# A survey of the fishes of the Kunene River, Namibia

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ABSTRACT

A survey of fishes of the Kunene River along the Namibia-Angola border in 1990-1991 resulted in a total of 69 freshwater and 19 marine species being recorded. Previously Bell-Cross (1982) reported 70 species, Bethune and Roberts (1991) 69 species and Van der Waal (1991) 63 species. The absence of several species not collected during the survey is attributed to the limited sampling done in floodplain and swampy areas. Several records from previous reports are questioned. The Epupa and Ruacana Falls do not appear to serve as effective isolation barriers to separate species in the Kunene River. Habitat preference is the major factor limiting the dispersal and distribution of fish species.

## INTRODUCTION

The Kunene River is the second largest river in Angola and originates at Boas Aguas near Huambo (Nova Lisboa) in the highlands of Angola (Figure 1). It flows southwards for 650 km, plunges over the Ruacana Falls and then heads westwards, forming the boundary between Namibia and Angola. It reaches the Atlantic Ocean 1 050 km from it's headwaters.

Between Ruacana Falls and the Atlantic Ocean the Kunene River is narrow, fast flowing, and characterised by many small rapids. A second waterfall, Epupa Falls (Quedas Mortenegro), is present 130 km downstream of Ruacana Falls. From Epupa Falls the river flows through the Bains Mountains before it reaches the Namib Desert where it flows between sand dunes.

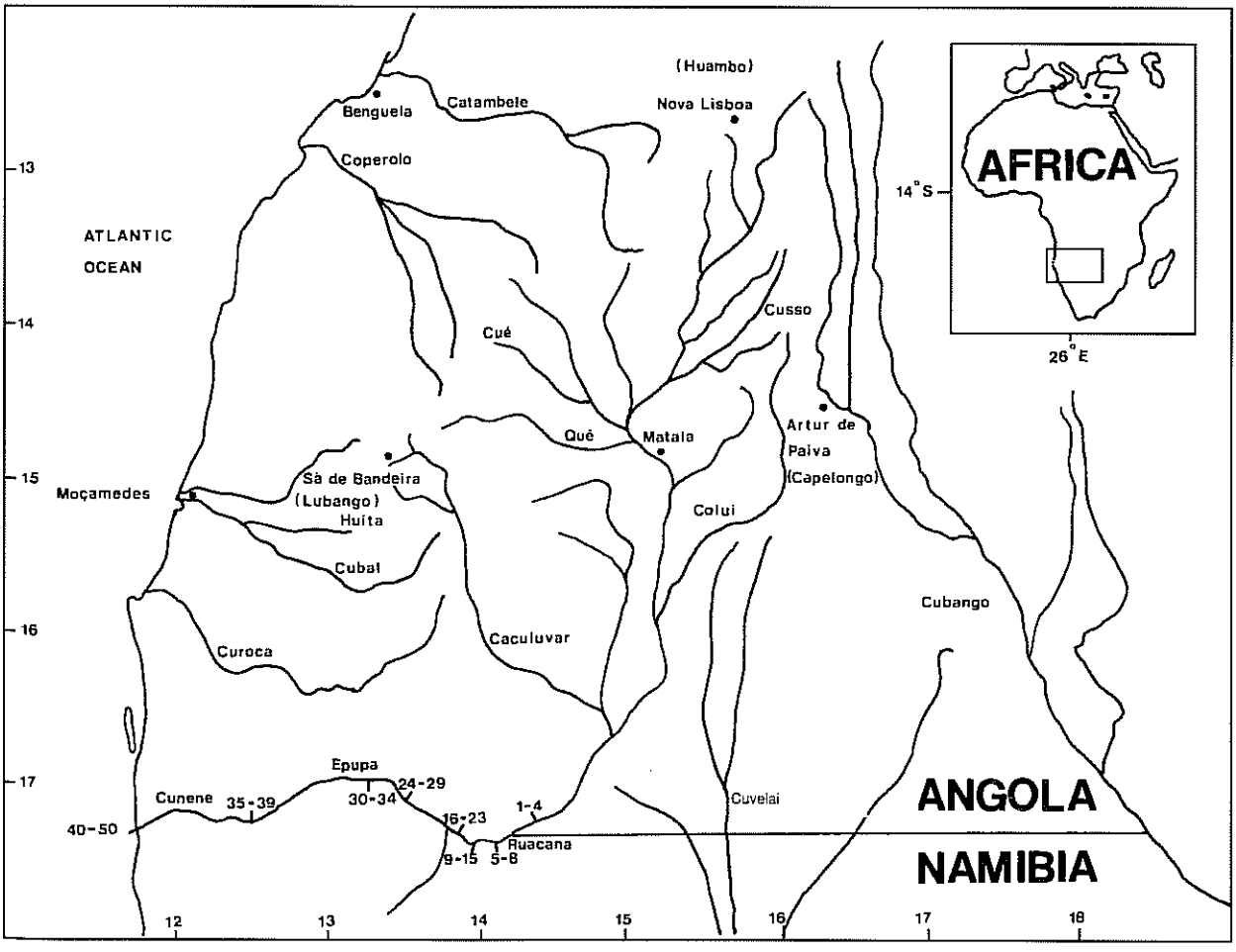


FIGURE 1: The Kunene River in relation to Namibia and collecting sites. Details of the collecting sites and location names are given against collecting site numbers in Table 4.

## Climate

The rainfall ranges from over 1500 mm per annum in the highlands of Angola to less than 50 mm per annum in the Namib Desert (Van der Merwe 1983). More than 80% of the rainfall in Kaokoland occurs between October and March with a maximum during January and February. Streamflow is correlated with rainfall which peaks between February and May and is lowest in September and October. December is the hottest month in Kaokoland. Mean maximum temperatures range from 35°C in the east to about 30°C in the west (Van der Merwe 1983).

## Hydrology

The Kunene River has a total catchment area of 106500 km$^2$ (Midgley 1966). The headwaters lie between 1700 and 2000 m above sea level. A small portion of the upper catchment area is hilly with a relatively high runoff. Tributaries include the Caculuvar, Cului and Cassava. The mean annual runoff for the Kunene River calculated at the river mouth is 5800 million m$^3$ per annum. Towards the central reaches the gradient declines (1:4500) to form widening marshy plains (Midgley 1966).The portion between Calueque and Ruacana (1:215) is characterised by a series of rapids followed by a vertical drop of 120 m at the Ruacana Falls.The channel from Ruacana to the sea is steeply graded (1:447) with distinct falls and rapids (Epupa and Ondorusu).

## Temperature

The water temperature varies between 18,5 °C in July and 28,5 °C in February (data provided by SWAWEK). Water temperature tends to increase from east to west. There is a decrease in water temperature with depth near the mouth (Table 1). This, however, is likely to be the influence of the cooler sea water. Temperature of surface water in the lagune is cooler than the water at the bottom. This is probably due to wind induced cooling.

TABLE 1: Water temperature (°C) at various localities on the Kunene River, December 1990.

| Depth (m) | Temperature (°C) at Locality No. (see Fig 1) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 5 | 10 | 18 | 24 | 30 | 35 | 41 | 45 | 49 |
| 0 | 20 | 20 | 20 | 20 | 21 | 22,5 | 21,8 | 20,0 | 25,5 |
| 0,5 | 20 | 20 | 20 | 20 | 21 | 22,5 | 22,3 | 20,0 | 25,4 |
| 1,0 | 20 | 20 | 20 | 20 | - | 22,5 | 22,5 | 20,0 | 24,8 |
| 1,5 | 20 | 20 | 20 | 20 | - | 22,5 | 22,7 | - | 23,8 |
| 2,0 | 20 | 20 | 20 | 20 | - | 22,5 | 23,0 | - | - |
| 2,5 | 20 | - | 20 | - | - | 22,5 | 23,2 | - | - |
| 3,0 | 20 | - | 20 | - | - | 22,5 | 23,3 | - | - |

## Water quality

The pH values of the Kunene are more or less neutral (Table 2). Conductivity is low except for the mouth.

The turbidity in the Kunene River is low except for the areas near the mouth (Table 2).The lagune widens near the mouth with a decrease in depth.Wave, wind and tidal action in these areas are responsible for the increased turbidity. Locality 40 is situated near a rapid that increases the water turbulence and therefore also the turbidity.The lower turbidity at localities 49 and 50 is influenced by sea water that generally has a low turbidity.

TABLE 2: Water analysis at various localities on the Kunene River, December 1990.

| Locality | pH | Conductivity mS/m | Total dissolved solids mg/l | Chlorine mg/l | Turbidity NTU |
|---|---|---|---|---|---|
| 1 | 6,4 | 3,8 | 25 | 1 | 6 |
| 5 | 6,4 | 3,9 | 26 | 1 | 9 |
| 10 | 7,1 | 4,2 | 28 | 1 | 3 |
| 24 | 7,0 | 4,1 | 27 | 1 | 3 |
| 30 | 8,2 | 8,9 | 59 | 1 | 3 |
| 35 | 7,4 | 6,4 | 42 | 1 | 3 |
| 40 | 7,2 | 8,3 | 55 | 4 | 27 |
| 41 | 7,7 | 8,6 | 57 | 8 | 25,0 |
| 44 | 7,1 | 8,2 | 54 | 34 | 26,0 |
| 46 | 8,0 | 99,5 | 657 | 160 | 5,9 |
| 48 | 7,4 | 400,0 | 2640 | 1160 | 23,0 |
| 49 | 7,9 | 5190,0 | 34254 | 19800 | 12,0 |
| 50 | 7,6 | 5210,0 | 34386 | 20000 | 6,7 |

## Oxygen

No oxygen stratification was detected in the river (Table 3).

TABLE 3: Oxygen content (mg/l) of the water at various localities on the Kunene River, December 1990.

| Depth (m) | Hippo Pool | Opkoron Gombe | Ondozo | Otjim Bundu | Epupa | Otjinungwa |
|---|---|---|---|---|---|---|
| 0 | 8,9 | 3,1 | 3,7 | 4,0 | 7,4 | 5,4 |
| 1 | 8,9 | 3,1 | 3,7 | 4,8 | - | 5,8 |
| 2 | 8,9 | 3,0 | 3,6 | - | - | 5,8 |
| 3 | 8,6 | - | 3,4 | - | - | - |

## Previous collections from the Kunene

The earliest documented collection of fish species from Angola comes from Steindachner (1866) and Boulenger (1898, 1910-1916). Further expeditions were made by Nichols and Boulton (1927), the Vernay-Lang Kalahari expedition (Fowler 1930), Dr. Jordan (Trewavas 1936), Pellegrin (1936), Ladiges and Voelker (1961), Ladiges (1964) and Poll (1967). One of the earliest recorded species from the Kunene system is *Pelmatochromis welwitschi* (Boulenger 1898), the synonym for *Chetia welwitschi* (Boulenger 1898), that was collected by Dr. Welwitsch at Fluila (Boulenger 1898). Fluila is probably the misspelt form of Huila that is close to the Huila River, a tributary of the Kunene (Bell-Cross 1975). A survey done by Penrith (1978) included several marine species that were sampled in the mouth and lagune of the Kunene River. In 1982 an additional 13 species from south-western Angola, mainly from the Kunene basin, were added by Penrith. Bell-Cross (1982) listed 70 species from the Kunene in his biogeography of the Zambezi River fish fauna. The most recent lists are by Van der Waal (1991) totalling 63 species and Bethune and Roberts (1991) with 69 species from the Kunene River.

TABLE 4: Description of the fish collecting sites on the Kunene River

| Figure 1 Ref. no. | Sites | Substratum | Vegetation | Flow rate | Mean depth | Sampling methods |
|---|---|---|---|---|---|---|
| 1 | Calueque floodplain | Sandy | Marginal | Slow | 2m | Gill-net series |
| 2 | | Sandy | Marginal | Slow | 3m | Gill-net series |
| 3 | | Clay | Aquatic | Slow | 1m | Seine net |
| 4 | | Rocky | None | Slow | 0.5m | Rotenone |
| 5 | Hippopool | Rocky | None | Slow | 4m | Gill-net series Rotenone |
| 6 | | Rocky & Sandy | *Phragmites* sp. | Strong | 2m | Gill-net series |
| 7 | | Sandy | *Phragmites* sp. | Slow | 1m | Seine & mosquito net |
| 8 | | Sandy | Marginal | Slow | 2m | Gill-net series |
| 9 | Opkorongombe | Sandy | Marginal | Strong | 2m | Gill-net series |
| 10 | | Sandy | Marginal | Strong | 2m | Gill-net series |
| 11 | | Clay | None | Slow | 2m | Mosquito net |
| 12 | | Clay | *Phragmites* sp. | None | 1m | Seine net |
| 13 | | Clay | Aquatic | Slow | 0,4m | Rotenone |
| 14 | | Clay | None | Slow | 1m | Mosquito net |
| 15 | | Clay & Rocky | None | None | 1m | Seine net |
| 16 | Opatyamaungu | Clay & Sandy | None | Slow | 1m | Seine net |
| 17 | Kunene Stein | Clay | None | None | 0,5m | Mosquito net |
| 18 | Ondozo rapid | Rocky | Aqnatic | Medium | 0,4m | Rotenone |
| 19 | Ondozo | Clay | None | Slow | 2m | Casting and Mosquito net |
| 20 | | Clay & Sandy | None | Strong | 2m | Gill-net series |
| 21 | | Clay & Sandy | Marginal | Strong | 2m | Gill-net series |
| 22 | Ondorusu falls (rapid) | Rocky | None | Strong | 0,5m | Rotenone |
| 23 | | Clay & Rocky | None | None | 1m | Rotenone |
| 24 | Otjimbundu | Rocky & Sandy | None | Medium | 3m | Gill-net series |
| 25 | | Sandy | None | Slow | 1,5m | Casting and Mosquito net |
| 26 | | Sandy | None | None | 0,3m | Mosquito net |
| 27 | | Sandy | None | Strong | 1m | Mosquito net |
| 28 | | Sandy | *Phragmites* sp. | Slow | 0,2m | Mosquito net |
| 29 | | Sandy | None | Medium | 1,5m | Mosquito net |
| 30 | Epupa | Rocky & Sandy | None | Slow | 2m | Rotenone |
| 31 | | Rocky & Sandy | None | None | 0,5m | Rotenone |
| 32 | | Sandy | None | Strong | 2m | Casting and Mosquito net |
| 33 | | Sandy | None | Strong | 1m | Rotenone |
| 34 | | Sandy | None | Strong | 1m | Mosquito net |
| 35 | Otjinungwa | Sandy | None | Medinm | 2m | Seine, mosquito, casting nets, traps & angling |
| 36 | | Sandy | Marginal | Strong | 2m | Gill-net series |
| 37 | | Sandy | Marginal | Strong | 2m | Gill-net series |
| 38 | | Sandy | Marginal | Strong | 2m | Gill-net series |
| 39 | Rapid | Rocky | None | Strong | 0,5m | Rotenone |
| 40 | Seven km from Mouth | Clay & Sandy | *Phragmites* sp. | Slow | 3,5m | Gill-net series |
| 41 | Six km from mouth | Clay | *Phragmites* sp. | Medium | 1,5m | Gill-net series |
| 42 | One km from mouth | Sandy | None | None | 1m | Mosquito net |
| 43 | Lagune | Sandy | Marginal | Strong | 3m | Gill-net series |
| 44 | Lagune | Sandy | None | Strong | 0,5m | Water sample |
| 45 | Isolated pool | Sandy | Aquatic | None | 1m | Rotenone |
| 46 | Isolated pool | Sandy | None | None | 1,5m | Rotenone |
| 47 | Rapid | Rocky | None | Medium | 0,4m | Rotenone |
| 48 | Lagune | Sandy | None | Strong | 1,5m | Gill-net series |
| 49 | Mouth | Sandy | None | Strong | 4m | Angling,Seine |
| 50 | Sea | Sandy | None | Strong | 2m | Water sample |

Grid references of the collecting sites:

| | | | |
|---|---|---|---|
| Calueque Floodplain: | 17° 16'S14° 30'E | Ondozo: | 17° 24'S13° 57'E |
| Hippopool: | 17° 23'S14° 12'E | Ondorusu Falls: | 17° 24'S13° 56'E |
| Opkorongombeo: | 17° 25'S14° 04'E | Otjimbundu: | 17° 17'S13° 45'E |
| Opatyamaungu: | 17° 25'S14° 02'E | Epupa: | 17° 00'S13° 15'E |
| Kunene Stein: | 17° 21'S13° 59'E | Otjinungwa: | 17° 15'S12° 15'E |
| | | Mouth: | 17° 15'S11° 45'E |

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| 13 | | Clay | Aquatic | Slow | 0,4m | Rotenone |
| 14 | | Clay | None | Slow | 1m | Mosquito net |
| 15 | | Clay & Rocky | None | None | 1m | Seine net |
| 16 | Opatyamaungu | Clay & Sandy | None | Slow | 1m | Seine net |
| 17 | Kunene Stein | Clay | None | None | 0,5m | Mosquito net |
| 18 | Ondozo rapid | Rocky | Aquatic | Medium | 0,4m | Rotenone |
| 19 | Ondozo | Clay | None | Slow | 2m | Casting and Mosquito net |
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| 24 | Otjimbundu | Rocky & Sandy | None | Medium | 3m | Gill-net series |
| 25 | | Sandy | None | Slow | 1,5m | Casting and Mosquito net |
| 26 | | Sandy | None | None | 0,3m | Mosquito net |
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| 43 | Lagune | Sandy | Marginal | Strong | 3m | Gill-net series |
| 44 | Lagune | Sandy | None | Strong | 0,5m | Water sample |
| 45 | Isolated pool | Sandy | Aquatic | None | 1m | Rotenone |
| 46 | Isolated pool | Sandy | None | None | 1,5m | Rotenone |
| 47 | Rapid | Rocky | None | Medium | 0,4m | Rotenone |
| 48 | Lagune | Sandy | None | Strong | 1,5m | Gill-net series |
| 49 | Mouth | Sandy | None | Strong | 4m | Angling,Seine |
| 50 | Sea | Sandy | None | Strong | 2m | Water sample |

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| | | | |
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| | | Mouth: | 17° 15'S11° 45'E |

## METHODS

### Equipment and description of collecting sites

Collections were made during August 1990, December 1990 and December 1991; two summer and one winter surveys. Calueque is the only locality with mainly floodplain and swamp habitats as the river below the Ruacana Falls consists of rapids and fast flowing water. There are few isolated pools and side streams in the middle and lower reaches of the river. The survey at Calueque was limited in time which probably effected the species composition of fish captured. Collecting sites were selected to include all habitat types of the river. Sampling in the lower reaches was hampered by rugged terrain.

The following equipment were used to sample fishes during the surveys:

1. A series of gill nets with the following stretch mesh sizes:35, 45, 57, 73, 93, 118 and 150 mm (30 m each) were used in the main stream and at Calueque. Gill nets were also used in the lagune at the river mouth.
2. A 30 m x 1 m seine net with a 12 mm stretch mesh size was used in shallow water. Side streams and floodplains at Calueque were also sampled with this gear.
3. A 10 m x 1 m mosquito mesh seine net was used for streamlets.
4. Rotenone was used in isolated pools, rapids and vegetated areas.
5. Angling was used in the river mouth.
6. Traps, 45 x 41 x 18 cm, covered by a 12 mm mesh size net and with four inlets were used in deep water habitats and vegetated areas.
7. A 2 m diameter casting net with a 35 mm stretch mesh size was used in rapids and fast flowing currents.

### Temperature

Temperature was measured at 10h00 at each collecting site.

### Water quality

Water was sampled and kept as cool as possible. The analysis was done by the Department of Water Affairs, Windhoek.

### Oxygen

An YSI 54A oxygen meter was used for the determination of the Oxygen content.

The descriptions of the collecting sites are listed in Table 4.

## RESULTS AND DISCUSSION

Forty-three freshwater species were collected from the Kunene River during these surveys. Most of the species were from the family Cyprinidae followed by the Cichlidae (Table 5). The absence of the families Bagridae, Distichodontidae and Kneriidae during these surveys can be attributed to specialised habitats as well as to their being uncommon in the Kunene River. Although no species separation is apparent in the Kunene River, several species do indicate restricted distribution such as *Barbus breviceps* (Trewavas 1936), *Kneria maydelli* (Ladiges & Voelker 1961), *K. polli* (Trewavas 1936), *Labeo ruddi* (Boulenger 1907) and *Synodontis thamalakanensis* (Fowler 1935) (Table 5). These species were not found above the Ruacana Falls.The majority of the species are present above the Ruacana Falls with a decline in species numbers towards the river mouth. Greater habitat diversity, in the upper reaches is likely to be the reason for this. It is unlikely that the major waterfalls prevent the downriver movement of fish. Another factor is that fewer surveys have been conducted in the lower reaches of the river compared to the upper reaches.

*Barbus breviceps* and *K. polli* are new records from the Kunene River. Although not in the main stream, they were collected in a southerly tributary of the Kunene River. Common species in the Kunene River are *Brycinus lateralis* (Boulenger 1900), *Micralestes acutidens* (Peters 1852), *Barbus fasciolatus* (Günther 1868), *B. mattozi* (Guimaraes 1884), *B. radiatus* (Peters 1853), *B. poechii/trimaculatus*, *B. unitaeniatus* (Günther 1866), *Mesobola brevianalis* (Boulenger 1908), *Schilbe intermedius* (Linnaeus 1762), *Oreochromis macrochir* (Boulenger 1912), *Pseudocrenilabrus philander* (Weber 1897) and *Thoracochromis buysi* (Penrith 1970). Dominant species during night sampling were *Aplocheilichthys johnstonii* (Günther 1893), *B. fasciolatus*, *B. lateralis* and *M. acutidens*.

TABLE 5: Fish species from the Kunene River and their distribution in relation to the Epupa and Ruacana waterfalls.

X - denotes species present in the Kunene River.
? - denotes dubious or unconfirmed records.
* - species not recorded during present surveys, but additionally recorded by previous collectors.

| Species | Below Epupa | Epupa-Ruacana | Above Ruacana |
|---|---|---|---|
| MORMYRIDAE | | | |
| *Hippopotamyrus ansorgii* | | X | X |
| * *H. discorhynchus* | | | X |
| *Marcusenius macrolepidotus* | X | X | X |
| *Mormyrus lacerda* | X | X | X |
| *Petrocephalus catostoma* | X | X | X |
| *Pollimyrus castelnaui* | X | X | X |
| KNERIIDAE | | | |
| * *Kneria maydelli* | | X | |
| * *K. angolensis* | | | X |
| * *K. polli* | X | | |
| CHARACIDAE | | | |
| *Brycinus lateralis* | X | X | X |
| *Micralestes acutidens* | X | X | X |
| * *Rhabdalestes maunensis* | | | X |
| HEPSETIDAE | | | |
| *Hepsetus odoe* | X | X | X |

| Species | Below Epupa | Epupa-Ruacana | Above Ruacana |
|---|---|---|---|
| DISTICHODONTIDAE | | | |
| * *Hemigrammocharax machadoi* | | X | X |
| * *H. multifasciatus* | | | X |
| CYPRINIDAE | | | |
| * *Barbus afrovernayi* | X | | X |
| * *B. barotseensis* | | X | X |
| *B. barnardi* | | X | X |
| * *B. bifrenatus* | | X | X |
| * *B. breviceps* | X | | |
| * *B. codringtonii* | ? | ? | ? |
| *B. eutaenia* | X | X | X |
| *B. fasciolatus* | X | X | X |
| * *B. lineomaculatus* | | | X |
| *B. mattozi* | X | X | X |
| * *B. multilineatus* | | | X |
| *B. paludinosus* | X | X | X |
| *B. radiatus* | | X | X |
| *B. kerstenii* | X | | X |
| *B. thamalakanensis* | | | X |
| *B.poechii/trimaculatus* | X | X | X |
| *B. unitaeniatus* | X | X | X |
| * *B. dorsolineatus* | | | X |
| * *B. puellus* | ? | ? | ? |
| *Mesobola brevianalis* | X | X | X |
| *Labeo ansorgii* | X | X | X |
| *L. ruddi* | X | X | |
| AMPHILIIDAE | | | |
| * *Leptoglanis rotundiceps* | | X | X |
| SCHILBEIDAE | | | |
| *Schilbe intermedius* | X | X | X |
| CLARIIDAE | | | |
| * *Clarias theodorae* | | | X |
| *C. ngamensis* | | X | X |
| *C. gariepinus* | X | X | X |
| * *C. liocephalus* | ? | ? | ? |
| *C. stappersii* | | X | X |
| MOCHOKIDAE | | | |
| * *Chiloglanis neumanni* | | | X |
| *Synodontis leopardinus* | X | X | X |
| *S. nigromaculatus* | X | X | X |
| *S. vanderwaali* | X | X | X |
| * *S. thamalakanensis* | | | X |
| *S. macrostigma* | | | X |
| *S. woosnami* | | | X |
| * *S. macrostoma* | | | X |
| CYPRINODONTIDAE | | | |
| *Aplocheilichthys macrurus* | X | X | X |
| *A. johnstonii* | X | X | X |
| * *A. katangae* | X | | X |
| CICHLIDAE | | | |
| * *Chetia welwitschi* | | X | X |
| * *Orthochromis machadoi* | X | X | X |
| *Oreochromis macrochir* | X | X | X |
| *O. andersonii* | X | X | X |
| *Pseudocrenilabrus philander* | X | X | X |
| * *Pharyngochromis acuticeps* | ? | ? | X |
| *Sargochromis coulteri* | X | X | X |
| *S. codringtonii/giardi* | | X | X |
| * *S. gracilis* | ? | ? | ? |
| * *S.greenwoodi* | | X | X |
| *Serranochromis angusticeps* | | X | X |
| * *S. altus* | ? | ? | ? |
| *S. macrocephalus* | X | X | X |
| * *S. robustus jallae* | | X | X |
| * *S. thumbergi* | | X | X |
| *Tilapia rendalli* | X | X | X |
| *T. sparrmanii* | X | X | X |
| *Thoracochromis buysi* | X | X | X |
| *T. albolabris* | X | X | X |
| GOBIIDAE | | | |
| *Chonophorus guineensis* | X | | |
| *Nematogobius ansorgei* | X | | |
| * *Ctenogobius lepturus* | X | | |
| ELEOTRIDAE | | | |
| *Eleotris vittata* | X | | |
| *Batanga lebretonis* | X | | |
| EXOCOETIDAE | | | |
| *Cheilopogon milleri* | X | | |
| CARANGIDAE | | | |
| *Lichia amia* | X | | |
| POMADASYIDAE | | | |
| *Pomadasys jubilini* | X | | |
| *P. rogeri* | X | | |
| SCIAENIDAE | | | |
| *Argyrosomus hololepidotus* | X | | |
| SPARIDAE | | | |
| * *Lithognathus aureti* | X | | |
| MUGILIDAE | | | |
| * *Liza aurata* | X | | |
| *L. falcipinnis* | X | | |
| * *L. dumerilii* | X | | |
| *Mugil cephalus* | X | | |
| POLYNEMIDAE | | | |
| *Galeiodes decadactylus* | X | | |
| ARIIDAE | | | |
| *Arius latiscutatus* | X | | |
| BOTHIDAE | | | |
| * *Citharichthys stampflii* | X | | |
| GOBIESOCIDAE | | | |
| * *Diplecogaster megalops* | X | | |

## DISTRIBUTION (TABLE 5) AND HABITAT PREFERENCES (TABLE 6) OF SPECIES COLLECTED:

### Mormyridae

*Hippoptamyrus ansorgii* (Boulenger 1905) was not found below the Epupa Falls. It prefers shallow water with a sandy substrate, but was also collected in deep water with a rocky substrate. Bell-Cross and Minshull (1988) reported it from rocky-bottomed habitats with fast flowing water.

*Marcusenius macrolepidotus* (Peters 1852) has a wide habitat preference and is distributed throughout the system. It was found to be more active during the night. Gaigher (1969) collected it in pools and slow flowing rapids in rivers from the Transvaal, South Africa. It is found in marsh and reed beds in the Okavango River (Bethune 1991).

*Mormyrus lacerda* (Castelnau 1861) is distributed throughout the system. It was recorded in floodplain as well as deep water habitats and appears to be more active during the night. Van der Waal and Skelton (1984) indicated their habitat preference to be deep standing water while Bell-Cross and Minshull (1988) reported it from deep pools with associated aquatic vegetation.

TABLE 6: Habitat preferences of species from the Kunene River.

| Species | Habitat preferences |
|---|---|
| MORMYRIDAE | |
| *Hippopotamyrus ansorgii* | Shallow water, sandy substrate |
| *H. discorhynchus* | Larger waterways |
| *Marcusenius macrolepidotus* | Wide habitat preference |
| *Mormyrus lacerda* | Floodplain, deep water |
| *Petrocephalus catostoma* | Floodplain, rocky substrate |
| *Pollimyrus castelnaui* | Vegetated areas |
| KNERIIDAE | |
| *Kneria maydelli* | Rocky substrate |
| *K. polli* | Rocky substrate |
| CHARACIDAE | |
| *Brycinus lateralis* | Floodplain, main stream |
| *Micralestes acutidens* | Open, moving water |
| *Rhabdalestes maunensis* | Swampy areas |
| HEPSETIDAE | |
| *Hepsetus odoe* | Floodplain, deep water |
| DISTICHODONTIDAE | |
| *Hemigrammocharax machadoi* | Shallow water, aquatic vegetation |
| *H. multifasciatus* | Shallow water, aquatic vegetation |
| CYPRINIDAE | |
| *Barbus afrovernayi* | Vegetated areas |
| *B. barotseensis* | Vegetated areas |
| *B. barnardi* | Floodplain, swampy areas |
| *B. bifrenatus* | Running water, vegetated areas |
| *B. breviceps* | Rocky substrate |
| *B. eutaenia* | Rapids, rocky areas |
| *B. fasciolatus* | Shallow, slow-moving water |
| *B. lineomaculatus* | Wide habitat |
| *B. mattozi* | Preference for quiet water |
| *B. multilineatus* | Quiet waters, aquatic vegetation |
| *B. paludinosus* | Wide habitat |
| *B. radiatus* | Swampy areas, Shallow water |
| *B. kerstenii* | Floodplain |
| *B. thamalakanensis* | Floodplain |
| *B.poechii/trimaculatus* | Floodplain, isolated pools |
| *B. unitaeniatus* | Floodplain, isolated pools |
| *Mesobola brevianalis* | Shallow, quiet water, vegetation |
| *Labeo ansorgii* | Shallow, swampy, rocky areas |
| *L. ruddi* | Quiet water |
| AMPHILIIDAE | |
| *Leptoglanis rotundiceps* | Shallow water |
| SCHILBEIDAE | |
| *Schilbe intermedius* | Wide habitat |
| CLARIIDAE | |
| *C. ngamensis* | Floodplain |
| *C. gariepinus* | Wide habitat |
| *C. stappersii* | Shallow water, vegetated areas |
| MOCHOKIDAE | |
| *Chiloglanis neumanni* | Rapids |
| *Synodontis leopardinus* | Floodplain, mainstream |
| *S. nigromaculatus* | Shallow water |
| *S. vanderwaali* | Vegetated areas |
| *S. macrostigma* | Floodplain, deep water |
| *S. woosnami* | Shallow water, vegetated areas |
| *S. macrostoma* | Rocky environments |
| POECILIIDAE | |
| *Aplocheilichthys macrurus* | Shallow water, side stream |
| *A. johnstonii* | Wide habitat |
| CICHLIDAE | |
| *Orthochromis machadoi* | Rocky environments |
| *Oreochromis macrochir* | Shallow, slow-moving water |
| *O. andersonii* | Isolated pools, rapids |
| *Pseudocrenilabrus philander* | Wide habitat |
| *Sargochromis coulteri* | Shallow water, sandy substrate |
| *Serranochromis angusticeps* | Floodplain |
| *S. altus* | Wide habitat |
| *S. macrocephalus* | Wide habitat |
| *S. robustus jallae* | Open water |
| *S. thumbergi* | Flowing water |
| *Tilapia rendalli* | Main, side streams, rapids |
| *T. sparrmanii* | Floodplain, vegetated pools |
| *Thoracochromis buysi* | Wide habitat |
| *T. alholabris* | Rocky substrate, swampy areas |

*Petrocephalus catostoma* (Günther 1866) is present throughout the Kunene System. This species was collected from floodplain areas covered with aquatic vegetation as well as from areas with a rocky substrate. It is less common in the main stream. It has a wide distribution in the Incomati River (Gaigher1969) and prefers pools in the Limpopo (Gaigher 1973).

*Pollimyrus castelnaui* (Boulenger 1911) is present throughout the system. It was collected in littoral reaches of the main stream near vegetated banks. Its preferred habitat is vegetated backwaters, but the species may enter fast flowing habitats (Bell-Cross & Minshull 1988). Van der Waal and Skelton (1984) reported it to be abundant in shallow floodplain areas in the Caprivi. *Hippopotamyrus pappenheimi* (Boulenger 1910) as reported from the Kunene River by Poll (1967) is probably a synonym of this species.

Characidae

*Brycinus lateralis* (Boulenger 1900) is abundant and present throughout the Kunene River. It prefers floodplain and swampy areas, but has also been collected in deep water habitats. This species is listed as rare in the Red Data Book of southern Africa (Skelton 1987), but does not appear to be threatened in Namibia. The preferred habitat in the Caprivi is deep water as well as shallow floodplain areas (Van der Waal & Skelton 1984).

*Micralestes acutidens* (Peters 1852) was collected from Calueque to the mouth. This species is common in the Kunene River and active during the night. It prefers open, moving waters near the banks, although it is present in a wide range of habitats. Bethune (1991) also reported it to prefer open, flowing water.

Hepsetidae

*Hepsetus odoe* (Bloch 1794) is present in floodplains, deep water areas as well as rapids throughout the Kunene River. The absence of *Hydrocynus vittatus* (Castelnau

1861) in the Kunene River may have increased the habitat and distribution range of *H. odoe* in this system ( c.f. Bell-Cross & Minshull 1988).

Cyprinidae

*Barbus barnardi* (Jubb 1965) was not found below the Epupa Falls. Its habitat preference is swampy and floodplain areas. It is not common in the Kunene River. It was collected from the Olushandja Dam in the Cuvelai System which consists of floodplain and swampy habitats.

*Barbus eutaenia* (Boulenger 1904) is present throughout the system, but appears to be uncommon. It was collected in rapids whereas Bell-Cross and Minshull (1988) indicate their preference to be fast flowing water with vegetation. Gaigher (1973) reports that oxygen may limit their distribution.

*Barbus tangandensis* (Jubb 1954) has been assigned to *B. kerstenii* (Skelton pers. comm.) and is present at the upper and lower reaches of the system in floodplain areas.

*Barbus thamalakanensis* (Fowler 1935) was collected above the Ruacana Falls from floodplain areas. Bell-Cross and Minshull (1988) reported it to be present in vegetated areas.

*Barbus mattozi* (Guimaraes 1884) is distributed throughout the river with a preference for quiet water. Gaigher (1973) reported the preference of this species to be deep pools. Bell-Cross and Minshull (1988) also indicated a preference for quiet waters.

*Barbus radiatus* (Peters 1853) has not been collected below the Epupa Falls. The preferred habitats are swampy areas with aquatic vegetation and shallow water with a clay substrate. Bell-Cross and Minshull (1988) indicated that it has a wide habitat preference which is supported by its wide distribution in the Limpopo System (Gaigher 1969).

The status of *B. trimaculatus* (Peters 1852) and *B. poechii* (Steindachner 1911) requires further investigation (Greenwood 1962). *Barbus poechii* as identified by one dash on the peduncle is present in the Okavango and Upper Zambezi Rivers. *Barbus trimaculatus* with three lateral spots has a much wider distribution that includes the Middle and Lower Zambezi, Zaire, Limpopo and Orange River Systems. Specimens from the Cuvelai System resemble *B. poechii* whereas specimens from the Kunene River have three distinct lateral spots. Van der Waal (1991) collected intermediate forms from the Cuvelai System. The specimens collected from the Kunene River were from floodplain areas, shallow waters and isolated pools throughout the system.

*Barbus unitaeniatus* (Günther 1866) is common throughout the system. This species was collected in floodplains and shallow water. Our results were sirnilar to those of Gaigher (1973) who reported it to have a wide distribution in the Limpopo system, and Bell-Cross and Minshull (1988) who also indicated it to have a wide habitat preference.

*Barbus fasciolatus* (Günther 1868) is distributed throughout the system but is more common in the lower reaches. This species was collected in shallow, slow-moving water. It was also collected during the night in a variety of habitats. Van der Waal and Skelton (1984) recorded it from floodplain areas.

*Barbus paludinosus* (Peters 1852) is present along the entire river.It was sampled from rocky and sandy substrates in sidestreams, floodplains as well as the main stream. It was found to be abundant in the Vernay collection from the Kunene River (Fowler 1930). Although common, it was found not to be abundant during our surveys.

*Labeo ansorgii* (Boulenger 1907) is evenly distributed from Calueque through to the mouth. It has a wide habitat tolerance from shallow swampy areas covered with aquatic vegetation with a sandy substrate to deep water areas with a rocky substrate and rapids. It was more active during the day than at night. *Labeo cylindricus* (Peters 1852) and *L. molybdinus* (du Plessis 1963) have been listed by previous authors from this system, but specimens identified as these species are now assigned to *L. ansorgii* (Skelton pers. comm.). This is the dominant species of the two *Labeos* found in the Kunene River.

*Labeo ruddi* (Boulenger 1907) has not yet been collected above the Ruacana Falls. It has a more limited distribution than the previous species and prefers quiet water. It prefers pools in the Limpopo River (Gaigher 1973).

*Mesobola brevianalis* (Boulenger 1908) is distributed throughout the river. Shallow quiet waterwith aquatic vegetation is preferred. It is abundant in the Limpopo River with a wide habitat preference (Gaigher 1973).

Schilbeidae

*Schilbe intermedius* (Linnaeus 1762) was collected throughout the Kunene River and has a wide habitat preference. Reizer (1974) reported that it is restricted by elevated salinity.

Clariidae

*Clarias gariepinus* (Burchell 1822) is distributed throughout the system with a wide habitat preference.This species is known to have a wide distribution (Gaigher 1973; Van der Waal & Skelton 1984; Bell-Cross & Minshull 1988).

*Clarias ngamensis* (Castelnau 1861) was not collected below the Epupa Falls. It is primarily a floodplain species.

*Clarias stappersii* (Boulenger 1906) has not yet been collected below the Epupa Falls. It appears to prefer shallow water with vegetation. *Clarias stappersii* had previously been confused with *C. submarginatus* (Peters

1882) which only occurs in Cameroon (Skelton & Teugels 1991).

Mochokidae

Our collections confirm the presence of *Synodontis leopardinus* (Pellegrin 1914) in the Kunene River although it was not reported from this system by Skelton and White (1991). Re-examination of the specimens is therefore needed before these records can be confirmed. It preferred the floodplains, but was also collected in the main stream and rocky areas.

Only one specimen of *S. nigromaculatus* (Boulenger 1905) was collected in shallow water with a sandy substrate. Pellegrin (1936) and Ladiges (1964) recorded *S. melanostictus* (Boulenger 1905) from the Kunene River which is regarded as a junior synonym. Their specimens need to be critically re-examined (Skelton pers. comm.). Poll (1967) and Bell-Cross and Minshull (1988) also reported *S. nigromaculatus* from the Kunene River.

*Synodontis woosnami* (Boulenger 1911) appears to prefer shallow water with vegetation and is present above the Ruacana Falls. Van der Waal and Skelton (1984) and Bell-Cross and Minshull (1988) reported it from floodplain areas.

*Synodontis vanderwaali* (Skelton and White 1990) is distributed throughout the system. It prefers water with vegetation, but has also been collected in the main stream.

*Synodontis macrostigma* (Boulenger 1911) is present above the Ruacana Falls and in floodplain areas as well as deep water habitats. Van der Waal and Skelton (1984) recorded it from deep water and sandy substrate areas in the Caprivi.

Cyprinodontidae

*Aplocheilichthys macrurus* (Castelnau 1861) is distributed throughout the system and was collected from shallow water with a rocky substrate and side streams with vegetation. Further investigation is required to confirm the identity of this species in the Kunene River (Skelton pers. comm.).

*Aplocheilichthys johnstonii* (Günther 1893) is distributed throughout the system. It was collected from side streams with a rocky substrate and in shallow water in the main stream with a rocky substrate. In the Limpopo River System it appears to prefer clear pools and slow flowing sections with vegetation (Gaigher 1973).

Cichlidae

*Oreochromis macrochir* (Boulenger 1912) is evenly distributed throughout the system. It prefers slow, shallow water, but was also collected in rapids. Van der Waal and Skelton (1984) however listed it from deep water and swamp habitats in the Caprivi.

*Oreochromis andersonii* (Castelnau 1861) is not common in the Kunene River but was collected throughout the system. It was mainly collected in isolated pools and rapids.

*Pseudocrenilabrus philander* (Weber 1897) is widely distributed in various habitats which include rapids and vegetated pools. Bruton and Kok (1980) reported it to be abundant in vegetated pans in Maputaland.

*Sargochromis coulteri* (Bell-Cross 1975) is present throughout the system. It was sampled in slow, shallow water over sandy substrate. Bell-Cross (1975) recorded it from fast flowing water over alternatively stone and soil substrata.

The status of the *S. codringtonii/giardi* complex needs further investigation. Greenwood (1984) considers that at present it is not possible to refer Kunene specimens with certainty to either *S. codringtoni* (Boulenger 1908) or *S. giardi* (Pellegrin 1904).

*Serranochromis angusticeps* (Boulenger 1907) has not yet been collected below the Epupa Falls. The preferred habitats are shallow water and floodplains. Winemiller and Kelso-Winemiller (1991) indicate the preferred habitat to be vegetated areas and shallow backwaters as well as floodplains.

*Serranochromis macrocephalus* (Boulenger 1899) is present throughout the system with a wide habitat range, including floodplain areas, deep water and rapids. Trewavas (1964) reported it to be present in open water.

*Tilapia sparrmanii* (Smith 1840) is distributed throughout the system and was collected mainly from floodplain areas with a preference for well-vegetated pools. Gaigher (1969) reported it to be present in the Incomati River System in vegetated pools.

*Tilapia rendalli* (Boulenger 1896) is widely distributed throughout the system. It was located in rapids, the main stream as well as side streams. Philippart and Ruwet (1982) considered temperature and salinity to be the major factors limiting the distribution of this species. Gaigher (1969) also reported that temperature and the absence of aquatic vegetation limits their distribution.

*Thoracochromis buysi* (Penrith 1970) is distributed throughout the system. It was found to be the dominant cichlid, especially in the lower reaches. This species was collected from a wide variety of habitats.

*Thoracochromis albolabris* (Trewavas and Thys van den Audenaerde) is distributed throughout the system. It was collected in swampy areas, the main stream as well as shallow water with a rocky substrate.

Nineteen marine species are listed from the Kunene River mouth of which 13 species were collected during these surveys. *Arius latiscutatus*, *Cheilopogon milleri* (Gibbs and Staiger 1970), *Galeiodes decadactylus* (Bloch 1795),

*Pomadasys jubilini* (Cuvier 1830) and *P. rogeri* (Cuvier 1830) are recorded for the first time from the Kunene River mouth. *Cheilopogon milleri* is an oceanic species and is not considered to be a permanent inhabitant of the river mouth. *Batanga lebretonis* (Steindachner 1870), *Eleotris vittata* (Dumeril 1860), *Chonophorus guineensis* (Peters 1876), *Nematogobius ansorgei* (Boulenger 1910), *Mugil cephalus* (Linnaeus 1758) and *Liza falcipinnis* (Valenciennes) were the only marine species present in fresh water. Except for *L. falcipinnis* the former species were sampled in isolated pools with fresh water as far as eight kilometers upstream of the mouth. They were associated with fresh water species such as *Barbus paludinosus*, *B. trimaculatus/poechii*, *Tilapia rendalli* and *Oreochromis andersonii*.

SPECIES NOT RECORDED DURING PRESENT SURVEY:

Due to limited time spent at Calueque, several floodplain-loving species were not collected including *Aplocheilichthys katangae* (Boulenger 1912), *Barbus barotseensis* (Pellegrin 1920), *B. bifrenatus* (Fowler 1935), *B. multilineatus* (Worthington 1933), *Clarias theodorae* (Weber 1897), *Hemigrammocharax machadoi* (Poll 1967), *H. multifasciatus* (Boulenger 1923) and *Rhabdalestes maunensis* (Fowler 1935). Cichlids such as *Sargochromis codringtonii*, *S. greenwoodi* and *S. robustus jallae* which prefer standing deep water habitats were also not collected. These habitats are uncommon in the lower reaches of the system.

Mormyridae

*Hippopotamyrus discorhynchus* (Peters 1852) is present above the Ruacana Falls (Namibian State Museum collection). This species needs further confirmation. It's habitat preference appears to be the larger waterways.

Kneriidae

Specimens recently collected by Griffin and Eyre at Okavanje (Freshwater Fish Institute NHF 425a), in a southern tributary of the Kunene River, had been identified as *Kneria polli*. *Kneria polli* was described by Trewavas (1936) from Mt. Moco, Angola, in the Cuvo River System. Poll (1967) also recorded it from Serra do Chela with neither being part of the Kunene River System. *Kneria maydelli* was described by Ladiges and Voelker (1961) from the type locality Ruacana. Bell-Cross (1982) listed *K. angolensis* (Steindachner 1866) from the Kunene River and it has also been given in the Okavango/Upper Zambezi River System by Ladiges (1964), Bell-Cross (1966) and Poll (1967). An unidentified *Kneria* sp. is listed in the Namibian State Museum collection and was collected from the Ondato River, a southern tributary of the Kunene. Thus three *Kneria* spp. are listed from the Kunene River, but re-examination of the specimens is required to establish their identification.

Characidae

*Brycinus humilis* (Boulenger 1905) is listed by Ladiges(1964), Poll (1967) and Bell-Cross (1982) but the status of this species is still not certain and it is currently assigned to *B. lateralis* (Skelton pers. comm.).

Bethune and Roberts (1991) listed *Hydrocynus vittatus* from the Kunene River. However this is an error as the species was not taken during the present survey nor is there any other known records of it in the Kunene River.

*Micralestes argyrotaenia* (Trewavas 1936) is listed by Ladiges(1964), Jubb (1967), Poll (1967) and Bell-Cross (1982), but is currently assigned to *Micralestes acutidens* (Skelton pers. comm.).

*Rhabdalestes maunensis* has only been collected above the Ruacana Falls (Van der Waal 1991). It has been reported to have a preference for swampy areas. Van der Waal (1991) sampled it in the Olushandja Dam (Cuvelai System) which consists of swamp and floodplain habitats.

Distichodontidae

*Hemmigrammocharax machadoi*(*Nannocharax monardi*) has not yet been collected below the Epupa Falls. Preferred habitat appears to be shallow water with dense aquatic vegetation (Bell-Cross & Minshull 1988).

The distribution of *Hemmigrammocharax multifasciatus* (*Nannocharax fasciolaris*) appears to be limited to above the Ruacana Falls (Nichols & Boulton 1927). The habitat preference is shallow water with dense aquatic vegetation (Bell-Cross & Minshull 1988).

Cyprinidae

*Barbus afrovernayi* (Nichols and Boulton 1927) is present below the Epupa and above the Ruacana Falls and prefers vegetated areas of rivers and swamps and requires well oxygenated waters.

The record of *B. barotseensis* is dubious. *Barbus annectens* (Gilchrist and Thompson 1917), which is currently assigned to *B. barotseensis*, is listed by the State Museum of Namibia. Jubb (1967) also pointed out the close similarity between these species. Vegetated areas appear to be the preferred habitat.

*Barbus bifrenatus* is absent below the Epupa Falls. This species was taken mainly in running water with vegetation. Van der Waal (1991) collected it from running oshanas in the Cuvelai System, but considers it as an unsuccessful invader of the oshanas in Owambo.

*Barbus breviceps* was sampled at Okavanje in a stream south of the Kunene River by Griffin and Eyre (Freshwater Fish Institute NHF 425b). The stream forms permanent pools and therefore will reach the Kunene River after sufficient rains. The species is only known from the type

locality which is 100 km south-east of Quibala, Angola, in the Longa River System (Trewavas 1936). Pellegrin (1936), Ladiges (1964) and Poll (1967) identified *B. burgi* (Boulenger 1911) from the Kunene River. *Pseudobarbus burgi* is confined to the south-western Cape and listed in the Red Data Book-Fishes (Skelton 1987) and has been misidentified from the Kunene River (Skelton pers. comm.). Another closely related species, *B. anoplus* (Weber 1897), was reported from the Gaub River which is a tributary of the Kuiseb River (Dixon & Blom 1974). Re-examination of *B. anoplus* is required to confirm its identity.

*Barbus codringtonii* (Boulenger 1908) has only been listed from the Kunene River by Ladiges and Voelker (1961), Jubb (1967) and Poll (1967). *Barbus codringtonii* was not found during these surveys. The occurrence of *B. codringtonii* in the Kunene River requires confirmation.

*Barbus lineomaculatus* (Boulenger 1903) has only been collected above the Ruacana Falls (Poll 1967). It appears to have a wide habitat tolerance. This species was collected in well oxygenated water in the Limpopo River System (Gaigher 1973).

*Barbus multilineatus* has been collected above the Ruacana Falls (Namibian State Museum collection) and prefers quiet waters with dense aquatic vegetation (Bell-Cross & Minshull 1988).

*Barbus dorsolineatus* (Trewavas 1936) is listed by Bell-Cross (1966, 1982) from the Kunene River. The type locality is from a tributary of the Catumbela River. Ladiges (1964) and Poll (1967) reported it from the Angolan basin, but not from the Kunene River.

*Barbus puellus* (Nichols & Boulton 1927) was described from Chitau in Angola which forms part of the Quanza drainage basin (Nichols & Boulton1927). AlthoughBell-Cross (1966, 1982), Jubb (1967) and Poll (1967) listed this species, its presence in the Kunene River is questioned.

*Barbus argenteus* (Günther 1868) is listed by Farquharson (1962), Ladiges(1964), Jubb & Farquharson (1965),Poll (1967) and Bell-Cross (1982) from the Kunene River. Skelton (pers. comm.) suspects that juvenile *B. mattozi* in the Kunene River have been mistaken as *B. argenteus* by earlier collectors as the latter species was not collected during the present survey. Boulenger (1910-1916) also indicated the closeness of *B. mattozi* and *B. argenteus*.

*Coptostomobarbus wittei* (David and Poll 1937) was collected by Van der Waal (1991) from the Olushandja Dam in the Cuvelai System which is artificially connected to the Kunene River. Although it has not yet been collected from the Kunene River it is likely to be present. The preferred habitat is floodplains and it is therefore expected to be collected in the upper reaches.

Amphiliidae

*Leptoglanis rotundiceps* (Hilgendorf 1905) has not yet been collected below the Epupa Falls (Namibian State Museum collection). This species is restricted to shallow water with a sandy substrate (Bell-Cross & Minshull 1988).

Clariidae

*Clarias theodorae* has only been collected between the Ruacana and Epupa Falls. Skelton and Teugels (1991) reported it to have a wide distribution and it is therefore expected to be present throughout the Kunene River. It is often collected in shallow water with vegetation as well as in rapids (Bell-Cross & Minshull 1988).

Pellegrin (1936) and Ladiges (1964) reported the presence of *C. dumerilii* (Steindachner 1866) in the Kunene River. The distribution of *C. dumerilii* is confined to the Zaire River System (Teugels 1982). Skelton and Teugels (1991) pointed out the similarities with *C. liocephalus* (Boulenger 1898).Whether *C. dumerilii* collected by Pellegrin (1936) and Ladiges (1964) is *C. liocephalus* still needs confirmation. The distribution of the latter species as indicated by Skelton and Teugels (1991), however, does not include the Kunene River.

Mochokidae

Bell-Cross (1966, 1982) and Jubb (1967) listed *Chiloglanis neumanni* (Boulenger 1911) from the Kunene River. *Chiloglanis angolensis* (Poll 1967), which is probably a synonym for *C. neumanni*, was reported from the Angolan coastal basin by Poll (1967). The presence of this species should be further investigated. It appears to prefer rapids and was also collected in isolated pools.

*Synodontis macrostoma* (Skelton and White 1990) is restricted to rocky environments and is present above the Ruacana Falls and *Synodontis thamalakanensis* (Fowler 1935) is present between the Ruacana and Epupa Falls.

Cyprinodontidae

*Aplocheilichthys katangae* has been collected below the Epupa Falls and above the Ruacana Falls (Namibian State Museum collection). The habitat appears to be swamps as well as clear pools and slow flowing water with abundant vegetation (Gaigher 1973).

Cichlidae

*Chetia welwitschi* (Boulenger 1898) was collected by Welwitch (Boulenger 1898) at Huila and by Pellegrin (1936) from the Cusso River, a tributary of the Kunene River. Ladiges (1964) and Poll (1967) reported it from the Angolan basin, but not from the Kunene. It appears to prefer swampy areas.

*Orthochromis machadoi* (Poll 1967) has been collected throughout the system. It is endemic to the Kunene River System (Greenwood 1984).

*Pharyngochromis darlingi* (Boulenger 1911) has been re-assigned to *Ph. acuticeps* (Regan 1922) by Greenwood (1992). It was collected by Poll (1967).

*Sargochromis greenwoodi* (Bell-Cross 1975) was not found below the Epupa Falls. Bell-Cross (1975) reported it to have a preference for slow water covered with aquatic vegetation.

*Serranochromis altus* (Winemiller and Kelso-Winemiller 1991) was described by Winemiller and Kelso-Winemiller (1991) from the Upper Zambezi River. It has been confused with *S. angusticeps*. *Serranochromis altus* is distinguished from *S. angusticeps* on morphometric characters and colour patterns especially the absence of distinct speckles on the face and chest and eye stripes that are characteristic of *S. angusticeps*. *Serranochromis altus* is likely to be present in the Kunene River, but further investigation is necessary. This species is a main stream dweller.

*Serranochromis robustus jallae* (Boulenger 1896) has not been recorded below the Epupa Falls (Namibian State Museum and Bell-Cross 1966). Larger specimens are mainly present in open waters with a slow current. Aquatic vegetation is also preferred.

Material submitted by Van der Waal to the J.L.B. Smith Institute of Ichthyology, Grahamstown, (Rusi no. 35354) has tentatively been identified as *Sargochromis gracilis*. However further investigation and specimens are needed to confirm the identification. This species is known only from the Cutato River in Angola which forms part of the Okavango drainage basin (Greenwood 1984).

*Serranochromis thumbergi* (Castelnau 1861) has not yet been collected below the Epupa Falls (Namibian State Museum collection). This species prefers flowing waters.

Representatives of the families Anguillidae, Anabantidae, Aplocheilidae and Mastacembelidae are all absent from the Kunene River. These are present from the neighbouring Okavango/Upper Zambezi River System. Species from the families Anabantidae and Mastacembelidae have been recorded by Bell-Cross (1982) from the Quanza River which forms part of the same watershed as the Kunene River. These families are encountered mainly from floodplain areas which dominate the upper reaches of the Kunene River. Their absence could therefore be related to the few collections made in these areas in recent years. Neither Pellegrin (1936), Ladiges and Voelker (1961), Ladiges (1964) nor Poll (1967), who performed surveys in the upper reaches, reported these families from the Kunene River. In contrast the Kunene River has a high degree of endemism in the haplochromine species such as *Thoracochromis buysi*, *Th. albolabris*, *Orthochromis machadoi* and *S. coulteri*. A further three species, *Barbus breviceps*, *B. dorsolineatus* and *Labeo ansorgii* from the Kunene River are endemic to Angola.

The influx of sea water into the mouth depends on the flow in the river itself and a true estuary is not present. Penrith (1982) stated that the total dissolved solid concentration rarely exceeded 2000 mg/l but a total dissolved solid concentration of 34254 mg/l was recorded during the 1990 survey (Table 2). The salinity is likely to decrease during late summer with an increase in river flow. This would result in an influx of fresh water species, especially cichlids, as these fish are known to move to and from saline lagunes with fluctuating waterlevels (Day *et al.* 1981).

## CONCLUSION

When considering species diversity several anomalies appear. *Hydrocynus vittatus* is absent from the Kunene River. On the other hand *B. mattozi* and *L. ruddi* are present in the Kunene River, skip the Okavango/Upper Zambezi River System and reappear in the Limpopo System. The genus *Chetia* exhibits a similar distribution with *Chetia flaviventris* being present in the Limpopo River System and *C. welwitschi* in the Kunene River. Both species are absent in the Okavango/Upper Zambezi System. In the family Cichlidae *S. carlottae*, *S. longimanus* and *T. ruweti* have been identified from the Okavango/Upper Zambezi River System with no record from the Kunene River System. Bell-Cross (1982) suggested that these anomalies may be traced to an early diversion of the Kunene River from a western basin of internal drainage from which many tropical southern Africa fishes are associated.

The Epupa and Ruacana Falls form formidable barriers to upstream migration. Despite these barriers no faunal separation appears to be present. The absence of several species from some river sections is probably due to their not being collected rather than them not being present. Habitat preferences and especially the large difference between the nature of the upper reaches and the middle and lower reaches seems to be the major factor limiting the distribution of the species.

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