

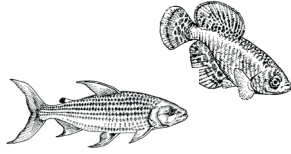
AbcTaxa

A Guide to the Parasites of African Freshwater Fishes

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Volume 18 (2018)



Chapter 2.1.

FISH DIVERSITY AND ECOLOGY

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Diversity of fishes in Africa

Fishes are the most taxonomically diverse group of vertebrates and Africa shares a large portion of this diversity. This is due to its rich geological history – being a part of Gondwana, it shares taxa with the Neotropical region, whereas recent close geographical affinity to Eurasia permitted faunal exchange with European and Asian taxa. At the same time, relative isolation and the complex climatic and geological history of Africa enabled major diversification within the continent. The taxonomic diversity of African freshwater fishes is associated with functional and ecological diversity. While freshwater habitats form a tiny fraction of the total surface of aquatic habitats compared with the marine environment, most teleost fish diversity occurs in fresh waters. There are over 3,200 freshwater fish species in Africa and it is likely several hundreds of species remain undescribed (Snoeks *et al.* 2011). This high diversity and endemism is likely mirrored in diversity and endemism of their parasites.

African fish diversity includes an ancient group of air-breathing lungfishes (*Protopterus* spp.). Other taxa are capable of breathing air and tolerate poor water quality, including several clariid catfishes (*e.g.*, *Clarias* spp.; Fig. 2.1.1D) and anabantids (*Ctenopoma* spp.). Africa is also home to several bichir species (*Polypterus* spp.; Fig. 2.1.1A), an ancient fish group endemic to Africa, and bonytongue *Heterotis niloticus* (Cuvier, 1829) (Osteoglossidae), a basal actinopterygian fish. Special adaptations of particular fishes are expected to affect parasite communities.

Functional diversity of African freshwater fishes includes specialised predatory tigerfishes (*Hydrocynus* spp.; Fig. 2.1.1K), weakly electric elephantfishes (Mormyridae; Fig. 2.1.1C), electric catfishes (*Malapterurus* spp.; Fig. 2.1.1B), pufferfishes (*Tetraodon* spp.; Fig. 2.1.1I) and many other specialised forms. Among other unique fishes, Africa has its blind cave fish (*Caecobarbus geertsii* Boulenger, 1921), miniature fishes from rainforest streams (*e.g.*, *Barboides britzi* Conway *et Moritz*, 2006), small annual killifishes (*Nothobranchius* spp.; Fig. 2.1.1E) that survive annual desiccation of their habitat as dormant embryos encased in dry substrate, or brood parasites that parasitise mouth brooding cichlids and use them as foster parents for their offspring (cuckoo catfish, *Synodontis multipunctatus* Boulenger, 1898; Fig. 2.1.1F). Large functional diversity can evolve even at small temporal and spatial scales, such as in haplochromine cichlids in Lakes Victoria, Malawi and Tanganyika and species of *Labeobarbus* Rüppell, 1835 (Cyprinidae) in

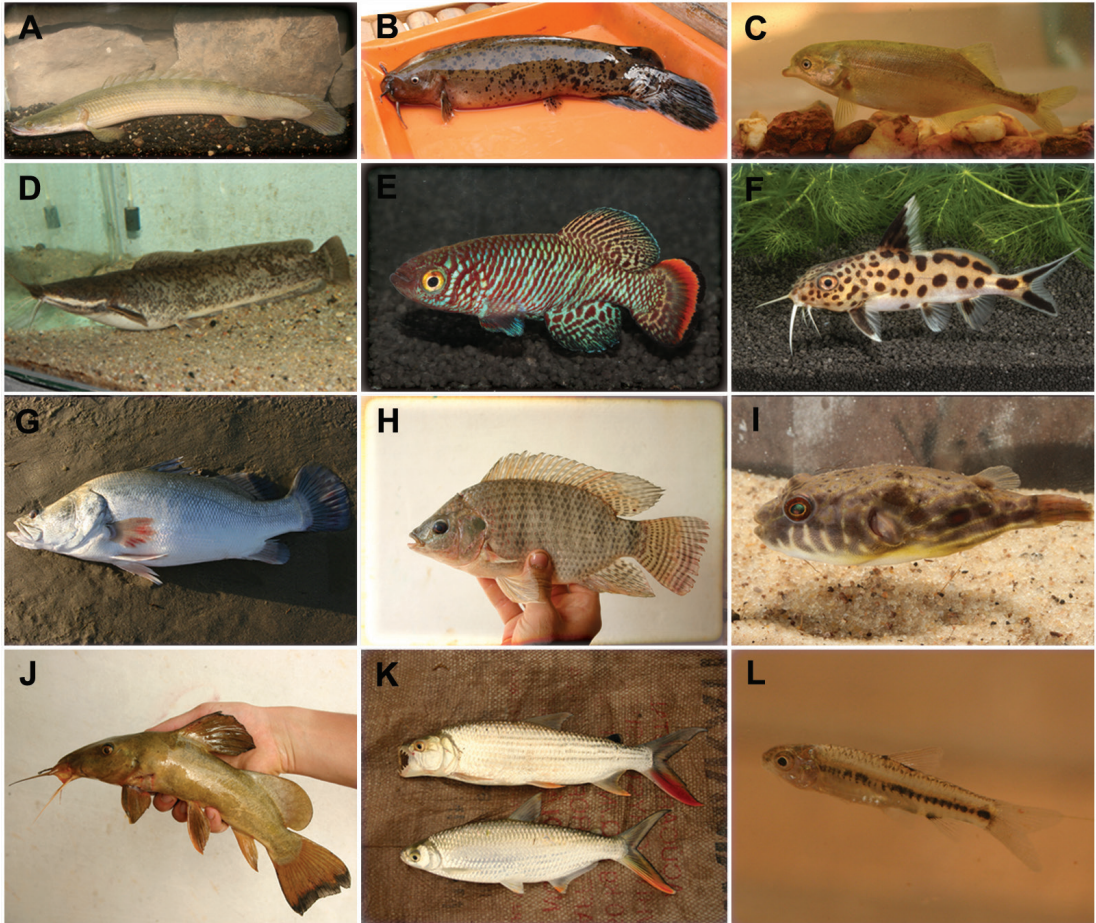


Fig. 2.1.1. Examples of African freshwater fish diversity. **A.** *Polypterus bichir* (Polypteridae); **B.** *Malapterurus occidentalis* (Malapteruridae); **C.** *Marcusenius senegalensis* (Mormyridae); **D.** *Clarias gariepinus* (Clariidae); **E.** *Nothobranchius pienaar* (Nothobranchiidae); **F.** *Synodontis multipunctatus* (Mochokidae); **G.** *Lates niloticus* (Latidae); **H.** *Oreochromis niloticus* (Cichlidae); **I.** *Tetraodon lineatus* (Tetraodontidae); **J.** *Auchenoglanis occidentalis* (Claroteidae); **K.** *Hydrocynus brevis* and *Alestes baremoze* (Alestidae); **L.** *Enteromius niokoloensis* (Cyprinidae). (Photographs by R. Blažek and M. Reichard.)



Fig. 2.1.2. Map of Africa with identification of 10 main ichthyofaunal regions. **1.** Maghreb Province; **2.** Nilo-Sudanian Province; **3.** Congo Province; **4.** Upper Guinea; **5.** Lower Guinea; **6.** Zambezi Province; **7.** East Coast Province; **8.** Southern (Cape) Province; **9.** Quanza Province; **10.** Abyssian Highlands Province (according to Thieme *et al.* 2005). The base map is from Wikimedia Commons: Bamse (self-made) using GMT, CC BY-SA 3.0.

Lake Tana. How such small-scale diversification rates are translated into parasite diversification remains largely unexplored.

The fish diversity in Africa is subject to intense scientific interest, with special attention to understanding their evolution, biology and adaptations, and to explore fish as a resource for local small-scale fisheries and larger scale commercial activities. A better understanding of the diversity and importance of the fish parasite fauna should be based on solid background knowledge of African fish biology and taxonomy.

Zoogeography

The major ichthyofaunal provinces are separated into 10 main continental regions (Roberts 1975; Snoeks *et al.* 2011; Fig. 2.1.2) and Madagascar, though a finer scale resolution to 93 freshwater ecoregions is also available (Thieme *et al.* 2005). The Maghreb Province is the most distinct African ichthyofaunal province. As part of the Palearctic realm, its ichthyofauna displays a high similarity with the European fish fauna (*e.g.*, *Barbus* spp., *Salmo trutta* Linnaeus, 1758, *Cobitis* sp.). The largest province is the Nilo-Sudanian Province, spanning from the River Gambia in the West to the Kenyan coastal drainage in the East. It includes major rivers such as the Nile, the Niger and the Volta, as well as the Lake Chad Basin in its centre. The Congo Province includes the entire drainage of the Congo River, the second largest river basin in the world, with a very high species richness and diversity. It also includes Lake Tanganyika. Two other West African provinces are the Lower and Upper Guinea, separated by the Dahomey Gap and the Volta River. The Upper Guinea includes the coastal rivers of the West African forest region, whereas the Lower Guinea is adjacent to the Congo Province. These regions have been well researched and their ichthyofauna is relatively well known. The Zambezi Province includes rivers flowing eastward to the Indian Ocean from the Zambezi Basin in the North to the Limpopo Basin in the South. It also includes the Okavango Basin. Geographically, Lake Malawi is part of this system, though it has a unique lacustrine ichthyofauna. The East Coast Province includes smaller rivers flowing eastward along the coast of northern Mozambique, Tanzania and southern Kenya, and includes Lake Victoria, with its unique haplochromine cichlid fauna and other lakes in the region. The Southern (Cape) Province includes many temperate rivers south of the Zambezi Province. It has a small number of native (autochthonous) species compared to other provinces (42) and higher-order taxa, but species in the province are often endemic (36 endemic species). The Quanza Province includes a small region of coastal Angolan rivers, with their ichthyofauna being largely unexplored. Finally, the small Abyssian Highlands Province is composed of Lake Tana (with its intra-lacustrine radiation of *Labeobarbus*) and adjacent parts of the effluent rivers.

Main families of fishes

Almost all African freshwater species are continent-endemic and over 40% of the 76 families are restricted to the African continent, which is a relatively high

level of endemism at family level. Cichlidae is the most species-rich family (at least 900 species), with the main species diversity in the lakes of East Africa (Tanganyika, Malawi, Victoria), though the number of riverine cichlid species is also high. Cyprinidae (almost 500 species) are typically riverine fishes whose species diversity outnumbers that of the ecologically similar Alestidae (African tetras) by a factor of four (approximately 120 species). Distichodontidae is an endemic family to Africa containing 101 described species. The catfishes are dominated by squeaker catfishes (Mochokidae, 209 species), Claroteidae (86 species) and air-breathing Clariidae (approximately 75 species in Africa). Killifishes are separated into Nothobranchiidae (262 species) and Poeciliidae (about 65 egg-laying species in Africa). The endemic and weakly electric elephantfishes (Mormyridae) include 221 described species (Froese & Pauly 2017). There are also several species from widespread families such as Gobiidae, non-endemic families such as Galaxiidae (in the Southern Province) and many small families endemic to Africa (e.g., Hepsetidae, Pantodontidae). An overview of main freshwater fish families in Africa with estimates of their species richness, general distribution and abundance is shown in Table 2.1.

Ecological guilds

African fishes inhabit all available ecological niches, with examples of species adapted to pelagic and benthic habitats, to strong rapids, swamps, temporary habitats, river margins and deep lacustrine habitats repeated in numerous taxa. Africa harbours native catadromous and anadromous migratory fishes (e.g., Anguillidae) and species with a largely nocturnal lifestyle (e.g., Mormyridae). Several species possess weakly poisonous glands in proximity to sharp fin rays (Mochokidae) and appropriate care should be taken when handling them. Ecological guild largely dictates fish lifestyle and this should aid in the choice of appropriate sampling techniques.

Commercially important fish

Several native African species are commercially exploited in aquaculture in Africa itself and in other continents. Nile tilapia *Oreochromis niloticus* (Linnaeus, 1758) (Fig. 2.1.1H) and a few related species and hybrids are the most popular species in tropical aquaculture, and Nile tilapia is successfully cultured across Africa. Information on their parasite fauna and its dynamics may be critical for the success of aquaculture at high population densities. Some species became important for larger-scale fisheries, including many lacustrine cichlids and the Nile perch *Lates niloticus* (Linnaeus, 1758) (Fig. 2.1.1G) in East Africa, West African pygmy herring *Sierrathrissa leonensis* Thys van den Audenaerde, 1969 in Lake Volta and Tanganyikan kapenta sardine *Limnothrissa miodon* (Boulenger, 1906) in Kariba and Cahora Bassa reservoirs and in Lakes Kivu and Tanganyika. Many other fishes are important for local sustainable fisheries, such as *Clarias* spp. (Fig. 2.1.1D) or riverine migratory species. Particularly, the larvae of digeneans with a complex life cycle may opportunistically infect commercial species as intermediate hosts and may reduce the commercial value of these species. Their final hosts are predatory fish or birds.

Table 2.1. An overview of main African freshwater fish families with estimates of their species richness, general distribution and abundance

Order	Family	Species richness	Distribution
Lepidosireniformes	Protopteridae	1 genus, 4 species	widespread
Polypteriformes	Polypteridae	2 genera, 10 species	widespread
Anguilliformes	Anguillidae	5+ species	Indian and Mediterranean drainages
Clupeiformes	Clupeidae	13 genera	widespread, abundant
	Denticipitidae	1 species	restricted: West Africa
Osteoglossiformes	Arapaimidae	1 species	widespread, introductions
	Pantodontidae	1 species	relatively widespread: West Africa
	Notopteridae	2 genera, 3 species	widespread: West Africa
	Mormyridae	221 species	widespread, abundant
	Gymnarchidae	1 species	widespread: West Africa + Soudanian
Salmoniformes	Salmonidae	several introduced species	native to Magreb (1 species), introduced to East and Southern Africa
Osmeriformes	Galaxiidae	1 species	endemic to South Africa
Gonorynchiformes	Kneriidae	4 genera, 10 species	geographically widespread but locally uncommon
	Phractolaemidae	1 species	endemic to West Africa
Hepsetidae	Hepsetidae	1 genus, 6 species	West, Middle and South Africa
Characiformes	Alestidae	19 genera, 119 species	widespread, abundant
	Distichodontidae	17 genera, 101 species	widespread, abundant
	Citharinidae	3 genera, 8 species	widespread, abundant
Cypriniformes	Cyprinidae	500+ species	widespread, abundant
	Nemacheilidae	1 species	endemic to Ethiopia
	Cobitidae	1 species	endemic to Maghreb
Siluriformes	Bagridae	1 genus, 11 species	widespread
	Claroteidae	13 genera, 86 species	widespread, abundant
	Schilbeidae	5 genera, 33 species	widespread, abundant
	Amphiliidae	13 genera, 68 species	widespread
	Clariidae	13 genera, 75 species	widespread, abundant
	Malapteruridae	2 genera, 21 species	widespread
	Mochokidae	9 genera, 200+ species	widespread, abundant
Perciformes	Poeciliidae	7 genera, 65+ species	widespread, abundant
	Nothobranchiidae	12 genera, 250+ species	widespread, abundant
	Channidae	1 genus, 3 species	West and Central Africa
	Latidae	1 genus, 9 species	widespread
	Centrarchidae	2 genera, 4 species	introduced in South Africa

	Percidae	1 species	introduced in South Africa
	Nandidae	2 genera, 2 species	West Africa
	Cichlidae	900+ species	widespread, abundant
	Anabantidae	3 genera, 32 species	widespread
	Gobiidae	30+ genera, 90+ species	widespread
	Eleotridae	approx. 25 species	widespread
Synbranchiformes	Mastacembelidae	1 genus, 45 species	widespread
Tetraodontiformes	Tetraodontidae	6 species	geographically widespread

Estimates on taxonomic richness, distribution and abundance are based from Skelton (1988), Darwall *et al.* (2005) and Froese & Pauly (2017).

Non-native species and other threats to local fish fauna

Many fish species were translocated within Africa, especially for commercial use in aquaculture. The best-known examples include Nile tilapia (Fig. 2.1.1H) and Nile perch (Fig. 2.1.1G). Nile tilapia is more aggressive and competitively superior to other tilapias (and many other cichlids that share its ecological niche) and has displaced them from many habitats. In addition, Nile tilapia hybridises with native species of *Oreochromis* Günther, 1889, further threatening their existence. Predictably, transport of Nile tilapia includes transport of their parasites, with potential spill-over and spill-back effects on local fish fauna. Nile perch, native to West African rivers and Lake Turkana, has been introduced to other places to supplement local fisheries, sometimes with catastrophic consequences for the local fish fauna (exemplified by the Lake Victoria case). Other fish species being translocated worldwide can be found in Africa, including Eurasian cyprinids such as common carp *Cyprinus carpio* Linnaeus, 1758, Chinese silver carp *Hypophthalmichthys molitrix* (Valenciennes, 1844) or grass carp (*Ctenopharyngodon idella* Valenciennes, 1844) and several North American centrarchids, including largemouth bass *Micropterus salmoides* (Lacépède, 1802). These species, however, are mainly constrained to relatively colder parts of Africa such as the Southern Province. Research on the parasite fauna of non-native species is interesting as missing parasites are often linked to the success of introductions.

The African fish fauna is also threatened by water pollution (especially inorganic pollution near mining sites and sedimentation from soil erosion), river regulation (dams preventing upstream migration), conversion of wetlands to rice paddies and overfishing in particular habitats. Especially water pollution is expected to have a major impact on the parasite fauna. Notably, heavy metals tend to accumulate in parasites and fish parasites might be used as potential biomarkers for mining-related water pollution (Sures *et al.* 1999).

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