

Lepidocephalichthys eleios, a new loach from Lake Indawgyi basin, Kachin State, Myanmar (Teleostei: Cobitidae)

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Abstract. *Lepidocephalichthys eleios*, new species, is described from the basin of Lake Indawgyi in Irrawaddy drainage in northern Myanmar. It is a small-sized species (largest known specimen 22.8 mm SL) distinguished from all congeners in having the last two rays of the pectoral fin in male adjacent, without membrane between them, not fused and without dorsal projections (vs. unbranched parts fused and forming a thick rod, with a dorsal projection in the other species of the genus). Its colour pattern is made of an irregular midlateral row of small spots, sometimes forming a stripe; a middorsal row of 9–12 irregular saddles; an arched black band at base of principal caudal-fin rays (no ocellus or black spot); caudal fin with 2–3 very irregular bars, irregularly connected or fused, leaving unpigment patches. The species lives in dense vegetation along the shores and in mud and vegetal debris at the bottom in the marshy lower course of tributaries of the lake and of its outlet. The incorrect use of ‘lamina circularis’ in recent cobitid literature is discussed.

Key words. Cobitoidei, Irrawaddy River, sexual dimorphism, lamina circularis

INTRODUCTION

Loaches of the genus *Lepidocephalichthys* typically inhabit slow flowing streams, lakes and marshes, where they mainly occur on muddy bottom. The genus presently includes 19 valid species (pers. obs., updated from Kottelat, 2012, 2013). It is widely distributed in Southeast and South Asia, from Sundaland and the Mekong drainage westwards to the Indus drainage and Sri Lanka. The species from the Malay Peninsula were revised by Kottelat & Lim (1992); Havird & Page (2010), and Havird et al. (2010) revised the genus and described additional species.

Lake Indawgyi is located in the Irrawaddy drainage, Myanmar, in the hills southwest of Myitkyina. The first information on the fish fauna of Lake Indawgyi was published by Prashad & Mukerji (1929). They recorded 64 species from the lake itself and its tributaries. Since, a few ichthyologists visited the lake and this has resulted in the addition of a few species, either already known from elsewhere in Myanmar or new to science (e.g., Britz, 2007, 2010; Kullander, 2008, 2012; Kullander & Britz, 2002; Kullander & Fang, 2005; Ng & Kottelat, 2007, 2009; Kottelat, 2017).

A survey conducted in 2013 by the Forest Department, the Zoology Department of Myitkyina University and Fauna & Flora International, and additional observations made in 2014,

brought the number of species from the lake and its basin to 95 native species (Kottelat, 2015). Safety conditions in 2013 and 2014 restricted very much the areas that could be visited around the lake; this survey, however, also obtained what are possibly the first fish samples from the outlet of the lake. The outlet (Indaw Chaung) flows through a large area of marshland, in a deep channel bordered by dense vegetation and under mats of ‘floating’ vegetation. The present article describes a new species from the basin of Lake Indawgyi.

MATERIAL AND METHODS

Measurements and counts follow Kottelat (1990) and Kottelat & Freyhof (2007). Head length is the lateral head length of Kottelat (1990). Last 2 branched dorsal and anal-fin rays articulating on a single pterygiophore are noted as “1½”. The last two posterior rays (6 and 7th branched rays) of the pectoral fin, when fused, are called *pectoral rod*. Terminology for mouth parts, see Fig. 1; the lower lip is interrupted in the middle; each half is made of a fleshy lobe in medial position (*mental lobe*), which ends in a point, may have a number of indentations on the medial side, and is separated from the lateral portion by a small notch; the lateral portion (*postlabial flange*) is the area between the mental lobe and the base of the maxillary barbel; the postlabial flange is thin, extends backwards, its posterior part is free from the throat and its posterior edge usually lobed or fringed (Fig. 1). Abbreviations used: CMK, collection of the author; MHNG, Muséum d’Histoire Naturelle, Genève; and ZRC, Lee Kong Chian Natural History Museum, Singapore.

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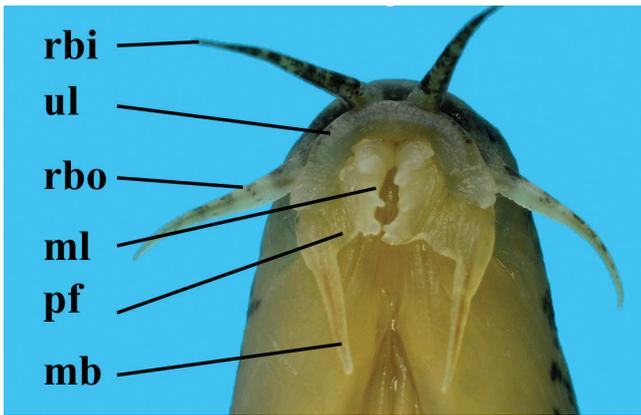


Fig. 1. Mouth parts in *Lepidocephalichthys bermorei* (CMK 25927, 71.1 mm SL), as example for the genus; ventral view. Abbreviations: mb, maxillary barbel; ml, mental lobe of lower lip; pf, posterior flange of lower lip; rbi, inner rostral barbel; rbo, outer rostral barbel; ul, upper lip.

Lepidocephalichthys eleios, new species
(Figs. 2, 3)

Holotype. MHNG 2768.058, 20.6 mm SL; Myanmar: Kachin State: Nam Phaung Sin Chaung (stream) near Nam Phaung Sin village, about 1.5 km before entering Lake Indawgyi north of Lonton; 175 masl; 25°07'23"N 96°17'15"E; M. Kottelat, Nyein Chan & Dankhaung H-Hkai, 7 December 2014.

Paratypes. CMK 25643, 13, 16.9–22.8 mm SL (and 3 fixed in 95 % ethanol); same data as holotype. — CMK 24160, 51, 17.2–22.7 mm SL (and 4 fixed in 95 % ethanol); ZRC 56629, 5, 20.3–22.0 mm SL; Myanmar: Kachin State: Indaw Chaung, outlet of Lake Indawgyi; 25°15'14"N 96°25'14"E; M. Kottelat & Dankhaung H-Hkai, 1 December 2013. — CMK 24171, 3, 14.8–19.2 mm SL; Myanmar: Kachin State: Nam Phaung Sin Chaung (stream) near Nam Phaung Chin village, entering Lake Indawgyi north of Lonton; 25°07'26"N 96°17'26"E; M. Kottelat & Dankhaung H-Hkai, 3 December 2013.

Diagnosis. *Lepidocephalichthys eleios* is distinguished from all other species of the genus by lacking any modifications of the pectoral-fin rays in males. Pectoral-fin rays 7–8 are adjacent, with narrow or without membrane between them; in males, they are separate, not fused and have no dorsal or ventral projections. Additional characters useful to distinguish the species from congeners but not unique to it are: an irregular midlateral row of irregularly set small spots, sometimes forming a stripe; a middorsal row of 9–12 saddles, reaching downwards to about ¼ of body depth, sometimes regular, sometimes irregularly shaped and of unequal density, wider than interspaces; an arched black band at base of principal caudal-fin rays (no ocellus or black spot at caudal-fin base); caudal fin with pigments on rays and membranes forming 2–3 very irregular bars, posterior



Fig. 2. *Lepidocephalichthys eleios*; MHNG 2768.058, holotype, 20.6 mm SL; Myanmar: Nam Phaung Sin Chaung, tributary of Lake Indawgyi.

Table 1. Morphometric data of holotype (H) and 6 paratypes of *Lepidocephalichthys eleios*. Range and mean include holotype data.

	H	Range	Mean
Standard length [mm]	20.6	18.1–22.8	
Total length [mm]	24.9	21.1–27.0	
In percent of standard length			
Total length	120.6	116.7–123.5	
Head length	23.9	22.3–24.9	23.8
Pre-dorsal length	52.9	52.9–56.7	54.9
Pre-pelvic length	50.2	46.9–51.2	49.5
Pre-anal length	72.5	71.2–72.5	72.0
Body depth at dorsal-fin origin	14.1	14.0–15.1	14.4
Depth of caudal peduncle	9.4	9.4–10.3	9.9
Length of caudal peduncle	19.4	17.9–23.1	19.7
Snout length	8.8	7.5–8.8	8.3
Eye diameter	3.9	3.9–4.4	4.1
Interorbital width	3.8	3.3–4.6	3.8
Length of pelvic fin	13.9	13.6–15.8	14.5
Length of pectoral fin	13.2	11.0–17.8	14.5
Length of caudal fin	21.0	19.1–23.3	21.0
In percent of head length			
Eye diameter	16	16–19	17.5
Snout length	37	32–37	35.1
Interorbital width	16	14–19	16.2

one along distal margin, bars irregularly in contact or fused, leaving variously shaped unpigmented patches; postlabial flange very long and narrow (Fig. 4); head scaleless; caudal fin truncate to slightly emarginate.

Description. See Fig. 2 for general appearance and Table 1 for morphometric data of holotype and 6 paratypes. Specimens are very small, soft and difficult to handle; measurements and counts were limited to these specimens but characters were checked on all paratypes. A moderately elongate cobitid with body depth increasing posteriorly from tip of snout up to about half of predorsal distance; behind dorsal fin, body depth decreasing slowly to end of anal-fin base, then uniform until caudal-fin base. Dorsal profile continuous between head and body. Head and body very compressed. Interorbital area arched. Eye below dorsal profile of head. Snout pointed. Suborbital spine bifid, posterior (inner) prong strongly curved medially (about a quarter of a circle), length equal to about half of eye diameter, anterior (outer) prong shorter, slightly curved. Caudal peduncle depth 1.7–2.3 times in its length, of uniform depth. Largest recorded size 22.8 mm SL.

Dorsal fin with 4 unbranched and 6½ branched rays; distal margin convex; last 2 unbranched rays with space between them. Second branched ray longest. Pectoral fin with 1 unbranched and 7 branched rays; reaching about halfway to pelvic-fin base; last two branched rays (6 and 7) not fused to form a pectoral rod but adjacent, with a narrow or without membrane between them, not thickened, without dorsal or ventral projection (in both sexes). Pelvic fin with 1 unbranched and 6 branched rays; reaching about halfway

to anal-fin origin; falcate; posterior margin straight; origin slightly in front of vertical through dorsal-fin origin. Anus immediately in front of anal-fin origin. Anal fin with 3 unbranched and 5½ branched rays; distal margin slightly convex. Caudal fin with 7+7 branched rays; truncate to very slightly emarginate.

Body entirely covered by deeply embedded scales. No scales on head. No lateral line. Anterior naris at tip of an (obliquely) truncate tube; posterior naris as a long slit, adjacent to anterior one. Mouth U-shaped, gape about twice as wide as long (Fig. 4). Upper lip with smooth edge. Lower lip with long mental lobe, with one or two short, thick projections along medial edge (close to base); rest of mental lobe slender and thin (hardly thicker than postlabial flange). Postlabial flange starting from tip of mental lobe, sometimes extending backwards further than tip of lobe) and with deeply concave posterior edge. Shape of flange variable. Lobe and flange sometimes together with appearance of flat ‘barbel’, especially in dehydrated specimens. Inner rostral barbel reaching beyond corner of mouth; outer one reaching beyond posterior margin of eye. Maxillary barbel reaching beyond posterior margin of eye.

Sexual dimorphism. There is no external sexual dimorphism except that in some of the largest specimens the pectoral fin is more rigid and expanded laterally (Fig. 2), and in these specimens the last two branched pectoral-fin rays are adjacent, without membrane between them. These specimens are probably males: a rigid and laterally expanded pectoral fin is observed in most species of the loach families Cobitidae and Nemacheilidae and is a character of males. In the

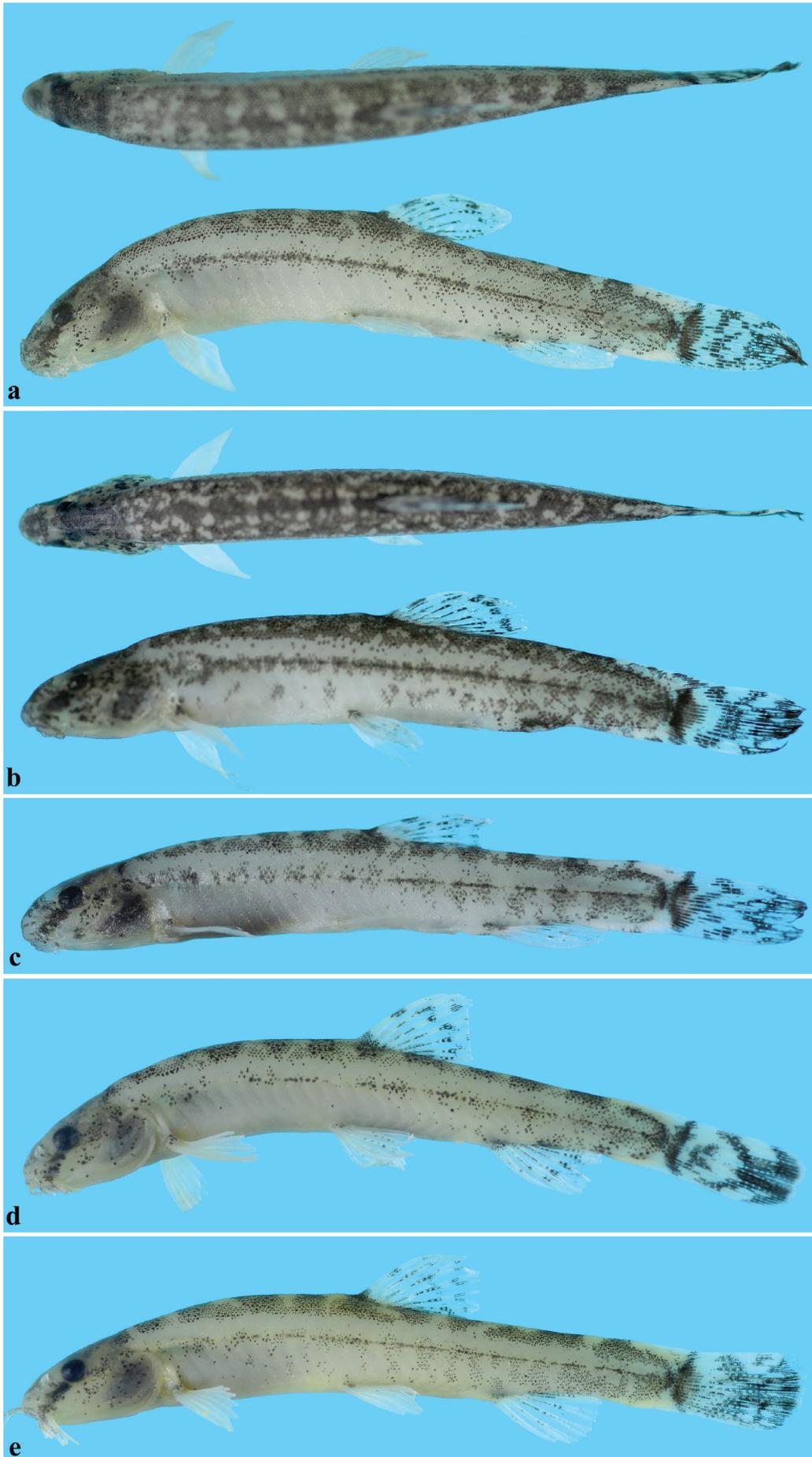


Fig. 3. *Lepidocephalichthys eleios*, paratypes; Myanmar: Lake Indawgyi basin. a, CMK 21460, 19.8 mm SL; b, CMK 21460, 22.6 mm SL; c, CMK 24171, 19.2 mm SL; d, CMK 25643, 19.5 mm SL; e, CMK 25643, 22.8 mm SL.

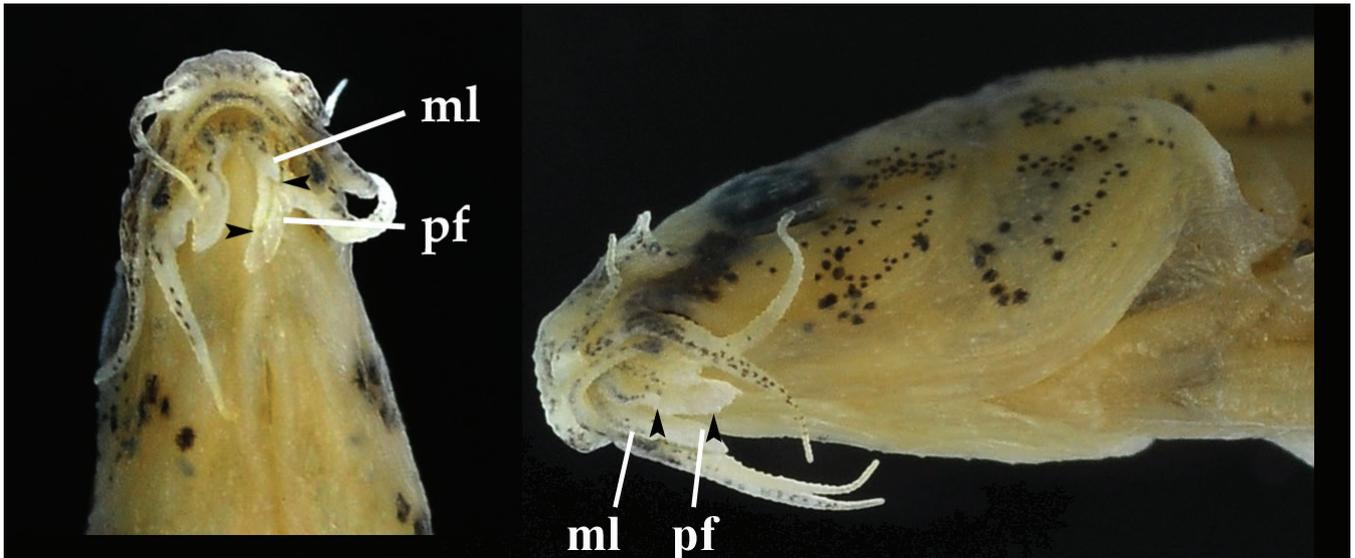


Fig. 4. *Lepidocephalichthys eleios*; CMK 24160, 21.0 mm SL (left) and 20.6 mm SL (right); mouth in ventral (left) and latero-ventral (right) views. Abbreviations: ml, mental lobe of lower lip; pf, postlabial flange. Arrows indicate tip of mental lobe and tip of medial projection.

other specimens, the fins are softer, and there is a narrow membrane between the last two rays. The specimens with a narrow membrane have a somewhat stouter appearance (not quantified), as observed in females of other species of *Lepidocephalichthys*. See further comments under Notes on biology.

Coloration. After one month in formalin. Head and body background colour pale yellowish grey; except otherwise stated, markings darker grey to blackish. Head with stripe between eye and base of outer rostral barbel, and diffuse blotches on nape and dorsal surface of snout. Body with 9–12 middorsal saddles (3–5 predorsal, 2–3 subdorsal, 3–6 postdorsal; modally 4+2+5) reaching downwards to about $\frac{1}{4}$ of body depth, sometimes regular (Figs. 2, 3a, d, e), sometimes irregularly shaped and of unequal density (Fig. 3b); wider than interspaces. An irregular midlateral row of irregularly set small spots or irregular blotches, sometimes forming a stripe; midlateral row or stripe leaving an unpigmented band between it and middorsal row of saddles. Otherwise, very few pigments on flank in front of level of anal fin; pigments denser posteriorly, especially on lower half of caudal peduncle. Three diffuse blotches along ventral midline: first one at anal-fin origin (on body and fin); second one at base of last anal-fin rays; third one at about midlength of caudal peduncle. Axial streak present.

Black mark at caudal-fin base: an arched band (tips pointing backwards) at base of principal rays, not reaching dorsal and ventral midlines. No ocellus.

Dorsal fin hyaline, with dark brown pigment along most of unbranched rays 3–4, most of unbranched part of branched rays; black marks on membranes near branching points. A dark spot at base of anterior rays. Caudal fin hyaline, with pigments on rays and membranes forming 2–3 irregular bars, posterior one along distal margin; bars irregularly in contact or fused, leaving variously shaped unpigmented patches; pigments present on membranes (especially in posterior



Fig. 5. Myanmar: Kachin State: Nam Phaung Sin Chaung, tributary of Lake Indawgyi, north of Lonton; type locality of *Lepidocephalichthys eleios*.

part of fin) and on rays, except at joints between segments. Anal fin hyaline, with dark brown pigments along most of unbranched rays 3–4, most of unbranched part of branched rays; black marks on membranes near branching points (pattern mostly visible only with magnification). A dark spot at base of anterior rays. Pelvic fin hyaline, with a few isolated dots on rays and membranes. Pectoral fin hyaline.

In life: body slightly purplish brown, slightly translucent.

Notes on biology. *Lepidocephalichthys eleios* was observed at 3 of 12 sites sampled in Lake Indawgyi basin: one in the outlet of the lake, two in a tributary. These three sites are characterised by deep water, very slow current, dense shore vegetation (Figs. 5, 6), large extents of floating mats of plants (Fig. 7), and bottom made of mud or clay covered with a layer of vegetal debris. The specimens were obtained from the leaf litter, from among the dense vegetation or by scraping with a tray net the underside of the ‘floating’ vegetation. Other species collected in the same micro-habitat were: *Oreichthys* sp., *Pethia erythromycter*, *Heteropneustes*

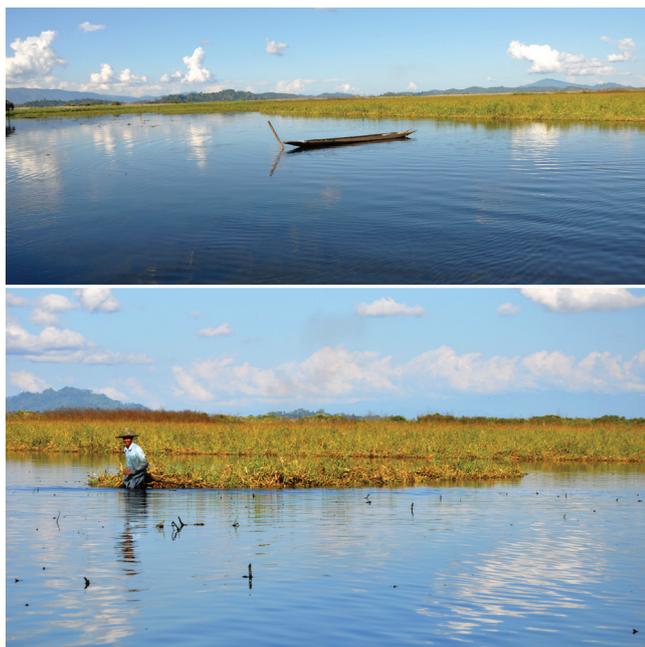


Fig. 6. Myanmar: Kachin State: marshes along Indaw Chaung, outlet of Lake Indawgyi (a); mats of floating vegetation are moved by farmers (b); locality and habitat of *Lepidocephalichthys eleios* (CMK 24160).

fossilis, *Chaudhuria* sp., *Mastacembelus pantherinus*, *Monopterus cuchia*, *Indostomus paradoxus*, *Badis corycaeus*, *Dario hysginon*.

Fourteen of the largest and stoutest specimens guessed to be females were dissected; either the abdominal cavity was swollen but empty, or there were unripe ovaries. Two individuals had what seemed to be one and three ova, about 0.1 mm diameter. All samples were obtained in December; a distended belly and the absence of ova suggest that spawning possibly already occurred for some individuals. No specimen smaller than 15 mm SL was observed (mesh size was about 1 mm and they would have been seen). Several hours of sampling by up to 5 persons, at different depths of water and over and in different substrates yielded hundreds of individuals (of which only a subsample was preserved), but no specimen larger than 22.8 mm SL was observed. Admittedly, this does not demonstrate that they are mature, but there is also no evidence that sexual maturity is not reached at this size or smaller. The modified (rigid and curled) pectoral fins of males, the female with swollen belly (possibly spent), and the absence of small individuals suggest they are mature or close to.

Distribution. *Lepidocephalichthys eleios* is presently known only from Lake Indawgyi basin, Kachin State, Myanmar, in the Irrawaddy drainage. Because no sampling could be done in similar habitats downstream of the lake in the Mogaung watershed, it is premature to conclude that *L. eleios* is endemic to the lake and its basin.

Etymology. From the classical Greek ἑλειος *heleios*, *eleios*, meaning ‘of the marsh’, ‘dwelling in the marsh’. A noun in apposition.

Remarks. The genus *Lepidocephalichthys* is distinguished from all other genera of the family Cobitidae by having the pectoral-fin with 1 unbranched and 7 branched rays, of which, in males, the last 2 rays are fused, forming a pectoral rod thicker than the other rays, with a variously developed projection, at about midlength of the dorsal side, ranging from a small swelling (pectoral rod swelling) to an elevated, thin, vertical flange (pectoral rod plate); in one species there is also a vertical flange along the ventral side of the ray (Nalbant, 1963; Kottelat & Lim, 1992; Havird & Page, 2010; Deenin et al., 2014). Other characters are: slender body; absence of lateral line; dorsal fin with 3–4 unbranched and 6½ branched rays; pelvic fin with 1 unbranched and 6 branched rays; anal fin with 3 unbranched and 5½ branched rays; caudal fin with 14 branched rays; three pairs of barbels (2 rostral and 1 maxillary); each half of lower lip (Fig. 1) with a pointed mental lobe separated from postlabial flange by a small notch, posterior margin of flange and medial edge of lobe denticulated, crenulated or fringed; anterior naris at tip of a short tube (not extended into a ‘nasal barbel’).

Lepidocephalichthys eleios is, however, missing the main character diagnosing *Lepidocephalichthys*, the presence of the pectoral rod in males. Sexual dimorphism provides very efficient characters to identify lineages in Cobitidae (Nalbant, 1963, 1994; Šlechtová et al., 2008; Kottelat & Tan, 2008; Kottelat, 2012: 138). In specimens of *L. eleios* identified as males, the last two pectoral rays are not fused into a rod but close to each other, without membrane between them, they are not thickened, and there is neither a dorsal nor a ventral flange. As is described above, all the other characters used to diagnose the genus are present in *L. eleios* and show a similar appearance as in the other species of *Lepidocephalichthys*. The organisation of pectoral-fin rays 7 and 8 in close contact in male *L. eleios* is considered either as a plesiomorphy or as precursor stage to the fusion into a pectoral rod, and is possibly related to an incomplete development resulting from the small size of the species (developmental truncation), as observed in many other miniature fishes (see, e.g., Britz & Kottelat, 2003, 2008; Kottelat et al., 2006; Britz & Conway, 2009; Britz et al., 2014).

Lepidocephalichthys eleios cannot be a member of the other genera of Cobitidae as it does not have the characters distinguishing them from *Lepidocephalichthys* either. To mention only the genera present on mainland Southeast Asia: the lamina circularis in males of *Cobitis* and *Misgurnus*; the serrated edge of the 2nd ray of the pectoral-fin in males of *Kottelatlimia*; the strongly elongated body and snout and very ornamented lips with large conical and lacinated projections along the edges of *Acanthopsis*; the slender to anguilliform body, the backward position of the dorsal fin and the curled pectoral fin in males of *Pangio*; the deep and uniformly dark brown body, small eye and poorly distinct or missing mental lobe of *Lepidocephalus*; the four barbel-like projections of the lower lip and the keeled and vertically distorted caudal peduncle in males of *Microcobitis*; and the ridges of papillae along the barbel and lips and the slender translucent to whitish body of *Acanthopsoides*.

Kottelat & Lim (1992) described sexual dimorphism in the Sundaic and some Indochinese species of *Lepidocephalichthys*. Havird & Page (2010) reported sexual dimorphism in most species of *Lepidocephalichthys*, but with a confused terminology. The main problem is their misunderstanding of the ‘lamina circularis’ present in some genera of Cobitidae. They commented (p. 137) on the fused last two pectoral-fin rays: “[t]his modification is referred to as the lamina circularis and is formed by a fusion and hardening of the innermost (seventh and eighth) pectoral rays. In mature males of other cobitid genera, the lamina circularis is formed by different pectoral rays (usually the second) or is absent”. To refer to just any sexually dimorphic modification of the pectoral rays in Cobitidae as ‘lamina circularis’ is erroneous as the structures compared are not homologous (a structure on fin rays 7 and 8 vs. a structure on ray 2). There is an extensive literature on cobitids and their sexual dimorphism by authors in Europe, China, Japan, and Korea, spanning over about 140 years (e.g., Bacescu, 1962; Nalbant, 1963; Šlechtová et al., 2008). Lamina circularis means circular lamella. The sexual dimorphism in *Cobitis* was first described by Canestrini (1871) as a swelling at the base of the first branched pectoral-fin ray; it was later recognised as a circular, ‘scale-shaped’ projection of the ray itself and became known as Canestrini scale and later as lamina circularis, which is more appropriate because the structure is not a scale. The lamina circularis is a lamina, usually but not always circular, posterior projection of the first (proximal-most) segment of the dorsal hemitrich of the first branched pectoral-fin ray (see, e.g., Nalbant, 1963: 356; Kottelat & Freyhof, 2007: 301, fig. 61). A second lamina circularis is present on the second branched ray in some species. Obviously, the lamina circularis of males of *Cobitis* and *Misgurnus* is not homologous with the fused pectoral-fin rays 7–8 of male *Lepidocephalichthys*, with the thickened pectoral-fin rays 1–2 of male *Theriodes*, with the curled pectoral fins with thickened pectoral-fin ray 2 of male *Pangio*, *Lepidocephalus*, *Acantopsis* and *Acanthopsooides*, with the modified pectoral-fin rays 5–8 of male *Neoeucirrhichthys*; or with the blade-like formation or ‘saw’ on pectoral-fin ray 2 of male *Kottelatlimia* (Kottelat & Lim, 1992; Kottelat & Tan, 2008; Šlechtová et al., 2008; Kottelat, 2012; Deenin et al., 2014).

Two other species of *Lepidocephalichthys* have been observed in Lake Indawgyi basin, *L. berdmorei* and *L. alkaia*. In both, the last 2 pectoral-fin rays are fused into a rod in adult males. *Lepidocephalichthys berdmorei* is a large species (up to 78 mm SL) found in small streams with moderate to fast current, usually with pebble to stone bottom. It has a stout body, yellowish brown colouration with numerous small black spots, a midlateral row of irregular small black blotches, a black blotch on base of branched caudal-fin rays 3–7; the caudal fin has 3–6 thin black bars; the last two pectoral-fin rays are fused in a thick cylindrical rod. *Lepidocephalichthys alkaia* reaches up to 61 mm SL and is found in more sluggish streams. It has a stout body, a pale yellowish background colour, a midlateral row of blotches more or less contiguous to form a midlateral stripe, continued by black pigments on median caudal-fin rays and membranes inbetween, a black blotch on base of branched rays 3–7 of caudal fin base, and

the caudal fin has 5–8 thin irregular vertical rows of black spots; the last two pectoral-fin rays are fused into a rod with a low dorsal swelling, highest at about midlength.

Material used for comparison. *Lepidocephalichthys alkaia*: CMK 24128, 50; CMK 25618, 33; Myanmar: Lake Indawgyi basin. — CMK 14649, 7; Thailand: Salween drainage. *L. berdmorei*: CMK 24152, 2; CMK 24190, 1; Myanmar: Lake Indawgyi basin. — CMK 25430, 1; Myanmar: Tenasserim. — CMK 14648, 1; Thailand: Salween drainage. — CMK 25927, 8; CMK 25941, 3; Laos: Mekong drainage. *L. cf. goalparensis*: CMK 26462, 1; CMK 26518, 1; Myanmar: Irrawaddy drainage: Putao. *L. cf. kranos*: CMK 12646, 4; Laos: Mekong drainage. *L. furcatus*: CMK 16516, 5; Thailand: Tapi drainage. *L. guntea*: CMK 5429, 1; India: Karnataka. *L. hasselti*: CMK 24894, 5; Myanmar: Tenasserim. — CMK 13249, 47; Laos: Mekong drainage. — CMK 7316, 1; Indonesia: Sumatra: Siak drainage. — CMK 20580, 1; Indonesia: Sumatra: Musi drainage. — CMK 8263, 21; Malaysia: Kelantan. — CMK 5124, 24; Thailand: Sai Buri. *L. jonklaasi*: CMK 12190, 29; Sri Lanka. *L. lorentzi*: CMK 6967, 2; Indonesia: Borneo: Kapuas drainage. *L. micropogon*: CMK 26657, 2; Myanmar: Irrawaddy drainage: Myitkyina. — CMK 25065, 1; CMK 25230, 1; Myanmar: Tenasserim. *L. thermalis*: CMK 7059, 10; Sri Lanka. — CMK 9340, 12; India: Kerala. *L. tomaculum*: CMK 8033, 6 paratypes; Malaysia: Selangor. — CMK 11273, 7; Indonesia: Sumatra: Batang Hari. — CMK 11927, 4; Indonesia: Bintan. *L. zepplini*: CMK 7968, 2; CMK 23025, 2; Laos: Mekong drainage. — CMK 10749, 5; Thailand: Mekong drainage.

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