemacheilid with body depth slowly increasing up to dorsal-fin origin, then decreasing slowly to caudal-fin base. Dorsal profile with shallow concavity between head and body. Head slightly compressed; body slightly compressed anteriorly to compressed posteriorly. Interorbital area arched. Cheeks slightly swollen. Snout rounded in dorsal view, blunt in lateral view. Depth of caudal peduncle 1.3 times in its length, slightly tapering posteriorly. Low dorsal crest on posterior 1/4 of post-dorsal area. Very low ventral crest on posterior 1/3 of caudal peduncle. Dorsal crest continuous with upper margin of caudal fin but separated by a shallow concavity, supported by procurent rays. Length of single known specimen 80 mm SL.

Dorsal fin with 4 unbranched and 8½ branched rays; distal margin straight. Second branched ray longest. Pectoral fin with 1 unbranched and 12 branched rays, falcate, reaching

about 2/3 of distance to pelvic-fin base. Pelvic fin with 1 unbranched and 7 branched rays; reaching to anus; slightly falcate; origin below base of branched dorsal-fin ray 2; axillary lobe present only as swelling (on Fig. 1, swelling appears as a lobe on left side, but this is an artefact because specimen is bent; only small swelling on right side). Anus situated at posterior extent of pelvic fin, distance between anus and anal-fin origin about 4 times in distance between anus and pelvic-fin base. Anal fin with 3 unbranched and 5½ branched rays; distal margin straight. Caudal fin with 10+8 branched rays; 11 dorsal and 9 ventral procurent rays; forked; lobes pointed, upper lobe longer than lower one (possibly an artefact).

Body covered by scales, except on predorsal area, along base of dorsal fin, anterior part of flank (scales extending forward until about mid-length of pectoral fin), and belly in front of pelvic fins. Scales deeply embedded. Lateral line almost complete, reaching until above posterior extremity of anal-fin base, with about 86 pores (difficult to count with accuracy). Cephalic lateral line system with 6 supraorbital, 4 + 11 infraorbital, about 9 preoperculo-mandibular, and 3 supratemporal pores (only supraorbital and infraorbital canals clearly visible).

Anterior nare pierced in front side of a pointed flap-like tube. Posterior nare adjacent to anterior one. Eye regressed, reduced to a small black dot, at bottom of a deep longitudinal slit (Fig. 2). Mouth arched, gape about 2 times wider than long (Fig. 3). Lips fleshy (tissues collapsed because of ethanol fixation and folds and wrinkles no longer recognisable). Upper lip with a median shallow concavity. Processus dentiformis present. Lower lip with wide median interruption. Width of lower lip almost constant; medial extremity not connected to skin of throat by a frenum. Tip of lower jaw not exposed. No concavity in lower jaw. Inner rostral barbel reaching corner of mouth; outer rostral and maxillary barbels reaching a vertical through junction of infraorbital and supraorbital canals.

Digestive tract not extracted from abdominal cavity, stomach about twice wider than intestine, intestine apparently with small bend immediately posterior to stomach (not clearly distinct, tissues collapsed because of ethanol fixation). Posterior chamber of air bladder oval, large, extending from capsule of anterior chamber until level of pelvic-fin base.

Sexual dimorphism. The single known specimen has a globulose suborbital flap (Fig. 4) and modified pectoral fins. In nemacheilid species that have a suborbital flap, it is present only in males. In several genera, males have modified pectoral fins, with rays variously thickened or ornamented, and with membranes between rays reduced. The present specimen is therefore identified as a male. Unbranched and first branched rays adjacent except near base. Branched rays 1–3 branched only once, anterior branch thicker than posterior one; no membranes between branches; following rays branched twice. Narrow membranes between branched rays 1 and 2, and between 2 and 3. Densely set tubercles on



Fig. 1. *Kayahschistura lokalayensis*, new species, MHNG 2782.033, holotype, 80.0 mm SL; Myanmar: Kayah: Lokalay Loku Gu cave (lateral view is an assemblage of three photographs).

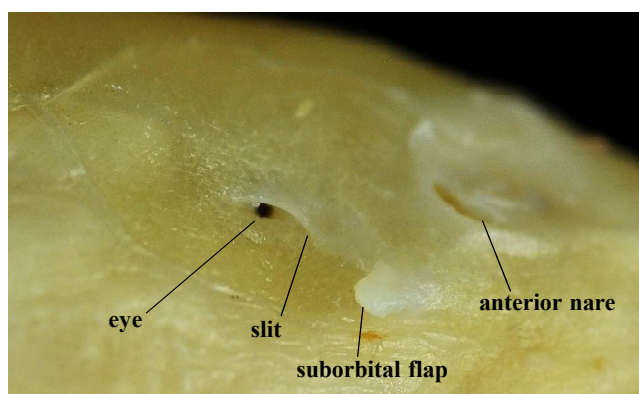


Fig. 2. *Kayahschistura lokalayensis*, MHNG 2782.033, 80.0 mm SL; head, right side, lateral view.

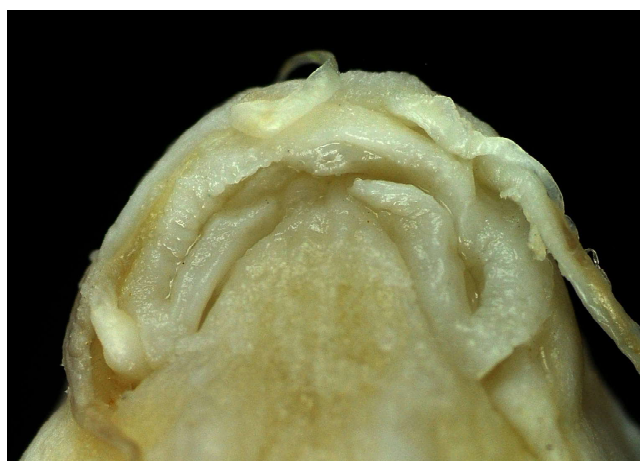


Fig. 3. *Kayahschistura lokalayensis*, MHNG 2782.033, 80.0 mm SL; mouth.

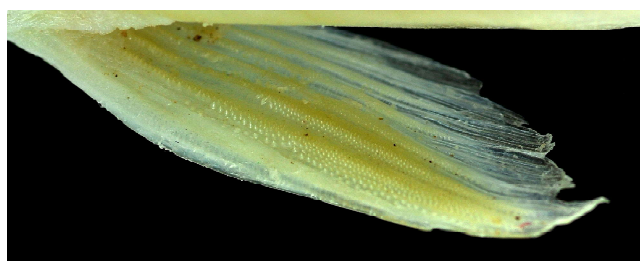


Fig. 4. *Kayahschistura lokalayensis*, MHNG 2782.033, 80.0 mm SL; left pectoral fin, dorsal view.

dorsal surface of branched rays 1–3 and membranes between them, from base to almost tip, forming a continuous patch. Tubercles also on rays 4–6, less densely set, only on rays, not on membranes. A few tubercles along edge of unbranched ray and along ventral surface of branched rays 1 and 2. Tubercles not firmly attached and easily lost by abrasion.

Colouration. In ethanol, head and body pale yellowish brown, except body above anal fin and outer rostral barbels, which are darker. The only black marks are the regressed eyes.

Distribution, habitat and field observations. Lokalay Loku Gu cave is located on the eastern slope of Karen Hills. Its entrance is at about 1,330 masl. It is probably connected to the system of Phruno chaung [=stream] and Phruno cave. During a visit of Lokalay Loku cave in February 2019, JG

Table 1. Morphometric data of holotype of *Kayahschistura lokalayensis*, new species.

Standard length (mm)	80.0
Total length (mm)	95.0
In percent of standard length	
Total length	118.7
Head length (dorsal)	19.6
Head length (lateral)	23.1
Predorsal length	52.4
Prepelvic length	57.6
Pre-anus length	73.7
Pre-anal length	78.1
Head depth	13.3
Body depth at dorsal-fin origin	17.0
Depth of caudal peduncle	11.7
Length of caudal peduncle	15.0
Head width	14.4
Body width at dorsal-fin origin	14.7
Length of dorsal fin	18.5
Length of upper caudal-fin lobe	21.1
Length of median caudal-fin rays	15.4
Length of lower caudal-fin lobe	18.5
Length of anal fin	16.7
Length of pelvic fin	18.1
Length of pectoral fin	21.1

observed *K. lokalayensis* only in the bottom part. Although there is no present surface connection, topography and satellite imagery (Google Earth) indicate that Lokalay Loku Gu cave is in the catchment of an apparently unnamed temporary stream, itself a tributary of Salween River. The cave is 830 m long. During the monsoon season it drains a 1.5 km long West–East orientated blind valley into a large cave portal (Fig. 5) under a limestone cliff. About 100 m from the cave entrance, a narrow neck is blocked by washed down dead wood and bamboo, followed by a vertical or subvertical large fossil passage. Large deposits of gravel sediments at the side of the old passage indicate a historical sediment fill up to the cave ceiling, and recently a phase of sediment wash out by temporary waters. The upper part of the old cave is dry during the cold season. The bottom part of the cave, below large collapsed blocks, has a fresh corrosive modulation and a clean autochthonous (restricted to the interior of the cave) stream appears only in the last 30 m of the bottom passage, at a depth of 70 m. The stream was generally shallow, 10–20 cm deep, with a gravel bed, fast flowing water, and a few small 60 cm deep ponds with moderate current; it is entered by a small side stream (Fig. 6).

Several individuals of *K. lokalayensis* were observed in the deeper ponds, and a few specimens were in the hydrodynamic shade of larger stones in the fast stream. The fish sensitively reacted to any movement on the gravel bank and in the water.



Fig. 5. Lokalay Loku Gu cave: entrance part with dry river bed and large accumulation of boulders and gravel sediments. (photograph: Urs Etter).

Etymology. Derived from Lokalay Cave, the type locality of the species. An adjective.

Remarks. A number of the features observed in the specimen are possibly artefacts, resulting probably from injuries, like the caudal fin with a conspicuously longer upper lobe, the postlabial groove on the left side extending medially to lower jaw and lower lip forming a fold; and possibly the absence of distal secondary branches on the anterior branched pectoral-fin rays. The absence of membranes between the branches of branched pectoral-fin rays 1–3 maybe real or might be an artefact because of desiccation.

DISCUSSION

Among nemacheilid genera from northeast India and continental Southeast Asia, *K. lokalayensis* shares the sexually dimorphic male character of a rigid, thickened, curved, first branched pectoral-fin ray with narrow or no space between branches with *Mustura*, *Pteronemacheilus* Bohnen & Šlechtová, 2011, *Physoschistura* Banarescu & Nalbant, in Singh, Sen, Banarescu & Nalbant, 1982, *Petruichthys* Menon, 1987, *Rhyacoschistura* Kottelat, 2019 and (based on photographs) apparently *Protonemacheilus* Yang & Chu, 1990 (the status of this genus is, however, unclear and discussed in Kottelat, 2018). Although the first branched pectoral-fin ray is thickened in many other genera of Nemacheilidae, the ray is not modified as in the above genera. Additional characters observed in most species of these genera are the presence of a suborbital flap, the forked caudal fin, the dorsal and ventral surfaces of the unbranched pectoral-fin ray covered by unculiferous pads (sensu Conway et al., 2012), and the two halves of the lower lip wider medially than laterally and connected to the tissues of the throat by a frenum. *Kayahschistura lokalayensis* is distinguished from these genera in having the lower lip with a uniform width and without frenum.



Fig. 6. Lokalay Loku Gu cave: stream at -70 m; **a**, habitat of *Kayahschistura lokalayensis*; and **b**, final sump 830 m from entrance (photographs: Urs Etter).

In addition, *K. lokalayensis* is distinguished from these genera as follows:

In *Mustura*, the posterior chamber of the air bladder is very small or missing (vs. extending in abdominal cavity from bony capsule until above pelvic-fin base). In most species of *Mustura*, the body is distinctly deeper at the level of the dorsal-fin origin, the caudal peduncle is slender (depth 7–12% SL, 47–60 % of body depth, 1.3–19 times in its length; vs. 12 %, 69 % and 1.3 times, respectively, in *K. lokalayensis*).

In *Pteronemacheilus*, the males have neither suborbital flap nor suborbital groove. The branched pectoral-fin ray 2 has an elevated flange of skin on its dorsal side, on the proximal 1/3–1/2. Branched rays 3 and 4 are connected by thick tissues forming a hard (ossified ?) elongate swelling (rod) between them on their dorsal surface; the rays have a small bend downwards at about the distal extent of the rod, creating a shallow concavity in the ventral surface of the fin. In addition, the posterior chamber of the air bladder is very small (vs. extending in abdominal cavity from bony capsule until above pelvic-fin base).

In *Physoschistura* the two halves of the air bladder capsule are joined medially (a character that cannot be examined in *K. lokalayensis* without a damaging dissection) and the

posterior chamber is free, well developed and in direct contact with the capsule but does not occupy the whole length of the abdominal cavity (vs. occupies the whole length).

In *Petruichthys*, the nares are separated from each other, the anterior one is at the extremity of a short tube (vs. nostrils adjacent, anterior nare on the front face of a valve-like flap); the supratemporal canal of the cephalic lateral line system has two pores on each side of the head (vs. a median pore and one on each side); the postlabial groove extends along the whole posterior edge of the lower lip, and the frenum is in the groove, under the lip (vs. not extending along whole posterior margin, no frenum).

In *Rhyacoschistura*, the caudal fin is emarginate (vs. forked); and the pelvic-fin origin is below or slightly in front of dorsal-fin origin (vs. under base of branched dorsal-fin ray 2), there is no visible posterior chamber of the air-bladder in the abdominal cavity, and the scales are very distinct, covering the whole body, including predorsal area and chest (vs. scales are missing in the predorsal area, the anterior part of the flank, and the belly in front of the pelvic-fin base).

Males of *Malihkaia* also have a suborbital flap and modified pectoral fin rays, but they are missing the patches of tubercles and the genus is apparently not closely related to the above genera. It also has a deeply furrowed lower lip (vs. smooth in *K. lokalayensis* and all the genera mentioned above).

In conclusion, *K. lokalayensis* is distinguished from the above genera by a combination of characters used to diagnose genera in South and Southeast Asian nemacheilids, and therefore is placed in a distinct, new genus. We doubt that *Kayahschistura* is a genus restricted to the single type species; we expect that a number of surface species in the Salween, Sittaung, and Irrawaddy drainages will be found to also belong to the genus.

Several other nemacheilid species in the Salween and Irrawaddy drainages have a forked caudal fin, a relatively deep caudal peduncle, a suborbital flap and a pectoral fin with thick anterior rays (e.g. *Schistura mahnerti* Kottelat, 1990, *S. sikmaiensis* (Hora, 1921), *S. paucicincta* Kottelat, 1990, *S. vinciguerrae* (Hora, 1935)), but none has the rays modified as in *Kayahschistura*, *Mustura*, *Pteronemacheilus*, *Malihkaia* Kottelat, 2017, *Physoschistura*, *Petruichthys* and *Rhyacoschistura* and there are no tubercles on the rays.

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