FRESHWATER FISHES IN AFRICA

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Keywords: Africa, Inland water, Fish, Biodiversity, Biology, Human utilization

Contents

1. The Lakes and Rivers of Africa
2. Advances in African freshwater ichthyology
3. Paleontology
4. Characteristics of the African inland water fish fauna
5. Biogeography
6. Freshwater habitats and fish assemblages
7. Reproductive strategies
8. Life history styles
9. Human utilization
10. Threats to freshwater ecosystems
11. The value of freshwater biodiversity
Glossary
Bibliography
Biographical Sketches

Summary

The African continent can broadly be divided into two large regions: Low (West and North Africa) and High Africa (South and East Africa). About ten large river basins occupy the continent and most of them flow towards the ocean. However there are also some large endorheic basins such as the Chari and the Okavango. The climate is of utmost importance in determining the distribution of aquatic systems.

Altogether, the combined effects of geographic, climatic and topographic factors have given rise to a high diversity of ecosystems, freshwater fishes and assemblages. Currently 3,360 species of fresh and brackish water fish species have been described from Africa. The long period of exondation of most of the African continent, which lasts for more than 600 Myrs ago during the Precambrian, may explain the diversity of the freshwater fish fauna and its unparallel assemblage of so-called archaic families of which mostly are endemic.

Thirteen ichthyological provinces or bioregions, based on their specific fish fauna, have been identified in Africa. In each bioregion the ratio of endemic species is generally high. One of the most noteworthy features is the existence of ‘‘species-flocks’’ in each ancient Eastern African Great Lakes.

Most of the African fish, except cichlids, are egg-scattering pelagic spawners, with a reproductive style which seems to be the general, if not the ancestral, condition of reproduction in this continent. Reproductive cycles are adapted to seasons and therefore

to the hydrological cycle of the basins in different climatic zones. For species with a long breeding period, such as many cichlids, it remains difficult to assess which key factors stimulate, inhibit or exert any regulatory influence on the various stages of the breeding cycles. Numerous species of fluviatile fishes migrate long distances upstream to spawn.

Fish is today a major source of protein all over the sub-Saharan Africa and the economy of many rural communities is heavily dependent on inland fisheries. The large increase of the human population created a huge demand on fish, and many fish stocks are today overexploited.

Although aquaculture is of considerable antiquity, especially in the Far East, the fish farming remains underdeveloped in Africa compared to other tropical countries where tilapiines (originally an exclusive African group of fish species) provide the bulk of aquaculture production. Species introductions are also a key to support fisheries and there have been several introductions or translocations, particularly in lakes.

The quantity of fish sold for aquarists is weak compared to that of aquaculture and fishing, but the generated benefices are considerable and it was estimated that the annual turnover of African fish for Europe represented 2.5 million US $.

A number of anthropogenic threats to freshwater ecosystems are recognized to operate at the continental scale, including: habitat loss or transformation, water extraction and hydrological disruption, invasive alien species, pollution, and overexploitation.

On one hand, freshwater biodiversity provides a broad variety of valuable goods and services for human societies. But, on the other hand, freshwater biodiversity has also a strong link to human health and some water-borne diseases continue to be widely responsible for major diseases and human misery.

1. The Lakes and Rivers of Africa

Taking into account the current relief, the African continent can broadly be divided into two large regions: Low and High Africa (Beadle, 1981) (Figure 1). Low Africa (West and North Africa) is primarily composed of sedimentary basins and upland plains below 600 m above sea level. In contrast High Africa, to the South and East, is mainly at 1,000 m above sea level.

The famous Rift Valley is the result of tectonic events. It includes some of the most ancient lakes in the world, such as Lake Tanganyika (9-12 million year old) and Lake Malawi (Lake Nyasa) (4-5 million year old) (Cohen *et al*., 1993) where evolution gave rise to unique species flocks of fish and invertebrates.

Five large basins occupy the center of the continent and most of these rivers flow towards the ocean: Niger, Nile, Congo, Zambezi and Orange. Some basins have no outlet (endorheic basins) and most of the incoming water is evaporated. The Chad basin for instance was, during the Pleistocene, an enclosed and internal sea (Mega Chad) larger than any of the present lakes. Other endorheic systems are the Kalahari and the

Okavango which are drained by the Zambezi River although a major portion of their waters is trapped in the marshes of the Okavango and Makarikari. Finally, to the North of the continent, almost all the rivers south of the Atlas Mountains drain into chotts and seasonal saline pools in semi-arid climate.

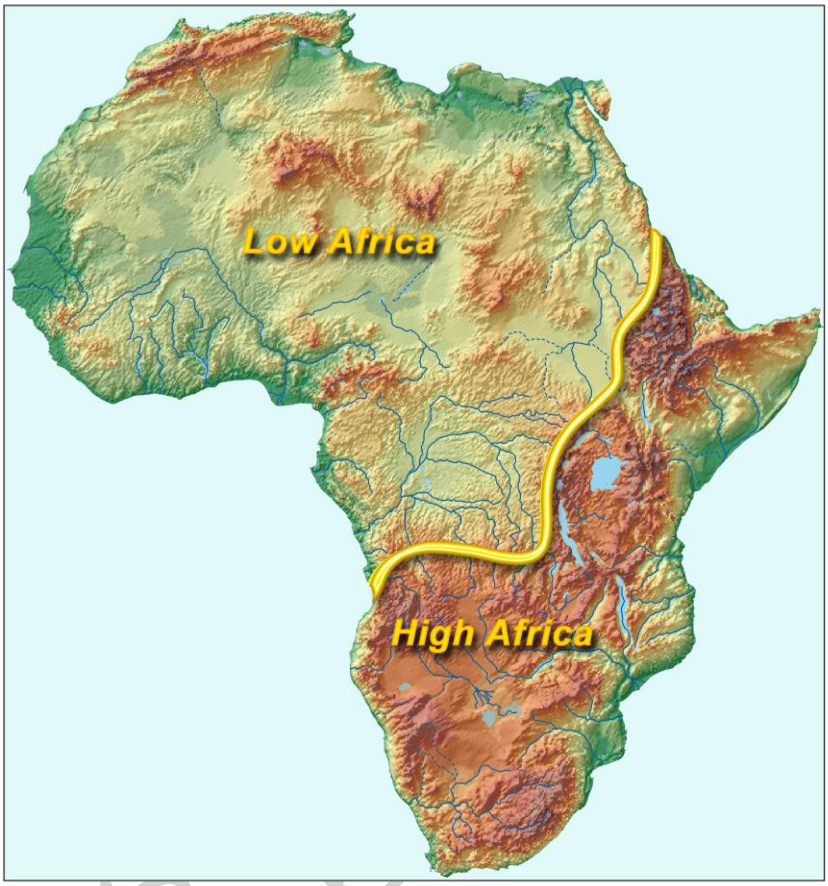

Figure 1. The general topography of Africa showing the approximate division between High and Low Africa (redrawn from Beadle, 1981).

The present day hydrographic system (Figure 2) is the remain of a pre-Miocene age system that was altered in the eastern part of the continent by the uprising of a wide band of 500 to 800 km width, oriented north-south from Eritrea to Zambezi. This ditch, approximately 1000 m deep, is due to plate tectonics and was formed about 20 million years ago. It is the origin of the vast depression of the Rift Valley oriented NE/SW, in which most of the Great African Lakes are located. Lake Victoria which covers an area of 65,000 km², occupies another depression located at the junction of the two branches of the Rift Valley. The volcanic activity associated with these geological events resulted in the creation of hundreds of crater lakes, mainly along the Western Rift.

The climate is of utmost importance in determining the distribution of aquatic systems. Within tropical Africa, three major climatic types prevail:

- *equatorial*: hot and humid with two rainy seasons;
- *tropical*: hot with summer rain;
- *subtropical*: hot and arid. In the north and south of the continent.

Mediterranean climate types also occur, with arid summers and winter rains. The amount of rain and its distribution throughout the year vary greatly within Africa. Both the within and between years, variations in rainfall affect river flows and lake levels. Evidently, these large patterns in rainfall and temperature greatly influence the ecology of aquatic organisms.

Figure 2. Distribution of river systems in Africa.

2. Advances in African Freshwater Ichthyology

Currently 3,360 species of fresh and brackish water fish species have been described from Africa, belonging to 95 families (Lévêque *et al*., 2008). Numerous other species collected in the East African lakes are awaiting description.

The knowledge of the ichthyological brackish and freshwater fauna in Africa is a very long story (Paugy, 2010b). From the time of the Ancient Egyptians to the present, more than 3,300 species (89 families and 529 genera) have been discovered, drawn and described. Michel Adanson (middle 18th century) initiated the first material collections during the eighteenth century. During the 19th century, the work of traveling scientists (Étienne Geoffroy Saint-Hilaire, Andrew Smith) and explorers (including Mungo Park, Pierre Savorgnan de Brazza and Henry Morton Stanley) added substantially to developing zoological collections from their field trips. At that time, many species descriptions were based on fish preserved in these collections. Towards the end of the 19th and into the early part of the 20th century, knowledge of African fishes was greatly enhanced, especially through the work of Georges A. Boulenger, Albert C.L.G. Günther and Franz Steindachner who, respectively, described 640, 119 and 53 species. Boulenger did visit Africa once during his life, in 1905 when he went to Cape Town for a conference. With this one exception, none of these scientists ever themselves traveled to Africa. In contrast to those of the previous century, the majority of naturalists of the 20th century who were interested in African fishes took part in collecting expeditions (Table 1). The majority of the naturalists working in Africa during the middle and later parts of the 20th century tended to specialize in particular groups.

Surname	First and middle name	Life span	No. of African fish species described
Valenciennes	Achille	1794-1865	45
Peters	Wilhelm Carl Hartwig	1815-1883	37
Bleeker	Pieter	1819-1878	34
Günther	Albert Charles Lewis Gotthilf	1830-1914	119
Steindachner	Franz	1834-1919	53
Boulenger	George Albert	1857-1937	640
Pellegrin	Jacques	1873-1944	145
Regan	Chrales Tate	1878-1943	83
Fowler	Henry Weed	1878-1965	44
Nichols	John Treadwell	1883-1958	33
Ahl	Ernst	1898-1943/44	40
Trewavas	Ethelwynn	1900-1993	159
Poll	Max	1908-1991	209
Daget	Jacques	1919-2009	60
Greenwood	Peter Humphrey	1927-1995	74
Thys v.d. Audenaerde	Dirk F.E.	1934	52
Roberts	Tyson Robert	1940	48
Seegers	Lothar	1947	35

Table 1. Main contributions to the knowledge of ichthyology (more than 30 species described)

Thanks to these naturalists the number of known African freshwater fish species reached 1,900 before the Second World War, 2,150 at the end of the 1950s and finally more than 3,300 at the present time (Figure 3). In addition to conventional systematic studies, there was a steady rise in the numbers of contributions invoking genetics, specific parasites, and electrophysiology, amplifying fish identification using criteria other than morphology. These methods have proved helpful in finding explanations for the radiation of cichlids in the Rift Valley Lakes of East Africa. Blending all these methods, descriptions of hitherto unknown species continue to be published.

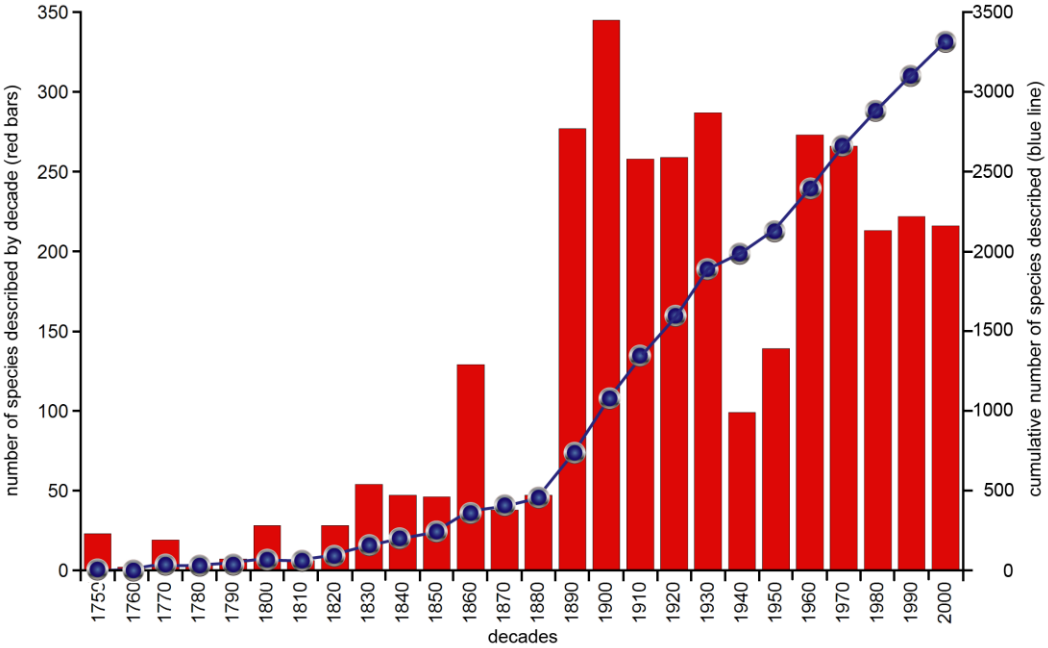

Figure 3. Number of African freshwater fish species currently described (updated from Paugy, 2010b).

The cichlid fishes are an extremely important group: they are widely used in scientific research and are popular with aquarists. So, in the since the 1960s, interest in this family has shown a spectacular rise. The behavior, the ecology and the evolution of the numerous species of cichlids of the large East Africa Lakes, are spectacular, posing manifold scientific questions. Among some landmark publications, that by Fryer & Iles (1972), "*The Cichlid Fishes of the Great Lakes of Africa: Their Biology and Evolution*", constituted for a long time an authoritative standard reference to all ichthyologists involved in cichlid studies. In this book, the authors synthesized all available information on the biology and evolution of the cichlids found in Lakes Victoria, Tanganyika, Malawi and some smaller lakes of East Africa. Through this book and many original papers, Geoffrey Fryer has made a major contribution to the study of African ichthyology and evolution, and its remarkable demonstration of adaptive radiation.

Since 1972, there has been a rapid increase in the number of publications on cichlid fishes especially at the beginning of the 1990s when the molecular techniques appeared. In recent years, many investigators have undertaken new studies on the evolution and speciation of cichlids in the East African Great lakes. Perhaps most of these might be considered mainly molecular biologists but they are also naturalists with wide interests and deep knowledge of the fishes in their favored regions.

The only general fish fauna available on a pan-African scale is the classical Catalogue of Boulenger (1909-1916) which now has mainly historical value. At the regional level, fish fauna are presently available for Southern Africa (Skelton, 2001), Western Africa (Paugy *et al*., 2003) and Lower Guinea (Stiassny *et al*., 2007). Besides the production of regional accounts, many taxonomic revisions of fish families or genera have more or less recently been published. Among the most recent, is the splitting of the old Bagridae family into four new families: Auchenoglanididae (6 genera: *Anaspidoglanis*, *Auchenoglanis*, *Liauchenoglanis*, *Notoglanidium*, *Parauchenoglanis* and *Platyglanis*), Austroglanidae (genus *Austroglanis*), Bagridae (genus Bagrus) and Claroteidae (7 genera: *Amarginops*, *Bathybagrus*, *Chrysichthys*, *Clarotes*, *Gephyroglanis*, *Lophiobagrus* and *Phyllonemus*) (Mo, 1991 and Nelson, 2006). Conversely, some families with a doubtful status have been now grouped together. That is the case of the species of the old families Cromeriidae and Grasseichthyidae which must now be considered to belong to the Kneriidae because of their monophyly within the Gonorynchiformes (Lavoué *et al*., 2005).

Most of the African continent has remained above sea level since more than 600 Myrs ago (Precambrian). Such a long period of exondation may explain the diversity of the freshwater fish fauna and its unparallel assemblage of archaic families which are mostly endemic. Madagascar's freshwater fish fauna contrasts with the continental one (Sparks & Stiassny, 2003). Of the total of 135 native fish species, 84 are endemic to the island itself. Many of the major groups of freshwater fish present in continental Africa are absent in Madagascar. Noteworthy is the absence of primary freshwater families such as cyprinids, alestids and mormyrids.

3. Paleontology

During the Middle and Late Paleozoic (ca -416 to -250 Myrs), present-day Africa was part of the mega continent Pangaea. This land mass slowly moved in the south hemisphere and, during the Devonian (ca -416 to -360 Myrs), central Africa was located near the South Pole. The related climatic conditions explain the scarcity of the fossil fish record during those times. However, few heterostracans and acanthodians ("spiny" fishes) have been recorded in the Silurian (ca -444 to -416 Myrs) of Algeria. Abundant placoderms, acanthodians, chondrichthyes (sharks), actinopterygians and sarcopterygians (lobe-finned fishes) have been found in the Devonian of North Africa (Morocco, Algeria, and Libya) and South Africa (Lelièvre *et al*. 1993).

During the Late Paleozoic, no major diversification affected the fish faunas. The actinopterygians that inhabit the African freshwaters are primitive taxa. Mesozoic times (Triassic -250 to -200 Myrs, Jurassic -200 to -150 Myrs, Cretaceous -150 to -65 Myrs), and later on Cenozoic times (from -65 Myrs to actual period), saw a high diversification of both marine and freshwater actinopterygians with abundant remains throughout the African continent.

During the Triassic and the Jurassic a slow diversification of basal teleosts fishes occurred, while Pangaea started its northward rotation and dislocation. At the end of the Jurassic and beginning of the Cretaceous the Afro-Arabian plate became isolated.

By the Late Jurassic, fishes had been populating the waters of the Earth for well over 200 million years, from their origins with the earliest jawless forms. Although they had already evolved greatly from their early ancestors, the Jurassic fish fauna still would be unfamiliar to people today. Many of these Late Jurassic fishes were heavy bodied forms with thick scales covered by enamel (ganoin), large mouths, paired fins placed well posteriorly on the body, and heterocercal tails. They formed a diverse fauna of ganoid fishes in most regions of the world including non-teleost ray-finned fishes (basal Actinopterygii), essentially the chondrosteans and neopterygians. Today, only some of them are still represented by few species: chondrosteans by *Acipenser* and *Polyodon*, lepisosteiforms by *Lepisosteus* and amiiforms by *Amia* (Nelson, 2006). The teleosts arose in the Late Triassic and Early Jurassic with stem-group forms of uncertain relationships such as the “paleonisciforms” and “pholidophoriforms” that formed a dominant component of the African fauna at the end of the Jurassic only. At that time, lungfishes and sarcopterygians show a greater diversity of species than today all along the Mesozoic times.

From the Cretaceous to the Neogene times, the Afro-Arabian plate remains isolated from other continents, until the collision with Eurasia at about 18 Myrs ago. The modern teleost ichthyofauna evolved during the Cretaceous and the current families root in the Late Cretaceous and the Paleocene (about -65 to -55 Myrs). In Africa, the Paleogene freshwater fish fossil record is relatively reduced and concentrates in a few regions notably the Lower Nile outcrops of the Fayum, in Niger and Nigeria (for a review, see Murray, 2000).

The Neogene (starting 23 Myrs ago) shows a rather similar ichtyofauna to that of today in Africa. For example the ichthyofauna associated to the Toumaï site (Toros-Menalla, Chad, ca 7 Myrs ago) or Abel site (Koro-Toro, Chad, ca 3.5 Myrs ago) is more or less the same as the one encountered today (Otero *et al*, 2009; Otero *et al*., 2010) (Figure 4). It includes current genera of the families that evolved during the Paleogene (like gymnarchids, mormyrids and alestids) together with Eurasian fishes that enter the continent at the dawn of Miocene, such as cyprinids. Moreover some Neogene fish belong to extinct genera. This African ichthyofauna typed by the presence of Nilo-Sudanian taxa is more widely distributed than today. During the Miocene, the fishes of this paleo Nilo-Sudan ichthyofauna inhabited at least the north-equatorial half of the Afro-Arabian plate, including Maghreb and Arabia. During the Pliocene, the ichthyofauna impoverished in these two regions and is replaced by a new fauna, notably a European typed fish association in the Maghreb notably with cyprinid fishes that originate in Iberia (Doadrio, 1994).

Figure 4. The “paleo bichir” *Polypterus faraou* (top, © MPFT/D. Paugy) is very close to the species encountered today *Polypterus ornatipinnis* (bottom, © Aquarium Tropical de la Porte Dorée/F. Busson).

4. Characteristics of the African Inland Water Fish Fauna

4.1. Main Characteristics

- There are about 48 families of freshwater fishes in tropical and southern Africa, from which 15 are endemic. The African ichthyofauna has fewer families and species than South America but it includes a higher number of basal and archaic families.
- The African ichthyofauna includes a high number of basal and "archaic" families. Among them we can quote the Polypteridae recorded since the Cretaceous, the Denticipidae considered as the sister Clupeiformes and the Kneriidae.
- The African fauna also includes remnants of archaic elements of wider distribution, such as the Protopteridae, Notopteridae and Osteoglossiformes. Three other families of the predominantly Gondwanan Osteoglossomorpha are endemic to Africa: the archaic family Mormyridae, and the monotypic Gymnarchidae and Pantodontidae.
- Two large lineages of secondary division freshwater fishes are present in Africa: the Cyprinodontiformes and the Cichlidae, both extremely diversified.
- Peripheral freshwater fish families (Myers, 1951) are relatively poorly represented in African inland waters in comparison to other continents. Only a few families include exclusively freshwater genera or several freshwater resident species: Clupeidae, Ariidae, Synbranchidae, Latidae (ex Centropomidae), Gobiidae, Eleotridae, Mugilidae, Syngnathidae and Tetraodontidae.
- True catadromous species are rare in Africa. The genera *Anguilla* occurs in the Maghreb and five species are known from the east coast. However, the genus is completely absent from western and central Africa. This is also the case for many gobioids which occur all around African coasts.

4.2. Main Ichthyological Provinces in Africa

Several ichthyological provinces have been identified in Africa (Roberts, 1975; Thieme *et al*., 2005; Levêque & Paugy, 2006) (Figure 5):

1. The Maghreb has a very depauperate fauna with Paleartic affinities.
2. The Nilo Sudanian province extends from the Atlantic coast to the Indian Ocean and includes the major drainage basins of the Sahelian zone: Nile, Chad. Niger, Senegal, Volta. The fish fauna is relatively rich (Paugy *et al*., 2003). This province includes two sub-regions, Ebuneo-Ghanaian and Abyssinian.
3. The Upper Guinean province includes the coastal rivers from Guinea to Liberia and exhibits faunistic affinities with the Lower Guinean Province and the Congo. Fauna well diversified with many endemic taxa (Paugy *et al*., 2003).
4. The Lower Guinean province covers coastal rivers from Cameroon to the mouth of the Congo River, with a well-diversified fauna (Stiassny *et al*., 2007).
5. The Ethiopian region can be divided in two main sub-regions: Ethiopian Rift Valley (ERV) and Coastal Red Sea (CRS). Lake Tana itself is also a particular hot spot sub-region (Paugy, 2010).

6. The Congolese province includes the entire Congo basin, which is the largest in Africa. The ichthyofauna is rich and diversified, but existing information needs to be synthesized and many new discoveries are anticipated.
7. The Angolan Province which covers Cuanza River basin and some Angolan coastal drainages, is expected to be of great interest, while being still poorly known.
8. The Zambezian province including the river Cunene, Okavango and Limpopo has a moderately rich fauna and is fairly well documented (Skelton, 2001)
9. The East Coast province covers the coastal drainages from the Juba in the North to the Zambezi in the south. The fauna is moderately rich and a new synthesis is needed.
10. The Karoo province includes the large Orange-Vaal basin. The fauna is moderately rich and well known (Skelton, 2001)
11. The Cape Province, groups all the Southern coastal systems. The fauna is well known but not very rich (Skelton, 2001).
12. The Malagasy province is mainly constituted by secondary or peripheral families of which several species are endemic (65% of the 150 species known).
13. The Great Lakes of the Eastern Rift Valley constitute a particular assemblage. Each of these lakes has a specific endemic cichlid fauna (more than 95% of endemic species).

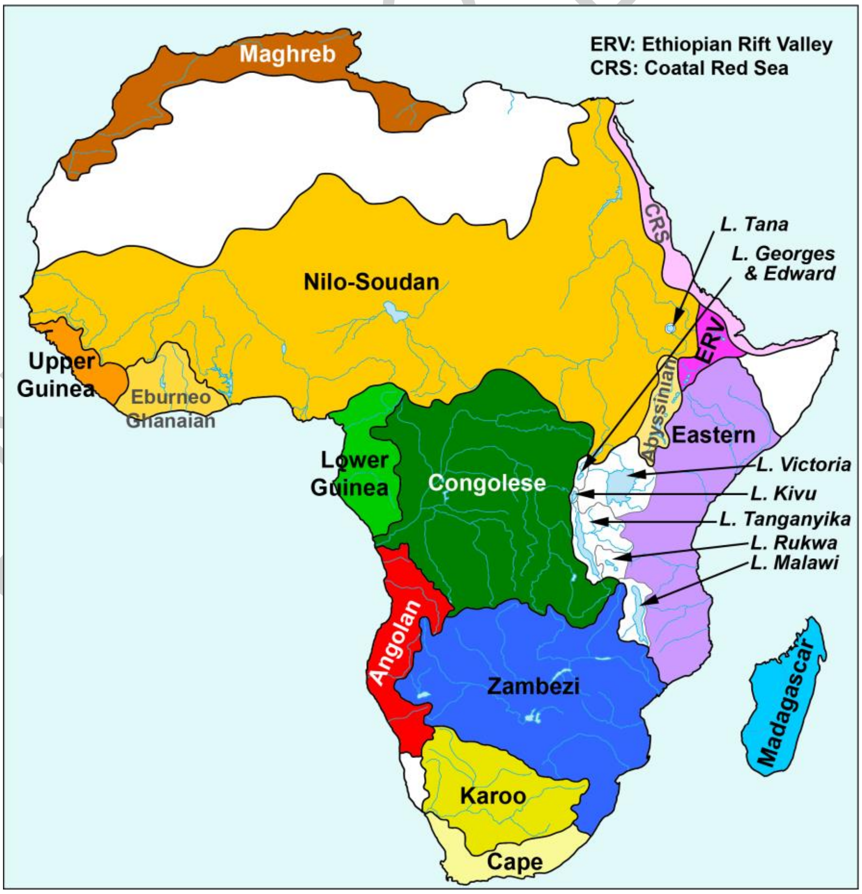

Figure 5. Main ichthyological provinces in Africa (after Lévêque & Paugy, 2006).

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Canonico G.C., Arthington A., McCrary J.K. & Thieme M. (2005). The effect of introduced tilapias on native biodiversity. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 15: 463-483. [This review indicates that tilapia species are highly invasive. Thus, the authors have concluded that, despite potential or observed benefits to human society, introductions cannot continue unchecked without further exacerbating damage to native fish species and biodiversity].

Carmouze J.P., Durand J.R. & Lévêque C. (eds.), 1983. *Lake Chad: ecology and productivity of a shallow tropical ecosystem*. Monographiae Biologicae 53, W. Junk Publisher, The Hague, 575 p. [A large synthesis which takes into account most of the subjects of the limnology. These studies constitute one of the rare examples of a multidisciplinary approach to a continental aquatic environment in tropical Africa. A book, which constitutes a reference just before the almost entire lake dryness].

Cohen A., Bills R., Cocquyt C.Z. & Caljon A.G. (1993). The impact of sediment pollution on biodiversity in Lake Tanganyika. *Conservation Biology*, 7, 3: 667-677. [This paper shows that, in Lake Tanganyika, Ostracodes and fish may be more affected by sedimentation because they are mostly endemic and may require clear water habitats, whereas the benthic diatom species in the lake are largely cosmopolitan and in many cases also occur in turbid affluent rivers].

Cohen A.S., Soreghan M.J. & Scholz C.A. (1993). Estimating the age of formation of lakes; an example from Lake Tanganyika, East African Rift system. *Geology*, 21, 6: 511-514. [Age estimates from the reflection seismic-radiocarbon method (RSRM) suggest that the structural basins of central Lake Tanganyika began to form between 9 and 12 Ma. Estimates for the northern and southern basins are younger, 7 to 8 Ma and 2 to 4 Ma, respectively].

Coulter G.W. (1966). The deep benthic fishes of the South of Lake Tanganyika with special reference to distribution and feeding in *Bathybates* species, *Hemibathes stenosoma* and *Chrysichthys* species. *Fishery Research Bulletin, Zambia*, 4: 33-38. [This is a short review of the deep benthic fish communities of the Lake Tanganyika].

Coulter G.W. (1991). *Lake Tanganyika and its life*. Oxford University Press, Oxford and British Museum (Natural History) London, 372 p. [This book is a shining edition which attempts an objective, comprehensive and critical summary of knowledge of Lake Tanganyika. The book is subdivided into ten self-contained chapters for most of which the foregoing provides a general summary and several illustrations. Lake Tanganyika and its Life is a solid book, written to the best academic standards].

Darwall W.R.T., Tweddle D., Skelton P.H. & Smith K.S. (2009). *Background*: 1-15. *In* Darwall W.R.T., Smith K.S., Tweddle D. and Skelton P.H. (eds) *The Status and distribution of freshwater biodiversity in Southern Africa*. Gland, Switzerland: IUCN and Grahamstown, South Africa: SAIAB, viii+118 pp. [This report summarizes the assessment of the status and distribution of the main freshwater taxa in Southern Africa. A regional synthesis, conclusions and recommendation are done].

Davies B. (1986). *The Zambezi river system*: 225-267. *In* Davies B.R. and Walker K.F. (eds.), *The ecology of river systems*. Monographiae Biologicae 60, W. Junk Publisher, Dortrecht, 793 p . [This is a short synthesis of the Zambezi system. This includes hydrology, land-use, climate, physico-chemistry and aquatic ommunities. This work includes also a part concerning the ecology of the large man-made lakes built along the Zambezi River].

De Rahm P.H., (1996). *Poissons des eaux intérieures de Madagascar*: 423-440. *In* Lourenço, W.R. (ed.), *Biogéographie de Madagascar*. Colloques & Séminaires, Orstom Editions, Paris, 588 p. [Madagascar's freshwater ichthyofauna is characterized by a low number of species (about 150), a high level of endemism, and the fact that the endemic species occupy basal, primitive positions as compared with the continental members of their respective groups].

De Vos L. & Snoeks J. (1994). The non-cichlid fishes of the Lake Tanganyika basin. *Archiv für Hydrobiologie*, 44: 391-405. [This short review gives of the diversity of the non-cichlid ichthyofauna of the Lake Tankanyika basin with reference to their presence in the main habitat zones and their distribution in the lake itself. The high endemism in these families is discussed and comments are made on the species' origins and affinities].

Dejoux, C. (1988). *La pollution des eaux continentales africaines. Expérience acquise, situation actuelle et perspectives*. Travaux et Documents, 213, Ortsom Éditions, Paris, 513 p. [The main purpose of this work is to summarize what it is known about the pollution of the continental water in Africa].

Denny P. (ed.) (1985). *The ecology and management of African wetland vegetation.* Geobotany, 6. W. Junk Publisher, Dordrecht, 344 p. [This book is a major contribution to the understanding of biology, ecology and conservation of African wetlands. The book is restricted to non-marine waters and excludes estuarine systems. Text (9 chapters), figures and plates are, almost without exception, of high quality].

Denny P. (1993). *Wetlands of Africa. Introduction*: 1-31. *In* Whigam D., Dykyjova D. & Hejny S. (eds), *Wetlands of the world : inventory, ecology and management.* Volume 1. Klüwer Academic Publishers, 768 p. [An overview of the distribution and ecology of African wetlands].

Doadrio I. (1994). Freshwater fish fauna of North Africa and its biogeography: 21-34. *In* Teugels G.G., Guégan J.F. & Albaret J.J. (eds.), *Biological diversity of African fresh- and brackish water fishes*. *Annales Sciences zoologiques*, 275, Musée royal d'Afrique centrale, Tervuren (Belgique), 177 p. [The Maghreb province played located between the African and Eurasian plates played an important role in the speciation and dispersion of freshwater fish fauna. Forty one species arranged in eight families were recorded in this province. Cyprinidae was the most widespread family].

Dudgeon D., Arthington A.H., Gessner M.O., Kawabata Z.-I., Knowler D.J., Lévêque C., Naiman R.J., Prieur-Richard A.-H., Soto D., Stiassny M.L.J. & Sullivan C.A. (2005). Freshwater biodiversity: importance, threats, status and conservation challenges. *Biological Research*, 81: 163-182. [This article explores the special features of freshwater habitats and the biodiversity they support that makes them especially vulnerable to human activities].

Dumont H. (2009). *The Nile. Origin, environments, limnology and human use*. Monographiae Biologicae, 89, Springer, 818 p. [This book is a remarkable updated synthesis after the famous publication of Rzoska in 1976. Numerous topics are explored in 36 chapters, from the geological history to the human use through of environment, limnology and biological diversity. A particular accent is given to the changes, mainly human interventions, which have meanwhile occurred in the basin during these thirty last years].

Duponchelle F., Ribbink A.J., Msukwa A., Mafuka J. & Mandere D. (2003). Seasonal and spatial patterns of experimental trawl catches in the South West Arm of Lake Malawi. *Journal of Great Lakes Research*, 29: 216-231. [Experimental demersal trawl samples were collected in the southwest arm of Lake Malawi. Haplochromine cichlids dominated the catches at every. About twenty species (about 140 were caught) accounted for most of the catches at any depth, suggesting that many species are uncommon. The greatest diversity of species is in shallow waters, but the highest catches in terms of biomass were recorded between 50 and 125 m. Some fishing recommendations are given].

Duponchelle F., Ribbink A.J., Msukwa A., Mafuka J., Mandere D. & Bootsma H. (2005). Food partitioning within the species-rich benthic fish community of Lake Malawi. *Canadian Journal of Fisheries and Aquatic Sciences*, 62, 7: 1651-1664. [The results illustrate benthic algal production contributed to the energy requirements of offshore fishes that occupy depths between 10 and 30 m. The importance of the lake fly as a food source for demersal fishes was confirmed, supporting the recent hypothesis that deep demersal fish production is principally sustained through the pelagic food chain rather than from benthic detrital sources].

FAO (2010a). AQUASTAT. http://www.fao.org/nr/water/aquastat/main/index.stm [AQUASTAT is FAO's global information system on water and agriculture, developed by the Land and Water Division].

FAO (2010b). FAOSTAT. http://faostat.fao.org/default.aspx [FAOSTAT provides time-series and cross sectional data relating to food and agriculture for some 200 countries].

FAO, 2010c. FishStat Plus. Universal software for fishery statistical time series. http://www.fao.org/fishery/statistics/software/fishsta.en [This database contains statistics on production volume and value by species, country or area, fishing area and culture environment].

Froese R. & Pauly D. (2010). Fishbase. World Wide Web electronic publication. http://www.fishbase.org [This data base is a global information system with all you ever wanted to know about fishes. It is a relational database with information to cater to different professionals such as research scientists, fisheries managers, zoologists and many more].

Fryer G. & Iles T.D. (1972). *The cichlid fishes of the Great Lakes of Africa: their biology and evolution*. Tropical Fish Hobbyist Publications Inc. Edinburgh, Oliver & Boyd, London, 641 p. [This is always a standard reference about the cichlids of the African great lakes. Despite its publication date this synthesis constitutes always reference books].

Fryer G. (1965). Predation and its effect on migration and speciation in African fishes: a comment. *Proceedings of the Zoological Society of London*, 144: 301-322. [This paper gives new information concerning the role of the predators in large lakes. Contrary to an expressed view very little factual evidence has been brought forward to support the idea that predatory fishes have had restrictive effects on speciation among other African freshwater fishes. The suggestion that predators are responsible for the inception of the habit of upstream migration for purposes of spawning is also discredited].

Fryer G. (1996). Endemism, speciation and adaptative radiation in great lakes. *Environmental Biology of Fishes*, 45: 109-131. [This work makes a synopsis of the major features which characterize the evolution of fishes, mainly cichlids, in great lakes of Africa. These situations pose many questions, such as convergent evolution in different lakes, the nature of isolating mechanisms, competition and co-existence in complex communities, the roles of diverse mutualistic associations, and many others. These rich faunas also provide particularly favorable opportunities for studying patterns of speciation. Nevertheless, notwithstanding their evolutionary exuberance, these rich faunas are fragile].

Furse M.T., Kirk R.C., Morgan P.R. & Tweddle D. (1979). *Fishes: distribution and biology in relation to changes*: 209-229. *In* Kalk M, McLachlan A.J. & Howard-Williams C. (eds), *Lake Chilwa : studies of change in a tropical ecosystem*. Monographiae Biologicae 35, W. Junk Publisher, The Hague, 462 p. [This chapter provides information concerning the composition of the fish communities in relation with the water level].

Garcia N., Cuttelod A., Abdul Malak D. (eds) (2010). *The Status and Distribution of Freshwater Biodiversity in Northern Africa*. Gland, Switzerland, Cambridge, UK and Malaga, Spain : IUCN,2010. xiii+140 p. [This report summarizes the assessment of the status and distribution of the main freshwater taxa in Northern Africa. A regional synthesis, conclusions and recommendation are done].

Glantz, 2004. Lake Chad and the Aral Sea: a sad tale of two lakes. http://www.fragilecologies.com/sep09_04.html [This paper reports the sad drying and threat that affect these two lakes. The decrease in Lake Chad size is attributed to human water use and to shifting climate pattern].

Goudswaard P.C., Witte F. & Katunzi E.F.B. (2002). The tilapiine fish stock of Lake Victoria before and after the Nile perch upsurge. *Journal of Fish Biology*, 60: 838-856. [A continuous increase in fishing pressure led initially to a declining catch per unit of effort, and a smaller average fish size; eventually, there was a reduced landing of tilapiines].

Grove A.T. (1985). *The Niger and its Neighbours. Environmental history and hydrobiology, human use and health hazards of the major West African rivers*. A.A. Balkema, Rotterdam, 331 p. [This book on the Niger is concerned with the ecology of the river and with those features associated with its remarkable course through different climatic zones (from desert to forest). This book includes also material from Senegal River and Lake Chad which share the Niger's genesis].

Gupta M.V. & Acosta B.O. (2004). From drawing board to dining table: the success story of the GIFT project. *NAGA WorlFish Center Quaterly*, 27: 4-14. [This paper traces the history of the Genetic Improvement of Farmed Tilapia (GIFT) project initiated by the WorldFish Center and its partners for the development of methods for genetic enhancement of tropical finfish using Nile tilapia (Oreochromis niloticus) as a test species].

Gwahaba J.J., (1975). The distribution, population density and biomass of fish in an equatorial lake, Lake George, Uganda. *Proceedings of the Royal Society of London*, B, 190: 393-414. [This paper presents and discusses data about the distribution of 29 species of fish species (for a total of 32) in the Lake George, Uganda. Fish are more abundant inshore than offshore, and the possible causes for this distribution are discussed].

Harbott B.J. & Ogari J.T.N. (1982). *The biology of the larger cichlid fish of Lake Turkana*: 1331-1355. *In* A.J. Hopson (ed.), *Lake Turkana. A report of the findings of the lake Turkana Project 1972-1975.* Overseas Development Administration, London. Published by the University of Sterling, Sterling, 1614

p. + fig. [This paper details results about distribution and biological traits of three large cichlid species in Lake Turkana].

Hickling C.F. (1961). *Tropical Inland Fisheries*. Longmans, London, 285 p. [This book does not only give a complete description of the conditions in tropical inland fisheries but also comments on their possible future developments. This book, of great interest to fisheries, constitutes an excellent testimony of fishery methods in the first part of the twentieth century].

Hopson A.J. (1972). *A study of the Nile perch (*Lates niloticus *L, Pisces: Centropomidae) in Lake Chad*. Overseas Research Publications, London, 19: 93 p. [This is a complete study concerning the biological features of *Lates niloticus* in the Western part of the Lake Chad].

Hopson A.J. (1982). *Lake Turkana. A report on the findings of the Lake Turkana project 1972-1975*. Overseas Development Administration, London, 1614 p. + fig. [The purpose of this work is to present the details findings of the Lake Turkana project which was run during four years. This complete work details information both to the physical and chemical limnology of the lake and to the biology and population dynamics of the exploited fish].

Howell P., Lock M. & Cobb S. (1988). *The Jonglei canal: Impact and opportunity*. Cambridge University Press, Cambridge, 576 p. [Based on scientific studies of the, the aim of this book is to present a multi-disciplinary survey of the very complex interrelated hydrological, ecological, biological and human problems involved in the absorption and dissipation of the swamps and wetlands in Southern Sudan].

Jackson P.B.N. (1961). The impact of predation, especially by the tiger fish (*Hydrocynus vittatus* Castelnau) on African freshwater fishes. *Proceedings of the Zoological Society of London*, 136: 603-622. [The study of *Hydrocyon vittatus* reveals that this fish nearly always swallows the prey fish whole. The size structure of *Hydrocynus* populations is such that the main predation pressure is upon fishes of small size. The view that the presence of these predators has the effect of retarding speciation is supported].

Jackson P.B.N. (1988). *Aquaculture in Africa*: 459-480. *In* Lévêque C., Bruton M.N. & Ssentongo G.W. (eds), *Biology and ecology of African freshwater fishes*. Travaux & Documents 216, Orstom Éditions, Paris, 508 p. [This review briefly considers African aquaculture, the treatment being descriptive rather than technical. The main species, exotic and indigenous, reared in ponds or cages are listed. An overview about constraints in African aquaculture is also given].

Jackson P.B.N., Marshall B.E. & Paugy D. (1988). Fish communities in man-made lakes: 325-350. . *In* Lévêque C., Bruton M.N. & Ssentongo G.W. (eds), *Biology and ecology of African freshwater fishes*. Travaux & Documents 216, Orstom Éditions, Paris, 508 p. [This chapter summarizes the negative and positive environmental consequences of African rivers impoundment with particular attention to fish communities].

Junk W.J., Bayley P.B. & Sparks R.E. (1989). *The flood pulse concept in river-floodplain systems*: 110-127. *In* D.P. Dodge (ed.) Proceedings of the International Large River Symposium. *Canadian Special Publication in Fisheries and Aquatic Sciences*, 106, 628 p. [This presents a comprehensive discussion where it is shown that the principal driving force responsible for the existence, productivity, and interactions of the major biota in river-floodplain systems is the flood pulse].

Kirkpatrick, M. & Price, T. (2008). In sight of speciation. *Nature*, 455: 601-602. [Adaptation of a fish's eyes to its visual environment can bias females to mate with different males according to their coloration. This sensory preference can contribute to the formation of new species. The cichlid fish in Lake Victoria, where the study was done, show a fantastically high rate of speciation].

Laë R. (1995). Climatic and anthropogenic effects on fish diversity and fish yields in the Central delta of the Niger River. *Aquatic Living Resources*, 8: 43-58. [At different levels, various factors like drought and overfishing modified the biological cycle of the fish which are adapted to the hydrological cycles of the Niger River basin. As fish catches fell, yields per hectare increased. The increase in fish productivity is characterized by a decrease of species whose reproduction is linked to the floodplains and of species which visit frequently flooded areas].

Laléyé P, (2000). *Acadja fisheries enhancement sustems in Benin: their productivity and environmental impacts*: 51-52. *In* Abban E.K., Casal C.M.V., Falk T.M. & Pullin R.S.V. (eds), *Biodiversity and sustainable use of fish in the coastal zone*. ICLARM Coni Proceeding, 63, 71 p. [Acadjas are "brush park" type installations that are found in several West African coastal lagoons. Acadjas function by artificially replicating the habitat favored by certain fish species. They offer shelter from predators, suitable places for breeding and, above all, a high abundance of food].

Lavoué, S., Miya M., Inoue, J.G., Saitoh K. & Nishida, M. (2005). Molecular systematics of the gonorynchiform fishes (Teleostei) based on whole mitogenome sequences: Implications for higher relationships within the Otocephala. *Molecular Phylogenetics and Evolution*, 37: 165-177. [Within Otocephala, the mitogenome data supported the monophyly of Alepocephaloidei, Gonorynchiformes, Otophysi, and Clupeiformes. The Gonorynchiformes and the Otophysi formed a sister group, rending the Ostariophysi monophyletic. The results confirm that the paedomorphic species *Cromeria nilotica* and *Grasseichthys gabonensis* belong to the family Kneriidae, however, together they do not form a monophyletic group].

Legendre M. & Ecoutin J.M. (1989). Suitability of brackish water tilapia species from the Ivory Coast for lagoon aquaculture. I- Reproduction. *Aquatic Living Resources*, 2: 71-79. [The main characteristics of the reproductive biology of Tilapia guineensis and Sarotherodon melanotheron have been studied in Ebrié lagoon (Ivory Coast), with a comparison between natural and cultured populations. Some difference between the two species are observed].

Lelièvre H., Janvier P. & Blieck A. (1993). *Silurian-Devonian vertebrate biostratigraphy of western Gondwana and related terranes (South America, Africa, Armorica-Bohemia, Middle East)*: 139-173. *In* Long J.A. (ed.), *Paleozoic vertebrate biostratigraphy and biogeography*. Belhaven, London, 369 p. [This paper provides an overview a vertebrates for South America, included as part of West Gondwana. Again, an excellent summary of localities is presented].

Leprieur. F., Brosse, S., Garcia-Berthou. E., Oberdorff. T., Olden, J.D., & Townsend. C.R. (2009). Scientific uncertainty and the assessment of risks posed by non-native freshwater fishes. *Fish and Fisheries*, 10, 1: 88-97. [This paper suggests that it is actually very little known about ecological impacts associated with fish introductions and that it would be therefore wholly inappropriate to equate a lack of data with a conclusion of 'no impact'. Then, it is discussed four major challenges for enhancing the assessment of risks posed by non-native freshwater fishes in the face of scientific uncertainty].

Lévêque C. (1997). *Biodiversity dynamics and conservation: the freshwater fish of tropical Africa*. Cambridge University Press, Cambridge, 438 p. [This comprehensive book brings together a wealth of information on the fish of tropical African systems, and discuss how these systems evolved, what holds them together and what is tearing them apart. It is a reference for all those concerned with biodiversity conservation].

Lévêque C., Hougard J.-M., Resh V., Statzner B. & Yaméogo L. (2003). Freshwater ecology and biodiversity in the tropics : what did we learn from 30 years of onchocerciasis control and the associated biomonitoring of West African rivers? *Hydrobiologia*, 500: 23–49. [This paper summarizes researches carried out during a long term control of river blindness. A particular discussion is done about the criteria used to implement the long-term biomonitoring on non-target aquatic fauna].

Lévêque C. & Paugy D. (2006). *Les poissons des eaux continentales africaines. Diversité, écologie et utilisation par l'homme*. IRD Éditions, Paris, 564 p. [This book, by assembling existing information on African fishes, is a synthesis of multiple research activities concerning aquatic media which can give response to the good management of continental waters. It is a reference for all those concerned with African fish diversity].

Lévêque C., Dejoux C. & Iltis A. (1983). Limnologie du fleuve Bandama (Côte d'Ivoire). *Hydrobiologia*, 100: 113-141. [The present contribution summarizes the information collected on the Bandama River, a tropical basin in Côte d'Ivoire. After a brief description of the basin and its geological setting, climate and hydrology, results of studies on the water chemistry, biology and ecology of its animal and plant are presented. The human impact on the system is also discussed].

Lévêque C., Oberdorff T., Paugy D., Stiassny M.L.J. & Tedesco P.A, (2008). Global diversity of fish (Pisces) in freshwater. *Hydrobiologia*, 595: 545-567. [This is a global inventory of freshwater fishes. A biogeogaphical distribution in each continental region is given and at the continental scale, different ichthyological provinces have been identified. Numerous fish-species flocks have been identified in various ancient great lakes. The major threats to fish biodiversity are listed].

Lever C. (1996). *Naturalized fishes of the world*. Academic Press, Harcourt Brace & Company, Publishers, London, 408 p. [This book describes where, when, how and by whom the alien inland fishes now living in a wild state throughout the world were introduced, how they subsequently became naturalized and what, if any, effects they have had in their new environment].

Lewis D.S.C. (1981). Preliminary comparisons between the ecology of haplochromine cichlid fishes of Lake Victoria and Lake Malawi. *Netherlands Journal of Zoology*, 31: 746-761. [This paper shows many similarities between the ecology of the two species flocks in the Lake Victoria and the Lake Malawi. In each lake distribution and abundance of species are shown to be strongly influenced by both depth and bottom type, though the degree of association with the substrate varies between species. The most notable difference between the two species flocks is that many species from Lake Malawi have restricted distributions within the lake whereas there is, as yet, no evidence for this in Lake Victoria].

Lowe-McConnell R.H. (1985). *The biology of the river systems with particular reference to the fishes*: 101-140. *In* Grove A.T. (ed.), *The Niger and its Neighbours*, Balkema, Rotterdam, 331 p. [This is a short synthesis of the ecology of fish in the Niger River system and most of the sudanian river basins. This works summarizes the information collected during the last thirty years. Some information is given concerning the utilization of fish stocks].

Lowe-McConnell R.H. (1987). *Ecological studies in tropical fish communities.* Cambridge tropical biology series, Cambridge University Press, 382 p. [This book brings together the results of widely scattered research on fish in tropical rivers, lakes and seas. As far as they are concerned by tropical climatic conditions, all continents are studied. In a final synthesis section the responses of fish to the varied conditions are discussed. The final chaper deals with man's utilisation of fish].

Lowe McConnell R.H. (2006). The tilapia trail. The life story of a fish biologist. MPM Publishing, Ascot, 296 p. [This book is a great autobiography by the author. From page to page we travel, with Ro, in the African Great Lakes region and in the South American rivers. All over the reading we share her passion for fish and particularly for cichlids "*The Tilapia trail*". It is also a reminder of how both science and society have changed over the past sixty years].

MacArthur R.H & Wilson E.O. (1967). *The theory of island biogeography*. Princeton University Press, Princeton, New Jersey, 203 p. [In this book, the authors developed a general theory to explain the facts of island biogeography. The theory builds on the first principles of population ecology and genetics to explain how distance and area combine to regulate the balance between immigration and extinction in island populations. This book laid the foundations for the study of island biogeography].

Marshall L.G. (1988). *Extinction*: 219-254. *In* Myers A.A. & Giller P.S. (eds), *Analytical Biogeography: an integrated approach to the study of animal and plant distributions*. Chapman & Hall, London, 584 p.[In this chapter the author explains that extinction is for species what death is to individuals and he lists the different theories. Traditionally (Darwinism) extinction is viewed as a constructive process for eliminating obsolete species. It is sometimes recognized that there is simply no way that a species can anticipate and accordingly pre-adapt to the environmental conditions. Another view maintains that extinction is neither constructive nor non-constructive, only inevitable (Red Queen Hypothesis).]

Marshall B.E. (1995). *Why is Limnothrissa miodon such a successful introduced species and is there anywhere else we should put it?*: 527-545. *In* Pitcher T.J. & Hart P.J.B. (eds): *The impact of species changes in African lakes*. Fish & Fisheries series 18, Chapman & Hall, London, 601 p. [This paper evaluates the factors responsible for the successful introduction of the clupeid species in different lakes, natural or not. It is concluded that this species is probably capable of being successful in any lakes but further introductions should be limited to human-made lakes].

McAllister D.E., Craig J.F., Davidson N., Delany S. & Seddon M. (2001). *Biodiversity impacts of large dams*. Background paper Nr. 1 Prepared for IUCN / UNEP / WCD. IUCN / UNEP, 68 p. [This paper lists the main impacts provided by dams and their associated reservoirs. A number of recommendations are made].

McCartney M.P., Sullivan C. & Acreman M.C. (2001). *Ecosystem impacts of large dams*. Background paper Nr. 2 Prepared for IUCN / UNEP / WCD. IUCN / UNEP, 82 p. [This document contains a summary of dams impact on the environment that have relevance for the environmental economist, and how these may be valued. Through a literature review, a range of valuation methodologies are identified, along with examples of how these have been applied in practice. Some discussion is provided of how environmental values can be used to contribute to decision-making].

Mérona B. de (1981). Zonation ichthyologique du bassin du Bandama (Côte d'Ivoire). *Revue d'Hydrobiologie tropicale*, 14: 63-75. [The results show that the ichthyological zonation is poorly marked in this kind of rivers. It exists an upper course and a lower course zones, both very small, and, between them, a large zone of middle course with an homogenous fish population].

Merron G.S., Holden K.K. & Bruton M.N. (1990). The reproductive biology and early development of the African pike, *Hepsetus odoe*, in the Okavango delta, Botswana. *Environmental Biology of Fishes*, 28: 215-235. [The main characteristics of the reproductive biology of *Hepsetus odoe* have been studied in Okavango Delta. Original data concerning the nest building and the embryonic development are given].

Mo T. (1991). *Anatomy, relationships, and systematics of the Bagridae (Teleostei: Siluroidei) with a hypothesis of siluroid phylogeny*. These Zoologicae, 17, Koeltz Scientific Books, 216 p. [This work presents a wealth of new information on "bagrids" catfishes and, most important, reveals the nonmonophyletic nature of a group that has been long accepted by default. Problems of nomenclature and the phylogenetic hypothesis for Bagridae and Claroteidae may be regarded as important additions].

Moreau J., Arrignon J. & Jubb R.A. (1988). Les introductions d'espèces étrangères dans les eaux continentales africaines. Intérêt et limites: 395-425. *In* Lévêque C., Bruton M.N. & Ssentongo G.W. (eds), *Biology and ecology of African freshwater fishes*. Travaux & Documents 216, Orstom Éditions, Paris, 508 p. [In this chapter, introductions of non-endemic species fishes into inland water are discussed. The most successful translocations have involved the occupation of vacant ecological niches, nevertheless many introduced species have created major problems. In conclusion, it is emphasized that careful studies should be made on species to be introduced].

Murphy, W.J. & Collier. G.E. (1997). A molecular phylogeny for aplocheiloid fishes (Atherinomorpha, Cyprinodontiformes): The role of vicariance and the origins of annualism. *Molecular Biology and Evolution*, **14**:790-799. [The data of this work confirm the monophyly of the Neotropical family Rivulidae, while demonstrating a paraphyletic Old World assemblage. The basal sister group position of Indo-Malaysian and Madagascaran strongly indicates the role of vicariance in the diversification of these fishes. The distribution of annualism onto this topology implies a single early origin for this suite of characters, prior to the divergence of South American and African taxa].

Murray A.M. (2000). The Palaeozoic, Mesozoic and Early Cenozoic fishes of Africa. *Fish and Fisheries*, 1: 111-145. [This paper summarizes the known fish fossils, excluding otoloths, from marine and freshwater deposits throughout Africa from the Paleozoic, Mesozoic and first part of they Cenozoic].

Musa I.K., Bila M., Mana B. & Mahaman C. (2008). *Saving Lake Chad*. Based on the Proceedings of Sirte Roundtable, Lybia, 17th December 2008. Lake Chad Basin Commision (LCBC) and International Commission of Irrigation and Drainage (ICID), 16 p. [This Report is the revised and prose version of what was first presented to a Roundtable discussion on Saving Lake Chad Basin held during the Ministerial Conference on Water for Agriculture and Energy in Africa. The report seeks to highlight the social, economic, political and environmental challenges that need to be urgently addressed to save the Lake Chad Basin].

Myers G.S. (1951). Freshwater fishes and East Indian zoogeography. *Stanford Ichthyological Bulletin*, 4: 11-21. [This work represents one of the most cited studies on historical biogeography. In this paper he defines three types of species according to their tolerance with salinity].

Nagelkerke L.A.J. & Sibbing F.A. (1996). Reproductive segregation among the *Barbus intermedius* complex of Lake Tana, Ethiopia. An example of intralacustrine speciation. *Journal of Zoology*, 65 (suppl.): 3-7. [In this paper, reproductive segregation among the large barbs *Barbus intermedius* complex, of Lake Tana, Ethiopia, was investigated. Combined with the morphological, ecological, and genetic differences, the data suggest the existence of several *Barbus* species, forming a unique species flock, which probably evolved within the lake. The results show the importance of the rivers for *Barbus* reproduction and stress the urgent need for careful management of fishing activities in spawning times and areas].

Nagelkerke L.A.J. & Sibbing F.A. (2000). A revision of the large barbs (*Barbus* spp., Cyprinidae, Teleostei) of Lake Tana (Ethiopia), with a description of a new species, *Barbus osseensis*. *Netherlands Journal of Zoology*, 50: 179-214. [This paper describes a new species and summarizes the major features of the other species. Figures of all fifteen barb species of Lake Tana are presented and an identification key is provided].

Nakai K., Kawanabe H. & Gashagaza M.M. (1994). Ecological studies on the littoral cichlid communities of Lake Tanganyika: The coexistence of many endemic species. *Archiv für Hydrobiologie*, 44: 373-389. [The researches show that many species with 'rather similar' ecological requirements are well segregated in utilization of commonly required resources either for feeding or breeding. Further, this paper also reveals that some commensally or mutually beneficial relationships are prevalent among the species even with 'almost the same' resource requirements].

Nelson J.S. (2006). *Fishes of the World*. 4th edition. John Wiley & Sons, Hoboken, New Jersey, 601 p. [This book presents a cladistically based classification of all the major living and fossil fish groups. The taxonomy of fish presented includes the anatomical characteristics, distribution, common names and phylogenetic relationships for all families of living fishes].

Ng, H.H. & Sparks J.S. (2005). Revision of the endemic Malagasy catfish family Anchariidae (Teleostei: Siluriformes) with descriptions of a new genus and three new species. *Ichthyological Exploration of Freshwaters*, 16, 4: 303-323. [In this paper, Anchariidae, a group of strictly freshwater catfishes endemic to Madagascar, is revised. Two genera are recognized and are further distinguished on the basis of branched anal-fin ray count, snout shape and mouth position, and morphology of the maxillary and outer mandibular barbels. Five species are recognized, three of which are described as new].

Nilsson C., Reidy C.A., Dynesius M. & Revenga C. (2005). Fragmentation and flow regulation of the world's large river systems. *Science*, 308, 405-408. [This is a global overview of dam-based impacts on large river systems shows that over half are affected by dams, including the eight most biogeographically diverse. Dam-impacted catchments experience higher irrigation pressure and about 25 times more economic activity per unit of water than do unaffected catchments. In view of projected changes in climate and water resource use, these findings can be used to identify ecological risks associated with further impacts on large river systems].

Nyenje P.M., Foppen J.W., Uhlenbrook S. Kulabako R. & Muwanga A. (2010). Eutrophication and nutrient release in urban areas of su-saharan Arica – A review. *The Science of the Total Environment*, 408, 3: 447–455. [In this review it is established the relationship between eutrophication of fresh inland surface waters in sub-Saharan Africa and the release of nutrients in their mega-cities].

Ochumba, P.B.O. (1996*). Measurement of water currents, temperature, dissolved oxygen and winds on the Kenyan Lake Victoria*: 155-167. *In*: Johnson T.C. & Odada E.O. (eds), *The limnology, climatology and paleoclimatology of the East African lakes*. Gordon and Breach, Toronto, 664 p. [This paper summarized the results of more than 100 samples recorded to assess the temperature, dissolved oxygen, winds and currents structure on the Kenyan area of Lake Victoria. The results show that the lake is stratified during five months and that oxygen levels are always very low below a depth of 40 m].

Odada E.O., Olago D., Kulindwa K.A.A., Bugenyi F., West K., Ntiba M., Wadinga S. & Karimumuryango J (2004). *East African Rift Valley Lakes*. UNEP, GIWA Regional assessment 47. University of Kalmar, Kalmar, Sweden, 141 + xv p. [This report draws up an assessment of four large lakes in East Africa: freshwater shortage, pollution, habitat modification, unsustainable living resources… Policy options are proposed].

Okedi J. (1969). Observations on the breeding and growth of certain mormyrid fishes from Lake Victoria basin. *Revue de Zoologie et de Botanique africaine*, 79: 34-64. [The feeding habits including the feeding requirements of both adults and immature fish are investigated for five mormyrid species in Lake Victoria basin].

Otero O., Pinton A., Mackaye T.M., Likius A., Vignaud P. & Brunet M. (2009). First description of a pliocene ichthyofauna from Central Africa (site KL2, Kolle area, Eastern Djurab, Chad): What do we learn? *Journal of African Earth Sciences*, 54: 63-74. [This is the first extensive study of a freshwater fish fauna from a Pliocene site in Central Africa, based on fossils collected in the fossiliferous area of Kolle (Lower Pliocene, Chad). A relatively high fish diversity is revealed, confirming the presence of 19 fish taxa. The aquatic environment corresponding to the fossil fish assemblage might be a floodplain crossed by well-oxygenated open waters].

Otero O., Pinton A., Mackaye T.M., Likius A., Vignaud P. & Brunet M. (2010). The early/late Pliocene ichthyofauna from Koro-Toro, Eastern Djurab, Chad. *Geobios*, 43: 241-251. [This is the first extensive study of a freshwater fish fauna from the Pliocene site of Koro-Toro (Chad), aged 3.58-0.27 Ma. The assemblage includes an 16 different taxa. The diversity is relatively low when compared with other

Chadian Neogene sites. This is probably mostly explained by the wind erosion of the outcrops being responsible for the lack of minute remains. The aquatic environment recorded corresponds to open waters].

Paugy D. (1978). Écologie et biologie des *Alestes baremoze* (Pisces, Characidae) des rivières de Côte d'Ivoire. *Cahiers ORSTOM, série Hydrobiologie*, 12: 245-275. [This paper presents morphological and biological parameters of the *Alestes baremoze* in Côte d'Ivoire. Comparisons with other sudanian populations are given].

Paugy D. (1980). Écologie et biologie des *Alestes imberi* (Pisces, Characidae) des rivières de Côte d'Ivoire. Comparaison méristique avec *Alestes nigricauda*. *Cahiers ORSTOM, série Hydrobiologie*, 13: 129-141. [This paper presents morphological and biological parameters of the *Brycinus imberi* in Côte d'Ivoire. Comparisons with other african populations are given. The comparison between *B. nigricauda* and *B. imberi* shows differences between the morphological characters and the reproduction pattern].

Paugy D. (2002). Reproductive strategies of fishes in a tropical temporary stream of the Upper Senegal basin: Baoulé River in Mali. *Aquatic Living Resources*, 15: 25-35. [In the Baoulé River (Mali), during the peak of the dry season, the remaining pools comprise only 10% of the total length of the river. During the wet season, there is a short (three months) but intense period of flooding. In this study, the reproductive strategies of 18 species of fishes were investigated in the upper reach of the Baoulé drainage. Two main types of spawning strategies may be distinguished among these species].

Paugy D. (2010a). The Ethiopian subregion fish fauna: an original patchwork with various origins. *Hydrobiologia*, 649: 301-315. [This paper, analyses the biogeographical distribution and the historical origin of freshwater fish of the Ethiopian Rift Valley. The old Abyssinian ichthyo-province is not homogeneous in species composition. Four main geographical units are distinguished based on the present species composition which seemed to be mainly influenced by historical events].

Paugy D. (2010b). An historical review of African freshwater ichthyology. *Freshwater Reviews*, 1-32. [In this paper, the history of freshwater ichthyology in Africa is reviewed. More than 3200 species have been discovered, drawn and described. Brief biographies of the principal ichthyologists are presented].

Paugy D. & Lévêque C. (2007). Le lac Victoria (Afrique de l'Est) malade de la perche du Nil : réalité, mythe ou mystification. *Nature, Sciences, Sociétés*, 15 : 389-398. [While looking like a documentary, the film *Darwin's Nightmare* is, in fact, a tale and a fiction. The amalgam of all calamities (prostitution, Aids, malnutrition, war, etc.) attributed to Nile perch introduction is not credible. The ecological side is quite weak and provides false conclusions. The economic side is also very caricatural and it cannot obviously be resumed to the denunciation of the North exploiting the South].

Paugy D., Lévêque C. & Duponchelle F. (2006). La reproduction: 147-175. *In* Lévêque C. & Paugy D. (eds), *Les Poissons des eaux continentales africaines. Diversité, écologie, utilisation par l'homme*. IRD Éditions, Paris, 564 p. [This chapter, by assembling existing information of African fishes, is a synthesis of the reproduction parameters of numerous species in relation with their environment].

Paugy D., Lévêque C. & Teugels G.G. (2003). *Poissons d'eaux douces et saumâtres de l'Afrique de l'Ouest*. Collection Faune et Flore tropicales 40, IRD Édition, Paris, Vol. 1 (457 p.), Vol. 2 (815 p.), + cédérom**.** [This fauna displays an up to date account of the knowledge on the systematics of the fresh and brackishwater fishes of West Africa. These volumes are bilingual (French and English). Distribution maps are provided for freshwater species].

Petr T. (1986). *The Volta river system*: 163-199. *In* Davies B.R. & Walker K.F. (eds), *The ecology of river systems*. Monographiae Biologicae 60, W. Junk Publisher, Dortrecht, 793 p. [This is a short synthesis of the Volta system in West Africa. This includes hydrology, physico-chemistry, fish and fisheries. This work includes also a long part concerning the ecology of the Akosombodam built in the lower course. The consequences of this daming are discussed].

Philippart J.C. & Ruwet J.C. (1982). *Ecology and distribution of Tilapias*: 15-59. *In* Pullin R.V.S. & Lowe-McConnell R. (eds), *The biology and culture of tilapias*. ICLARM Conference Proceedings 7. ICLARM, Manila, Philippines, 432 p. [This paper reviews three aspects of the ecology of tilapias. Data on the natural distribution, ecological amplitude and eco-ethological characteristics can help the selection of species for culture and introduction and the prevention of unfortunate consequences].

Pitcher T.J. & Hart P.J.B. (1995) *The impact of species changes in African lakes*. Fish and Fisheries Studies 18, Chapman & Hall, London, 601 p. [This book covers the impact of species changes engendered by the introduction of fish species, impoundment and heavy exploitation].

Postel S. & Richter B.D. (2003). *Rivers for life: Managing Water for People and Nature*. Island Press, Washnigton D.C., 220 p. [This book offers case studies of river management from the United States and South Africa, along with numerous examples of new and innovative policy approaches that are being implemented in those and other countries].

Pouyaud L. & Agnèse J.-F. (1995). Phylogenetic relationships between 21 species of three tilapiine genera *Tilapia*, *Sarotherodon* and *Oreochromis* using allozyme data. *Journal of fish Biology*, 47: 26-38. [With the aim of detecting speciation events in Tilapia sensu lato, 24 enzyme loci were studied in 21 species of cichlids. The phylogenetic trees obtained show a clustering of species (except for one) according to their genera, i.e. *Tilapia*, *Sarotherodon* or *Oreochromis*, which confirms the systematics adopted by Trewavas. The phylogenetic trees obtained confirm the hypothesis that mouthbrooders (Sarotherodon and Oreochromis) have a single origin, i.e., egg layers (Tilapia)].

Reizer C. (1974). *Définition d'une politique d'aménagement des ressources halieutiques d'un écosystème aquatique complexe par l'étude de son environnement abiotique, biotique et anthropique. Le fleuve Sénégal Moyen et Inférieur*. Doctorat en Sciences de l'Environnement. Dissertation Arlon, Fondation Universitaire Luxembourgeoise, 4 vols. [Biology and ecology of senegalese fish; state of the fishery in the Senegal River in the 1970s and proposals to improve a sustainable fishery].

Ribbink A.J. & Eccles D. (1988). *Fish communities in the East African Great Lakes*: 277-301. *In* Lévêque C., Bruton M.N. & Ssentongo G.W. (eds), *Biology and ecology of African freshwater fishes*. Travaux & Documents 216, Orstom Éditions, Paris, 508 p. [This chapter is a short synthesis which presents the East African Great Lakes, their major habitats and their fish communities associated. Each type of habitat is colonized by specific species which are never met elsewhere].

Ribbink A.J. (1991). *Distribution and ecology of the cichlids of the African Great Lakes*: 36-59. *In* Keenleyside M.H.A. (ed.), *Cichlid fishes: behaviour, ecology and evolution*. Fish and Fisheries Series 2, Chapman & Hall, London, 378 p. [In this chapter, it was shown that within each cichlid community there are narrowly stenotopic species which are strictly confined to their specific habitat, but there are also eurytopic members which routinely cross the boundaries between habitats].

Ribbink A.J., Marsh B.A., Marsh A.C., Ribbink A.C. & Sharp B.J. (1983). A preliminary survey of the cichlid fishes of rocky habitats in Lake Malawi. *South African Journal of Zoology*, 18: 149-310. [The distribution of 196 species of Mbuna is given with notes on habitat preferenda, depth distribution and behaviour. Considerable emphasis is placed on coloration and marking for identification ant it is argued that they are important for mate recognition. Brief notes are given on some of the other rocky shore. Most Mbuna species are geographically restricted and stenotopic].

Richter B.D., Matthews R., Harrison D.L. & Wigington R. (2003). Ecologically sustainable water management: managing river flows for ecological integrity. *Ecological Applications*, 13: 206-224. [This article offers a framework for developing an ecologically sustainable water management program, in which human needs for water are met by storing and diverting water in a manner that can sustain or restore the ecological integrity of affected river ecosystems].

Roberts T.R. (1975). Geographical distribution of African freshwater fishes. *Zoological Journal of the Linnean Society*, 57: 249-319. [This is a reference paper. Geographical distribution of African freshwater fishes is discussed with emphasis on the effect of major continental features, hydrographic history, and Pleistocene climatic fluctuations. The African continent can be divided into ten ichthyofaunal provinces].

Rowntree J. (1984). Fisheries management in the northern Nile Delta lakes of Egypt: the case of Hosha. *FAO, Studies and Reviews*, 61: 541-555. [In Egypt, private land reclamation efforts on the lake margins are generally preceded by hosha, a fish capture technique harvesting all fish trapped in a periodically drained, dyked enclosure in the lake. Hosha yields approximately equals 2.5 times the fish catch per hectare produced in the open lake and now produces approximately equals 35-40% of the total catch in the two largest lakes investigated].

Saad M.A.H., Amuzu A.T., Biney C., Calamari D., Imevbore A.M., Naeve H. & Ochumba P.B.O. (1994). *Domestic and industrial organic loads*: 23-32. *In* Calamari D. & Naeve H. (eds), *Review of Pollution in the African Aquatic environment*, CIFA Technical Report, 25, FAO, Rome, 118 p. [This chapter summarizes the sources and the impact of organic wastes loads on the aquatic environment and on fisheries].

Schliewen U.K., Rassmann K., Markmann M., Markert J., Kocher T.D. & Tautz D. (2001). Genetic and ecological divergence of a monophyletic cichlid species pair under fully sympatric conditions in Lake Ejegham, Cameroon. *Molecular Ecology*, 10: 1471-1488. [This paper presents an unequivocal case of sympatric speciation with a cichlid species flock that comprises five *Tilapia* forms endemic to a tiny lake (Lake Ejagham with a surface area of approximately 0.49 km 2) in Western Cameroon. Analysis of mitochondrial D-Loop sequences shows that the flock is very young (approximately 10^4 years) and has originated from an adjacent riverine founder population].

Schliewen U.K., Tautz D. & Pääbo S. (1994). Sympatric speciation suggested by monophyly of crater lake cichlids. *Nature*, 368: 629-632. [An excellent case of sympatric speciation may be made for cichlid species flocks in small, ecologically monotonous crater lakes. This paper presents a mitochondrial DNA analysis of cichlid species flocks endemic to two such lakes in Cameroon. The results suggest that the flocks in each lake are monophyletic: the implication being that each lake was colonized once only].

Seegers, L. & Tichy H. (1999). The *Oreochromis alcalicus* flock (Teleostei: Cichlidae) from Lakes Natron and Magadi, Tanzania and Kenya, with descriptions of two new species. *Ichthyological Exploration of Freshwaters* **10**(2): 97-146. [This paper describes a small monophyletic species flock from the Lake Natron drainage (Tanzania and Kenya), comprising; at least 3 morphologically distinct species. *Oreochromis alcalicus* is redescribed and two new species are described].

Seehausen O., Lippitsch E., Bouton, N & Zwennes H. (1998). Mbipi, the rock-dwelling cichlids of Lake Victoria: description of three new genera and fifteen new species. *Ichthyological Exploration of Freshwaters* 9, 2: 129-228. [This paper recognizes four clades within the Mbipi lineage. Three of them are described as new genera and fifteen new species are also described].

Skelton P.H. (1994). *Diversity and distribution of freshwater fishes in East and Southern Africa*: 95-131. *In* Teugels G.G., Guégan J.F. & Albaret J.J. (eds.), *Biological diversity of African fresh- and brackish water fishes*. *Annales Sciences zoologiques*, 275, Musée royal d'Afrique centrale, Tervuren (Belgique), 177 p. [This paper presents a biogeographic model based on the pattern of fish distribution and the hydrographic history. The conclusions are that the fish faunas of "High" Africa have evolved through the Tertiary largely in situ in accordance with and within a framework of the considerable geomorphological dynamics of the region].

Skelton P.H. (2001). *A complete guide to the freshwater fishes of southern Africa*. 2nd ed. Struik Publishers, Cape Town, South Africa, 388 p. [This guide fills a major gap in southern Africa's natural history literature. For each of the 245 species many information are given, such as: description, ecology, distribution map and keys to families, genera and species].

Skelton P.H., Tweddle D. & Jackson P.B.N. (1991). *Cyprinids of Africa*: 211-239. *In* Winfield I.J. & Nelson J.S. (eds), *Cyprinid fishes: systematics, biology and exploitation*. Fish and Fisheries Series 3, Chapman & Hall, London, 668 p. [This chapter reviews the main characteristics concerning the cyprinids which are a major component of the total fish of the African inland waters: taxonomy, biogeography, biology features, fisheries and conservation].

Slootweg R. (1989). Proposed introduction of *Astatoreochromis alluaudi*, an East African mollusc-crushing cichlid, as a means of snail control. *Annales du Musée royal d'Afrique centrale, Sciences Zoologiques*, 257: 61-64. [A mollusc-crushing cichlid is proposed to control in Africa. A biological control against snails vector populations].

Snoeks J. (1994). *The haplochromines (Teleostei, Cichlidae) of Lake Kivu (East Africa). A taxonomic revision with notes on their ecology*. Annales Musée Royal de l'Afrique Centrale, Sciences Zoologiques, 270, 222 p. [This book describes or redescribes fifteen endemic haplochromine species from Lake Kivu. For each species a detailed morphological description is given. When available, ecological data have been included].

Snoeks J. (2000). How well known is the ichthyodiversity of the large East African lakes? *Advances in Ecology Research*, 31: 17-38. [This is a review based on the problems in systematics on the fish of the East African Lakes. A characteristic feature of most of these lakes is the high number of endemic cichlid species. General and lake-specific taxonomic and phylogenetic problems are discussed].

Snoeks J. (2001). Cichlid diversity, speciation and systematics: examples from the Great African Lakes. *Journal of Aquaculture and Aquatic Sciences Cichlid Research: State of the Art*, 9: 150-166. [This paper considers the number of cichlids species in the Great African Lakes from different angles. A review is given of the data available on the tempo of their speciation, and some of the biological implications of its explosive character are discussed].

Snoeks J., De Vos L. & Thys van den Audenaerde D.F.E. (1997). The ichthyogeography of Lake Kivu. *South African Journal of Science*, 93: 579-584. [In this paper, it is recommended to include Lake Kivu in the same ichthyological province as lakes Victoria and Edward-Georges, namely, the East Coast Province].

Sparks J.S. (2008). Phylogeny of the cichlid subfamily Etroplinae and taxonomic revision of the Malagasy cichlid genus *Paretroplus* (Teleostei: Cichlidae). *Bulletin of the American Museum of Natural History*, 314:1-51. [This work provides significant data concerning relationships between Malagasy–South Asian cichlids. Also a revision of the Malgasy *Paretroplus*]

Sparks J.S. & Smith. W.L. (2004). Phylogeny and biogeography of the Malagasy and Australasian rainbowfishes (Teleostei: Melanotaenioidei): Gondwanan vicariance and evolution in freshwater. *Molecular Phylogenetics and Evolution* **33**:719-734. [This study represents the first phylogenetic analysis of the endemic Malagasy family Bedotiidae and includes a nearly complete taxonomic review of all nominal species, as well as numerous undescribed species].

Sparks J.S. & Stiassny M.L.J. (2003). *Introduction to Madagascar's freshwater fishes*: 849-963. *In* Goodman S.M. & Benstead J.P. (eds), *The natural history of Madagascar*. University of Chicago Press, Chicago, IL, 1728 p. [This paper shows that the freshwater fish fauna of Madagascar is already so heavily affected by human influence that it is likely too late to save all but small remnants].

Spinney L. (2010). Dreampond revisited. *Nature*, 466: 174-175. [This short paper asks what Lake Victoria cichlids have revealed about speciation].

Ssentongo G.W. (1988). Population structure and dynamics: 363-377. . *In* Lévêque C., Bruton M.N. & Ssentongo G.W. (eds), *Biology and ecology of African freshwater fishes*. Travaux & Documents 216, Orstom Éditions, Paris, 508 p. [This paper shows that the tropical multispecies fish populations have strong interspecific relationships and there is a compromise between production of a large production of offspring ('r' selection) and persistance ('K' selection). There is no particular structure compared to communities which inhabit temperate zone].

Stauch A. (1966). *Le bassin camerounais de la Bénoué et sa pêche*. Mémoires Orstom, 15, Orstom Éditions, Paris, 152 p. [This book is a very complete description of all the features concerning the fisheries in the Benue River, Cameroon. The description concerns the orography and the hydrography of the river, the aquatic fauna, the traditional fisheries and the small scale fishing gears].

Stiassny, M.L.J. (1990). Notes on the anatomy and relationships of the bedotiid fishes of Madagascar, with a taxonomic revision of the genus *Rheocles* (Atherinomorpha: Bedotiidae). *American Museum Novitates*, 2979: 1-33. [This paper investigates the anatomy and relationships of the bedotiid fishes of Madagascar. There follows a taxonomic revision of the genus *Rheocles* with the description of a new species. The intrarelationships of *Rheocles* are resolved and a species-level cladogram is presented].

Stiassny, M.L.J., Chakrabarty, P. & Loiselle P.V. (2001). Relationships of the Madagascan cichlid genus *Paretroplus* Bleeker 1868, with description of a new species from the Betsiboka River drainage of northwestern Madagascar. *Ichthyological Exploration of Freshwaters*, 12**,** 1: 29 - 40. [*Paretroplus tsimoly*, new species, is described from the Akalimilotrabe River. As currently recognized, *Paretroplus* comprises a clade of nine species whose closest relatives are the three species of east Asian genus *Etroplus*].

Stiassny, M.L.J. & Sparks J.S. (2006). Phylogeny and taxonomic revision of the endemic Malagasy genus *Ptychochromis* (Teleostei: Cichlidae) with the description of five new species and a diagnosis for *Katria* gen. nov. *American Museum Novitates*, 3535: 1-55. [In this paper, the Malagasy cichlid genus *Ptychochromis* is revised and five new species are described, one of which is presumed to be extinct. A phylogeny of ptychochromin cichlids, derived from the simultaneous analysis of morphological features and nucleotide characters from a combination of mitochondrial and nuclear genes is presented].

Stiassny M.L.J. & Raminosoa N. (1994). The fishes of the inland waters of Madagascar: 133-149. *In* Teugels G.G., Guégan J.F. & Albaret J.J. (eds.), *Biological diversity of African fresh- and brackish water fishes*. *Annales Sciences zoologiques*, 275, Musée royal d'Afrique centrale, Tervuren (Belgique), 177 p. [This paper describes the vulnerability of the freshwater fish fauna which seems much endangered. Freshwater fishes are undergoing a severe attrition as a result of the combined onslaught of deforestation and the introduction of an array of exotic species].

Stiassny M.L.J., Teugels G.G. & Hopkins C.D. (2007). *Poissons d'eaux douces et saumâtres de basse Guinée, ouest de l'Afrique centrale*. Collection Faune et Flore tropicales 42, IRD Édition, Paris, Vol. 1 (800 p.), Vol. 2 (603 p.). [This fauna displays an up to date account of the knowledge on the systematics of the fresh and brackishwater fishes of Lower Guinea, West-Central Africa. These volumes are bilingual (French and English). Distribution maps are provided for freshwater species].

Stiassny, M.L.J., Schliewen U.K. & Dominey W.J. (1992). A new species flock of cichlid fishes from Lake Bermin, Cameroon with a description of eight new species of *Tilapia* (Labroidei; Cichlidae). *Ichthyological. Exploration of Freshwaters*, 3, 4: 311-346. [The Lake Bermin cichlids (Cameroon) are the first example of a substrate-spawning lacustrine radiation within the tilapiine assemblage. The extremely small size of the lake and the relatively low taxonomic diversity of this radiation render the Lake Bermin flack an ideal model for long term studies of the mechanism of speciation].

Teugels G.G. (1986). A systematic revision of the African species of the genus *Clarias* (Pisces, Clariidae). *Annales du Musée royal d'Afrique centrale, Sciences Zoologiques*, 247: 199 p. [This book is a complete mophological study and a systematic revision of all African *Clarias* known in Africa. For each species a distribution map is given].

Thiémé M.L., Abell R., Stiassny M.L.J., Skelton P., Lehner B., Teugels G.G., Dinerstein E., Kamdem Toham A., Burgess N. & Olson D. (2005). *Freshwater Ecoregions of Africa and Madagascar*. Island Press, Washington, 431 p. [This book provides fundamental informations on ninety-three of africa's most significant wetland areas].

Thiémé M.L., Lehner B., Abell R. & Matthews J. (2010). Exposure of Africa's freshwater biodiversity to a changing climate. *Conservation Letter*: 1-8. [The results show that by the 2050s, ecoregions containing over 80% of freshwater fish species and several outstanding ecological and evolutionary phenomena are likely to experience hydrologic conditions substantially different from the present, with alterations in annual discharge or runoff of more than 10%].

Thys van den Audenaerde D.F.E. (1963). La distribution géographique des *Tilapia* au Congo. *Bulletin des Séances de l'Académie royale des Sciences d'Outre-Mer*, 9, 3: 570-605 [Geographical distribution of Congolese *Tilapia* species is discussed. The Congolese basin continent can be divided into thirteen geographical areas].

Tichy, H. & Seegers L. (1999). The *Oreochromis alcalicus* flock (Teleostei: Cichlidae) from Lakes Natron and Magadi, Tanzania and Kenya: a model for the evolution of "new" species flocks in historical times? *Ichthyological Exploration of Freshwaters*, 10, 2: 147-174. [The *Oreochromis alcalicus* flock from the Lake Natron basin (Tanzania and Kenya) is presented as a model of contemporary formation of a species flock by radiation which started to evolve not more than about 7000 years ago].

Turner J.L. (1981). Changes in multi-species fisheries whan many species are caught at bthe same time. *CIFA Technical Paper / Document Technique Comité des Pêches Continentales pour l'Afrique*, 8: 201-211. [This paper provides an example of several multispecies fisheries, when many species are caught at the same time, were selected to determine their potential yield and to monitor changes in species composition. The relationship between catch per effort and effort was both highly significant and linear for the fisheries studied.A shift from large to small species occurred in each fishery with the amount of the change dependent on the mesh size of the fishing gear. The yield from exploitation at similar levels of effort remained fairly constant even with extensive changes in species composition].

Tweddle D. (1982). Fish breeding migrations in the North Rukuru area of Lake Malawi with note on gillnet colour selectivity. *Luso: Malawi Journal of Sciences & Technology*, 3: 67-74. [White nets caught consistently more fish than coloured nets, the results of the comparison between white and red net catches being statistically significant].

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Ulyel A.P., Ollevier F., Ceusters R., Thys van den Audenaerde D.F.E. (1990). Régime alimentaire des *Haplochromis* (Teleostei: Cichlidae) du lac Kivu en Afrique. 1. Relations trophiques interspécifiques. *Belgian Journal of Zoology*, 120: 143-155.

United Nations (2010). Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, *World Population Prospects: The 2008 Revision*, http://www.un.org/esa/population/publications/wpp2008/wpp2008_highlights.pdf, Thursday, September 30, 2010. [This report presents the highlights of the results of the *2008 Revision* of the official world population estimates and projections prepared by the Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat].

Van den Bossche J.P. & Bernacsek G.M. (1990). *Source book for the inland fishery resources of Africa*. Vol. 1 and 2. CIFA Technical Paper, n° 18/1 and 18/2. Rome, FAO, 411 and 240 pp. [These books, three volumes, are compendium, water body-by-water body, country-by-country, of information on inland fisheries and related topics. The overall objective is to promote inland fisheries management and development].

van der Waal B.C.W. (1985). Aspects of the biology of larger fish species of Lake Liambezi, Caprivi, South West Africa. *Madoqua*, 14: 101-144. [In this paper several biological parameters of the species of the Liambezi Lake, Namibia, are studied and discussed].

Van Oijen M.J.P., Witte F. & Witte-Maas E.L.M. (1981). An introduction to ecological and taxonomic investigations on the haplochromine cichlids from Mwanza Gulf of Lake Victoria. *Netherlands Journal of Zoology*, 31: 149-174. [This paper describes the research area and the fishing techniques as basic information for folowing publications. Taxonomic studies resulted in the recognition of 150+ new species].

Viner A.B. & Smith I.R. (1973). Geographical, historical and physical aspects of Lake George. *Proceedings of the Royal Society of London*, B, 184: 235-270. [This paper resumes some physical characteristics concerning the equatorial Lake George in Uganda. Its geographic location gives to it a climatic regime which makes for an exceptionally unvaried physico-chemical environment within the water mass throughout the year. This is enhanced by peculiarities of the local geomorphometry and the morphometry of the lake. These features promote a continuous productivity. The nocturnal turbulence wind regime provides an efficient recirculation of nutrients within the shallow water column. Progressive organic enrichment has existed throughout the lake's history (3600 ± 90 years)].

Welcomme R.L. (1972). An evaluation of the acadja method of fishing as practised in the coastal lagoons of Dahomey (West Africa). *Journal of Fish Biology*, 4: 39-55. [This paper describes a method of fishing using installations of the fish-park type, known collectively as acadjas, is common in the coastal lagoons of Benin. Acadjas are installed in shallow sheltered waters and are constructed of dense masses of branches planted in the muddy bottom. The yield of the acadjas increases logarithmically with increasing densities of branches planted].

Welcomme R.L. (1979). *Fisheries ecology of floodplain rivers*. Longman, London, 317 p. [This book assembles information on the general ecology of those rivers that undergo seasonal flooding, and applies it to the special case of fisheries. It was shown how the various activities accuring in river basin can influence the fish communities inhabiting them].

Welcomme R.L. (1985). *River fisheries.* FAO Fisheries Technical Paper n° 262. FAO, Rome, 330 p.. [This technical paper is intended as a general summary of the current thinking based on literature on all aspects of river fisheries from the physical and biological environment in which they are pursued to their magement. Its pupose concerns as well tropical areas as temperate ones].

Welcomme R.L. (1988). *International Introductions of Inland Aquatic Species*. FAO Fisheries Technical Paper, n° 294, FAO Rome, 318 p. [This book analyses a total of 1354 introductions of 237 specie into 140 countries. It is concluded that the introduction is a valuable management tool bt, because of the risks to hosts communities, any further introductions should be made only after careful consideration on any impacts].

Welcomme R.L. (1999). A review of a model for qualitative evaluation of exploitation levels in multi-species fisheries. *Fisheries Management and Ecology*, 6: 1-19. [The present review concludes that, out of the various explanatory variables, the mean length of fish caught is one of the most significant together with the numbers of species in the catch and the time taken for catches in fluctuating systems to respond to floods. More complex indicators are based on emergent characteristics of the system such as the production:biomass or predator:prey ratios. Three major strategies are identified for management based on responses of fish assemblages to increases in effort].

Welcomme R.L. (2005). *Impacts of Fishing on Inland Fish Populations in Africa*: 81-85. *In* Thieme M.L., Abell R., Stiassny M.L.J., Skelton P., Lehner B., Teugels G.G., Dinerstein E., Kamdem Toham A., Burgess N. & Olson D. (eds), *Freshwater Ecoregions of Africa and Madagascar. A Conservation Assessment*. WWF, Island Press, Washington, USA, 431 p. [This short paper resumes the different factors which can affect the diversity and richness of African inland waters fish assemblage. Indicators that can be used to diagnose the state of fisheries or of aquatic biodiversity in general are listed].

Welcomme R.L. & Halls A.S. (2004). *Dependence of river fisheries on river flow*: 267-283. *In* Welcomme R.L. & Petr T. (eds), *Proceedings of the Second International Symposium on the Management of Large Rivers for Fisheries*. Volume 2, Phnom Penh, 11-14 February 2003, 310 p. [This study shows that in large tropical rivers, fish are heavily influenced by flood regimes that fluctuate naturally from year to year. Recently increasing pressure on water for a wide range of uses has substantially altered flood regimes of rivers. Such alterations usually have resulted in the loss of fish production and biodiversity].

Weyl O.L.F., Ribbink A.J. & Tweddle D. (2010). Lake Malawi: fishes, fisheries, biodiversity, health and habitat. *Aquatic Ecosystem Health and Management*, 13, 3: 241-254. [This overview is based on litterature data. Concerning the fisheries, there are signs of over exploitation and an increasing fishing effort].

White E. (1983). *The vegetation of Africa: a descriptive memoir to accompany the UNESCO/AETFAT/UNSO vegetation map of Africa*. UNESCO, Paris, 356 pp. [The Vegetation Map of Africa is a compendium of various existing map sources for different regions/countries. The first draft of the map was checked by extensive fieldwork and discussions with local experts. The vegetation classification used is the UNESCO standard based on physiognomy and floristic composition (not climate), and it includes a total of 80 major vegetation types and mosaics. Water is added as category 81 in the GRID legend for the digital map].

Winemiller K.O. (1992). Life history strategies and the effectiveness of sexual selection. *Oikos*, 62: 318-327. [This pare reexamines the hypothesized relationship between the relative strength of sexual selection and life-history strategies. The potential effectiveness of sexual selection depends not only on the relative survivorship of immature stages, but also on other components of fitness. A general three-dimensional demographic model provides a more comprehensive conceptual framework for life-history comparisons].

Witte F., de Graaf M., Mkumbo O.C., El-Moghraby A.I. & Sibbing A. (2009). *Fisheries in the Nile System*: 723-747. *In* Dumont H.J. (ed.), *The Nile: origin, environments, limnology and human use*. Monographiae Biologicae, 89, Springer, 818 p. [This paper is a review to fisheries of the River Nile itself and of the Nilotic lakes. Except some few examples, all studied areas show signs of overfishing].

Witte F. (1981). Initial results of the ecological survey of the haplochromine cichlid fishes from the Mwanza Gulf of Lake Victoria (Tanzania): breeding patterns, trophic and species distribution, with recommendations for commercial trawl-fisher. *Netherlands Journal of Zoology*, 31: 175-202. [This preliminary paper provides the first results concerning the trophic strategies and the breeding activities of the haplochromine Cichlidae from the Mwanza Gulf of Lake Victoria. It reveals also that most haplochromine species appear to be strongly habitat-restricted throughout life].

Witte F. (1984). *Ecological differentiation in Lake Victoria Haplochromines: comparison of cichlid species flocks in African lakes*: 155-167. *In* Echelle A.A. & Kornfield I.L. (eds.), *Evolution of fish species flocks*. University of Marine Press, Orono, Maine, 257 p. [This work refutes or weakens many of the ancient conclusions concerning differences between the Lake Victoria flock and those of lakes Malawi and Tanganyika. It demonstrates also that differences between the ecology of the cichlid flocks of Lake Victoria and those of lakes Malawi and Tanganyika are weaker than supposed. Finally, it is supposed that intra- and extralacustrine allopatric speciation processes, as well as sympatric speciation may have been important in forming the species flocks in all three lakes].

Witte F., Goldschmidt T., Wanink J. H., van Oijen M., Goudswaard P. C., Witte-Maas E. & Bouton N. (1992) The destruction of an endemic species flock: Quantitative data on the decline of the haplochromine cichlids of Lake Victoria. *Environmental Biology of Fishes*, 34: 1-28. [This paper describes the species composition of haplochromines in a research area in the Mwanza Gulf of Lake Victoria prior to the Nile perch upsurge. The decline of the haplochromines as a group and the decline of the number of species in various habitats in the Mwanza Gulf was monitored between 1979 and 1990].

Witte F. & Van Oijen M.J.P. (1990). Taxonomy, ecology and fishery of Lake Victoria haplochromine trophic groups. *Zoologische Verhandelingen, Leiden*, 262, 47 p. [Based on ecological and morphological features, the 300 or more haplochromine cichlid species of Lake Victoria are classified into fifteen (sub)trophic groups. A key to the trophic groups, mainly based on external morphological characters, is presented. Of each trophic group a description is given comprising data on taxonomy, ecology and fishery].

Witte F., Wanink J.H., Kishe-Machumu M., Mkumbo O.C., Goudswaard P.C., & Seehausen O. (2007). Differential decline and recovery of haplochromine trophic groups in the Mwanza Gulf of Lake Victoria. *Aquatic Ecosystem Health & Management*, 10, 4: 416–433. [This paper shows the decline and partial recovery of the different haplochromine trophic groups in the northern part of the Mwanza Gulf, Lake Victoria, Tanzania].

World Commission on Dams (2001). *Dams and development: a new framework for decision making*. *Overview of the report of the World Commission on Dams*. Earthscan Publications Ltd, London, 17 p. [This paper presents an overview of the issues asked by the dams construction, summarising the main recommendations and proposals].

Yamaoka K., Hori M. & Kuratani S. (1986). Eco-morphology of feeding in ‘goby-like’ cichlid fish in Lake Tanganyika. *Physiology and Ecology, Japan*, 23: 17-29. [This paper is a detailed comparative investigation of dental morphology, relative gut length, food and feeding behaviour in nature of three goby-like small cichlids in Lake Tanganyika].

Biographical Sketches

LÉVÊQUE Christian was a director of Research at IRD (Research Institute for Development) (presently retired)

Fields of expertise

• Ecological dynamics of aquatic systems
• Biology, ecology of African fishes
• Climate changes and biodiversity
• Management of aquatic resources
• Ecosystem restoration

PAUGY Didier is a director of Researches, equivalent full Professor at IRD (Research Institute for Development).

Fields of expertise

African Freshwater Ichtyology:

• Taxonomy of African Characids
• Fish fauna of West African inland waters, Biogeography.
• Biology, ecology and life strategies of freshwater fishes in West Africa.
• Impact of anthropic activities on the freshwater fish fauna in West Africa.
• Knowledges basis on African freshwater fish (Panafrican network with Belgium and South Africa).
• FAUNAFRI: a global information system on the distribution of African Freshwater Fishes (http://www.ird.fr/poissons-afrique/faunafri/)