# Fish communities in river systems and associated biotopes

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**Except for the many lakes of East Africa, most African aquatic environments are formed by rivers whose total length is estimated at 13 million km (Welcomme & Mérona, 1988). Nevertheless, the communities, in these species-rich lotic environments, are far less well-known than those of lakes and reservoirs. Sampling difficulties in fluvial environments, particularly during flood periods, are one of the main reasons for the relative scarcity of information about riverine communities.**

## Dynamics of river systems and consequences for fish assemblages

Water flow varies according to seasons, as well as the morphology of the fluvial landscapes (see chapter *Variability of climate and hydrological systems*). The periodic shifts between floods and low water flows create a large diversity of habitats, of varying durations, that follow each other over time. For tropical rivers, changes in water level associated with the seasonal flooding of neighbouring floodplains are the main factors driving hydrosystem functioning (Welcomme, 1979; Lowe-McConnell, 1985; 1988).

In small watercourses, floods are often short-lived and unpredictable as they depend on the characteristics of local precipitation across the drainage basin. This is also the case for many rivers bordering the Sahara. During the dry season, these rivers dry up or are reduced to a series of residual pools. They are only inhabited by fishes that are able to adapt to extreme conditions, either through diapause or the ability to survive in environments that are sometimes relatively oxygen-poor.

Meanwhile, in large river systems, which are often associated with floodplains, floods are more regular and longer-lasting. Here, variations in the river's flow regulate the intensity and duration of exchanges between the different parts of the river-floodplain interactive system. When the level rises, the water enters part of the floodplain, creating connections and allowing exchanges with the minor river bed. When the level falls, some parts of the floodplain are isolated from the riverbed.

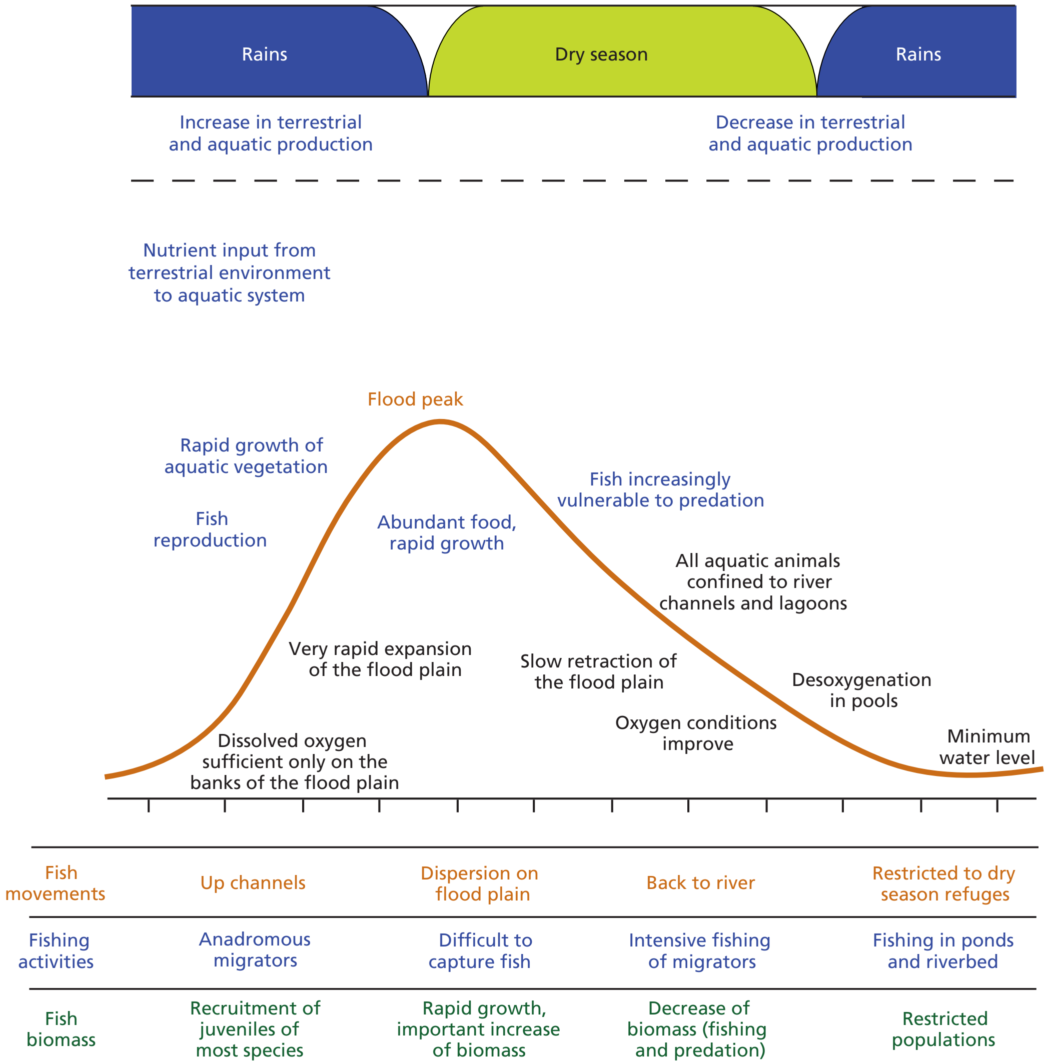


**FIGURE 18.1.**
The seasonal cycle of events in a floodplain river (from Lowe-McConnell, 1985).

The river system thus functions by "flood pulses" (Junk *et al.*, 1989) whose rhythm is regulated by oscillations in the hydrological system, and whose impact depends on the degree, duration, frequency, and/or regularity of floods. Depending on the period at which high or low water levels occur, they exert a more or less strong influence on the life cycles of species and the productivity of hydrosystems. In particular, the period during which connections exist between the river and its annexes has significant consequences on the system's function and the biology of species. In relatively large rivers, a predictable flood of long duration favours development in organisms that survive by adaptation and opportunistic strategies that allow them to make efficient use of the transition zone between the aquatic and terrestrial environments, rather than depending solely on the resources of permanent aquatic environments. Some organisms, such as fishes, actually leave the main watercourse during the flood in order to use the habitats and resources available in the floodplain, and return to the main watercourse when the water level drops. If the flood is exceptionally too short, some organisms cannot complete their life cycle.

The seasonal cycle of events in a floodplain were summarized by Lowe-McConnell (1985) (figure 18.1). During the flood, floodplain waters are enriched in nutrients from the decomposition of organic matter and vegetation, as well as animal droppings (cattle, wild animals) grazing in the plains. This leads to the rapid development of bacteria, algae, zooplankton, and more generally speaking a rich fauna of aquatic invertebrates. At the same time, aquatic vegetation grows rapidly. Once the flood reaches its peak, the water begins to fall and leaves the floodplains through a series of channels to return to the river's main watercourse. Animals also leave the floodplains, but some are trapped in pools that are cut off, most of which will dry up before the next flood. Some of these pools remain throughout the year and serve as a refuge for aquatic fauna.

## River zonation and fish assemblages

The gradient of physical conditions found throughout the watercourse, from upstream to downstream, induces a response from biological communities, with a progressive change according to the capacities of species to adapt to environmental constraints and available food resources. This longitudinal zonation is accompanied by an increase in species richness.

In temperate environments, there have been a number of attempts to establish the general principles of fish distribution throughout a longitudinal gradient, and several ecological zonations for watercourses have been put forth. One of the most well-known in Europe is the one proposed by Huet (1949), sometimes called the "slopes rule". It is based on the principle that for a given biogeographic territory, running waters of the same dimensions (width and depth) and with comparable slopes will have similar biological characteristics. By using simple parameters such as slope and watercourse width, we can thus predict the nature of dominant fish populations.

Little work has been done for Africa, and the initial attempts at characterization are based on the classification by Illies & Botosaneanu (1963) who recognize three main zones in a watercourse: the crenon (spring zone), the rhithron (middle course) with turbulent, oxygenated waters, and the potamon (lower course) which is the downstream section and corresponds to slow and turbid watercourses in the plains. This basic classification was applied to fish communities of the Luanga River, a higher-altitude river of the Congo basin (Malaisse, 1976).

A more elaborate form was applied to other West African rivers such as the Bandama (Côte d'Ivoire) which hosts about 90 fish species (figure 18.2). Its course is a succession of rapid areas (riffles) and calm areas (pools) wherein four main zones can be distinguished (Mérona, 1981):

• a short spring zone corresponding to narrow brooks, sometimes temporary, populated essentially by small species (*Barbus*, Cyprinodontiformes, small Alestidae);

• an upper course characterized by the presence of *Brycinus longipinnis*, *Hepsetus odoe* and *Schilbe intermedius*;

• a very extensive middle course with a relatively homogenous community, characterized by the presence of *Alestes baremoze*, *Brycinus nurse* and *B. macrolepidotus* in the deep biotopes and *Labeo parvus* in the riffles;

• downstream, the lower course, under marine influence, where estuary species can be found. This zone again contains *Brycinus longipinnis* and *Hepsetus odoe*.

The Ogun River in Nigeria (Sydenham, 1977) also has a very extensive middle course with a homogenous fish community. This situation is probably characteristic of rivers having a gradual slope over most of its course.

In the Mono (Togo), Paugy & Bénech (1989) showed that species diversity increased rapidly as one moves away from the source and then reached an asymptote. While their results for zonation are quite similar to the ones obtained for the Bandama, these authors have nonetheless noted that *Brycinus longipinnis* and *Hepsetus odoe* are frequently captured throughout the Mono, even though these species populate essentially the upper and lower courses of the Bandama. The much smaller size of the Mono drainage basin (22,000 km$^2$ versus 97,000 km$^2$ for the Bandama), probably accounts for the absence of a middle course similar to the Bandama's, especially given there are fewer species there (66 versus 90 for the Bandama), and that species such as *Hydrocynus forskalii,* which are characteristic of the middle course of the Bandama, are rarely found in the Mono basin.

The relationship between river size and species richness may be explained by the existence of a greater diversity of habitats when moving downstream. In a study of the longitudinal zonation of fishes in the Niandan River (upper basin of the Niger in Guinea), Hugueny (1990) highlighted a fairly strong relationship between species richness and the river's maximum depth, that is, a variable linked to river size. This relationship appears to be tied to the fact that shallow environments can only be colonized by small-sized species or individuals, and that there is a lower limit below which a fish, given its size, can no longer travel efficiently. Communities do not become complex in a random manner from upstream to downstream, but essentially by the addition of species, with few disappearances, at least for the portion of the Niandan River that was studied. In species-poor communities, there is a bias towards small species that feed near the surface, whereas more species-rich communities contain more large species that feed at the bottom.

The river zonation can be modified according to the river's shape. Balon & Stewart (1983) have described an unusual gradient in the Luongo River, a tributary of the Luapula River that flows into Lake Mweru. The upper and lower courses have steep slopes with riffles and falls, and are separated by a gradually-sloping middle course with a floodplain. The fish communities of the upper and lower courses contain species adapted to running waters, but the species composition is different in each one.

**FIGURE 18.2.**
Schematic longitudinal zonation of fishes in the Bandama basin (from Mérona, 1981).

| Zonation | Habitat | Characteristic species |
|---|---|---|
| **Spring zone** ↓ | Brooks or pools | small *Barbus*<br>small Alestidae<br>Cyprinodontiformes<br>*Neolebias* sp. |
| **Upper course** ↓ | Small pools | *Brycinus longipinis*<br>*Hepsetus odoe*<br>*Schilbe intermedius*<br>*Synodontis schall* |
| **Middle course** ↓ | Alternating pools and riffles | **pools**<br>*Alestes baremoze*<br>*Brycinus nurse*<br>*Brycinus macrolepidotus*<br>*Hydrocynus forskalii*<br>*Schilbe mandibularis*<br>**riffles**<br>*Labeo parvus*<br>*Mastacembelus nigromarginatus*<br>*Nannocharax* sp.<br>*Brycinus imberi*<br>*Tilapia* spp. *s. lat.* |
| **Lower course** | Large pools, salinity influence | **continental species**<br>*Brycinus longipinnis*<br>*Hepsetus odoe*<br>*Schilbe intermedius*<br>*Synodontis schall*<br>**estuarine species**<br>*Elops lacerta*<br>*Awaous lateristriga* |

In their upper course and occasionally a portion of their middle course, tropical rivers are seasonal. They flow during the rainy season and are interrupted part of the year during which the course dries up or is reduced to a string of residual pools. Most of the observations for fish communities are carried out during a period of water outflow, when sampling conditions are favourable, whereas it is much more difficult to carry out sampling during the flood, when some species carry out longitudinal migrations that allow them to recolonize and sometimes even reproduce in upper courses.

Changes in the structure of communities in the upper course of the Ogun River, which is seasonal, have been studied by Adebisi (1988). Piscivorous fishes (*Hydrocynus forskalii, Hepsetus odoe, Bagrus docmak, Mormyrops anguilloides*) are particularly abundant in captures using gillnets at the start and end of the flood. Some of them (*Hydrocynus* spp., *Mormyrops* spp.) probably migrate to the upper reaches to reproduce, then go down to lower reaches when the water level falls. Towards the end of the flood, omnivorous species (*Schilbe intermedius, Clarias gariepinus, Heterobranchus longifilis, Synodontis schall*) become preponderant until fragmentation into residual pools begins. In these pools, fish communities are essentially dominated by herbivorous species (*Brycinus macrolepidotus, B. nurse, Coptodon zillii*, but also *Labeo senegalensis, Chromidotilapia guntheri, Sarotherodon galilaeus*) and insectivores (Mormyridae, *Chrysichthys auratus*).

Similar observations were also made in the residual pools of the upper course of the Baoulé River (upper basin of the Senegal, in Mali) (Paugy, 1994). At the end of the period of low water, the community composition and structure of the largest residual pools, rare in number (two to three over the 500 km of the Baoulé), are essentially identical to what is observed in the major bed. They thus most certainly serve as refugia that allow species to recolonize the environment when the water rises. For smaller surface pools, there is a correlation between species richness and composition and the available water surface (figure 18.3). For these species, we can see the complete disappearance of *Labeo* spp., plentiful in normal conditions, still relatively numerous when the amount of water is sufficient and rocks are scattered over the biotope, and totally absent when water is scarce and the substrate is just a mixture of sand and mud. Another significant phenomenon is the decrease and disappearance of almost all the different Mormyridae species. Most of the members of this group are known to be sensitive to decreases in dissolved oxygen concentrations (Bénech & Lek, 1981). This is quite likely to be one of the possible causes for their disappearance.

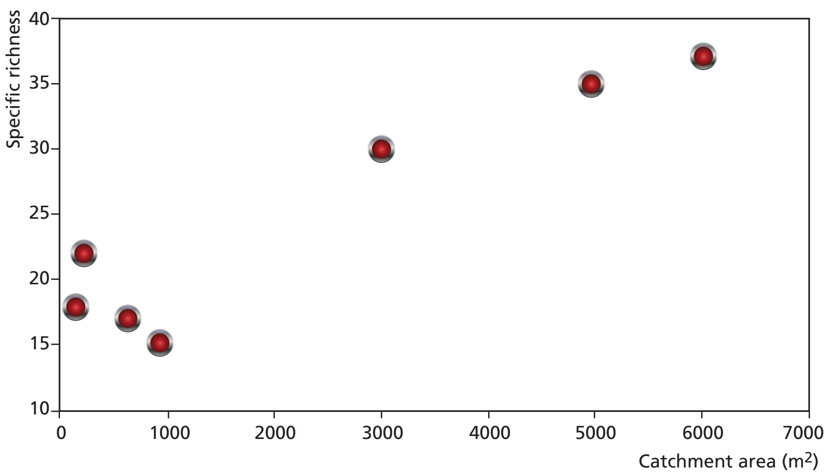


**FIGURE 18.3.**
Relationship between the ponds area and the specific richness (Baoulé River, upper Senegal basin, Mali) (from Paugy, 1994).

In the residual pools of the floodplain of the Sokoto River, a tributary of the Niger in Nigeria, species composition remains relatively similar from one year to another (Chapman & Chapman, 1993). However, the observations were only made for a short period and cannot be generalized.

# The floodplains

In river systems with floodplains, there is a large variety of habitats ranging from small temporary pools to permanent swamps and lakes, and whose distribution and dynamics vary according to hydrological season (Welcomme, 1979; Welcomme & Mérona, 1988). The role of floodplains in the functioning of river systems has been studied in Africa, where these environments are well-developed in nearly all basins of the savannah zone: the Senegal, Niger, Volta, Ouémé, Chari and Logone, Nile rivers, etc. Floodplains are both food sources and breeding areas for fishes. They serve as a refuge for fry that find shelter from predators there.

Based on his observations in the Ouémé River during the dry season, Welcomme (1979, 1985) proposed a general outline for the distribution of fishes in floodplains. The distinction between "white fish" and "black fish" was an attempt to distinguish between two sets that differed in terms of ecology and behaviour. A third set, the "grey fish", was also suggested (table 18.I) (Regier *et al.*, 1989).

**TABLE 18.I**

Black-grey-white: three ecological assemblages of riverine fish and some African taxa and characteristic features (from Regier *et al.*, 1989).

| | White fish | Grey fish | Black fish |
|---|---|---|---|
| **Families** | Alestidae<br>Cyprinidae<br>Mormyridae (*Mormyrops*) | Cichlidae<br>Citharinidae<br>Cyprinidae (*Labeo*)<br>Distichodontidae<br>Mochokidae<br>Mormyridae (*Gnathonemus*)<br>Schilbeidae | Anabantidae<br>Channidae<br>Clariidae<br>Gymnarchidae<br>Mormyridae (*Pollimyrus*)<br>Notopteridae |
| **Respiratory organs** | gills | gills with some physiological adaptations to low oxygenation | gills and air-breathing organs with physiological adaptations to low oxygenation |
| **Respiratory tolerance** | highly oxygenated waters | medium to low oxygenation | low oxygenation - anoxic |
| **Muscle fibre type** | red | red / white | white |
| **Migratory behaviour** | long distance longitudinal | short distance longitudinal, often long lateral migrations | local movements |
| **Body form** | round, fusiform | laterally compressed, spiny, often heavily scaled | aterally compressed or soft; lelongated and flabby; scales reduced or absent |
| **Colour** | silvery or light | dark, frequently ornamented or coloured | very dark, often black |
| **Reproductive guild** | non-guarders; open substrate spawners; lithophils; pelagophils | guarders; nests spawners; open substrate spawners; phytophils | guarders; internal or external bearers; complex nests builders |
| **Dry season habitat** | main channel; lake | backwaters or main channel fringes | floodplain waterbodies |
| **Wet season habitat** | main channel or floodplains | floodplains | floodplains or marshy fringes |

- The first group, or "*white fish*", depends heavily on the main channel for reproduction, even though many species enter the floodplains to breed and feed. Long-distance migrations may occur towards areas found upstream to reproduce just before the start of the flood.

- The second group, or "*black fish*", lives in floodplains or their marshy fringes. Their movements are limited to lateral migrations, and species have adapted to resist difficult environmental conditions, particularly water oxygenation. These species generally have interval spawning spread over time, with a breeding season that begins prior to the flood and continues throughout it.

• The third group or "*grey fish*" lives in marshy zones and the floodplain's lake borders, as well as the main channel during the dry season. They carry out lateral migrations from the main channel to the floodplain during the flood to breed and find food. The species of this group have a more flexible behaviour pattern than the previous ones, and adapt rapidly to changes in hydrological conditions.

The flood areas of the Sudd in Sudan occupy some 30,000 km$^2$ and include a permanent complex of rivers, lakes, *Papyrus* and *Typha* swamps, as well as floodplains in periods when the water level rises. Four main types of habitats, corresponding to characteristic fish communities, have been identified by Bailey (1988). The spatial and temporal distribution of species depends on their ecological thresholds and their requirements in terms of food, shelter, breeding areas, etc:

• river courses where common species are Alestidae (*Hydrocynus forskalii*, *Alestes dentex*, *Brycinus nurse*, *B. macrolepidotus*), Bagridae (*Bagrus bajad*), Claroteidae (*Auchenoglanis biscutatus*), Mochokidae (*Synodontis schall*, *S. frontosus*), Schilbeidae (*Schilbe intermedius*), Nile perch (*Lates niloticus*), Cichlidae (*Oreochromis niloticus*);

• lakes and drainage channels that offer the greatest diversity to fishes (Hickley & Bailey, 1986). The most abundant species, in descending order, are: *Alestes dentex*, *Hydrocynus forskalii*, *Synodontis frontosus*, *S. schall*, *Schilbe mystus*, *Auchenoglanis biscutatus*, *Clarotes laticeps*, *Oreochromis niloticus*, *Labeo niloticus*, *Distichodus* spp., *Citharinus* spp., *Mormyrus cashive*, *Heterotis niloticus*, *Lates niloticus*;

• *Cyperus papyrus* and *Typha domingensis* swamps are rather inhospitable habitats owing to poor water oxygenation. Many fishes with aerial or accessory respiration are the most common inhabitants, that is, only 23 species of the 62 identified in the Sudd: *Protopterus aethiopicus*, *Polypterus senegalus*, *Heterotis niloticus*, *Gymnarchus niloticus*, *Brevimyrus niger*, *Clarias gariepinus*, *Ctenopoma petherici*, *C. muriei*, *Hemichromis fasciatus* and *Parachanna obscura*;

• in floodplains that are *Oryza longistaminata* prairies, 33 fish species have been collected: Cyprinodontiformes, *Ctenopoma muriei*, *Clarias gariepinus*, *Oreochromis niloticus*, *Nannaethiops unitaeniatus*, *Barbus stigmatopygus*, *Polypterus senegalus*, *Parachanna obscura*, small Mormyridae (*Brevimyrus niger*).

Fishes perform "lateral" migrations between the minor bed and the floodplain, then back in the opposite direction. Bénech *et al.* (1994) have studied the precise conduct of migrations between the Niger River and a floodplain in relation to seasonal hydrology. They distinguish three main types of migratory patterns:

• a group of species that follows water movements, with a preponderance of entries as the pool fills, and a preponderance of exits as the water level falls. This group includes juveniles of *Lates niloticus*, juveniles and adults of *Schilbe intermedius*, *Brycinus leuciscus*, as well as small-sized species: *Barbus* spp., *Petrocephalus bovei*, *Siluranodon auritus*, etc. For *B. leuciscus*, lateral migrations appear to be very complex, influenced by both hydrology and the lunar cycle;

• a group of species characterized by late entry and early exit, thus making a short stay in the floodplain. This group includes small-sized species (*Pellonula, Physailia, Micralestes, Chelaethiops*) as well as juveniles of *Alestes baremoze* and *Hydrocynus forskalii*;

• a group of species that is mainly present as the water level falls, and mostly leaving the floodplain, composed mainly of large-sized forms: *Hyperopisus bebe*, *Auchenoglanis occidentalis*, *Mormyrus rume*, *Clarias anguillaris*, *Citharinus citharus*, *Distichodus brevipinnis*, *Malapterurus electricus*, etc.

# Fish assemblages in the riffles

Fishes that live in the riffles are adapted to turbulent conditions (table 18.II). Three groups can be distinguished (Welcomme & Mérona, 1988):

• those clinging to the surface of the bottom or to vegetation. They are generally elongated and flat so that the current pushes them against the bottom. Some species have also developed special adaptations such as ventral fins or suckers for mouths. The Amphiliidae (*Amphilius* spp., *Phracura* spp., *Doumea* spp.), some Mochokidae such as *Chiloglanis* and *Synodontis* spp., Cyprinidae belonging to the genera *Labeo* and *Garra*, are in this category;

**TABLE 18.II**
Species composition of fish assemblage sampled with electric fishing gear, in middle course riffles of different coastal river systems from Côte d'Ivoire.

| | Léraba | Bandama | N'Zi | Sassandra |
|---|---|---|---|---|
| **Mormyridae** | | | | |
| *Petrocephalus bovei* | | ● | ● | |
| **Alestidae** | | | | |
| *Brycinus imberi* | ● | ● | ● | ● |
| *Brycinus nurse* | ● | ● | ● | ● |
| *Micralestes occidentalis* | ● | | | |
| **Distichodontidae** | | | | |
| *Nannocharax occidentalis* | ● | ● | | ● |
| **Cyprinidae** | | | | |
| *Barbus bynni waldroni* | | ● | ● | ● |
| *Barbus macinensis* | ● | | | |
| *Barbus macrops* | ● | | | ● |
| *Barbus sublineatus* | ● | | ● | ● |
| *Barbus wurtzi* | | ● | ● | ● |
| *Labeo parvus* | ● | ● | ● | ● |
| *Raiamas senegalensis* | ● | ● | ● | ● |
| **Amphiliidae** | | | | |
| *Amphilius atesuensis* | ● | ● | ● | ● |
| *Phractura intermedia* | ● | | | |
| **Mochokidae** | | | | |
| *Chiloglanis occidentalis* | | | | ● |
| *Synodontis bastiani* | ● | ● | ● | |
| *Synodontis comoensis* | ● | | | |
| **Cichlidae** | | | | |
| *Hemichromis* spp. | ● | ● | ● | |
| *Tilapia* spp. | ● | ● | ● | |
| **Mastacembelidae** | | | | |
| *Mastacembelus nigromarginatus* | ● | ● | ● | ● |

• those that find shelter in the openings and holes between rocks. These species are generally elongated and small, and this is the case for the different species of Mastacembelidae, some Clariidae (*Gymnallabes, Clariallabes*), the Polypteridae *calabaricus*, some Mormyridae belonging to the genera *Mormyrops*, *Brienomyrus* or *Brevimyrus* and Cichlidae such as *Leptotilapia irvinei* or *Gobiocichla* sp.;

• those that can swim well enough to resist the current up to certain resistance thresholds. They include for instance *Barbus altianalis*, various species of Bagridae (*Bagrus*), Claroteidae (*Chrysichthys*), Alestidae (*Alestes, Brycinus, Hydrocynus*) and Cichlidae.

# Biomass estimates

It is difficult to estimate biomass in watercourses, which explains why data are so scarce and often disparate. Sampling using ichthyotoxics were the most often carried out.

In West Africa, values range from 50 kg $ha^{-1}$ (Daget *et al.*, 1973) at low water periods in the Bandama River (Côte d'Ivoire) upstream of the current Kossou dam, before its closure, to 5,260 kg $ha^{-1}$ in the fluvial annexes of the Chari (Loubens, 1969). This latter value is probably exceptional given that the average for several measurements taken in the Chari is 1,430 kg $ha^{-1}$. Similar values have been observed in the Logone (1,210 kg $ha^{-1}$), but biomasses of around 100-500 kg $ha^{-1}$ are more common.

The average of biomass measurements in the Maraoué is 100 kg $ha^{-1}$ (Daget & Iltis, 1965), and that of the N'Zi is 102 kg $ha^{-1}$ (Lévêque *et al.*, 1983). These two rivers are tributaries of the Bandama, in which average values of 125 kg $ha^{-1}$ and 177 kg $ha^{-1}$ have been obtained during the flood upstream from the current Kossou dam. In periods of low water levels, and downstream from the dam, average values of 305 kg $ha^{-1}$ have been observed in river annexes (Daget *et al.*, 1973). These values are rather low compared with those obtained in the Kafue Flats which range from 339 in low water periods to 435 kg $ha^{-1}$ during the flood (Lagler *et al.*, 1971).

During dam constructions (such as for the Kainji, on the Niger), or mass poisonings of large water surfaces, it has been possible to carry out relatively exhaustive sampling that allowed estimates of the contribution of different species to biomass. Some results (tables 18.III and 18.IV) show that the most of this biomass is generally represented by a small number of species. This is particularly true for the Kafue where only four Cichlidae species represent 75% of the biomass. In the Chari, the most abundant species were *Oreochromis niloticus*, *Sarotherodon galilaeus, Lates niloticus*, *Heterotis niloticus*, *Synodontis nigrita* and *Polypterus endlicheri*.

**TABLE 18.III**
The relative abundance of fish species caught in the 18 ha coffer-dammed lake in the Niger River at Kainji, 1966. Some specimens of *Polypterus*, *Heterotis*, *Gymnarchus*, *Malapterurus*, *Lates*, *Oreochromis*, *Tilapia* and *Tetraodon*, were also collected (from Motwani & Kanwai, 1970).

| | Number of species | Number of individuals | % of individuals | Total weight (kg) | % weight |
|---|---|---|---|---|---|
| **Mormyridae** | **19** | **1198** | **20.7** | **219** | **19.5** |
| *Hyperopisus bebe* | 1 | 166 | | 49 | |
| *Mormyrus* | 3 | 180 | | 47 | |
| *Mormyrops* | 3 | 122 | | 55 | |
| *Campylomormyrus* | 1 | 366 | | 38 | |
| *Marcusenius* | 4 | 292 | | 27 | |
| *Hippopotamyrus* | 3 | 56 | | 3 | |
| others | 4 | | | | |
| **Alestidae** | **8** | **2103** | **36.3** | **136** | **12.1** |
| *Hydrocynus* | 2 | 28 | | 11 | |
| *Alestes* | 2 | 1447 | | 100 | |
| *Brycinus* | 4 | 628 | | 25 | |
| **Citharinidae** | **3** | **288** | **5** | **94** | **8.8** |
| **Distichodontidae** | **2** | **66** | **1.1** | **118** | **11** |
| **Cyprinidae** | **5+** | **192** | **3.3** | **48** | **4.3** |
| *Labeo* | 2 | 183 | | 47 | |
| *Barbus* | 2+ | 8 | | | |
| *Raiamas* | 1 | 1 | | | |
| **Bagridae** | **2** | **187** | **3.2** | **157** | **8.2** |
| *Bagrus* | 2 | 187 | | 157 | |
| **Claroteidae** | **5** | **235** | **4** | **47** | **10** |
| *Chrysichthys + Clarotes* | 5 | 235 | | 47 | |
| **Schilbeidae** | **3** | **463** | **8** | **40** | **3.6** |
| *Schilbe* | 3 | 448 | | 40 | |
| **Mochokidae** | **18** | **1064** | **18** | **209** | **18.7** |
| **Total catch** | **65** | **5796** | | **1068** | |

**TABLE 18.IV**
Relative abundance by weight of 19 species of commercial fish at high water (June-July) and at low water (August-September) in the Kafue Flats in 1970 (from Lagler *et al.*, 1971).

| **Species** | **High water biomass, % total** | **Low water biomass, % total** |
|---|---|---|
| *Oreochromis andersonii* | 26.6 | 31.7 |
| *Oreochromis macrochir* | 18.4 | 19.1 |
| *Coptodon zillii* | 17.4 | 5.0 |
| *Tilapia sparrmanii* | 13.0 | 2.1 |
| *Serranochromis angusticeps* | 3.0 | 2.3 |
| *Serranochromis macrocephalus* | 0.3 | 0.2 |
| *Serranochromis robustus* | 0.2 | 0.3 |
| *Serranochromis thumbergi* | 0.6 | 0.1 |
| *Sargochromis carlottae* | 3.2 | 0.8 |
| *Sargochromis codringtoni* | 0.2 | |
| *Sargochromis giardi* | 0.1 | 1.5 |
| *Hepsetus odoe* | 4.0 | 6.0 |
| *Marcusenius macrolepidotus* | 0.7 | 2.2 |
| *Schilbe intermedius* | 1.8 | 15.6 |
| *Clarias gariepinus* | 5.6 | 8.0 |
| *Clarias ngamensis* | 3.5 | 4.4 |
| *Synodontis macrostigma* | 0.4 | 0.4 |
| *Labeo molybdinus* | 0.6 | 0.3 |
| Total ichthyomass of commercial species | 84% | 84% |
| Total ichthyomass of non-commercial species | 16% | 16% |
| Mean ichthyomass | 435 kg $ha^{-1}$ | 339 kg $ha^{-1}$ |

Scientific editors
Didier Paugy   Christian Lévêque   Olga Otero

# The Inland Water Fishes of Africa

## *Diversity, Ecology and Human Use*

Africa TERVUREN
KONINKLIJK MUSEUM VOOR MIDDEN-AFRIKA
MUSÉE ROYAL DE L'AFRIQUE CENTRALE

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