Updating Names, Distribution and Ecology of Riverine Fish of Kenya in the Athi-Galana-Sabaki River Drainage System

Daniel O. Okeyo

Abstract

Few studies of the riverine fish of the Athi-Galana-Sabaki river drainage area of Kenya have been carried out since the last comprehensive surveys of the 1950s and early 1960s. This paper presents updated information on scientific and recommended common names, distribution and ecology of selected fish species of this catchment. At least 28 riverine fish families consisting of 46 genera and 62 species occur in the drainage system, of which 39 species are strictly freshwater (4 introduced) while 23 species are of marine origin. Five unique behavioral categories of the riverine fish of the drainage system are discussed. The four most speciated riverine fish in the system belong to the families Cyprinidae (14 species), Cichlidae (6 species), and Mormyridae and Gobiidae (4 species each). Thirty fish species occur in areas below the River Tsavo-Athi confluence, 18 fish species above the confluence, while 12 fish species occupy the entire drainage system. One cichlid species, *Oreochromis spilurus spilurus* (Günther, 1894), only occurs in the Tsavo river, while the occurrence in the entire system of one snoutfish species, *Mormyrops anguilloides* (Linnaeus, 1758) is uncertain. The use of information from this study is recommended when carrying out further studies of fish from the Athi-Galana-Sabaki river drainage.

Introduction

Few studies of the riverine fish species of eastern Africa have been carried out compared to the western, central and southern regions of the continent (Skelton 1994). Considering that the human population in Africa is expected to increase threefold or fourfold by 2030, it is essential that watersheds in the continent be studied for reasons of diversity and conservation. Such population increase may bring about ecosystem degradation, along with loss of organisms (Craig 1992).

This study of fishes of the Athi-Galana-Sabaki river drainage updates old but comprehensive surveys which were carried out in the 1950s (Trewavas 1953; Copley 1958) and 1960s (Whitehead 1960; 1962a, 1962b). This is one of the first attempts in more than three decades to fill the gap of scientific and recommended common names, distribution and ecology of fish of this important eastern flowing river drainage of Kenya. We hope that it will become a base leading to further studies of a similar nature.

Methods

The Athi-Galana-Sabaki river system is the second largest, eastward-flowing system of Kenya (Fig. 1). Rising near Nairobi, it drains the Kapiti Plains south of Nairobi, the southern slopes of the Aderdare Mountains, parts of Yatta Plateau and the eastern flanks of Mount Kilimanjaro. Its major tributaries are the Nairobi, the Kiboko and the Tsavo rivers. Below Lugard's Falls (near the Tsavo river confluence), the river is called Galana; its lower most course is the Sabaki. The Tsavo river, which is maintained by the Mazima Springs, is the only permanent flowing affluent of the lower drainage system.

This study is a result of intensive research and examination of literature and museum collections. It also involved field visits to collect fish, which were subjected to standard methods of systematics and laboratory analysis (Boulenger 1911a, b, 1916).

Using the database of the British Museum of Natural History, London, all taxonomic revisions of

riverine fish species of the Athi-Galana-Sabaki river drainage since the 1950s were incorporated. Eschmeyer (1990) was widely followed, with some modifications and exceptions. For example, Protopteridae and Characidae were considered as independent families, following Nelson (1994). In contrast to Nelson (1994), however, Myers (1929), Gery (1977) and Paugy (1986) were followed in accepting the genus *Brycinus* as distinct from the genus *Alestes*. Mo (1991) was followed in recognizing the family *Claroteidae* as separate from the family *Bagridae*. The genus *Pantanodon* is placed in the family *Aplocheilichthyidae* according to Seth (1960) and Meyer and Lydear (1993), separate from the recognized family *Poeciliidae* (Eschmeyer 1990). *Mastacembelidae* was recognized as a family under the order *Synbranchiformes*, not the order *Perciformes*, in accordance with Gosline (1983) and Travers (1984a, 1984b). All spelling of fish names follow the original descriptions. Names of the authorities who recorded original information on respective fish species are included.

Data were also collected on the general distribution of fish in the drainage system of the River Tsavo and Athi confluence in order to provide general patterns of local fish distribution. The distribution above and below the confluence is referred to as "upper reaches" and "lower reaches", respectively; otherwise the distribution covered "both upper and lower reaches" of the entire river drainage. The

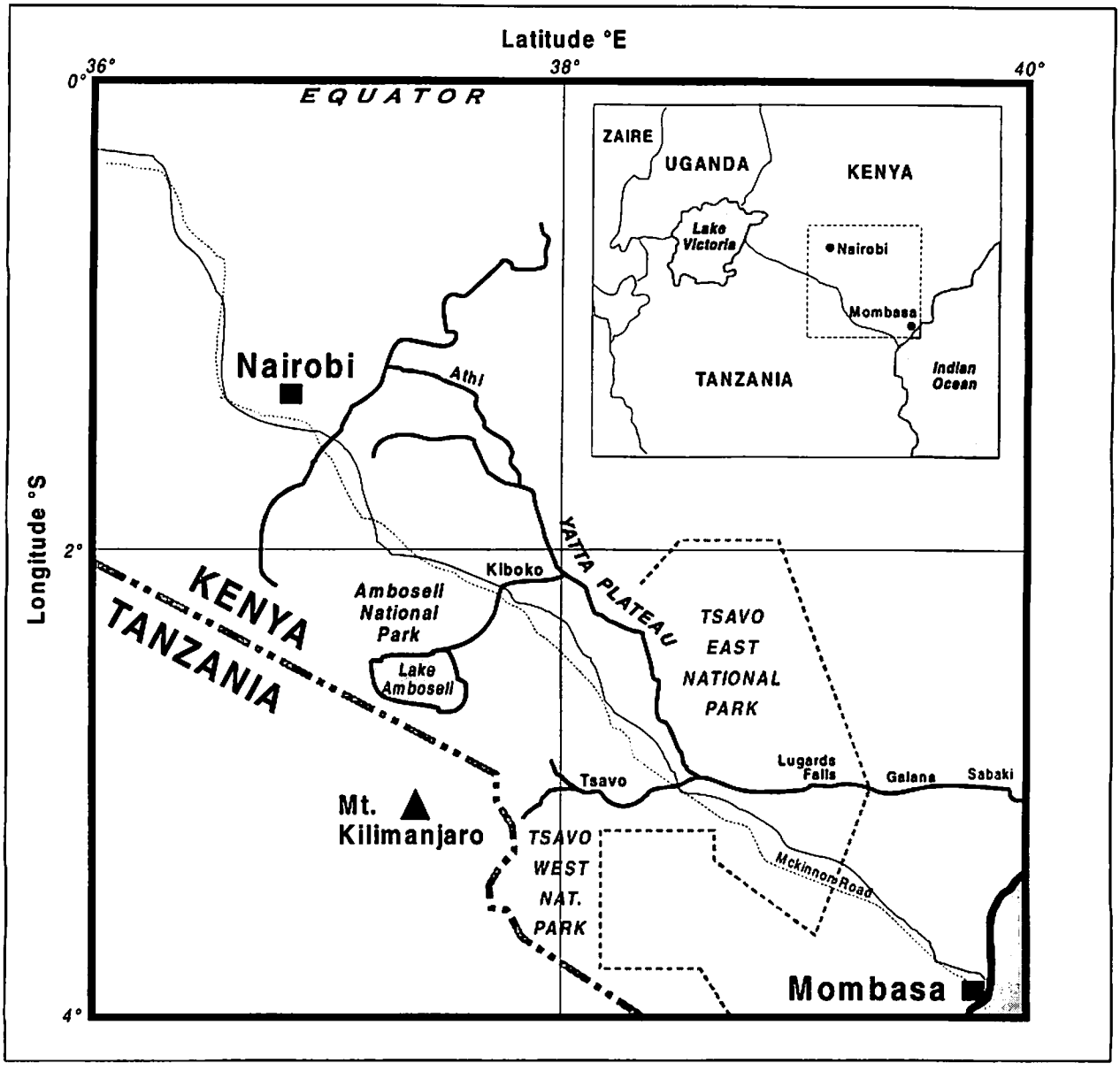

Fig. 1. Location of Athi-Galana-Sabaki river drainage system where the studies were undertaken.

distribution of the riverine fish, occurring in estuary, lagoon and marine littoral zones and which may enter into the river drainage was also recorded.

Comments from accumulated field and laboratory studies on the ecology (habitat, feeding, breeding) of some selected riverine fish were compiled to show examples of the complex diversity in the biology of these riverine fish species or groups.

Findings

At least 28 riverine fish families with 46 genera and 62 species are known to occur in the Athi-Galana-Sabaki river drainage (Table 1). Fourteen of the riverine fish families contribute at least 39 species which are entirely freshwater, two of which [(*Ctenopharyngodon idella* (Valenciennes 1844), *Cyprinus carpio carpio* (Linnaeus 1758)] were introduced for the purpose of culture and two of which [(*Oncorhynchus mykiss* (Walbaum 1792), *Salmo trutta trutta* (Linnaeus 1758)] were introduced for purposes of sports fishing (Kenya Gov. 1990a). Twelve of the riverine fish families consist of at least 18 species which move up into freshwater from marine, lagoon and estuarine areas. The most numerous fish species occurring in the drainage system belong to the family *Cyprinidae* (14 species), followed by the families *Cichlidae* (6), *Mormyridae* (4) and *Gobiidae* (4) (Table 1).

The general distribution (Table 2) shows a greater diversity of fish species in the lower reaches (30) than in the upper reaches (18) of the Athi-Galana-Sabaki river drainage system. Fewer fish species (12) have evolved to occupy the entire river drainage. Those fish species found throughout the Athi river system also tend to occur in the Nairobi, Kiboko and the Tsavo rivers, while several of those only occurring below the Tsavo/Athi confluence also occupy ephemeral affluents during the rainy seasons. One cichlid species, *Oreochromis spilurus spilurus* (Günther 1894), only occurs in the Tsavo drainage. The existence of the snoutfish, *Mormyrops anguilloides* (Linnaeus 1758), in the entire drainage (Copley 1958) is uncertain (Bigorne 1987). The updated scientific and recommended English common names of the riverine fish species are accompanied by names of the au-

Table 1. Number of genera and species in families of riverine fish known to occur in the Athi-Galana-Sabaki river drainage, Kenya.

Family	Genera	Species
Carcharhinidae*	1	1
Pristidae*	1	1
Protopteridae	1	1
Mormyridae	2	4
Megaloptidae	1	1
Anguillidae*	1	3
Clupeidae*	1	1
Cyprinidae	6	14
Characidae	1	1
Claroteidae	1	1
Amphiliidae	1	1
Clariidae	1	1
Ariidae*	1	2
Mochokidae	2	3
Salmonidae	2	2
Aplocheilichthyidae	1	1
Poeciliidae	1	2
Aplocheilidae	1	1
Syngnathidae*	2	2
Mastacembelidae	1	1
Ambassidae*	1	1
Kuhliidae*	1	1
Monodactylidae*	1	1
Scatophagidae*	1	1
Cichlidae	5	6
Mugilidae*	2	2
Eleotridae*	2	2
Gobiidae	4	4
TOTAL	46	62

* Fish families containing species which move up into the freshwater system from marine, lagoon and estuarine systems.

Table 2. List of scientific and recommended common names of fish species known to occur in the Athi-Galana-Sabaki river drainage, Kenya. Authority and date are separated by a comma according to the International Code of Zoological (1985) nomenclature. Fish species with uncertain occurrence are designated by a question mark (?). Fish species which move into freshwater system from marine, lagoon and estuarine systems are designated with an asterisk (*).

Class: Chondrichthyes
Order: Carcharhiniformes
Family: Carcharhinidae - Requiem Sharks

1. *Carcharhinus leucas* (Müller & Henle 1839) - bull shark*

Distribution: Lower reaches, Galana-Sabaki.

Order: Pristiformes
Family: Pristidae - Sawfishes

2. *Pristis microdon* (Latham 1794) - smalltooth sawfish*

Distribution: Lower reaches, Galana-Sabaki.

Class: Osteichthyes
Order: Lepidosireniformes
Family: Protopteridae - African lungfishes

3. *Protopterus annectens annectens* (Owens 1839) - lungfish

Distribution: Lower reaches, Galana-Sabaki; coastal drainage (Littrell 1971; Bemis 1983; Kenya Gov. 1990b).

Ecology: Associated strongly with life of aquatic plants in terms of breeding and feeding ecologies. Makes nests in weedy areas; feeds mostly on plant material (roots). The fish is an evolutionary organism; hibernating in mud awaiting predictable water cycles. Most fish die if the cycle is broken because of desiccation and undernourishment. The fish has developed a particular ability to produce fat for hibernation.

Order: Osteoglossiformes
Family: Mormyridae - snoutfishes

4. *? Mormyrops anguilloides* (Linnaeus 1758) - cornish Jack (roof-bottelneus)

Distribution: Identification of *Mormyrops* sp. in the drainage system is uncertain (Bigorne 1987).

5. *Mormyrus bernhardi* (Pellegrin 1926) - no recommended English common name

Distribution: Upper reaches, Nairobi city vicinity.

6. *? Mormyrus kannume* (Forsskål 1775) - elephant-snout fish

Distribution: Upper reaches, Athi (Corbert 1961; Kenya Gov. 1983). There may be an undescribed *Mormyrus* sp. in Kenya's Athi system which may be kannume or bernhardi (Boulenger 1898).

7. *Mormyrus tenuirostris* (Peters 1882) - no recommended English common name

Distribution: Upper reaches, Athi (Whitehead and Greenwood 1959; Kenya Gov. 1983).

Order: Elopiformes
Family: Megalopidae - Tarpons

8. *Megalops cyprinoides* (Broussonet 1782) - oxeye tarpon*

Distribution: Lower reaches, Galana-Sabaki (Fowler 1973; Bruton and Kok 1980).

Order Anguilliformes
Family: Anguillidae - Eels

9. *Anguilla bicolor bicolor* (McClelland 1844) - shortfin eel*

Distribution: Both upper and lower reaches (Copley 1958).

10. *Anguilla mossambica* (Peters 1852) - African longfin eel*

Distribution: Both upper and lower reaches (Copley 1958).

11. *Anguilla bengalensis labiata* (Peters 1852) - African mottled eel*

Distribution: Both upper and lower reaches, Athi (Copley 1958).

Ecology: Require rivers and oceans. Young fish migrate upstream with a continued feeding mode, especially on invertebrates (i.e., blackfly larvae) found on rocks and logs washed by fast moving waters. Adults need moving water to migrate back to the ocean, especially after heavy rains. Food for adults consists of crabs, frogs and insects. This is the only remaining system for *Anguilla* spp. for the conservation of Kenyan eels. Damming Tana River prevents eels from reaching original feeding grounds (eels only enter rivers where they were born to feed and grow before they travel into the ocean for spawning).

Order: Clupeiformes
Family: Clupeidae - Herrings

12. *Pellona ditchela* (Valenciennes 1847) - Indian pellona*

Distribution: Lower reaches.

Order Cypriniformes
Family: Cyprinidae - Barbs, Minnows and Labeos

13. *Barbus apleurogramma* (Boulenger 1911) - East African redfinned barb

Distribution: Both upper and lower reaches, Athi (Seegers 1996; in press).

14. *Barbus kerstenii kerstenii* (Peters 1868) - Kersten's barb

Distribution: Both upper and lower reaches, Athi (Hubbs 1918).

15. *Barbus mariae* (Holly 1929) - Rhino-fish

Distribution: Upper reaches, Athi (Copley 1958; Fowler 1936; Kenya Gov. 1990b).

16. *Barbus neumayeri* (Fischer 1884) - Neumayer's barb

Distribution: Upper reaches, Nairobi River, Kenya (not Nairobi in Mount Kilimanjaro), Makindu, Tsavo (Boulenger 1911; Greenwood 1962).

17. *Barbus oxyrhynchus* (Pfeffer 1889) - Pangani barb

Distribution: Upper reaches, Athi, (southeast of Nairobi), Nairobi river, Kenya (Hubbs 1918; Petr 1975).

18. *Barbus paludinosus* (Peters 1852) - straightfin barb

Distribution: Both upper and lower reaches, perhaps more common in the lower reaches, Lower Galana-Sabaki, Voi (Hubbs, 1918; Seegers 1987).

Ecology: Found in shallow, fast waters of rivers. Adults spawn during floods.

19. ? *Barbus toppini* (Boulenger 1916) - East-Coast barb

Distribution: Only one specimen, collected by S. Engelhardt, described from lower reaches, Galana-Sabaki (Boulenger 1916).

20. *Barbus zanzibaricus* (Peters 1968) - Zanzibar barb

Distribution: Lower reaches, Galana-Sabaki, coastal area (Greenwood 1962).

21. *Ctenopharyngodon idella* (Valenciennes 1844) - grass carp

Distribution: Upper reaches, Athi, introduced for culture.

22. *Cyprinus carpio carpio* (Linnaeus 1758) - common carp

Distribution: Upper reaches, Athi, introduced for culture.

23. *Garra dembeensis* (Ruppell 1836) - Dembea stone lapper

Distribution: Upper reaches, Athi (Seegers 1987).

24. *Labeo cylindricus* (Peters 1852) - redeye labeo

Distribution: Upper reaches, Athi, Athi river town and vicinity (Hubbs 1918).

25. *Labeo trigliceps* (Pellegrin 1926) - Nairobi labeo

Distribution: Upper reaches, Athi (Reid 1985)

Ecology: Only known from small streams in Nairobi Province, Kenya but has not been studied.

26. *Neobola fluviatilis* (Whitehead 1962) - Athi sardine

Distribution: Lower reaches, Galana-Sabaki (Whitehead 1962a).

Ecology: Main river and flooded pools. Mainly over sandy beaches. Important in dams. Shoaling fish. Little is known about feeding ecology, except that they are insectivores. Little is known about breeding habits; but juvenile distribution suggests that breeding perhaps occurs in shallow areas, especially flooded pools at river edges, some of which are seasonal.

Order: Characiformes
Family: Characidae - Characins

27. *Alestes affinis* (Günther 1894) - redfin robber

Distribution: Both upper and lower reaches, Athi, Ngong, Nairobi River (Kenya), Kiboko, Tsavo (Whitehead 1959).

Order: Siluriformes
Family: Claroteidae - Clarotid catfishes

28. *Clarotes laticeps* (Rüppell 1829) - widehead catfish

Distribution: Both upper and lower reaches, Athi, Tsavo (Fowler 1936; Copley 1958; Kenya Gov. 1970).

Family: Amphiliidae - Mountain Catfishes

29. *Amphilius uranoscopus* (Pfeffer 1889) - stargazer (mountain catfish)

Distribution: Upper reaches, Athi (Seegers 1987).

Family: Clariidae - Catfishes

30. *Clarias gariepinus* (Burchell 1822) - sharptooth catfish, common catfish

Distribution: Both upper and lower reaches, Athi, lower Sabaki flood plains (Whitfield 1980; Whitehead 1959; Teugels 1986).

Family: Ariidae - Sea Catfishes

31. *Arius africanus* (Günther 1867) - African sea catfish*

Distribution: Lower reaches (Jayaram 1984; Kenya Gov. 1991).

32. *Arius dussumieri* (Valenciennes 1840) - Shupanga sea catfish*

Distribution: Lower reaches (Bianchi 1985).

Family: Mochokidae - Squeakers and Suckermouths

33. *Chiloglanis brevibarbis* (Boulenger 1902) - short barbelled suckermouth

Distribution: Upper reaches, Athi (Whitehead 1958).

34. *Synodontis serpentis* (Whitehead 1962) - Tana squeaker

Distribution: Lower reaches, Galana-Sabaki (Whitehead 1962b; Mann 1966).

Ecology: Small streams, main rivers and flooded pools. Not well-studied yet. Feeding ecology not known. Breeding occurs shortly after floods due to rains (twice a year for Galana-Sabaki river), when ripe fish enter small streams from the main river and move to flooded pools in order to breed. The phenomenon occurs rather abruptly, when adult fish, in large schools, migrate upstream over a period of less than a week (three to four days maximum). One or two additional smaller migrations may occur after the main peak. There is sudden lack of catch by fishers after migration. The major stimulus to such migration needs to be studied. Perhaps the stimulus may be the same as those already reported for other fish which display similar breeding behavior (especially with rainfall).

35. *Synodontis zanzibaricus* (Peters 1868) - eastcoast squeaker

Distribution: Lower reaches, Galana-Sabaki.

Ecology: Inhabit deep parts of main river. Feed benthically on detritus, plant and animal (i.e., snails) matters. Adults spawn during floods.

Order: Salmoniformes
Family: Salmonidae - Trouts

36. *Oncorhynchus mykiss* (Walbaum 1792) - rainbow trout

Distribution: Upper reaches, Athi, introduced for angling (Kenya Gov. 1990b)

37. *Salmo trutta trutta* (Linnaeus 1758) - brown trout

Distribution: Upper reaches, Athi, introduced for angling.

Order: Cyprinodontiformes
Family: Aplocheilichthyidae - Topminnows or Lampeyes

38. *Aplocheilichthys stuhlmanni* (Ahl 1924) - eastcoast lampeye

Distribution: Lower reaches, coastal drainage (Seegers, in press).

Family: Poeciliidae - Livebearers

39. *Poecilia reticulata* (Peters 1859) - guppy, million fish

Distribution: Upper reaches, Kibwezi and Athi river near Athi river town, introduced in Kenya for aquatic invertebrate (i.e., mosquito) control (Whitehead 1959; Seegers 1987).

40. *Poecilia latipinna* (LeSueur 1821) - sailfin molly

Distribution: Lower reaches, Galana-Sabaki, introduced.

Family: Aplocheilidae - Nothobranchius

41. *Nothobranchius jubbi* (Wildekamp and Berkenkamp 1979) - blue nothobranch

Distribution: Lower reaches, seasonal pools, swamps and small streams (Wildekamp and Berkenkamp 1979).

Ecology: Temporary pools, swamps and ditches (rain pans), usually without connection to river courses. Adults die when waterbodies dry out with low rainfall. Aggressive predators on insects and other aquatic invertebrates. Popular aquarium species. Used for mosquito larva control. Males display to attract ripe females, pair off and spawn, grasping the female by folding over the large dorsal and anal fins. Spawning occurs daily for an extended period; few eggs are laid at a time. Eggs are laid in the bottom sediments and development is suspended when the waterbodies dry out. Eggs can endure desiccation. The eggs hatch the following rainy season when the pan fills, the fish growing to maturity in a few weeks. Males grow larger than females and are brightly colored. *N. jubbi* usually complete their life cycle within a year.

Order: Syngnathiformes
Family: Syngnathidae - Pipefishes

42. *Hippichthys (Hippichthys) cyanospilus* (Bleeker 1854) - blue spotted pipefish*

Distribution: Lower reaches, coastal streams, estuaries and lagoons.

43. *Microphis* (Belonichthys) *fluviatilis* (Peters 1852) - freshwater pipefish*

Distribution: Lower reaches, coastal streams, rivers, estuaries, lagoons and marine.

Ecology: Found in quiet water among vegetation, where they stand on their heads to conceal themselves amongst the fronds. Can also be found in the vicinity of logs at river edges. This species has not been fully studied; generally follow ecological descriptions of other *Microphis* spp. Probably feed on minute invertebrate organisms such as crustaceans and insects. Collectors may have overlooked the fish in the past or it may be slowly moving upstream by population dispersal of the young, perhaps aided by increase in salinities of rivers due to industrial and agricultural run-off. Male brood eggs and larvae in abdominal pouch. During mating the female passes eggs to the male. The eggs become fertilized as they pass into the pouch of the male. The lining of the pouch thickens and is charged with blood vessels. Folds of this lining grow between the eggs, so carrying oxygen to the developing embryos. A nutrient secretion is also produced. After about three weeks the pouch opens and the male gives birth to fully formed young, afterwards shedding the placenta-like lining. The young begin to feed soon and may take refuge in the male pouch if necessary.

Order: Synbranchiformes
Family: Mastacembelidae - Spinyeels

44. *Afromastacembelus frenatus* (Boulenger 1901) - longtail spinyeel

Distribution: Both upper and lower reaches, Athi (Copley 1958).

Order: Peciformes
Family: Ambassidae - Glassies

45. *Ambassis gymnocephalus* (Lacépède 1802) - bald glassy*

Distribution: Lower reaches.

Family: Kuhliidae - Flagtails

46. *Kuhlia rupestris* (Lacépède 1802) - rock flagtail*

Distribution: Lower reaches, coastal streams, estuaries, lagoons.

Family: Monodactylidae - Moonies

47. *Monodactylus argenteus* (Linnaeus 1758) - silver moony*

Distribution: Lower reaches, coastal streams, estuaries, lagoons.

Family: Scatophagidae - Scats

48. *Scatophagus tetracanthus* (Lacépède 1802) - African scat*

Distribution: Lower reaches, coastal streams, estuaries, lagoons.

Family: Cichlidae - Cichlids

49. *Astatoreochromis alluaudi* (Pellegrin 1904) - Alluaud's haplo

Distribution: Upper reaches, Athi (near Nairobi, Kenya) (De Rhan 1991a).

50. *Haplochromis pectoralis* (Pfeffer 1893) - Pangani haplo

Distribution: Mazima Springs, Tsavo drainage.

51. *Oreochromis spilurus spilurus* (Günther 1894) - Sabaki tilapia

Distribution: Lower reaches, Athi, Voi, flood plains, saline lakes.

52. *Oreochromis spilurus niger* (Günther 1894) - Athi River tilapia

Distribution: Upper reaches, Athi, Makindu, Tsavo (Boulenger 1916b; Hubbs 1918; Seegers 1987).

53. *Pseudocrenilabrus multicolor victoriae* (Seegers 1990) - dwarf Victoria mouthbrooder

Distribution: Both upper and lower reaches, introduced into Athi (Seegers 1987; De Rham 1991a, 1991b).

54. *Tilapia rendalli* (Boulenger 1897) - redbreast tilapia

Distribution: Both upper and lower reaches, introduced into Athi-Galana-Sabaki river drainage (De Rham 1991a).

Family: Mugilidae - Mullets

55. *Liza macrolepis* (Smith 1846) - large-scale mullet*

Distribution: Lower reaches.

56. *Mugil cephalus* (Linnaeus 1758) - flathead mullet*

Distribution: Lower reaches.

Family: Eleotridae - Sleepers*

57. *Butis butis* (Hamilton 1822) - pointed head gudgeon*

Distribution: Lower reaches.

58. *Eleotris fusca* (Schneider & Forster 1801) - dusky sleeper*

Distribution: Lower reaches, Galana-Sabaki (Whitehead 1959; Whitfield 1980; Blaber and Cyrus 1981).

Ecology: Epibenthic in fresh, brackish and inshore (littoral) waters. Common under logs and rootstocks in muddy reaches of estuaries and mangrove swamps and freshwater streams leading into coastal lagoons. Feeding ecology unclear yet. Breeding ecology needs study.

Family: Gobiidae - Gobies

59. *Acentrogobius simplex* (Sauvage 1880) - Bagamoyo goby*

Distribution: Lower reaches.

60. *Awaous aeneofuscus* (Peters 1852) - freshwater goby*

Distribution: Lower reaches, Athi-Galana-Sabaki (Copley 1958; Whitehead 1959).

61. *Glossogobius giuris* (Hamilton 1822) - tank goby*

Distribution: Lower reaches, Galan-Sabaki (Copley 1958).

Ecology: Epibenthic, littoral, intertidal entering rivers.

62. *Stenogobius kenyae* (Smith 1959) - East African rivergoby*

Distribution: Lower reaches, Galan-Sabaki (Smith 1959).

Ecology: Only common and found in Sabaki river. Unstudied; feeding and breeding ecologies unknown.

thorities who describe them (Table 2).

The scientific and recommended common names and the number of families (28), genera (46) and species (62) recorded are considered the most accurate and up to date for riverine fish of the Athi-Galana-Sabaki river drainage. We have used the term "at least" in the results because the exact number is uncertain (Trewavas 1953; Copley 1958; Whitehead 1960; Daget et al. 1984). The study has revealed that a number of riverine fish species are called by different names by different authors, suggesting that historical records may present an inflated number of species. For example, the sharptooth catfish, *Clarias gariepinus* (Burchell 1822), is usually listed in the literature under its synonym *Clarias mossambicus* (Peters 1852) (Teugels 1986). Yet Boulenger (1901), Worthington and Ricardo (1936) and Hopson and Hopson (1982) called it *Clarias lazera*. The lungfish, *Protopterus annectens annectens* (Owen 1839) has been called *Protopterus amphibius* (Peters 1844; Trewavas 1953), while Bemis (1983) was of the opinion that both fish species occurred in the system, which contradicts the findings in this study. Only the former, *Protopterus* sp., is recorded in the system by this study. This illustrates how two fish species may be counted as five or six different species.

Five unique patterns of behavior are observed among riverine fish found throughout the entire river drainage. The first is reflected in the eel family (*Anguillidae*). The three species of eel [the shortfin eel, *Anguilla bicolor bicolor* (McClelland 1844); the African longfin eel, *Anguilla mossambica* (Peters 1852); and the African mottled eel, *Anguilla bengalensis labiata* (Peters 1852)] all breed in the Indian Ocean and return to live and mature in the drainage system (Copley 1958). This indicates that eels are a robust species, able to withstand a wide variety of ecological conditions.

The second interesting behavioral pattern is observed among the barb, minnow and *Labeo* family (*Cyprinidae*); the characin family (*Characidae*); and the catfish family (*Clariidae*). Kersten's barb, *Barbus kerstenii kerstenii* (Peters 1868; Trewavas 1893; Hubbs 1918), redfin robber, *Alestes affinis* (Günther 1894; Whitehead 1959; Trewavas 1983) and sharptooth catfish, *Clarias gariepinus* (Burchell 1822; Whitehead 1959; Kenya Gov. 1989), all breed in April-June after migrating upstream following the onset of high river levels during the rainy season.

The third pattern is again demonstrated in the barb, minnow and *Labeo* family (*Cyprinidae*) as well as the cichlid family (*Cichlidae*). The Athi sardine, *Neobola fluviatilis* (Whitehead 1962, 1962a), and the Athi river tilapia, *Oreochromis spilurus niger* (Günther 1894; Whitehead 1960; Seegers 1987) breed in the flood pools and lakes of the Galana-Sabaki floodplain as well as in the main river channel.

The fourth observation was noted in the African lungfish family (*Protopteridae*) and the *Nothobranchius* family (*Aplocheilidae*). The lungfish, *Protopterus annectens annectens* (Owens 1839; Bemis 1983; Kenya Gov. 1983, 1990a) blue nothobranch, *Nothobranchius jubbi* (Wildekamp and Berkenkamp 1979; Seegers 1981), have adapted to living in ephemeral and shallow pools and swamps that dry up during the dry seasons. The lungfish hibernates in the dried-up mud, while the eggs of the nothobranch can withstand months of desiccation in the dried-up mud, awaiting the next rains.

Finally, among the tarpon (*Megalopidae*), sea catfish (*Ariidae*), pipefish (*Syngnathidae*), sleepers (*Eliotridae*) and the goby (*Gobiidae*) families, the oxeye tarpon, *Megalops cyprinoides* (Broussonet 1782), the African sea catfish, *Arius africanus* (Günther 1867), the freshwater pipefish, *Microphis (Belonichthys) fluviatilis* (Peters 1852), the dusk sleeper, *Eleotris fusca* (Schneider and Forster 1801; Whitehead 1959) and the tank goby, *Glossogobius giuris* (Hamilton, 1822; Whitehead 1959) could withstand the higher salinities of estuaries as well as the freshwater conditions upstream.

Further taxonomic investigations on the riverine fish species of the Athi-Galana-Sabaki river drainage are highly recommended, but there is a shortage of African scientists capable of carrying out riverine fish collection and curation. More scientists from these countries need to gain taxonomic as well as systemic expertise through training and research. African governments and international donors need to allocate specific financial resources and to negotiate training placements with institutions, such as the JLB Smith Institute of Ichthyology, Grahamstown (the Republic of South Africa), the Natural History Museum, London (United Kingdom), the Museum of Central African Fisheries, Tervuren (Belgium) and the American Museum of Natural History, New York (USA), to mention a few.

There is a great need to carry out taxonomic studies of riverine fish species of eastern Africa for the following reasons: to fill the literature gap; to fulfill an obligation to satisfy needs for biodiversity and conservation in respect to Agenda 21 of the Rio de Janeiro Convention; and to develop the theme associated with understanding the ecology of species introduction. Finally, the fish species should be entered into an East African (or Kenyan) diversity database to show the uniqueness of the fauna.

Acknowledgments

The idea of updating information on the riverine fish species of Kenya was highly encouraged during discussions with officials of the Ministry of Regional Development (MRD), Kenya (Mr. N. Odero, Mr. S. Oburu, Ms. J. Kinya), the JLB Smith Institute of Ichthyology, Grahamstown (Prof. P.H. Skelton), the Natural History Museum, London (Dr. H.P. Greenwood, Dr. R. McConnell, Dr. D.J. Siebert), the Museum of Central African Fisheries, Tervuren (Dir. D.F.E. Thys van den Audenaerde, Dr. G.G. Teugels, Dr. J. Snoeks) and the American Museum of Natural History, New York (Dr. M.L.J. Stiassny) and I owe them all special thanks. Dr. Lothar Seegers made comments on some results during the study. Part of the study was carried out at the Natural History Museum (NHM), London, and in the field in Kenya. I am grateful to the entire staff of the fish section and the library (NHM), to the personnel of the MRD (the Department of Fisheries, Kenya Marine and Fisheries Research Institute, Development Authorities) and to my academic colleagues and students, for their kind assistance during the study. Part of this study was sponsored by the Association of Commonwealth Universities, KE F034, through Kenyatta University, Nairobi, Kenya, and the British Council, KE/0003/29.

References

Bemis, W.E. 1983. Studies on the evolutionary morphology of

lepidosirenid lungfish (Pisces: Dipnoi). University of California, Berkeley. 331 p. Dissertation.

Bianchi, G. 1985. Field guide to the commercial marine and brackishwater-water species of Tanzania. FAO Species Identification Sheets for Fishery Purposes. FAO, Rome. 199 p.

Bigorne, R. 1987. Le genre *Mormyrops* (Pisces, Mormyridae) en Afrique de l'Ouest. Rev. Hydrobiol. Trop. 20(2): 145-164.

Blaber, S.J.M. and D.P. Cyrus. 1981. A revised checklist and further notes on the fishes of the Kasi System. The Lammergeye 31: 5-15.

Boulenger, G.A. 1898. A revision of the genera and species of fishes of the family Mormyridae. Proc. Zool. Soc. London 1898: 775-821.

Boulenger, G.A. 1901. On a small collection of fishes from Lake Victoria made by order of Sir H.H. Johnston K.B.C. Proc. Zool. Soc. London 1901: 158-162.

Boulenger, G.A. 1911a. Catalogue of the freshwater fishes of Africa in the British Museum (Natural History). Vol. II. British Museum (Natural History), London.

Boulenger, G.A. 1911b. Catalogue of the freshwater fishes of Africa in the British Museum (Natural History). Vol. IV. British Museum (Natural History), London.

Boulenger, G.A. 1916. On specimens of the perciform fish *Tilapia nilotica* with increased number of anal spines. Proc. Zool. Soc. London 1916: 345-347.

Bruton, M.N. and H.M. Kok. 1980. The freshwater fishes of Maputoland, p. 210-244. *In* M.N. Bruton and K.H. Cooper (eds.) Studies on the ecology of Maputoland. Rhodes University, Grahamstown Natal Branch of the Wildlife Society of Southern Africa, Durban, 560 p.

Copley, H. 1958. Common freshwater fishes of East Africa. H.F. & G. London, Witherby, 172 p.

Corbert, P.S. 1961. The food of the non-cichlid fishes in the Lake Victoria Basin, with remarks on their evolution and adaptation to lacustrine conditions. Proc. Zool. Soc. London 136(1): 1-101.

Craig, J.F. 1992. Human-induced changes in the composition of fish communities in African Great Lakes. Rev. in Fish Biol. and Fish. 2: 93-124.

Daget, J., J-P. Gosse and D.F.E. Thys van den Audenaerde (eds). 1984. Checklist of the freshwater fishes of Africa (CLOFFA). Vol. 1. ISNB, Brussels, MRAC, Tervuren, and ORSTOM, Paris. 520 p.

De Rham, P. 1991a. Safaris poissons au Kenya. 1ère Partie. Aquarama 25(120): 31-44.

De Rham, P. 1991b. Safaris poissons au Kenya. 1ère Partie. Aquarama 25(120): 21-30.

Eschmeyer, W.N. 1990. Catalogue of the genera of recent fishes. California Academy of Sciences, San Francisco. 697 p.

Fowler, H.W. 1936. Zoological results of the George Vanderbilt African expedition of 1934. III. The freshwater fishes. Proc. Acad. Nat. Sci. Philad. 88: 243-335.

Fowler, H.W. 1973a. A catalogue of world fishes (18). Q.J. Tiwam Mus. 26(1-2): 1-111.

Fowler, H.W. 1973b. A catalogue of world fishes (24 & 25). Q.J. Tiwam Mus. 29(1-24): 1-110, 277-396.

Gery, J. 1977. Characoids of the world. T.F.H. Publications, Neptune City, U.S.A. 672 p.

Gosline, W.A. 1983. The relationships of the mastacembelid and cynbranchid fishes. Japan J. Ichthyol. 29: 323-328.

Greenwood, P.H. 1962. A revision of certain *Barbus* species (Pisces, Cyprinidae) from East, Central and South Africa. Bull. Br. Mus. Nat. Hist. (Zool.) 8(4): 151-208.

Hopson, A.J. and J. Hopson. 1982. The fishes of Lake Turkana with a description of three new species: *Alestes ferox* sp. nov., *Alestes minutus* sp. nov. (Pisces, Characidae) and *Barbus turkanae* sp. nov. (Pisces, Cyprinidae). *In* A.J. Hopson (ed.) Lake Turkana. Vol. 1: 283-347. Overseas Development Administration, London.

Hubbs, C.L. 1918. Notes on fishes from the Athi river in British East Africa. Field Mus. Nat. Hist. Publ. 12 (2): 9-16.

International Code of Zoological Nomenclature. 1985. Third edition. British Museum (Natural History), London. 338 p.

Jayaram, C.K. 1984. FAO Species Identification Sheets for Fishing Purposes. Western Indian Ocean Fishing Area 51.1. Ariidae. 48 p.

Kenya Gov. (Ministry of Tourism and Wildlife). 1970. Kenya Fisheries Report of the Year 1967-1968. Republic of Kenya.

Kenya Gov. (Kenya Aquatic Bulletin - KAB). 1983. A Bulletin of Kenya Marine and Fisheries Research Institute. R.M. Nzioka (ed.) No. 1.

Kenya Gov. (Sagana Fish Culture Farm Annual Report - SFCR). 1989. Min. Reg. Dev., Fish. Dep. Report, Republic of Kenya. Njuki Investment Ltd., Sagana.

Kenya Gov. 1990a. Kenya District River Report. Kenya Fisheries Dep. DRL/2.

Kenya Gov. 1990b. Kindaruma Dam Commercial Fisheries Report. Kenya Fisheries Department. DRL/2/2.

Kenya Gov. 1991. Shimona Kwale Fisheries Report. Kenya Fisheries Dep. Vol. IV. Mar/15/A.

Litrell, L. 1971. African lungfishes. Trop. Fish Hobb. 19(8): 40-57.

Mann, M.J. 1966. A preliminary report on a survey of the fisheries of the Tana River, Kenya. EAFFRO., Annual Report (1965): 36-43.

Meyer, A. and C. Lydear. 1993. The evolution of copulatory organs, internal fertilization, placentas and viviparity in killifishes (Cyprinodontiformes) inferred from a DNA phylogen of the tyrosine kinase gene *X-src*. Proc. Roy.

Soc. Lond., Ser B 254: 153-162.

Mo, T. 1991. Anatomy, relationships and systematics of the Bagridae (Teleostei: Siluroidei) with a hypothesis of siluroid phylogen. Theses Zoologicae 17: 1-216.

Myers. G.S. 1929. Cranial differences in the African characin fishes of the genera *Alestes* and *Brycinus* with notes on the arrangement of related genera. Amer. Mus. Novit. 342: 1-7.

Nelson, J.S. 1994. Fishes of the world. Third edition. Wiley-Interscience, New York, 523 p.

Paugy, D. 1986. Revision systématique des *Alestes* et *Brycinus* Africains (Pisces, Characidae). ORSTOM, Paris, Etudes et Thèses, 295 p.

Petr, T. 1975. Limnology and fisheries of Nyumba ya Mungu, a man-made lake in Tanzania. Afr. J. Trop. Hydrobiol. Fish. 4(1): 39-50.

Reid, G. 1985. A revision of African species of *Labeo*. Theses Zoologicae. 6: 1-322.

Seegers, L. 1981. *Nothobranchius cyaneus* spec. nov., ein neuer Prachtgrundkärpfling aus Kenia. D.A.T.Z. 34(11): 365-368.

Seegers, L. 1987. Natürliche Biotope. Die Heimat unserer Aquarienfische. Der Athi-River bei Athi-River. Aquarium Heute 5(1): 35-37.

Seegers, L. 1996a. Zur Kenntnis von *Barbus apleurogramma* Boulenger, 1911 (Pisces: Cyprinidae), der ostafrikanischen Rotflossenbarbe. Die Aquarien- und Terrarienzeitschrift (DATZ). In press.

Seegers, L. 1996b. The fishes of the Rukwa Drainage. Ann. R. Mus. Afr. Centr. (Zool.), 394 p. (In press.)

Seth, R.P. 1960. Osteology and phylogeny of oviparous cyprinodont fishes (Order Cyprinodontiformes). Univ. Florida, Univ. Microfilms, Ann Arbor, 275 p.

Skelton, P.H. 1994. Diversity and distribution of freshwater fishes in East and Southern Africa. Ann Mus. R. Afr. Centr., Zool. 275: 95-131.

Smith, J.L.B. 1959. Gobioid fishes of the families Gobiidae, Periophthalmidae, Trypauchenidae, Taenioididae and Kraemiriidae of the western Indian Ocean. Ichthyol. Bull. Rhodes Univ. 13: 185-225.

Teugels, G.G. 1986. A systematic revision of the African species of the genus Clarias (Pisces: Clariidae). Ann. Mus. R. Afr. Centr., Sci. Zool. 247: 1-199.

Travers, R.A. 1984a. A review of the Mastacembeloidei, a suborder of synbranchiform teleost fishes. Part I: Anatomical descriptions. Bull. Br. Mus. Nat. Hist. (Zool.) 46(1): 1-133.

Travers, R.A. 1984b. A review of the Mastacembeloidei, a suborder of synbranchiform teleost fishes. Part II: Anatomical analysis. Bull. Br. Mus. nat. Hist. (Zool.) 47(2): 83-150.

Trewavas, E. 1953. The presence in Africa east of Rift Valley of two species of *Protopterus*, *P. annectens* and *P. amphibius*. Ann. Mus. R. Congo Belge (4) 1: 83-100.

Trewavas, E. 1983. Tilapiine fishes of the Genera *Sarotherodon*, *Oreochromis* and *Danakilia*. British Museum (Natural History), London, 583 p.

Whitehead, P.J.P. 1958. A new species of *Chiloglanis* (Pisces, Mochocidae) in Kenya. Ann. Mag. nat. Hist. 13(1): 197-208.

Whitehead, P.J.P. 1959. Notes on a collection of fishes from the Tana River below Garissa, Kenya. J.E. Afr. nat. Hist. Soc. 23: 167-171.

Whitehead, P.J.P. 1960. The river fishes of Kenya. Part II. The lower (Sabaki) river. East Afr. Agr. 25: 259-265.

Whitehead, P.J.P. 1962a. Two new river fishes from Eastern Kenya. Ann. Mus. Civ. Stor. Nat. Geneva, 73: 98-108.

Whitehead, P.J.P. 1962b. A new species of *Synodontis* (Pisces: Mochocidae) and notes on a mormyrid fish from the eastern rivers of Kenya. Rev. Zool. Bot. Afr. 65(1-2): 97-120.

Whitehead, P.J.P. and P.H. Greenwood. 1959. Mormyrid fishes of the genus *Petrocephalus* in eastern Africa, with a redescription of *Petrocephalus gliroides* (Vincig.) Rev. Zool. Bot. Afr. 60(3-4): 283-295.

Whitfield, A.K. 1980. A checklist of fish species of Maputoland estuarine systems. p. 204-209. *In* Cooper (ed.) Studies on the Ecology of Maputoland. Rhodes University, 560 p.

Wildekamp, R.H. and H.O. Berkenkamp. 1979. Untersuchungen zur Identität von *Nothobranchius neumanni* (Hilgendorf, 1905) aus Tansania, mit der Beschreibung einer neuen Art und einer Unterant aus dem Küstenfiefland Kenias. Deutsche Killifisch Gem. J. 11(5): 65-75.

Worthington, E.B. and C.K. Ricardo. 1936. Scientific results of the Cambridge expedition to the East African lakes, 1930-31. No. 15. The fish of Lake Rudolf and Lake Baringo. J. Linn. Soc. 39: 353-389.

D.O. Okeyo *is from the Department of Biology, University of Namibia, Private Bag 13301, Windhoek, Namibia. He was the former Coordinator of Aquatic Sciences at the Department of Zoology, Kenyatta University, Kenya.*