

A RECENT INVENTORY OF THE FISHES OF THE NORTH-WESTERN AND CENTRAL WESTERN COAST OF LAKE TANGANYIKA (DEMOCRATIC REPUBLIC CONGO)

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Background. Despite the importance of Lake Tanganyika's biodiversity for science and the livelihoods of the riparian people, high-resolution surveys of the fish biodiversity are sparse and fragmentary, especially along the western (Congolese) shoreline. The coast suffers locally from intensive human activities and lacks adequate protective measures or nature reserves. However, in view of the intra-lacustrine endemism of this fish fauna, conservation needs to be managed lake-wide at a fine scale, necessitating detailed inventories on fish species distribution. The study aims at updating knowledge on fish diversity and distribution along the north-western and central western shores of Lake Tanganyika.

Materials and methods. Fish specimens were collected using gill- and seine nets, by snorkelling and SCUBA diving, and through purchases on the local markets.

Results. Over 28 locations were sampled, and 84 cichlid- and 30 non-cichlid fish species (belonging to Protopteridae, Clupeidae, Cyprinidae, Alestidae, Claroteidae, Clariidae, Malapteruridae, Mochokidae, Poeciliidae, Latidae, and Mastacembelidae) collected.

Conclusion. Our records substantially expand the known range of fish species in a range of habitats. As numerous specimens are hard to assign to nominal species, a taxonomic revision of a number of genera is underway. It should take into account intraspecific geographic variation.

Keywords: Africa, ancient lake, biodiversity, Cichlidae, ichthyofauna, Mastacembelidae, Mochokidae, Teleostei

INTRODUCTION

Lake Tanganyika offers vital resources including food, household water, and transportation to an estimated 10 million people in the riparian countries, with an economic impact reaching far inland (Mölsä et al. 1999). The Democratic Republic Congo (DRC) part of Lake Tanganyika extends over 14 800 km² (45%) of the lake's surface and 795 km (43%) of its perimeter. The lake's only outflow, the Lukuga River, feeds into the Congo

River and is therefore regarded as one of the sources of the Congo Basin. Lake Tanganyika is the deepest and the oldest of the African Great Lakes (Cohen et al. 1997). It is home to about 250 species of Cichlidae, the world's morphologically and genetically most diverse cichlid assemblage, and 75 non-cichlid fish species (Snoeks 2000). The cichlids in the lake are polyphyletic and include ancestral lineages (Nishida 1991, Salzburger et al. 2005, Koblmüller et al. 2008). Its diversity makes Cichlidae in general

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and those of Lake Tanganyika in particular an important key group for understanding evolution in lower vertebrates (Kornfield and Smith 2000, Koblmüller et al. 2008). Most taxonomic work on Lake Tanganyika cichlids was performed by Boulenger (1915) and Poll (1956, 1986). Snoeks (2000) pointed out that since then, discovery and description of new varieties and species have mostly been carried out by ornamental fish hobbyists. Most information regarding their distribution is scattered through the aquarium literature (e.g., Brichard 1989, Konings 1998, Schupke 2003). Lake Tanganyika also excels in endemism and radiation of non-cichlid fishes (Snoeks 2000, Salzburger et al. 2002). Indeed, the lake is home to species flocks belonging to several other fish families, like Latidae (Coulter 1976), Mastacembelidae (Vreven and Snoeks 2009, Brown et al. 2010), and Mochokidae (Day and Wilkinson 2006, Koblmüller et al. 2006). Moreover, several invertebrate taxa radiated within Lake Tanganyika, such as atyid prawns (Fryer 2006), platytelphusid crabs (Marijnissen et al. 2006), thiarid (West and Michel 2000, Michel et al. 2004) and thalassoid (Wilson et al. 2004) gastropods, copepods (Coulter 1991a), ostracods (Martens and Schön 1999, Wouters and Martens 2001) and possibly *Eunapius* (spongillid Porifera) (Erpenbeck et al. 2011).

Dominating the pelagic zone and serving as the main target for fisheries are the clupeids *Limnothrissa miodon** and *Stolothrissa tanganyicae* Regan, 1917 and their latid predators *Lates stappersii* and economically less important *L. mariae*; *L. angustifrons*; and *L. microlepis* (see Coulter 1991b). Cichlids, however, dominate in the littoral zone, certainly in rocky habitats (Brichard 1989). Substrate has a considerable influence on the species composition of shore communities, with the rocky littoral being characterised by a higher degree of endemism (Brichard 1978, Konings 1998). Although ecological networks of species interactions render those communities rather stable in spite of some local perturbation, they are not adapted to “new” disturbance like pollution or invasive species. Hence, conservation efforts are important (Hori et al. 1993). Whereas the high fishing pressure on the pelagic (Mulimbwa and Shirakihara 1994, Mölsä et al. 1999, Mulimbwa 2006) and littoral (Allison et al. unpublished**) fish stocks might jeopardise sustainability, climate change represents another threat to pelagic fisheries (O’Reilly et al. 2003). The introduction of exotic species should be considered and avoided (Hori et al. 1993). However, successful establishment of exotics appears to remain limited in Lake Tanganyika so far; niches are well occupied and hence buffered (Hall and Mills 2000). Moreover, the physicochemical differences between the lake and surrounding water bodies (Coulter 1991a) might be a factor hampering spontaneous immigration. The lake has served as a “source” for the introduction of two of its endemic species, the freshwater sardine *Limnothrissa miodon* and the killifish *Lamprichthys tanganyicanus*, into Lake Kivu (Nshombo and Lushombo 2010). *Limnothrissa miodon* was also introduced into artificial lakes such as

Lake Kariba to support a pelagic fishery (Bell-Cross and Bell-Cross 1971). For littoral fish communities, pollution, mosquito net fishing and increased sedimentation (following deforestation) pose serious threats (Cohen et al. 1993, Hori et al. 1993, Allison et al. unpublished**, Donohue et al. 2003). Adverse effects of increased turbidity on the cichlid fauna have already been shown for amongst others Lake Victoria (Seehausen et al. 1997, Galis and Metz 1998). Although the stakeholders are well aware of problems, legislation is not up-to-date (Fermon 2007) and not any nature reserve has been designated in the Congolese part of the lake (Hori et al. 1993), while the regions around Uvira and Moba are subject to intensive human activities (Mölsä et al. 1999).

As many fish species have limited distributions within Lake Tanganyika and as species communities are highly structured on a small geographical scale (Sturmbauer 2008), it is important that conservation efforts are well targeted and spread across the lake. Unfortunately, few data are available on species distributions at a high resolution (Kawabata and Mihigo 1982, Hori et al. 1983, Fermon 2007), and often they are only found in the grey literature. In 1992, 1995, 2001, and 2008, the Royal Museum for Central Africa (RMCA) and the Royal Belgian Institute for Natural Sciences, together with local and international partners, joined forces in expeditions exploring most of the Tanzanian and Zambian coast, and resulting in large RMCA collections on the lake’s ichthyofauna. Political instability in the region has hampered sampling and hence obstructed scientific data gathering especially from the DRC (e.g., Schupke 2003 for *Tropheus* Boulenger, 1898). The aim here is therefore to provide a formal update of our knowledge on the diversity and distribution of fishes over a variety of habitats along the north-western and central-western Tanganyika coast.

MATERIALS AND METHODS

The 28 sampling sites (Table 1, Fig. 1) were mainly located in the rocky littoral, although specimens were also collected in intermediate habitats, sandy beaches, adjacent swamps, and the Lukuga outflow of the lake. Fish were caught while snorkelling and diving, using gill nets of mesh sizes 8, 10, 12, and 15 mm on rocky shores, and with seine nets at sandy beaches. At Bulumba Island and Mtotokainda, gill nets were placed overnight and at Luhanga and Bemba, specimens from the deeper littoral zone were collected by SCUBA diving (Table 1). Additional specimens were obtained from fishermen and fish markets. Specimens were identified to species level in situ and in the laboratory, following Poll (1978, 1986), Yamaoka (1983), Brichard (1989), Eccles (1992), Vreven (unpublished***), Wright and Page (2006), and Retzer (2010) and by comparison with type material. Fishes were collected from the Congolese lakeshore under mission statement (ordre de mission) no. 013/MNRST/CRH-U/2010 from the Ministère de la Recherche Scientifique et Technologique – Centre de Recherche en Hydrobiologie (CRH, Uvira). A reference collection has been stored at the CRH (Uvira, DRC) and at the RMCA (Tervuren,

* Authorities of the species examined in the presently reported study are provided in Tables 2 and 3.

** Allison E.H., Paley R.G.T., Ntakimazi G., Cowan V.J., West K. 2000. Biodiversity assessment and conservation in Lake Tanganyika. BLOSS final technical report.

*** Vreven E. 2001. A systematic revision of the African spiny-eels (Mastacembelidae; Synbranchiformes). PhD thesis. K.U. Leuven, Leuven.

Belgium). Taxon and author names in this study follow Seegers (2008) for claroteid catfishes belonging to *Bathybagrus* Bailey et Stewart, 1984, and Eschmeyer and Fricke (2011) for all other fish species.

RESULTS

In total we collected 84 cichlid- and 30 non-cichlid species. Tables 2 and 3 provide an overview of species presence at the various localities.

This list is not intended to be a complete species inventory of the collection sites. As the vast majority of specimens were collected using gill nets that were placed close to shore, species that are known to occur in deeper waters, and shell or cave dwellers are missing or underrepresented. For example, *Neolamprologus furcifer*, a common cave dweller with a secretive lifestyle (Konings 1998) was only caught once. As it was only collected when nets were left overnight, this agrees with Brichard (1989) who suggested *N. furcifer* to possibly be a nocturnal species. Also the pelagic species belonging to Clupeidae, Latidae, and *Bathybates* that are known to have lake-wide distribu-

tions, were seldom encountered. *Cyprichromis microlepidotus*, a species that is mostly found below 10 m of depth, was also only collected twice. At both occasions, this was at the leeward side of an island and far from the shore. This corresponds to Brichard (1989) who claimed that *Cyprichromis* only occurs in very quiet water. *Lepidolamprologus mimicus*, an aggressive mimic of *C. microlepidotus* (see Schelly et al. 2007) was collected only together with its model. Moreover, the maximal number of cichlid species collected (36 at Mukamba, where the collection effort was the highest) is lower than the number of species encountered on a 400 m² quadrant by Hori et al. (1983) (38) at Luhanga in the north-western and by Sturmbauer et al. (2008) (41 and 46) and Takeuchi et al. (2010) (54) in the southern part of the lake. *Raiamas moorii* was only caught in turbulent water in intermediate habitats, where visibility was low. The fisheries target species belonging to the Boulengerochromini, Tylochromini, Tilapiini, Bathybatini as well as *Lates stappersii* and *Malapterurus tanganyikaensis* were only obtained through fishermen operating from sediment

Table 1
Sampling localities in Lake Tanganyika with habitat types and collection method

Sampling site (or locality)	Date	Coordinates	Habitat type	Collection method
1 Nyangara wetland, Rusizi floodplain	20 Mar 2010	3°20'S, 29°09'E (market)	swamp	from Kilomoni market
2 Luhanga	27 Mar 2010	3°31'04"S, 29°08'57"E	rocky shore	snorkelling, SCUBA
3 Bemba			rocky shore	snorkelling, SCUBA
4 Munene	26 Mar 2010	3°37'22"S, 29°08'56"E	sandy beach with vegetation	caught by hand
5 Bulumba Island	25 Mar 2010	3°46'11"S, 29°07'10"E	rocky shore	includes overnight gill netting
6 Lubumba	24 Mar 2010	3°58'54"S, 29°06'32"E	rocky shore	snorkelling
7 Cap Banza	22 Mar 2010	4°03'53"S, 29°13'48"E	rocky shore	snorkelling
8 Kisokwe	23 Mar 2010	4°14'31"S, 29°10'35"E	rocky shore with pebbles	snorkelling
9 Mukindu	25 Apr 2010	5°36'01"S, 29°22'36"E	rocky shore	snorkelling
10 Murega	24 Apr 2010	5°38'22"S, 29°23'06"E	rocky shore	snorkelling
11 Mtotokainda	25 Apr 2010	5°38'60"S, 29°22'53"E	rocky shore	overnight gill netting
12 Magogoro	23 Apr 2010	5°39'19"S, 29°22'51"E	rocky shore	snorkelling
13 Musinwa	25 Apr 2010	5°40'57"S, 29°24'31"E	rocky shore	snorkelling
14 Kalemie	23–24 Apr 2010	5°54'54" S, 29°11'39"E	Lukuga outflow	purchased on market
15 Mulembwe	9 Apr 2010	6°07'10"S, 29°16'18"E	intermediate with vegetation	purchased from local fishermen, overnight gill net
16 Cape Tembwe	10 Apr 2010	6°29'39"S, 29°25'29"E	intermediate	snorkelling
17 Kabulu	21 Apr 2010	6°39'32"S, 29°29'36"E	intermediate	snorkelling
18 Mpala	21 Apr 2010	6°44'53"S, 29°31'59"E	sandy beach with swamps	purchased from local fisherman
19 Mugayo North	11 Apr 2010	6°46'42"S, 29°33'30"E	rocky shore	snorkelling
20 Mugayo	11 Apr 2010	6°46'51"S, 29°33'42"E	beach	seine net
21 Mukamba	14 and 16 Apr 2010	6°56'51"S, 29°42'43"E	rocky shore	snorkelling
22 Mtoto	15 Apr 2010	6°58'03"S, 29°43'50"E	rocky shore	snorkelling
23 Kapakwe	15 Apr 2010	6°58'27"S, 29°44'05"E	rocky shore	snorkelling
24 Moba	13–20 Apr 2010	7°02'30"S, 29°46'30"E	sandy beach	purchased from local fishermen, seine net
25 Migenzi	16 Apr 2010	7°04'56"S, 29°53'17"E	rocky shore	snorkelling
26 Mufazi	13 Apr 2010	7°05'12"S, 29°54'45"E	rocky shore	snorkelling
27 Kyanza	19 Apr 2010	7°06'42"S, 29°58'34"E	rocky shore	snorkelling
28 Kikoti	20 Apr 2010	7°11'28"S, 30°04'01"E	rocky shore	snorkelling

shores. Several members of the ecologically diverse tribe Ectodini (see Koblmüller et al. 2004) (e.g., *Ectodus descampsi*, *Grammatotria lemairii*, *Xenotilapia melanogenys*, and *X. sima*) as well as *Mastacembelus albomaculatus*, were only obtained by seine netting at sandy beaches. Species endemic to the Lake Tanganyika basin but not found in the lake proper were collected in the vicinity of the Lukuga outflow. These include *Barbus lufukiensis*, *Micralestes vittatus*, *Auchenoglanis tanganicus*^{*}, and *Haplochromis burtoni*.

DISCUSSION

The present study features among the first during the last decades to formally report on fish diversity and distribution along the Congolese Lake Tanganyika coast. The fish community composition differs substantially between sampling localities, pointing to different geographical ranges and habitat preferences (e.g., regarding substrate) of the various taxa. Sampling strategy (e.g., methodology, sampling effort, weather conditions, time of the day) influences which species are caught. Although the rocky littoral is clearly the most diverse Tanganyika habitat, with the highest degree of endemism (*cf. supra*), these results demonstrate the need to include as many habitat types as possible in biodiversity surveys of both cichlid and non-cichlid radiations. Fine-scale insights in the species diversity of fishes and other biota across the various lake habitats can be used to propose additional areas for conservation, or to efficiently manage existing ones. In this regard, Sturmbauer (2008) proposed the establishment of many micro-scale protected areas that can be managed by local communities and that maximize the conservation of overall biodiversity. Additionally, practices other than protected reserves are recommended, such as coastal zone management (Allison et al. unpublished**) and a ban on littoral fisheries (Mulimbwa 2006).

Taxonomic problems and distribution in *Synodontis mochokid* catfishes. Some specimens belonging to the species-rich genus *Synodontis* Cuvier, 1816 were difficult to identify. The specimens referred to as *S. aff. multipunctata* 1 and *S. aff. multipunctata* 2 agree with the description of Wright and Page (2006), except that the occipito-nuchal shield is naked in these specimens whereas it should be covered with skin in *S. multipunctata*. These specimens were classified as two species as they differ greatly in pigmentation pattern. The specimen identified as *S. aff. multipunctata* 1 has many medium-sized spots on the dorsal but not on the ventral part of the body, whereas *S. aff. multipunctata* 2 has fewer, but larger spots that occur on the whole body.

The specimen assigned to *S. irsacae* corresponds to the description of the species as provided by Wright and Page (2006), except for the axillary pores, which are clearly visible in this specimen. Matthes (1962) put *S. irsacae* into synonymy with *S. dhonti*, a suggestion which was later confirmed by Poll (1971). The absence of an axillary pore was one of the reasons leading Wright and Page (2006) to rehabilitate *S. irsacae*, rendering

S. dhonti (Boulenger, 1917) monotypic. After close examination of the type series, we also found an axillary pore on the holotype and two of the six paratypes of *S. irsacae*. Therefore, the status of this species should be reviewed. As the type specimen, and the only specimen, of *S. dhonti* measures 395 mm total length (TL) and the largest specimen available of *S. irsacae* measures only 161 mm (TL), comparing both species is difficult and additional material is required.

From the central western coast, *S. polli* had hitherto not been collected, whereas *S. petricola* was only known from Mtoto until now. Given that the two species are now known from the extreme south, the extreme north and from a few localities along the east coast, this suggests that they have a lake-wide distribution.

Geographical variation versus species status in the paraphyletic cichlid genus *Simochromis*. Recently intraspecific geographic variation has increasingly been valued in cichlid taxa of the East-African Great Lakes (Hanssens and Snoeks 2003, Risch and Snoeks 2008, Anseeuw et al 2011). In Lake Tanganyika, such variation is especially found in species from rocky shores, both in colour pattern (Kohda et al. 1996, Konings 1998) and in morphology (Risch and Snoeks 2008). As many Lake Tanganyika species are described from a single locality, assigning a geographical morph to a nominal species often proves difficult. This was, for example, the case for some

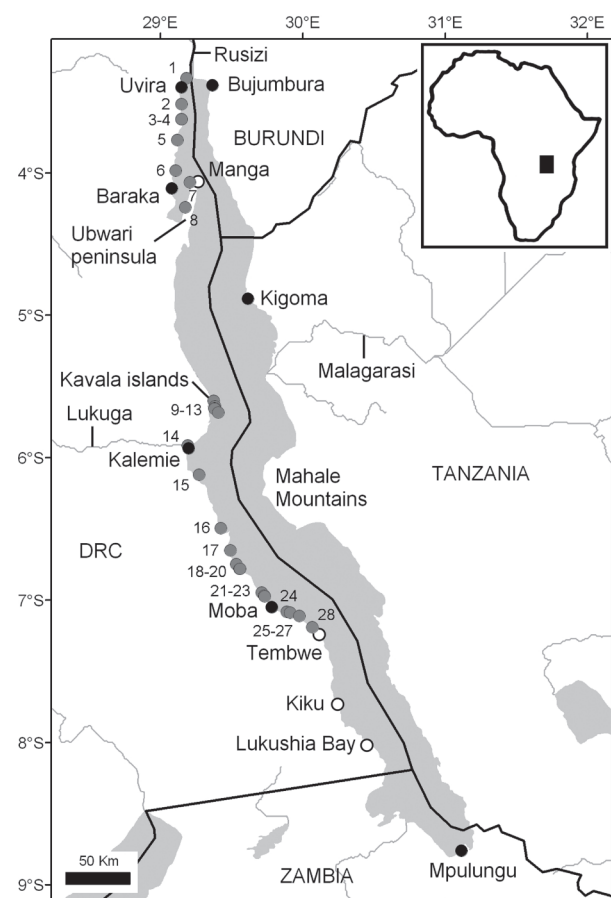


Fig. 1. Map of Lake Tanganyika; numbers refer to sampled locations (Table 1)

^{*} Editor's comment: According to FishBase *Auchenoglanis tanganicus* Boulenger, 1906 is a junior synonym of *Auchenoglanis occidentalis* (Valenciennes, 1840). The present authors, however, adhere to Eschmeyer and Fricke (2011) for nomenclature and more specifically for this species to Retzer (2010).

^{**} See footnote on page 202.

of the *Simochromis* Boulenger, 1898 specimens collected. *Simochromis marginatus* is a species described from five specimens caught at Manga on the Ubwari peninsula (Fig. 1). It was hitherto unknown from more southern locations along the west coast. At the Kavala Islands (localities 11 and 12), *Simochromis* specimens were assigned to *S. marginatus*, following a detailed morphological analysis (unpublished data). The specimens did however differ from the description given by Poll (1956), as they lack the black band on the dorsal fin, a character used by Poll (1956) to distinguish this species from its congeners.

The best studied areas are situated at the northernmost and southernmost end of the lake's shoreline. Therefore, species formally described from populations collected at either side could either be true sister species, or part of a continuum of geographical morphs. Konings (1998) proposes the latter hypothesis for *S. babaulti* and *S. pleurospilus*, the former being described from specimens from Uvira in the extreme North, the latter from Zambian specimens in the extreme South. In Nelissen's (1978) description of *S. pleurospilus*, geographic variation in *S. babaulti* was not included. Although he mentioned that both species occur in sympatry along the southern coast, he did not compare *S. pleurospilus* with *S. babaulti* specimens originating from the southern part for wanting of sufficiently sized southern *S. babaulti* specimens. As Nelissen (1978) did not mention any clear morphometric or meristic characters that can be used to differentiate between *S. pleurospilus* and *S. babaulti*, the difference between both species mostly lies in their colouration pattern: *S. pleurospilus* has numerous small red spots arranged in horizontal rows on the flanks, while only a few red spots are present in *S. babaulti*. In specimens collected to the south of Moba, spots were always visible in the larger individuals, and these specimens were therefore identified as *S. pleurospilus*. In specimens collected to the north of Kalemie, very few or no spots could be seen, which justifies their assignment to *S. babaulti*. In specimens caught between Kalemie and Moba, spots were sometimes clearly visible and sometimes absent, even on large individuals. Specimens from those populations were, until further study, identified as *S. babaulti*. As colour patterns are known to show a great deal of variation within several Lake Tanganyika cichlid species (Konings 1998), one should avoid colour as the sole criterion for species delineation. From these examples, it is clear that the paraphyletic genus *Simochromis* (see Koblmüller et al. 2010) is in need of revision. The same holds for the paraphyletic genus *Petrochromis* Boulenger, 1898 and although specimens collected during this survey were identified according to the current taxonomy, it should be noted that the genus' species richness is drastically underestimated, with the nominal species *P. polyodon* alone containing several undescribed species (Konings 1998, Makasa and Snoeks 2003, Koblmüller et al. 2010).

The need of taxonomic revision of Lake Tanganyika's cichlid fauna: examples from eretmodine and lamprologine cichlids. Of the monospecific

eretmodine *Eretmodus* Boulenger, 1898, two distinct morphotypes were encountered along the western shore. South of Kalemie, the typical *E. cyanostictus* was collected, whereas to the north of the Lukuga River, a variant with vertical bands across the flanks and a subterminal and wider mouth was found. The existence of two *Eretmodus* spp. was suggested by Verheyen et al. (1996) and Rüber and Adams (2000). Rüber et al. (1999) looked at mitochondrial sequences of all eretmodine species, and found six different lineages that did not correspond with the nominal species. For *E. cyanostictus*, two lineages were found: A and C, the distributions of which correspond with those of the two morphotypes encountered here. The undescribed northern species is listed here as *E. cyanostictus* "north", following Konings (1998). It should, however, be mentioned that according to Konings (1998), the "true" *E. cyanostictus* is to be found even further south and that *E. cyanostictus* from Kapampa, near Kiku (Fig. 1), has a colour pattern intermediate between the northern and the southern form.

A comparable situation was found in the lamprologines *Chalinochromis* Poll, 1974 and *Julidochromis* Boulenger, 1898. Both genera have a similar ecology and rarely co-occur (Konings 1998). For *Julidochromis*, a specimen of *J. marlieri* was caught at Bemba whereas further south, at Bulumba Island and Lubumba, *J. regani* was found. While for the northern basin *J. marlieri* is known from Burundi and a few locations scattered along the Congolese side (Konings 1998, Allison et al. unpublished*), *J. regani* is found on the north-eastern (Burundese) side, off the Ubwari Peninsula and, as in this survey, on some western localities to the north of it (Brichard 1978, Konings 1998). At localities further south, three distinct morphotypes of *Chalinochromis* were collected. Currently, only two species have been described within this genus, although some geographical forms probably deserve species status (Konings 1998). *Chalinochromis brichardi* and *C. popelini* can be distinguished by (1) the shape of the caudal fin, which is rounded in the former and lyre-shaped in the latter, and (2) by their colour pattern: *C. popelini* always has three complete lateral bands, one at the base of the dorsal fin and two over the lateral line and a dark spot on the base of the caudal fin, whereas *C. brichardi* has zero to two bands and lacks a spot on the caudal fin (Brichard 1989). The specimen collected at Musinwa off the Kavala Islands has a rounded caudal fin, lacks any bands on the flanks and corresponds to the description of *C. brichardi*. All specimens collected between Kalemie and Moba have a lyre-shaped caudal fin and three bands on the flanks; they have been identified as *C. popelini*. The two specimens collected further south at Kyanza and Kikoti have a rounded caudal fin and show only two clear bands on the flanks. Moreover, they differ from *C. popelini* as they do not have a dark spot at the base of the caudal fin. Given that such specimens are known in the aquarium trade under the name *C. sp.* "bifrenatus" (Tawil 1986), these specimens are listed here as such. This record is interesting

* See footnote on page 202.

as until now *C. sp.* “bifrenatus” was only known from the central Tanzanian coast, and as Konings (1998) argues that *C. sp.* “bifrenatus” could be a geographical morph of *C. popelini* occurring on the opposite shoreline. As the distribution of *C. sp.* “bifrenatus” seems much larger, and as we found no intermediate forms between the west coast *C. sp.* “bifrenatus” and *C. popelini*, this claim seems unlikely. Given these new data and the disjointed and patchy distributions of *Julidochromis* spp., the relationships between all representatives of *Chalinochromis* and *Julidochromis*, and their affiliation with *Telmatochromis* Boulenger, 1898, should be revised (Poll 1986, Konings 1998). Sturmbauer et al. (2010) demonstrated the paraphyly of *Julidochromis* with respect to *Chalinochromis*, confirming the morphological tree of Takahashi (2003) in which representatives of *Chalinochromis* and *Julidochromis* cluster together. It hence seems likely that the taxonomy of these genera should be revised.

Cases of sympatry in *Tropheus*. Species of the genus *Tropheus* are stenotypic rock-dwelling cichlids occurring on Lake Tanganyika’s rocky shores. Their limited dispersal ability gave rise to over 100 mostly allopatric colour morphs. Although the genus’ taxonomy is incomplete and confusing, most colour morphs can be classified in a few lineages (Schupke 2003) or presumed species (Konings 1998) mostly supported by molecular studies (Sturmbauer et al. 2005, Egger et al. 2007). The distribution of these lineages reflects geological events in the lake’s history (Baric et al. 2003). In the present survey, representatives of at least six biological species were found along the western shore of Lake Tanganyika. As the number of anal spines is a taxonomically important character in *Tropheus* (see Brichard 1989, Snoeks et al. 1994), species delineation was based on anal spine counts as well as on colouration. As such, the same classification was obtained as in Konings (1998), whose nomenclature is followed here. Both *T. duboisi* and *T. annectens* could easily be identified given their unique morphological features within the genus. The species listed here as *T. aff. brichardi* are characterized by their yellow paired fins. They correspond to the nominal species described from the opposite shore, in having a modal anal spine count of six and in showing clear sexual dichromatism. In this species, females keep the juvenile pattern of vertical bands, whereas adult males obtain uniformly dark green or brown flanks (Konings 1998). Where this species coexists with *T. annectens*, its territory is situated in the deeper part of the littoral zone, the upper part being occupied by its larger congener *T. annectens*. A similar situation of *T. annectens* in sympatry with a genetically and phenotypically different *Tropheus* sp. was described in this region by Baric et al. (2003) and Sturmbauer et al. (2005). The species listed here as *T. sp.* “black” is an undescribed species that probably deserves specific status as it is sympatric with the species classified here as *T. moorii* as well as with *T. annectens* at the east coast of the lake, south of the Mahale Mountains (Konings 1998). As Schupke (2003) splits this northernmost “species” in separate lineages, and as different mitochondrial lineages are known to occur in this part of the lake (Egger et al. 2007), further

scrutiny is needed to verify whether different populations from the north-eastern shore are conspecific.

The species listed as *T. moorii* corresponds in colouration to what Schupke (2003) calls the rainbow *Tropheus*. However, these specimens have five anal fin spines instead of six in the “true” *T. moorii* from the type locality in the extreme south of the lake. At the southernmost locality of this survey, both *T. moorii* and a specimen with six anal fin spines and with a clearly different colouration, corresponding to what Konings calls *T. sp.* “red”, were caught. Although the ranges of *T. sp.* “red” and *T. moorii* are known to overlap near the village of Kiku (Fig. 1), this zone of sympatry is assumed to be just a few hundreds of meters long (Konings 1998). Yet as we found a specimen, clearly belonging to *T. sp.* “red”, 60 km further north, this indicates that both species may occur in sympatry over a larger section of the coast. As members of both species are known to mate assortatively (Egger et al. 2008), species boundaries are expected to be maintained in this contact zone.

Species shifts along a north-south axis. A clear shift in species composition was observed along a large section of the western coast visited, especially along rocky shores. For *Tropheus*, *Simochromis*, *Eretmodus*, *Chalinochromis*, and *Julidochromis*, this was discussed above, but the phenomenon was also noticed for some other rock dwelling Lamprologini, with *Neolamprologus niger* and *N. toae* being found in the northern half of the lake and *Variabilichromis moorii* in the southern basin. The distributions found for the ectodine *Ophthalmotilapia* Pellegrin, 1904, with *O. heterodonta* found in the northern and central part of the lake and *O. ventralis* found only in the southern part correspond with Hanssens and Snoeks (1999). These distributions reflect the historical split of Lake Tanganyika into several subbasins (Snoeks 2000). Yet, the many taxonomical problems that remain (*cf. supra*) indicate that the complexity of Lake Tanganyika cichlid systematics has been grossly underestimated (Snoeks 2000). Therefore, it is expected that such patterns will be observed once other taxa whose distribution spans more than one subbasin, are revised, such as the rock-dwelling tropheine *Petrochromis*, with several undescribed species (Makasa and Snoeks 2003).

Perspectives. As many localities visited during this survey were sampled for the first time, many records are new. For *Simochromis pleurospilus*, *Altolamprologus calvus*, and *Tropheus* sp. “red”, the localities presented here contain the northernmost localities where these species have hitherto been observed, while for *Simochromis marginatus*, *Julidochromis regani* and *Chalinochromis* sp. “bifrenatus”, these results drastically enlarge their known distributions. For *A. calvus*, voucher specimens were until now only available from the southwestern part of the lake, from Lukushia Bay to the extreme South, whereas for *S. pleurospilus*, no collections have been made outside of Zambia. Our records therefore show that these species occur more than 100 km further north, which agrees with Büscher (1998) who found both

Table 3
Occurrence of cichlid fishes, in Lake Tanganyika, classified by tribe following Takahashi (2003)

Tribe and species	Sampling site																											
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Tilapini																												
<i>Oreochromis niloticus</i> (L.)	+																											
<i>Oreochromis tanganyicae</i> (Günther, 1894)																				+								
Tylochromini																												
<i>Tylochromis polylepis</i> (Boulenger, 1900)																												
Lamprologini																												
<i>Altolamprologus calvus</i> (Poll, 1978)																												
<i>Altolamprologus compressiceps</i> (Boulenger, 1898)																												
<i>Chalinochromis brichardi</i> Poll, 1974																												
<i>Chalinochromis</i> sp. "bifrenatus"																												
<i>Chalinochromis popelini</i> Brichard, 1989																												
<i>Julidochromis marlieri</i> Poll, 1956																												
<i>Julidochromis regani</i> Poll, 1942																												
<i>Lamprologus callipterus</i> Boulenger, 1906																												
<i>Lamprologus lemairii</i> Boulenger, 1899																												
<i>Lepidolamprologus attenuatus</i> (Steindachner, 1909)																												
<i>Lepidolamprologus cummingtoni</i> (Boulenger, 1906)																												
<i>Lepidolamprologus elongatus</i> (Boulenger, 1898)																												
<i>Lepidolamprologus mimicus</i> Schelly, Takahashi, Bills et Hori, 2007																												
<i>Lepidolamprologus profundicola</i> (Poll, 1949)																												
<i>Neolamprologus brichardi</i> (Poll, 1974)																												
<i>Neolamprologus leleupi</i> (Poll, 1956)																												
<i>Neolamprologus fasciatus</i> (Boulenger, 1898)																												
<i>Neolamprologus furcifer</i> (Boulenger, 1898)																												
<i>Neolamprologus mondabu</i> (Boulenger, 1906)																												
<i>Neolamprologus niger</i> (Poll, 1956)																												
<i>Neolamprologus petricola</i> (Poll, 1949)																												
<i>Neolamprologus tetracanthus</i> (Boulenger, 1899)																												
<i>Neolamprologus toae</i> (Poll, 1949)																												
<i>Neolamprologus trotecephalus</i> (Boulenger, 1899)																												
<i>Telmatochromis brachygnathus</i> Hanssens et Snoeks, 2003																												
<i>Telmatochromis dhonti</i> (Boulenger, 1919)																												
<i>Telmatochromis temporalis</i> Boulenger, 1898																												
<i>Variabilichromis moorii</i> (Boulenger, 1898)																												

Continues on next page

Table 3
(continuation)

Tribe and species	Sampling site																												
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
Perissodini (continuation from previous page)																													
<i>Haplotaxodon microlepis</i> Boulenger, 1906					+					+	+	+								+	+								+
<i>Haplotaxodon trifasciatus</i> Takahashi et Nakaya, 1999					+			+		+	+						+			+	+								+
<i>Perissodus microlepis</i> Boulenger, 1898		+			+	+	+	+		+	+	+																	+
<i>Plecodus straeleni</i> Poll, 1948		+								+	+	+																	+
Bathybatini																													
<i>Bathybates ferrox</i> Boulenger, 1898																				+									
<i>Bathybates minor</i> Boulenger, 1906																			+										
Boulengerochromini																													
<i>Boulengerochromis microlepis</i> (Boulenger, 1899)																				+									+
Cyphotilapini																													
<i>Cyphotilapia frontosa</i> (Boulenger, 1906)		+																											
Cyprichromini																													
<i>Cyprichromis microlepidotus</i> (Poll, 1956)					+						+																		
Ectodini																													
<i>Aulonocranus dewindti</i> (Boulenger, 1899)																													+
<i>Callochromis macrops</i> (Boulenger, 1898)																													+
<i>Callochromis melanostigma</i> (Boulenger, 1906)																													+
<i>Callochromis pleurospilus</i> (Boulenger, 1906)																													+
<i>Cunningtonia longiventralis</i> Boulenger, 1906																													+
<i>Cyathopharynx furcifer</i> (Boulenger, 1898)																													+
<i>Ectodus descampsi</i> Boulenger, 1898																													+
<i>Grammatotria lemairii</i> Boulenger, 1899																													+
<i>Lestradea perspicax</i> Poll, 1943																													+
<i>Ophthalmotilapia heterodonta</i> (Poll et Matthes, 1962)																													+
<i>Ophthalmotilapia nasuta</i> (Poll et Matthes, 1962)																													+
<i>Ophthalmotilapia ventralis</i> (Boulenger, 1898)																													+
<i>Xenotilapia bathyphila</i> Poll, 1956																													+
<i>Xenotilapia leptura</i> (Boulenger, 1901)																													+
<i>Xenotilapia melanogenys</i> (Boulenger, 1898)																													+
<i>Xenotilapia ochrogenys</i> (Boulenger, 1914)																													+
<i>Xenotilapia sima</i> Boulenger, 1899																													+

Continues on next page

species at the village of Tembwe (which is not to be confused with Cape Tembwe, a locality further north that was sampled in this study), just 10 km further south of our southernmost sampling site (Fig. 1). Although littoral cichlid communities are much better known than those that occur in deeper water or further from shore, our findings illustrate that our knowledge of their specific composition remains fragmentary. Therefore, it can be expected that sampling in less accessible habitats will lead to even more discoveries. Between 1989 and 1997, 12 new cichlids were described by Büscher (e.g., 1997), who collected all of them in the south-western Congolese part of the lake, mostly in habitats not targeted during this survey. This illustrates the need for more field surveys, especially along less explored coast and further from shore, as the cichlid community at greater depths is completely different from the one found at rocky shores.

New insights in the distribution of many species, and the near-unavailability of such data in the published literature, underpin the fact that, despite the large number of evolutionary studies in Lake Tanganyika, a lot of work remains to be carried out on the taxonomy, distribution and phylogenetics of the fish biodiversity, certainly in the DRC. Such investigations could foster other research fields for which they are ultimately needed, such as conservation biology, fisheries studies, population genetics, and fish parasitology. For example, recently Lake Tanganyika cichlids have been shown to harbour a parasite fauna at least as diverse as the fishes themselves (Vanhove et al. 2011a, b, Gillardin et al. 2011).

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