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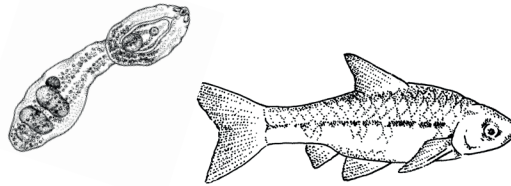
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PART 2

FISH AS HOSTS OF PARASITES, THEIR ECOLOGY AND SAMPLING

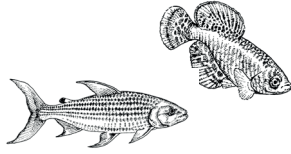


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Chapter 2.1.

FISH DIVERSITY AND ECOLOGY

Martin REICHARD

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

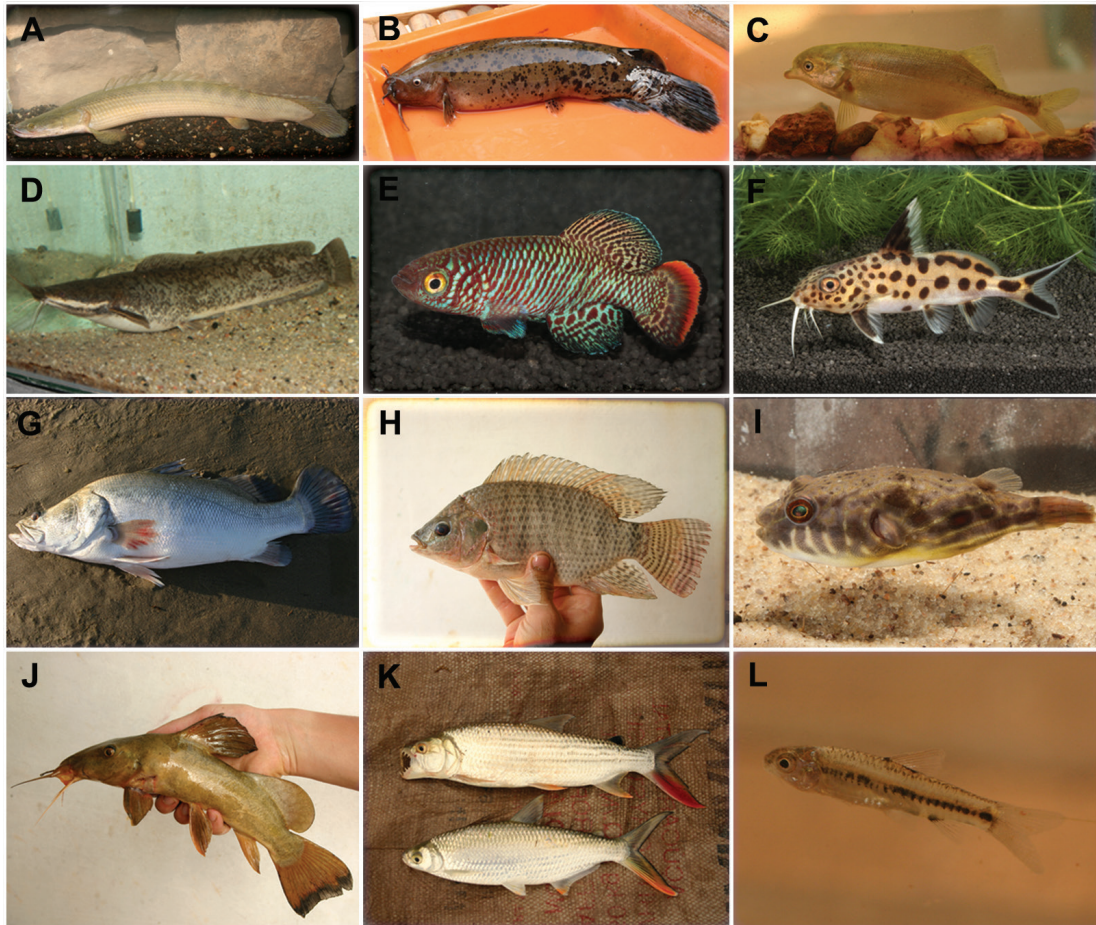


Fig. 2.1.1. Examples of African freshwater fish diversity. **A.** *Polypterus bichir* (Polypteridae); **B.** *Malapterurus occidentalis* (Malapteruridae); **C.** *Marcusenius senegalensis* (Mormyridae); **D.** *Clarias gariepinus* (Clariidae); **E.** *Nothobranchius pienaarri* (Nothobranchiidae); **F.** *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