The distribution of fish in the Fish River, Namibia

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ABSTRACT

Fifteen fish species were recorded from the Fish River, Namibia, including two hybrids, which were confined to the area near Hardap Dam. A waterfall near Witputs prevented the dispersal of some small species upstream. Three species exotic to the Fish River were recorded. *Oreochromis mossambicus* (Peters, 1852), *Cyprinus carpio* (Linnaeus,1758) and *Tilapia rendalli* (Dumeril, 1859). *Barbus hospes* (Barnard, 1938), a Red Data species (Skelton 1987), was found to be abundant in the system.

INTRODUCTION

The Fish River originates in the Nauchas Highlands in the western Rehoboth district of central Namibia and flows in a southerly direction for approximately 800 km to join the Orange River 120 km from the sea (Simpson 1956) (Fig. 1). Two waterfalls occur near Tses in Namaland (about 10 m high) and near the farm Witputs (about 5 m high). Two major dams are situated in the Fish River system, the large Hardap Dam near Mariental and the smaller Naute Dam on the Löwen River, a tributary near Keetmanshoop.

No detailed information was previously available on the fishes of the Fish River. Records at the Institute at Hardap of a survey by Bloemhoff in the early seventies were not published, and this survey is of limited use because collective names were used for the smaller *Barbus* spesies. The *Barbus aeneus* X *Barbus kimberleyensis* hybrid is referred to as *B. cf. kimberleyensis* (Gaigher 1976) in this paper.

MATERIALS AND METHODS

The survey was carried out during September 1989 except in the Witputs area which was surveyed in May 1990. The apparatus used depended on the habitat, and consisted of multifilament gill nets of 35, 45, 57, 73, 93, 118 and 150 mm mesh sizes, and 30 m anchovy mesh seine net.

The larger species were weighed and measured (to nearest 1 g and 1 cm respectively, and sexed. A subsample of the smaller species were collected. The following codes, according to the procedures of Nikolsky (1963), were used to access the developmental stages of the gonads:

1 = undeveloped gonads (resting gonads)
2 = developing gonads
3 = developed gonads
4 = gonads spent

Morphometric characteristics which were determined for the identification of *B. aeneus* (Steindacher, 1894) and *B. kimberleyensis* (Gilchrist & Thompson, 1913) are as follows.

Standard length / Body depth	(SL/BD)
Head length / Eye diameter	(HL/ED)
Head length / Head width	(HL/HW)
Standerd length / Head length	(SL/HL)
Snout length / Opercular groove	(SN/OG)
Opercular groove / Head length	(OG/HL)

The identification of certain species was assisted and confirmed by Dr. Skelton at the JLB Smith Institute of Ichthyology, Grahamstown, South Africa.

The taxonomic status of the yellowfish populations at Kub and Sunnyside are uncertain. These populations are dealt with as pure populations and compared with the populations of the lower reaches where pure populations of *B. aeneus* and *B. kimberleyensis* exist. Student t-tests were used to determine the significance of the data. The SN/OG ratio is used as it is the main morphological difference between *B. aeneus*, *B. kimberleyensis* and the hybrid (Van Vuuren et al. 1989).

Water was analysed from each location by means of a HACK DR/EL 4 spectrophotometer.

The locations are divided into two sections for the examination of the yellowfishes (Fig. 1). Collecting sites 1 - 4 and collecting sites 6-11. The habitats of the different collecting sites are listed in Table 1.

RESULTS

The results are summarised in Tables 2-4.

Family Cyprinidae

Barbus cf. kimberleyensis

The majority of the sexed fish were in a reproductively inactive stage. Only two male individuals, with a minimum length of 19 cm and one female with a length of 38 cm had developed gonads. The female to male sex ratio was 0,81:1 which corresponded with the finding of Schrader (1986) of 0.61:1 in Hardap Dam. The largest specimen was a female of 67 cm, caught at Sunnyside, which resembled *B. kimberleyensis*.

No significant difference (SN/OG ratio) was found between *B. aeneus* caught at Kub and those caught in the lower reaches which definitely resembled *B. aeneus* ($t = 1,52$; $df = 78$; $p > 0,05$) (Table 4). The comparison between populations at Sunnyside and those in the lower reaches differ significantly ($t = 3,75$; $df = 107$; $p < 0,05$). Similarly for *B. kimberleyensis*, no significant difference was found between populations at Kub and those in the lower reaches ($t = 0,203$; $df = 25$; $p > 0,05$), while at Sunnyside there was a significant difference ($t = 2,203$; $df = 28$; $p < 0,05$). The yellowfishes at Sunnyside taken as one population and compared with *B. cf. kimberleyensis* at sites 7 - 10 showed a significant difference ($t = 4,27$; $df = 114$; $p < 0,05$). The yellowfish population at Sunnyside is probably a mixture of pure and hybrid individuals. It thus differs from both the pure and the hybrid populations.

Barbus aeneus (Steindacher, 1894)

B. aeneus is the most abundant large *Barbus* species in the lower

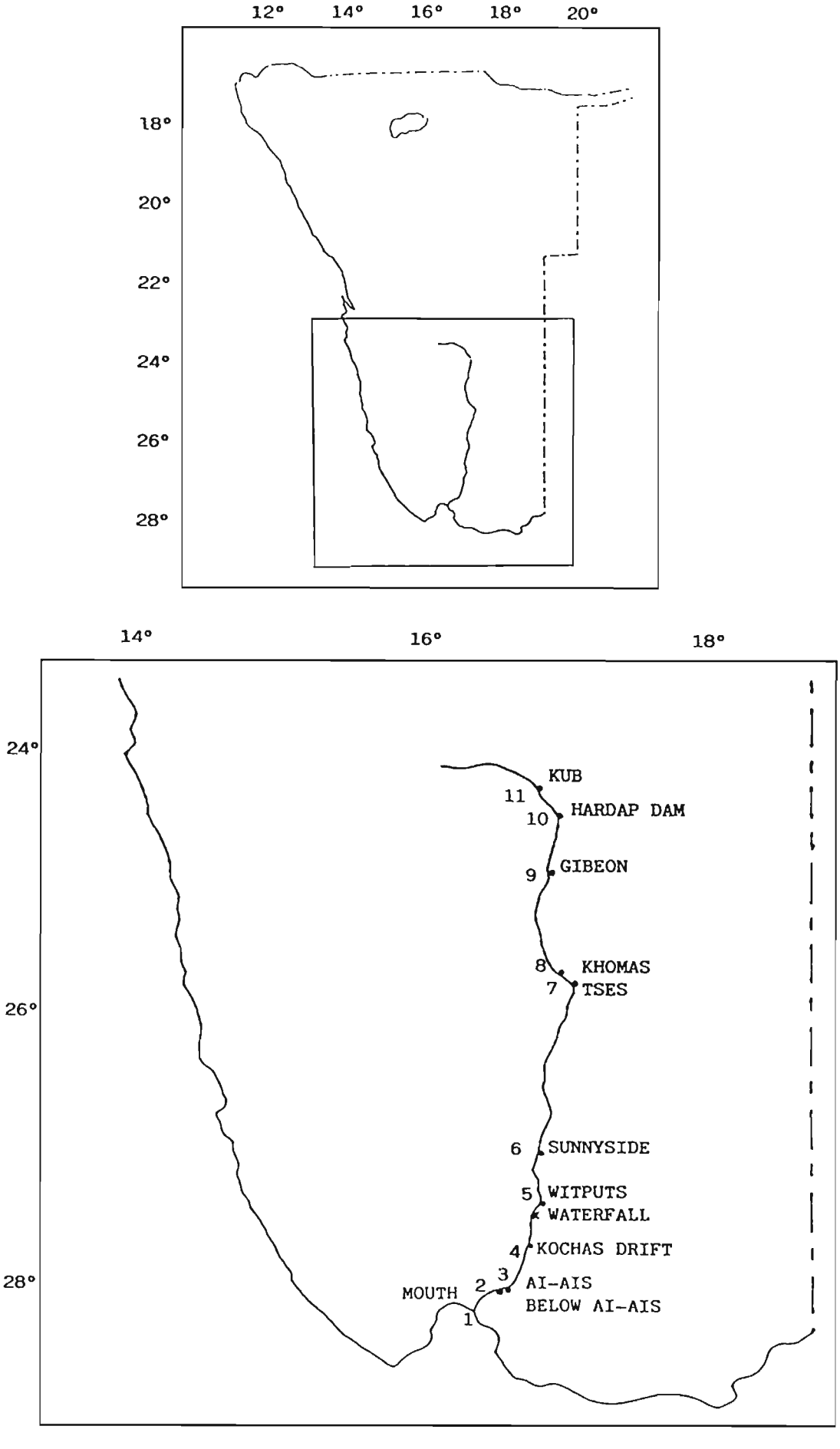

FIGURE 1: Map of study area, Fish River, Namibia

TABLE 1: Habitats at collecting sites in the Fish River

Collecting site	Dimension (m)	Depth (m)	Substrate	Vegetation
Confluence at Orange River	30 x 300	2	Clay	*Phragmites australis*
15 km below Ai-Ais	50 x 400	1.5	Sand and clay	*P. australis*
Ai-Ais	30 x 180	1.5	Sand and gravel	*P. australis & Tamarix usneoides*
Kochas Drift	40 x 500	1.5	Clay	*T. usneoides*
Witputs	40 x 100	1.5	Sand	*P. australis*
Sunnyside	40 x 600	4	Sand and clay	*P. australis*
Tses	40 x 800	4	Sand and rock	No vegetation
Khomas	30 x 150	1.5	Sand	No vegetation
Gibeon	80 x 600	1.5	Sand	Grassy vegetation
Below Hardap Dam	50 x 600	4	Sand and rock	*P. australis*
Kub	40 x 800	2	Sand	*P. australis*

TABLE 2: Distribution of fish species in the Fish River: Namibia

	Kub	Below Hardap dam	Gibeon	Khomas		Tses	Sunnyside	Witputs		Kochas Drift	Ai-Ais	Below Ai-Ais	Mouth
B. cf. kimberleyensis	X	X	X	X	W	X	X		W				
B. aeneus					A				A	X	X	X	X
B. kimberleyensis					T				T	X	X	X	X
L. capensis	X	X	X	X	E	X	X		E	X	X	X	X
O. mossambicus	X	X	X	X	R	X		X	R		X		
L. umbratus	X	X			F	X	X		F				
Labeo hybrid	X	X	X	X	A	X			A				
C. caprio		X	X	X	L	X			L		X		
C. gariepinus	X	X	X	X	L	X	X	X	L	X	X	X	X
T. rendalli		X											
T. sparrmanii		X											
B. paludinosus	X	X	X	X		X	X	X			X		X
B. hospes										X	X	X	X
M. brevianalis										X	X	X	X
B. trimaculatus										X	X		

TABEL 3: Result of gillnet catches in the Fish River: Namibia

	Kub	Below Hardap dam	Gibeon	Khomas		Tses	Sunnyside		Kochas	Ai-Ais	Below Ai-Ais	Mouth	Total
B. cf. kimberleyensis	20	300	1	5	W	12	38	W					376
B. aeneus					A			A	1	3	1	17	22
B. kimberleyensis					T			T	2	3	2	3	10
L. capensis	127	285	42	38	E	193	147	E	35	45	26	30	968
O. mossambicus	8	72	185	1	R	11		R		1			278
L. umbratus	14	55			F	31	4	F					104
Labeo hybrid	9	156	8	4	A	4		A					181
C. carpio		1	1	1	L	2		L		1			6
C. gariepinus	21	1	11	2	L	16	26	L	2	9	2	14	104
B. paludinosus				2									2

TABEL 4: Morphometric data of the yellowfishes with the sample size, mean and standard deviation

	Barbus kimberleyensis			*Barbus aeneus*			*Barbus cf. kimberleyensis*
	Lower reaches	Sunnyside	Kub	Lower reaches	Sunnyside	Kub	Sites 7 - 10
n	24	5	2	61	47	18	63
SL/BD	4.731 ± 0.321	4.464 ± 0.239	3.980 ± 0.283	4.095 ± 0.350	4.234 ± 0.272	3.962 ± 0.250	4.171 ± 0.233
HL/ED	5.762 ± 1.596	7.060 ± 2.483	5.375 ± 1.888	4.937 ± 0.656	5.175 ± 1.233	4.968 ± 0.536	6.203 ± 0.699
HL/HW	2.270 ± 0.266	2.062 ± 0.232	1.750 ± 0.269	2.029 ± 0.191	1.997 ± 0.175	1.827 ± 0.158	1.967 ± 0.241
SL/HW	3.668 ± 0.242	3.588 ±0.189	4.115 ± 0.149	3.930 ± 0.223	3.961 ± 0.321	4.018 ± 0.221	4.104 ± 0.189
SN/OG	1.083 ± 0.085	1.184 ± 0.134	1.070 ± 0.042	1.482 ± 0.144	1.372 ± 0.160	1.425 ± 0.120	1.246 ± 0.148
OG/HL	0.263 ± 0.033	0.270 ± 0.044	0.245 ± 0.050	0.211 ± 0.021	0.226 ± 0.031	0.204 ± 0.013	0.251 ± 0.025

Fish River (Collecting sites 1-4), representing 80% of the yellowfishes caught at these locations. 24% of the sexed fish had gonads in a developing stage. The largest was a male of 42 cm. The largest mature female was 36 cm. A sex ratio of 0.88 males to 1 female was found.

Barbus kimberleyensis (Gilchrist & Tompson, 1913)

A total of 28 specimens were caught during the survey (Collecting sites 1-4). The sexed fish were in a reproductive dormant stage, the largest specimen caught was a male of 54 cm. The sex ratio was 0.2 males to 1 female.

Labeo capensis (Smith, 1841)

L. capensis was the most abundant fish representing 43% of the total of the larger species caught. The male/female sex ratio was 0.65:1 with the majority of the fish in a dormant stage. 64% of the specimens larger than 30 cm were females; the largest was a female of 47 cm. *L. capensis* was found to be the most abundant fish in Hardap Dam (Schrader 1986; Gaigher & Bloemhoff 1975) with a sex ratio of 1:1 (Schrader 1986) and more females in the higher length classes.

Labeo umbratus (Smith, 1841)

L. umbratus was present at collecting sites 6 to 11. No specimens were collected in the lower Fish River.

L. capensis X L. umbratus hybrid

The hybrid was present at collecting sites 7-11. The highest concentration was near Hardap Dam (Table 3). The sex ratio was 0.64 males to 1 female. The largest specimen was a 51 cm female. The sexed fish were in a dormant stage except for those at Kub which were in a developed stage.

Cyprinus carpio (Linnaeus, 1758)

Only 10 specimens were collected during the survey with one individual in the Lower reaches caught at Ai-Ais. The smallest specimen was a male of 24 cm caught at Gibeon which suggests that breeding does not occur in the Fish River.

Barbus paludinosus (Peters, 1852)

B. paludinosus was present throughout the system but was more numerous in the upper reaches. It was found during a survey in May 1990 together with *Clarias gariepinus* in the Guruchab River, a tributary of the Fish River, at a water temperature of 14.5°C. The largest specimen collected was 8 cm. No specimens were collected at Kochas Drift and at site 2 although individuals might be present.

Barbus hospes (Barnard, 1938)

B. hospes was collected at sites 1-4. It was numerous and together with *Mesobola brevianalis* was the dominant small fish species collected in the lower Fish River. The largest specimen was 7 cm.

Mesobola brevianalis (Boulenger, 1908)

M. brevianalis was abundant and seems to flourish in the Fish River. It represented 57% of the fish collected in the middle and lower Orange River by Cambray in March 1982 (Cambray 1984). The largest specimen caught was 6 cm.

Barbus trimaculatus (Peters, 1852)

Only eight individuals were collected at sites 3 and 4 with the largest a specimen of 7 cm.

Family Cichlidae

Oreochromis mossambicus (Peters, 1852)

O. mossambicus was collected during the September survey at sites 7-11 as well as at Ai-Ais, and at Witputs during May. The sex ratio was 0.7 females per male with the gonads of the sexed fish in a developing stage. Schrader (1986) found a 1.6 female per male ratio in Hardap Dam. The largest specimen collected was a male of 40 cm.

Tilapia rendalli (Dumeril, 1859)

Five specimens were collected beneath the Hardap Dam in a pool covered with vegetation and rocks. They probably escaped from the Fresh Water Institute where they are being bred for distribution to the northern areas of Namibia. No live specimens remain as the pool has since dried up.

Tilapia sparrmanii (Smith, 1840)

Twelve specimens were caught in the same pool below Hardap Dam. *T. sparrmanii* is bred at the Fresh Water Institute from where it probably escaped. The possibility exists that *T. sparrmanii* is present in the lower Fish River as it was collected by Bloemhoff in 1971 at Ai-Ais (unpublished data).

Family Clarridae

Clarias gariepinus (Burchell, 1822)

C. gariepinus was collected at all the collecting sites, emphasising their tolerance of a wide range of environmental conditions.

The sex ratio was 1:1 with the majority of the males in a developing and the females in a resting stage. Eight males were in an active stage. The largest specimen, 129 cm, was collected at Kub (site 11) in a seine net. The stomach contents of all the fish collected at Gibeon consisted mainly of *Orechromis mossambicus*, insects and plant material. Nematodes were also present in the stomach contents that entered via *O. mossambicus* which were infected.

DISCUSSION

The survey was aimed mainly at obtaining information on the distribution of the 15 fish species in the Fish River and the effect the hybrids in Hardap Dam might have on the rest of the system.

The waterfall at Witputs prevented the dispersal of *B. hospes*, *B. trimaculatus* and *M. brevianalis* further upstream (Table 2).

The genetic status of the yellowfishes in the Fish River are being threatened by hybridization. Evidence of hybridization was found up to 400 km downstream although further studies are needed before the taxonomic status of the Hardap Dam population can be proven beyond doubt (Van Vuuren et al. 1989). Identification by staff at the J L B Smith Institute of Ichthyology confirmed that pure individuals as well as hybrids are present at Kub and Sunnyside. The identification was based on morphological features which have certain limitations. To overcome these, electrophoretic analysis are needed.

The high concentration of *B. cf. kimberleyensis* near Hardap Dam (Table 3) confirms that this species prefers lentic conditions that exist in the dam (Gaigher 1976). It is not dependent upon an annual spawning migration for reproduction. *B. cf. kimberleyensis* does not seem to have a negative effect on the system as it does not find the isolated pools favourable for reproduction.

It seems that the locations from Kochas Drift southwards to the mouth consists mainly of pure populations of *B. aeneus* and *B. kimberleyensis* although it is possible that hybrids could be present. These hybrids could be washed down into the Orange River, but the flow of water would probably limit their chance of survival.

L. capensis inhabits a wide range of habitats and does not have a specific spawning migration (Mulder 1973). This is also obvious in the Fish River where it is abundant at all locations. It is not clear why *C. carpio* is so uncommon in the Fish River because it can tolerate a wide range of habitat conditions and temperatures (Jubb 1978). *C. carpio* poses no threat to the system as it breeds mainly in Hardap Dam, and a length frequency analysis (Schrader 1986) indicates a possible decrease in the Hardap Dam population. Table I indicates that this species does not favour the lower reaches except for Ai-Ais which is densely vegetated.

O. mossambicus is a thermophilic species (Allanson et al. 1964) with a preferred temperature range of 27° C to 33.5° C (Badenhuizen 1967). Temperature is therefore probably the main factor that prohibits further dispersal as it was only found at Ai-Ais in the lower Fish River where the temperature was sufficiently high and where dense vegetation was present.

The population at Witputs was probably that year's offspring that had not yet encountered low temperatures. *O. mossambicus* would probably be present throughout the Fish River after the rainy season when the water temperature was higher. The temperature at Witputs in May was 16.5° C and it would be expected to decrease in winter, resulting in the mortality of this species.

L. capensis X *L. umbratus* and *L. umbratus* were only present in the vicinity of Hardap Dam indicating their preference for still water conditions. No juveniles were found confirming the fact that this species does not breed in the system. Schrader (1986) states that *L. umbratus* breeds mainly in tributaries.

The low number of *B. trimaculatus* could be attributed to its dependence on rapids for breeding purposes as well as its preference for perennial streams (Gaigher 1973). Cambray (1984) found that the flow regulation in the Orange River benefitted *B. hospes*. It would therefore be important to monitor this species during periods of drought when no lotic conditions exist in the Fish River.

The sluices of Hardap Dam were opened during February 1989 and this could have contributed to the present species combination and the population structure of the system. The separation of the yellowfishes could, therefore, be more distinct during drought when the sluices are not opened.

It is important to monitor the distribution of the hybrids in the Fish River to determine the long term effect of these species. Ai-Ais needs particular attention as it has ideal habitat for the survival of alien species, i.e. high water temperatures throughout the year and dense vegetation. Also *B. hospes* needs more attention as it is listed in the Red Data Book (Skelton 1987).

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