Fish biodiversity survey of small water bodies in the Nkhotakota District, Malawi.

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Abstract

We surveyed 6 small lakes and the lower reaches of the Kaombe River in Nkhotakota District of Malawi (in 2 seasons; rainy and dry hot seasons), primarily to determine if two species previously reported only from Lake Chilingali were still present in the area following the collapse of the Chilingali Dam in 2012 and failure to rediscover the species in 2016 and subsequently. We report that *Lethrinops chilingali* was now abundant in the northern part of Lake Chilingali. It was also found elsewhere in the Kaombe catchment, including Lake Chitenje and the main river channel, as well as in Lakes Kamphambe and Nadzenje on the Kang'ona River system to the south. *Rhamphochromis sp.* 'chilingali' was not found at any location and thus may be extinct in the wild. A total of 23 fish species were recorded, although the fishing methods used mean that it is likely to be biased towards day-active species and may under-represent catfishes and mormyrids. Brief descriptions of all sites and species are given, along with notes on fishing methods observed.

Keywords: Lake Malawi, satellite lakes, Kaombe River, fish, cichlidae

Introduction

Satellite lakes are small water bodies lying within the catchment of larger lakes, such as Lakes Malawi and Victoria (Turner et al. 2019), and they are believed to play a role in the generation of biodiversity, through allopatric speciation followed by subsequent colonisation of the main lake (Greenwood 1965; Genner et al. 2007; Tyers et al. 2014). Lake Chilingali, one of the satellite lakes located to the west of Lake Malawi has been reported to contain two species from genera endemic to the Lake Malawi catchment, *Rhamphochromis sp.* 'chilingali' (see Genner et al. 2007) and *Lethrinops chilingali* Turner, Crampton & Genner 2023. Laboratory trials indicated that both species mated assortatively in the presence of congeneric species most likely to be found in similar habits- shallow swampy bays or lagoons likely to have represented precursors to satellite lakes, namely *Rhamphochromis longiceps* (Günther 1864) (Genner et al. 2007) and *Lethrinops lethrinus* (Günther 1894) (Tyers et al. 2014), indicating that both Chilingali forms represent unique species. Early maps show that two distinct lakes existed in the area: Chilingali in the north and Chikukutu in the south, but a dam was constructed in 1992 resulting in a single larger lake, generally known as Chilingali. The dam was not maintained and after years of conspicuous erosion, collapsed in 2012. A visit in 2016 found that there was by then at least two separate lakes (see Google Earth; Turner et al. 2019), both shallow and muddy (particularly Chikukutu) and neither of the putative endemic species was located. The dam was reconstructed from around 2020 and a single large lake was restored (see on satellite imagery, such as Google Earth from 2022-23). However, later surveys from 2022 failed to find any *Rhamphochromis*, while evidence for *Lethrinops* was ambiguous, with the possibility that specimens might have been *Otopharynx tetrastigma* (H. Svardal pers. comm.). This was difficult to judge from the photographs which were of rather dried out specimens. The aim of the current survey was to re-investigate Lake Chilingali to look for the putatively endemic species, and to investigate neighbouring water bodies in case the two focal species proved to have wider distributions than previously believed.

Methods

Sites were first visited from 2nd to 5th September 2024, representing the hot dry season. A second survey was carried out on some of the water bodies from 27th February to 3rd March 2025 (rainy season) to test claims from local fishers that certain species were more readily available during the rainy season. Where possible, fish were obtained from local fisherfolk, but if we were unable to do so, sampling gears belonging to the Malawi Fisheries Research Centres were employed. Specimens were identified to species level in the field, or subsequently from photographs. Nomenclature followed Fricke et al. (2024) or Tweddle (1996), Turner et al. (2019) for undescribed species. Any other fish species found were recorded. A selection of voucher specimens were collected for the Malawi Fisheries Department field museum at Monkey Bay, preserved in 10% formalin. Sizes and locations of water bodies were obtained from satellite images on Google Earth. We discussed fish species in the lakes with fisherfolk we met, and in particular, we showed laminated sheets with photographs of *Lethrinops chilingali* and *Rhamphochromis sp.* 'chilingali'. Sites visited and species collected are outlined in the results section.

Results

Six lakes / reservoirs were investigated, as well as the lower region of the Kaombe River near its inflow to Lake Malawi. Four sites were re-visited in the second survey: Lake Chilingali, Lake Chitenje (no fish collected), Lake Kamphambe and the Lower Kaombe River (only *Clarias* seen). Lakes Tabitabi and Ndila were not re-visited as these were relatively distant from Lake Chilingali on different river systems and had not been reported to contain either the *Rhamphochromis* or *Lethrinops* species.

Overall, 23 fish species were identified, mainly cichlids and cyprinids (Table 1).

Site 1: Lake Chilingali (-12.951, 34.213).

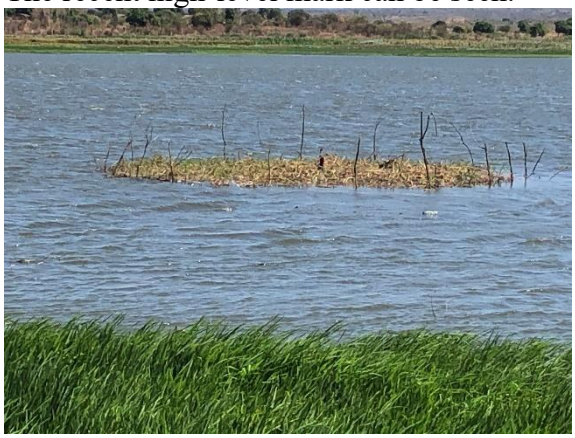
The lake had maximum dimensions 5.2 x 1.1km and elevation 495m on 2023 satellite images. The location and 'large-lake' topography can be seen in Turner et al. (2019). However, on our visit, the lake level seems to have dropped substantially due to erosion of the earthen bank on the northern end of the dam wall (fig. 1). This was reported to be due to backflow of the river downstream of the dam, due to recent high rainfall events. The dam itself is intact and a substantial rocky/earthen base appears to be retaining the lake water at a much higher level than prior to the dam restoration, but at least 2-3m below recent levels. The bank looked vulnerable to further erosion. Fishers on the lake report that a narrow channel connects the deeper northern (Chilingali) basin with the shallower southern (Chikukutu) basin. Fishing activity appeared to be low, with a single offshore (nkacha) seine seen at the northern end and a few mosquito seines and gillnets in the south, although a number of fish attraction devices were also seen in the south, consisting of a ring of sticks, with a superstructure of horizontal sticks and a turf roof. At the north end a fish fence was seen, probably to operate when the river was back-flowing (there was no flow at the time of visiting, in September 2024).

At the northern end, the offshore seine catch was dominated by *Lethrinops chilingali*, but no *Rhamphochromis* were found. In the south of the lake, catches were dominated by small *Pseudocrenilabrus*, *Astatotilapia* and *Oreochromis.* When shown photographs, the lead fisherman of the offshore seine claimed that *Rhamphochromis* were still present, but easier to catch in the rainy season (December-April), but when given our phone number and the promise of a financial reward did not get back in touch subsequently. An older gillnet fisherman in the southern part of the lake claimed that *Rhamphochromis* were once common, but had not been seen since the 2012 dam collapse. Overall, the fish diversity (8 species) was much lower than in 2009 before the dam collapse, when 25 species were reported, admittedly from a much more thorough survey. Some absences, such as *Clarias gariepinus*, were probably due at least in part to the fishing methods used: we did not sample overnight-set gill nets or baited lines and traps. Juveniles of this species were observed in the low-lake conditions of 2016, so it seems most likely present in 2024, and indeed it was collected in 2025.

Eroded bank at the dam wall, northern end of Lake Chilingali.

Fish fence in the shallows at the north end. The recent high-level mark can be seen.

Offshore (nkacha) seine operated from a plank boat at the northern end of Lake Chilingali



Fish attraction device in shallow water at southern end of Lake Chilingali.

Mosquito seine, southern end of Lake Chilingali, operated by wading.

Monofilament gillnets and dugout canoes operated by punting, southern Lake Chilingali

Figure 1: Eroded dam and fishing activities, Lake Chilingali 2024.

Site 2. Lake Chitenje (-12.917, 34.267).

Lake Chitenje lies in a wetland on the North-West margin of the present Nkhotakota town, about 4km west of the shore of Lake Malawi. Satellite images from September 2022 showed Lake Chitenje with maximum dimensions 0.79 x 0.23km; elevation 486m, which is about half-way between the elevations of Lake Malawi and Lake Chilingali. However, on our visit, most of the area was swampy wetland, much of it cultivated with rice etc, with a relatively small open water area in the south. The April 2016 satellite image shows almost the entire wetland area given over to rice paddies, with a few small pools visible. Evidently, the system is rather dynamic. The wetland/lake is drained by a tributary of the Kaombe River, for a short distance until it unites with other small tributaries to form the slowly meandering main channel. Chitenje receives input from a network of afferents stretching over 5km to the south, even beyond the M18 road and lying between Lakes Nadzenje and Kamphambe, best seen in the 2016 satellite image. In 2014, we were able to hire a local mosquito seine team, who landed a huge catch comprised mainly of small *Astatotilapia* and *Oreochromis*, with some small cyprinids – in amongst all this, we found 4 tiny specimens of *Lethrinops chilingali*, confirming for the first time, its occurrence outside Lake Chilingali. *Rhamphochromis* was reported as occurring in the rainy season, but given that this location was relatively close to Lake Malawi, this could have been mouthbrooding female *R. longiceps*. No fishers were found at that locality on the second visit and we did not obtain a sample.

Figure 2: Seine netting and a substantial mosquito seine catch on Lake Chitenje.

Site 3: Lower Kaombe River (-12.891, 34.286)

Late in the afternoon of 3rd September 2024, we visited the slowly meandering lower region of the Kaombe River near its mouth, elevation 480m, less than 3m above the level of Lake Malawi. We found the river to be deep and wide with numerous side channels (fig. 3), rich in vegetation including reeds, papyrus, water lilies, water hyacinth (*Eichhornia*), water lettuce (*Pistia*) and hornwort (*Ceratophyllum*). We were able to inspect a number of fisherfolk's catches, although we did not see specific fishing methods or gears. The composition of some catches suggested mosquito seining (as evidenced by tiny cyprinids), while another contained earthworm bait, so was presumably angling. The catch was diverse, dominated by *Oreochromis shiranus*, but notably included a mature male *Lethrinops chilingali*, indicating that this species was probably actually breeding in the river, the first evidence for a member

of a Malawi endemic genus breeding in a Malawi afferent. During the 2025 visit, only a single handliner was fishing, and he had only caught *Clarias gariepinus*. It was further revealed during the rainy season sampling that most of the fishers operate as part time and concentrate on their maize fields.

Figure 3. Lower reaches of the Kaombe River.

Site 4. Lake Tabitabi (-13.035, 34.275).

Lake Tabitabi is a relatively small lake, at an elevation of 487m, shown as 0.5 x 0.16 km on the satellite image, but this area of open water lies in a much larger wetland. It is a large natural wetland on the slow-flowing Kayanjamwano River, with additional open lakes downstream, reported to drain to the Chia lagoon, but satellite photos suggest a separate river outlet to Lake Malawi at -13.071, 34.326. It was said to be up to 9m deep, but all fishing activities we saw were conducted from fragile-looking bark canoes, driven by punting – in deeper water, punting sticks with no blades were used to paddle the craft. We saw only mosquito seine catches. *Lethrinops* were reported but not seen, there were no reports of *Rhamphochromis*. Catches were dominated by small *Enteromius* and *Tilapia sparrmanii*. Small juveniles of the large predator *Serranochromis robustus* were seen.

Figure 4: Lake Tabitabi, with its bark punting fishers.

Site 5. Lake Ndila (-13.071, 34.246).

Lake Ndila is an artificial reservoir on a river draining into the Chia Lagoon, measuring 1.19 x 0.55km, with an elevation of 494m on a 2019 Google earth image. This water body was not easy to find or to sample. The main road bridge over the river downstream had collapsed, with vehicles fording the river. The lakeshore was accessed down a steep track, but we were able to hire a mosquito seine crew (Fig. 5), whose catch was dominated by the characin *Rhabdalestes* (formerly *Hemigrammopetersius*) *barnardi*, with some *Micropanchax johnstoni.* No *Lethrinops chilingali* or *Rhamphochromis* were found or reported by local fishers.

Figure 5: Lake Ndila, with mosquito net being landed.

Site 6: Lake Kamphambe (-12.958, 34.270)

This natural weedy lake was shown as 0.46 x 0.22km, elevation 495m on satellite images. It was reported to be at least 4m deep. It drains to the Kang'ona River which enters Lake Malawi well to the south of the Kaombe (outlet at around -12.948, 34.305). The lakeshore was approached from a mission hostel with an area of natural woodland towards the lake. A single fisher, with boat and gill nets, showed us his catch and later set out our gillnet and 5 of his for later inspection. The catch was diverse but dominated by *Tilapia sparrmanii*. The morning gillnet catch included a number of species that are perhaps less likely to be caught in daytime gillnets, such as *Clarias* and mormyrids. These have perhaps been under-represented in our other samples. *Lethrinops chilingali* but not *Rhamphochromis*, was reported by the gillnet fisherman to occur in the lake, but neither species was seen in 2024. *Lethrinops chilingali* was, however, collected in 2025, but *Rhamphochromis* was absent.


Figure 6: Lake Kamphambe with the gillnet fisher who helped us with fish samples.

Site 7: Lake Nadzenje (-12.983, 34.254)

This shallow swampy lake lies upstream from Kamphambe, also on the Kang'ona River. Satellite images indicate it is 0.5 x 0.17km; elevation 503m. It seemed rather regressed when we visited in 2024, and was shallow and swampy. A single plank boat was present, owned by the same fisherman we worked with on Lake Kamphambe. He had already deployed his gillnets on the other lake but was able to recruit a crew to make a seine net haul. The dominant species were *Enteromius macrotaenia* and *Lethrinops chilingali* (large and rather spotted), with other cichlid species. This was the first clear confirmation of *Lethrinops chilingali* from outside the Kaombe system.


Figure 7: Lake Nadzenje, with Department of Fisheries seine catch being landed.

Table 1: Fish species recorded at each site in 2024 (1) and 2025 (2) surveys

Species	Family	1. Chilingali	2. Chitenje	3. Kaombe	4. Tabitabi	5. Ndila	6. Kamph'b	7. Nadzenje
Astatotilapia calliptera	Cichlidae	1,2	1	1		1	1,2	1
Brachyalestes imberi	Alestidae						1,2	
Clarias gariepinus	Clariidae	2		2			1,2	
Coptodon rendalli	Cichlidae			1			1,2	1
Cyphomyrus discorhynchus	Mormyridae			1			1	
Enteromius arcislongae	Cyprinidae			1				
Enteromius greenwoodi	Cyprinidae				1			
Enteromius kersteni	Cyprinidae			1				
Enteromius cf lineomaculatus A	Cyprinidae	1,2					2	
Enteromius macrotaenia	Cyprinidae	1	1		1	1		1
Enteromius paludinosus	Cyprinidae		1					
Enteromius radiatus	Cyprinidae				1		1,2	
Enteromius trimaculatus	Cyprinidae			1				
Labeo cylindricus	Cyprinidae						1,2	
Lethrinops chilingali	Cichlidae	1,2	1	1			2	1
Marcusenius macrolepidotus	Mormyridae			1			1,2	
Micropanchax johnstoni	Procatopodidae					1		
Opsaridium microcephalum	Danionidae	1						
Oreochromis shiranus	Cichlidae	1,2	1	1	1	1	1,2	1
Pseudocrenilabrus philander	Cichlidae	1,2		1	1	1	1,2	1
Rhabdalestes barnardi	Alestidae					1		
Serranochromis robustus	Cichlidae				1		1,2	1
Synodontis njassae	Mochockidae	2					2	
Tilapia sparrmanii	Cichlidae			1	1		1,2	1

Cichlidae

Cichlids tend to be dominant in still-water habitats in the region. They are generally recognised by their long-based dorsal fins, which have a longer anterior spiny part and a shorter posterior soft-rayed region. They are generally diurnal fish that are strongly territorial in the breeding season and use bright colours to signal to conspecifics and potential predators of their offspring. All known species practice parental care of eggs, larvae and sometimes of juveniles. Species in the region show one of two distinct social systems. *Coptodon* and *Tilapia* are pair-forming substrate spawners in which both sexes adopt similar bright colours. The other species are maternal mouthbrooders, in which females carry the young in their mouths. Females are generally drably coloured. In some species (*Astatotilapia, Oreochromis, Pseudocrenilabrus*), females stand guard over free-swimming fry and will recover them at night or when threatened by predators. In other species, fry are released once and then abandoned (*Lethrinops, Rhamphochromis*). Male maternal mouthbrooders do not care for the young but are generally brightly coloured to attract mates and repel rivals.

Astatotilapia calliptera (Günther 1894)

This small omnivorous cichlid is widespread in shallow weedy parts of Lake Malawi and in most afferent river systems as well as more widely in the region (Turner et al. 2021). The body shape is generally more elongated than most other cichlids in the area and lacks strong barring or a dorsal fin ‘tilapia mark’. Females and juveniles are sandy coloured, countershaded and generally with orange pelvic and anal fins. They are very difficult to distinguish from those of *P. philander*, but generally have larger mouths, more acutely pointed snouts, and a more ‘truncate’, less rounded caudal fin. In the surveyed region, males of both species were metallic golden yellow with colourful spotted fins, blue lips and sometimes a dark stripe through the eye. However, male *A. calliptera* have a number of large yellowish ‘eggspots’, marked by a dark margin, on their anal fins (fig. 8). These are lacking in *P. philander* males, which have a red spot at the tip of the longest soft rays in the anal fin.

Male *A. calliptera*, Lake Chitenje

An unusually large dark male *A. calliptera* from the Lower Kaombe River.

Figure 8: Male *Astatotilapia calliptera* are readily distinguished by their prominent anal fin eggspots.

Astatotilapia calliptera was recorded at all sites except Lake Tabitabi, and was the dominant species at Lake Chitenje. The largest specimens were taken at the Lower Kaombe River.

***Coptodon rendalli* (Boulenger 1897)**

Coptodon rendalli is a widely distributed species in central and southern Africa (Seegers 1996). The centre for diversity of *Coptodon* lies in West Africa and *C. rendalli* is the only member of the genus found in central and southern Africa. In Lake Malawi it is largely confined to shallow vegetated areas. It is a large, deep-bodied species with a steep head-profile, which is often rather greenish or sandy-coloured, often with a bright red underside, including the lower half of the caudal fin. It has a large dark irregular blotch at the base of the anterior part of the soft dorsal fin, generally surrounded by a paler area. The species is generally omnivorous but feeds mainly on plant material and algae. In our survey, it was found in the lower Kaombe River and in Lakes Nadzenje and Kamphambe, but was never abundant. Smaller specimens might have been confused with *T. sparrmanii*, which was generally more numerous.

C. rendalli from the lower Kaombe River.

C. rendalli from Lake Nadzenje.

Figure 9: *Coptodon rendalli* is generally paler and less strongly barred than *Tilapia sparrmanii.*

***Lethrinops chilingali* Turner, Crampton & Genner 2023.**

Lethrinops chilingali was thought to be endemic to Lake Chilingali. It is similar to *Lethrinops lethrinus*, but has a more broken stripe and shorter snout. Like many Lake Malawi endemics, it shows strong sexual dimorphism, with large bright blue males and much smaller, more camouflaged females. Among species in the study area, females and immature males are distinguished by their broken horizontal flank stripes and long snout. Our surveys recorded it as abundant in the Nkacha seine catch in the north of Lake Chilingali, but a few juveniles were also found Lake Chitenje, and adults in the lower Kaombe and in Lakes Nadzenje and Kamphambe. Thus, the species appears to be not only thriving at the type locality, but is also more widespread and thus less threatened than believed.

Mature male *Lethrinops chilingali,* Lake Chilingali

Female/immature *L. chilingali*, Lake Chilingali

Juvenile *L. chilingali*, Lake Chitenje

Mature male *L. chilingali*, Kaombe River.

Figure 10: *Lethrinops chilingali* from Lake Chilingali and other sites on the Kaombe River.

Figure 11: *Lethrinops chilingali* in Lake Nadzenje appeared more golden and spotted than those from the Kaombe catchment.

***Oreochromis shiranus* Boulenger 1897**

This species found throughout Lake Malawi and its catchment, including Lake Malombe and the Upper and Middle Shire Rivers, with a subspecies *O. shiranus chilwae* in Lake Chilwa (Trewavas 1983). The relationships of these to the two subspecies of *O. placidus* remains confused (Ciezarek et al. 2024), but this is not relevant to the present study. In Lake Malawi, it is a species of shallow vegetated areas (Turner 1996). The species is a heavily-built typical *Oreochromis* with a golden-tinted body and a tendency to show horizontal dark bands. In the south of Lake Malawi, most individuals have 4 anal spines, but a large number of 3-spined individuals were found in Lake Chilingali. Small juveniles are often more silvery grey with thin irregular vertical bars and a large rounded spot in the soft dorsal fin. Mature adult males are black with a red dorsal fin margin, long jaws and a concave head profile (Trewavas 1983). The species was found in all 7 sampled sites, where it seemed to be the most abundant large-bodied species and a key target of fishing activities.

Lake Nadzenje.

Adult male (dried out), Kaombe River

Lake Ndila, juvenile

Lake Chilingali (specimen covered in sand)

Figure 12: *Oreochromis shiranus* sampled in various lakes during the survey

***Pseudocrenilabrus philander* (Weber 1897)**

This small cichlid is widely distributed in southern Africa, and male breeding colour shows a lot of geographic variation (Twentyman-Jones et al. 1997). To the north, it is replaced by *P. multicolor*, whose range extends to Egypt. It is not clear where one species transitions to the

other, but conventionally *P. multicolor* is found in the Lake Victoria catchment and *P. philander* in the Lake Malawi catchment southwards. The Lake Victoria population has generally been regarded as a subspecies, *P. m. victoriae*. A proposal to raise this to specific rank (Freyhof 1995) does not seem generally accepted (Fricke et al. 2024). The species has never been recorded in Lake Malawi per se, but is common in the catchment in two areas: the far north in the vicinity of Kyela in Tanzania, and the area around Nkhotakota in Malawi. It is not known elsewhere in the catchment, but occurs in Lake Chilwa. Phenotypically, the Lake Malawi catchment form of *P. philander* looks pretty much identical to *P. m. victoriae*. Males are bright golden with blue lips, have red and blue spotted fins and a bright red spot at the tip of the anal fin. Females are generally drab sandy-coloured. *Pseudocrenilabrus philander* was recorded at all sites except Lake Chitenje, but nowhere seemed to be dominant, although they were particularly abundant in the mosquito seine catch in southern Lake Chilingali. In most sites, mature males were sometimes extremely small (4cm TL).

Lake Nadzedje, male

Lake Chilingali, male.

Lake Tabitabi, male

Figure 13: *Pseudocrenilabrus philander.*

***Serranochromis robustus* (Günther 1864)**

Serranochromis robustus is a very large predatory species closely related to a distinct haplochromine cichlid group mainly found in the Congo and South-West Africa. Populations in the Zambezi, Okavango, Kafue and Zambian Congo were once assigned to the subspecies *S. r. jallae*, but this is now considered a distinct species, so that *S. robustus* is now considered endemic to the Lake Malawi catchment (Stauffer et al. 2020). The species is identified by its huge mouth, small eyes and deep cheek. Juveniles tend to have wide dark brown horizontal bands on a pale whitish background. It occurs mainly in swampy, vegetated areas in Lake Malawi, although it can be occasionally spotted in other habitats including rocky shores. It is often found in Lake Malawi afferents and satellite lakes, including Lake Kingiri in Tanzania (Turner et al. 2019). It was formerly recorded in Lake Chilingali (Turner et al. 2019), but was not found there in the current survey. It was recorded in Lakes Tabitabi, Kamphambe and Nadzenje, but nowhere in the Kaombe system (Table 1).

L. Kamphambe, Male, with blue breeding dress developing.

Lake Tabitabi

Lake Tabitabi, small juvenile

Figure 14: *Serranochromis robustus.*

***Tilapia sparrmanii* Smith 1840**

Tilapia sparrmanii is found widely in central and southern Africa. Its distribution in the Lake Malawi catchment matches perfectly with that of *P. philander*, having never been recorded in Lake Malawi per se, but occurring in rivers, pools and small lakes in the catchment in the far north around Kyela in Tanzania and then again in the central west around Nkhotakota. There are unpublished records from the area in between, including Nkhata Bay and the streams from the Viphya Plateau. It is established in crater Lakes Ikapu and Kyungululu in Tanzania (Turner et al. 2019), although it was almost certainly stocked in the latter. It is very deep-bodied with a relatively small head, and often shows a large spot in the soft dorsal fin, so it mainly could be confused with *C. rendalli.* The background colour tends to be more yellowish, and dark vertical barring is often shown. The belly is never red/pink as in *C. rendalli*, but there are often rows of red-edged scales behind the operculum. Territorial adults generally have wide black bars overlying thin strips of whitish background colour, with strong red markings on the post-opercular flank regions. Lips are sometimes iridescent blue. It was formerly abundant in Lake Chilingali but was not recorded there in the current survey, although it was found in the lower Kaombe River and in three lakes.


Lake Tabitabi


Kaombe River


Lake Kamphambe


Lake Nadzenje

Figure 15: *Tilapia sparrmanii.*

Non-cichlid fishes.

Lake Malawi and its catchment has a rich community of non-cichlid fishes. They are more genetically diverse, representing many different families but far fewer species than the cichlids. The main group are the Ostariophysans, which generally have short-based dorsal fins, elongate bodies and pelvic fins positioned further back than is shown by cichlids. The three main groups are the catfishes (no scales, long barbels, strongly spined fins, often nocturnal), the characins (scales, no barbels, no fin spines, jaw teeth, adipose fins) and the carps (scales, small barbels, sometimes a single dorsal spine, no jaw teeth, no adipose fins). Each of these groups is now comprised of numerous families, doubtless with many more to come. The second major group in the catchment is the Mormyridae, nocturnal weakly-electric fishes with small barely functional eyes. Apart from a few catfishes, most of these fish show no parental care of the young. Signalling is often by touch, olfaction, sound or electric pulses, and rarely through conspicuous colours, although a few cyprinids show some breeding colours. The most problematic to identify are the numerous species of small *Enteromius* (formerly 'small *Barbus*'): most of these are widespread and of little conservation concern. *Enteromius paludinosus* supports a major fishery in Lake Chilwa, but otherwise they are generally not commercially important either in the food fishery or the aquarium trade. Non-cichlid fishes will be dealt with according to family.

Alestidae

Alestids are the main African group of Characins (no barbels, adipose fins). Both species known from the lake Malawi catchment were observed, and both have recently undergone generic reassignment: *Brachyalestes* (formerly *Brycinus*) *imberi* and *Rhabdalestes* (formerly *Hemigrammopetersius*) *barnardi*. Both are typical slender shoaling fishes, but have obvious adipose fins. *Brachyalestes imberi* has very large silvery scales, gets relatively large and often has a red or orange adipose fin and large dark spots behind the operculum and on the caudal peduncle. It was previously recorded in Lake Chilingali (Turner et al. 2019), but was not found there in the current survey (Table 1), occurring only in Kamphambe. *Rhabdalestes barnardi* is a smaller, more delicate fish with a subtle, opalescent beauty (fig. 16). It was also previously reported from Lake Chilingali (Turner et al. 2019), but again not recorded there in the present survey (Table 1). It was the dominant species in Lake Ndila, where it was caught in vast numbers in a mosquito seine.

B. imberi, Lake Kamphambe

R. barnardi, Lake Ndila.

Figure 16: Alestidae: *Brachyalestes imberi* and *Rhabdalestes barnardi*.

Clariidae

Clarias gariepinus is a big tough catfish found throughout most of Africa. It is widely exploited as a food fish, both in capture fisheries and aquaculture. It has a wide head, strong pectoral spines and a rather elongated eel-like body. A number of other species are found in the Malawi catchment, including the more eel-like *C. theodorae*, which was formerly reported from Lake Chilingali, but was not found in any location in 2024-25. *Clarias gariepinus* was recorded from several sites and is probably present in most, if not all, of the water bodies surveyed.

Figure 17: *Clarias gariepinus*, Lake Kamphambe.

Cyprinidae

Many species of cyprinids are found in the Lake Malawi catchment. We did not collect any of the large *Labeobarbus*, but we found the widespread and abundant *Labeo cylindricus*, an algae-rasping sucker-mouthed species that is common in Lake Malawi but spawns in streams. The species is easily identified with its yellow-brown colour, usually with a darker wide flank stripe and red eyes. At present, all of the smaller ones are placed in the genus *Enteromius*, but it is unclear whether or not this represents a natural group.

Labeo cylindricus, Lake Kamphambe.

E. arcislongae, Kaombe River

E. greenwoodi, Lake Tabitabi

E. kersteni, Kaombe River

Enteromius cf lineomaculatus A, Lake Chilingali

E. macrotaenia, Lake Chitenje

E. paludinosus Lake Chitenje

E. radiatus, Lake Tabitabi

E. trimaculatus, Kaombe River NB: flank spots faded.

Figure 18: Cyprindae: *Labeo* and *Enteromius* species.

Danionidae

Until recently, Danionids were considered cyprinids, but they have been split off into their own family. The Lake Malawi catchment has three species of *Opsaridium* and two of *Engraulicypris. Opsaridium* are fast-swimming surface-living fish. The most abundant species is the medium-side *O. microcephalum*, the Sanjika, which lives and breeds in Lake Malawi and in river habitats (Fig. 19). We found it in Lake Chilingali (Table 1). The related species are *O. microlepis*, which has small scales and grows very large, and *O. tweddleorum*, which is small and lives entirely in rivers- when adult, it has a wide dark dorsal fin margin.

Figure 19: *Opsaridium microcephalum* (Günther 1864)

Mormyridae

Seven species of mormyrids are known from the Lake Malawi catchment (Snoeks 2004). All appear to live both in the lake and in rivers and smaller lakes in the catchment. Three or four species were known from Lake Chilingali before (Turner et al. 2019), but none were collected there in the present survey. *Cyphomyrus discorhynchus* is a deep-bodied species with a bulbous head and a projecting bulge under the head. It also has a distinctively long dorsal fin, longer than the anal fin, in contrast to other round-headed species (Figure 20). This species was found in the Kaombe River and Lake Kamphambe (Table 1). *Marcusenius* species have a projecting snout bulge underneath a small mouth. *Marcusenus macrolepidotus* has simple, conical teeth, while *M. livingstonii* has bicuspid teeth: this is not easy to see in the field! All specimens we collected looked very similar and some of them could be seen to have conical teeth, so we have assumed they were probably *M. macrolepidotus*.

C. discorhynchus L. Kamphambe, showing scars of the gillnet behind the head.

M. macrolepidotus, L. Kamphambe,

Figure 20: Mormyridae: *Cyphomyrus discorhynchus, Marcusenius macrolepidotus*.

Protocapodidae

Micropanchax johnstoni (Günther 1894) is a small 'lampeye' killifish feeding at the surface in shallow weedy habitats. Although many similar allopatric species are found in central and southern Africa, this appears to be the only species in the Malawi catchment and so it is relatively easy to identify. The generic name has flipped around quite a bit, from *Aplocheilichthys*, to *Micropanchax* to *Lacustricola*. The latter seems likely to be the ultimate destination for the species, but publications so far have failed to offer the combination, using formally invalid formats such as 'Lacustricola' *johnstoni* or *Lacustricola cf. johnstoni* (Fricke et al. 2024). We found the species in mosquito seine hauls in Lake Ndila.

Figure 21: Protocapodidae: *Micropanchax johnstoni*. The dark horizontal line across the belly is a piece of vegetation, not an element of a colour pattern.

Discussion

The survey has shown that *Lethrinops chilingali* is not endemic to its type locality of Lake Chilingali but is found more widely in the Kaombe River system and beyond and is therefore less likely to be endangered than previously thought. However, the results are unprecedented in that it is the first known species of an endemic Lake Malawi haplochromine genus to apparently breed in a river system and to be as yet unknown from the main lake. This also argues against the idea that the species evolved allopatrically through isolation within the satellite lake (Tyers et al. 2014) but rather did so through invasion of a novel habitat (the river) across an ecotone or sharp environmental gradient, more akin to the invasion of deeper water habitats by cichlid fishes in Lake Victoria and Lake Masoko (Malinsky et al. 2015). The survey also provided tantalising evidence of geographic variation with *L. chilingali*, with possible phenotypic variation between the Kaombe and Kang'ona River catchments which is worthy of more thorough investigation with genetic samples and specimens preserved for morphological study.

We did not find evidence of *Rhamphochromis sp.* 'chilingali' in any of the water bodies sampled. When shown photographs of the species, the spokesman of the offshore seine crew in the north of Chilingali reported that the species was present in the lake but more common in the rainy season (December-April). However, the lake is small and shallow and prior to the dam collapse in 2012, *Rhamphochromis* were readily obtained from fishers outside the rainy season (Turner et al. 2019). The second survey was carried out in the rainy season specifically to investigate this claim and no *Rhamphochromis* were found. Therefore, it appears likely that the species is extinct in the wild.

Live breeding stocks of the species are available in the United Kingdom, at Bangor University and Chester Zoo among other places, and so it may prove possible to reintroduce the species, should this be agreed by the relevant authorities.

Among the other species investigated, a major biogeographic puzzle is the presence of both *Pseudocrenilabrus philander* and *Tilapia sparrmanii* from Nkhotakota to the Kyela regions but nowhere else in the catchment of Lake Malawi.

Conclusions

Of the two species believed to be endemic to Lake Chilingali before the collapse of its dam, we conclude that one of them (*Lethrinops chilingali*) has recovered and is actually more widely distributed than thought, while the other, as yet undescribed *Rhamphochromis* is extinct in the wild, but available for possible reintroduction through captive stocks maintained in Europe.

Acknowledgements

We are grateful to Denis Tweddle for assistance in identifying small cyprinid fishes from blurry photographs, Gerardo Garcia for helping develop the idea and Anthony Nkhoma, Albert Matonyola, Symon Ngwira, Chikumbutso Phambala, Salama Amiri, Madalitso Banda and Christopher Chisesa for field assistance. We are grateful to ACE-Aquafish, EUAC (European Union of Aquarium Curators) and Chester Zoo for funding.

References

Ciezarek AG, Mehta TK, Man A, Ford AGP, Kavembe GD, Kasozi N, Ngatunga BP, Shechonge AH, Tamatamah R, Nyingi DW, Cnaani A, Ndiwa TC, Di Palma F, Turner GF, Genner MJ, Hearty W (2024) Ancient and recent hybridization in the *Oreochromis* cichlid fishes. Molecular Biology & Evolution, 41(7):msae116

Denys FJM, Hagen DJ, Stephens T, Brown R, Namukopwe V (2013) Lake Chilingali Dam Rehabilitation. Presentation at SANCOLD Conference November 2013. Available from: https://tinyurl.com/5epzav8z (accessed 11 July 2023)

Freyhof J (1995). *Haplochromis*-Verwandte der Flüsse Zentralafrikas. Cichliden. Festschrift zum 25. Jubiläum der DCG. 10-15

Fricke R, Eschmeyer WN, van der Laan R, eds (2024) Eschmeyer's Catalog of Fishes http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp. Accessed 7th Sept 2024.

Genner MJ, Nichols P, Carvalho GR, Robinson RL, Shaw PW, Smith A, Turner GF (2007) Evolution of a cichlid fish in a Lake Malawi satellite lake. *Proceedings of the Royal Society of London B* 274, 2249-2257.

Greenwood PH (1965) The cichlid fishes of Lake Nabugabo, Uganda. *Bulletin of the British Museum (Natural History), Zoology* 12, 315–357.

Malinsky M, Challis R, Tyers AM, Schiffels S, Terai Y, Ngatunga BP, Miska EA, Durbin R, Genner MJ, Turner GF (2015) Genomic islands of speciation separate cichlid ecomorphs in an East African crater lake. *Science* 350, 1493-1498

Seegers L (1996) *Fishes of Lake Rukwa*. Tervuren, Belgium.

Snoeks J (2004). The non-cichlid fishes of Lake Malawi: a compilation. pp. 20-26 in Snoeks J. (ed.) *The cichlid diversity of Lake Malawi/Nyasa/Niassa: identification, distribution and taxonomy.* Cichlid Press, El Paso, Texas, 360 pp.

Stauffer JR jnr, Bills R, Skelton PH, Weyl OLF (2020). Re-elevation to species level and redescription of *Serranochromis jallae* and *Serranochromis robustus* (Teleostei: Cichlidae). Zootaxa 4858 (no. 1): 126-134.

Trewavas E (1983) *Tilapiine Fishes of the Genera* Sarotherodon, Oreochromis *and* Danakilia. British Museum (Natural History) Publications. 583pp.

Turner GF (1996) *Offshore Cichlids of Lake Malawi*. Cichlid Press, Germany. 240pp.

Turner GF, Ngatunga BP, Genner MJ (2019) The natural history of the satellite lakes of Lake Malawi. EcoevoRxiv. https://ecoevorxiv.org/sehdq/ 131pp.

Turner GF, Ngatunga BP, Genner MJ (2021). *Astatotilapia* species (Teleostei, Cichlidae) from Malawi, Mozambique and Tanzania, excluding the basin of Lake Victoria. EcoevoRxiv https://ecoevorxiv.org/eu6rx/ 107pp.

Turner GF, Crampton DA, Genner MJ (2023) A new species of *Lethrinops* (Cichliformes: Cichlidae) from a Lake Malawi satellite lake, believed to be extinct in the wild. Zootaxa 5318 (4), pp.515-530

Tweddle D (1996). Fish survey of Nkhotakota wildlife reserve. Report to Japanese International Co-operation Agency on behalf of the Wildlife Society of Malawi. 79pp.

Twentyman-Jones V, Ribbink AJ, Voorvelt D (1997). Colour clues to incipient speciation of *Pseudocrenilabrus philander* (Teleostei, Cichlidae). South African Journal of Science. 93:529-537

Tyers AM, Bavin D, Cooke GM, Griggs C, Turner GF (2014). Peripheral isolate speciation of a Lake Malawi cichlid fish from shallow-muddy habitats. *Evolutionary Biology* 41, 439-451.