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A new genus and three new species of nemacheilid loaches from northern Irrawaddy drainage, Myanmar (Teleostei: Cypriniformes)

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Abstract. *Malihkaia aligera*, new genus, new species, is described from the Mali Hka River in the northernmost Kachin State, Myanmar. It is distinguished by strongly furrowed lips and a type of sexual dimorphism new in Nemacheilidae: the pectoral fin of males is greatly elongated as a 'wing', rigid and curled, with the first branched ray the longest, and with all branches and sub-branches adjacent and without membranes between them. *Schistura nubigena*, new species, is described from the same locality. It is distinguished by its colour pattern that evolves from 4 broad bars in juveniles about 20 mm SL, to a pattern of 8 bars that become coalescent along the flank and along the back, leaving a row of pale spots between them. *Schistura wanlainensis*, new species, is described from the Mon Lan Chaung, a tributary of the Mali Hka. It is distinguished by its unique colour pattern of a pale grey to whitish background with 18–32 narrow, regularly shaped black bars, extending from dorsal midline and reaching downwards to below level of pectoral fins, continuous over back with contralaterals, wider than interspaces anteriorly, narrower than interspaces on caudal peduncle; some of anterior bars fused at their dorsal extremity.

Key words. Cobitoidei, *Schistura*, *Malihkaia*, Mali Hka

INTRODUCTION

Loaches of the family Nemacheilidae are a very important component of the streams and creeks in hilly areas of South and mainland Southeast Asia. Most have small geographic ranges and are restricted to a single or a few river systems. Their restricted movements downwards in less favourable lowland habitats and the active geomorphological processes (of which river captures at both large and small scales are probably the most important) are likely responsible for speciation and high endemism. In the hilly areas of mainland Southeast Asia, members of the Nemacheilidae represent about 20% of the fish fauna of any small to medium drainage. For example, in the upper Nam Theun of Laos, up to seven species may occur in syntopy (Kottelat, 1998, 2015, unpubl. data). Nemacheilidae can be used as indicator species in different ways; their requirement for cold and well-oxygenated water can be used as an indicator of water quality; their diversity and specialisation for peculiar microhabitats at a single site can be used as an indicator of habitat integrity.

Nemacheilid diversity can also be used as an indicator of the quality of our knowledge of the biodiversity in a given area, or to evaluate the quality of Environmental Impact Assessments, which throughout mainland Southeast Asia are notoriously of very poor quality, incompetent or even fabricated. A survey of a moderate size drainage in a hilly area (let's say about 1,000 km^2) that does not include at least 6–10 nemacheilid species is likely to have been very superficial or to have missed all the critical habitats and therefore of limited value (admittedly, safety or access issues may be limiting factors). If these 6–10 species do not include species endemic to that drainage, or unnamed species, or include species otherwise only known from a very distant, not contiguous, drainage, then this may suggest a capability problem. The life history, evolution and habitat of many genera of Sisoridae (Ng & Kottelat, 2016; Vidthayanon et al., 2009) and Psilorhynchidae (Conway, 2011; Conway & Britz, 2010, 2015; Conway & Kottelat, 2007, 2010; Conway & Mayden, 2008) show the same pattern and they have a similar indicator potential, except that their diversity at a single locality is much lower.

The largest genus of the family is *Schistura*, with about 210 named valid species to which should be added a minimum of about 50 unnamed species that I am already aware of and that await description (pers. obs., updated from Kottelat, 2012b, 2013). Loaches of the genus *Schistura* typically occur in fast flowing water of small streams and less often in other habitats such as large rivers and caves. The genus has its greatest diversity in Southeast Asia (Irrawaddy, Salween, Mae Khlong, Chao Phraya, Mekong and Red River drainages, and drainages in between) from where about 160 species have been described; most are described and figured in Kottelat (1990, 1998, 2000, 2001) and Freyhof & Serov (2001). Besides, new species are still regularly described (e.g., Bohlen & Šlechtová, 2010; Ou et al., 2011; Plongsesthee et al., 2011, 2013; Bohlen et al., 2016), especially in Myanmar

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(e.g., Bohlen & Šlechtová, 2013a, b; Bohlen et al., 2014; Chen & Neely, 2012; Kottelat, 2017). The interrelationships within *Schistura* have not been thoroughly studied yet but the accumulating (and still unpublished) morphological, molecular and distribution data unsurprisingly show that the genus is paraphyletic.

Irrawaddy is the main river of Myanmar. It flows north to south from the northernmost tip of the country in Kachin state, from the divide with the Brahmaputra in India and the Salween in China. It is formed by the confluence, upriver of Myitkyina, of two main branches, the eastern N'mai Hka and the western Mali Hka. N'mai Hka flows between high hills along its whole length and is still very difficult to access and to travel. Its drainage is ichthyologically virtually unexplored in Myanmar (with the apparent exception of the description of *Glyptosternon malaisei* by Rendahl & Vestergren (1941) and a small survey conducted by FFI in July 2015); there is information on its tributary Taron (or Trung) from the Chinese part of its course (where it is called Dulong; Chen et al., 2006a, b, 2012). The Mali Hka also flows in a hilly area, but in the area of Putao the valley widens to form a plain, which is more accessible, by land in the dry season (if safety allows) and by air. There is somewhat more information on the fish fauna of the Mali Hka around Putao (Putao Plain or Putao basin in the literature).

The first data on the fish fauna of the area of Putao were published by B. L. Chaudhuri in 1919. They were based on specimens collected in February 1918 by Murray Stuart, a geologist of the Geological Survey of India. Chaudhuri recorded 12 species and considered that three of them were new to science. In fact, with present knowledge, it seems that at least 10 were unnamed by that time. Later, Mukerji (1933, 1934) reported on a collection of fishes obtained in the Mali Hka River drainage in March 1930, but these included only samples from the area of Sunprabum (approx. 26°30′–26°45′N 97°45′E) and none from the middle and upper stretches. Fishes were also obtained in Putao in 1934 by R. Malaise (in part reported by Rendahl, 1948).

The area remained unaccessible for decades because of security reasons until the 1990s. Sampling by S. Kullander and R. Britz in 1998 resulted in the addition of several species to the list, either already known from elsewhere in Myanmar or new to science (e.g., Conway & Britz, 2010; Kullander, 2012; Kullander & Britz, 2002; Kullander & Fang, 2005; Ng, 2008; Anonymous, 2015).

A survey of the fishes in the drainage of the upper Mali Hka was conducted in November to December 2014 by the Forest Department, the Zoology Department of Myitkyina University and Fauna & Flora International (FFI). Safety conditions in 2014 restricted very much the areas that can be visited in northern Myanmar and sampling was possible only in a few areas of Putao Plain. An additional survey in July 2015 by FFI sampled additional sites on Putao Plain and also in higher altitude along the Mon Lan Chaung, a main tributary flowing from the water divide between the Brahmaputra in India (Arunachal Pradesh) and the Irrawaddy in Myanmar and entering the Mali Hka from the west. These surveys resulted in the discovery of 10 species apparently new to science. Three of them are described here; one of them represents a new genus.

MATERIAL & METHODS

Measurements and counts follow Kottelat (1990) and Kottelat & Freyhof (2007). Last 2 branched dorsal and anal-fin rays articulating on a single pterygiophore are noted as "1½". Frequency of meristic values are indicated in parentheses, if more than one value is observed; asterisks indicate the condition for the holotype. Abbreviations used: CMK, collection of the author; MHNG, Muséum d'Histoire Naturelle, Genève; and ZRC, Lee Kong Chian Natural History Museum, Singapore.

The toponymy of northern Myanmar is extremely labile, depending of different transcription systems of the languages of the various ethnic and language groups. The following alternative spellings of the mentioned places can be seen on maps and in the literature: Kang Mu Lon (Kaung Mu Lon), Mali Hka (Malika, Malikah, Malikha), Mon Lan Chaung (Mone Lan, Mon Laing), Phunganrazi (Phonganrazi, Phanganrazi, Hponganrazi, Hpon-kan Razi), Wa Sar Dam (Wasandum, Wasandam, War Zan Dum, Wasondum). Dam means village and chaung means stream.

Malihkaia, new genus

Type species. *Malihkaia aligera*, new species (Figs. 1–2).

Diagnosis. *Malihkaia* is distinguished from all other genera of nemacheilids by the unique morphology of the lips and the unique pectoral fin sexual dimorphism. Lips thick, with numerous, closely set, deep furrows (Fig. 3). Upper lip with a small median notch, with transverse furrows on its whole length, edge crenulated. Lower lip with a median interruption; with transverse furrows on its whole length, edge crenulated.

In the male, the pectoral fin is strongly falcate (Fig. 2). The unbranched ray is flexible and shaped as in other species of Nemacheilidae. The first branched ray is rigid, arched and curled upwards (Fig. 4). It is about 5 times wider than the other branched rays. It is flattened dorso-ventrally and very elongate, reaching beyond pelvic-fin base. It is first branched at about midlength. The posterior main branch is thicker than the anterior main branch; it is branched again twice, the third branching about at distal one-sixth of the ray. The anterior branch is branched again only once, in a position intermediate to that of branching points 2 and 3 of posterior main branch. There is no membrane between all the branches and sub-branches, but there is a membrane around the tip of the ray.

The second and third branched rays are very slender, branched only at their distal third, the anterior branch is thicker than the posterior one and it is branched again once; the posterior branch has no sub-branches. The membrane between the branches is very narrow. The spaces and relative 'depth'

Fig. 1. *Malihkaia aligera*, MHNG 2766.051, holotype, male, 65.7 mm SL; Myanmar: Irrawaddy drainage; Mali Hka River near Putao.

of the branching increase regularly in the following rays. The fourth and following branched rays have two branches that are each branched once. There is some variation in the branching apparently related to size and small injuries; the above is based on intact fins.

The lower surface of the unbranched ray and the unbranched part of first branched ray and the membrane between the three first rays are covered by an unculiferous pad (Conway et al., 2012), thickest under the first branched ray. There are also pads under the membranes between the other rays, but less developed. There also are granulations (unculi?) on the dorsal surface of the rays and thickened tissue on the membranes.

In females, the pectoral fin is rounded; there are unculiferous pads under the rays, thickest under the unbranched and first branched ones, decreasing in extant and thickness posteriorly. The unbranched ray is thicker than the following rays and rigid; dorsally, the membrane between the first two rays is thickened. The first branched ray is thickened but flexible, round in cross-section, thicker than the following rays; the anterior branch is unbranched. The posterior branch is branched once, the anterior sub-branch is unbranched and the posterior one branched again. In the second branched ray, the anterior branch is unbranched and the posterior branch is branched again. The remaining rays are all branched twice as in other nemacheilids. There is some little variation in the branching, related with small injuries and regrowth; the above is based on one intact fin on each female.

Fig. 2. *Malihkaia aligera*, CMK 25508, paratypes; a, male, 73.0 mm SL; b, female, 77.2 mm SL; Myanmar: Irrawaddy drainage: Mali Hka River near Putao.

Fig. 3. *Malihkaia aligera*, CMK 25508, 73.0 mm SL; ventral view of head.

In both sexes, in both pelvic and pectoral fins, the anterior edge of the unbranched ray has a thick tissue cover. In both sexes, the pelvic fin has thickened tissue on membranes between the unbranched ray and branched rays 1–3, dorsally and ventrally, also covering part of these rays ventrally.

Additional characters useful to distinguish the genus are: processus dentiformis present; suborbital flap present in males; 8½ branched dorsal-fin rays; 9+8 branched caudal-fin rays; axillary pelvic lobe present; anus situated about 1.5–2 eye diameter in front of anal fin; body entirely scaled; lateral line complete; air bladder without posterior chamber; body with 9–12 bars extending from dorsal midline to level of pectoral fin, bars of quite regular width and shape in front of dorsal fin, less regular posteriorly, much wider than interspaces; and black mark at caudal-fin base made of a more or less squarish blotch in middle of base, a more or less triangular blotch over dorsal procurrent rays, fainter pigments over base of uppermost and lowermost 4–6 principal rays of caudal fin.

Etymology. Named for Mali Hka River, where the type species was discovered. Gender feminine.

Remarks. The deeply furrowed lower lip of *Malihkaia aligera* is unique in South and Southeast Asian Nemacheilidae. *Acanthocobitis* (including *Paracanthocobitis*, see Kottelat, 2012b: 74, 2013: 198) has papillated lips (Kottelat, 1990, 2012a). On the upper lip, the papillae are organised in several rows; on the lower lip there is a broad median interruption and, on each side, a widened, strongly papillated pad, covered by papillae. Species of *Acanthocobitis* also have a very different colour pattern, made of obliquely organised bars, usually of irregular shape and organisation. All species of *Acanthocobitis* have a small black spot (sometime ocellated) at the upper extremity of the base of the caudal fin. Finally, species of *Acanthocobitis* have a longer dorsal fin, with 9–18½ branched rays.

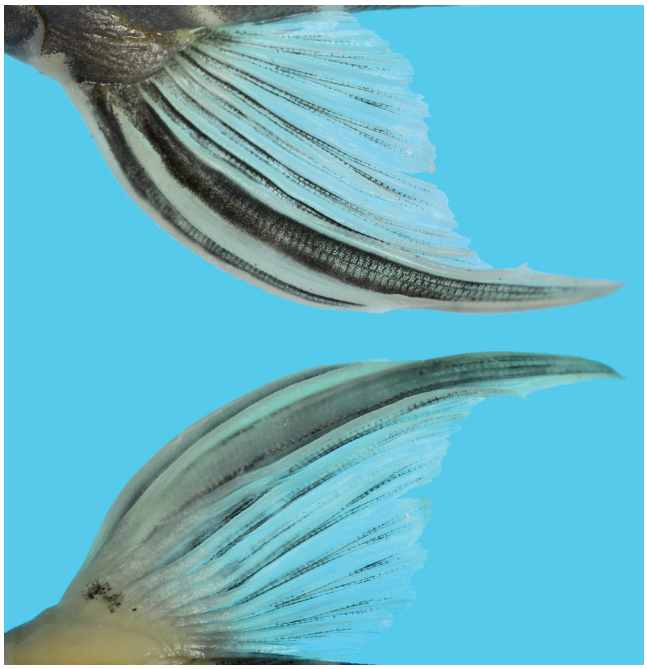

Fig. 4. *Malihkaia aligera*, CMK 25508, 73.0 mm SL; left pectoral fin of male; dorsal (above) and ventral (below) view. Extremity of fourth branched ray damaged.

In Nemacheilidae, the deeply furrowed lips are otherwise known only in some species of *Labiatophysa*, *Triplophysa* and *Tarimichthys*, all endemic to the Tibetan plateau, the Tarim and adjacent endorheic basins in China, Kazakhstan and Kyrgyzstan, and adjacent waters. These genera are distinguished, among others, by the absence of scales (most species), males with densely set unculi on the side of the head below the eye and on the dorsal surface of anterior pectoral-fin rays (Prokofiev, 2004, 2010).

Cobitiforms have developed a great variety of sexual dimorphism, but most of it associated with the pectoral fins and involving thickening and modification of rays (see, e.g., Šlechtová et al., 2008 for sexual dimorphism in *Cobitis* and related genera; Kottelat & Lim, 1992 for *Lepidocephalichthys*; Kottelat & Tan, 2008 for *Kottelatlimia* and *Acantopsis*; Kottelat, 1990 for Indochinese Nemacheilidae; Bohlen & Šlechtová, 2011 for *Pteronemacheilus*); sexual dimorphism may also involve, for example, thickening of parts of the body (e.g., in *Sabanejewia*, Kottelat & Freyhof, 2007) or vertical torsion of the caudal peduncle (in *Microcobitis*; pers. obs., unpubl.). The modified pectoral fin of male *M. aligera* seems unique in Nemacheilidae but is very reminiscent of what is observed in some Cobitidae, especially species of *Acantopsis*. In *Acantopsis*, the branches of the first branched ray are in contact and there is no membrane between them and the ray is covered by a dense layer of unculi (pers. obs.; Kottelat & Tan, 2008). In *Kottelatlimia*, the first branched ray is branched only at the tip and may appear as an unbranched ray (Kottelat & Tan, 2008). A curled pectoral fin in males is observed in Cobitidae in *Acantopsis* and *Pangio* (e.g., Kottelat & Tan, 2008; Kottelat & Lim, 1993) but has not been reported in Nemacheilidae before.

Table 1. Morphometric data of type material of *Malihkaia aligera* (n=6). Range and mean include holotype data.

	Holotype	Range	Mean
Standard length (mm)	65.7	64.9–77.2	
Total length (mm)	81.4	80.8–94.5	
In percent of standard length			
Total length	123.8	122.0–124.6	123.2
Head length (dorsal)	20.5	20.5–23.6	22.1
Head length (lateral)	24.6	23.8–25.9	24.8
Predorsal length	51.3	50.2–54.7	52.0
Prepelvic length	53.1	52.3–54.0	53.0
Pre-anus length	74.5	72.7–76.4	74.7
Pre-anal length	79.2	77.4–80.6	79.2
Head depth	13.9	13.6–14.4	14.0
Body depth at dorsal-fin origin	17.2	16.0–19.0	17.1
Depth of caudal peduncle	11.4	10.3–11.9	11.1
Length of caudal peduncle	14.6	14.6–16.8	15.6
Head width	14.9	14.0–16.2	15.0
Body width at dorsal-fin origin	11.5	10.5–13.3	11.7
Snout length	9.8	9.7–11.2	10.3
Eye diameter	5.0	4.4–5.1	4.8
Interorbital width	5.8	5.2–5.9	5.6
Length of dorsal fin	21.6	17.3–21.6	19.7
Length of upper caudal-fin lobe	21.5	20.5–22.7	21.6
Length of median caudal-fin rays	16.1	14.1–16.8	16.1
Length of lower caudal-fin lobe	25.4	20.7–25.4	23.0
Length of anal fin	17.8	16.7–18.2	17.6
Length of pelvic fin	18.8	17.6–20.4	18.7
Length of pectoral fin	30.5	19.8–32.2	31.0
In percent of dorsal head length			
Snout length	48	41–50	46
Eye diameter	24	18–24	22
Interorbital width	28	23–28	25
In percent of lateral head length			
Snout length	40	40–44	41
Eye diameter	20	18–20	19
Interorbital width	24	21–24	23

Malihkaia aligera, new species
(Figs. 1, 2)

Holotype. MHNG 2766.051, male, 65.7 mm SL; Myanmar: Kachin State: Mali Hka River, about 9 km upstream of Kang Mu Lon; 402 masl; 27°25′54″N 97°27′56″E; M. Kottelat, Nyein Chan et al., 26 November 2014.

Paratypes. CMK 25508, 2 males, 64.9–73.0, 2 females, 73.1–77.2 mm SL; ZRC 55630, 1 male, 65.9 mm SL; same data as holotype.

Diagnosis. See generic diagnosis for characters distinguishing the species from all other nemacheilids.

Description. See Figs. 1 & 2 for general appearance and Table 1 for morphometric data of holotype and paratypes. An elongate nemacheilid with body depth increasing until somewhat in front of dorsal-fin origin, then decreasing until posterior extremity of dorsal-fin base. Behind dorsal fin, body depth almost uniform until caudal-fin base. Dorsal profile with a marked hump behind head. Head strongly arched in lateral view, slightly depressed; body slightly compressed anteriorly to very compressed on caudal peduncle. Interorbital area arched. Eye below dorsal profile of head. Head deep, with high cheek. Cheeks not swollen (in both sexes). Snout rounded in dorsal and lateral view. Caudal peduncle 1.3–1.5 times longer than deep, of uniform depth. Low dorsal keel on posterior half of post-dorsal area. Low ventral keel on posterior half of caudal peduncle. Dorsal keel continuous with upper margin of caudal fin. Largest recorded size 77.2 mm SL.

Dorsal fin with 4 unbranched and 8½ branched rays; distal margin straight to slightly concave. Second branched ray longest. In first branched ray, anterior branch not branched a second time, shorter than posterior branch. Pectoral fin with 1 unbranched and 10 branched rays, falcate in males,

reaching beyond pelvic-fin base, rounded in females, reaching about two thirds of distance to pelvic-fin base (see diagnosis of genus for more detailed description of pectoral fin; Fig. 4). Pelvic fin with 1 unbranched and 6 (1) or 7 (5*) branched rays, reaching about three-fifths of distance to anal-fin origin (not reaching anus); rounded; posterior margin straight; origin below base of branched dorsal-fin rays 1 to 2. Axillary pelvic lobe present, entirely free. Anus situated about 1.5–2 eye diameter in front of anal fin. Anal fin with 3 unbranched and 5½ branched rays; distal margin straight. Caudal fin with 9+8 branched rays; forked, lobes rounded, lower lobe slightly longer than upper one; upper lobe 1.3–1.5 times longer than median rays.

Body entirely scaled except on anterior half of predorsal area and belly in front of pelvic fins. Lateral line complete, with 89–99 pores. Cephalic lateral line system with 6 supraorbital, 4+10–11 infraorbital, 8–9 preoperculo-mandibular and 3 supratemporal pores.

Anterior nostril pierced in front side of a pointed flap-like tube. Posterior nostril adjacent to anterior one. Mouth U-shaped, gape about 1.5 times wider than long (Fig. 3). Lips thick, with numerous, closely set, deep furrows. Upper lip with a small median notch, with furrows on its whole length, edge crenulated. Processus dentiformis present. Lower lip with a median interruption; with furrows on its whole length, edge crenulated. Tip of lower jaw not exposed. No median concavity in lower jaw. Inner rostral barbel reaching beyond corner of mouth; outer one reaching vertical of middle of eye. Maxillary barbel reaching beyond posterior margin of eye. Intestine with a loop posterior to stomach (Fig. 5). Air bladder without visible posterior chamber.

Sexual dimorphism. Males with suborbital flap; females with neither suborbital flap nor suborbital slit. Pectoral fin rounded in females, strongly falcate in males. In males, unbranched and first branched rays rigid, arched and curled upwards. First branched ray about 5 times wider than other branched rays, flattened dorso-ventrally, reaching beyond pelvic-fin base; without membrane between the branches and all sub-branches. Second branched ray slender, branched only at tip, membrane between branches very narrow. See diagnosis of genus for more detailed description of pectoral fin of both sexes.

Coloration. In formalin, shortly after fixation. Body background colour pale yellowish brown, throat and belly whitish; except otherwise stated, all markings blackish brown to black. Head black, cheek marmorated, lower side whitish. Irregularly set and shaped patches of black pigments on lips, but always a patch on posterior edge of lower lip and on adjacent part of throat. Body with 9–12 bars (3–4 predorsal, 3 subdorsal, 3–5 postdorsal), extending from dorsal midline to level of pectoral fin (or ventral midline on caudal peduncle), mostly continuous over back with contralaterals; bars of quite regular width and shape in front of dorsal fin, less regular posteriorly; much wider than interspaces.

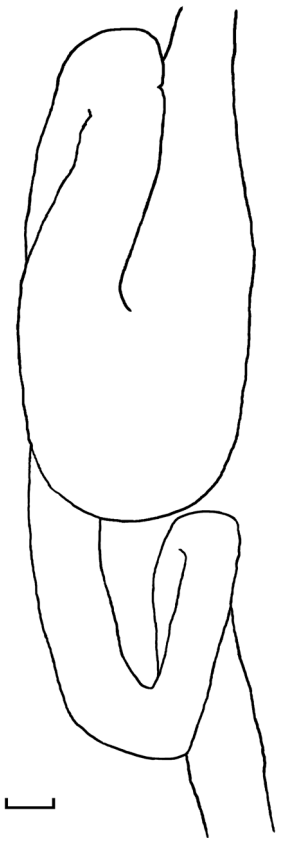

Fig. 5. *Malihkaia aligera*, MHNG 2766.051, holotype, 65.7 mm SL; digestive tract. Scale bar = 1 mm.

A conspicuous more or less squarish black blotch at middle of caudal-fin base, depth about ⅓–¼ of depth of base of fin. A more or less triangular black blotch over dorsal procurrent rays, including dorsal midline. Fainter pigments over base of uppermost and lowermost 4–6 principal rays of caudal fin, making a slightly elongated, arched mark, variably contrasted, and variably connected with other two blotches. Space between upper triangular blotch and last bar on body somewhat reddish. Axial stripe faint, or not distinct except on caudal peduncle where darker and wider, combining with blotch at middle of caudal-fin base to make a larger and more conspicuous blotch.

Dorsal fin hyaline, no pigments on membranes, with a small black spot at base of unbranched rays and middle and distal parts of last unbranched ray black; pigments on rays at branching points and on middle of unbranched part of first branched rays (and branched rays 2–4 in largest specimens). Caudal fin hyaline, with pigments between segments of branched rays and near branching points. Anal fin hyaline, with pigments near branching points of branched rays.

Pelvic fin hyaline, with pigments along rays and near branching points of branched rays. Pectoral fin with membranes hyalines, pigments on rays, darker along posterior edge of branched rays 2–10. In males, unbranched and first branched rays more or less completely covered by pigments, on dorsal side, on whole length; identical in females, but pigments less densely set.

Notes on biology. The two females did not have ripe ovaries. The stomach contained unidentifiable insect remains.

Distribution and habitat. *Malihkaia aligera* has been observed only once, in the Mali Hka River near Putao. It was collected over gravel and cobble, in fast riffles, in about 60 cm depth (Fig. 6). Other species collected in the same microhabitat at this locality include *Bangana* sp., *Garra* sp. (Cyprinidae), *Psilorhynchus brachyrhynchus* (Psilorhynchidae), *Homalopteroides rupicola* (Balitoridae), *Acanthocobitis* sp., *Schistura malaisei*, *S. nubigena*, *S. sikmaiensis* (Nemacheilidae), *Batasio procerus* (Bagridae), *Amblyceps murraystuarti* (Amblycipitidae), *Pseudecheneis brachyurus* (Sisoridae) and *Mastacembelus armatus* (Mastacembelidae). *Schistura malaisei* and *Homalopteroides rupicola* were the most abundant species.

Etymology. From the Latin *aliger* (*aligera*, *aligerum*), winged. An adjective.

Remarks. The colour pattern of the six available specimens of *M. aligera* is made of very regular bars on body, with very well marked edges, on a pale background. This general pattern is rare among Southeast Asian nemacheilids. Interestingly, one of the species collected together with *M. aligera* is *Schistura sikmaiensis*, which also has a regular and contrasted colour pattern (Fig. 7). A third species collected at the same locality is *S. nubigena* (described below), which

Fig. 6. Type locality of *Malihkaia aligera* and *Schistura nubigena*; Myanmar: Kachin state: Mali Hka River near Kang Mu Lon; 402 masl; 26 November 2014.

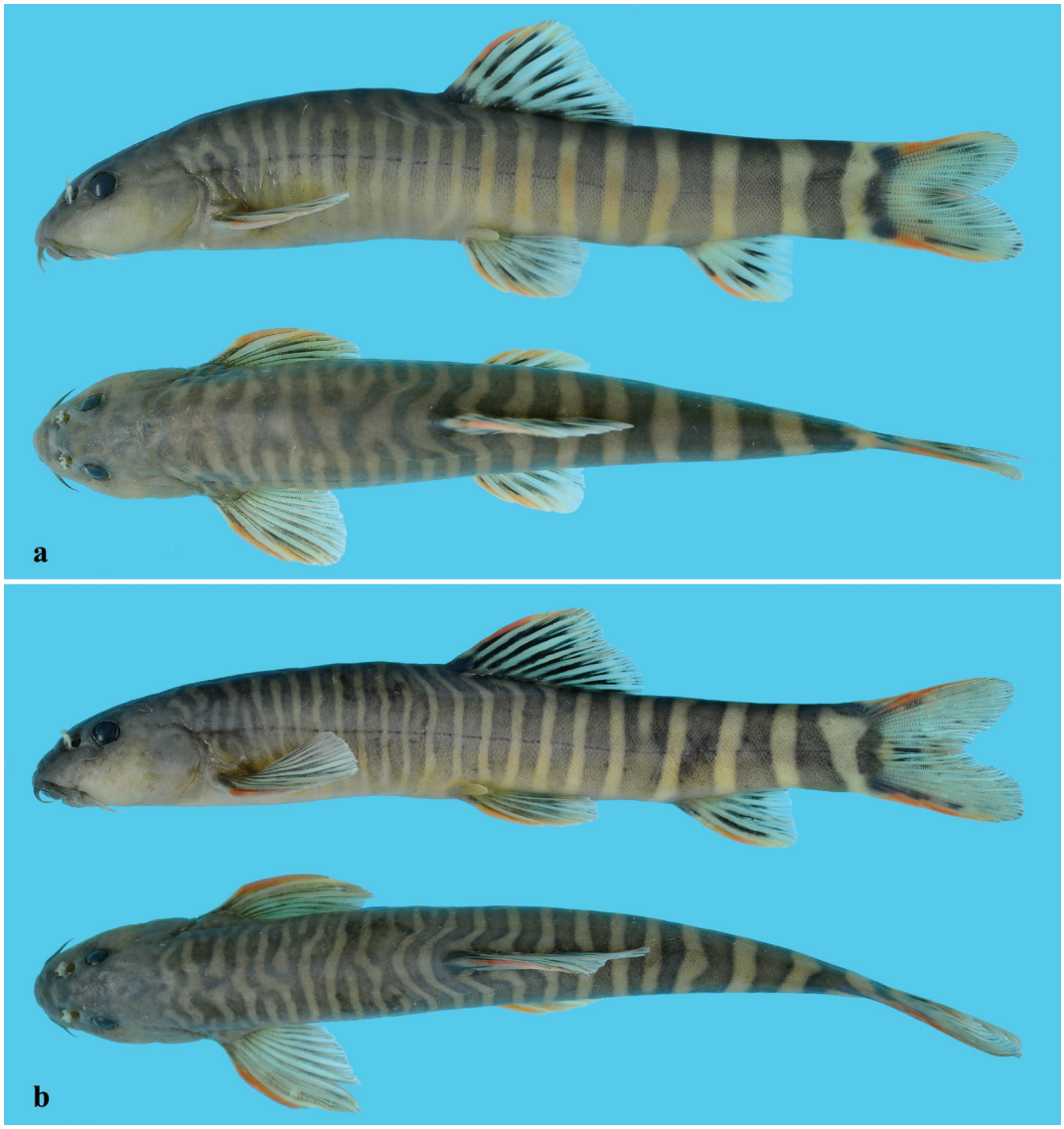

Fig. 7. *Schistura sikmaiensis*, CMK 25560; Myanmar: Irrawaddy drainage: Mula River at Lika; a, female, 61.6 mm SL; b, male, 72.7 mm SL.

has a sharply contrasted colour pattern of 4 bold black bars on a whitish background. Finally, *S. wanlainensis*, also described below, from the same area but at higher altitude and habitat with higher gradient, also has a very contrasted colour pattern of very regular bars on a pale background.

***Schistura nubigena*, new species**
(Figs. 8–10)

Holotype. MHNG 2766.052, 33.6 mm SL; Myanmar: Kachin state: Mali Hka River, about 9 km upstream of Kang Mu Lon; 402 masl; 27°25′54″N 97°27′56″E; M. Kottelat, Nyein Chan et al., 26 November 2014.

Paratypes. CMK 25509, 11, 19.5–38.7 mm SL; same data as holotype.

Diagnosis. *Schistura nubigena* is distinguished from all other species of the genus by its unique colour pattern made of 4 black bars in juveniles that evolve into 8 bars, more or less fused on the flank and the back to leave only 2 series of pale yellowish spots in the predorsal area and 4 narrow transverse bands in subdorsal and postdorsal areas. Although not unique, the following characters help to identify the species: incomplete lateral line, reaching at most to above pelvic-fin base; two vertically elongated blotches on proximal extremity of all rays of caudal fin (one blotch per lobe); no observed sexual dimorphism; 8½ branched dorsal rays.

Description. See Figs. 8–10 for general appearance and Table 2 for morphometric data of holotype and three largest paratypes. A moderately elongate nemacheilid with body depth slowly increasing up to about above tip of pectoral fin. Behind dorsal fin, body depth decreasing slowly to caudal-fin base. Dorsal profile with a small concavity between head and body. Head slightly compressed; body slightly compressed anteriorly to compressed posteriorly. Interorbital area slightly convex. In lateral view, eye below or flushed with dorsal profile of head. Cheeks not swollen. Snout rounded in dorsal and lateral view. Caudal peduncle depth 1.6–2.0 times in its length, of uniform depth. Low dorsal crest on posterior half of post-dorsal area. Low ventral crest on entire length of caudal peduncle. Dorsal crest continuous with upper margin of caudal fin. Largest recorded size 38.7 mm SL.

Dorsal fin with 4 unbranched and 8½ branched rays; distal margin straight to slightly concave. Second branched ray longest. Pectoral fin with 1 unbranched or 8 (3*) and 9 (1) branched rays (including small last rays, usually unbranched), rounded, reaching about two thirds of distance to pelvic-fin base. No axillary pectoral lobe. Pelvic fin with 1 unbranched and 6 branched rays; reaching to anus; falcate, posterior margin rounded; origin below base of fourth unbranched or first branched dorsal-fin ray. Axillary pelvic lobe present, entirely free. Anus situated about 1 eye diameter in front of anal fin. Anal fin with 3 unbranched and 5½ branched rays; distal margin straight. Caudal fin with 9+8 branched rays; forked, lobes rounded, lower lobe slightly longer than upper one.

Body entirely covered by scales, except nape and predorsal area, and belly in front of anal fin. Scales deeply embedded. Lateral line incomplete, reaching between tip of pectoral fin and pelvic-fin origin, with 19–31 pores (number apparently increasing with increasing size). Cephalic lateral line system with 6 supraorbital, 4+11 infraorbital, 9 preoperculo-mandibular and 3 supratemporal pores.

Anterior nostril pierced in front side of a pointed flap-like tube. Posterior nostril adjacent to anterior one. Mouth

Fig. 8. *Schistura nubigena*, MHNG 2766.052, holotype, 33.6 mm SL; Myanmar: Irrawaddy drainage: Mali Hka River near Putao.

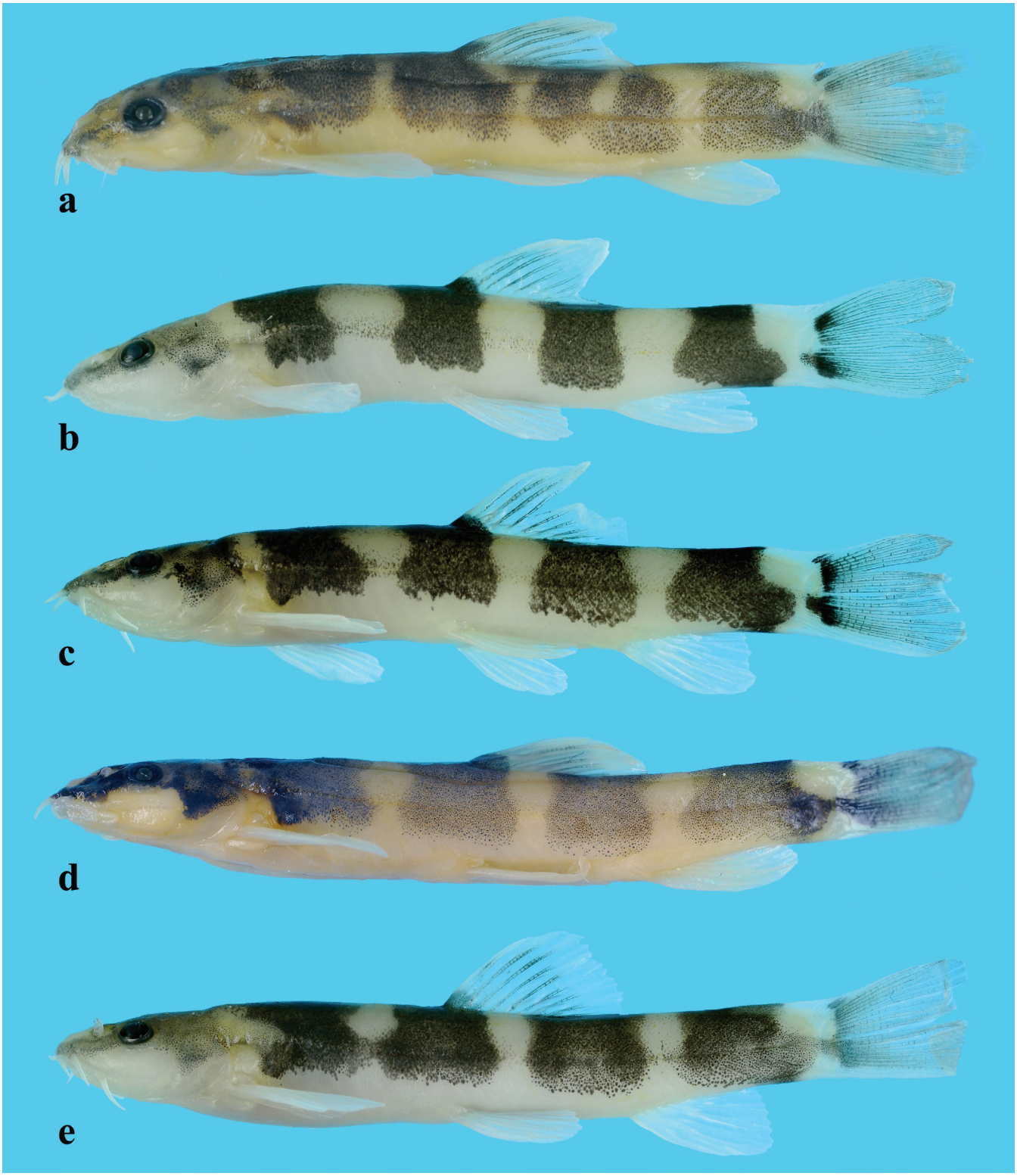

Fig. 9. *Schistura nubigena*, CMK 25509, paratypes; Myanmar: Irrawaddy drainage: Mali Hka River near Putao; a, 20.0 mm SL; b, 21.1 mm SL; c, 23.8 mm SL; d, 26.7 mm SL; e, 26.9 mm SL.

Table 2. Morphometric data of holotype and three largest paratypes of *Schistura nubigena*.

	Paratype	Holotype	Paratype	Paratype
Standard length (mm)	38.7	33.6	26.2	26.9
Total length (mm)	48.1	40.9	32.2	33.1
In percent of standard length				
Total length	124.2	121.8	122.6	123.4
Head length (dorsal)	22.1	21.4	24.0	21.1
Head length (lateral)	23.2	24.6	24.8	23.9
Predorsal length	54.2	54.2	54.7	52.4
Prepelvic length	52.8	51.8	52.6	50.1
Pre-anus length	71.7	69.0	70.9	69.6
Pre-anal length	76.3	73.1	72.5	76.4
Head depth	13.0	11.1	11.2	11.7
Body depth at dorsal-fin origin	15.6	16.4	12.6	14.1
Depth of caudal peduncle	11.0	11.4	11.0	9.9
Length of caudal peduncle	21.5	18.4	20.2	18.3
Head width	14.6	14.4	13.2	13.9
Body width at dorsal-fin origin	13.7	11.8	9.2	9.6
Snout length	10.0	9.6	9.9	9.2
Eye diameter	4.2	4.2	4.7	4.8
Interorbital width	5.5	6.0	6.9	7.0
Length of dorsal fin	21.4	20.4	20.8	20.2
Length of upper caudal-fin lobe	22.7	20.6	19.2	19.5
Length of median caudal-fin rays	18.2	17.9	15.1	17.7
Length of lower caudal-fin lobe	23.4	22.8	19.8	21.3
Length of anal fin	22.2	21.0	19.3	20.9
Length of pelvic fin	19.9	17.5	17.3	19.3
Length of pectoral fin	21.6	20.3	16.0	19.4
In percent of dorsal head length				
Snout length	45	45	41	44
Eye diameter	19	20	20	23
Interorbital width	25	28	29	33
In percent of lateral head length				
Snout length	43	39	40	39
Eye diameter	18	17	19	20
Interorbital width	24	25	28	29

U-shaped, gape about 2 times wider than long (Fig. 11). Lips thin but fleshy. Upper lip without median notch, with numerous shallow furrows on whole length, edge finely crenulated. Processus dentiformis present. Lower lip with wide median notch; median part with 2–4 sulci, lateral parts smooth. Tip of lower jaw exposed. No median notch or concavity in lower jaw. Inner rostral barbel reaching slightly beyond base of outer one; outer one reaching slightly beyond base of maxillary barbel. Maxillary barbel reaching almost vertical of posterior margin of eye. Intestine straight behind stomach (Fig. 12). Air bladder without free posterior chamber.

Sexual dimorphism. None of the characters associated with sexual dimorphism in other nemacheilids have been observed in *S. nubigena*.

Coloration. After fixation in formalin. Head and body background colour pale yellowish grey; throat, belly and lower part of caudal peduncle whitish; except otherwise stated, all markings dark brown to black. Top of head and opercle dark brown. A white squarish patch between tip of snout and nostrils; a few smaller, less sharply marked pale spots on top of head.

Body with 4 bars (behind head, below dorsal-fin origin, below end of dorsal-fin base and on caudal peduncle). Bars continuous across back with contralaterals, not reaching down to level of pectoral fin. Bars slightly wider than interspaces in small specimens (less than about 22 mm SL; Fig. 9b), becoming wider with increasing size. Bars wider on dorsal midline and at lower extremity. In many specimens bars appearing divided vertically with a paler median area (Fig. 9e). Some or all bars maybe in contact at lower and upper extremities. In largest specimen, all bars appearing as vertically split in two (total 8 bars; Fig. 10), and all fused along flank in a broad milateral stripe, predorsal bars also merged on back, leaving only two longitudinal rows of 3 yellowish spots. Interspace between subdorsal and postdorsal bars persisting as 4 narrow transverse band; an additional one between head and first flank bar. In most specimens,

Fig. 10. *Schistura nubigena*, CMK 25509, paratype, 38.7 mm SL; Myanmar: Irrawaddy drainage: Mali Hka River near Putao.

posteriormost bar more irregular than others, with lower posterior corner projecting towards ventral midline and caudal-fin base (Fig. 9b–e), and in two specimens appearing as a separate blotch.

Black marks at caudal-fin base appearing as two vertically elongated deep black blotches, one covering proximal extremity of all branched rays of lower lobe, and one on all those of upper lobe (best seen on Fig. 9c). Two posterior dorsal procurrent rays black. Overimposed on upper extremity of lower black blotch, a small patch of less dense pigments, oriented diagonally upwards forwards. In larger specimens, this last patch may be connected to lower posterior extension of posterior bar, leaving a pair of large roundish white blotches (paler than rest of yellowish background colour; Figs. 9d, e, 10f). A faint inner axial stripe visible in few specimens.

Dorsal fin with hyaline membranes and a dark patch along anterior half of base, above subdorsal bar; an elongate patch of black pigments at midlength of last unbranched ray and near first branching of branched rays. Caudal fin with hyaline membranes, and pigments along all rays and between all segments. Anal and pelvic fin membranes and rays hyaline. Pectoral fin membranes and rays hyaline;

Fig. 11. *Schistura nubigena*, CMK 25509, paratype. 38.7 mm SL; mouth.

in largest specimens (33.6, 38.7 mm SL; Figs. 8, 10), an elongate patch of pigment near branching of branched rays 1–4, on dorsal side only.

Distribution. *Schistura nubigena* has been observed only once, in the Mali Hka River near Putao. It was collected over gravel and cobble, in fast riffles (Fig. 6) together with *Malihkaia aligera*; see under that species for more information.

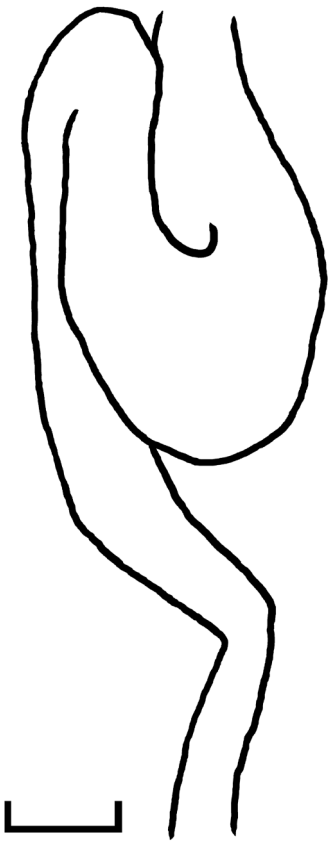

Fig. 12. *Schistura nubigena*, MHNG 2766.052, holotype, 33.6 mm SL; digestive tract. Scale bar = 1 mm.

Etymology. From the Latin adjective *nubigenus*, *-a*, *-um*, who engenders clouds, a reference to the white spots on the back resulting from the partial fusion of the bars (*nubigena* is also a noun meaning cloud-born, but this is not the meaning used here).

Remarks. *Schistura nubigena* has a colour pattern made of 4 black bars in juveniles that evolve into 8 bars, more or less fused on the flank and the back to leave only 2 series of pale yellowish spots in the predorsal area and 4 narrow transverse bands in subdorsal and postdorsal areas. This colour pattern, and its ontogeny, has not been reported for any named species of nemacheilid in Southeast and South Asia.

Schistura wanlainensis, new species
(Figs. 13, 14)

Holotype. MHNG 2766.053, female, 84.4 mm SL; Myanmar: Kachin State: Phunganrazi Wildlife Sanctuary: area of Wa Sar Dam: Mon Lan Chaung (stream) near Wan Lain Dam village); 27°29′10″N 97°10′29″E, 850 masl; Nyein Chan, 25 July 2015.

Paratypes. CMK 26417, 5, 79.6–91.8 mm SL; same data as holotype. — CMK 26584, 1, 81.2 mm SL; CMK 26377, 3, 71.2–78.2 mm SL; ZRC 55631, 1, 74.8 mm SL; Myanmar: Phunganrazi Wildlife Sanctuary: area of Wa Sar Dam: Mon Lan Chaung (stream); 27°28′51″N 97°10′35″E, 843 masl; Nyein Chan, 22 July 2015.

Diagnosis. *Schistura wanlainensis* is distinguished from all other species placed in *Schistura* in Southeast Asia by its unique colour pattern of a pale yellowish to pale grey background with 18–32 narrow, regularly shaped black bars, extending from dorsal midline and reaching downwards to below level of pectoral fin, continuous over back with contralaterals in most specimens, wider than interspaces anteriorly, narrower than interspaces on caudal peduncle; some of anterior bars fused at their dorsal extremity.

Additional characters useful to identify the species (but not unique) are: black pattern at base of caudal fin made of a vertically elongated blotch at middle of base, and a smaller blotch at its dorsal and ventral extremities (blotches contiguous in one specimen); 8½ branched dorsal-fin rays; caudal fin forked; caudal peduncle depth 1.2–1.5 times in its length; very low dorsal and ventral crests on caudal peduncle; lips thick, fleshy; upper lip with median notch; lower lip with narrow median interruption, with numerous furrows; processus dentiformis present, feebly marked, very wide (more than half of mouth gape); largest recorded size 91.8 mm SL; and females with a suborbital slit (males unknown but expected to have a suborbital flap).

Description. See Figs. 13 & 14 for general appearance and Table 3 for morphometric data of holotype and paratypes. A moderately elongate nemacheiline with a massive appearance. Body depth increasing up to dorsal-fin origin. Behind dorsal fin, body depth decreasing slowly until above base of anal fin, then uniform until caudal-fin base.

Dorsal profile continuous between head and body. Head slightly depressed; body slightly compressed anteriorly, very compressed posteriorly. Interorbital area arched. Eye below dorsal profile of head. Cheeks not swollen. Snout rounded in lateral and dorsal views. Caudal peduncle 1.2–1.5 times longer than deep, of uniform depth. Very low dorsal crest on posterior half of post-dorsal area. Very low ventral crest along entire length of caudal peduncle. Dorsal crest continuous with upper margin of caudal fin. Largest recorded size 91.8 mm SL.

Dorsal fin with 4 unbranched and 8½ branched rays; distal margin straight to slightly concave. Second branched ray longest. Pectoral fin with 1 unbranched and 11 branched rays (two specimens with an additional small, unbranched ray), rounded, reaching about halfway of distance to pelvic-fin base; rays without filamentous extensions. No proper axillary pectoral lobe, but swelling dorsally at base of fin. Pelvic fin with 1 unbranched and 7 branched rays; reaching about two thirds of distance to anus; posterior edge rounded, second or third ray longest; origin below base of branched dorsal-fin rays 2–3. Axillary pelvic lobe present, free, conspicuous. Anus situated about 2 eye diameters in front of anal fin, hidden under a protuberant, massive genital papilla (at least in females before spawning). Anal fin with 3 unbranched and 5½ branched rays; distal margin slightly concave. Caudal fin with 9+8 branched rays; dorsal and ventral procurrent rays cannot be counted; forked, upper lobe 1.4–1.8 times longer than median rays, lobes rounded, of equal length.

Fig. 13. *Schistura wanlainensis*, MHNG 2766.053, holotype, 84.4 mm SL; Myanmar: Irrawaddy drainage: Mon Lan Chaung near Wan Lam Dam.

Body entirely scaled, except around lateral line pores 1–5 and belly between pectoral fins. Scales deeply embedded and not densely set in anterior half of body. Lateral line complete, with 90–106 pores (difficult to count with accuracy). Many lateral line scales with 2 auxillary pores, above and below main pore. Cephalic lateral line system with 6 supraorbital, 4+11 infraorbital, 8–10 preoperculo-mandibular and 3 supratemporal pores.

Anterior nostril pierced in front side of a pointed flap-like tube. Posterior nostril adjacent to anterior one. Mouth arched, gape about two times wider than long (Fig. 15). Lips thick, fleshy. Upper lip with median notch, with furrows along whole length, edge crenulated. Lower lip with narrow median interruption; median part without sulci, lateral part with numerous furrows on whole length. Processus dentiformis present, feebly marked, very wide (more than half of mouth gape); no sharp edge on upper jaw. Tip of lower jaw exposed. A median concavity in lower jaw. Inner rostral barbel not reaching corner of mouth; outer one reaching base of maxillary barbel. Maxillary barbel reaching vertical of posterior margin of eye. In single dissected specimen, intestine with a large loop behind stomach (Fig. 16). No apparent posterior chamber of air bladder.

Sexual dimorphism. All specimens apparently females; presence of eggs, about 0.6 mm diameter observed in four specimens 78.2–91.8 mm SL; most slender specimen (85.6 mm SL) indeterminate, remaining specimens not checked but all with distended belly. All specimens have a short slit in a position that would correspond to posterior edge of suborbital flap in species in which males have a suborbital flap (compare Figs. 17 & 18); in species in which such a slit is present in females, the males usually have a suborbital flap. No tubercles or unculi observed.

Coloration. After two months in formalin. Head and body background colour pale yellowish to pale grey; throat and

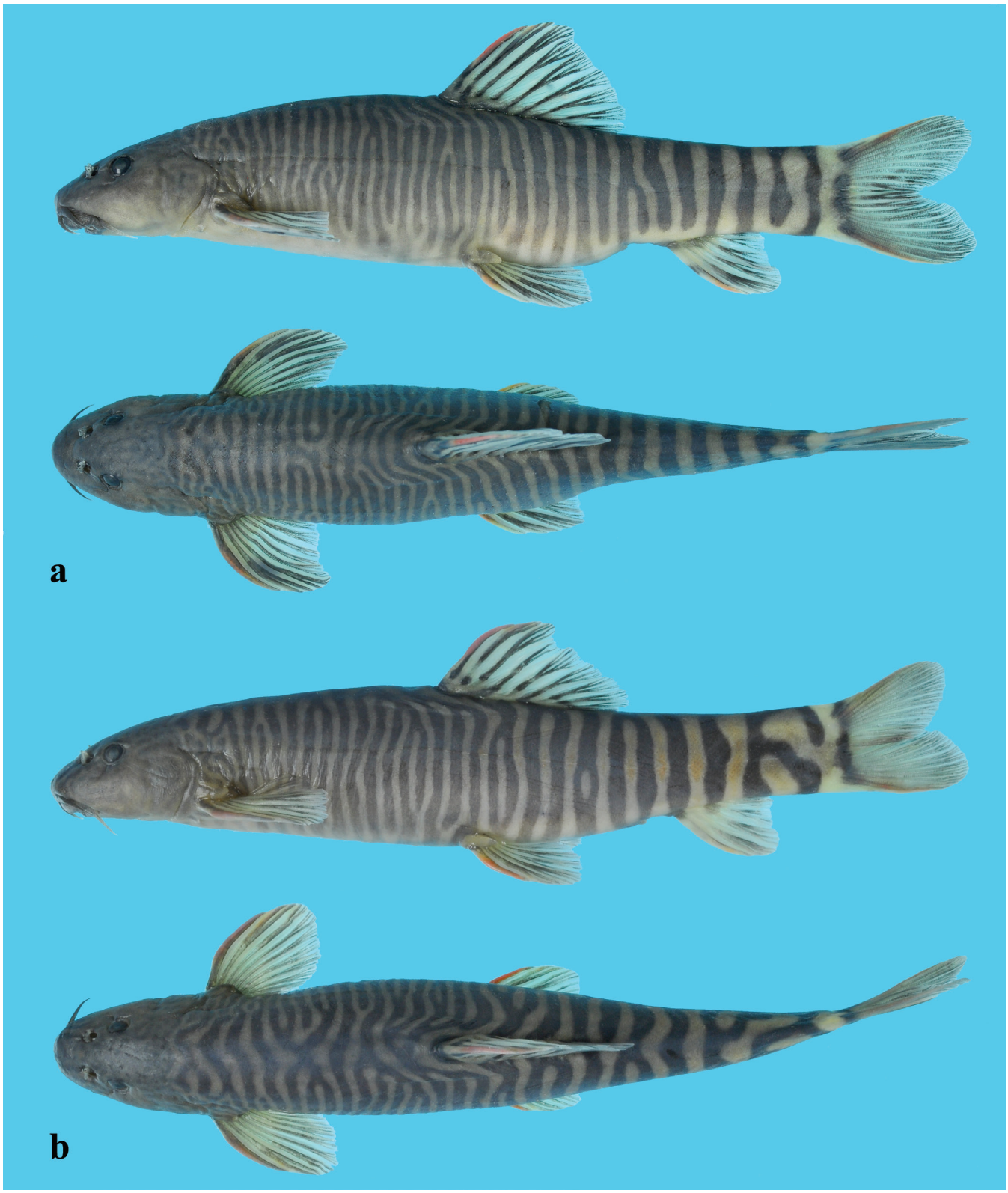

Fig. 14. *Schistura wanlainensis*, CMK 26417, paratypes; Myanmar: Kachin state: Irrawaddy drainage: Mon Lan Chaung near Wan Lam Dam; a, 85.6 mm SL; b, 91.8 mm SL.

Table 3. Morphometric data of type material of *Schistura wanlainensis* (n=11). Range and mean include holotype data.

	Holotype	Range	Mean
Standard length (mm)	84.4	71.2–91.8	
Total length (mm)	100.0	95.9–108.8	
In percent of standard length			
Total length	118.4	116.0–121.5	119.3
Head length (dorsal)	17.8	18.5–21.0	19.8
Head length (lateral)	21.4	21.4–23.2	22.1
Predorsal length	51.0	50.0–54.7	51.9
Prepelvic length	52.7	52.7–56.7	54.3
Pre-anus length	73.9	73.1–76.4	75.0
Pre-anal length	79.5	77.0–80.2	79.2
Head depth	12.4	12.4–14.2	13.0
Body depth at dorsal-fin origin	23.1	19.6–24.9	22.6
Depth of caudal peduncle	11.6	10.7–12.5	11.5
Length of caudal peduncle	14.9	14.6–17.6	15.8
Head width	14.3	14.3–16.0	15.1
Body width at dorsal-fin origin	17.2	14.7–21.0	17.3
Snout length	8.8	8.8–10.2	9.5
Eye diameter	3.1	2.4–3.7	3.1
Interorbital width	5.7	5.5–6.1	5.8
Length of dorsal fin	16.6	15.6–19.7	18.1
Length of upper caudal-fin lobe		16.8–16.8	21.1
Length of median caudal-fin rays	10.7	10.0–13.4	10.6
Length of lower caudal-fin lobe	19.9	17.5–21.4	19.8
Length of anal fin	15.1	14.1–17.7	15.8
Length of pelvic fin	16.6	15.1–17.8	16.6
Length of pectoral fin	18.1	16.4–19.8	18.6
In percent of dorsal head length			
Snout length	50	46–49	48
Eye diameter	17	12–17	16
Interorbital width	32	27–33	29
In percent of lateral head length			
Snout length	41	40–45	43
Eye diameter	14	11–15	14
Interorbital width	27	25–28	26

belly whitish to pale yellowish; darker on back; head darker grey in most specimens. Except otherwise stated, markings blackish brown to black. Head with vermiculated pattern on top, snout, suborbital area and opercle. Body with 18–32 bars, extending from dorsal midline and reaching downwards to below level of pectoral fin (on belly in largest specimens but not reaching ventral midline); continuous over back with contralaterals in most specimens; bars of regular shape, wider than interspaces anteriorly, narrower than interspaces on caudal peduncle; some of anterior bars fused at their upper extremity.

Black pattern at base of caudal fin made of a vertically elongated blotch at middle of base, and a smaller blotch at its dorsal and ventral extremities; blotches contiguous in one specimen. Median blotch occupying about median half of fin base; with a median constriction. Upper blotch elongated, slanted forwards upwards, at base of principal unbranched ray and upper branched rays 1–3; in some specimens continued posteriorly by a band of black and red pigments on upper branched ray. Lower blotch elongated, slanted towards lower edge of caudal fin, on base of principal unbranched ray and lower branched rays 1–3, continued posteriorly by a band of black and red pigments on lower branched ray. No visible inner axial stripe.

Dorsal fin with hyaline membranes. All branched rays black except distal extremity; proximal third paler in some specimens, greyish in one (holotype). Last unbranched ray black on posterior half, orange on anterior half. Other unbranched rays black. Membrane between last unbranched and first branched ray orange in distal area; membranes between branches of first branched ray orange; distalmost part of membrane between first two branched rays yellowish.

Caudal fin with hyaline membranes in most specimens, pale orange in some. Rays blackish brown. One or two irregular and incomplete vertical rows of spots corresponding to

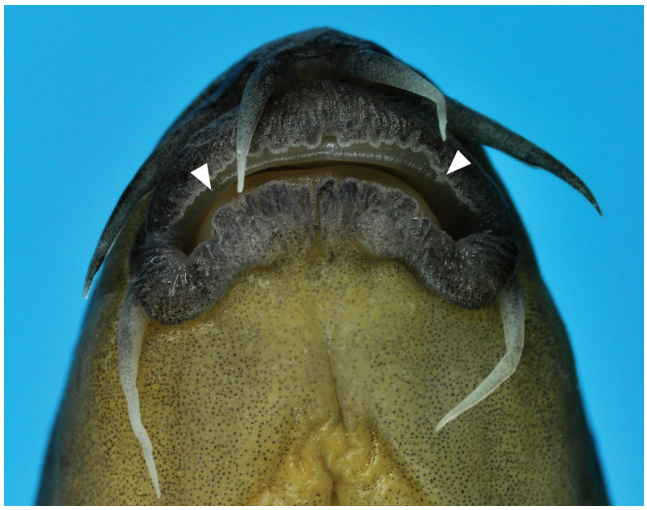

Fig. 15. *Schistura wanlainensis*, CMK 26417, 84.3 mm SL; mouth. Arrows indicate lateral extent of processus dentiformis.

accumulation of pigments at primary and secondary branching points. Black stripes along principal unbranched ray of each lobe (see above, black pattern at caudal-fin base), surrounded by pale-orange to reddish area.

Anal fin with hyaline membranes. Branched rays with one or two rows of black spots corresponding to accumulation of black pigments at primary and secondary branching points. Last unbranched ray orange, as well (in some specimens) as distal extremity of membrane between last unbranched and first branched rays. Blackish areas adjacent to lower extremity of flank bars.

Pelvic fin with hyaline membranes. Branched rays with one or two rows of black spots corresponding to accumulation of black pigments at primary and secondary branching points. Unbranched ray orange (and in one specimen, also distal extremity of first branched ray), as well (in some specimens) as distal extremity of membrane between unbranched and first branched rays.

Pectoral fin with hyaline membranes. Rays black; in some specimens, unbranched ray orange as well as anterior half of first branched ray. In all branched rays, posterior branch more densely pigmented than anterior branch. Membrane between unbranched and first branched rays orange, at least distally.

Notes on biology. A dissected female (CMK 26584, 81.2 mm SL) with distended belly had ovaries filled with a large number (probably > 1000) of eggs 0.6 mm in diameter. Its stomach contained unidentified green vegetal material.

Distribution and habitat. *Schistura wanlainensis* is presently known only from the Mon Lan Chaung in the area of Wa Sar Dam, in Phunganrazi Wildlife Sanctuary (Fig. 19). The Mon Lan Chaung becomes known as Mula Chaung on Putao Plain and is a tributary of the Mali Hka, which it enters from the west on Putao Plain.

At the places of sampling, the Mon Lan Chaung is a large river about 50 m wide, with very fast water flowing over

Fig. 16. *Schistura wanlainensis*, CMK 26584, 81.2 mm SL; digestive track. Scale bar = 10 mm.

Fig. 17. *Schistura wanlainensis*, CMK 26417, 84.3 mm SL, female; note suborbital slit.

a stone and boulders bottom. Other species collected in the same microhabitat at these localities include *Garra* cf. *dulongensis*, *Garra* sp., *Neolissochilus compressus*, *Oreinus meridionalis*, *Semiplotus cirrhosus* (Cyprinidae), *Acanthocobitis* sp., *Schistura malaisei* (Nemacheilidae), *Amblyceps murraystuarti* (Amblycipitidae), *Glyptothorax* sp., *Oreoglanis* sp. (Sisoridae) and *Mastacembelus armatus* (Mastacembelidae). *Schistura malaisei* was the most abundant species.

Etymology. Named for Wan Lain Dam village where the fish were collected, and whose inhabitants have established a fish conservation zone. An adjective.

Fig. 18. *Schistura sikmaiensis*, CMK 25560; a, female, 61.6 mm SL, with suborbital slit; b, male, 72.7 mm SL, with suborbital flap.

Remarks. *Schistura sikmaiensis* was diagnosed from all other species of *Schistura* in Southeast Asia by the absence of processus dentiformis (Rendahl, 1948: 27; Kottelat, 1990: 208). Examination of additional material suggests that the processus dentiformis could also be described as present but feebly marked and very wide, as in *S. wanlainensis*. *Schistura sikmaiensis* (of which *S. putaoensis* is a synonym) is recorded from a few localities in the upper Irrawaddy in Myanmar, China and India (Kottelat, 1990: 208) but it was not found in the Mon Lan Chaung and its tributaries in the hills. It was observed only on Putao Plain (see Fig. 7). The two species share a number of characters, including the pale background colour, the bars on the anterior part of the body narrower than those on the posterior part and often fused in pairs dorsally, a similar black pattern at the base of the caudal fin, and the presence in females of a slit in a position that corresponds to the posterior edge of suborbital flap of males.

Schistura wanlainensis is distinguished from *S. sikmaiensis* by its general appearance (compare Figs. 13, 14 & 7). For example, the more slender caudal peduncle whose depth is 1.8–2.1 times in the depth of the body (vs. 1.3–1.6) and 1.2–1.5 times in its own length (vs. 1.3–1.7), a pointed snout (vs. rounded), a somewhat shorter head (lateral length 21.4–23.2 % SL vs. 22.3–24.6). Besides, *S. wanlainensis* has more (18–32 vs. 13–21) and narrower bars, the bars on the caudal peduncle narrower than the interspaces (vs. wider than the interspaces), and the bars on the anterior part of the body not much narrower than the posterior ones and

Fig. 19. Type locality of *Schistura wanlainensis*; Myanmar: Kachin state: Mon Lan Chaung near Wan Lain Dam, 850 masl; 25 July 2015. Photograph by Zau Lunn.

not all regularly fused in pairs dorsally (vs. much narrower and regularly fused). In *S. wanlainensis*, the bars are of uniform intensity of black. In *S. sikmaiensis*, the edge of the bars is clearly darker than the inner and this is gradually more marked from the posterior to the anterior bars, with some bars becoming vertically split and the number of bars increasing with size.

Comparison material. *Schistura sikmaiensis*: CMK 25507, 1, 54.5 mm SL; Myanmar: Kachin state: Mali Hka River, about 9 km upstream of Kang Mu Lon. — CMK 25560, 10, 54.5–77.9 mm SL; Myanmar: Kachin state: Mula River at Lika village, about 0.8 km downriver of Mulashidi.

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