Aspects of the ecology of *Barbus hospes* from the Fish River, Namibia

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ABSTRACT

Environmental conditions in the Fish River affect several ecological aspects of *Barbus hospes* which emphasised the importance of the link between populations in the Fish and Orange Rivers. Higher growth and mortality rates were found for this species in the Fish River compared to those in the Orange River. Factors other than temperature seem to stimulate gonad development. The survival of *B. hospes* in the Fish River probably depends on a healthy population in the Orange River.

INTRODUCTION

Barbus hospes is listed in the South African Red Data Book-Fishes as rare in the lower Orange River (Skelton 1987). It is endemic to the lower Orange River and was collected by Cambray (1984) from below the Augrabies Falls to close to the mouth. The distribution of *B. hospes* into Namibia via the Fish River is limited to the lower reaches due to the presence of a waterfall near Witputs (Hay 1991).

The limited information on the biology of *B. hospes* is reported on by Cambray (1984) who concentrated on the effect of stream regulation on the fish fauna in the middle and lower Orange River. Although this author suggested the removal of *B. hospes* from the list of threatened species, it has been included because of its restricted distribution.

In the Fish River *B. hospes* is exposed to severe environmental conditions. The habitat consists mainly of isolated pools interconnected by periodic floods. The biggest threat to this species in the Orange River appears to be further development which increases pollution and siltation (Cambray *et al.* 1986). The aim of the current study was to determine the effect of various environmental conditions in the Fish River on the survival of *B. hospes*.

MATERIALS AND METHODS

Several isolated pools were sampled at Ai-Ais during June 1990. These pools had sandy to clay substrates with limited vegetation and with surface areas of about 200 m^2. The depths were approximately 1,5 m with water temperatures ranging between 13°C and 17°C. A 10 m x 1,5 m mosquito net with a fine mesh size and the fish poison rotenone were used to sample fish.

The length frequencies obtained for the fish from the Orange River as reported by Cambray (1984) were used for the calculation of the growth and mortality rates for the Orange River population.

Growth and mortality parameters were calculated by using the Length-based Fish Stock Assessment (LFSA) and Electronic Length Frequency Analysis (Elefan) software respectively. The methodology for obtaining these parameters is outlined in Sparre *et al.* (1989).

Growth comparison is not reliable when comparing growth parameters separately. Munro's phi prime (Ø) is the combination of the growth parameters which were used to compare the different growth rates (Sparre *et al.* 1989). The higher the phi prime value the better the growth rate. The following growth parameters are used for the determination of Munro's phi prime:

$L\alpha$ = the mathematical asymptote of the curve.
K = a measure of the rate at which the growth curve according to the growth formula approaches the asymptote.

The formula for Munro's phi prime (Ø) is as follows:

$$Ø = \ln k + 2 \times \ln l\alpha$$

Total mortality is defined as follows (Sparre *et al.* 1989):

$$Z = F + M$$

Where : Z = Total mortality
F = Fishing mortality
M = Natural mortality

With limited exploitation taking place at Ai-Ais, the natural mortality was taken as the total mortality (Z = M). The chi-square test was used to determine the significance of the deviation from a one to one sex ratio.

RESULTS AND DISCUSSION

Length frequency

A total of 341 specimens were collected with a minimum and maximum fork length of 3 cm and 7 cm respectively

(Figure 1). The length frequency peaked at the 5 cm and 6 cm length classes. Juveniles were absent at all the collecting sites. Maximum length for both sexes was the same. The minimum lengths however differed with lengths of 4 cm and 6 cm for the males and females respectively.

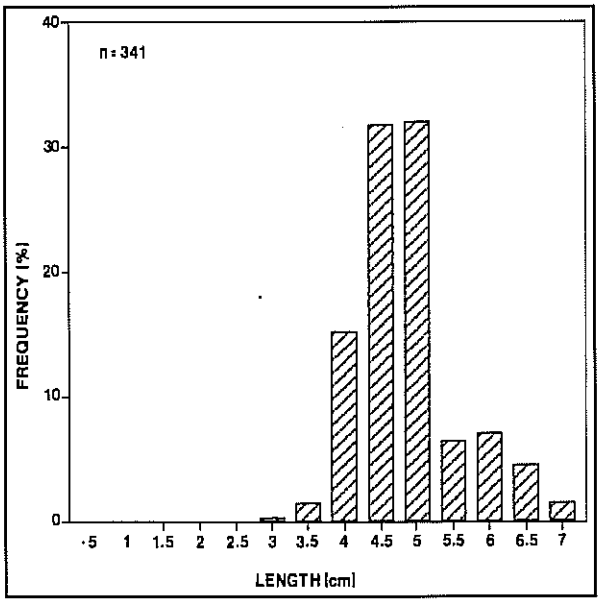

FIGURE 1: Length frequency of *Barbus hospes* from the Fish River.

Growth and Mortality

The Fish River population appears to have a higher growth rate than the Orange River population (Table 1). The growth rate for the females was slightly higher than for the males for the Fish River population (Table 1).

TABLE 1: Growth and mortality rates of *Barbus hospes* based on length frequency, sampled at Ai-Ais, Fish River (June 1990) and the Orange River (Cambray 1984).

	Fish River (June)	Fish River Males (June)	Fish River Females (June)	Orange River (March)	Orange River (September)
Lα	7,4	7,8	7,0	8,5	6,4
K	0,82	0,73	1,01	0,19	0,37
to	- 0,32	- 0,45	- 0,15	- 0,83	- 0,56
Ø	3,80	3,79	3,90	2,62	2,72
Z	1,28	1,35	1,11	0,90	0,63

The mortality rate of the Fish River population appeared somewhat higher than the Orange River population (Table 1) with a predicted survival of 28% after the first year compared to 41-53% in the Orange River (Table 2). The data suggests that males from the Fish River had a higher mortality than the females (Table 1).

Sex ratio

The population had a one to 1,73 male to female sex ratio which differs significantly from an expected one to one sex ratio (Table 3). This correlates with the results of Cambray (1984) who found a male to female ratio of 1:1,82 in the Orange River. The 4-4,5 cm length classes were the only length classes to differ significantly ($P \leq 0,05$) from a 1:1 sex ratio (Table 3).

TABLE 2: Percentage survival rate per year of *Barbus hospes* at Ai-Ais, Fish River, and the Orange River (Cambray 1984).

Year	Fish River (June)	Fish River Males (June)	Fish River Females (June)	Orange River (March)	Orange River (September)
1	27,8%	25,9%	33,3%	40,7 %	53,3 %
2	7,7%	6,7%	11,1%	16,5 %	28,4 %
3	2,2%	1,7%	3,7%	6,7 %	15,1 %

TABLE 3: The sex ratio of *B. hospes* at different length classes, sampled at Ai-Ais, Fish River, June 1990.

Length (cm)	N Fish	N♂	N♀	♂:♀	X^2	Significance level
3	1	0	1	-	-	-
3.5	5	0	5	-	-	-
4.0	51	5	46	1 : 9.2	32.960	$p \leq 0,05$
4.5	107	31	76	1 : 2.45	18.926	$p \leq 0,05$
5.0	108	54	54	1 : 1	0	$p \geq 0,05$
5.5	22	14	8	1 : 0.57	1.636	$p \geq 0,05$
6.0	24	8	16	1 : 2	2.667	$p \geq 0,05$
6.5	15	8	7	1 : 0.88	0.067	$p \geq 0,05$
7.0	5	4	1	1 : 0.25	1.8	$p \geq 0,05$
Total	338	124	214	1 : 1.73	23.964	$p \leq 0,05$

Minimum length at sexual maturity

None of the fish sampled in June had ripe gonads while 76% of the males and 21% of the females possessed developing gonads. The minimum length for male and female fish with developing gonads was 4 cm and 3,5 cm respectively. The highest percentage of developing gonads in males was present in the 5 cm length class and in females in the 6 cm length class. Gonad development was observed in water with temperatures as low as 13°C.

Stomach contents

Although no detailed analysis was done, the stomach contents contained mainly algae and sand grains. The sand grains indicate that *B. hospes* is predominantly a substrate feeder. The analysis may have been biased as the isolated pools contained a limited diversity and supply of food.

Relative abundance

Barbus hospes constituted 23,9% of the species collected at Ai-Ais, approximately the same as *B. paludinosus* (22,2%). Only *Mesobola brevianalis* (Boulenger 1908) was more abundant, at 41% (Table 4).

Figure 1 indicates that limited or no recruitment took place at Ai-Ais during the 1989/90 season. According to Cambray (1984) *B. hospes* prefers riverine conditions which have benefited from the river regulation and it breeds at localised sites along the entire lower Orange River. The fact that the Fish River flows seasonally might influence breeding success. If the assumption by Cambray (1984) is correct that *B. hospes* spawns twice during a

season, the 3 cm and 3,5 cm length classes shown in Figure 1 might have been the survivors of limited early breeding during the 1989/90 season.

TABLE 4: The relative abundance (percentage, n = 1427) of all the species sampled at Ai-Ais (June 1990).

Species	Relative abundance (%)
Barbus aeneus	1.89
Barbus hospes	23.90
Barbus paludinosus	22.21
Barbus trimaculatus	0.35
Clarias gariepinus	0.07
Labeo capensis	6.94
Mesobola brevianalis	40.93
Oreochromis mossambicus	3.71

The high growth rate in the Fish River population may be an adaptation to reach maturity in a short time period, to counteract the relatively high mortality in the Fish River, which was twice as high as that in the Orange River in September.

In the Fish River the development of the male gonads of *B. hospes* seem to start earlier in the season and have a much higher percentage development rate than those of the females. The stimulant for gonad development can be attributed to factors other than temperature since developing gonads were collected in fish at low water temperatures. The minimum length at which sexual maturity was reached (Fish River population), coincided with the Orange River population.

Barbus hospes was found to be abundant at Ai-Ais although no juveniles were collected. Migration from the Orange River may account for the high relative density at Ai-Ais. The high abundance may also be due to the lack of predators.

Barbus hospes, although abundant, does not appear to have adapted well to the lentic conditions which are present in the Fish River during most of the year. Whether successful breeding can take place during favourable conditions still remains to be seen. The present status of *B. hospes* in the Fish River indicates a possible dependence on the Orange River population for their survival. The protection of *B. hospes* in the Orange River is therefore of the utmost importance if the Fish River population is to survive the environmental conditions which exist in this system. Further studies are, however, required to shed more light on the status of *B. hospes* in the Fish River.

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