

The Morphological Study of the Stone Loach, *Schistura* cf. *nicholsi* (Cypriniformes: Nemacheilidae) from Salad Dai Waterfall, Nakhon Nayok Province

Salawin Thepsupornkul¹ and Salinee Khachonpisitsak²

¹ SCiUS, Piboonbumpen Demonstration School, Burapha University, 169 Long-Hard Bangsaen Road, Saensook, Mueang, Chon Buri, 20131 Thailand

² Department of Biology, Faculty of Science, Burapha university, 169 Long-Hard Bangsaen Road, Saensook, Mueang District, Chon Buri, 20131 Thailand

Article History

Received: 17 February 2024

Accepted: 26 June 2024

Published Online: 8 August 2024

Corresponding author

Salinee Khachonpisitsak

E-mail: salineek@buu.ac.th

Editor

Dr. Weeyawat Jaitrong

E-mail: polyrhachis@yahoo.com/

weeyawat@nsm.or.th

Abstract

Morphological characters of the stone loach, *Schistura* cf. *nicholsi*, were studied. Twenty-eight specimens of the stone loach fish were collected by scoop nets from Salad Dai Waterfall, Nakhon Nayok Province, Bangpakong River Basin, Thailand. Some morphological characteristics, for instance a black spot at the base of the dorsal fin, the lateral line complete, lips thick, and the lower lip with a median sulcus were observed, measured, and then compared with morphological characteristics of *Schistura nicholsi* (Smith, 1933), a closely related species. The results show that the specimens collected from Salad Dai Waterfall agreed well with *Schistura nicholsi* but only a few variations have been found. The characteristic to distinguish *S. nicholsi* from other species in the genus is the presence of the median incision on the upper lip. This character was found in all specimens examined. However, the character was not documented in the original description of *S. nicholsi*. For the moment, we roughly identify these specimens as *S. nicholsi*. Moreover, this stone loach fish is recorded for the first time in the Bangpakong River Basin.

Keywords

Salad Dai Waterfall, morphology, Nemacheilidae, *Schistura* cf. *nicholsi*, Bangpakong Basin

Introduction

Stone loach is the common name of fishes in the genus *Schistura* McClelland, 1838 belonging to the family Nemacheilidae in order Cypriniformes. They are benthic fishes that live in running water (Suvannaraksha, 2012). Nemacheilines are distributed in Eurasia, and many species live in hill streams, especially in Thailand, other Southeast Asian countries, India, and China. There are ten genera in Thailand (out of 43 genera worldwide): *Acanthocobitis* Peters, 1861; *Mustura* Kottelat, 2018; *Nemacheilus* Bleeker, 1863; *Neonoemacheilus* Zhu & Guo,

1985; *Physoschistura* Bănărescu & Nalbant, 1982; *Pteronemacheilus* Bohlen & Šlechtová, 2011; *Schistura* McClelland, 1838; *Sectoria* Kottelat, 1990; *Tuberoschistura* Kottelat, 1990 and *Yunnanilus* Nichols, 1925 (Fricke *et al.*, 2024; Kottelat, 2018).

The genus *Schistura* (type species: *Schistura rupecula* McClelland, 1838) characterized by an elongated body with almost uniform depth, mouth moderately arched, 2.0–3.5 times wider than long; lower lip with a median interruption, but not forming two lateral triangular pads, ranging from smooth to strongly furrowed; no free posterior chamber of the air-bladder; diverse color patterns, but usually dark with more or less regular bars; typically a black bar at the caudal fin base; dorsal fin with one or two black marks along its base; no acuminate scales on the caudal peduncle; presence or absence of a median notch in the lower jaw; caudal fin ranging from truncate to forked; and sexual dimorphism may be present or absent (Kottelat, 1990). There are 42 species found in Thailand viz., *S. alticrista* Kottelat, 1990; *S. aurantiaca* Plongsesthee, Page & Beamish, 2011; *S. balteata* (Rendahl, 1948); *S. breviceps* (Smith, 1945); *S. crocotula* Plongsesthee, Page & Beamish, 2011; *S. deansmarti* Vidthayanon & Kottelat, 2003; *S. desmotes* (Fowler, 1934); *S. dorsizona* Kottelat, 1998; *S. dubia* Kottelat, 1990; *S. geisleri* Kottelat, 1990; *S. hartli* Dvořák, Bohlen, Kottelat & Šlechtová, 2023; *S. jarutanini* Kottelat, 1990; *S. kengtungensis* (Fowler, 1936); *S. kohchangensis* (Smith, 1933); *S. kuehnei* Dvořák, Bohlen, Kottelat & Šlechtová, 2023; *S. laterimaculata* Kottelat, 1990; *S. mahnerti* Kottelat, 1990; *S. maejotigrina* (Suvarnaraksha, 2012); *S. magnifluis* Kottelat, 1990; *S. menanensis* (Smith, 1945); *S. moeiensis* Kottelat, 1990; *S. myrmekia* (Fowler, 1935); *Schistura nicholsi* (Smith, 1933); *S. oedipus* (Kottelat, 1988); *S. pantherina* Page, Plongsesthee & Randall, 2012; *S. paucicincta* Kottelat, 1990; *S. paucifasciata* (Hora, 1929); *S. peninsulæ* Dvořák, Bohlen, Kottelat & Šlechtová, 2023; *S. poculi* (Smith, 1945); *S. pridi* Vidthayanon, 2003; *S. reidi* (Smith, 1945); *S. robertsi* Kottelat, 1990; *S. schultzi* (Smith, 1945); *S. sexcauda* (Fowler, 1937); *S. similis* Kottelat, 1990; *S. sirindhornæ* Suvarnaraksha, 2015; *S. spiei* Vidthayanon & Kottelat, 2003; *S. spilota* (Fowler, 1934); *S. tenebrosa* Kangrang, Page & Beamish, 2012; *S. udomritthiruji* Bohlen & Šlechtová, 2010; *S. vinciguerræ* (Hora, 1935) and *S. waltoni* (Fowler, 1937) (Fricke *et al.*, 2024).

Schistura nicholsi was originally described as *Nemacheilus nicholsi* by Smith (1933) on the basis of a single specimen collected from a small mountain stream near Pak Chong District, Nakhon Ratchasima Province, Thailand. Subsequently, Kottelat (1990) placed *N. nicholsi* in the genus *Schistura* because of morphological differences between *Schistura* and *Nemacheilus*, e.g., lower lip usually with median interruption (vs. lower lip continuous along its anterior margin or with a slight incision but never with a median interruption in *Nemacheilus*); no acuminate scales on caudal peduncle (vs. acuminate scales on caudal peduncle); caudal fin from truncate to forked, usually emarginated (vs. caudal fin forked to deep forked); median notch in lower jaw present or not (vs. median notch in lower jaw absent).

Schistura nicholsi was previously reported only from the Mekong Basin (Nagao Natural Environment Foundation, 2021). Twenty-eight stone loaches, resembling *S. nicholsi*, were found during the survey of freshwater fishes at Salad Dai waterfall, Nakhon Nayok Province, the Bangpakong Basin in 2021. This study aimed to examine and compare external morphological characters between *Schistura* sp. collected from Salad Dai Waterfall with the holotype from Pak Chong District, Nakhon Ratchasima Province (based on the original description) and those *S. nicholsi* provided by Kottelat (1990).

Materials and methods

Terminology and measurements, expressed as percentages of standard length (SL) and head length (HL) and shown in Table 1, follow Kottelat (1990). Counts and measurements were made on the left side wherever possible, except for count of the pectoral-fin ray (count on both

sides). Measurements were made with digital calipers to the nearest 0.1 mm. The specimens examined in this study were from the Salawin Collection (SLWC), a private collection, deposited at Department of Aquatic Science, Faculty of Science, Burapha University.

Results

Schistura cf. nicholsi (Smith, 1933) (Figures 1A, 1B, 2B; Table 1)

Specimens examined. Twenty-eight specimens (39.0–60.0 mm SL), **THAILAND:** Bangpakong Basin, Nakhon Nayok, Ban Na, Salad Dai Waterfall, 1.VIII.2023 scoop nets, Salawin Thepsupornkul leg.

Measurements. SL, SLWC 0001, 60.0 mm; SL, SLWC 0002, 59.0 mm; SL, SLWC 0003, 43.0 mm; SL, SLWC 0004, 40.0 mm; SL, SLWC 0005, 40.0 mm; SL, SLWC 0006, 36.0 mm; SL, SLWC 0007 57.0 mm; SL, SLWC 0008, 50.0 mm; SL, SLWC 0009, 42.0 mm; SL, SLWC 0010, 43.0 mm; SL, SLWC 0011, 50.0 mm; SL, SLWC 0012, 40.0 mm; SL, SLWC 0013, 39.0 mm; SL, SLWC 0014, 39.0 mm; SL, SLWC 0015, 42.0 mm; SL, SLWC 0016, 45.0 mm; SL, SLWC 0017, 44.0 mm; SL, SLWC 0018, 46.0 mm; SL, SLWC 0019, 50.0 mm; SL, SLWC 0020, 43.0 mm; SL, SLWC 0021, 39.0 mm; SL, SLWC 0022, 43.0 mm; SL, SLWC 0023, 42.0 mm; SL, SLWC 0024, 49.0 mm; SL, SLWC 0025, 46.0 mm; SL, SLWC 0026, 40.0 mm; SL, SLWC 0027, 40.0 mm; SL, SLWC 0028, 47.0 mm.

Description. Selected meristics and morphometrics, including comparative data, expressed as percentages of, are presented in Table 1. Body moderately elongate, nearly cylindrical in anteriorly and slightly compressed in posteriorly; covered with small, embedded scales except belly in front of posterior margin of pectoral fin. Dorsal profile of body gently rising from snout tip to dorsal fin origin and slightly decreasing to caudal-fin base, origin of dorsal fin level with pelvic-fin insertion. Head slightly depressed. Eye small, rounded, positioned rather near to tip of snout. Two pairs of nasal openings, close together, located in front of eyes, anterior nostril with pointed flap-like tube, posterior nostril without rim. Mouth small, inferior, ventral to body axis, moderately arched, posterior margin not reach anterior margin of eye; lips thick, lower lip with a median notch, upper lip with a median incision; 3 pairs of slender barbels, rostral barbel shorter than maxillary barbel, inner rostral barbel not reaches or just reaches corner of mouth, outer rostral barbel reaches maxillary barbel, maxillary barbel extending beyond vertical through anterior margin of eye; lateral line complete, extending from behind of ocular to caudal-fin base. Dorsal-fin base short, fin origin anterior to pelvic-fin insertion. Anal-fin base short, reach or almost reach caudal-fin base, fin origin far behind posterior margin of dorsal-fin base. Pectoral-fin short, not reach pelvic-fin origin, its length equal to pelvic fin, fin origin level with vertical through posterior edge of opercle. Pelvic fin short, not reach anal-fin insertion. Caudal fin emarginate, lobes bluntly pointed, its length slightly greater than pectoral fin.

Color when fresh (Figure 1A): head and body yellow brown, ventral white to light brown; a large black stripe extending from the snout to the basis of caudal fin; 9–11 dark brown bars across the body, extending from dorsal to the lateral black stripe; a narrow dark brown band on caudal-fin base; one or two large black spots at the dorsal fin base, with a red spot at the center of each black spot. All fins are yellowish. Lower lip without black marks.

Color of preserved specimens (Figure 1B): head and body yellow brown, ventral yellowish, retaining the same color pattern as the live specimens, including a large black spot at the dorsal-fin base but a red spot at the center of each black spot faded to yellowish. All fins are pale yellowish. Lower lip without black marks.

Distribution. *Schistura cf. nicholsi* is only known from the Salad Dai waterfall, Ban-na District, Nakhon Nayok Province, central Thailand, which flows into Nakhon Nayok River, Bangpakong Basin.

Table 1. Morphometric data of *Schistura cf. nicholsi* (this study) and *Schistura nicholsi* based on Smith (1933) and Kottelat (1990).

Measurements	This study	Smith, 1933	Kottelat, 1990		
	Non-types n = 28	Holotype KUMF 0170	Non-types n=14		
Standard length (SL; mm)	36.0–0.0	50	19.3–67.0		
Head length (HL; mm)	8.0–15.0	-	-		
Counts	Modes	Modes	Modes		
Dorsal-fin rays	3–8	3–8	3,8	-	4–8
Anal-fin rays	3–6	3–6	2,5	-	3–5
Pectoral-fin rays	9–12	11	-	10–12	-
Pelvic-fin rays	6–8	8	-	-	8
Caudal-fin rays	10+9	10+9	-	-	9+8
Measurements (% of SL)	Means	Means	Means	Means	Means
Dorsal head length	20.0–33.3	26.3	-	19.7–22.5	21.2
Head length	20.0–30.8	25.5	-	23.2–25.7	24.4
Pre-dorsal-fin length	47.5–55.8	52.2	-	51.4–55.9	53.5
Pre-pelvic-fin length	48.0–53.8	51.3	-	49.9–54.9	52.2
Pre-anus length	68.3–81.0	77.4	-	65.3–71.2	68.3
Pre-anal-fin length	65.3–74.4	69.7	-	73.9–78.8	76.5
Head depth (at eye)	7.1–11.6	9.4	-	10.6–12.8	11.6
Head depth (at nape)	6.8–11.6	9.8	-	12.9–15.5	14
Body depth	7.5–14.3	11.7	-	16.8–20.9	18.8

Table 1. Morphometric data of *Schistura cf. nicholsi* (this study) and *Schistura nicholsi* based on Smith (1933) and Kottelat (1990). Continued

Measurements	This study		Smith, 1933	Kottelat, 1990	
	Non-types n = 28		Holotype KUMF 0170	Non-types n=14	
Caudal peduncle height	11.4–16.7	14.2	-	13.2–16.1	14.6
Caudal peduncle base length	6.8–14.0	9.4	-	13.3–15.3	14.3
Snout length	7.0–16.0	9.5	-	8.7–10.8	10
Head width (at nares)	10.0–16.7	12.1	-	10.8–13.6	11.8
Maximum head width	7.0–16.9	14.1	-	12.7–18.4	16.7
Body width (dorsal origin)	4.8–12.5	10.1	-	12.4–15.7	13.9
Body width (anal origin)	4.0–7.7	5.9	-	7.6–9.7	8.7
Eye diameter	3.3–5.6	4.5	-	3.2–5.6	3.9
Interorbital width	5.0–16.7	8.2	-	6.5–8.3	7.1
Dorsal-fin height	9.3–21.4	16.6	-	9.9–16.3	12.6
Anal-fin height	10.2–20.5	15.4	-	16.5–19.1	17.5
Pelvic-fin length	15.4–22.5	18.5	-	15.4–19.8	17.5
Pectoral fin length	15.4–23.9	20.9	-	18.0–23.8	19.5
Caudal-fin length	18.4–25.6	21.5	-	19.0–24.4	21
Measurements (% of HL)	Means	Means		Means	Means
Lateral head length	90.0– 115.7	97.7	-	104.0–107.0	115
Head depth (at eye)	23.1–50.0	36.4	-	47.0–72.0	55
Head depth (at nape)	23.1–72.7	37.9	-	57.0–72.0	66
Body depth	23.1–57.7	45.3	-	75.0–99.0	89
Caudal peduncle height	38.5–69.2	54.6	-	59.0–75.0	69

Table 1. Morphometric data of *Schistura cf. nicholsi* (this study) and *Schistura nicholsi* based on Smith (1933) and Kottelat (1990). Continued

Measurements	This study		Smith, 1933	Kottelat, 1990	
	Non-types		Holotype	Non-types	
	n = 28		KUMF 0170	n=14	
Caudal peduncle base length	23.1–46.2	35.8	-	61.0–77.0	68
Snout length	23.1–61.5	36.6	-	41.0–54.0	47
Head width (at nares)	30.8–63.6	46.7	-	49.0–67.0	55
Maximum head width	30.8–72.7	54.6	-	60.0–88.0	79
Body width (dorsal origin)	18.2–55.6	39.3	-	59.0–73.0	66
Body width (anal origin)	15.4–30.8	22.8	-	37.0–47.0	41
Eye diameter	13.3–25.0	17.5	-	15.0–25.0	18
Interorbital width	22.2–63.6	31.7	-	30.0–37.0	33
Dorsal-fin height	36.4–90.9	64.6	-	47.0–72.0	59
Anal-fin height	7.7–81.8	59.3	-	78.0–88.0	82
Pelvic-fin length	53.8–91.7	71.3	-	75.0–88.0	82
Pectoral-fin length	61.5– 100.0	80.5	-	85.0–106.0	92
Caudal-fin length	61.5– 111.1	83.5	-	90.0–109.0	99

Discussion

Schistura nicholsi is distinguished from others species in the genus *Schistura* as follow: it is distinguished from *S. oedipus*, *S. deansmarti* and *S. spiesi* by having dark brown bars on head and body (vs. discoloured); is distinguished from *S. jarutanini* by having bars in front of dorsal fin as wide or wider than those behind (vs. light background and bars in front of dorsal fin conspicuously thinner than those behind, usually united in pairs at their upper); is distinguished from *S. balteata* by having lateral black line and 8–10 dark brown bars on body (vs. 2–4 black vertical bars under dorsal fin); is distinguished from *S. geisleri* by having suborbital flap not hammer-shaped (vs. hammer-shaped suborbital); is distinguished from *S. poculi*, *S. vinciguerrae*, *S. mahnerti*, *S. udomritthiruji* by having bars in front of dorsal fin as wide or wider than those behind (vs. bars in front of dorsal fin conspicuously thinner



Figure 1. Fresh (A) and preserved (B, C) specimens. A, B: *Schistura cf. nicholsi* (SLWC 0001, 60.0 mm SL, this study); C: *Schistura nicholsi* (KUMF 0170, 50.0 mm SL, Holotype, photographed by Sudtawee Thepsuponkul).

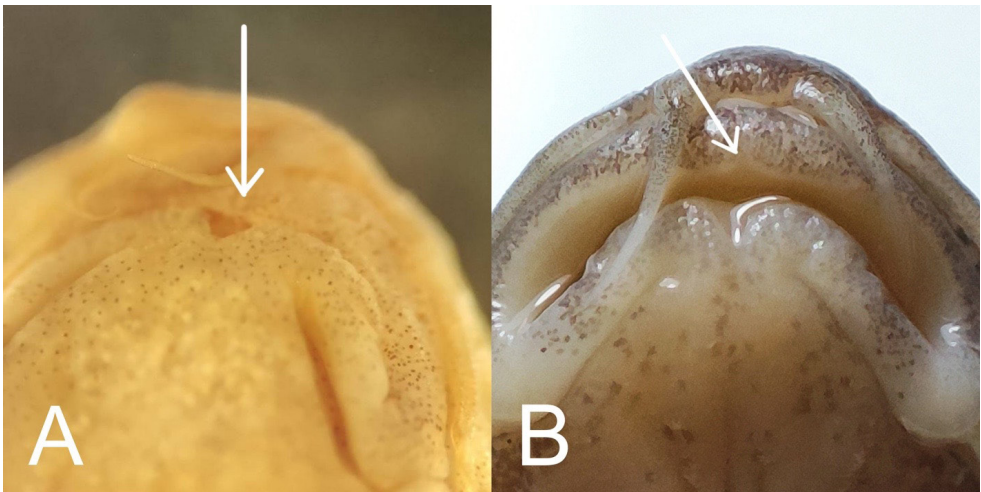


Figure 2. Ventral side of head; A: arrows indicated median incision on the upper lip absent in *Schistura nicholsi* (KUMF 0170, 50.0 mm SL, Holotype, photographed by Sudtawee Thepsuponkul), B: arrows indicated median incision on the upper lip present in *Schistura cf. nicholsi* (SLWC 0009, 42.0 mm SL, this study).

than those behind, usually united in pairs at their upper extremity); is distinguished from *S. desmotes* by having males without a suborbital flap, color pattern consisting 8–10 bars (vs. males with a suborbital flap, color pattern consisting 7–9 very regular bars); is distinguished from *S. kohchangensis* by having males without a suborbital flap (vs. males with a suborbital flap); is distinguished from *S. paucicincta* and *S. laterimaculata* by having lateral line complete or nearly complete (vs. lateral line incomplete, not reaching beyond pelvic fins); is distinguished from *S. paucifasciata*, *S. robertsi*, *S. aurantiaca*, *S. crocotula*, *S. peninsulae*, *S. hartli* and *S. kuehnei* by having lateral line complete or nearly complete, 8 pelvic rays (vs. lateral line incomplete, not reaching beyond pelvic fins, 6–7 pelvic rays); is distinguished from *S. alticrista* by having 8 dorsal rays, caudal peduncle without high adipose crest (vs. 9 dorsal rays, caudal peduncle with very high adipose crest); is distinguished from *S. dubia* by having black caudal basal bar complete with forward and backward projection at each extremities (vs. black basal caudal bar dissociated); is distinguished from *S. menanensis* by having a longitudinal dark stripe superposed over the bar pattern not obscuring it, its width under dorsal origin is more than 3 times in body depth, colour pattern usually over a light background (vs. a longitudinal dark stripe superposed over the bar pattern obscuring it, its width under dorsal origin is about 2.0–2.3 times in body depth, colour pattern usually over a dark background); is distinguished from *S. moeiensis* by having 8–10 bars, black basal caudal bar reaching dorsal and ventral midlines, with forwards and backwards directed triangular process at each extremity (vs. 10–13 bars, black basal caudal bar thin and not reaching dorsal and ventral midlines, without forwards and backwards directed triangular process at each extremity); is distinguished from *S. breviceps* by having axillary pelvic lobe present, head never with greatly inflated cheeks (vs. axillary pelvic lobe absent or rudimentary, head with greatly inflated cheeks); is distinguished from *S. magnifluis* and *S. spilota* by having posterior bars usually not dissociated into blotches (vs. posterior bars often dissociated into blotches along sides); is distinguished from *S. schultzi* by having 8–10 bars on body, eye diameter 3.2–5.6 %SL (vs. 13–18 bars on body, eye diameter 2.5–3.4% SL); is distinguished from *S. reidi* by having black basal caudal bar complete (vs. black basal caudal bar usually dissociated into a vertically elongate blotch at extremity of lateral line); is distinguished from *S. similis*, *S. sexcauda*, *S. waltoni* and *S. kengtungensis* by having black basal caudal bar reaching dorsal and ventral midlines backward directed triangular pads at each extremity (vs. black basal bar not reaching dorsal and ventral midline and without triangular continuation); is distinguished from *S. sirindhornae* by having black blotches between the eyes (vs. orange crown-shaped mark between the eyes); is distinguished from *S. maejotigrina* 8–10 black bars on side of body (vs. 21–25 dark brown tiger-shape bars on side of body); is distinguished from *S. pantherina* by having by having 8-10 black bars on body (vs. 11–16 black spots along mid-side of body); is distinguished from *S. tenebrosa* by having 8-10 black bars on side of body (vs. uniform dusky brown color pattern without marks on dorsum or side of body); is distinguished from *S. pridii* by having 8–10 black bars on light background (vs. body with 4 bars on a bright yellow background); is distinguished from *S. myrmekia* by having dorsal

rays 4/8, anal rays 3/5, caudal rays 9 + 8, pectoral rays 10–12, pelvic rays 8 (vs. dorsal rays 4/8, anal rays 3/5, caudal rays 9 + 8, pectoral rays 11, pelvic rays 8); is distinguished from *S. dorsizona* by having 8–10 black bars on light background (vs. black saddles and/or mid-lateral stripe on a beige background (whitish ventrally)) (Smith, 1933; Kottelat, 1990; Phongsesthee *et al.*, 2021; Kangrang *et al.*, 2012; Page *et al.*, 2012; Singer and Page, 2012; Suvarnaraksha, 2012; Suvarnaraksha, 2015; Kottelat, 2017; Nagao Natural Environment Foundation, 2021; Panitvong, 2022; Dvořák *et al.*, 2023).

Although, the specimens examined in this study showing median incision on the upper lip (Figure 2B) and a horizontally black stripe at the middle of body, running from the tip of snout to caudal fin base [vs. lack of median incision on the upper lip (Figure 2A) and lack of a horizontally black stripe at the middle of body (Smith, 1933 and Kottelat, 1990)]. The present specimens closely resemble *S. nicholsi* by having a complete lateral line; 3/8 dorsal-fin rays; 3/8 anal-fin rays; 9–12 (usually 11) pectoral-fin rays; 9–11 dark brown bars on body, extending from dorsal to the lateral black stripe; a narrow dark brown band on caudal-fin base; a large black spots at the dorsal fin base, with a red spot at the center of each black spot. We assigned the specimens in this study as *S. cf. nicholsi* and more morphological and genetic studies are needed for further study.

Acknowledgements

This project was financially supported by Science Classroom in University-Affiliated School Project (SCiUS), Piboonbumpen Demonstration School, Burapha University. We are eternally grateful to Domes Limpivadhana (Kasetsart University Museum of Fisheries, Bangkok) for loans of specimens. We are thankful to Sudtawee Thepsupornkul, Warunyupa Thepsupornkul and Kritcharat Nammongkhol for your encouragement and facilitation.

References

- Dvořák, T., J. Bohlen, M. Kottelat and V. Šlechtová. 2023. Revision of the *Schistura cincticauda* species group (Teleostei, Nemacheilidae) using molecular and morphological markers. **Scientific Reports** 13(1): 16996.
- Fricke, R., W.N. Eschmeyer and R. Van der Laan. 2024. **Eschmeyer's catalog of fishes: genera, species, references**. Downloaded from <http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp>. on 22 April 2024.
- Kangrang, P., L.M. Page and F.W.H. Beamish. 2012. *Schistura tenebrosa*, a new species of loach from the Kwai Noi River system, Mae Khlong basin, Thailand (Teleostei: Nemacheilidae). **Zootaxa** 3586(1): 69–77.
- Kottelat, M. 1990. **Indochinese nemacheilines: a revision of nemacheiline loaches (Pisces: Cypriniformes) of Thailand, Burma, Laos, Cambodia, and southern Viet Nam**. Verlag Dr. Friedrich Pfeil, München, Germany. 262 pp.
- Kottelat, M. 2017. Three new species of loaches of the genus *Schistura* from the Nam Ngiep drainage, central Laos (Teleostei: Nemacheilidae). **Raffles Bulletin of Zoology** 65: 691–706.
- Kottelat, M. 2018. *Mustura celata*, a new genus and species of loaches from northern Myanmar, and an

- overview of *Physoschistura* and related taxa (Teleostei: Nemacheilidae). **Ichthyological Exploration of Freshwaters** 28(4): 1–26.
- Nagao Natural Environment Foundation. 2021. **Fishes of the Indochinese Mekong**. Nagao Natural Environment Foundation. 545 pp.
- Page, L.M., R. Plongsesthee, F.W.H. Beamish, P. Kangrang, Z.S. Randall, R.A. Singer and Z.P. Martin. 2012. *Schistura* (Teleostei: Nemacheilidae) in the Mae Khlong basin in southwestern Thailand with description of a new species. **Zootaxa** 3586(1): 319–328.
- Panitvong. 2022. **Freshwater Fishes of Thailand 2nd Edition**. Siamensis Press. 817 pp.
- Plongsesthee, R., L.M. Page and W. Beamish. 2011. *Schistura aurantiaca*, a new species from the Mae Khlong basin, Thailand (Teleostei: Nemacheilidae). **Ichthyological Exploration of Freshwaters** 22(2): 169.
- Singer, R.A. and L.M. Page. 2012. Redescription of *Schistura myrmekia* (Fowler, 1935) (Teleostei: Nemacheilidae). **Zootaxa** 3586(1): 347–352.
- Smith, H.M. 1933. Contributions to the ichthyology of Siam. IX-XIX. **Journal of the Siam Society, Natural History Supplement** 9(3): 287–325.
- Smith, H.M. 1945. **The fresh-water fishes of Siam, or Thailand**. Bulletin of the United States National Museum. i–xi, 1–622, 107 figs, 9 pls.
- Suvarnaraksha, A. 2012. *Schistura maejotigrina*, a new stream loach (Pisces: Nemacheilidae) from northern Thailand. **Zootaxa** 3586: 131–137.
- Suvarnaraksha, A. 2015. A new species of highland loach, *Schistura sirindhornae*, from the upper Chao Phraya River basin, Thailand (Pisces: Ostariophysi: Nemacheilidae). **Zootaxa** 3962(1): 158–170.

