

## Short communication

# Food overlap between the alien *Oncorhynchus mykiss* and the indigenous fish species *Barbus aeneus* and *Clarias gariepinus* in a man-made lake, South Africa

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## Abstract

The introduction of *Oncorhynchus mykiss* into the Sterkfontein Dam necessitated an investigation of the food overlap between this fish species and the indigenous fish species. The Schoener index of similarity was used to determine possible food overlap between adult fish of three fish species in the Sterkfontein Dam, part of the Tugela-Vaal Water Transfer Scheme. Although the data are incomplete, indications are that the intra- and interspecific food overlap between adult fish of the fish species *Oncorhynchus mykiss*, *Barbus aeneus* and *Clarias gariepinus* was generally large.

## Introduction

Sterkfontein Dam serves as a storage reservoir for the Tugela-Vaal inter-catchment transfer scheme. About 36 000 (5.04 fish/ha) juvenile *Oncorhynchus mykiss* (rainbow trout) with a mean fork length of 18.3 cm (SD 2.25) and a mean mass of 78.5 g (SD 27.03) were released into the Sterkfontein Dam during February 1984 for fishing purposes (Dörgeleh, 1986).

The introduction of alien fish species often poses threats to native species and community stability in natural environments (Prout et al., 1990). The ecological relationship of a species with the aquatic community is partly influenced by its feeding pattern (Beauchamp, 1990). If a newly introduced fish species is a more efficient predator than the indigenous species, it may effect changes in the structure of the food resource (Lammens et al., 1985) and may competitively "exclude" these species from a common resource. Seasonal shifts in abundance, availability or vulnerability of prey species are often reflected in the diet of a predator (Beauchamp, 1990) and therefore affect the food overlap between species.

A literature review and a study of the feeding habits of three fish species (Dörgeleh, 1994), i.e. the alien *O. mykiss*, and the indigenous *Barbus aeneus* (smallmouth yellowfish) and *Clarias gariepinus* (sharp-tooth catfish), suggested a degree of overlap for food resources. *O. mykiss* has wide-ranging feeding habits extending from planktivory to piscivory (Beauchamp, 1990; Hubert et al., 1994; Swartzman and Beauchamp, 1990). Reservoir populations of *B. aeneus* may change from a primarily planktivorous to a herbivorous diet during their life-cycle (Eccles, 1983; Gaigher and Fourie, 1984), while *C. gariepinus* is euryphagous (Bruton, 1977).

Few studies on food overlap have been conducted in South Africa (e.g. Heeg and Kok, 1988). The objective of this study was to investigate the degree of food overlap between an introduced, alien fish species and two indigenous species in Sterkfontein Dam and to serve as baseline data for further, more in-depth feeding studies.

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## Study area

Sterkfontein Dam (28°23'-28°35'S and 28°58'-29°04'E) is situated in the eastern part of the Free State province (South Africa), near the summit of the lower Drakensberg escarpment, at an altitude of 1 620 m (Fig. 1). It is located on the Nuwejaar Spruit, which is a tributary of the Vaal River system. This clear water reservoir (10 NTU for about 80% of the total surface area (Dörgeleh et al., 1993) has a capacity at full supply level of  $2\,656 \times 10^6$  m<sup>3</sup>, a total surface area of 6 940 ha and a maximum depth of 82 m. Sterkfontein Dam forms part of the Tugela-Vaal Water Transfer Scheme (Dept. of Water Affairs, 1986) and serves as a storage reservoir for the Vaal Dam. Its entire water supply is pumped from the Tugela River.

## Materials and methods

Fish were collected monthly from March 1984 to March 1986 at four sites (Fig. 1) with gill nets of stretched mesh sizes 35, 50, 65, 73, 85, 100, 120 and 150 mm respectively. The contents of the oesophagi and stomachs of *O. mykiss* (n = 374) and *C. gariepinus* (n = 167), and the oesophagi and foreguts of *B. aeneus* (n = 286) were removed and analysed under a stereo microscope (Dörgeleh, 1994). The seasonal food overlap between species was determined of length groups with at least 20 fish per length group (Table 1) presented in Dörgeleh (1994).

It is recommended that at least 20 stomachs or foreguts of each group (e.g. length or sex) are examined to detect gross changes in overlap (Smith, 1985). This sample size was not achieved in all length groups and seasons, especially of fish <30 cm from indigenous species and <20 cm from *O. mykiss*. Less than 1% of all fish caught fell in these length groups. Therefore, the length intervals had to be enlarged to include 20 or more fish, or omitted from the calculations where less than 20 fish were sampled. However, it is recognised that variations in diet with size cannot be assessed accurately by combining length groups.

For the measure of food overlap among length groups of each fish species, the Schoener index of similarity (Colwell and Futuyma, 1971; Sale, 1974; Schoener, 1968) based on percentage mass was used:

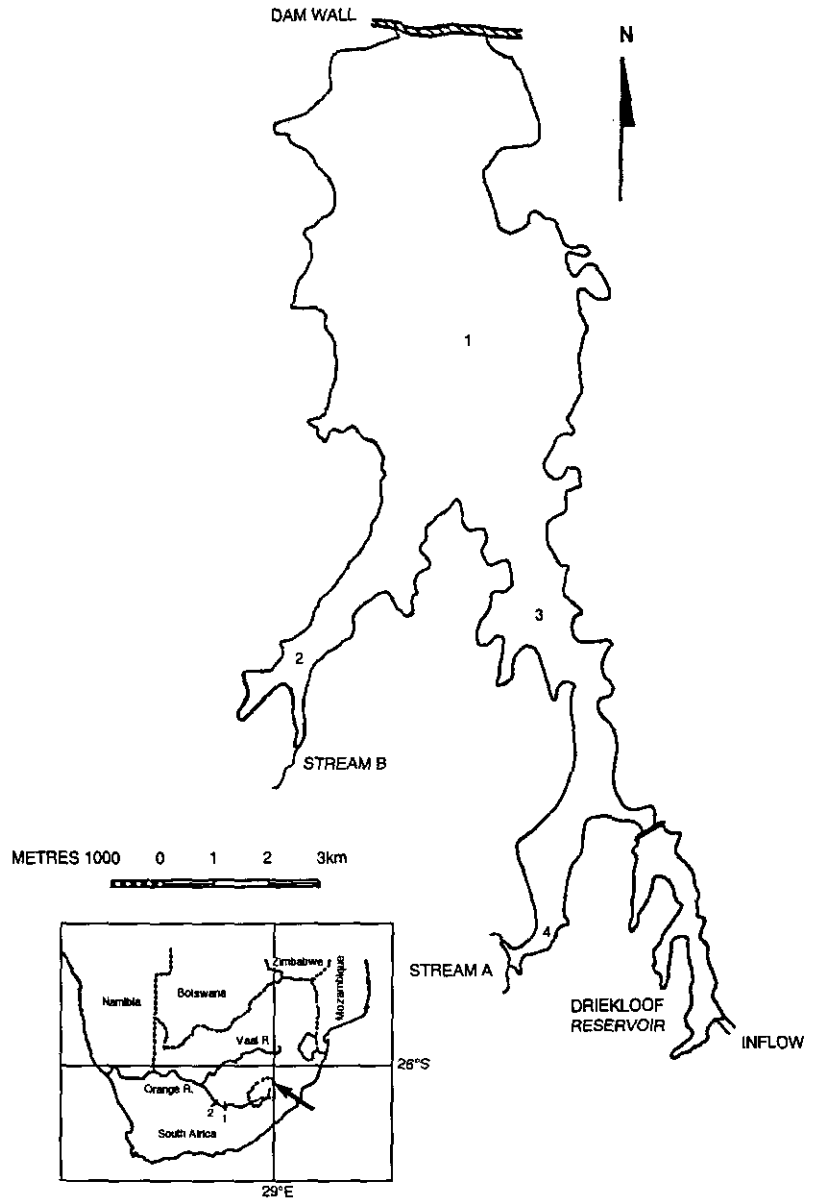
**TABLE 1**  
**FOOD TYPES EXPRESSED AS % MASS (%M) AND % FREQUENCY (%F) OF DIFFERENT LENGTH GROUPS OF O. MYKISS, B. AENEUS AND C. GARIEPINUS**  
**FOR EACH SEASON (BASED ON DÖRGELOH, 1994)**

		<i>Oncorhynchus mykiss</i>																		
Season	Length Groups	Autumn 1984		Winter 1984		Spring 1984		Summer 1984		Autumn 1984		Winter 1984		Spring 1984		Summer 1984				
		20-29.9 cm n = 20	% M	20-29.9 cm n = 77	% M	30-39.9 cm n = 73	% M	30-39.9 cm n = 128	% M	30-39.9 cm n = 59	% M	20-29.9 cm n = 20	% M	20-29.9 cm n = 77	% M	30-39.9 cm n = 73	% M	30-39.9 cm n = 59	% M	
	Zooplankton	47.9	100	42.5	49	44.9	77	21.4	37	23.9	15	49	44.6	92	26.4	89	55.6	97	57.5	100
	Micronekton	20.4	70	3.5	34	5.1	42	1.4	27	1.3	14	34	3.5	21	15.4	68	5.3	51	4.4	51
	Zoobenthos	4.4	50	1.7	21	8.1	66	16.3	77	13.0	61	73	7.7	73	8.1	66	16.3	77	13.0	61
	Plant material	1.1	65	7.7	92	26.4	89	55.6	97	57.5	100	26.2	44.6	92	26.4	89	55.6	97	57.5	100
	Unidentified	26.2	90	44.6	92	26.4	89	55.6	97	57.5	100	26.2	44.6	92	26.4	89	55.6	97	57.5	100

		<i>Barbus aeneus</i>																	
Season	Length Groups	Autumn 1984		Winter 1984		Spring 1984		Summer 1984/85		Autumn 1984		Winter 1984		Spring 1984		Summer 1984/85			
		30-39.9 cm n = 32	% M	30-39.9 cm n = 34	% M	≥40 cm n = 43	% M	30-39.9 cm n = 34	% M	≥40 cm n = 40	% M	30-39.9 cm n = 34	% M	≥40 cm n = 40	% M	30-39.9 cm n = 20	% M	≥40 cm n = 41	% M
	Zooplankton	8.7	34	14.9	56	6.1	38	17.4	52	2.0	32	7.9	20	2.8	7	7.9	20	2.8	7
	Micronekton	0.0	0	0.4	3	0.0	0	0.0	0	0.6	3	0.0	0	0.0	0	0.0	0	0.0	0
	Zoobenthos	8.3	28	16.2	41	33.3	75	7.4	28	16.6	35	9.6	30	12.0	49	9.6	30	12.0	49
	Plant material	32.6	94	12.6	79	10.1	65	9.0	72	16.3	68	21.5	75	20.1	83	21.5	75	20.1	83
	Unidentified	50.4	100	56.0	100	50.5	100	66.2	100	64.4	100	61.0	100	65.2	100	61.0	100	65.2	100

		Clarias gariepinus															
Season	Length Groups	Autumn 1984				Winter 1984				Spring 1984				Summer 1984/85			
		30-69.9 cm n = 14		≥70 cm n = 31		30-69.9 cm n = 2		≥70 cm n = 6		30-69.9 cm n = 27		≥70 cm n = 27		30-69.9 cm n = 33		≥70 cm n = 27	
		% M	% F	% M	% F	% M	% F	% M	% F	% M	% F	% M	% F	% M	% F	% M	% F
	Zooplankton	12.4	36	34.0	74	9.0	50	5.8	50	7.7	37	23.2	70	2.1	15	2.5	19
	Micronekton	5.4	29	4.2	23	0.0	0	0.0	0	1.7	41	1.1	15	5.6	33	9.4	37
	Zoobenthos	46.8	79	13.3	32	27.0	50	9.2	33	33.5	74	22.3	70	33.0	79	22.8	59
	Plant material	13.7	86	18.9	94	6.0	50	11.6	67	15.0	74	23.8	89	20.8	94	30.6	85
	Unidentified	21.7	93	29.6	97	58.0	100	73.4	100	42.1	100	29.6	93	38.5	100	34.8	93



**Figure 1**  
Map of Sterkfontein Dam indicating the sampling sites (1 to 4) for fish. Insert map of Southern Africa indicates the positions of Sterkfontein Dam (●), Gariep Dam (HF Verwoerd Dam) (1) and Vanderkloof Dam (PK le Roux Dam) (2)

$$C_{jk} = 1 - \frac{1}{2} \sum_i |P_{ij} - P_{ik}|$$

where

$C_{jk}$  = resource overlap between species j and species k

$P_{ij}$  and  $P_{ik}$  = proportions of the  $i^{\text{th}}$  resource (food type) used by species j and species k.

The index ranges from zero when there is no overlap between resources used by species j and k, to one when their patterns of resource use are identical.

## Results

When sufficient numbers of a length group were sampled, the intraspecific food overlap for each species was large during each season (Table 2). The interspecific

**TABLE 2**  
**VALUES OF SEASONAL INTER- AND INTRASPECIFIC (BOLD) FOOD OVERLAP (SCHOENER INDEX OF SIMILARITY) FOR *O. MYKISS*, *B. AENEUS* AND *C. GARIEPINUS***

Autumn 1984					
	O.m. 1 n = 20	B.A. 1 n = 32	B.a. 2 n = 43	C.g. 2 n = 31	
B.a. 1	0.52				
B.a. 2	0.43	<b>0.91</b>			
C.g. 2	0.72	0.76	0.72		
Winter 1984					
	O.m. 1 n = 77	O.m. 2 n = 73	B.a. 1 n = 34	B.a. 2 n = 40	
O.m. 2	<b>0.89</b>				
B.a. 1	0.75	0.80			
B.a. 2	0.63	0.68	<b>0.86</b>		
Spring 1984					
	O.m. 2 n = 128	B.a. 1 n = 25	B.a. 2 n = 31	C.g. 1 n = 27	C.g. 2 n = 27
B.a. 1	0.93				
B.a. 2	0.84	<b>0.84</b>			
C.g. 1	0.78	0.78	0.87		
C.g. 2	0.87	0.78	0.83	<b>0.75</b>	
Summer 1984/85					
	O.m. 2 n = 59	B.a. 1 n = 20	B.a. 2 n = 41	C.g. 1 n = 33	C.g. 2 n = 27
B.a. 1	0.85				
B.a. 2	0.81	<b>0.96</b>			
C.g. 1	0.69	0.82	0.86		
C.g. 2	0.67	0.81	0.84	<b>0.88</b>	
<i>O. mykiss</i> (O.m.): 1) 20 to 29.9 cm; 2) 30 to 39.9 cm; <i>B. aeneus</i> (B.a.): 1) 30 to 39.9 cm; 2) ≥40 cm; <i>C. gariepinus</i> (C.g.): 1) 30 to 69.9 cm; 2) ≥70 cm. Sample size is shown as n.					

food overlap was small between *O. mykiss* and *B. aeneus* during autumn, but large between *C. gariepinus* and the other species (Table 2). During winter the food overlap was large between *O. mykiss* and *B. aeneus*. No sufficient numbers of *C. gariepinus* were sampled during the cold season. For the remaining seasons, spring and summer, large similarities in food resource use were found between all three species (Table 2).

### Discussion

Although incomplete for all length groups, the data do give some indication of the food overlap of adult fish between these fish species. The large intraspecific food overlaps found for each species support the findings of food selection (Dörgeloh, 1994). A similar diet between length groups was also found by Hubert et al. (1994) for *O. mykiss aquilarum* in Lake DeSmet, Wyoming. The two

populations of indigenous fish species sampled comprised predominantly adult fish. Even sampling the littoral zone with small mesh-sized seine-nets revealed very few juvenile fish (Dörgeloh, 1986). Fish within these adult-dominated populations utilised similar food resources, resulting in the large intraspecific food overlap.

The degree of overlap in food resource use between these fish species was generally large, but small differences in food selection were found by Dörgeloh (1994) in Sterkfontein Dam with *O. mykiss* being planktivorous, *B. aeneus* being herbivorous/benthivorous and *C. gariepinus* being benthivorous. When several species coexist, the degree of overlap in their resource use is a measure of their similarity to one another, and therefore does not necessarily measure the degree of inter- or intraspecific competition or lack of competition between them (Angermeier, 1982; Colwell and Futuyma, 1971; Keast, 1977; Sale, 1974).

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