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A new species of highland loach, *Schistura sirindhornae*, from the upper Chao Phraya River basin, Thailand (Pisces: Ostariophysi: Nemacheilidae)

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Abstract

Schistura sirindhornae, a new species of nemacheilid, is described from the Nan River basin in northern Thailand. It is distinguished from all other species of *Schistura* in having overlapping scales on the entire body similar to scales of balitorids, transparent scales on the belly and thorax, a lateral-line canal that is similar to that of most cyprinids and balitorids in being present across the entire lateral-line surface of the scale instead of being represented only by a pore. It also has a unique color pattern of irregular brown bars on the back and side of the faint yellow-orange body, a bright triangular orange mark on the occiput, an orange crown-shaped mark between the eyes, an uninterrupted black mark along the base of the dorsal fin, a crescent-shaped bar on the base of the caudal fin, and bright iridescent orange areas on the upper and lower extremities of the caudal-fin base. *Schistura sirindhornae* is known only from the upper Nan River drainage, Nan Province, Thailand.

Key words: Nan River basin, conservation, fish diversity, freshwater fish, stream ecology

Introduction

The fish fauna of northern Thailand is largely undescribed, particularly that in the small mountainous streams at high elevations (Suvarnaraksha *et al*. 2011). Recent surveys of small streams in the upper Nan River basin near the Laos border have revealed a number of unnamed species (Kottelat 2004; Chen & Kottelat 2005). Herein a new species of loach in the genus *Schistura* is described from the Nan Province of northern Thailand.

Kottelat (2012) listed 46 genera of Nemacheilidae as valid. Bănărescu and Nalbant (1995) considered only 28 genera as valid. Nemacheilids found in Indochina have very distinct characteristics: *Acanthocobitis* has several rows of papillae and a papillated pad on each side of the lower lip, *Tuberoschistura* has well-developed tubercles around the eyes and in the interorbital area and enlarged scales along the lateral line, *Neonemacheilus* has hypertrophied lips, *Sectoria* has a horny sheath and sharp edges on both jaws, *Nemacheilus* has the lower lip continuous along the anterior margin or with a slight incision, *Physoschistura* has a triangular-shaped lower lip (Kottelat 1990), and *Pteronemacheilus* has elongated skinfolds on the dorsal side of the second and third branched pectoral-fin rays in males (Bohlen & Šlechtová 2011).

Schistura, with at least 193 species (Kottelat 2012) is distinguished from other nemacheilids in having a medially interrupted lower lip, a moderately arched mouth 2.0–3.5 times wider than long, usually a black bar (sometimes dissociated) on the caudal-fin base, and a dorsal fin with one or two black marks along its base (Kottelat 1990; Vishwanath & Laishram 2001). However, the black marks on the dorsal-fin base may be absent (e.g., in *S. geisleri*), continuous or discontinuous and sometimes separated by a reddish or orange blotch, and black bars on the base of the caudal-fin base in nemacheilids may be divided into three groups: dissociated, complete, and complete with forward and backward projections at the upper and lower extremities (Kottelat 1990a).

Overlapping scales as found in most teleosts are not known in Indochinese nemacheilids; instead, all described species have small and non-overlapping or embedded scales. However, herein a new species of *Schistura* with overlapping scales is described.

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Materials and Methods

Fishes were captured using a backpack electroshocker and scoop net. After capture, fishes were euthanized in ice water, preserved in 10% formalin, and then stored in 75% ethanol at Maejo Aquatic Resources Natural Museum (MARNM), Maejo University and the Florida Museum of Natural History, University of Florida (UF). Measurements were taken with digital calipers to the nearest 0.1 mm. Measurements and counts were made on the left side whenever possible following Kottelat (1990, 2001). The number of specimens with a given meristic count is indicated in parentheses after the count. Measurements of parts of the head are presented as proportions of head length (HL), and the head length and measurements of other parts of the body are expressed as percentages of standard length (SL).

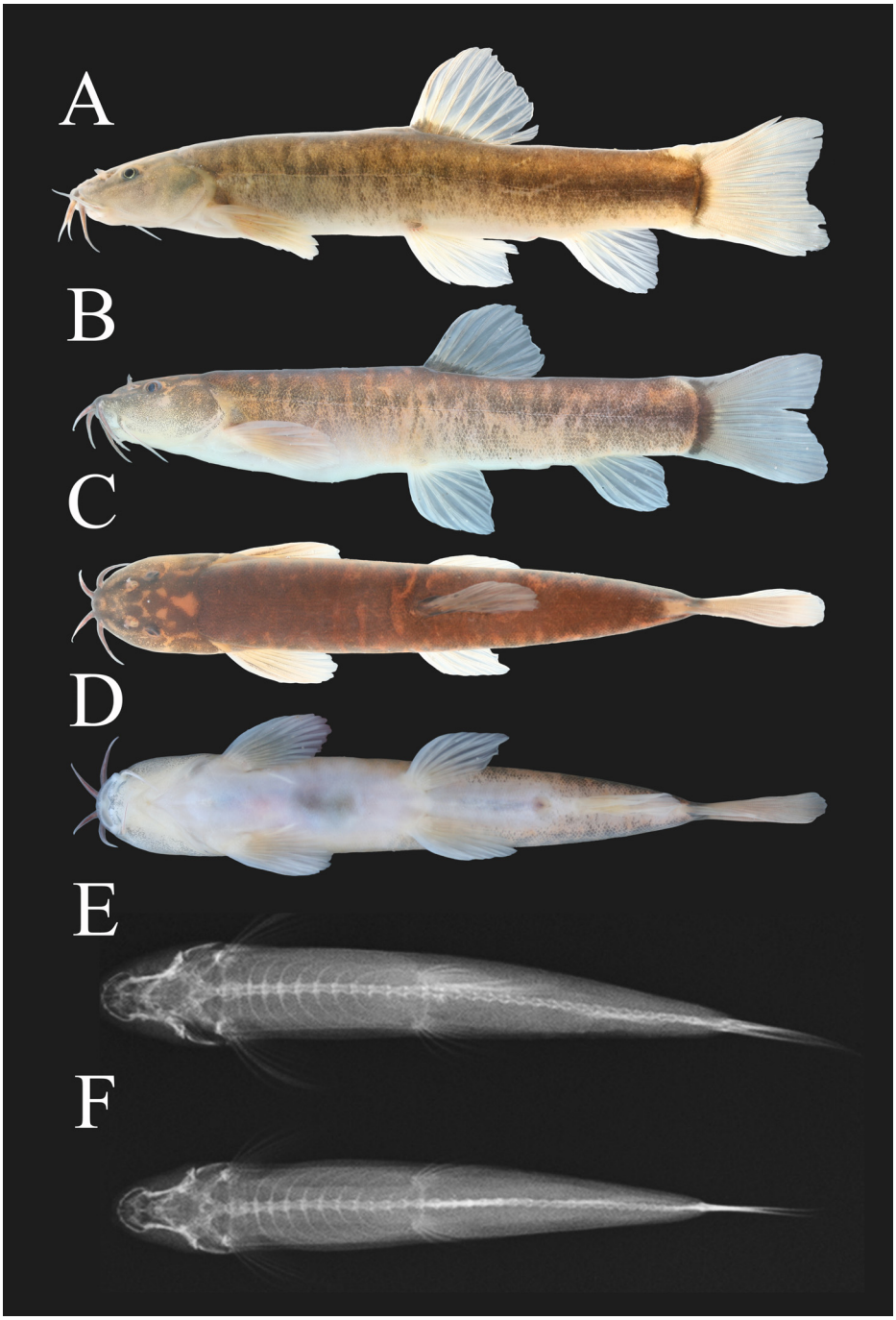

FIGURE 1. *Schistura sirindhornae*. A) lateral view of holotype of MARNM 5555, 71.8 mm SL; B) lateral, C) dorsal, and D) ventral views of paratype, MARNM 5434/2, 78.9 mm SL; ventral views of radiographs of uncatalogued male (E) and female (F).

***Schistura sirindhornae* sp. nov.**
Crown Scaly Stream Loach (Fig. 1)

Type material. Holotype: MARNM 5555, 71.8 mm SL, female; small creek, Huay Nampan, Ban Khunkoon, Moo 2, Tumbon Phukha, Pua District, Nan Province, 19°8'12.24"N, 101°0'33.18"E, elevation 721 m asl, 3 March 2013, A. Suvarnaraksha, R. Wattanasiriserekul, and W. Phinrub.

Paratypes: MARNM 5434, 2, 59.3–74.3 mm SL (males); 2, 73.8–78.9 mm SL (females); Huay Toey, Ban Toey, Tumbon Phuka, Pua District, Nan Province, (19°12'50.6"N, 101°04'28.4"E), elevation 1,055 m asl, 4 March 2013, A. Suvarnaraksha, R. Wattanasiriserekul, and W. Phinrub. MARNM 5130, 3, 39.2–41.7 mm SL, and UF 237129, 2, 35.4–65.2 mm SL, Huay Pan, Ban Huay Tone, Moo 2, Tumbon Dongpaya, Borkrua District, Nan Province, (19°13'33.7" N, 101°14'06"E), elevation 1122 m asl, 4 March 2013, A. Suvarnaraksha, R. Wattanasiriserekul, and P. Suktip.

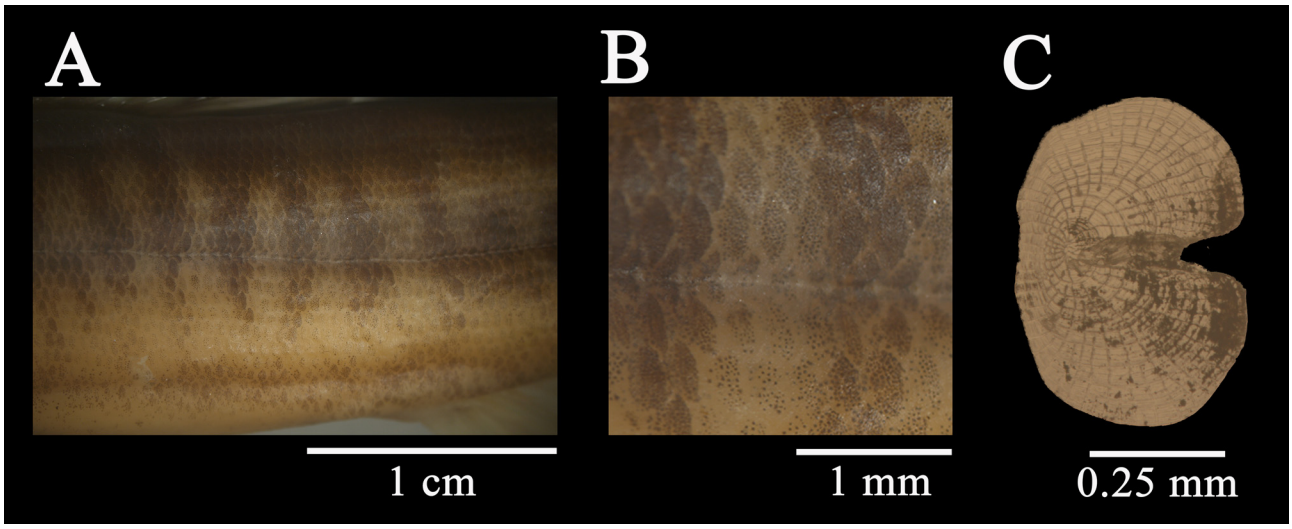

FIGURE 2. Non-embedded and lateral scales of *Schistura sirindhornae*, paratype, MARNM 5434/3, 73.8 mm SL. A) non-embedded scale, B) magnification of A, C) single lateral-line scale with pore.

Diagnosis. *Schistura sirindhornae* is distinct from all other species of *Schistura* in having overlapping scales on the entire body similar to the scales of balitorids (Fig. 2A & 2B), transparent scales on the belly and thorax, a lateral-line canal (Fig. 2C) that is similar to that of most cyprinids and balitorids in being present across the entire lateral-line surface of the scale instead of being represented only by a pore, and a unique color pattern (Fig. 1A and B) of irregular brown bars on the back and side of the faint yellow-orange body, a bright triangular orange mark on the occiput, an orange crown-shaped mark between the eyes (Fig. 3B), an uninterrupted black mark along the base of the dorsal fin (Fig. 4A), a crescent-shaped bar on the base of the caudal fin (Fig. 4B), and bright iridescent orange areas on the upper and lower extremities of the caudal-fin base. Scales of *S. sirindhornae* are generally larger than those of other nemacheilids with a larger focal area (Fig. 5).

Description. General appearance is shown in Figures 1 to 5, and morphometric data of the holotype and 17 paratypes are in Table 1. Large nemacheilid with moderately elongated, robust body. Body anteriorly rounded in cross section, body depth/width at dorsal-fin origin 1.2±0.10 times, slightly compressed posteriorly. Body depth/width at anal-fin origin 2.0±0.55 times, caudal peduncle slightly compressed. Maximum body depth between pectoral-fin base and dorsal-fin origin. Dorsal-fin origin slightly posterior to pelvic-fin origin. Dorsal fin with 3 simple and 6½–7½ branched rays. Distal margin of dorsal fin straight or slightly convex. Anal fin with 3 simple, 5½ branched rays, with tip nearly reaching caudal-fin base. Pelvic fin with 1 simple ray, 7–8 branched rays, not reaching beyond anus. Axillary pelvic lobe present. Pectoral fin rounded, reaching half distance to pelvic-fin base, with 1 simple ray, 8–10 (rarely 8) branched rays, reaching half-way between its origin and pelvic-fin origin. Anus closer to anal fin than to pelvic-fin. Caudal fin with 8+8 branched rays, deeply emarginated, lobes rounded. Nineteen trunk and 11 caudal vertebrae (Fig 1). Caudal peduncle length/depth 1.0±0.08 times.

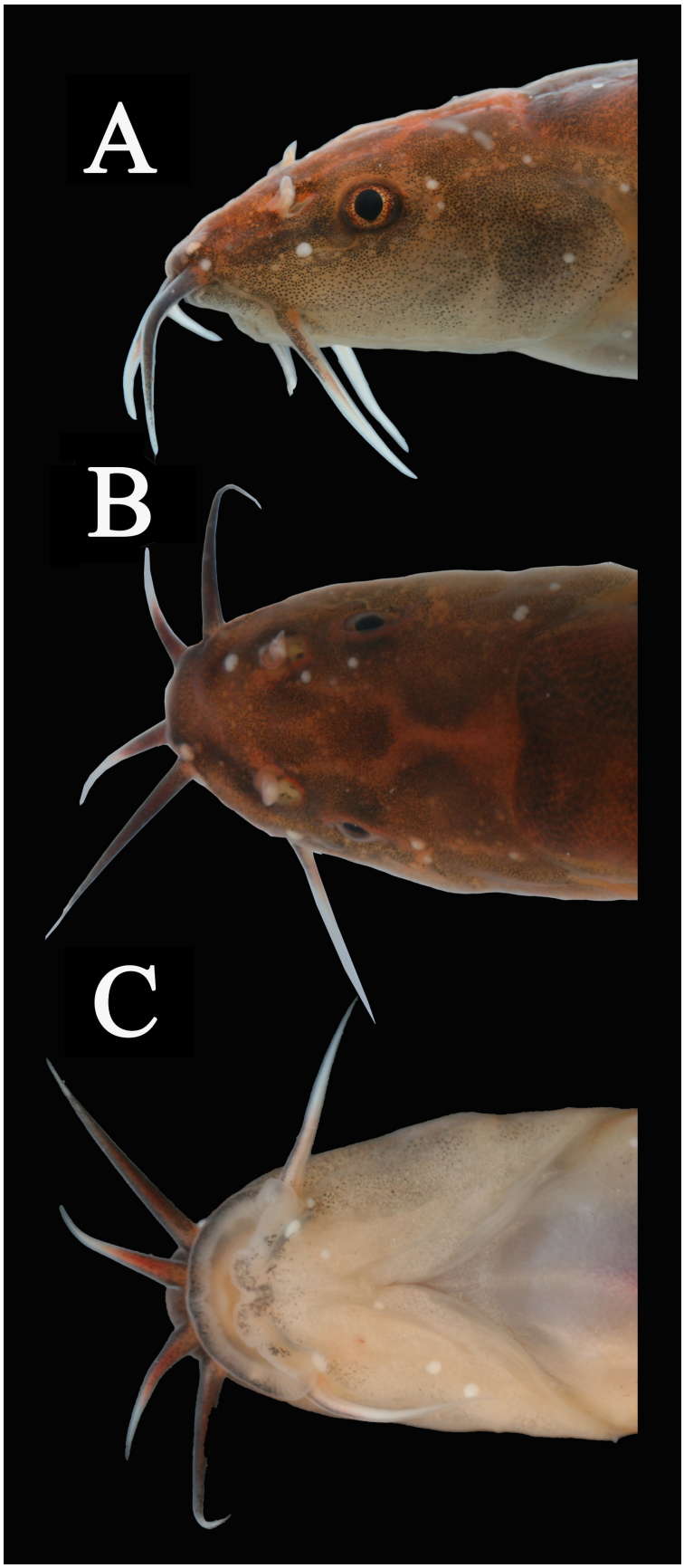

FIGURE 3. Head of *Schistura sirindhornae*, paratype, MARNM 5130/1, 41.7 mm SL. A) lateral view of head of young male with white tubercles, B) dorsal view of adult female with crown mark and triangular orange mark on the occiput, C) ventral view of head of adult female showing mouth morphology.

TABLE 1. Morphometric data of holotype and 17 paratypes of *Schistura sirindhornae*.

	Holotype (Female)	Paratypes					
		Males (5)		Females (12)		Both sexes	
		range	mean ±SD	range	mean ± SD	range	mean ± SD
Standard length (mm)	71.8	35.4-78.9		41.7-76.7		35.4-78.9	
Total length	122.9	118.6-125.2	123.3±2.63	121.5-127.9	122.9±2.15	118.6-127.9	123.3±2.28
Fork length	118.6	114.5-123.1	119.4±3.14	117.9-123.0	118.6±1.80	114.5-123.1	118.9±2.18
% standard length							
Pre-pectoral fin length	21.8	18.8-23.8	22.9±2.00	19.0-24.1	21.8±1.90	18.8-24.1	22.1±1.88
Pectoral fin length	22.2	21.3-22.3	22.1±0.38	20.7-25.4	22.2±1.39	20.7-25.4	22.1±1.18
Predorsal length	20.7	18.9-21.5	21.1±1.03	18.9-23.4	20.7±1.47	18.9-23.4	20.9±1.32
Preanal length	54.6	52.2-57.0	53.2±2.00	52.2-56.6	54.6±1.45	52.2-57.0	54.4±1.58
Prepelvic length	78.0	75.0-79.8	78.1±2.20	76.2-80.5	78.0±1.46	75.0-80.5	78.1±1.66
Pelvic-fin length	51.1	49.0-52.1	50.1±1.36	48.3-53.8	51.1±1.55	48.3-53.8	51.0±1.49
Pelvic to vent distance	19.1	18.2-21.6	19.7±1.23	17.5-22.6	19.1±1.54	17.5-22.6	19.3±1.42
Dorsal-fin base length	20.7	16.9-23.4	19.7±2.56	17.4-23.7	20.7±2.50	16.9-23.7	19.7±2.44
Dorsal-fin length	14.4	13.0-14.9	14.2±0.81	13.4-18.6	14.4±1.62	13.0-18.6	14.4±1.46
Anal-fin base length	20.6	19.4-20.6	19.9±0.45	18.1-27.0	20.6±2.39	18.1-27.0	20.1±2.04
Anal-fin length	9.4	9.1-11.4	9.9±0.89	8.0-12.6	9.4±1.31	8.0-12.6	9.6±1.20
Body depth at dorsal-fin origin	18.1	16.9-20.1	17.9±1.28	15.4-21.7	18.1±1.86	15.4-21.7	18.1±1.67
Body width at dorsal-fin origin	16.7	14.8-17.7	16.0±1.19	15.0-18.0	16.7±0.91	14.8-18.0	16.5±0.98
Body depth at anal-fin origin	13.8	12.2-13.1	12.7±0.40	11.9-14.6	13.8±0.97	11.9-14.6	13.1±0.92
Body width at anal-fin origin	15.2	14.3-15.6	14.7±0.53	13.9-15.8	15.2±0.61	13.9-15.8	14.8±0.58
Caudal-peduncle length	9.2	7.3-9.4	9.0±0.91	7.9-10.6	9.2±0.91	7.3-10.6	9.2±0.91
Caudal-peduncle depth	12.5	11.8-14.0	13.2±0.86	9.7-13.9	12.5±1.38	9.7-14.0	12.9±1.30
Caudal-fin length	13.1	12.5-13.5	13.0±0.35	11.9-14.5	13.1±0.73	11.9-14.5	13.0±0.64
% head length							
Dorsal head length	80.0	74.9-83.3	80.0±3.50	73.4-87.6	81.8±4.34	73.4-87.6	80.7±4.14
Head width at eye	67.4	55.6-70.9	64.4±5.74	58.4-72.7	62.3±4.71	55.6-72.7	62.6±4.86
Head width at nape	70.3	66.2-73.6	69.9±5.23	65.4-77.4	68.7±4.64	65.4-77.4	68.7±4.35
Head depth at eye	45.2	37.6-44.5	41.0±4.88	42.7-47.9	43.5±2.15	37.6-47.9	43.5±3.05
Head depth at occiput	54.0	45.0-56.6	52.7±4.31	43.5-58.4	49.3±4.95	43.5-58.4	51.0±4.65
Eye diameter	13.7	13.9-15.8	14.7±0.71	13.9-16.2	14.2±0.79	13.9-16.2	14.4±0.74
Interorbital length	35.1	35.2-37.9	37.4±1.09	33.8-38.6	38.1±1.68	33.8-38.6	37.9±1.49
Inter-nostril distance	24.2	23.2-29.9	25.5±3.13	22.2-29.5	26.0±2.61	22.2-29.9	25.7±2.68
Snout length	38.2	34.0-42.9	39.7±3.26	32.0-38.7	36.3±2.01	32.0-42.9	36.7±2.80
Mouth width	43.3	38.2-42.7	41.8±2.04	31.4-41.3	39.2±3.92	31.4-42.7	39.5±3.78
Mouth length	21.6	17.9-23.1	21.5±1.94	17.8-22.2	19.7±1.38	17.8-23.1	20.8±1.58
Rostral barbel I	32.5	30.5-39.8	33.7±3.98	31.3-38.9	34.1±2.71	30.5-39.8	33.9±3.02
Rostral barbel II	47.0	46.8-54.1	50.1±3.16	40.4-54.9	47.6±4.82	40.4-54.9	48.0±4.50

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TABLE 1. (Continued)

	Holotype (Female)	Paratypes					
		Males (5)		Females (12)		Both sexes	
		range	mean ±SD	range	mean ± SD	range	mean ± SD
Maxillary barbel length	43.4	43.3-49.7	47.1±2.37	40.3-50.2	45.2±3.14	40.3-50.2	45.7±2.93
Ratios							
Standard length/head length	4.3	4.0-4.5	4.1±0.22	3.9-6.7	4.3±0.76	3.9-6.7	4.3±0.65
Eye diameter/Interorbital space	0.4	0.4-0.4	0.4±0.01	0.3-0.5	0.4±0.04	0.3-0.5	0.4±0.04
Mouth width/mouth length	2.0	1.8-2.1	2.0±0.15	1.4-2.3	1.8±0.28	1.4-2.3	1.8±0.26
Snout/rostral barbel I	1.2	1.0-1.4	1.0±0.18	0.9-1.2	1.0±0.10	0.9-1.4	1.0±0.13
Snout/rostral barbel II	0.8	0.6-0.9	0.8±0.10	0.6-1.0	0.7±0.10	0.6-1.0	0.8±0.10
Snout/maxillary-barbel length	0.9	0.7-0.9	0.8±0.10	0.7-0.9	0.8±0.06	0.7-0.9	0.8±0.07
Lateral head l./pectoral-fin l.	1.2	1.0-1.3	1.1±0.11	0.8-1.2	1.1±0.11	0.8-1.3	1.1±0.11
Caudal-peduncle length/depth	0.9	0.9-1.1	1.0±0.06	0.8-1.0	1.0±0.07	0.8-1.1	1.0±0.08
Pectoral-fin l./pelvic-fin l.	1.0	1.0-1.1	1.1±0.03	1.0-1.2	1.1±0.06	1.0-1.2	1.1±0.05
Body depth at dorsal fin/BD at anal fin	1.6	1.4-2.6	1.7±0.46	1.3-2.9	2.1±0.58	1.3-2.9	2.0±0.55
Body depth/body width at dorsal-fin origin	1.3	1.2-1.4	1.3±0.06	1.1-1.4	1.2±0.11	1.1-1.4	1.2±0.10

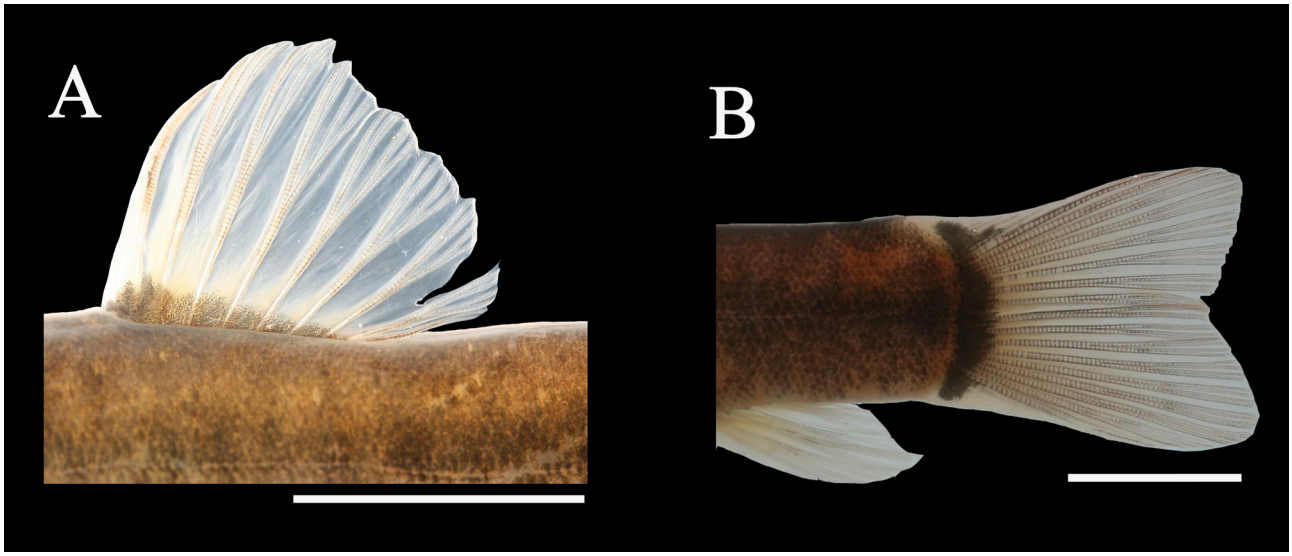

FIGURE 4. Bars on dorsal-fin base and caudal-fin base of *Schistura sirindhornae*. A) uninterrupted black mark along base of dorsal fin, holotype, MARNM 5555, 71.8 mm SL, B) crescent-shaped bar on base of caudal fin, MARNM 5434/2, 78.9 mm SL. Scale bar = 1 cm.

Head moderately large 4.3±0.65 times in SL. Eye relatively small, 0.4±0.04 times in interorbital space, 14.4±0.74% HL (Fig. 3A and B). Mouth moderately large, width 39.5±3.78% HL (Fig. 5C). Anterior nostril with flap-like tube with low anterior rim. Mouth arched, width 1.8±0.26 times in mouth length (Fig. 3C). Processus dentiformis present on upper jaw, broadly rounded; none on lower jaw. Lips thick; upper lip with well-marked median incision, small furrows on entire length. Lower lip with broad median interruption with prominent pad on each side, and thin flap of lip on corner of mouth, occasionally including 3–5 furrows (Fig. 3C); sometimes smooth in fresh specimens, with black spot on pads (Fig. 3C). Inner rostral barbel reaching beyond vertical to nostril, length 1.0±0.13 times in snout length (33.9±3.02% HL). Outer rostral barbel reaching beyond vertical through posterior rim of eye, length 0.8±0.10 times in snout length, 48.0±4.50% HL. Maxillary barbel 45.7±2.93% HL, 0.8±0.07 times in snout length. Largest individual 78.9 mm SL.

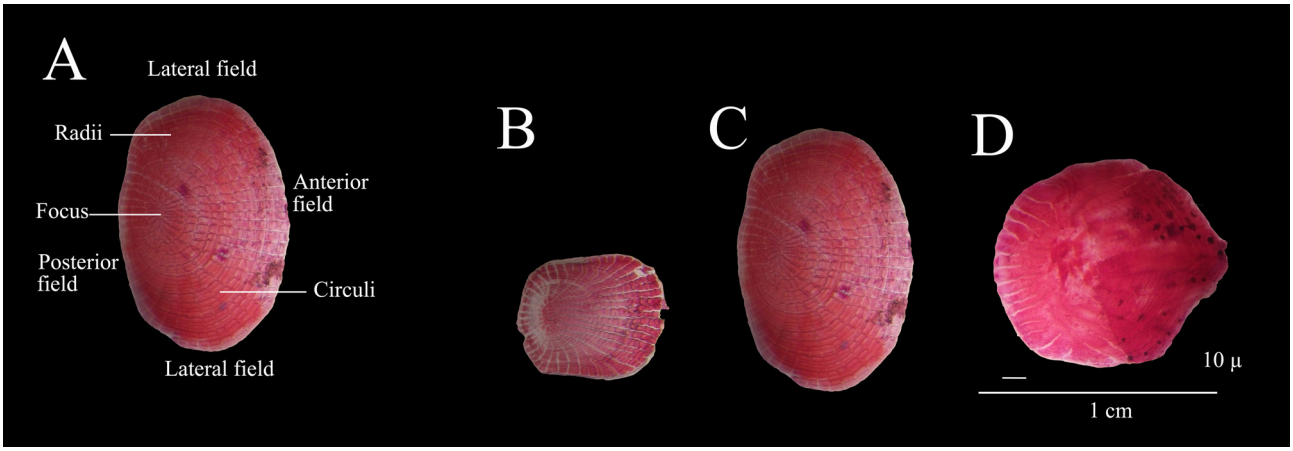

FIGURE 5. Scales. A) scale from above lateral line below dorsal-fin of *Schistura sirindhornae*, MARNM 5434/2, 78.9 mm SL, B) scale of *S. maejotigrina* uncatalogued, C) scale of *S. sirindhornae*, MARNM 5434/2, 78.9 mm SL, D) scale of *Pseudohomaloptera sexmaculata,* uncatalogued. Scale bars = 1 mm and 1 cm.

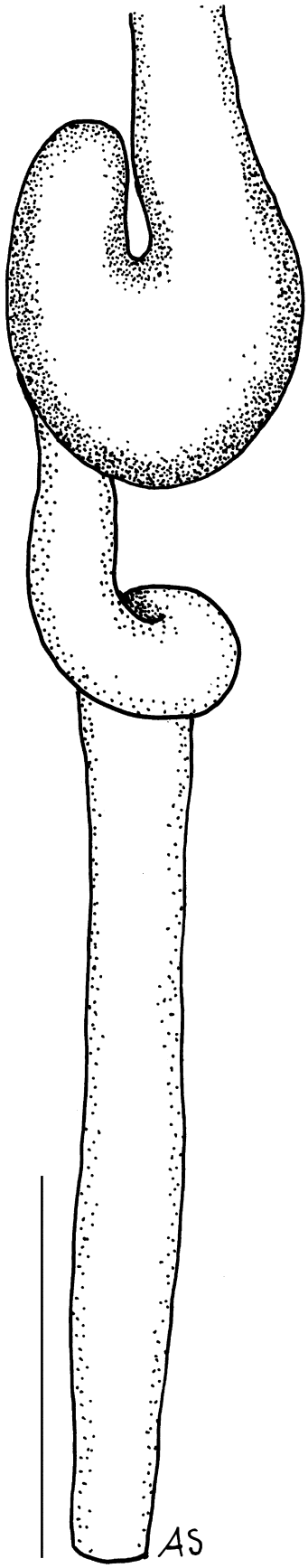

FIGURE 6. Stomach and loop of intestine of *Schistura sirindhornae,* MARNM 5434/2, 78.9 mm SL. Scale bar 1 cm.

Body completely covered with exposed, non-embedded scales, including between belly and thorax. Scales larger than in other nemacheilids, closely resembling those of balitorids (Fig. 5), with large focal area (Fig. 5A). Lateral line complete to hypural plate, ends slightly before posterior margin of caudal peduncle with 118–123 scales; lateral-line canal (Fig. 2C) similar to that of cyprinids and balitorids in being present across entire lateral-line surface of scale instead of being represented only by pore. Scales absent on head. Cephalic lateral line system with 7 supraorbital, 4+10-12 infraorbital, 8–10 preoperculo-mandibular, and 3 supratemporal pores. Stomach syphonal, intestine straight with single bend (Fig. 6); gas bladder with two encapsuled chambers united by short encapsuled duct. Lips and barbels covered with unculi.

Coloration. Live specimens golden brown on back and side of body, venter white. Numerous irregular dark brown bars punctuated by bright, luminous orange vertical bars across back and side of body similar to the tiger (Fig. 1), *Pantera tigris*. Dark longitudinal stripe on side of body posterior to dorsal fin. Pelvic and anal-fin rays hyaline. Head with orange crown-like mark between eyes, triangular-shaped bright orange mark on occiput (Fig. 3B); underside of head uniformly light gray, slightly paler on gular region (Fig. 1D). Numerous minute chromatophores on median incision of lower lip (Fig. 3C). All barbels bright orange with becoming darker proximally and lighter distally. Dark crescent-shaped bar on caudal-fin base. Color variation not correlated with size or sex in specimens examined.

Color in alcohol: Freshly preserved specimens ranged from light to dark brown, becoming lighter on venter. Dorsal portion of head with crown-shaped mark. Upper lip and rostral barbels with black pigment of varying density, being lighter distally. Black pigment on lower lip usually present and concentrated medially. Lateral pattern varying substantially among individuals. Side of body usually with dark brown bars reaching ventrally to lower level of pectoral-fin base. Most specimens with black stripe with indistinct outline along posterior half of body. No dark pigment on fins.

Sexual dimorphism. Males with spoon-shaped suborbital flap (Fig. 7A & 7B) similar to that in *S. bella*, *S. mahnerti*, and *S. desmotes* (Kottelat 1990) and *S. maejotigrina* (Suvarnaraksha 2012). Males have longer pectoral fins (Fig. 7B) as in *Physoschistura chulabornae* (Suvarnaraksha 2013), upwardly oriented pectoral-fin tips (Fig. 7B), and with the first branched pectoral-fin ray enlarged (Fig. 7E and F) with numerous small tubercles similar to those found in *Barbatula*, *Neonoemacheilus*, *Physoschistura*, and other species of *Schistura* (Kottelat 1990, Suvarnaraksha 2012). Some males observed white tubercles on head, cheek and anterior part of body (Fig. 3A).

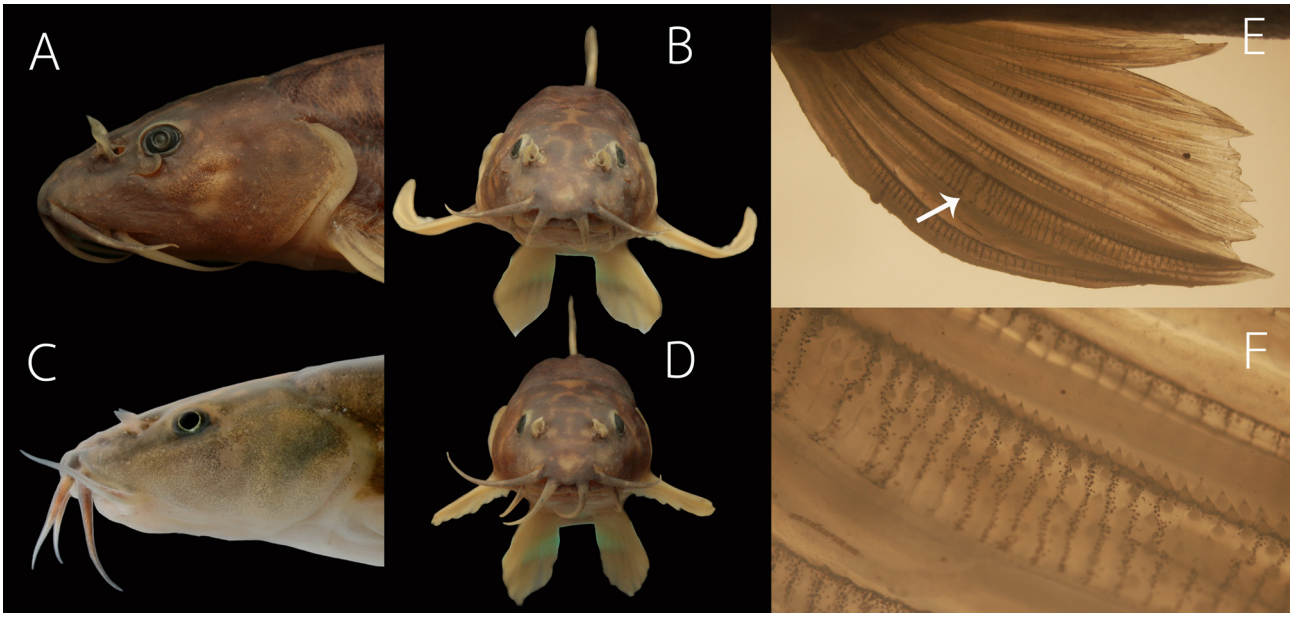

FIGURE 7. Sexual dimorphism in *Schistura sirindhornae*. A) MARNM 5434/1, male: spoon-shaped suborbital flap, B) MARNM 5434/1, male: long and upwardly curved pectoral fins, C) MARNM 5434/3, female: no suborbital flap, D) MARNM 5434/3, female: short and straight pectoral fins, E) MARNM 5434/3: enlarged 1st branched pectoral-fin ray, F) MARNM 5434/3): numerous small tubercles on the 1st branched pectoral-fin ray.

Ecology, food and reproductive biology. *Schistura sirindhornae* lives in upland areas on the bottoms of cool, clear, flowing streams with pools and forest canopy. *Schistura sirindhornae* has been collected from 721-1,155 m above sea level in steep streams in Huay Nampan and tributaries of the Nan River basin. The Huay Nampan was about 2–4 m wide (Fig. 8A) and 0.2–0.5 m deep at the time of sampling (start of the hot-dry season); water volume might be much higher during the rainy season. This species was observed only in shaded areas and was absent from light-exposed open areas and lowlands. Substrate consisted mainly of stones, bedrock, and some sand and gravel in small pools. The upper stream bank was covered by large native trees with more than 90% canopy cover. At the time of sampling, the water was clear, and the temperature was 18.4°C (air temperature 22.5°C), conductivity 2.6 S $\cdot$ m^{-1}, and pH 6.5. Other species of fishes collected with *S. sirindhornae* were *S. menanensis* (Nemacheilidae) and *Oreoglanis suraswadii* (Sisoridae). Gut dissections indicated that *S. sirindhornae* feeds mainly on aquatic insect larvae.

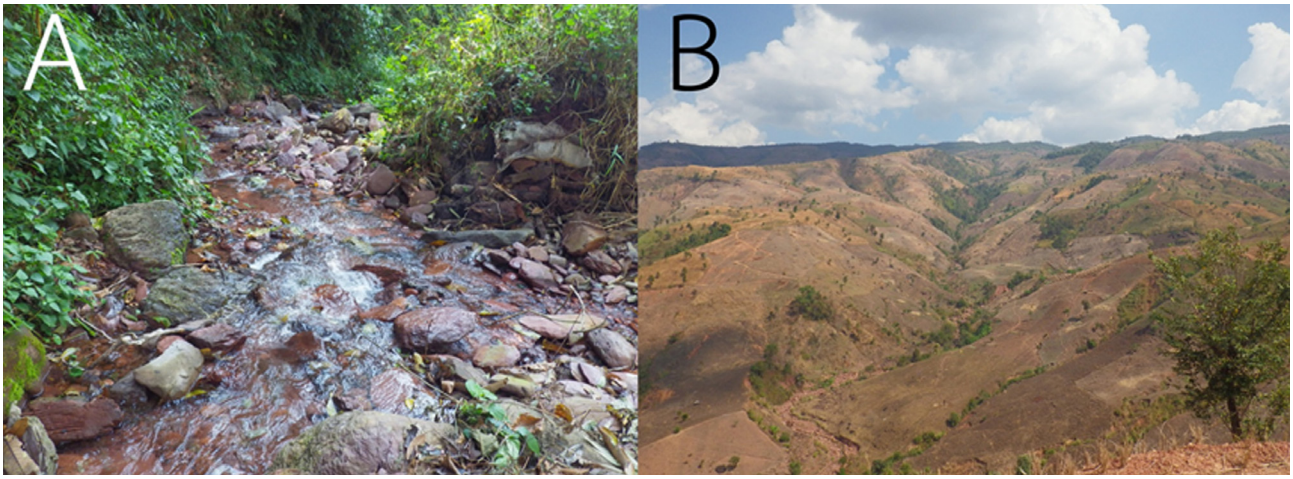

FIGURE 8. A) Type locality of *Schistura sirindhornae*: Huay Nampan, upper Nan River basin, Ban Khun Koon, Moo 2, Tumbon Phuka, Pua District, Nan Province, B) deforested area with a maize plantation and dry stream bed adjacent to type locality .

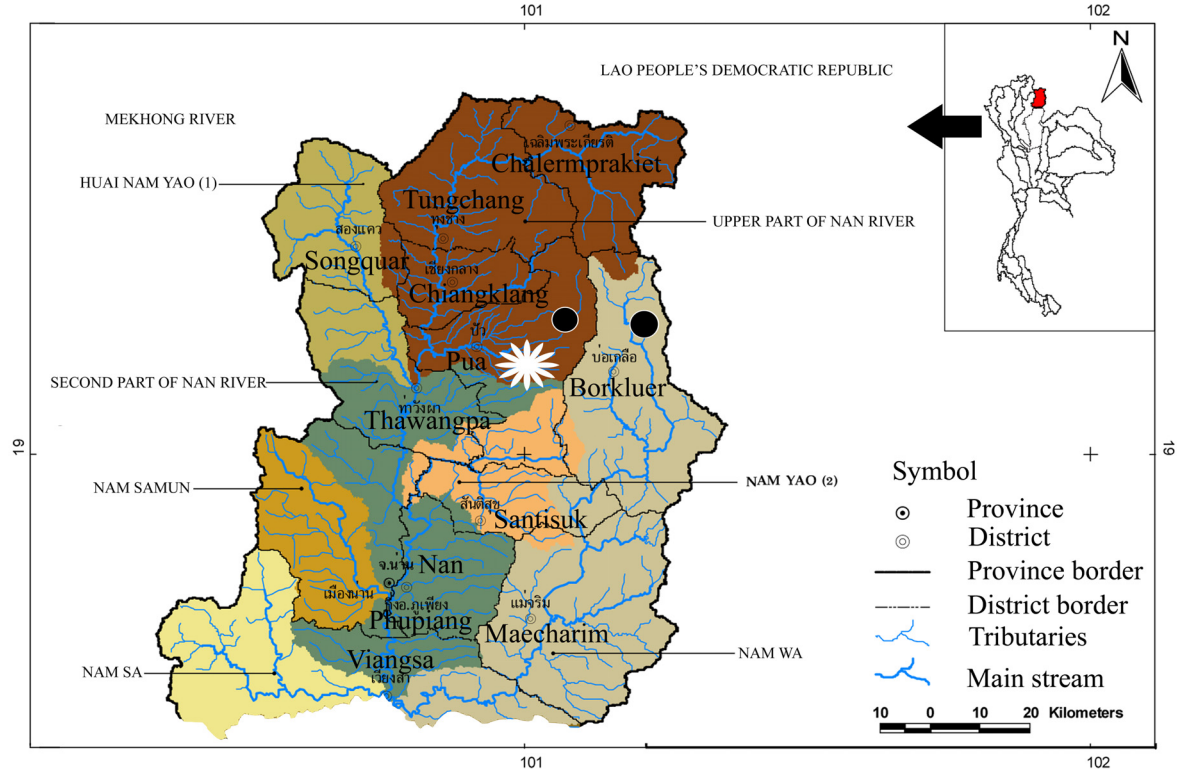

FIGURE 9. Nan river basin and collection localities of *Schistura sirindhornae*. Star = type locality.

Distribution. *Schistura sirindhornae* is known only from the tributaries of the upper Nan River basin, in Pua and Borkluea districts, Nan Province, Thailand. The type locality is a small creek with a very steep slope, in Huay Nampan, Ban Khunkoon, Moo 2, Tumbon Phukha, Pua District, Nan Province (Figs. 8A and 9). Collection localities are in the upper-most tributaries near Xayaboury Province of the People's Democratic Republic of Lao.

Etymology. The species epithet honors Her Royal Highness Princess Maha Chakri Sirindhorn for her 60th birthday anniversary, her biodiversity conservation projects including a Plant Genetic Conservation Project Under the Royal Initiation of Her Royal Highness Princess Maha Chakri Sirindhorn (RSPG), several projects in education and protein source security for rural communities, and many projects located in Nan Province, the type locality of this species.

Discussion

Schistura sirindhornae is assigned to the genus *Schistura* as defined by Kottelat (1990) by the moderately arched mouth with a median interruption of the lower lip. However, it differs from other *Schistura* in having exposed, non-embedded scales on the entire body, transparent scales on the belly and thorax, a lateral-line canal (Fig. 1C) across the entire lateral-line surface of the scale instead of being represented only by a pore, and a unique color pattern. *Schistura sirindhornae* is further distinguished from other species of Schistura in northern Thailand as discussed below and shown in Table 2.

Schistura sirindhornae differs from *S. maejotigrina* in having irregular, vertical dark brown coloration to the venter, punctuated by bright orange in live specimens (vs. irregular tiger-stripe bars with wavy black stripes on the upper side above the lateral line, extending under the dorsal fin; Suvarnaraksha 2012). It is further distinguished by a crown and triangle at the occiput (vs. scattered dark-brown spots on top of the head), an uninterrupted black mark along the base of the dorsal fin (vs. one black spot at the base of the simple dorsal ray); a crescent-shaped bar on the base of the caudal fin (vs. black bar at caudal-fin base incomplete, with small blotch dorsally at the origin of the fin, bar extending from the middle of the upper caudal lobe to the middle of the lower caudal lobe); hyaline caudal fin (vs. scattered dark spots) and lower lip with black spots (vs. without black marks) (Suvarnaraksha 2012).

Schistura sirindhornae is similar to *S. similis* in having an uninterrupted black mark along the base of the dorsal fin, but differs in having a tiger colour pattern (vs. 10 regular bars), visible scales (vs. embedded scales), 6½–7½ branched dorsal-fin rays (vs. 8½), 8+8 branched caudal-fin rays (vs. 9+8), a spoon-shaped suborbital flap (vs. no suborbital flap), an uninterrupted black mark along the base of the dorsal fin (vs. one black spot at base of the simple dorsal ray), the pelvic-fin origin in front of the dorsal-fin origin (vs. at 1st and 2nd branched dorsal-fin rays) and distribution only in the Nan River basin (vs. Salween River basin) (Kottelat 1990).

Schistura sirindhornae is similar to *S. robertsi* in having black on the lower lip, but differs in having irregular bars on the body (vs. 8–10 regular bars), male with suborbital flap (vs. no suborbital flap), complete lateral line (vs. incomplete), a crescent-shaped bar on the base of the caudal fin (vs. vertical basicaudal bar), axillary pelvic lope (vs. no lobe), and distribution only in upper Nan River, northern Thailand (vs. peninsular Thailand) (Kottelat 1990).

Schistura menanensis is the only nemacheilid species in the same locality, but *S. sirindhornae* differs in having an irregular color pattern (vs. 7–10 obscure dark brown bars with margins not well marked, bars wider than interspaces), complete lateral line (vs. incomplete), 6½–7½ branched dorsal-fin rays (vs. 8½), male with suborbital flap (vs. no flap), bright orange crown mark between the eyes and a triangular mark at the occiput (vs. a mottled irregular dark pattern on head), axial stripe in some specimens (vs. a prominent axial stripe) (Smith 1945; Kottelat 1990), longer barbels with inner rostral barbel reaching to anterior rim of eye (vs. barbel reaches halfway to base of maxillary barbel), outer rostral barbel reaches to posterior margin of eye (vs. barbel reaches to base of maxillary barbel), and maxillary barbel reaches to half of head length (vs. reaches vertical at rear border of eye).

Non-embedded scales are found in *S. sirindhornae*, *S. dubia*, *S. magnifluvis* and *S. malaisei* but are present on the entire body in *S. sirindhornae* and as slightly overlapping scales on the posterior part of the body in the other species (Table 2). *Schistura sirindhornae* is distinguished from *S. dubia* by having 6½–7½ branched dorsal-in rays (vs. 8½), 8+8 branched caudal-fin rays (vs. 9+8), a spoon-shaped suborbital flap (vs. no flap), complete lateral line with 110–123 lateral-lines scales (vs. incomplete lateral line with 25–54 pores), and an irregular body color pattern (vs. 8–11 regular bars). It differs from *S. magnifluvis* by having 6½–7½ branched dorsal-fin rays (vs. 8½), 8+8

branched caudal-fin rays (vs. 9+8), a spoon-shaped suborbital flap (vs. no flap), a robust caudal-peduncle length/depth (0.8–1.0 times in males, 0.8–1.1 times in females, vs. more slender 1.2–1.5 times), an irregular body color pattern (vs. 13–14 regular bars), and distribution only in the upper Nan River (vs. Mekong River basin) (Kottelat 1990). Its differs from *S. malaisei* by having a complete lateral line (vs. incomplete lateral line reaching about to the pelvic-fin origin), a spoon-shaped suborbital flap (vs. no flap), a crescent-shaped bar on the base of the caudal fin (vs. an isolated spot at its upper extremity), an uninterrupted black mark along the base of the dorsal fin (vs. a black spot at base of simple and first branched rays), hyaline caudal fin (vs. a vertical row of dark spots on the caudal fin, at about ⅔ of ray length), and distribution in Nan River basin (vs. Putao, in the Chinwin basin of northern Myanmar) (Kottelat 1990).

An uninterrupted black mark along the base of the dorsal fin in *S. sirindhornae* is similar to that of *S. nasifilis* and *S. paucifasciata*. *Schistura sirindhornae* differs from *S. nasifilis* by having a processus dentiformis only on the upper jaw (vs. on both jaw), 6½–7½ branched dorsal-fin rays (vs. 8½), 8+8 branched caudal-fin rays (vs. 9+8), pelvic-fin origin in front of dorsal-fin origin (vs. under branched dorsal-fin rays 1–2), shorter pre-pelvic length (48.3–53.8% vs. 56.7–59.8% SL), longer pelvic fin (17.6–22.6% vs. shorter 15.4–17% SL), higher dorsal fin (18.1–27.0% vs. 12.7–16.3% SL), shorter caudal-peduncle (9.7–13.9% vs. longer 12.9–14.6% SL), longer caudal fin (19.0–24.1% vs. 18.3–19.8% SL), and shorter snout (32.0–38.7% vs. 42.0–52.0% HL) (Kottelat 1990). *Schistura sirindhornae* differs from *S. paucifasciata* by having irregular blight orange bars on a uniformly brown body (vs. 2–4 black vertical bars below the dorsal fin, similar to that in *S. balteata*), 8+8 branched caudal-fin rays (vs. 9+8), pelvic fin origin in front of dorsal fin origin (vs. under the first branched dorsal-fin ray), complete lateral line (vs. incomplete lateral line, reaching to about vertical of pelvic-fin origin), entire body covered by non-embedded scales (vs. deeply embedded scales), longer pelvic fin (17.55–22.58% vs. shorter 15.9% SL), and distribution in Nan River basin (vs. Irrawaddy basin in Myanmar) (Kottelat 1990).

Schistura sirindhornae is similar to *S. pridii* by having 8+8 branched caudal-fin rays, but differs in having 7–8 pelvic-fin rays (vs. 6), an uninterrupted black mark along the base of the dorsal fin (vs. a spot on the anterior of the dorsal-fin base), with a suborbital flap (vs. no flap), entire body with non-embedded (vs. embedded) scales, several irregular bars on the body (vs. 4 bars), medium to large size (vs. small size), and distribution in the Nan River basin (vs. Ping River basin) (Vidthayanon 2003).

Notes on conservation. The main habitat of *S. sirindhornae* is high elevation, mountainous areas with more than 90% canopy cover, in cool, clear riffles, runs and small pools. The substrate is composed of bedrock and gravel. Specimens have been collected far from anthropogenic areas. Recently, many local villagers have been cutting trees for agricultural activities, especially for maize fields, in high mountains of the Nan Province and adjacent areas (Fig. 8b). These areas appear green from young maize fields in the rainy season, but in reality they no longer support suitable stream habitats in the hot-dry season. Also, these villagers are using pesticides, herbicides, fungicides, and other pollutants. All of these products directly impact small streams. These inappropriate highland agricultural activities will have negative effects on highland aquatic fauna by contributing to: 1) habitat loss by deforestation resulting in reduced canopy cover, higher water temperatures, erosion, and reduction of food sources; and 2) the inevitable introduction of agricultural chemicals into the aquatic system.

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