RAFFLES BULLETIN OF ZOOLOGY **71**: 520–530
Date of publication: 4 September 2023
DOI: 10.26107/RBZ-2023-0039
http://zoobank.org/urn:lsid:zoobank.org:pub:AF123DD1-E2DA-492C-BC89-34788516E615

Schistura palma, a new species of loach from the Nam Ngiep drainage, central Laos (Teleostei: Nemacheilidae)

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Abstract. *Schistura palma*, new species, is described from the middle Nam Ngiep drainage, central Laos. It is distinguished from all other species of *Schistura* in Southeast Asia by the combination of having a dorsal keel on the entire length of the caudal peduncle in small individuals that develops into a conspicuous crest in large ones; cheeks conspicuously swollen in large individuals; lips smooth or with short, shallow wrinkles, their free edge entire; 8½ branched dorsal-fin rays; 7–10 [commonly 8–9] uniformly dark brown bars on body; plain brown cheeks. It occurs in fast-flowing stretches of the main river and lower course of main tributaries.

Key words. Cobitoidei, *Schistura*, Mekong basin, stone loach

INTRODUCTION

Loaches of the genus *Schistura* typically occur in fast-flowing waters of small streams as well as in other habitats, such as large rivers and caves. The genus presently includes about 230 valid species (pers. obs., updated from Kottelat, 2012, 2013). 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). New species are still regularly described (e.g., Bohlen & Šlechtová, 2010, 2013a, b; Ou et al., 2011; Plongsesthee et al., 2013; Bohlen et al., 2014, 2016; Kottelat, 2017a–f). The interrelationships within *Schistura* have not been studied in detail but accumulating morphological, molecular, and distribution data unsurprisingly show that the genus is paraphyletic (pers. obs.; see also, e.g., Freyhof et al., 2016; Dvořák et al., 2022).

The Nam Ngiep is a river of central Laos flowing in a north–south direction from the hills fringing the east of the Plain of Jars at about 1,600 masl to the Mekong, which it enters near Pakxan (Fig. 1). It flows roughly parallel to the Nam Xan to the east, which also enters the Mekong near Pakxan, about 7 km downriver of the mouth of the Nam Ngiep. To the west, the Nam Ngiep is adjacent to the Nam Ngum, which also flows from the Plain of Jars to the Mekong. The Nam Ngiep originates in the hills east of the

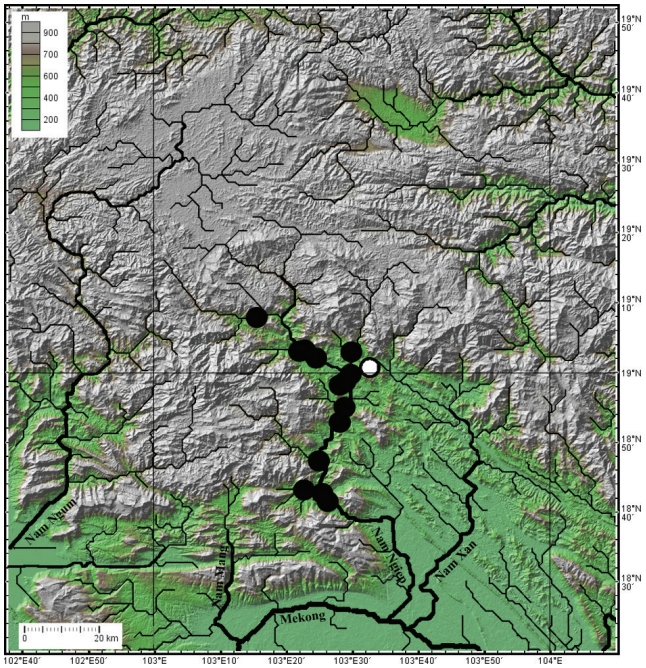

Fig. 1. Laos: Nam Ngum, Nam Ngiep and Nam Xan watersheds, showing distribution of *Schistura palma*, new species (black circles), based on listed material and additional field observations. Shown topography is prior to construction of reservoirs. Open circle: type locality. One symbol may represent more than one locality.

Plain of Jars (where some maps mention its headwaters as Nam Ngiou and Nam Ko). It first flows for about 20 km with a low gradient then descends through a very fast stretch for about 50 km (where it is also named Nam Chiap on maps). It then reaches an area of smoother landscape for about 20 km around Ban Naxong and Ban Thaviang and then enters 70 km of gorges and rapids before continuing onto the plain, about 50 km before its confluence with the Mekong. The stretches in the gorges and most waterfalls are or will be flooded by dams.

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ISSN 2345-7600 (electronic) | ISSN 0217-2445 (print)

Fig. 2. *Schistura palma*, new species, MHNG 2790.080, holotype, 63.5 mm SL; Laos: Saysomboune Province: Nam Ngiep watershed.

Very little has been published on the fishes of the Nam Ngiep, except en-passant mention of some species of the Plain of Jars and the description of *S. crabro* from an unspecified locality (Kottelat, 2000, 2001). There is possibly information in some environmental assessments, but these have not been made available. Surveys of the fishes of the middle Nam Ngiep were conducted in 2013 and 2018 in connection with the construction of the Nam Ngiep 1 hydropower scheme (which has now led to the flooding of the whole of the lower gorges and rapids). Fifty-six species were observed in a stretch corresponding to the upper 50 km of the high gradient stretch. At the time of the survey, eight species were new or probably new to science. Three species of *Schistura* have already been described (Kottelat, 2017g). An additional species is described here.

MATERIAL AND 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. Basicaudal pattern refers to the pattern of black marks and the surrounding white or coloured patches at the posterior extremity of the caudal peduncle. Toponymy is as obtained in the field and on the 1:100,000 topographic maps (Service Géographique d'État, 1985: sheets E 48–15, 27, 28, 39, 40, 51, 52); names or spellings differing from those on the map are provided in square brackets, except for Nam Ngiep (Nam Gniap on map). Abbreviations used: CMK, collection of the author; MHNG, Muséum d'Histoire

Fig. 3. *Schistura palma*, new species, CMK 27661, paratype, 62.7 mm SL; Laos: Saysomboune Province: Nam Ngiep watershed.

naturelle, Genève; ZRC, Lee Kong Chian Natural History Museum, Singapore.

Schistura palma, new species
(Figs. 2–5)

Holotype. MHNG 2790.080, 63.5 mm SL (Fig. 2); Laos: Saysomboune Province: Thathom: Nam Ngiep watershed: Nam Long (tributary of Nam Chae), about 150 m upstream of confluence with Nam Chae; 353 masl; 19°02′07″N 103°30′00″E; M. Kottelat et al., 15 March 2018.

Paratypes. All from Laos, Mekong drainage, Nam Ngiep watershed. CMK 27661, 4, 54.4–74.8 mm SL; same data as holotype. — CMK 24294, 109, 30.4–67.4 mm SL; ZRC 64460, 10, 42.5–63.1 mm SL; Xiangkhouang Province: Thathom: Nam Ngiep, rapids about 8.2 km downstream of Ban Pou; 305 masl; 18°59′21″N 103°29′42″E; M. Kottelat et al., 29 January 2014. — CMK 24341, 2, 53.7–77.5 mm SL; Saysomboune Province: Khon: Nam Pouan [Nam Phouan], upstream of Ban Soppouan, about 300 m upstream of confluence with Nam Ngiep; 244 masl; 18°46′57″N 103°25′58″E; M. Kottelat et al., 31 January 2014. — CMK 27589, 3, 63.7–75.2 mm SL; Saysomboune Province: Thathom: Nam Siam, about 2 km upstream point of arrival of effluents of Nam Ao dam breakage; 492 masl; 19°07′41″N 103°15′53″E; M. Kottelat et al., 13 March 2018.

Additional material (not types). All from Laos, Mekong drainage, Nam Ngiep watershed. CMK 24328, 2, 38.3–39.2 mm SL; Saysomboune Province: Houay San, immediately upstream of confluence with Nam Ngiep, about 23 km downstream of Ban Pou, 18 km upstream of Ban Soppouan; 286 masl; 18°53′11″N 103°28′07″E; M. Kottelat et al., 30 January 2014. — CMK 24373, 11, 39.1–61.7 mm SL; Saysomboune Province: Khon: Nam Ngiep at Keng Wong Kou [rapids], about 2 km upstream of Ban Sopyouak [at ferry of road to Ban Bo]; 233 masl.; 18°43′35″N 103°25′29″E; M. Kottelat et al., 1 February 2014. — CMK 24402, 24, 45.4–69.1 mm SL; Saysomboune Province: Khon: Nam Youak [Nam Gnok] at Ban Sopyouak, about 200 m upstream of confluence with Nam Ngiep; 236 masl; 18°42′57″N 103°25′55″E; M. Kottelat et al., 2 February 2014. — CMK 24495, 11, 53.1–73.9 mm SL; Xiangkhouang Province: Thathom: Nam Ngiep north of Ban Naxong; 337 masl; 19°03′24″N 103°22′06″E; M. Kottelat et al., 17 February 2014. — CMK 27485, 1, 55.8 mm SL; Saysomboune Province: Thatom: Nam Khai at confluence with Nam Ngiep; 282 masl; 18°53′49″N 103°28′22″E; M. Kottelat et al., 10 March 2018.

Diagnosis. *Schistura palma* is characterised among other named species of *Schistura* sensu lato in Indochina by the presence of a dorsal keel along the entire length of the caudal peduncle in small individuals, that develops into a conspicuous crest in large ones. A low keel or crest exists in some other species of the genus, but in these it is restricted to the posterior part of the caudal peduncle. Among Southeast Asian species, such a crest extending along the entire length of the caudal peduncle is known in *S. porthos*

Fig. 4. *Schistura palma*, new species, CMK 27661, paratype, 57.4 mm SL; Laos: Saysomboune Province: Nam Ngiep watershed. Preserved (a) and immediately after fixation (b).

(Figs. 6, 7) from the Mekong drainage in northern Laos and Xishuangbanna in China, and in *S. alticrista* (Fig. 8) from the Salween drainage in Thailand.

Schistura palma is distinguished from *S. porthos* in having fewer bars on the body (7–10 [commonly 8–9], vs. 9–17); the pelvic-fin origin below the base of branched dorsal-fin rays 1–2 (vs. 3); a smaller pre-anal length (74.7–77.8% SL, vs. 77.3–80.2); the basicaudal pattern made of a conspicuous black bar, reaching dorsal and ventral mid-lines, axial stripe wider and blackish at posterior extremity (between last bar on body and black bar at base of caudal fin), appearing as a superimposed blotch (vs. posterior extremity of axial stripe usually not conspicuously darker); cheeks plain brown (vs. mottled); juveniles with bars in same number and position as in adults, bars wider and with wider interspaces (cannot be quantified), mostly regularly set and without greyish patches between bars (Fig. 9) (vs. bars with narrower interspaces, irregularly set, several appearing fainter, or with greyish patches between bars, or paired; Fig. 7).

Schistura palma is distinguished from *S. alticrista* in having uniformly dark bars (vs. bars paler in the middle); a more slender caudal peduncle (length 16.0–18.4% SL, vs. 13.9–15.4; depth 1.0–1.4 times in its length, vs. 0.8–1.1); the basicaudal pattern made of a conspicuous black bar, reaching dorsal and ventral mid-lines, axial stripe wider and blackish at posterior extremity (between last bar on body and black

Table 1. Morphometric data of type material of *Schistura palma*, new species (holotype, paratypes CMK 24294, 27589, 24341, 27661, n=13). Range and mean include holotype values.

	Holotype	Range	Mean
Standard length (mm)	63.5	53.7–77.5	
Total length (mm)	75.9	65.3–92.1	
In percent of standard length			
Total length	119.6	117.3–124.0	120.5
Head length (dorsal)	22.9	20.4–24.5	22.4
Head length (lateral)	24.9	22.6–27.0	25.1
Predorsal length	51.7	50.1–53.1	51.6
Prepelvic length	51.4	49.2–52.7	51.2
Pre-anus length	69.3	68.9–71.8	70.4
Pre-anal length	75.0	74.7–77.8	76.3
Head depth	14.6	12.6–14.9	14.0
Body depth at dorsal-fin origin	18.8	17.1–19.6	18.0
Depth of caudal peduncle	13.9	13.0–15.1	13.7
Length of caudal peduncle	16.7	16.0–18.4	16.9
Head width	17.2	15.2–21.2	18.0
Body width at dorsal-fin origin	13.7	11.9–15.7	13.7
Snout length	10.3	9.4–11.5	10.5
Eye diameter	4.3	3.6–4.7	4.2
Interorbital width	6.5	4.9–7.1	6.1
Length of dorsal fin	14.1	13.3–16.6	14.8
Length of upper caudal-fin lobe	19.8	18.0–22.6	20.2
Length of median caudal-fin rays	15.7	14.4–17.0	15.5
Length of lower caudal-fin lobe	20.4	19.0–23.2	20.8
Length of anal fin	16.6	16.6–18.5	17.5
Length of pelvic fin	16.3	14.7–20.1	17.3
Length of pectoral fin	19.4	18.1–21.6	19.3
In percent of dorsal head length			
Snout length	45	43–54	47
Eye diameter	19	16–21	19
Interorbital width	29	23–30	27
In percent of lateral head length			
Snout length	42	38–45	42
Eye diameter	17	14–19	17
Interorbital width	26	19–29	25

basal caudal bar), appearing as a superimposed blotch (vs. bar complete; inner axial stripe thin, not ending in a dark blotch superimposed on bar); fewer branched dorsal-fin rays (8½, vs. 9½); the pelvic-fin origin below the base of branched dorsal-fin rays 1–2 (vs. 2–3); a smaller prepelvic length (49.2–52.7% SL, vs. 51.3–55.1) and pre-anus length (68.9–71.8, vs. 74.0–77.3); a greater distance between anus and anal-fin origin (about 1 to 1¾ eye diameter, vs. ½ to 1); at about equal SL, the dorsal crest of the caudal peduncle less elevated (compare Figs. 2–5, 8); the lips smooth or with short shallow wrinkles, their free edge entire (vs. both lips with densely set furrows, edge crenulated; Fig. 10), and, in large individuals, the cheeks conspicuously swollen (vs. cheeks not swollen).

Description. See Figs. 2–5 for general appearance and Table 1 for morphometric data of holotype and 12 paratypes (53.7–77.5 mm SL). A moderately elongate nemacheilid with body depth gradually increasing up to slightly in front of dorsal-fin origin. Behind dorsal fin, body depth almost uniform until caudal-fin base. Dorsal profile continuous between head and trunk. Head depressed, increasingly more depressed with increasing size (Fig. 11); body compressed anteriorly to very compressed posteriorly. Interorbital area convex. In lateral view, eye flush with dorsal profile of head. Cheeks slightly swollen in most specimens, swollen to very swollen in some of the large specimens (sex undetermined). Snout rounded in dorsal and lateral view. Depth of caudal peduncle 1.0–1.4 times in its length, depth uniform. Depth of caudal peduncle about 1.1–1.4 times in body depth. Caudal peduncle with a low but distinct keel along its entire length in specimens including juveniles, with a marked concavity immediately in front of caudal-fin base, gradually becoming a conspicuous fleshy crest (Fig. 12). Low fleshy ventral crest

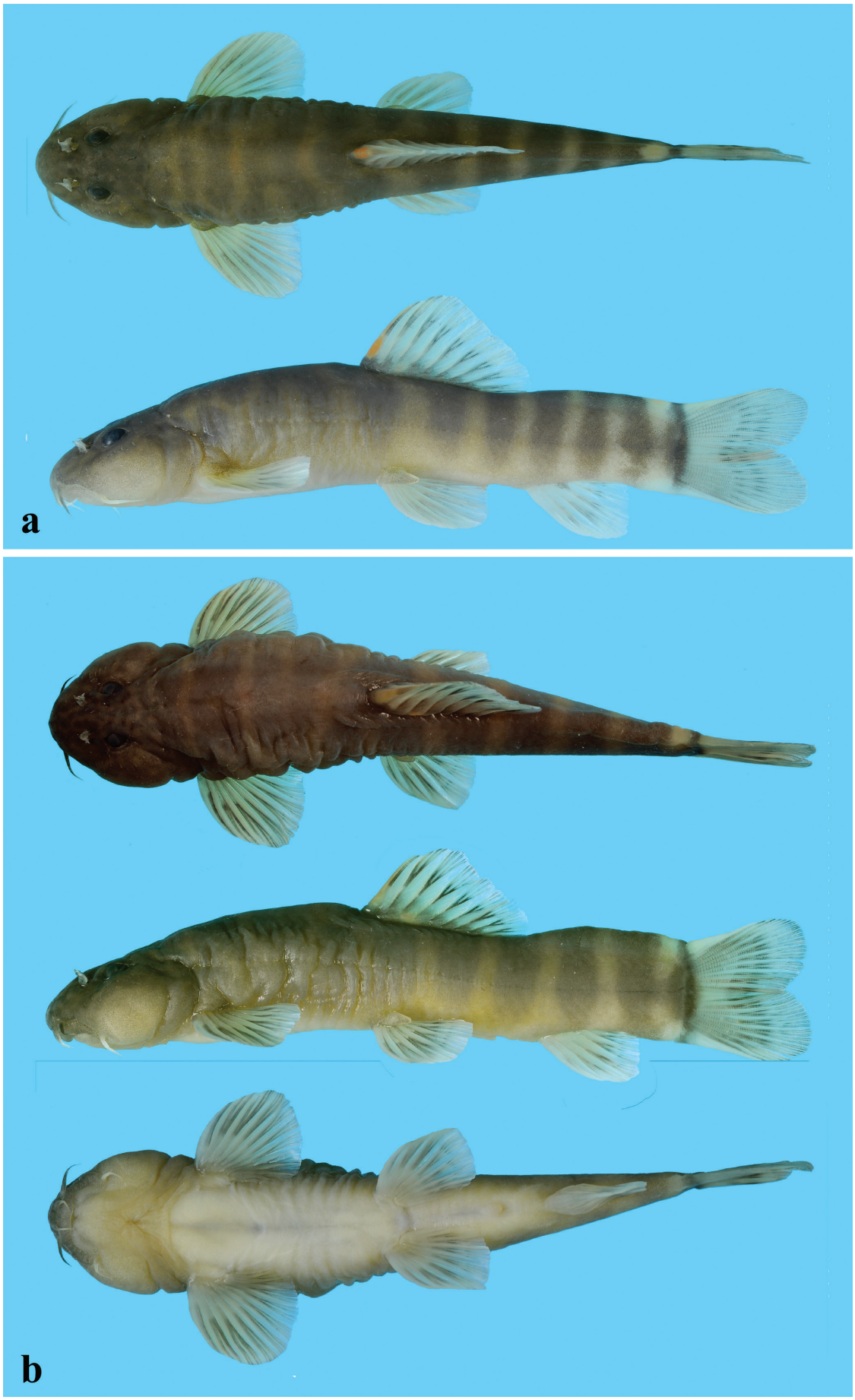

Fig. 5. *Schistura palma*, new species. **a**, CMK 24294, paratype, 64.6 mm SL; Laos: Xiangkhouang Province: Nam Ngiep watershed; **b**, CMK 24341, paratype, 77.5 mm SL; Laos: Saysomboune Province: Nam Ngiep watershed. Specimens with greatly developed crest on caudal peduncle and swollen cheeks.

Fig. 6. *Schistura porthos*, Laos: Mekong drainage; **a**, CMK 14096, 79.7 mm SL; Nam Ou watershed; **b**, CMK 14282, 78.7 mm SL; Nam Tha watershed.

on posterior half of caudal peduncle. In large specimens, in lateral view, caudal peduncle appearing as if twisted downward because of respective shapes of dorsal and ventral crests. Largest recorded size 77.5 mm SL.

Dorsal fin with 4 unbranched and 8½ branched rays; distal margin rounded anteriorly, then straight; second branched ray longest. Pectoral fin with 1 unbranched and 11 (5), 12 * (8) branched rays (including small last ray, usually unbranched), rounded, reaching ½–⅔ of distance to pelvic-fin base; rays without filamentous extensions; no axillary lobe. Pelvic fin with 1 unbranched and 7 branched rays (including small last ray, usually unbranched); reaching to anus; triangular to rounded; posterior margin convex; origin below base of branched dorsal-fin rays 1–2; axillary lobe present, entirely free. Anus about 1 to 1¾ eye diameter in front of anal fin, about at tip of pelvic fin. Anal fin with 3 unbranched and 5½ branched rays; distal margin straight; 2nd branched ray longest. Caudal fin with 9+8 branched rays, and one principal unbranched ray at each extremity; procurrent rays could not be counted; deeply emarginate to forked; lobes rounded, with upper lobe slightly longer than lower, about 1.1–1.4 times longer than median rays.

Body covered by scales behind about half of predorsal area, except belly in front of pelvic fins; embedded in skin. In large specimens, scales becoming deeply embedded and no longer visible as distinct structures. With increasing size, conspicuous adipose folds developing on anterior half of body, simultaneously with development of dorsal crest and widening of head. Lateral line complete, with about 80–95 pores (difficult or impossible to count in largest specimens, embedded or between skin folds). Cephalic lateral line system with 6 supraorbital, 4 + 11–13 infraorbital, 9 preoperculo-mandibular, and 3 supratemporal pores.

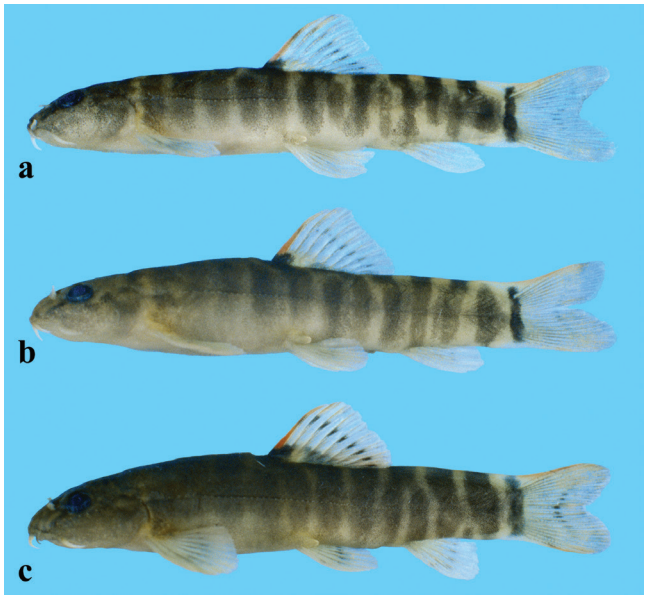

Fig. 7. *Schistura porthos*, CMK 14096, 26.0, 27.0, and 34.6 mm SL; Laos: Mekong drainage; Nam Ou watershed.

Fig. 8. *Schistura alticrista*, CMK 14730, 46.1 mm SL; Thailand: Salween drainage: Mae Hong Son.

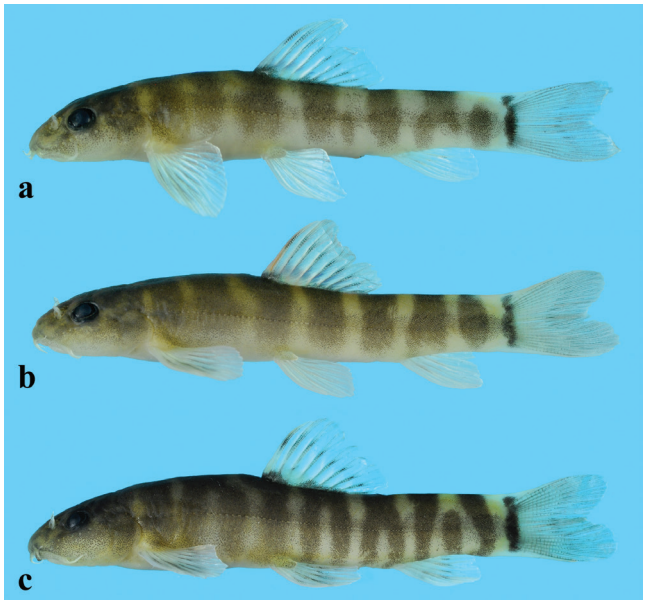

Fig. 9. *Schistura palma*, new species, CMK 24294, paratypes; Laos: Xiangkhouang Province: Nam Ngiep watershed; **a**, 30.4 mm SL; **b**, 34.5 mm SL; **c**, 39.1 mm SL.

Anterior nare pierced in front side of a pointed flap-like tube. Posterior nare adjacent to and same size as anterior one. Mouth arched, gape 2–3 times wider than long (Fig. 10a). Lips thick. Upper lip without median notch (or only very shallow notch), smooth or with short shallow wrinkles, free edge entire. Processus dentiformis present. Lower lip with narrow median interruption; median part with wrinkles, lateral part smooth or with shallow wrinkles. Anterior tip of lower jaw not exposed. A shallow median concavity in lower jaw. Inner rostral barbel reaching at most corner of mouth; outer one reaching vertical of space between nares and anterior margin of eye. Maxillary barbel reaching vertical of posterior margin of eye. Intestine with a loop behind stomach (Fig. 13). Air bladder without visible posterior chamber in abdominal cavity.

Sexual dimorphism. None observed. No specimen with suborbital flap, groove, or slit. No modified pectoral rays, no tubercles, no patches of unculi. Ripe females deeper bodied.

Colouration. After one month in formalin. Body background colour yellowish to grey, throat, belly, lower part of caudal

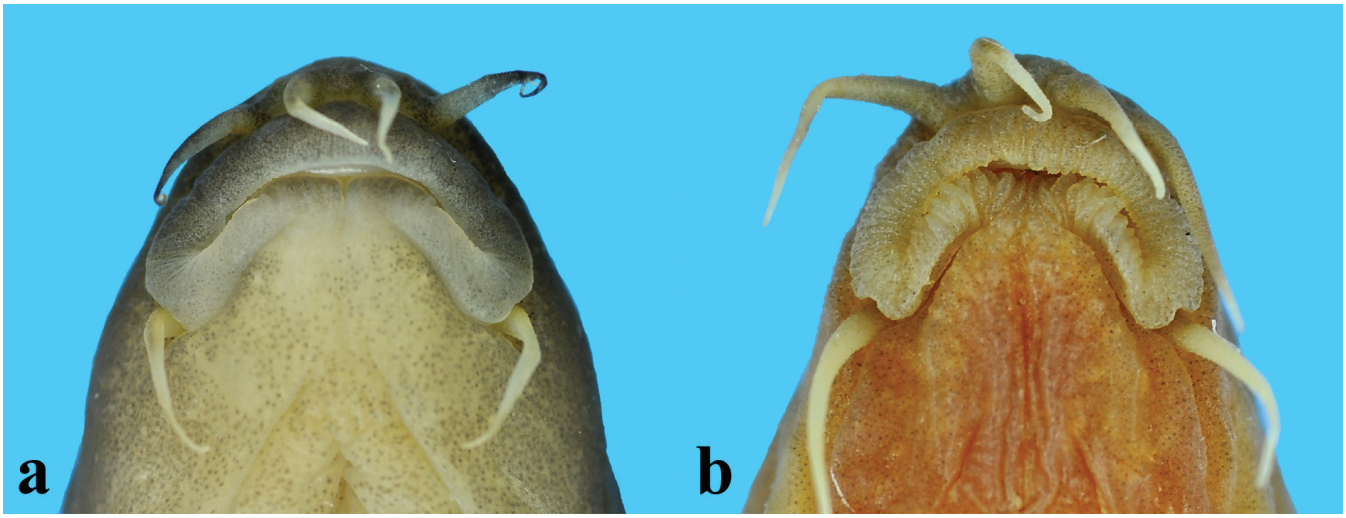

Fig. 10. Mouth of: **a**, *Schistura palma*, new species, MHNG 2790.080, holotype, 63.5 mm SL; **b**, *S. alticrista*, CMK 14730, 46.1 mm SL.

Fig. 11. *Schistura palma*, new species, CMK 24341, paratype, 77.5 mm SL; head in dorsal and ventral view.

Fig. 12. *Schistura palma*, new species, CMK 24294, paratype, 64.6 mm SL; caudal peduncle with developed dorsal and ventral crests.

peduncle paler. Except otherwise stated, markings dark brown to blackish. Head plain dark brown, except throat; a few specimens with mottled head. Body with 7–10 bars (usually 8 or 9), 2–3 predorsal, 1–3 subdorsal, 3–5 postdorsal, extending from dorsal mid-line and reaching downwards to level of pectoral fin anteriorly, to ventral midline from anal-fin origin backwards; bars continuous over back with contralaterals, of regular width and shape, wider than interspaces; some bars on caudal peduncle connected at upper extremity or appearing vertically divided in their lower part. Bars in front of dorsal-fin origin indistinct in largest specimens, appearing as a single dark brown patch. Inner dark axial stripe present, not very contrasted except at posterior extremity.

Pattern at caudal-fin base: A conspicuous black bar, usually reaching dorsal and ventral mid-lines, ending at both extremities by thin forward and backward projections. Inner axial stripe wider and blackish at posterior extremity (between last bar on body and black basal caudal bar), appearing as a superimposed blotch.

Dorsal fin hyaline, unbranched rays red, with a small black spot at base of simple rays and branched rays 1–2, and an elongated blotch at base on branched rays 3–8, a pale orange spot between them; middle part of last unbranched ray black; a longitudinal row of elongated marks on rays near first branching point (not on membranes), increasingly extensive and darker with increasing size. Caudal fin hyaline, with 1–2 rows of elongated black marks on rays near branching points (not on membranes), increasingly extensive and darker with increasing size. Anal and pelvic fins hyaline with a row of

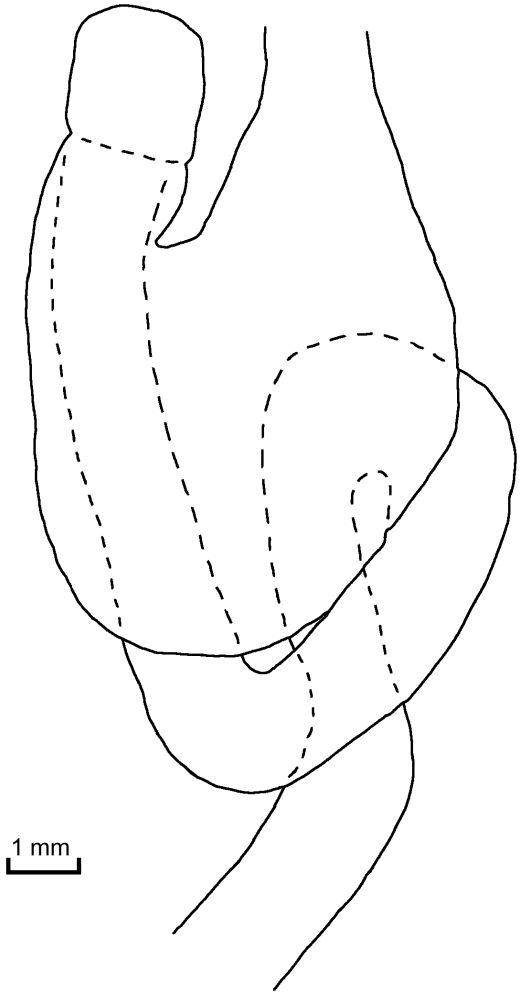

Fig. 13. *Schistura palma*, new species, CMK 24294, 53.2 mm SL; digestive tract.

elongated black marks on rays near first branching point (not on membranes), increasingly extensive and darker with increasing size. Pectoral fin with pigments along distal ⅔ of all rays, more densely set and more extensive with increasing size and along posterior edge.

Juveniles (Fig. 9): Smallest available specimen 30.4 mm SL. Body pale grey to yellowish, with darker grey to brown bars in number and position as in adults. Black bar at caudal-fin base complete.

In life (Fig. 4a): As preserved specimen, body background more intensely yellowish. Fins yellow, with orange-red unbranched rays in dorsal and anal fins and upper and lower unbranched caudal-fin rays.

Notes on biology. Out of eight dissected specimens, three were females (CMK 24294, 54.7–58.7 mm SL) collected in January and had ripe ovaries with eggs 1.3–1.6 mm in diameter (the number of eggs is relatively small compared to most other species of *Schistura* this size, in which the eggs are mostly about 0.9–1.2 mm in diameter, pers. obs.). The stomachs were full of unidentifiable material. The large individuals with swollen cheeks had no eggs and their sex could not be determined.

Fig. 14. Laos: Saysomboune Province: Nam Ngiep watershed. **a**, Nam Long, 353 masl; 15 March 2018; type locality; **b**, Nam Siam, 492 masl; 13 March 2018. Locality of specimens CMK 27589.

Schistura palma has been observed mainly in Nam Ngiep main river and the lowest part of its largest tributaries (Fig. 14b) and occasionally in fast moving stretches of smaller tributaries (Fig. 14a). It was present from about 30 to 100 cm depth (the deepest that could be sampled) in fast flowing water among stones.

Distribution. *Schistura palma* is apparently endemic to the Nam Ngiep drainage (Fig. 1). It has not been observed by surveys in similar habitats in the adjacent drainages (Nam Kading, Nam Xan, Nam Mang, Nam Ngum).

Etymology. From the Latin *palma*, the blade of an oar, an allusion to the shape of the caudal peduncle and caudal fin in large adults. A noun in apposition.

Remarks. A complete dorsal crest (from the base of the last dorsal-fin ray to the base of the caudal fin) is present on the caudal peduncle in several genera of Nemacheilidae (e.g., *Paracobitis*, *Sphaerophysa*, *Homatula*), but in Southeast Asia it is known only in *Schistura palma*, new species, *S. alticrista*, and *S. porthos*. Some other species of *Schistura* in Southeast Asia have a low crest but in these it is restricted to the posterior extremity of the caudal peduncle (e.g., *S. bucculenta*, *S. ephelis*, *S. macrocephalus*).

Material used for comparison. Most morphometric data are from Kottelat (1990, 1998, 2000). In addition, the following material was available for comparison of non-morphometric characters: *Schistura alticrista*: CMK 14730, 3; *S. atra*: CMK 12629, 1 paratype; *S. cataracta*: CMK 12244, 58 paratypes; CMK 19126, 72; *S. coruscans*: CMK 24291, 21; CMK 24523, 97; *S. crabro*: CMK 24534, 2; CMK 24559, 2; *S. defectiva*: CMK 24327, 251; *S. dorsizona*: CMK 21522, 8; CMK 24616, 109; *S. kongphengi*: CMK 12771, 31 paratypes; CMK 16034, 102; CMK 19107, 12; *S. leukensis*: CMK 13315, 90 paratypes; *S. nicholsi*: CMK 5029, 15; CMK 15039, 41; CMK 24680, 134; *S. nudidorsum*: CMK 12677, 14; *S. obeini*: CMK 12672, 18 paratypes; CMK 12501, 35; CMK 22875, 14; *S. personata*: CMK 13354, 12 paratypes; CMK 22705, 30; *S. porthos*: CMK 14096, 20; CMK 14282, 132 paratypes; *S. punctifasciata*: CMK 12393, 72 paratypes; CMK 12485, 24 paratypes; *S. quaesita*: CMK 22699, 42; CMK 22706, 14; CMK 22749, 40; *S. quasimodo*: CMK 13352, 37 paratypes; CMK 23578, 1; CMK 23805, 2; *S. sigillata*: CMK 13353, 23 paratypes; CMK 23806, 3; CMK 23822, 1; *S. somboonii*: CMK 12684, 72 paratypes; CMK 15241, 27; *S. tenura*: CMK 13324, 25 paratypes; CMK 13329, 22; *S. tubulinaris*: CMK 14354, 5 paratypes; CMK 22936, 8 paratypes.

ACKNOWLEDGEMENTS

The new species was obtained during surveys conducted in 2014 and 2018 for NNP1PC (Nam Ngiep 1 Power Company, Vientiane). I thank Thavone Phommavong (Living Aquatic Resources Research Center, Vientiane) for his great help in the field during the two surveys. In 2014 I benefitted from assistance in the field by Souksavanh Thepvongsa (NNP1PC), Adam Greenhalgh (ERM Environmental Resources Management, Brisbane) and Chanthone Viengsombut (Division of Fisheries, Vientiane). For the 2018 survey, I thank Natkritta Wongyai (NNP1PC) for her help in all aspects of logistics, communication and sampling. The 2018 survey was organised by Troy Hansel. Vendula Šlechtová and Jörg Bohlen (Institute of Animal Physiology and Genetics, Liběchov) shared unpublished information on molecular analyses. The manuscript benefitted from comments by two anonymous reviewers.

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