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A new species of *Nanochromis* (Teleostei: Cichlidae) from Lake Mai Ndombe, central Congo Basin, Democratic Republic of Congo

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Abstract

Nanochromis wickleri, a new cichlid species from Lake Mai Ndombe in the central Congo basin, is described. The large, deep-bodied species differs from all congeners in the possession of an elevated soft dorsal fin ray count (10–11 vs. 5–8) and by the presence, in adults, of strongly produced membranous fin lappets on the second and third dorsal fin spines. Pending comprehensive phylogenetic analysis *Nanochromis wickleri* is tentatively placed within a morphologically diagnosable subclade of *Nanochromis*, herein named the "*nudiceps* group".

Key words: *Nanochromis*, Congo Basin, new species

Introduction

Species diversity among the Congolese cichlid genus *Nanochromis* Pellegrin is poorly known, despite the fact that the first species was described more than a century ago and that the group has since attracted considerable attention from the aquarium hobby. The genus was erected by Pellegrin (1904) for the type species *nudiceps* Boulenger, 1899 as a replacement name for the preoccupied *Pseudoplesiops* Boulenger, 1899. As currently understood, *Nanochromis* belongs to a monophyletic group of African cichlids informally named the chromidotilapiines, and is diagnosed by the possession of a characteristically reduced infraorbital series, and an elevated lateral line that is posteriorly contiguous with the dorsal fin base (Greenwood 1987). Five of the nine described *Nanochromis* are known only from the region of the lower Congo rapids between the Malebo Pool and the town of Inga. However, the locality of the type species *N. nudiceps,* is "Kutu", a small Congolese town located in the inner Congo basin ("Cuvette Centrale") at the junction of the outlet of

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Lake Mai Ndombe (formerly Lake Leopold II) with the Lukenié-Fimi River, an affluent the Kasai River. More than eighty years after the description of the first species from the inner Congo basin, a second species, *N. transvestitus*, was described from the southern end of Lake Mai Ndombe close to the village of Ipeke (Roberts & Stewart 1984). The first ichthyological collection in the northern and main part of the lake basin in the vicinity of the town of Inongo was undertaken by the first author (UKS) during a survey in August/ September 2002. This collection yielded several *Nanochromis transvestitus*, numerous *Nanochromis cf. dimidiatus* and a small number of individuals of a highly distinctive *Nanochromis* which is described herein.

Material and methods

Measurements and counts follow Barel *et al*. (1977) with some exceptions: Gill raker counts were taken from the inner row of gill rakers instead of the outer row, because the outer row is difficult to count due to extensive coverage with pachydermous tissue. Body depth (BD) was measured in a vertical line perpendicular to the line through lower part of the lateral line at the level the pelvic fin base. Caudal peduncle length (CPl) is measured as the distance between the vertical line through the caudal point of the dorsal fin insertion and the point of caudal fin flexure. Prepectoral fin length (Prepcl) is measured as the distance from the point where the central pectoral ray inserts into muscle tissue to the symphysis of the premaxillae. Prepelvic fin length (Prepvl) is measured as the distance between the insertion of the interior pelvic rays in the pelvic girdle to the symphysis of the lower jaw. Pelvic fin length (Pvl) is measured as the distance between the insertion of the longest pelvic ray in the pelvic girdle to its tip. Upper lateral line scale counts includes all pored and unpored scales until the last pored scale is reached, lower lateral line scale counts start with the scale that is in the same vertical scale row as the last pored upper lateral line scale and does not include scales on the caudal peduncle. Scale rows are numbered as described by Kullander (1990) with the horizontal row including the lower lateral line is designated as row 0, and the rows are counted as E1, E2, E3, etc. dorsally, and as H1, H2, H3, etc. ventrally. All measurements were taken on the left side of the specimens with digital callipers with an accuracy of 0.03 mm. Vertebral counts include the last halfcentrum. Counts are taken from X-rays.

The following comparative material was examined (institutional abbreviations follow Leviton *et al*., 1985): *Nanochromis nudiceps*—MRAC 1045, 1, lectotype; *Nanochromis parilus*—MCZ 50202, 4, paratypes; *Nanochromis splendens*—MCZ 50202, 8, paratypes; *Nanochromis consortus*—MCZ 50522, 5, paratypes, AMNH 23667, 1, AMNH 233375, 1; *Nanochromis transvestitus*—ZSM 29705, 9; *Nanochromis minor*—MCZ 50342, 2, paratypes; *Nanochromis sabinae*—AMNH 235651, 2, paratypes; *Nanochromis dimidiatus* —CU 88552, 1; CU 88262, 1; AMNH 8150, 2; AMNH 227666, 1; *Nanochromis squamiceps*—IRSNB 13, 1, syntype; *Nanochromis* spp.—AMNH 233569, 1; AMNH

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6079, 5; AMNH 233373, 1; AMNH 233374, 1; FMNH 57121, 3; MRAC 96737, 1; MRAC 153663–53664, 2; MRAC 192224–192232; MRAC 135706–0,1; ZSM 32433, 7; IRSNB 7353, 5. Throughout this paper the phylogenetic species concept is adopted as a basis for taxonomic comparisons and discussion.

***Nanochromis wickleri*, new species**
(Figs. 1–3)

Holotype (Fig. 1a, b). ZSM 29695, male, 70.01 mm SL; Democratic Republic of Congo, Bandundu province: Lake Mai Ndombe at Inongo south of harbour (1°56´30´´S, 18°16´15´´E), 29th July to 4th August 2002, U. Schliewen.

Paratypes (Fig. 2a, b). ZSM 29696, female, 52.6mm SL; AMNH 236665, male, 50.2 mm SL; ZSM 33989, cleared and stained, 23.0–49.2 mm SL; AMNH 236666, cleared and stained, 44.7 mm SL; all paratypes with same locality and collection data as holotype.

Diagnosis

A large, deep-bodied species of *Nanochromis,* that differs from all congeners in possessing an elevated soft dorsal fin ray count (10–11 vs. 5–8) and the presence, in adults, of strongly produced membranous fin lappets on the second and third dorsal fin spines. *Nannochromis wickleri* is further distinguished from *N. squamiceps*, *N. dimidiatus* and *N. sabinae* in having an almost scaleless cheek and nape (vs. fully scaled cheek and nape), most of the upper lateral line contiguous with the dorsal fin base (vs. only the last few scales contiguous), five laterosensory pores on the dentary (vs. 4), a tubular pore canal in the anguloarticular (vs. no canal), and seven laterosensory pores on the preopercle (vs. 6). In addition to dorsal fin features it differs from *N. parilus* by the absence of a prominent light submargin beneath a black margin on the dorsal fin and the upper edge of the caudal fin; from *N. consortus* in the profile of the spinous dorsal fin which increases regularly in height from the very short first to the last dorsal spine in *N. consortus*, but steeply over the first 3 spines in *N. wickleri*, and by never having a prominent black margin in the anal fin; from *N. splendens* in being deeper bodied (BD 25.6–28.1 % SL *vs.* 20.4–24.9 % SL); from *N. transvestitus* and *N. minor* in having a higher midlateral scale count *(*26 *vs.* 23–25*)* and in lacking prominent vertical white bands (*N. transvestitus*) or an horizontal dark band (*N. minor*) on the caudal fin in females. Finally it differs from the lectotype and single known specimen of *N. nudiceps* in a higher gill raker count on the first gill arch (18–20 *vs.* 14), a longer and narrower caudal peduncle (CPl 10.9–14.4 *vs.* 9.4 % SL; CPd 10.4–11.7 *vs.* 12.7 % SL), and a slightly higher midlateral scale count (27 *vs.* 26) (for a full comparison with that specimen see Table 1).

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TABLE 1. Morphometric and meristic data for the holotype and 8 paratypes of *Nanochromis wickleri* **sp. n.** and the lectotype of *Nanochromis nudiceps* (Boulenger, 1899).

	Nanochromis wickleri						*N. nudiceps*
Character	Holotype	N	mean	min	max	SD	Lectotype
Total Length (mm)	91.3	9	54.3	28.4	91.3		64.7
Standard length (mm)	70.0	9	41.9	23.0	70.0		48.8
PERCENT OF STANDARD LENGTH							
Body depth (BD)	28.1	9	26.8	25.6	28.1	0.76	25.6
Head length (HL)	31.0	9	32.0	30.1	33.9	1.41	30.9
Caudal peduncle depth (CPd)	11.1	9	11.1	10.4	11.7	0.68	12.7
Caudal peduncle length (CPl)	12.0	9	12.1	10.9	14.4	0.93	9.4
Anal fin base length (Abase)	20.0	9	19.3	16.3	22.5	2.02	20.9
Dorsal fin base length (Dbase)	65.0	9	60.6	56.1	65.0	2.28	65.6
Pelvic fin length (Pvl)	27.4	9	25.5	17.8	29.8	3.63	31.8
Caudal fin length (Cfl)	30.7	9	29.6	23.0	34.7	3.64	31.1
Pectoral fin length (Pcl)	18.1	9	19.9	18.1	21.9	1.22	22.7
Predorsal length (PreDl)	30.4	9	31.9	30.4	33.9	1.21	29.5
Preanalfin length (PreAl)	64.7	9	65.3	64.7	67.9	1.86	66.0
Prepectoral length (PrePcl)	34.9	9	35.4	33.7	39.6	1.76	33.4
Prepelvic length (PrePvl)	37.4	9	36.4	35.3	37.4	0.84	36.1
PERCENT OF HEAD LENGTH							
Lower jaw length (LjL)	45.2	8	42.6	38.0	47.5	3.23	39.7
Horizontal eye diameter (EyD)	30.9	9	31.6	30.5	32,9	0.78	30.5
Snout length (Snl)	38.7	9	35.6	29.1	41.2	3.80	37.7
Interorbital width (IOW)	16.1	9	15.2	11.5	18.8	2.45	15.9
COUNTS							
Lateral line scales	14+11	14+10 (1), 14+11 (2), 15+9 (1), 15+10(2), 15+11 (2), 16+10 (1)					no count possible
Midlateral scales	27	27 (9)					26
Circumpeduncular scales	12	12 (9)					12
Dorsal fin	XVI+11	XVI+11 (6), XVII+10 (1)					XVIII+8
Anal fin	III+8	III+8 (9)					III+7
Gill rakers (inner row on 1st arch)	15+1+2	15+1+2 (1), 15+1+3(5), 16+1+3 (2)					10+1+2
Vertebrae	14+14	14+14 (9)					27

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Description

Based on the holotype and 8 paratypes. See Table 1 for a summary of morphometric and meristic data, and Figs. 1–2 for general aspect. A large, relatively deep-bodied *Nanochromis* bearing a superficial resemblance to cichlids of the Lake Tanganyikan genus *Xenotilapia*. Snout long with a steeply inclined and strongly convex dorsal contour and an almost straight ventral contour. Mouth large, lip fold of the African-type, lower lip fold continous over symphysis (Stiassny 1987). Maxilla extending to vertical from slightly posterior to anterior margin of orbit. Eye large, supralaterally positioned, its dorsal margin projecting slightly beyond predorsal contour, iris ovoid. Greatest body depth at about the base of third or fourth dorsal spine (25.6–28.1, mean 26.8% SL). Head length 30.1–33.9, mean 32.0 % SL. Dorsal body profile convex, curving gently downward along the length of the dorsal fin base to the slender (CPd 10.4–11.7, mean 11.1% SL) caudal peduncle.

Squamation. Opercle, interopercle, subopercle, and postorbital region naked except for a few vestigial scales deeply embedded along the upper anterior margin of the opercle; flank scales cycloid, ovoid with long axis vertical; Upper lateral line originates at the occipital margin of the opercle, ascends to the dorsal fin base where it reaches its highest point at the 6th pored scale and continues with half an intervening scale or no scale distance to the dorsal fin base to the level of the 5th or 6th soft dorsal ray. Upper lateral line (Upl) separated from the lower lateral line (Lll) by 2 scales (excluding pored rows); overlaps Lll by 1 scale or is contiguous; scales in front of 6th pored scales above the Upl much smaller than flank scales, occipital region naked; ventral and lateral chest and interpelvic region naked; belly scales smaller than flank scales with a gradual transition; scales in ventral portion of the belly and in anal-genital region very small; anteriormost portion of caudal fin with minute scales and one large pore-bearing scale.

Fins. Dorsal fin high; with XVI–XVII (mode XVI) spines and 10–11 (mode 11) rays. Anal fin with III spines and 8 soft rays. First three dorsal fin spines gradually increase in length, the following spines approximately equal in length. In the male holotype, the first three lappets are produced, pointed and are free, those of the second and third lappets are significantly longer (approximately half of the corresponding spine length) than the first. The fourth and subsequent lappets are also somewhat produced. In paratypes >45.0 mm SL (two males, two females) fin lappets are similarly produced although somewhat less markedly so. In the remaining specimens no elongation of dorsal fin lappets is visible. Soft dorsal and anal fins in larger males including the holotype are pointed, extending slightly beyond caudal fin base, in smaller specimens they are not obviously pointed or produced. Caudal fin longer than deep, subacuminate, with fin rays increasing in length from the outer rays towards the central rays. Pelvic fin with thick spine and first ray longest, reaching almost to the anal fin base. Pectoral fin rounded reaching vertical approximately at the midpoint of the spinous dorsal fin.

Gill rakers. Fifteen to 16 small, tuberculate gill rakers on the outer row of the lower limb of the first gill arch, a somewhat larger and more elongate raker in the angle of the

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arch, and 3 bulbous epibranchial rakers (Fig. 3a). All rakers on the lower limb are deeply embedded in highly folded, pachydermous tissue making it difficult to take an accurate count of rakers in the outer row. However, the rakers are readily visualized in cleared and stained specimens and from a count of the corresponding rakers along the inner row of the first arch. In common with most other chromidotilapiine cichlids a prominent visor-like, hanging pharyngeal pad is developed on the 2nd epibranchial, and no microbranchiospines are present on the outer faces of the 2nd, 3rd, or 4th gill arches.

FIGURE 1. *Nanochromis wickleri* , holotype, ZSM 29695, male, 70.01 mm SL (91.3 mm TL);, Lake Mai Ndombe at Inongo, Democratic Republic of Congo (a) preserved (b) in life.

Teeth. Outer row dentition on both premaxilla and dentary composed of extremely gracile, slightly recurved, elongate, unicuspid teeth (Fig. 3b). All teeth are pointed, close-set and evenly spaced along each jaw, the 3–4 teeth at the premaxillary symphysis are somewhat enlarged and procumbently implanted. A single, short row of strongly recurved inner row teeth is present anteriorly in both jaws.

Lower pharyngeal jaw (LPJ). Extremely gracile, with narrow horns and a short blunt keel. The dentigerous surface is sparsely covered with fine weakly bicuspid teeth. The posterior row LPJ teeth are elongate, erect, closely spaced bicuspids with a strong hooked major cusp and a smaller minor cusp. Anteriorly the LPJ teeth are weakly erect, somewhat shouldered, unicuspids (Fig. 3c).

Vertebrae. All specimens exhibit a formula of 14+14(28) vertebrae.

Miscellaneous osteology. As in all *Nanochromis* the lachrymal has four sensory canal pores and is followed by only a single, elongate infraorbital (IO2) element (Fig. 3d). The

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laterosensory canal in the dentary is perforated by 5 pores, a tubular canal is present in the anguloarticular, and there are 7 pores in the preopercular canal (Fig. 3b).

FIGURE 2. *Nanochromis wickleri,* paratypes, (a) ZSM 29696, female, 52.6mm SL, Lake Mai Ndombe at Inongo, Democratic Republic of Congo, (a) preserved (b) in life; (c) AMNH 236665, male, 50.2 mm SL (66.8 mm TL) in life (note produced fin-lappets of 2nd and 3rd dorsal spines).

Color pattern in alcohol

Ground color beige brown. Anterior ventral and central free part of individual dorsal flank scales of row 0 and E1 with narrow black pigment band creating a pattern of oblique black stripes, which are more pronounced in rows E1 than in row 0. In row E2 and E3 the

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black margin includes the dorsal part of the anterior margin creating a reticulate pattern below the dorsal fin base. Dorsal fin membranes between the spines beige with dusky hue, free dorsal fin lappets black; soft dorsal and caudal fin with a thin black margin, fin membranes of caudal part of soft dorsal fin and upper two thirds of caudal fin with alternating light and dark maculae creating a striped patterning. Anal fin dusky grey. Pelvic fin membranes white in males and juveniles, but dusky grey to blackish in the two large females. Pectorals translucent with a thin grey margin in the caudal part. Lips white; snout, interorbital and occipital region grey, branchiostegal membranes whitish. Dark outer spot at the outer edge of opercle ("opercular spot") present. Dorsal margin of the eye above the iris black, iris dark grey except for a small light colored area in the ventral portion. The two large females with a whitish area around the genital papilla and a broad reddish brown pigment patch extending from above this whitish area to the vicinity of scale row 0. In addition, the two large females exhibit a much less pronounced pattern of black scale and fin pigmentation resulting in a more uniform overall impression.

Color in life

Based on field photographs of the living male holotype, the second largest male and largest female paratype (see Fig. 1b–2b, c). Similar to coloration in alcohol except that overall body color is bluish-grey with a metallic hue in the dorsal half of the flanks; the inner margin of the iris is white and a small patch in the ventral part as well as in the frontal part of the iris is strongly reflective (depending on light conditions); the frontal parts of the lips are slightly metallic blue-green. The large female has a white chest and a rosy preanal region and violet-rosy reflective patch above the white part of the belly. No indications of black margins of the anal fin, upper portion of caudal fin and dorsal fin. Pelvic fins white.

Geographical distribution

Known only from the type locality (Fig. 4), Lake Mai Ndombe at Inongo south of the harbour (1°56´30´´S, 18°16´15´´E).

Local name

Ipoli-apoj, a name applied to all *Nanochromis* at Inongo.

Habitat

The type locality and single collection site is at a sandy beach interspersed with flat laterite terraces south of the port of Lake Mai Ndombe. The type series was collected with a large beach seine net (locally called "nziga") consisting of a terminal sac made of thin cotton cloth and wide meshed lateral nets, that was set approx.100 m offshore at a water depth of approx. 1–2 m with the help of pirogues. Lake Mai Ndombe is a shallow blackwater lake (average depth 3 m) with strongly acidic (pH 4.0), tea-colored water of

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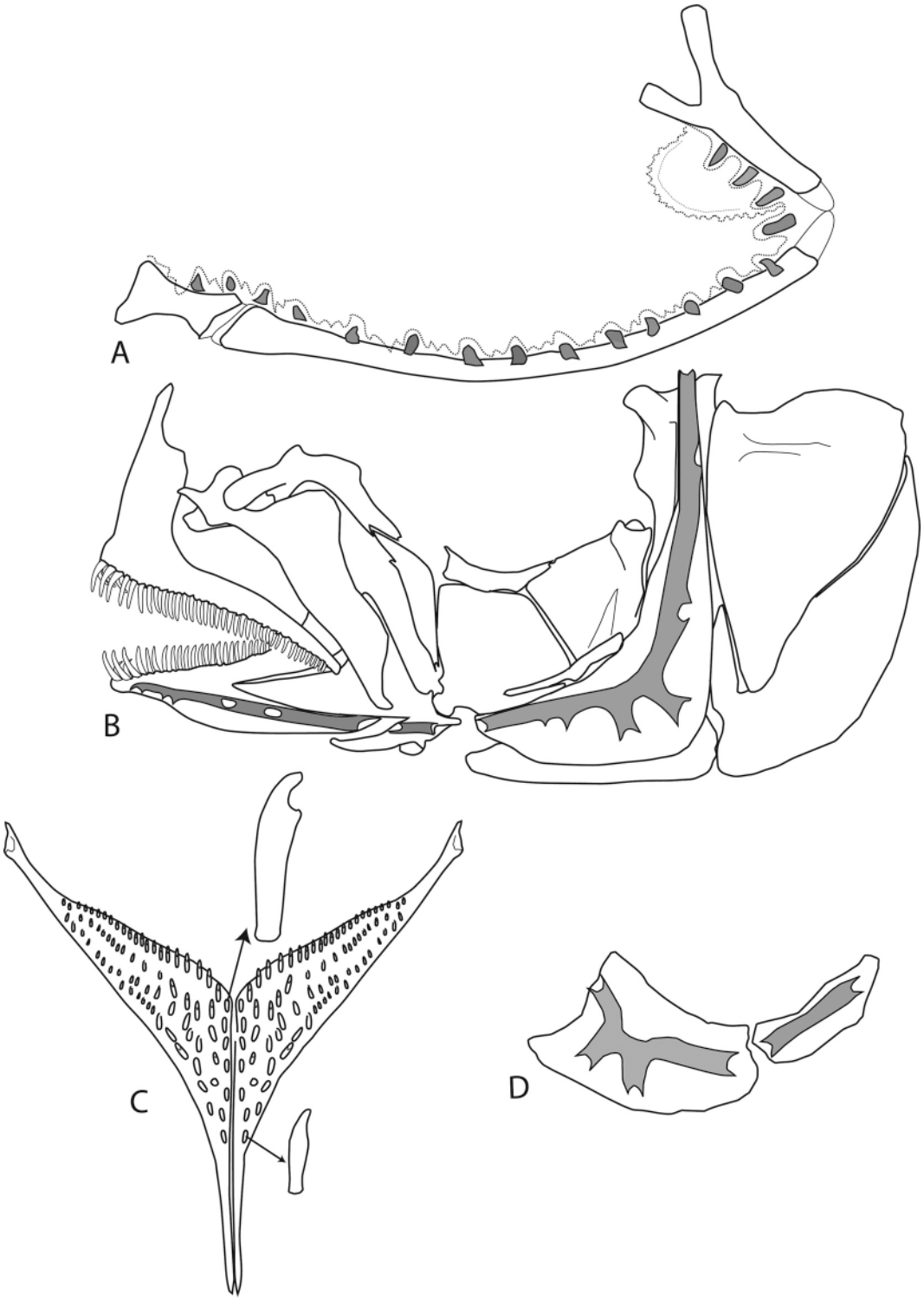

FIGURE 3. *Nanochromis wickleri*, paratype, AMNH 236666, 44.7 mm SL, (a) isolated 1st gill arch, (b) oral jaws, suspensorium and operculum, (c) LPJ, and (d) infraorbital series.

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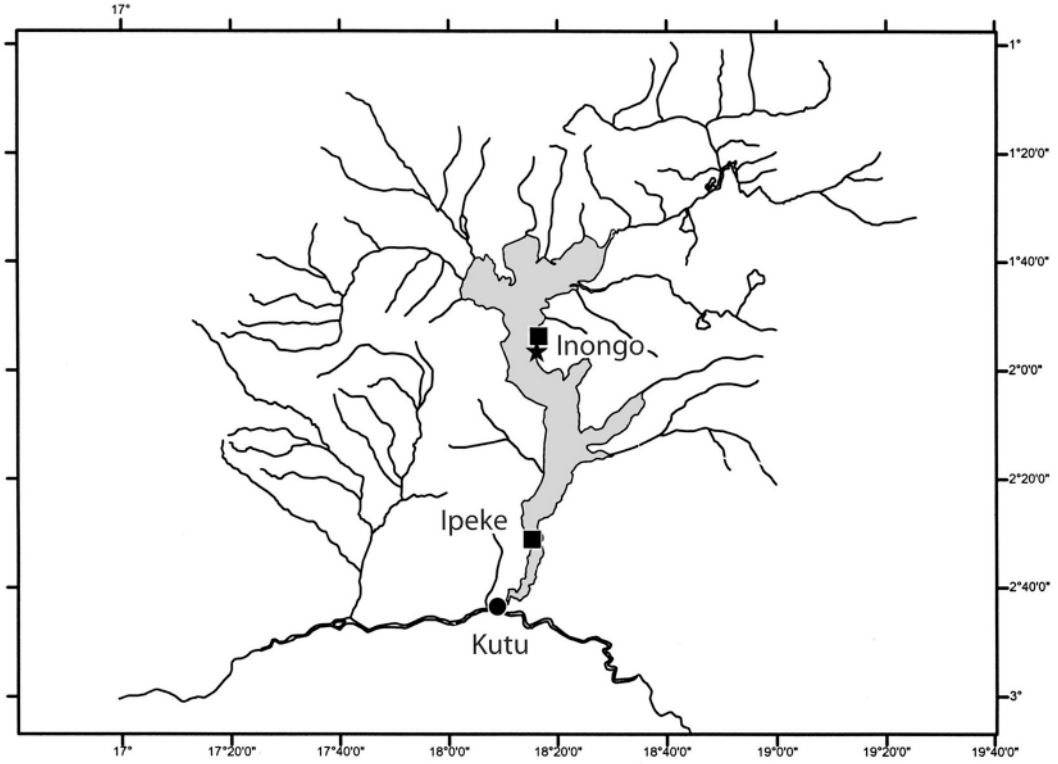

FIGURE 4. Collecting sites of *Nanochromis wickleri* (star), *Nanochromis transvestitus* (square), and *N. nudiceps* (circle) in the area of Lake Mai Ndombe.

high humic content (Stewart & Roberts 1984, Thieme *et al*. 2005). Light penetration is extremely low and already in 1 m depth there is almost complete darkness even in bright sunlight at midday. *N. wickleri* lives sympatrically with *N. transvestitus*, which however was collected and observed at several sites around Inongo and which appears to be more common than *N. wickleri*. Sites where *N. transvestitus* were collected always contained laterite stones distributed over sandy areas and included shallow water (< 1 m depth), whereas flat large laterite terraces were found only at the type locality of *N. wickleri* at a depth between 1 and 2 m.

Etymology

Named for Wolfgang Wickler in recognition of his behavioral studies of cichlids in general and of benthic Congolese cichlids in particular. As a former director of the Max-Planck-Institut for Behavioral Physiology in Seewiesen (Germany) W. Wickler generously supported studies on central African cichlid fishes conducted by UKS.

Relationships

Two species groups are discernable within *Nanochromis* as it is currently conceived, one, referred to here as the "*squamiceps*-group", consists of species with only the last 3–5

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pored scales of the upper lateral line contiguous with the dorsal fin base, a completely scaled belly and nape, a partially scaled chest and cheek, and a supraneural bone. Members of the *squamiceps* group additionally have 4 laterosensory pores on the dentary, are lacking a tubular pore canal in the anguloarticular, and have six laterosensory pores on the preopercle, features considered synapomorphic for the *squamiceps* group (Stiassny and Schliewen in prep.). Currently three species belonging to the *squamiceps*-group are recognized: *N. squamiceps* (Boulenger, 1902), *N. dimidiatus* (Pellegrin, 1900) and *N. sabinae* Lamboj, 2005. The second group, referred to here as the "*nudiceps*-group", contains six described species each with at least the posterior half of the upper lateral line contiguous with the dorsal fin base, a completely scaleless nape, cheek and belly, and no supraneural bone present in most individuals. Members of the *nudiceps*-group retain a plesiomorphic condition of the cephalic laterosensory system with 5 laterosensory pores on the dentary, a tubular pore canal in the anguloarticular, and 7 laterosensory pores on the preopercle. Members of the *nudiceps*-group are: *N. nudiceps* (Boulenger, 1899), *N. parilus* Roberts & Stewart, 1976, *N. consortus* Roberts & Stewart, 1976, *N. transvestitus* Stewart & Roberts, 1984 and *N. splendens* Roberts & Stewart, 1976 and *N. minor* Roberts & Stewart, 1976.

Nanochromis wickleri appears to belong to the *nudiceps*-group and shares several features with the other members of this group. For example, *N. wickleri* has an upper lateral line that is contiguous with the dorsal fin base for much of its length, cheek and nape squamation greatly reduced, and the absence of a supraneural bone; features that are interpreted as derived within the chromidotilapiine clade (Greenwood 1987; pers. obs.). Furthermore, *N. wickleri* lacks a dark longitudinal band or series of midlateral blotches extending from the eye to the caudal peduncle (males) or end of the caudal fin (females), a coloration patterning that appears characteristic of members of the *squamiceps* group (Lamboj 2004, Stiassny & Schliewen in prep.). Nonetheless, definitive placement of *N. wickleri* in the *nudiceps*-group depends on the results of a comprehensive phylogenetic analysis (Schliewen *et al*. in prep) that includes representation of all described species as well as several currently undescribed species known from the Congo basin (pers. obs.). Pending this analysis a definitive placement of *N. wickleri* within the *nudiceps*-group seems premature.

Discussion

The discovery of a novel species of *Nanochromis* in the northern part of Lake Mai Ndombe is not surprising as the ichthyofauna of the saucer-shaped inner Congo basin, the "Cuvette Centrale", is poorly known (Stewart & Roberts 1984, *Thieme et al*. 2005). Significant ichthyological collections accessible to the scientific community were made mostly along or in the vicinity of the Congo River main channel, major Congo tributaries and in Lake Tumba, a shallow blackwater lake approx. 80 km north of Lake Mai Ndombe

(Daget & Stauch 1963, Poll & Gosse 1963, Gosse 1963, Matthes 1964). Most other collections are relatively small and mostly contain species from smaller rivers and streams in the vicinity of former French or Belgian colonial posts or missionary stations. There remain extensive areas within the basin that are entirely unsampled such as, for example, the huge Salonga National Park which covers an area larger than the entire country of Belgium.

Nonetheless, the discovery of a large, benthic *Nanochromis* endemic to Lake Mai Ndombe is noteworthy, particularly as similar cichlid phenotypes (e.g., *Xenotilapia*) are currently known only from the East African rift lakes. Lake Mai Ndombe is a large (135 km long and up to 55 km wide) and very shallow lake (average depth of 3 m) with predominantly sandy beaches and with a few stretches of rocky lateritic shorelines. Interestingly, the lake is located at the lowest point of the Cuvette Centrale and the entire region is hypothesized to have been part of a large endorheic lake basin during the late Miocene and Pliocene (Beadle 1981). Beadle (1981) suggests that this large endorheic lake basin was probably captured sometime around the Plio-Pleistocene border by a coastal stream, subsequently resulting in the formation of the lower Congo rapids which extend from Pool Malebo to Matadi. Lake Mai Ndombe together with Lake Tumba may represent the last relicts of the hypothetical endorheic proto-Congo lake.

Nanochromis of the *nudiceps*-group have to date only been found in large rivers and lakes of the of the Cuvette Centrale at elevations below the 500 m altitudinal contour, in Pool Malebo, and in the rapids of the lower Congo. A preliminary phylogeny based on nuclear and mitochondrial data (Schliewen *et al.*, in prep), suggests a sistergroup relationship between the only two strictly lacustrine species, the new species described here, *N. wickleri,* and *N. transvestitus*, and that these in turn are the sistergroup of the two included riverine species *N. parilus*, *N.* sp. "*Kasai*". Clearly a rigorous test of a "Mai Ndombe relict fauna hypothesis" must include all described and undescribed species of the *nudiceps*-group in order to infer phylogenetic relationships as well as an estimate of the relative ages of the identified clades. Additional species descriptions are currently underway and once a clearer picture of the true species diversity of the *nudiceps* group has been established a comprehensive phylogenetic analysis will be forthcoming (Schliewen *et al*. in prep).

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