

A new species of loach, genus *Nemacheilus* (Osteichthyes, Balitoridae) from Aceh, Sumatra, Indonesia

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SYNOPSIS. A new species of the balitorid genus *Nemacheilus* is described from Aceh, Sumatra. The new species is distinguished from other *Nemacheilus* species by the combination of a colour pattern of dorsal saddles and lateral blotches but without a dark spot at the anterior base of the dorsal fin and the presence a row of enlarged, elongate, posteriorly directed, tear-drop shaped scales on either side of the lateral line scale row on the anterior part of the caudal peduncle, each of which bears a comparatively large, retrorse, apical tubercle.

INTRODUCTION

Little has been reported about fishes inhabiting inland waters of Aceh, Sumatra (Kreemer, 1922 (*vide* Wirjoatmodjo, 1987); Fowler, 1940; Wirjoatmodjo, 1987; Hadiaty and Siebert, 1998). A small collection of fishes was made from Sungai Lembang, Gunung Leuser National Park-Aceh Selatan during August–September 1997, as part of an ecosystem mapping project from the Research and Development Centre for Biology, Bogor. Gunung Leuser National Park, established in 1980, comprises 792,675 hectares of prime habitat. It, and an associated management area, include coastal lowlands, uplands, and montane habitats. The area is home to tiger, elephant, rhinoceros, orangutan and spectacular plants such as *Rafflesia atjehensis* and *Amorphophalus* sp. The fish collection contains several distinctive fishes, of which two species of *Osteochilus* were described earlier (Hadiaty & Siebert, 1998). The collection also contains a new species of the balitorid sub-family Nemacheilinae that has enlarged and elongate scales bordering the lateral line in anterior half of the caudal peduncle, each of which bears a large, retrorse tubercle near its posterior tip.

The Indonesian and Malaysian nemacheiline loaches were last revised by Kottelat (1984), who recognised nine species in the region but noted that several nominal taxa, especially some from Sumatra, could not be critically evaluated because of the lack of sufficient material. Since then Chin and Samat (1992) have described *N. elegantissimus* from Sabah, Malaysia and Kottelat *et al.* (1993) have recognised as valid two of the species, *N. pfeifferae* and *N. longipinnis*, that Kottelat could not evaluate earlier. The number of valid species recognised species in the region now stands at 12. Two of the species in the area, *N. selangoricus* and *N. spiniferus*, have acuminate scales, each of which bears a large tubercle, along the lateral line on the caudal peduncle. One, *N. selangoricus*, is widely distributed, occurring in Sumatra, Malaysia, and Borneo, while the other, *N. spiniferus*, is known only from Borneo (Kottelat *et al.*, 1993).

MATERIALS AND METHODS

Methods for counts and measurements follow Kottelat (1984). The

specimens of the new species were collected by electrofishing and are deposited at the Museum Zoologicum Bogoriense (MZB), Research and Development Centre for Biology, Cibinong, Java, Indonesia and The Natural History Museum (BMNH), London. The egg count was done by direct enumeration. Illustrations of scales and mouthparts were rendered from camera lucida tracings. Statistical testing of differences in the shape of caudal peduncle scales between males and females of the new species and between the new species and *N. chrysolaimos* are based on measurements of camera lucida tracing of individual scales made under compound microscopy. The abbreviation ZMA is for Zoologisch Museum, Amsterdam. Peter Bartsch, Museum fuer Natrkurkunde der Humboldt-Universitaet zu Berlin, examined the holotypes of *N. dunckeri* (ZMB 20546) and *N. longipinnis* (ZMB 20547) for us; he also provided a translation of Ahl's (1922) description of the colour pattern of each species.

SYSTEMATICS

Nemacheilus tuberigum sp.nov.

(Figs. 1–5; Tables 1, 2)

Holotype, MZB 9356 (48.5 mm SL, 59.2 mm TL); Indonesia, Sumatra, Aceh Selatan, Kecamatan Kluet Selatan, Desa Pucuk Lembang, Gunung Leuser National Park, caught in a clear forest stream tributary to Sungai Lembang; R.K. Hadiaty and A. Mun'im, 2 September 1997.

Allotype, MZB 10565 (43.0 mm SL); same data as holotype.

Paratypes, MZB 9357, 12 ex., (39.6–53.2 mm SL); same data as holotype. BMNH 2000.4.10.1–5, 5 ex., (42.2–50.5 mm SL); same data as holotype. MZB 9358, 4 ex., (44.8–53.4 mm SL); same location as holotype; R.K. Hadiaty and A. Mun'im, 31 August 1997. MZB 9359, 1 ex., (42.6 mm SL); same location as holotype; R.K. Hadiaty and A. Mun'im; 1 September 1997. MZB 9360, 4 ex., (42.6–49.2 mm SL) Indonesia, Sumatra, Aceh Selatan, Desa Pucuk Lembang, Alur Betung, a tributary of S. Lembang; R.K. Hadiaty and A. Mun'im; 2 September 1997. MZB 9361, 2 ex., (31.9 and 37.2 mm SL); Indonesia, Sumatra, Aceh Selatan, Suag Balimbing Research

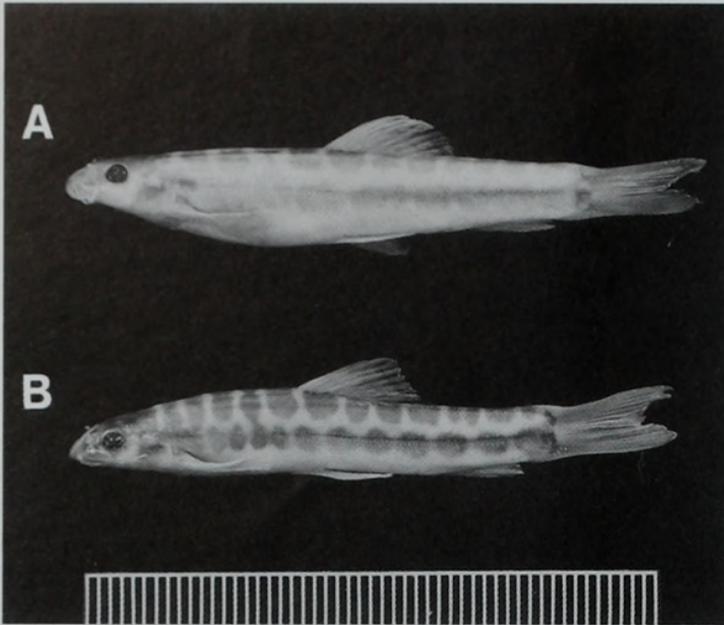


Fig. 1 A. Holotype of *N. tuberigum*, MZB 9356, 48.5 mm SL, gravid female. B. Allotype of *N. tuberigum*, MZB 10565, 43.0 mm SL, mature male. Scale bar in mm.

Station, caught in a muddy forest stream tributary to Sungai Lembang; R.K. Hadiaty and A. Mun'im; 4 September 1997.

Non-type materials: MZB 9351, 10 ex., (38.0–53.0 mm SL); data as for holotype. MZB 9362, 28 ex., (33.2–45.9 mm SL); location as for holotype; R.K. Hadiaty and A. Mun'im; 31 August 1997. MZB 9363, 27 ex., (34.7–52.2 mm SL); location as for holotype; R.K. Hadiaty and A. Mun'im; 1 September 1997. MZB 9364, 11 ex., (33.2–52.3 mm SL); Indonesia, Sumatra, Aceh Selatan, Desa Pucuk Lembang, Alur Betung, a tributary of Sungai Lembang; R.K. Hadiaty and A. Mun'im; 2 September 1997. MZB 10566, 2 ex., (47.2–48.2 mm SL); unnamed tributary of S. Alas, behind the camp at Ketambe Research Station, Aceh, Sumatra, Indonesia; R.K. Hadiaty & A. Mun'im; 21 June 1998. MZB 10567, 3 ex., (38.6–52.9 mm SL); unnamed tributary of S. Alas, Ketambe Research Station, Aceh,

Sumatra, Indonesia; R.K. Hadiaty & A. Mun'im; 20 June 1998. MZB 10568, 5 ex., (41.2–52.8 mm SL); unnamed tributary of S. Alas, in front of the National Park camp ground, Ketambe, Aceh, Sumatra, Indonesia; R.K. Hadiaty & A. Mun'im; 23 June 1998. MZB 10569, 2 ex., (39.8–44.9 mm SL); mouth of S. Sukarimbun, Ketambe, Aceh, Sumatra, Indonesia; R.K. Hadiaty & A. Mun'im; 20 June 1998. MZB 10570, 15 ex., (28.2–59.6 mm SL), unnamed tributary of S. Alas, behind the camp of the Ketambe Research Station, Sumatra, Indonesia; R.K. Hadiaty & A. Mun'im; 21 June 1998.

DIAGNOSIS. *Nemacheilus tuberigum* is easily distinguished from all other *Nemacheilus* by the following combination of characters: a row of comparatively large tubercles present on enlarged, elongate scales in the scale rows immediately above and below the lateral line scale row on the anterior half of the caudal peduncle, (comparatively large tubercles in a similar position present also in *N. selangoricus* and *N. spiniferus*, but on scales with peculiar posterior elongate processes); and colour pattern consisting of 11–15 dorsal saddles, a series of 8–13 lateral blotches centered along the lateral line and without a dark spot at anterior base of dorsal fin (present in *N. selangoricus* and *N. spiniferus*).

DESCRIPTION. General appearance and physiognomy are shown in Figure 1; morphometric and meristic data for the holotype and paratypes (range, as the minimum and maximum observation, mean and standard deviation) are given in Table 1. *Nemacheilus tuberigum* presents a shape and colour pattern general for many members of the genus.

Dorsal head length 5–6 times in SL; eye moderate, shorter than snout, 3–4 times in dorsal head length; suborbital flaplet present in males at anteroventral corner of eye, anterior nares a short tube (Fig. 2); small tubercles scattered over dorsal and lateral exposures of the head. Cephalic lateral line pores: supraorbital canal with 5 pores; post-temporal canal with 3 pores, infraorbital canal with 10 pores, supra-occipital canal with 3 pores; operculomandibular canal with 9 pores.

Mouth crescent-shaped (Fig. 3), with three pairs of barbels; anterior rostral barbel shortest, reaching to about middle of eye; posterior rostral barbel longest, reaching to half way between hind edge of eye and hind edge of opercle; mandibular barbel intermediate



Fig. 2 Lateral view of the head of the allotype of *N. tuberigum*, MZB 10565. Suborbital flap clearly evident; anterior naris a short tube, valve-like; small tubercles are scattered over the head.

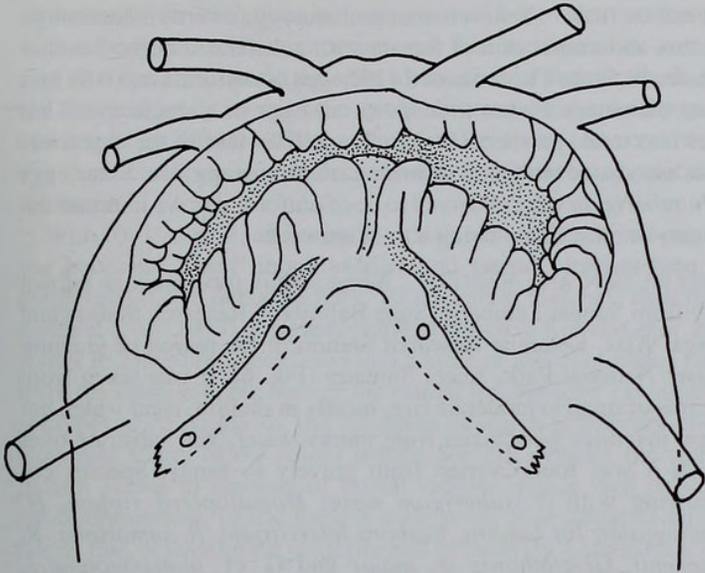


Fig. 3 Mouth of *N. tuborigum* MZB 9357, male, 48.4 mm SL. Lower lip completely separated at the midline; upper lip weakly crenulate, weakly papillate in posterolateral part.

in length between rostral barbels, reaching to end of posterior rostral barbel (Fig. 2). Process dentiformis small. Lips moderately fleshy: upper lip weakly crenulate to feebly papillose, posterolateral parts of upper lip weakly papillose; lower lip with a median incision completely separating right and left sides, with 2 or 3 deep pleats on either side of median incision.

Pectoral fin with 11 rays, reaching at most only halfway to pelvics; pelvics with 8 rays, nearly reaching anus, anal fin not reaching caudal fin. Hindborder of pectoral and pelvic fins with prolongations at extremities of rays. Caudal fin forked, short.

Body fully scaled scales small, ovoid slightly pointed posteriorly. Scales on caudal peduncle larger and longer than those from mid-body region. Scale rows immediately above and below the lateral line on the anterior part of the caudal peduncle with 5–10 obviously

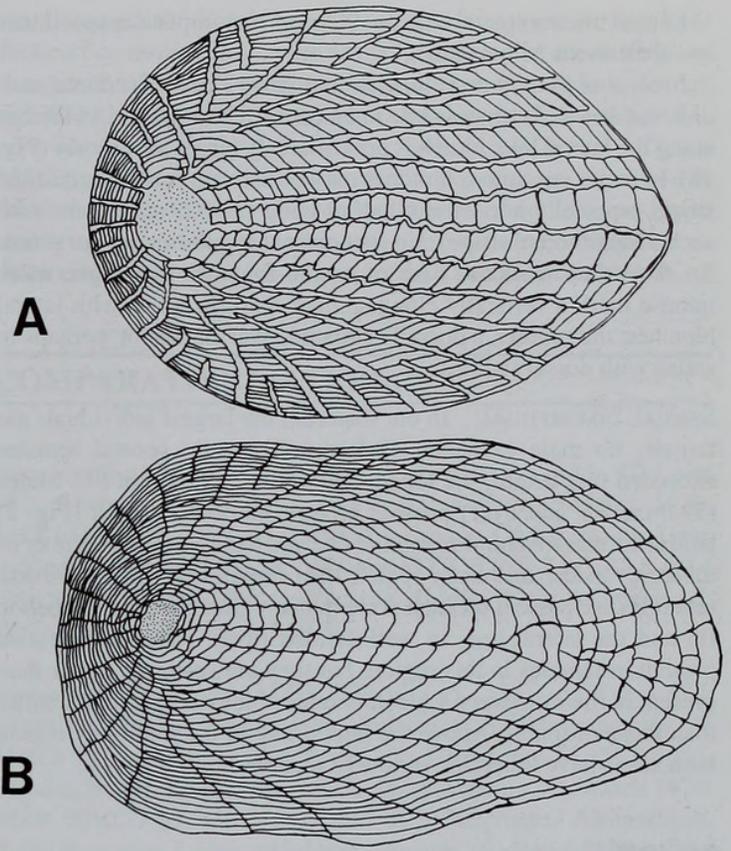


Fig. 4 Scales of *N. tuborigum*. A. Scale from mid-body below dorsal fin. B. Scale from scale row immediately adjacent to lateral line on caudal peduncle. These scales usually bear an enlarged tubercle near the posterior margin. Anterior to the left; scale bar = 0.1 mm.

elongate scales (Fig. 4) (l/w for males $\bar{x} = 1.64$, s.d. = 0.055, $n = 5$; l/w for females $\bar{x} = 1.55$, s.d. = 0.097, $n = 5$), usually tear-drop in shape, each bearing a large retrorse tubercle (Fig. 5) as on the acuminate scales of *N. selangoricus* and *N. spiniferus*.

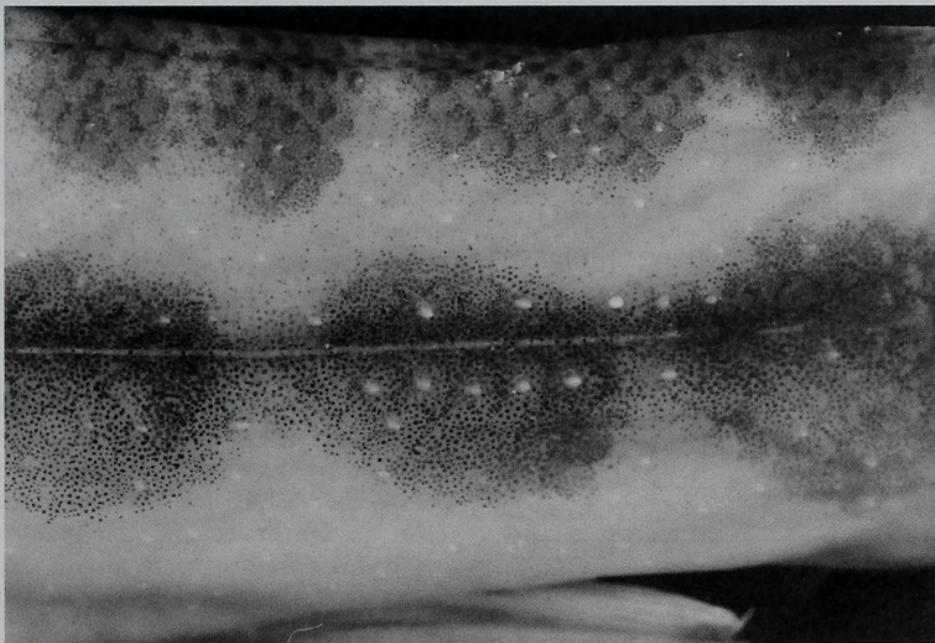


Fig. 5 Close up of anterior caudal peduncle of allotype of *N. tuborigum* (anterior to the left). Lateral line passes through the upper third of the three oval lateral blotches; small tubercles are scattered over the caudal peduncle generally. A row of larger tubercles can be seen on either side of the lateral line, beginning near the left edge of the second lateral blotch and ending near the left edge of the third blotch.

Lateral line complete, with 76–90 pores, incomplete in specimens less than about 30 mm SL.

In alcohol body pale yellowish with 10–15 irregular dorsal saddles, saddles wider than saddle interspaces. There are 8–13 blotches along the lateral line, blotches progressively larger posteriorly (Fig. 1b). In larger specimens blotches may be fused to form longitudinal stripe, especially in posterior half of body (9 of 29 specimens with such a longitudinal stripe). No spot present at anterior base of dorsal fin. Two dark marks at base of caudal-fin rays: the larger, more intense mark a vertically elongate dark mark in series with lateral blotches; the smaller, a dorsally situated, oval, dark spot, perhaps in series with dorsal saddles.

SEXUAL DIMORPHISM. In our material, the largest individuals are female; no male exceeded 48.5 mm SL while several females exceeded this length, the longest of which is 53.4 mm SL. Males (39.8 mm SL and over) possess a large subocular flaplet (Fig. 2) below the anteroventral margin of eye and have a greater number of tubercles in the mid-body region than females. In males retrorse tubercles are present on each scale in the region between the pelvic fin and the lateral line, in well-defined rows. Tubercles are also present in females in this region, but they are scattered rather than present in rows on every scale; tubercles of females are also smaller than those of males. Above the lateral line in the mid-body region both sexes have tubercles variously scattered.

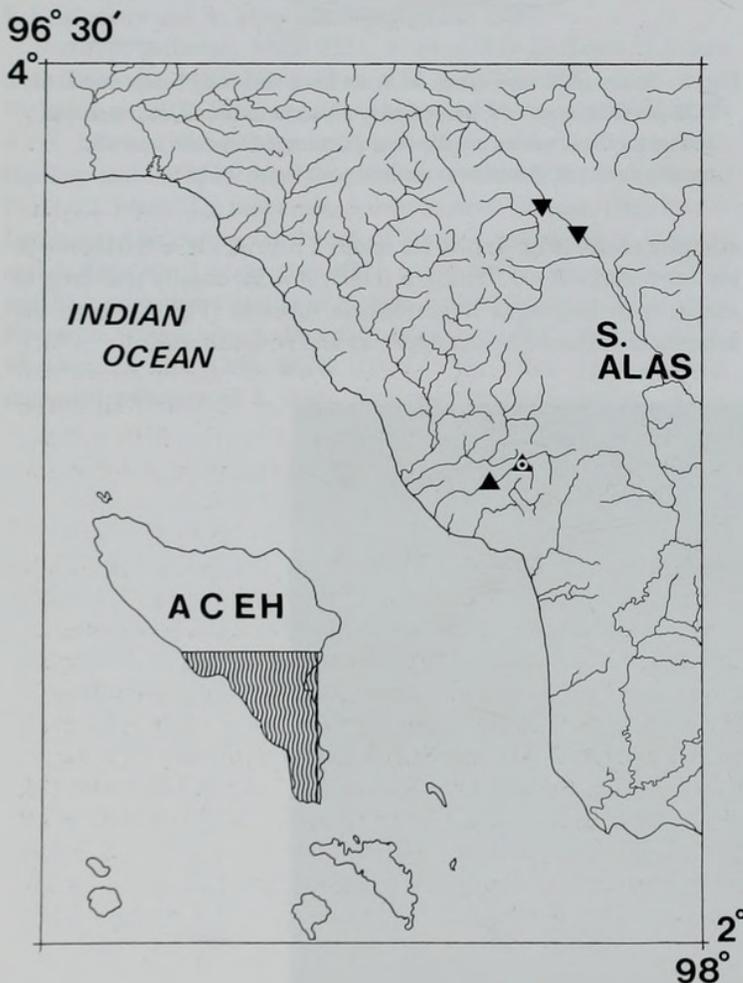


Fig. 6 Drainage map of Gunung Leuser National Park area from which *N. tuberigum* materials have been captured; the shaded area of the inset is the area covered by the drainage map. ▲ = S. Lembang localities near Suag Balimbing Research Station; target symbol = type locality. ▼ = S. Alas drainage localities near Ketambe Research Station.

REPRODUCTION. Yellow to orange mature eggs were visible through the thin abdominal skin of female with a distended belly. Another female, 48.5 mm TL, contained 4192 eggs of uniform size (0.61 mm mean diameter). Fishes that spawn all eggs in a single event are known as total spawners (Welcomme, 1979). One of the characteristics associated with total spawning is uniform egg size. Since eggs of *N. tuberigum* were observed to be of uniform size we interpret the species as most likely being a total spawner.

DISTRIBUTION AND HABITAT. *Nemacheilus tuberigum* is known only from Sungai Lembang, Suag Balimbing Research Station and Sungai Alas, Ketambe Research Station in the region of Gunung Leuser National Park, Aceh, Sumatra (Fig. 6). It was taken from streams of small to moderate size, mostly in shallow, clear water, but a few juveniles were taken from murky water. The substrate over which it was found varied from gravelly to sandy. Species co-occurring with *N. tuberigum* were: *Homaloptera ripleyi*, *H. gymnogaster*, *Tor tambra*, *Rasbora lateristriata*, *R. sumatrana*, *R. meinkenii*, *Glyptothorax cf. major* and *G. cf. platypogonoides*. Given the lack of general information on fish distributions in Sumatra it would not be surprising to find the species elsewhere.

ETYMOLOGY. The epithet *tuberigum*, a noun, is derived as suggested in Brown (1956: p. 44). It is constructed in reference to the comparatively large tubercles on either side of the lateral line on the anterior part of the caudal peduncle; it is from the latin words *tuber*, a neuter noun meaning swelling, and *mangus*, meaning large, the later dismembered to *-gus*, but modified appropriately to the gender of *tuber*.

COMPARISONS WITH OTHER SPECIES

EXTERNAL CHARACTERS. The presence of a row of enlarged tubercles on the caudal peduncle on the apex of elongated scales of the scale rows immediately above and below the lateral line scale row immediately separates *N. tuberigum* from all other known *Nemacheilus* except *N. selangoricus* and *N. spiniferus*. The lack of a dark spot at the anterior base of the dorsal fin immediately distinguishes *N. tuberigum* from these later two taxa; additional differences from these two species are recorded in Table 2. Nevertheless it is worthwhile to consider some general comparisons with other *Nemacheilus* from Sumatra, which include (Kottelat *et al.*, 1993; Kottelat & Whitten, 1996) *N. fasciatus*, *N. kapuasensis*, *N. lactogeneus*, *N. longipinnis*, and *N. pfeifferae* and the possibly valid nominal taxa *N. dunckeri*, *N. papillosa* and *N. jaklesii*. A third party reviewer also requested a comparison to *N. masyae*, a species present in peninsular Thailand and Malaysia at about the same latitude as *N. tuberigum*.

COLOUR PATTERN. The colour pattern of *N. tuberigum* is a series of dorsal saddles and midlateral blotches, a colour pattern general for all Sumatra *Nemacheilus* of which we are aware except *N. lactogeneus*. Nevertheless, *N. tuberigum* is distinguishable from some of the other species of *Nemacheilus* from Sumatra in matters of colour pattern details.

Nemacheilus fasciatus, *N. jaklesii* and *N. longipinnis* each possess a dark spot at the anterior base of the dorsal fin, which *N. tuberigum* lacks. In addition, *N. jaklesii* appears to have a colour pattern of dorsal saddles nearly confluent with relatively deep vertical, lateral bands rather than blotches along the lateral line. The photograph of the type of *N. longipinnis* reproduced in Kottelat *et al.* (1993; Fig. 139) indicates a dark spot at the base of the anterior part

of the dorsal fin even if the colour pattern is not evident on the rest of the body. Peter Bartsch examined this specimen for us and confirms the presence of the spot, although now faded, which Ahl (1922) specifically mentions in the description of the colour pattern of the species. *Nemacheilus longipinnis* also seems to have a larger eye than *N. tuberigum*, in which the eye is noticeably shorter than the snout.

With 10–15 dorsal saddles and 8–13 lateral blotches, *N. tuberigum* has generally fewer dorsal saddles and lateral blotches than *N. pfeifferae* (10–18 dorsal saddles, 10–15 lateral blotches; data from Kottelat *et al.*, 1993), the photograph of which in Kottelat *et al.* also shows its lateral blotches fused into a more or less continuous band from the opercle to the base of the caudal fin. We have examined 2 syntypes of *N. papillosa*, the condition of which is not very good. However, traces of the colour pattern are still evident; the colour pattern seems to consist of dorsal saddles with a well defined, relatively narrow, lateral band 3 scale rows wide centered on the lateral line, at least on the posterior half of the body. Lateral blotches in *N. tuberigum* may become confluent to form a lateral band, especially in the posterior half of the body, but in our material it is never as narrow or as distinct as in the syntypes of *N. papillosa* we examined. The colour pattern of some populations of *N. kapuasensis* is readily distinguishable from that of *N. tuberigum*. Dorsal saddles and lateral blotches of these *N. kapuasensis* are equal in number and more or less confluent, rendering an appearance of dorsal saddles that extend ventrally to the level of the insertion of the pectoral fin (see Kottelat, 1984: Fig. 16b; Kottelat *et al.*, 1993: Pl. 25). Dorsal saddles and lateral blotches of *N. tuberigum* form two clearly separate series.

Kottelat *et al.* (1993) suggest *N. dunckeri* may be a synonym of *N. pfeifferae*. The holotype of *N. dunckeri* was examined for us by Peter Bartsch. He reports the specimen to be faded but that there is no indication of a dark spot at the anterior base of the dorsal fin; Ahl (1922) specifically stated there are no spots on any of the fins. Ahl also described a sharply defined dark lateral stripe, wider than eye diameter, extending from the opercle to the caudal peduncle. The lateral blotches of *N. tuberigum* do not form such a band, not even on the caudal peduncle of the largest specimens examined by us.

True *N. lactogeneus* (*contra* Kottelat *et al.*, 1993; work in progress) are whitish, without any dorsal saddles at all sizes and possess an ocellated dark spot at the base of the middle caudal fin rays. Thus, it is readily distinguishable from *N. tuberigum*.

Nemacheilus tuberigum is easily and immediately distinguishable from *N. masyae* by colour pattern; *N. masyae* exhibits a prominent dark spot on the anterior, basal part of the dorsal fin (Smith, 1933; Kottelat, 1990: Fig. 29) which *N. tuberigum* does not.

DISCUSSION

Squamation and tuberculation among *Nemacheilus* species varies a great deal. The specialised 'acuminate' condition of certain scales, with large apical tubercles, on the caudal peduncle of *N. selangoricus* and *N. spiniferus* as described by Inger & Chin (1962) and Kottelat (1984) is perhaps one extreme of a continuum. *Nemacheilus tuberigum* possesses elongate, tear-drop shaped scales, even if not attaining an acuminate condition, with comparatively large apical tubercles, in the same general area as *N. selangoricus* and *N. spiniferus* and other species such as *N. chrysolaimos* and *N. papillosa* also have enlarged or elongated scales on the caudal peduncle, even if these species do not possess the distinctive rows of large tubercles along the lateral line of the caudal peduncle as do the three species

just discussed. Of *N. tuberigum*, *N. chrysolaimos* and *N. papillosa* the first two have scales on the caudal peduncle that are much more elongate than those of *N. papillosa* and those of *N. tuberigum* are significantly longer than those of *N. chrysolaimos* ($N. tuberigum \bar{x} = 1.59$, $sd = 0.08$; $N. chrysolaimos \bar{x} = 1.48$, $sd = 0.06$; $t = 3.23$, $p = 0.0023$). It is conceivable that when more species are examined in detail the gaps between different conditions of squamation found among species of *Nemacheilus* will narrow, or even disappear so that the transition between conditions will be seen as smooth.

COMPARATIVE MATERIAL

Nemacheilus chrysolaimos: MZB 1374 b, 10 ex. (43.0–47.3 mm SL); Cisarua, Bogor, Java, Indonesia; Yachya, 5 April 1970. MZB 1366, 9 ex. (27.9–41.6 mm SL); Ciapus, Gadog, Bogor, Java, Indonesia; Minin, 25 December 1969. MZB 1376 b, 3 ex. (45.5–49.4 mm SL); Cimatuk, Parung Panjang, Bogor, Java, Indonesia; S. Wargasmita, 28 October 1970.

Nemacheilus fasciatus: MZB 1372 b, 3 ex., (55.3–57.6 mm SL); Cikaniki, Cipaku, Bogor, Java, Indonesia; S. Wargasmita, 25 March 1970. MZB 1372 c, 6 ex., (56.7–69.2 mm SL); Cikaniki, Cipaku, Bogor, Java, Indonesia; S. Wargasmita, 25 March 1970. MZB 2010, 7 ex. (56.3–68.6 mm SL), Sangharus, Airnaningan, Pulau Panggung, Lampung Selatan, Sumatra, Indonesia; D. Hardjono & F. Sabar, 26 February 1975.

Nemacheilus jaklesii: BMNH 1866.5.2.60, paralectotype, (49.1 mm SL); Paya Kumbuh, Sumatra, Indonesia; male.

Nemacheilus papillosa: ZMA 112.874, 2 syntypes, (48.0 mm SL, male with subocular flap obvious; 56.3 mm SL, female with eggs apparent); Lake Toba, Balige, Sumatra, Indonesia.

Nemacheilus selangoricus: MZB 3551, 3 ex. (28.3–29.4 mm SL); small forested stream where it flows into S. Mandai upstream from its confluence with Kapuas mainstream, S. Kapuas basin, Kalimantan Barat, Indonesia; T. Roberts, 10 August 1976. MZB 2395 b, 3 ex., (29.3–41.4 mm SL); Tanah merah, Lempake, Kalimantan, Indonesia; M. Siluba, 27 February 1978.

Nemacheilus spiniferus: MZB 6807, 6 ex., (32.2–37.5 mm SL); S. Tarusan, a tributary of S. Laung, a tributary of S. Barito, Kalimantan Tengah, Indonesia; D.J. Siebert, A.H. Tjakrawidjaja & O. Crimmen, 16 July 1992. MZB 6877, 11 ex., (29.5–38.0 mm SL); S. Karingian, a tributary of S. Laung, a tributary of S. Barito, Kalimantan Tengah; D.J. Siebert, A.H. Tjakrawidjaja & O. Crimmen, 7 July 1992. MZB 6928, 2 ex., (38.7–40.0 mm SL); S. Laung, a tributary of S. Barito, Laung Tuhup, Barito Utara, Kalimantan Tengah, Indonesia; D.J. Siebert, A.H. Tjakrawidjaja & O. Crimmen, 15–18 July 1992. MZB 6948, 2 ex., (34.1–34.5 mm SL); S. Mata, a tributary of S. Barito below Muara Laung, Laung Tuhup, Barito Utara, Kalimantan Tengah, Indonesia; D.J. Siebert, A.H. Tjakrawidjaja & O. Crimmen, 8 July 1992.

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longipinnis for us and provided translations of Ahl's description of their colour patterns. Dr. Maurice Kottelat provided valuable suggestions as a third party reviewer. Permission from Taman Nasional Gunung Leuser and Leuser Management Unit to conduct studies in the Suag Balimbing Research Station is gratefully acknowledged. We also thank the Photography Unit of the Natural History Museum, London for photographs and Abdul Mun'im for dedicated assistance with fieldwork.

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Table 1 Morphometric and meristic data for *Nemacheilus tuberigum* sp.nov., $n = 28$ for paratypes; measurements follow Kottelat (1984).

	Holotype	Paratypes	\bar{x}	s.d.
Standard length	48.5	31.9–53.4		
Total length	122.1	121.1–127.7		
As % standard length				
Lateral length of head	22.1	20.3–24.8	22.7	0.96
Dorsal length of head	18.6	16.8–20.9	19.2	0.91
Predorsal length	48.7	47.0–52.0	49	1.36
Prepelvic length	51.2	47.9–52.8	50.4	1.20
Preanal length	75.4	73.0–78.5	75.7	1.47
Preanus length	69.2	65.1–73.3	69.4	2.11
Head height (at eye)	9.6	9.2–11.2	10.15	0.42
Body height (at nape)	12.2	11.9–14.5	12.8	0.58
Body height (at dorsal origin)	17.9	15.1–22.3	18.0	1.73
Height of caudal peduncle	10.8	10.6–11.9	11.3	0.33
Length of caudal peduncle	14.1	13.1–16.4	14.8	0.74
Snouth length	8.8	7.8–9.8	8.7	0.51
Head width (at nares)	4.8	4.5–5.5	5.0	0.22
Maximum head width	12.9	12.0–14.5	7.1	0.67
Body width (at dorsal origin)	12.1	10.0–16.3	15.9	1.55
Body width (at anal origin)	6.8	6.8–8.4	24.4	0.38
Eye diameter	5.0	2.3–6.3	5.0	0.66
Interorbital width	6.3	6.3–7.9	7.1	0.37
Height of dorsal fin	15.2	12.3–20.1	15.9	2.03
Length of upper caudal lobe	21.9	21.0–28.5	24.4	1.55
Length of lower caudal lobe	24.1	22.0–26.6	23.6	1.27
Length of median caudal ray	16.8	16.0–19.8	17.5	1.09
Length of anal fin	17.4	15.4–18.2	16.8	0.75
Length of pelvic fin	15.0	14.8–17.0	15.9	0.65
Length of pectoral fin	16.6	15.7–20.8	17.8	1.25
As % dorsal head length				
Lateral length of head	118.7	111–128	118	4.52
Head height at eye	51.9	47.5–58.1	52.9	2.30
Head width at nares	26.0	23.3–28.1	26.1	1.61
Maximum head width	69.3	60.8–76.5	68.1	4.88
Eye diameter	27.2	23.9–29.9	26.5	1.48
Interorbital width	34.1	32.2–43.1	36.9	2.31
C. peduncle : Length/height	1.3	1.1–1.4	1.3	0.11
D. fin rays (simple/branched)	4/9	4/9		
Caudal fin rays	9+8	9+8		
A. fin rays (simple/branched)	3/5	3/5		
Ventral fin rays	8	8		
Pectoral fin rays	11	11		
Lateral line pores	82	76–90		

Table 2 Comparison of selected features helpful in distinguishing *Nemacheilus tuberigum* from *N. selangoricus* and *N. spiniferus*.

	<i>N. tuberigum</i>	<i>N. selangoricus</i> *	<i>N. spiniferus</i> *
Colour Pattern	Body with 8–13 dark brown blotches, sometimes fused to form a longitudinal stripe in larger specimens. 10–15 dark brown saddles on the back, sometimes some of which are in contact with blotches on sides.	Body with 8–12 dark brown bars.	Body with 10–13 dark brown bars.
Eye diameter	Smaller, 5% SL (4.5–5.5%) 26.5% HL (23.9–29.9%)	Larger, 5.7% SL (4.7–6.9%) 29% HL (23–33%)	Larger, 6.5% SL (5.7–7.4%) 31% HL (26–33%)
Dorsal fin	Dorsal fin dusky, without spot at anterior base Height of dorsal fin shorter 15.9% SL (12.3–28.5%) 85.8% HL (65.8–108.7%)	Dorsal fin with 2 distinct black stripes and a black spot at anterior base Taller, 20.2% SL (16.4–24.9%) 101% HL (81–123%)	Dorsal fin with irregular stripes and a black spot at anterior base Taller, 20.7% SL (16.9–23.2%) 98% HL (80–113%)
Caudal fin	Upper caudal lobe, shorter 24.4% SL (21.0–18.5%) 126.5% HL (111–146.4%) Lower caudal lobe shorter 23.4% SL (15.7–20.8%) 123.4% HL (112.8–136.0%)	Longer, 33.4% SL (29.6–40.8%) 165.0% HL (144–211%) Longer, 28.8% SL (24.3–33.0%) 145.0% HL (127–158%)	Longer, 30.6% SL (26.8–34.1%) 142% HL (120–160%) Longer, 28.8% SL (23.8–34.3%) 135% HL (112–153%)
Pectoral fin	Shorter, 17.8% SL (15.7–20.8%) 92.9% HL (83.3–106.2%)	Longer, 21.1% SL (17.0–24.7%) 106% HL (92–122%)	Longer, 22.3% SL (19.1–26.7%) 105% HL (94–123%)
Lateral line pores	Complete, 82.6 (76–90)	Complete, 84.3 (77–96)	Complete, 88 (83–93)

*Data from Kottelat (1984).



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