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THE FISHES AND FISHERIES OF THE RUAHA RIVER BASIN, TANZANIA.

(SYSTEMATICS, ECOLOGY, ZOOGEOGRAPHY, FISHERIES).

by

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INTRODUCTION

This report englobes all that is now known about the general conditions prevailing in the area prospected, the fish fauna and the state of the fisheries there. The survey carried out in September 1966 by Mr. R. Sturgeon, Regional Fisheries Officer, Mbeya, and myself proved very useful in providing new data on the fish fauna and information of the African subsistence fisheries in the area.

A fisheries assistant is to remain in the area for some time, collecting further data so that fluctuations in fish species, populations and in catches may be better ascertained.

More information is also to be obtained from the fishermen themselves and a census made of fishermen, canoes, gear, etc.

The aim of the September survey was to determine whether enough fish could be caught in the area between Magoya and Mtera to supply Iringa regularly with fresh fish at least once a week (in addition to smoked/dried fish).

Previous to this survey nothing was known about the system concerning ecological conditions, fish population (potentials) and the extent fisheries. Only 26 species had been recorded from the whole basin (including the Kilombero and Rufiji rivers).

GENERAL NOTES

Area included in this report:

Great Ruaha river plus tributaries (Kisigo, Little Ruaha) to its confluence with the Rufiji river. N.B. The areas actually visited during the survey included the Great Ruaha near Mbeya (Mbeya-Iringa) road, the Little Ruaha at Iringa and Kimande, the Great Ruaha from Makuka (near Kimande) to Mtera (Iringa-Dodoma road) and at Mbuyuni (Iringa-Morogoro road), including the Lukosi, a large tributary.

Physiography:

The Ruaha-Rufiji drainage basin is one of the largest in East Africa, covering 68,500 square miles, of which about half is drained by the Great Ruaha and its tributaries, i.e. an area comparable to the Rukwa basin. The Ruaha drains from extensive plains to the N.W. (Kisigo and Njombe rivers) and S.W. except in its upper Western and S. Western regions (in the highlands) above 5,000 feet a.s.l. The elevation of these plains ranges from 2,500 to about 5,000 feet. Southwards, its tributaries, of which the Little Ruaha is the most important, drain from a mountainous area, 3,000 to 6,000 feet in elevation. To the East (from Mtera to Kidodi) the Great Ruaha runs through a long gorge before emerging into the coastal lowlands (elevation less than 1,000 feet) and joining with the Rufiji.

Climate:

On the plains, the climate is dry with low rainfall, 10-30 inches per year with an average of ± 20 ". In the highlands to the N. SW, S. and E the rainfall varies between 30 to 70"/year, the average being about 45". There is one major rainy season each year from December to March in the plains often interrupted by a short dry spell in January-February. The dry season lasts at least 6 months and may be as long as 9-10 months (only

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75 to less than 50 days of rain per year). In the highlands (W, S. & S.E.) the rainy season lasts from November to April and it often rains a little in October and May as well. The dry season lasts 4 to 6 months and there are 75 to 125 days of rain/year.

Temperatures:

Mean annual maximum: 80-85°F in the N. Western and Central regions of the basin. 75-80°F. in the highlands (S.W. S. & S.E.) Mean annual minimum 60-65°F. in the plains. 50-60°F. in the highlands.

Hydrology:

In the highlands and mountains bordering the Ruaha river basin to the W, S, and E. the streams start off as small rocky torrents, most of these drying up seasonally, or from small swamps (on the high plateaux). A number of these tributaries, however, are large enough to be perennial, especially those originating in marshy grasslands ~~or~~ in forested slopes. This water is usually acid (low pH), clear of even + tea-coloured according to the amount of humic acids [(from rotting vegetation)] they contain.

Once in the central Ruaha plain, the tributaries rapidly silt up (murram and alluvial soils) and become muddy and greyish-brown in colour (even during low-water season).

The Northern tributaries originate in fairly flat, and dry (semi-desert) country and all run dry over considerable periods, except for the Kisigo and Njombe. In the plains, the main river and its large tributaries meander between usually steep banks (from a few feet to over 15 feet high), often dyke-like, built up by flood action (restingas) with lower flood-plain areas behind them. The river-bottom is sandy to muddy with occasional small rapids (e.g. near Mtera) and sandbanks are a prominent feature at low water. The water is silty, greyish-brown and slightly alkaline. In the gorge region from Mtera to Kidoni the river is fast-flowing with generally rocky/gravelly bottom, some sand-banks and numerous rapids.

The only permanent swamp of any considerable size is the Bohoro (Buhoro) swamp (Isangu) N.E. of Mbeya at 4,000-5,000 feet a.s.l., at the base of the escarpment (Pers. comm., Mr. F.M. Savidge, Ruaha National Park).

Successive floods come down the mountain streams during the rainy season, gradually swelling the main river which is in full flood somewhat later, i.e. from February to May, after which the water level progressively decreases until December.

Flora:

- 1) Terrestrial vegetation: On the plains, ranges from desert to semi-desert conditions in the N. through bushland and thickets to intermediate woodlands or wooded grasslands. The dominant forms being the deciduous bushlands and armed thickets type, often interspersed with baobab trees. (*miombo*)

In the highlands, the vegetation types are extremely varied, from grassland through woodland to dense forest, and the influence of man is evident in the large tracts of cultivated land.

- 2) Riparian vegetation: (closely associated with the river) along the river-banks a gallery-forest often occurs, consisting of large trees and/or thickets (e.g. *Ficus*). Elsewhere, various tall grasses (e.g. *Pennisetum*) and reeds (*Phragmites*) are abundant.

In swampy or low-lying areas species like *Scirpus*, *Typha*, *Cyperus*, etc., commonly occur, as well as various grasses (*Oryza*, *Vossia*, etc.)

- 3) Aquatic vegetation: In the rapids, various filamentous algae and Characeae grow on the rocks, the latter especially abundant where the water flow is strong. Algae also commonly grow on the base and in the interstices of the tufts of *Phragmites* and sedges (*Scirpus*) growing between the rocks and in the quieter stretches.

In the slow-flowing parts various algae (filamentous) develop, as well as higher water-plants like *Ceratophyllum*, *Polygonum*, and *Potamogeton*, etc

In ponds, pools, swampy areas and + stagnant river bends, algae (filamentous as well as free-floating) and higher water-plants are abundant, particularly filamentous algae like Cladophora, in the smaller pools.

Most of the river-bed itself however, is bare of vegetation, and much of the marginal plants must get torn up or washed away during the floods.

Vegetation

Fauna:

I. Invertebrates: Quite a lot of material has been collected incidentally, but not yet identified. The substrate in the Ruaha, whether rock, sand or silt, appears fairly rich in organic material and in vegetable cover (algae) especially the mud, so that for instance Protozoa, Nematodes, Oligochaetes, Entomostraca and small insect life should be relatively abundant.

The main bed of the upper reaches of the river and the larger (perennial) tributaries however, with clear running water, sandy to rocky bottom, appear very poor. Of the larger invertebrates, many species of which were collected, most come from pools, channels, woody banks and quiet (deep) stretches of the river, where they are most abundant, especially in the pools.

The material collected consisted of the most common, abundant and readily caught, mainly invertebrates, e.g:

Mollusca: ^{species} Etheria elliptica ^{larger} (fresh-water oyster) very abundant on rocks, submerged logs, etc., in the rapids.
Aspatharia cf. kirki in quiet (deep) waters, on muddy bottom.
Coelatura cf. aegyptiaca, same as above.
Lanistes sp., same as above.
Lymnaea sp., in pools and weeds, especially along upper courses of small tributaries.
Biomphalaria sp., in marginal weedy pools, especially along upper courses of small tributaries.

Annelida: Oligochaetes (Tubificidae)
Leeches (Hirudinae)

Crustacea: Crabs (Potamon (Potamonautes) sp.) in rapids, under stones and elsewhere under submerged wood.
Shrimps (Caridina nilotica) numerous in submerged vegetation.

Insecta: Mosquitoes, midges, caddis-flies, etc., numerous along river course, especially where pools and quiet stretches are nearby.

Coleoptera: Gyrinidae, very common on surface of quiet waters (pools).
Dytiscidae, large (cf. Cybister) and medium sized spp. are common in pools.
Hydrophiliidae, also common in pools and calm stretches.

Hemiptera: Bdellostomidae and Pentatomidae, common in pools and under obstructions, e.g. submerged branches and tufts of reeds, along with water scorpions.
Notonectidae, very common in pools and quiet waters.
← (Ephemeroptera and Odonata, appear to be rather rare in the areas visited except at Mbuyuni, where marginal reeds are everywhere present, providing plenty of submerged vegetation which the young stages of these insects need.

← (Though not collected, representatives of the Trichoptera and various Dipteran families (e.g. Chironomids, Ceratopogonids, Tipulids and Culicids) were commonly observed.

II. Aquatic Vertebrates other than fish

Amphibia: Xenopus is very common in small pools.
Other toads (e.g. Bufo) and frogs also commonly present.

Reptiles: Pelomedusa sp. common.
Pelusios sinuatus common.
Varanus niloticus common.
Crocodylus niloticus very few and small (shot out).

Birds: Reed Cormorants very few. (more at Kimande).
Darters very few.
Grey Heron.
Purple Heron.
Night Heron.
Hammerhead.
Egyptian goose.
Fish Eagle.
Black Crake.
Charadriidae (plovers), e.g. Charadrius sp., very common.
Sandpipers (wood sandpiper?).
Pied Kingfisher.
Malachite Kingfisher.
(Pied Crow).

Mammals: Otters none seen, but well known and fairly common judging from tracks, droppings and fish skeletons.
Hippopotamus amphibius common in the Mtera area where deep, quiet water is available.

III THE FISHES

CHECK LIST OF THE FISHES OF THE RUAHA RIVER BASIN.

(including Rufiji fishes)

x = Species caught
+ = Species previously recorded from the system.
o = Species recognizably described by local fishermen.

Family Protopteridae

o Protopterus cf. amphibius (PTRS, 1844)

Family Kneriidae

x Kneria spekei GTHR., 1868.

Family Mormyridae

x Mormyrus longirostris PTRS., 1852.

x Gnathonemus livingstoni BLGR., 1898.

+ G. macrolepidotus (PTRS., 1852) (= G. graeverti STDR., 1915 : syn)

x Marcusenius discorhynchus (PTRS., 1852)

+ x Petrocephalus catostoma GTHR., 1866 (= P. affinis STDR., 1915 : syn).

Family Characidae

+ Alestes adolfi STDR., 1915 (probably = A. stuhlmanni PFEFF., 1896).

x A. cf. affinis GTHR., 1894

+ x Hydrocyon vittatus (CAST., 1861).

Family Citharinidae

o + Citharinus congicus BLGR., 1897.

+ x Distichodus petersi PFEFF., 1896 (= D. albini STDR., 1915 : syn)

+ x D. cf. rufigiensis NORM., 1922.

Family Cyprinidae

+ Barbus hindii BLGR., 1902.

x B. cf. macrolepis PFEFF., 1889. (or B. altus PFEFF., 1896)

x B. paludinosus PTRS., 1882.

- + B. zanzibarius PTRS., 1868: (= B. kiperegensis STDR., 1915 : syn.)
- x + B. kersteni PTRS., 1868.
- + B. neumayeri FISCH., 1884.
- x B. luikae RIC., 1938.
- x B. apleurogramma BLGR., 1911.
- x B. lineomaculatus BLGR., 1903.
- x B.n. sp. (aff. B. brevidorsalis BLGR., 1916)
- x Barbus aff. usambarae LONNB., 1907 & B. innocens. PFEFF., 1896.
- + x Barilius cf. loveridgei NORM., 1922. STDR., 1894
- x Labeo n. sp. (aff. L. lineatus BLGR., 1898 and L. rosae.)
- + x L. ulangensis STDR., 1915.
- x L. cylindricus PTRS., 1852 (L. loveridgei; REGAN, 1920, possibly synonymous).
- x Labeo n. sp. (aff. L. macrostoma BLGR., 1899).
- x Engraulicypris sp. n. (aff. E. conigicus NICH., & GRISC., 1917)

Family Bagridae

- + x Bagrus orientalis BLGR., 1902 (= B. occipitalis in STDR., 1915)
- o Chrysichthys or Clarotes sp.
- x Leptoglanis rotundiceps (HILG., 1905)

Family Mochocidae

- x Synodontis zambesensis PTRS., 1852.
- + x S. maculipinna NORM., 1922 (possibly synonym of S. zambesensis)
- x Synodontis n. sp. (aff. S. soloni Blgr., 1899)
- x Atopochilus cf. A. vogti PELL., 1922, but closer to A. dybowski (VAILL., 1892) from Congo
- x Chiloglanis deckeni PTRS., 1868
- x Chiloglanis n. sp.
- x Chiloglanis sp. n.

Family Amphiliidae

- x Amphilius "platychir" (GTHR., 1864)

Family Schilbeidae

- x Schilbe mystus (L., 1762)
- + Eutropius möbiusi PFEFF., 1896
- + Eutropius longifilis STDR., 1915
- Pareutropius micristius REGAN., 1920 } probably identical.

Family Clariidae

- + x Clarias mossambicus PTRS., 1852 (C. gariepinus in STDR., 1915)
- x C. aff. mellandi BLGR., 1905

Family Anguillidae

- o Anguilla sp. (probably A. nebulosa labiata)

Family Cyprinodontidae

- x Aplocheilichthys sp. (aff. A. johnstoni)
- + Nothobranchius neumanni (HILG., 1905)

Family Mastacembelidae

- + Mastacembelus frenatus BLGR., 1901 (M. taeniatus in STDR., 1915)

Family Cichlidae

- + Tilapia mossambica Ptrs., 1852. (fishes recorded as such are probably T. urolepis)
- * + x [T. adolfi STDR., 1915.] T. urolepis NORM., 1922, ~~sp. nov.~~
- + T. nilotica L., 1757. (doubtful sp./records.)
- + x Haplochromis bloyeti SAUV., 1883. (= Paratilapia volmeringi & P. kilossana STDR., 1915, = syn.)

Zoographical notes:

26 spp. previously recorded from system. 38 spp. caught during 1966 survey, (of which 25 are new records). 4 spp. described by fishermen, 3 of which would be new records for area. Total number spp. now positively known from Ruaha - Rufiji basin = 51. Of these, 16 are endemics (or restricted to the E.A. coastal rivers), 10 are East African in distribution, 9 are Zambezan species, 5 are more or less ubiquitous

* Now T. hornorum Trewavas (nom. nov.), 1966 [Wami river system]

species with a very wide distribution, 1 or 2 have nilotic origins and 8 are very clearly related to Congo basin species.

Possible species not yet recorded from the area:

- Mormyrops deliciosus
- Alestes imberi
- Petersius conserialis } doubtfully distinct.
- P. tangensis (*Rhabdolestes*)
- Nannocharax sp.
- Barbus amphigramma
- B. (Beirabarbus) radiatus
- B. eutaenia
- B. innocens.
- B. jacksoni
- B. laticeps.
- B. oxyrhynchus
- B. quadripunctatus
- Labeo kilossae (doubtful species)
- Arius africanus (in lower river)
- Clarius carsoni
- Malapterurus electricus
- Aplocheilichthys maculatus
- A. stuhlmanni
- Nothobranchius guentheri
- N. orthonotus
- Pantanodon podoxys)
- Electris fusca) in lower river.
- Haplochromis strigigena

VERNACULAR NAMES FOR THE LARGE RUAHA FISH SPECIES.

<u>LATIN NAME</u>	<u>LOCAL NAME</u>	<u>SWAHILI NAME</u>	<u>ENGLISH NAME.</u>
<u>Protopterus</u>		Kambale-mamba	Lung-fish
<u>Mormyridae</u>	Sulusulu		-
<u>(Mormyrus longirostris)</u>			(Elephant-snout fish, Bottle-nose)
<u>Hydrocyon</u>	Mchena		Tiger-fish
<u>Alestes</u>	Dagaa		-
<u>Citharinus</u>			Moon-fish
<u>Distichodus spp.</u>	Mpapala		-
<u>Barbus spp. (large)</u>	Mbalami		Barbel or barbus
<u>Labeo spp.</u>	Ntua		Mud-sucker.
<u>Labeo cylindricus</u>	Ningu		Mud-sucker.
<u>Bagrus</u>	Katoga		-
<u>Synodontis spp.</u>	Gogogo		Squeaker.
<u>Atopochilus</u>	Gogogo		-
<u>Schilbe</u>			Butterfish of Silver Barbel
<u>Clarias (large)</u>		Kambale	Cat-fish or Barbel.
<u>Anguilla sp.</u>	Mkungu		Eel.
<u>Tilapia spp.</u>		Ngege (Njege)	Tilapia or Bream
<u>Mastacembelus</u>			Spiny Eel

KEY TO THE RUAHA - RUFUJI (FRESHWATER) FISHES.

- 1 * Paired fins rayed 2
- * Paired fins long, whiplike filamentous. Fam: Protopteridae. Genus: Protopterus (1) Protopterus sp. (probably P. amphibius) - 90 cm.
- 2 * Body not eel-like; scales present or absent 3
- * Body eel-like; scales very small (or partly absent); ventral fins absent; no barbels around mouth. 47
- 3 * Body scaled; barbels usually absent 4
- * Body naked; usually well-developed barbels present. 33
- 4 * Mouth toothless 5
- * Teeth present (in mouth) 6

- 5 * Gill-opening very small; scales tiny, more than 60 in lateral line. Fam: Kneriidae Genus: Kneria (2) Kneria spekei - 8 cm
* Gill-opening large; less than 50 scales in lateral line. Fam: Cyprinidae 19
- 6 * Dorsal fin short; ventral fins well separated from pectoral fins 7
* Dorsal fin long; ventral fins inserted just below and behind pectoral fins; a single nostril on each side of snout. Fam: Cichlidae 49
- 7 * A small adipose fin present 13
* Adipose fin absent 8
- 8 * Eye relatively small; skin on head soft and thick; scales very small; (mouth inferior to terminal); Caudal peduncle long and thin Fam: Mormyridae (9)
* Eye large; head scaly; scales large; mouth superior and protractile, (caudal peduncle normal) Fam: Cyprinodontidae 48
- 9 * Dorsal and anal fins not of greatly differing length 10
* Dorsal fin at least twice as long as anal fin Genus: Mormyrus (3) M. longirostris - 60 cm.
- 10 * Teeth 3-10 in each jaw; mouth inferior to terminal; mental appendage present or absent 11
* Teeth 10-25 in each jaw; mouth inferior (below eye); no mental appendage; nostrils very close to each other and to eye. Genus: Petrocephalus (4) P. catostoma - 15 cm.
- 11 * Mouth inferior to sub-inferior; no or very little swelling on chin Genus: Marcusenius (5) M. discorhynchus - 25 cm.
* Mouth sub-inferior to terminal; a distinct swelling on chin Genus: Gnathonemus 12
- 12 * Teeth conical; 14-16 scales around caudal peduncle (6) G. macrolepidotus - 25 cm.
* Teeth notched; 12-14 scales around caudal peduncle (7) G. livingstoni 25 cm.
- 13 * Teeth large and strong; scales large, cycloid; body normal Fam: Characidae 14
* Teeth small and fine; scales small, cycloid or ctenoid; body strongly compressed Fam: Citharinidae 17
- 14 * Jaws with 2 rows of serrated teeth; mouth relatively small; Genus: Alestes 15
* Jaws with 1 row of large, sharp, simple teeth; mouth large; (lateral line scales 42-48) Genus: Hydrocyon (8) H. vittatus - 70cm.
- 15 * Lateral line scales 22-30 16
* Lateral line scales 36-37 (9) Alestes adolfi - 45 cm.
- 16 * Anal fin with 17-20 rays (usually 18-19); 5½ scale rows between lateral line and origin of dorsal fin: (10) Alestes cf. affinis 30 cm.
* Anal fin with 16-19 rays (usually 17-18); 4½ scale rows between lateral line and origin of dorsal fin; a large black blotch on caudal peduncle (11) A. imberi 25 cm.
- 17 * Scales ctenoid; mouth narrow, small; (body compressed) Genus: Distichodus 18
* Scales cycloid; mouth wide; body very high and compressed Genus: Citharinus (12) C. congicus 60 cm.
- 18 * Mouth moderate, sub-terminal; Sc. 70-75 in lateral line (13) Distichodus petersi - 45 cm.
* Mouth small, inferior; Sc. 56-60 in lateral line (14) Distichodus cf. rufigiensis - 40 cm.

- 19 * Anal fin with 7 or less branched rays; suborbital bones narrow, not covering cheek 20
* Anal fin with more than 7 branched rays; suborbitals wide, covering cheek; mouth large, terminal 32
- 20 * Lips normal; jaws without a horny ridge; mouth terminal to inferior; dorsal fin with 7-10 branched rays Genus: Barbus 21
* Lips fleshy; jaws with a horny ridge; mouth inferior; dorsal fin with 9-13 branched rays Genus: Labeo 29
- 21 * Scales with radiating striae; dorsal fin with 7-8 branched rays; (small spp.) 22
* Scales with numerous parallel striae; dorsal fin with 9-10 branched rays; (large spp.) (15) Barbus sp. (probably B. hindii) 40 cm.
- 22 * Dorsal fin with a serrated spine 23 *Macrolepis*
* Dorsal fin rays all flexible, spineless 27
- 23 * 2 pairs of barbels present; lateral line complete 24
* 1 pair of short barbels only or barbels absent, lateral line absent or incomplete 26
- 24 * Scales 32-38 (usually 35-36); pores on lateral line scales not outlined in black; barbels shorter than or equal to eye diameter, (16) Barbus paludinosus 13 cm.
* Scales 23-33; at least posterior barbel longer than eye 25
- 25 * No spots on flanks; scales 23-27 along lateral line; origin of dorsal behind origin of ventrals; anterior barbel smaller than or equal to eye; 10-12 scales around caudal peduncle; a thin dark stripe laterally, ending in a caudal spot (17) Barbus kersteni 9 cm.
* 3 spots or an interrupted dark mid-lateral band; anterior barbel longer than eye; lateral line scales 24-32 (usually 28); origin of dorsal above origin of ventrals; 10-16 (usually 12) scales around caudal peduncle (18) B. neumayeri 13 cm.
* Lateral line scales 28-33; a dark lateral band from operculum to caudal base; origin dorsal above middle of ventral base; anterior barbel much smaller than eye; 14-16 scales around caudal peduncle (19) B. zanzibaricus 10 cm.
- 26 * 1 pair of short barbels present; lateral line complete or interrupted (incomplete in juveniles); scales 26-29 in longitudinal line; a dark lateral streak from snout to middle of caudal fin. (20) B. luikae 6 cm.
* Barbels absent or 1 short pair present; lateral line absent to incomplete (first few scales only); longitudinal line scales 20-25 edged in black; black spots at base of dorsal, caudal and anal fins, which are also blackened (21) B. apleurogramma 6 cm.
- 27 * Two pairs of barbels; lateral line complete 28
* 1 pair of short barbels; lateral line pores absent or on first 1-4 scales only; a black stripe from below dorsal to caudal base; caudal spot present and a faint spot at anal base; longitudinal line scales 26-27 (22) Barbus sp. n. 5 cm.
- 28 * Body slender, 3.8-4.2 times as long as high; a series of more or less distinct spots laterally; lateral line scales 28-32 (23) B. lineomaculatus 10 cm.
* Body shorter, 3.5-3.8 times as long as high; an indistinct lateral band (sometimes broken up into elongate spots) and distinct caudal spot; lateral line scale series 27-29 (24) Barbus sp. (cf. B. usambarae) 5 cm.
- 29 * Inside of lips bearing numerous transverse aplicae 30
* Inside of lips smooth; mouth small, inferior (24) Labeo sp. n. 45 cm.
- 30 * Eye supero-lateral; snout fleshy, grooved, tuberculate 31
* Eye perfectly lateral, snout not grooved; dorsal fin very high, rays much longer than head (26) Labeo ulangensis 40 cm.

- 31 * 1 pair of barbels (small); body cylindrical, elongate; length/height = 3.9-4.9; mouth wide; caudal peduncle longer than deep (27) L. cylindricus 25 cm.
* No barbels; body compressed; length/height = 3.3-3.6; mouth very wide and lips fleshy; caudal peduncle deeper than long (28) Labeo n. sp. (aff. L. macrostoma) 45 cm.
- 32 * Origin of dorsal anterior to anal fin origin; transverse bands on flanks present (in adult) Genus: Barilius (29) B. cf. loveridgei 15 cm.
* Origin of dorsal above or posterior to anal origin; no bands on body Genus: Engraulicypris (30) Engraulicypris sp. (aff. E. congicus) 5 cm.
- 33 * Dorsal and anal fins long; only pectoral fins spiny Fam: Claridae Genus: Clarias 34
* Dorsal fin short 35
- 34 * Pelvic fins midway between end of snout and base of caudal. Vomerine toothband narrow, not wider than maxillary tooth-band (31) Clarias mossambicus 100 cm.
* Vomerine tooth-band wide, at least twice as wide as maxillary band (32) Clarias sp. (cf. mellandi) 90 cm.
- 35 * Anal fin short, 8-15 rays 38
* Anal fin long, more than 40 rays Fam: Schilbeidae 36
- 36 * Adipose fin present 37
* Adipose fin absent Genus: Schilbe (33) S. mystus 35 cm.
- 37 * Dorsal I (5)-6; 9-10 branchiostegal rays Genus: Eutropius (34) E. mobiusi 35 cm.
* Dorsal I 3-5; 8-9 branchiostegal rays Genus: Pareutropius (35) P. micristius 10 cm.
- 38 * Dorsal and pectoral fins spiny 39
* No bony spines in fins Fam: Amphiliidae Genus: Amphilius (36) A. platyichir 20 cm.
- 39 * Mandibular barbels branched or mouth disk - or sucker-like and barbels very short Fam: Mochochidae 42
* Mandibular barbels simple Fam: Bagridae 40
- 40 * Dorsal fin with 6-8 rays 41
* Dorsal fin with 10 or more rays Genus: Bagrus (37) B. orientalis 80 cm.
- 41 * No teeth on palate; no nasal barbels; large spots/blotches on body Genus: Leptoglanis (38) L. rotundiceps 6 cm.
- 42 * Mandibular barbels branched Genus: Synodontis 43
* Mouth sucker-like, barbels short 44
- 43 * Maxillary barbel not fringed, snout up to 1.3 times longer than post-ocular region of head; lips normal, not very fleshy or papillose (39) Synodontis zambesensis 35 cm.
* Maxillary barbel fringed with a narrow membrane along its basal half; snout 1.3-1.6 times post-ocular head region; lips fleshy, very papillose, expanded (40) Synodontis sp. (aff. S. soloni) 40 cm.
- 44 * Eye with free border; mandibular teeth forming a long line across edge of lower jaw Genus: Atopochilus (41) Atopochilus sp. (cf. A. vogti?) 35 cm.
* Eye small, covered by skin; mandibular teeth 5-20 in a short line or bunched (small spp.) Genus: Chiloglanis 45
- 45 * Mandibular teeth 8-18, in a line across edge of lower jaw 46
* Mandibular teeth 5-9 (+ up to 9 replacement teeth) in a bunch in middle of lower jaw; Anal. IV 6-7; skin on head not or slightly granulose; lower lip not very expanded; mandibular barbel relatively long and thin (42) Chiloglanis sp. (probably C. deckeni) 6 cm.

- 46 * Mandibular teeth 8 (+ up to 8 replacement teeth); A.III-IV 7-8; skin on head strongly rugose (granulose); development of lower lip moderate (43) Chiloglanis sp. 6 cm.
- * Mandibular teeth 16-18 (+ up to 16 replacement teeth); A.III 5-6; skin on head granulose; dorsal and pectoral spines short; lower lip strongly expanded, mouth nearly circular (44) Chiloglanis n. sp. 6 cm.
- 47 * A row of erectile spines along back Fam: Mastacembelidae Genus: Mastacembelus (45) M. frenatus 50 cm.
- * No spines along back Fam: Anguillidae Genus: Anguilla (46) Anguilla sp. (probably A. nebulosa labiata) 150 cm.
- 48 * Pectoral fins inserted in the lower half of the flanks; preorbital very narrow, less than 1/2 eye diameter; dorsal origin above or anterior to anal origin Genus: Hothobranchius (47) H. neumanni 5 cm.
- * Pectoral fin inserted in middle of flanks; preorbital at least 1/2 eye width; dorsal origin posterior to anal origin Genus: Aplocheilichthys (48) Aplocheilichthys sp. (probably A. johnstoni) 3 cm.
- 49 * Teeth bicuspid in outer row, tricuspid in inner rows; pharyngeal teeth fine and numerous; scales cycloid; gill-rakers 8-25; body length/height less than 2-8; young with large dark "Tilapia" spot at base of soft dorsal fin (adult size large) Genus: Tilapia 50
- * Teeth bicuspid in outer row, becoming conical towards sides of jaw; pharyngeal teeth large and less closely packed; scales partly ctenoid; gill-rakers 7-12; body length/height more than 2.8; no spot on dorsal fin, but egg-spots on anal fin present in males (adult size small) Genus: Haplochromis (49) H. bloyeti 12 cm.
- 50 * Gill-rakers short, 15-20 on lower outer gill-arch; mouth moderate in females large in adult males; usually 3 dark spots on sides; fins faintly spotted; Dental surface on pharyngeal bone triangular, wider than high (50) Tilapia mossambica 35 cm.
- * Gill-rakers long and slender 20-26; mouth small 51
- 51 * Soft parts of dorsal and caudal fin with narrow vertical dark bars: dental surface of pharyngeal triangular, as wide as high (51) T. nilotica 35 cm.
- * Fins darkened; hinder part of caudal faintly barred vertically; 2-3 blotches/spots on flanks; gill-rakers 24-25; caudal fin scaly; (52) T. ~~tricoloris~~ 35 cm.

BASIC ECOLOGY OF THE RUAHA-RUFIJI FRESHWATER FISHES

NB: To a large extent the following notes are extrapolated/inferred from what is known about the same or closely related species in other areas, as survey was too short to verify most of these data.

FAM: PROTOPTERIDAE

Protopterus cf. amphibius

Habitat: Swamps and flood-plains, especially in aquatic/submerged vegetation in main riverbed during low water or estivating in mud in dried-up channels/swampy ground.

Food: A lurking predator, mainly on Amphibia, fish, molluscs and other large invertebrates (crabs, large aquatic insects). Also probably eats weeds/aquatic plants on occasion.

Breeding: During floods male makes nest (tunnel) in muddy bank or among weeds (reeds) where female comes to spawn, after which male takes care of brood till the juveniles leave nest and disperse among the aquatic vegetation of their habitat. Eggs large, several thousand, very similar to Amphibian ova.

Behaviour: Solitary fish, only accepting presence of another during mating/spawning after which female is chased away. Very aggressive, always fighting each other if they meet. Don't move around very much; probably some seasonal migratory movement in and out of flood-plains/swamps. Estivation (in mucus cocoon) buried in mud may last up to 9 months, possibly even longer.

Breathing during this is purely airia (lungs).

NB: a species of probably limited distribution occurring sporadically in the lower Rufiji and in relatively swampy areas of the Ruaha system (e.g. near Kimande and Makuka).

FAM: KNERIIDAE

Kneria spekei

Habitat: Small tributaries and upper reaches of rivers, where water is clear and fast-flowing. However, during prolonged low-water (dry) season when tributaries dry up, found in main river-bed in rapids, where water, though muddy, is usually well oxygenated (also found trapped in residual pools in dried-up river beds).

Food: Algae (diatoms) and various micro-organisms, sucked/scraped off stones/plants.

Breeding: Probably towards end of flood season in shallow streams (in fast-flowing, rocky parts).

Behaviour: Secretive fish, hiding individually under stones, logs, weeds in shallow, running waters. Males possess an adhesive disc on sides of head probably so they can adhere to females during mating in fast-flowing water. Young fish often found in quieter water of pools in small, loose shoals swimming in mid-water and feeding on planctonic (free-floating) algae.

FAM: MORMYRIDAE

Mormyrus longirostris

Habitat: Large rivers (deeper stretches). May move into flood-plains to spawn (?). Mud-bottom preferred.

Food: Mainly insect larvae (chironomids and such-like) found on muddy/sandy bottom. Also worms, shrimps, small crabs, molluscs and sometimes weeds/filamentous algae.

Breeding: Breeding-grounds probably in upper reaches of rivers, affluents and flood plains, as deduced from upstream and lateral movements of mature fish during flood-season and from presence of juveniles in such areas (often over rocky bottom and in rapids). Eggs yellow, fairly large, numbering a few thousand.

Behaviour: Commonly occurs in small, loose groups, near the bottom. Upstream (spawning?) migrations occur during high water but are not very marked.

Gnathonemus spp. and Marcusenius discorhynchus

Habitat: Prefers less deep waters than Mormyrus and tend to stay closer to river banks, in quiet water. Move into flood-plains during high water.

Food: Insect larvae (mainly Chironomids, Odonata, Ephemeroptera) collected from banks and weeds.

Breeding: Takes place during flood-season in swamps, flood plains and river stretches with quiet water and abundant vegetation. Eggs number several hundred to a thousand or so.

Behaviour: Similar to that of Mormyrus, but near the banks and moves more readily into seasonally flooded (shallow-water) areas.

Petrocephalus catostoma

Habitat: Near the banks of large streams, especially where the water is deep and quiet and plenty of vegetation is present. Also in pools in small rapids. moves into flood-plains and swamps.

Food: Small insect larvae (Chironomids, Ephemerids), worms, ostracods and algae (filamentous).

Breeding: Peak maturity as with previous spp. occurs during high-water season and migratory movements into swampy areas indicate that spawning takes place there at this time. Eggs are small, numbering several hundred.

Behaviour: Occurs in fairly large shoals along river banks, migrates upstream and laterally into flood-plains/channels during high water.

FAM: CHARACIDAE

Alestes spp.

Habitat: Surface and mid-water areas of large rivers. Flood-plains, etc. during high-water season.

Food: Omnivorous; algae, leaves, flowers, fruit, insects fallen into water from the land, etc. Also some insect larvae (Ephemerids, mosquitos, dragon-flies) and occasionally small fish.

Breeding: During the floods in the swamps/flood-plains among weeds. Eggs fairly large, several hundred to a few thousand.

Behaviour: Generally in small shoals; juveniles closer to banks and also in rapids in pools. A definite upstream and lateral migration in relation to sexual maturity and spawning takes place soon after first floods come down.

Hydrocyon vittatus

Habitat: Large rivers, open water; juveniles in smaller streams and in surface waters close to banks.

Food: Large predator feeding mainly on other fish (Alestes, small Mormyrids, Barbus, etc.). Juveniles also eat large insects (Odonata nymphs, Ephemerids) and very young eat zooplankton.

Breeding: A very clearcut upriver spawning migration takes place after first floods and spawning takes place among weeds in shallow water. Probably several runs take place during flood season. Eggs are very small, yellow and number over 100,000 in large fish.

Behaviour: This voracious predator moves about, usually in small groups, in open-water areas, darting into shoals of small fish to pick out its prey. During the floods one or more upstream and lateral migrations take place for spawning purposes.

FAM: CITHARINIDAE

Distichodus spp.

Habitat: Quiet, deep stretches of main river, near bottom, especially where aquatic vegetation (reeds) is abundant. Moves into inundated areas during floods.

Food: Mainly higher plants, filamentous algae, insect larvae and molluscs in D. petersi, which has a larger mouth than D. cf. rufigiensis which feeds mainly on algae, leaves of higher plants (reeds) and small insect larvae.

Breeding: Takes place during the floods in inundated (swampy) areas where eggs are spawned among weeds and the young spend their lives till the waters recede. Clearcut upriver migrations take place in relation to spawning.

Eggs are small, several thousand in number.

Behaviour: Shoaling fishes, especially at migration periods - e.g. during spawning runs.

Citharinus congicus

Habitat: Similar to Distichodus.

Food: Swallows great quantities of bottom mud/ooze, out of which bacteria, algae (diatoms), worms, micro-organisms (protozoa) and small insect larvae are digested in the extremely long gut. Also observed feeding on surface scum (algae) in the manner of many Tilapia spp.

Breeding: Upstream and lateral migrations take place during the flood season and spawning probably occurs in shallow, weedy waters. Eggs are small and numerous (10,000 or more).

Behaviour: Shoaling species, feeding on muddy bottom or from the surface layer and with clearcut seasonal spawning migration. NB: This species is probably restricted to the Rufiji and Kilombero rivers *in the system*

FAM: CYPRINIDAE

Barbus hindii & B. cf. macrolepis

Habitat: Ubiquitous in the larger streams; the adults however, prefer the deeper, riverine stretches; juveniles abundant in shallows, pools and inundated areas.

Food: Omnivorous, but adult diet consists mainly of bottom invertebrates (insect larvae, worms).

Breeding: During high water; like most Characins and Citharinids the large Cyprinidae show clearcut upstream spawning migrations during the summer floods. Spawning takes place in the upper reaches of streams, generally over gravelly bottom in shallow, fast-running water.

Behaviour: Definite shoaling only occurs at spawning time during runs upriver after floods for breeding purposes.

Small Barbus spp.

Habitat: Ranges from swamps through small brooks to large rivers, but mainly found in + sheltered shallow areas like small rapids, grassy banks, reed-beds, pools, etc. Generally, flowing water is preferred, however.

Food: Usually omnivorous, mainly filamentous algae and small invertebrates (insect larvae, small adult insects and crustacea, worms, etc.).
Breeding: Some small species migrate up-stream to spawn but most just move (laterally) into sheltered areas (flood-plains, swamps) during high water. Eggs are fairly large, a few hundred in number usually and are laid among submerged vegetation (sticking to leaves, etc.).
Behaviour: Usually seen feeding in small groups/shoals off the bottom in shallow waters. Some species are anadromous, running upriver to spawn (e.g. B. lineomaculatus)

Barilius cf. loveridgei

Habitat: Open and surface waters of large streams, prefers rapidly flowing rivers.
Food: Terrestrial insects, fallen into water, free-swimming insect larvae, small fish, etc. Zooplankton in young.
Breeding: Spawning takes place over gravelly bottom in upper parts of streams, with shallow, well-oxygenated water. Eggs are fairly large, several hundred in numbers.
Behaviour: Except when shoaling during spawning runs up-river during flood-season these fish, when adult, occur individually. Strong, fast swimmers, they often jump after low-flying insects and their behaviour to a large extent resembles that of trout.

Engraulicypris aff. congius

Habitat: Open and surface waters, especially in calm river stretches.
Food: Zooplankton, some phytoplankton, small insect larvae, especially free-swimming types (e.g. mosquitos).
Breeding: Eggs small, a few hundred in number, probably shed in mid-water in calm river arms. No breeding migration known.
Behaviour: Generally occur in small shoals, juveniles close to the banks.

Labeo spp.

Habitat: Ubiquitous in large streams, both in rapids and in quiet reaches, except L. cylindricus which is frequently found in small streams and is + restricted to rapids and rocky bottoms. During high water move into inundated areas.
Food: Herbivorous, consists mainly of algae (diatoms, filamentous) scraped off the substrate, or sucked up with considerable quantities of bottom ooze. Also, various micro-organisms, small invertebrates (insect larvae) probably accidentally ingested. The structure of the mouth is very specialised towards this mode of feeding and the gut is exceedingly long (compare with Citharinus)
Breeding: Spawning runs, upstream as well as laterally into swamps and flood-plains occur in close connection with successive flood peaks during rainy season. Eggs are very small and very numerous usually numbering over 100,000. Spawning usually takes place in pools, channels and quiet stretches of the main river bed where aquatic vegetation is abundant. Development is rapid and larvae hatch after a day or so, moving into weedy areas and small pools for protection.
Behaviour: Bottom-living fishes; L. cylindricus is well adapted to life in rapids and tends to be nocturnal; shoaling common in juveniles and in migrating adults.

FAM: BAGRIDAE

Bagrus orientalis

Habitat: Deeper waters of large rivers.
Food: Predatory, the adults eat mainly fish (Cichlids, small Barbus, Clarias etc.), crabs, occasionally large insects. Juvenile diet mainly insect larvae and other small invertebrates.
Breeding: Spawning takes place in quiet shallow waters, usually on a sandy substrate where a nest is made, the eggs being taken care of by the male. Eggs are fairly large, a few thousand in number.
Behaviour: Solitary fish, forming couples during breeding season (high water period). No migratory movement recorded; maybe some lateral dispersion into flood-plain during rainy season. A lurking predator, this species can be quite fast in catching its prey.

Leptoglanis rotundiceps

Habitat: Small streams, in flowing water, under cover (rocks, plants) during daytime.

Food: Mainly small aquatic insects and larvae, worms and small crustacea taken from bottom.

Breeding: Unknown.

Behaviour: Secretive, nocturnal species, hiding by day, never moving much except possibly some seasonal up and down-stream movements in relation to water level (drying up) of stream.

FAM: MOCHOKIDAE

Synodontis spp.

Habitat: Benthic, nocturnal catfish, especially common on rocky bottoms or where obstructions (e.g. tree-trunks) occur. Also seek cover under reeds, e.g. along undercut banks.

Food: Omnivorous, the quite long, coiled intestine and large stomach containing sand, mud, vegetable matter, often filamentous algae and Characeae as well as small molluscs, insect larvae, shrimps, etc.

Breeding: Very little known, but some (Lake Tanganyika) species stick their eggs on the underside of rocks (in crannies). Correlation of sparse data shows that main breeding season probably occurs early during the high-water period, e.g. probably towards January in Ruaha river. Eggs yellow-brownish, fairly large (at least 1 mm ϕ), several thousand in numbers. Male gonad extremely branched.

Behaviour: Non-shoaling, essentially nocturnal and benthic. Often swim upside down, e.g. under rocks, submerged tree-trunks, reed-beds, etc., mainly in search of food. Produce very loud stridulating sounds (croaking, grunting or squeaking noises) by rasping the ribbed base of their pectoral spines over a bony projection in the pectoral girdle socket. This is magnified by the adjacent air-bladder which acts as resonance chamber. Externally a rapid back and forth movement of the pectoral fins can be noticed. The very sensitive branched barbels are held downwards and forwards and sense any movement made by bottom-living organisms (e.g. insect larvae) on which they feed.

Atopochilus cf. vogti

Habitat: Similar to that of Synodontis, but generally prefers rapids, or fast-flowing river stretches.

Food: Mainly herbivorous, e.g. filamentous algae, Characeae, etc., scraped from the substrate. Also insect larvae and other small organisms (e.g. Ostracods) probably ingested simultaneously. Intestine very long and coiled.

Breeding: Unknown, but probably as in Synodontis.

Behaviour: Nocturnal, benthic, solitary, can cling to substrate (rocks) with its sucker-like mouth (e.g. in rapids). Sound-production as in Synodontis.

Chiloglanis spp.

Habitat: these small species are typical inhabitants of rapids and fast-flowing streams where they cling to submerged rocks and vegetation with their sucker-like mouth. Only found free-swimming if dislodged.

Food: Algae, freshwater sponges, small insect larvae, mainly Chironomids Ceratopogonids, Ephemeroptera, Simuliidae, and benthic Entomostraca (Ostracods).

Breeding: Eggs yellowish, a few hundred or less in number, relatively large (at least 1 mm ϕ). Spawning (from various maturity data) seems to take place during low-water period, probably because the biotope is usually pretty well upset during flood-season.

FAM: SCHILBEIDAE

Schilbe mystus & Eutropius mobiusi

Habitat: Large rivers; juveniles in small streams (quiet stretches and pools); prefer deep, calm waters, near bottom and steep banks; hide under rocks or among weeds.

Food: Mainly carnivorous, feeding on insects (aquatic larvae, etc. as well as terrestrial insects fallen into the water) and on small fish, particularly benthic species, e.g. Haplochromis, Tilapia fry, Barbus. Vegetable matter of various kinds is also eaten occasionally (e.g. Fruits).

Breeding: Spawning takes place during the flood-season, probably in quiet backwaters and flooded areas. Eggs yellow, fairly small, numbering a few thousand.

Behaviour: Often occurs in small shoals. Breeding migration up-river and outwards onto the flood-plains during highwater season.

Pareutropius micristius

Nothing known of ecology of this rare small species.

FAM: AMPHILIIDAE

Amphilius "platychir"

Habitat: Mountain torrents, small rivers and stretches of shallow rapids in larger rivers. Also in matted vegetation trailing in flowing water.

Food: Insect (Larvae and adults), shrimps, Ostracods, and other similar small invertebrates.

Breeding: Very little known. A high percentage of the population has ripe gonads at the start of the flood period and spawning presumably takes place in shallow water (gravel bottom?) in small streams during high water. Eggs large, yellow, a few hundred in number.

Behaviour: Benthic, solitary, nocturnal catfish hiding by day under rocks, weed-mats, etc.

FAM: CLARIIDAE

Clarias mossambicus

Habitat: Quiet stretches and muddy bottoms of large rivers; swamps and flood-plains during high-water. Young in smaller streams, especially adjacent pools.

Food: omnivorous; a typical facultative feeder, being able to eat anything from phyto-plancton (algae) through plants, invertebrates (e.g. shrimps, crabs, insects, molluscs, etc.), fish (main diet in adults), reptiles (e.g. small snakes, lizards), young birds, eggs to all kinds of detritus (e.g. mud faeces, corpses).

Breeding: A short spawning run up small (temporary) streams and into flood-plains if present, takes place 1 or 2 times during the flood season and the fairly large (+ 2 mm ϕ), yellow eggs are attached to weeds, wood etc. on the bottom. About 36 hours after fertilization the larvae hatch out and remain 1 or 2 months in their spawning area before moving into deeper (larger) waters. Eggs (gonad) number up to + 10,000 in larger specimens.

Behaviour: Usually lie quietly in shady, secluded, calm water and pools or under rocks, reed-mats, etc., during the day-time and roam about at night. May be seen searching for food (e.g. feeding on phyto-plancton) at the surface on occasion, or coming up for air in de-oxygenated waters. Normally single, they group together in favourable habitats and when migrating, though a proper shoal as such has never been observed. Adults usually are lurking predators on small fish. Grunting or snorting noises are produced, particularly when fish is taken out of water, by expelling air from air-bladder.

FAM: CYPRINODONTIDAE

Aplocheilichthys aff. johnstoni

Habitat: shallow pools adjacent to river courses, small brooks, quiet (swampy) backwaters and seasonally inundated areas, particularly where aquatic plants or other (submerged) vegetation is abundant.

Food: Mainly small insects (Chironomid and Ceratopogonid pupae, mosquito pupae and larvae and small adult insects fallen into the water, e.g. ants). Also zooplankton (e.g. Copepods, Cladocera). Feeding usually takes place near the surface.

Breeding: During the flood season, principally. Eggs relatively very large, yellowish, translucent, few in number not more than a dozen or so being spawned at a time and stuck onto submerged vegetation. Young remain in shelter of weeds, in shallow water.

Behaviour: Usually occurs in small shoals among weeds at or near the surface in calm waters, the individual fish darting about in search of food. Scatter in all directions upon attack.

FAM: MASTACEMBELIDAE

Mastacembelus frenatus

Habitat: Occurs in matted weeds, in crannies and under rocks, submerged tree-trunks, etc. mainly in perennial, fairly large streams but sometimes in ponds and swamps as well.

Food: Insect larvae (chironomids, Ephemeroptera, etc.) shrimps, Oligochetes and occasionally vegetable matter (e.g. filamentous algae, leaves and stalks of aquatic plants).

Breeding: During flood-season. Eggs yellow, large (± 2 mm ϕ), 800-1,500 in number, are probably spawned in among water weeds. After 2-3 months the young are 30-50 mm long and commonly occur in shallow water (e.g. adjacent pools) under stones, grass, dead leaves, etc.

Behaviour: Essentially sedentary fish, \pm nocturnal and usually waiting for its prey to swim or drift within range whereupon the fish will dart momentarily out of its shelter to seize it.

FAM: CICHLIDAE

Tilapia *uzolepis*

Habitat: Quiet stretches of large streams, especially where plant-cover is present. During high-water moves into (inundated) swamps and flood-plains.

Food: Herbivorous, mainly feeding on filamentous algae, scraped from substrate (rock, wood, plant stems, etc.). Also ingests (bottom) mud, rich in organic matter and phytoplankton when this is available.

Breeding: Probably during high-water season, though spawning may extend right into the dry period, providing water temperatures don't get too low. The male builds a circular nest on generally soft bottom and through a stereotyped behaviour-pattern lures a female towards the nest and induces her to spawn. The eggs are picked up by the female immediately after spawning and brooded in the mouth. After hatching (a week or so later) the young remain in the mother's mouth until large enough to fend for themselves (at ± 10 mm SL); they then seek shelter and food in shallow water and marginal weeds. Meanwhile the female has ripened a new batch of eggs and thus several (possibly 5 or 6) spawnings occur per season. The juveniles shoal together in weedy shallows until large enough (± 90 mm S.L.) to escape predation in deeper, more open waters. Ova yellowish, up to a few thousand in number (large specimens) depending on the size of the fish.

Behaviour: Shoaling occurs in juveniles and often in adult females especially when they are mouth-brooding.

Adult males are strongly territorial, at least during the breeding period when each individual occupies a "territory" where it makes its nest and which it defends against intruders (particularly other males of the species). This territorial behaviour as well as the often complex displaying behaviour in relation to spawning/fighting activities is common to all Cichlids and has been extensively studied for many of them. The juveniles if attacked, scatter and often hide among pebbles, weeds, etc., never fleeing very far.

Haplochromis spp.

Habitat: Quite extensive, occurring in the calmer areas of rocky rapids as well as in deeper slower-flowing waters with muddy bottom and in pools, backwaters, swamps, flood-plains, temporary streams, etc. Preferential habitats however, are the smaller streams, pools and channels where the current is weak, the bottom sandy and aquatic vegetation abundant.

Food: More or less omnivorous; algae, plant debris, small crustacea, insect larvae, oligochetes, fish eggs and larvae, etc., being present in the gut. Mainly however, their diet is carnivorous. They often raid

Tilapia nests.

Breeding: In Tilapia, the male occupies a territory in a suitable area and scoops out a small circular nest in the bottom. The female is attracted by the displaying behaviour of the male; deposits at most a hundred or so yellow, fairly large eggs in the nest and immediately picks them up in her mouth. Fertilisation in species wherein the male has egg-spots on the anal fin (e.g. H. bloyeti) takes place after the female has picked up the eggs. The male spays out his anal fin on the nest bottom, displaying the egg-spots which the female then tries to pick off while the male milts, thus ensuring fecundation of the eggs in the female's mouth.

After hatching, the young still return for protection into the mother's mouth till they become too large and then live in shallow waters, where marginal cover is good. The main breeding season usually occurs during the flood period.

Behaviour: Very similar to that of Tilapia, but shoaling is much less prominent and these fish tend to be more benthic in habit. Males in their territory during the breeding season are extremely aggressive, even attacking fish much larger than themselves.

Population Studies.

Although very little can be said about such a complex subject during a two-week survey, a few general notions do apply in this case.

1. Distribution: The young of most spp. tend to remain in up-river areas, swamps, flooded zones, backwaters and pools, where the water is shallow and shelter generally present. With the seasonal drying up of many of these sheltered areas, they concentrate in the larger streams and the main river-course, but still in their more sheltered parts (e.g. shallows and marginal pools).
Adult fish also show a general upstream and lateral movement during high water and congregate in the deeper, quieter areas of the main rivers during low water. Some also migrate downstream to some extent.
2. Reproduction: Most of the commercial species breed during high water, especially those that run up-river to spawn (Characidae, Cyprinidae). Others, like bream (Cichlidae) and catfish (Claridae) may have a more extended breeding period and move laterally into flooded or swampy areas to spawn, and in the case of e.g. Tilapia, breeding can take place even during low-water in the main river-course, as the absence of floods allows nest-building spp. to spawn without danger to eggs or brood.
3. Feeding and growth: With the marked variations in environmental conditions during the year, especially in volume and extent of water, there are bound to be clear-cut changes in growth, either related to changes in feeding (e.g. in diet and/or lack of food at certain times) or in relation to reproductive activity.
Examination of the scales of most large fish shows definite rings, due to interruptions (breaks) in rate of growth, but no analysis of these has been done, as this would be based on too few specimens.
Under such conditions as pertain in the Ruaha basin, growth is probably slow and therefore recruitment to the fishable size range of the population pretty low, particularly if the mortality is high, which appears to be the case, due to predation and extreme environmental fluctuations (e.g. drying up of large water tracks where many juveniles become trapped).
4. Interrelationships: As already stated the annual cycle of changes in the biotope, mainly brought on by fluctuations in water levels, have a major effect on the fish population and on its behaviour (e.g. migrations).
Most fish move into the main river course and some even further downstream as soon as the waters start to recede. The extent of this reverse migration varies with the species and probably within a given species from year to year and place to place (e.g. Labeo spp. where L. cylindricus remains fairly sedentary in all local rapids, L. ulangensis retreats to the relative safety of deep river stretches and L. aff. lineatus appears to migrate a considerable distance down the main river).
Mortality rate among juveniles and small species is probably very high, mainly due to their becoming trapped in pools and backwaters which get cut off from the larger river-courses and later dry up completely.
Various species-associations occur during + optimum conditions, but during the long low-water period these break down and most of the fish population concentrates in the deeper (quieter) stretches of the river and the associations which then occur are largely the result of adverse environmental factors.
In regard to fishing, this tends to give an exaggerated picture of the productivity of the river and it must be borne in mind that these more favourable river-stretches are essentially a refuge biotope and were these to be fished out - as has happened for instance in the Limpopo river - the whole fish population would collapse.

The Fisheries

The actual state of the fishery in the area investigated is on subsistence level only, very few fishermen making a year-round living out of commercial fishing activities.

Methods and gear: Gill-netting is the only method used on a commercial scale. Nets are usually 50 yds. long, very crudely mounted (by the half) both with and without floats and/or sinkers. Mesh size ranges from 2" to 4". The nets are set in various ways, mostly in the deeper, quieter stretches of the river, i.e. parallel to the shore, or across (perpendicular to the river-banks). They are lifted 2-3 times a day (morning, noon, evening) from small dug-out canoes. The gear appears to be kept in fairly good repair by most fishermen. Hippos are a menace to the nets in several places and most fishermen in the Mtera area complained about hippo damage.

Catches: These are said to vary greatly according to the season. During the survey period (low water), the catch per unit effort, both in the simple experimental nets and in the nets of a fisherman who was fishing regularly and whose catches were sampled, was fairly good.

Processing: When the catch is brought in, the fish are immediately scaled with the sharp edge of a large landsnail (Achatina) shell, then opened and gutted (except the Mormyrids) and finally, washed. Mormyrids are simply impaled on sticks and only opened if large, as they are said to have no guts!

The fish are then smoke-cured on a wire or reed trellis about 2 1/2 feet above a relatively small, not very smoky fire, in a simple lean-to smoke-house. The process is akin to cold-smoking, and fish are smoked for 6-24 hours on the rack directly above the fire (the length of time depending on their size). When sufficiently smoked, they are stored on a shelf or trellis above or beside the smoking platform until baled and taken to the market. Further slow smoke-curing takes place here as well.

The finished product, although produced by primitive methods, is generally clean, firm and of good appearance, mainly because the catch is processed immediately and the smoking itself is not done too close to the fire, a common fault in many cases, which causes the fish to be half-cooked, seriously impairing its quality. Nothing is known about the length of time this smoked fish can be kept (in storage) but it should certainly remain good for 1 month at least.

Marketing: After about a week or two, depending on the size of the catch, the fisherman or one of his associates packs up his cured fish in 25 to + 50 lb. bales and travels (by bus) to Iringa where he sells his product. Prices usually average about 1/- per lb.

Conclusions and Recommendations

On the evidence now available, mainly the following facts:

1. Lack of any extensive permanent swamps/flood-plains in the middle Ruaha area which could provide a refuge during the long dry season and extensive breeding/feeding grounds (during high-water).
2. The paucity of suitable areas where the water remains deep enough all through the year for gill-netting (in the area where communications with a major market, e.g. Iringa, are reasonably good). It is not recommended to develop the fishing there much above the present level.

Estimates made at the time of the survey show that catches would have to be at least doubled in order to make it worthwhile economically for a fish-trader to tour the area (Mtera-Kimande) once a week, picking up both fresh and processed fish for marketing in Iringa. It is doubtful if the fish population could bear the strain of a doubled production and overfishing, with an ensuing total collapse of the fishery, might easily take place,

Only a long-term survey (of at least one year) of the annual catch and its fluctuations, followed up preferably by a biological study of the fish population can make it clear whether anything further should be done to encourage the fishing industry in the area under consideration.

Further recommendations therefore are as follows:

- (1) Continued recording and analysis of catches and other data (e.g. on gear, methods, floods, fluctuations in number of fishermen, etc.) by a fisheries assistant in the area.
- (2) Eventual biological population survey if catch records show encouraging results (e.g. a regular sustained yield per unit effort).
- (3) Improving existent fishermen's gear and methods as well as market prices for fish if necessary (e.g. as an incentive to improve catch and product).
- (4) Regulating and stabilising the number of fishermen in the area.

