A survey of the fish fauna of Transkei estuaries Part Four: The Mntafufu and Mzamba River estuaries

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Received 14 March 1989; accepted 2 May 1991

The Mntafufu and Mzamba Rivers have small catchment areas (178 and 505 km^2, respectively) in the forested coastal belt of Transkei and have relatively small estuaries (5 and 2 km long, respectively). Although the annual rainfall is in excess of 1000 mm in this area, the mean annual runoff was less than 70 Mm^3 in both cases. Serious floods were not observed during the survey period, while turbidity and sediment loads were usually very low. Salinities were usually high ($\bar{x}$ = 30,0–38,0‰) in the bottom water and temperatures in the upper reaches were usually higher than in the lower reaches. The species composition, and seasonal and spatial abundance of the fish fauna of the two estuaries were determined by means of gill nets. A total of 1043 fish (385,8 kg) representing 42 species were caught in the Mntafufu estuary. The orangemouth glassnose *Thryssa vitrirostris* and *V. cunnesius* were the most abundant fish in the estuary. Numerically 42% of the catch (46% gravimetrically) belonged to the family Mugilidae (11 species) of which *Mugil cephalus, Valamugil buchanani* and *V. cunnesius* were the most important. A total of 389 fish (241,1 kg) were caught in the Mzamba estuary. Twenty-five species were obtained with *Hilsa kelee* dominating numerically. Seven species of mullet contributed 38,3% of the numbers or 54,2% of the fish biomass. The diamond mullet (*Liza alata*) and the flathead mullet (*Mugil cephalus*) were the most abundant in terms of biomass. The highest catches in the two estuaries were taken in the lower reaches. Mean number and biomass of fish taken per net was 20,5 fish and 7,2 kg, and 16,2 fish and 10,1 kg in the Mntafufu and Mzamba estuaries, respectively.

Die Mntafufu- en Mzamba-riviere besit klein opvanggebiede (onderskeidelik 178 en 505 km^2) wat in die beboste kusstreek van Transkei onstaan en wat altwee in relatief klein riviermondings eindig (onderskeidelik 5 en 2 km lank). Alhoewel die jaarlikse reënval in die gebied meer as 1000 mm is,is die gemiddelde afloop in beide gevalle minder as 70 Mm^3. Geen groot vloede het gedurende die opnameperiode plaasgevind nie en die turbiditeit en sliklading was laag. Die soutgehalte van die bodemwater was gewoonlik hoog ($\bar{x}$ = 30,0–38,0‰) en temperature in die boonste gedeeltes van die riviermondings was gewoonlik hoër as dié by die mondgebied. Die visspesiesamestelling asook die seisoensverspreiding en voorkeurgebiede van die visse is met behulp van kiefnette vasgestel. 'n Totaal van 1043 vis (385,8 kg) wat 42 spesies verteenwordig het, is in die Mntafufu gevang. Die oranjebek-glasneus (*Thryssa vitrirostris)* en *Valamugil cunnesius* het die algemeenste voorgekom. Die familie Mugilidae waarvan *Mugil cephalus, V. buchanani* en *V. cunnesius* belangrik was, het 42% van die aantal visse en 46% van die totale biomassa uitgemaak. Weens die lengte (2 km) van die Mzamba-riviermonding is slegs twee versamelingspunte gebruik en is 389 vis (241,1 kg) bestaande uit 25 spesies gevang. Hiervan was sewe harderspesies wat 38,3% van die aantal visse en 54,2% van die totale biomassa verteenwordig het. Die biomassa is deur *Liza alata* en *M. cephalus* oorheers terwyl *Hilsa kelee* numeries die volopste was. Die onderste gedeelte van die riviermonding het die beste vangsresultate opgelewer. Gemiddelde aantal vis en biomassa per net was 20,5 visse en 7,2 kg, en 16,2 visse en 10,1 kg in Mntafufu en Mzamba onderskeidelik.

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Many of the estuaries in Natal have been degraded owing to bad agricultural practices, discharge of effluent and the construction of road and railway bridges across the sensitive flood plains (Begg 1978; 1979). It is also evident that the rate of siltation of estuaries has increased with more intensive cultivation (Day 1981a) in the catchments and along estuary banks (Begg 1979). Similarly with increasing population pressure, degradation of estuaries in Transkei has gradually increased and is especially noticeable in larger estuaries such as the Mzimvubu, Mbashe and Kei which arise in the far Transkei interior where soil erosion is particularly severe (Day & Grindley 1981; Day 1981a). Many of the smaller Transkei estuaries are presently still relatively unscathed owing to smaller forested catchment areas (Day 1981c), and lower population densities along the coast demanding less of the environment in terms of agricultural needs (Day & Grindley 1981). Sugar cane production is being encouraged along the coastal strip betweeen Port St Johns and the Natal border. If precautions such as those suggested by Begg (1978; 1979; 1984a; b) are not taken in this area it remains a matter of time before Transkeian estuaries will suffer the same fate as those of Natal.

Mntafufu and Mzamba occur approximately 11 and 80 km north of Port St Johns. Very little baseline data is available for either estuary. With the exception of a plankton survey in Mntafufu (Wooldridge pers. comm.) and a superficial examination of the Mzamba estuary (Begg 1986), no biological data is available for the Mntafufu or Mzamba estuaries. The major objectives of the present study were to determine the species composition, the seasonal distribution and the abundance of fish caught in gill nets in the two estuaries.

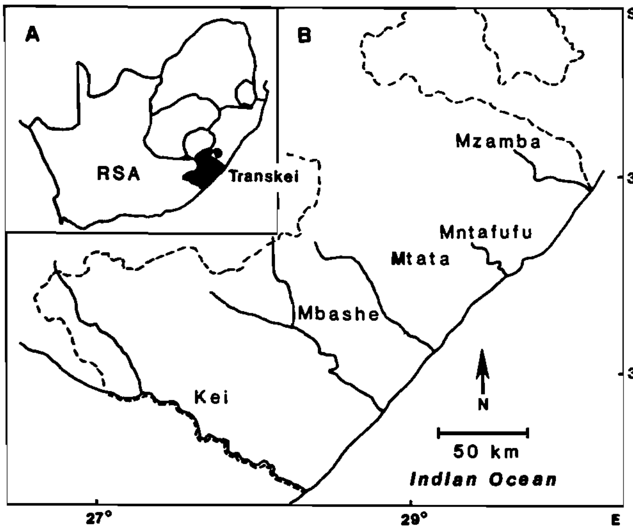

Figure 1 Geographical position of the Transkei (A) and estuaries (B) investigated, within the confines of southern Africa.

Study areas

Mntafufu Estuary

The Mntafufu estuary (31°33,49'S / 29°38,12'E) (Figure 1) is situated 11 km north of Port St Johns. The catchment area (178 km^2) is small and well forested resulting in negligible silt loads. At the coast the mean annual precipitation (MAP) is 1231 mm, yet the nett mean annual runoff (MAR) was only 46 Mm^3 (Eksteen, van der Walt & Nissen Inc. 1979). At the mouth of the estuary a large sandspit occurs on the northern bank, whilst the southern bank consists of a steep hill with rocks on the seaward side (Figure 2). A channel approximately 700 m long opens into a lagoon (*sensu* Day 1981b) which is lined with mangroves, *Avicennia, Bruguiera* and *Rhizophora* on either side. These mangroves extend for 2 km upriver with a few isolated mangals being found further upstream. A fairly large mangrove community lines a creek which enters the estuary 1,5 km from the mouth. The swamps and intertidal banks support a large *Uca* community. The estuary was navigable for 5 km but after heavy rains in January 1981 rocks were washed into the upper reaches of the estuary (Point A — Figure 2), effectively reducing the navigable section of the estuary to 4 km.

Mzamba Estuary

The Mzamba estuary (31°6,28'S / 30°10,10'E) (Figure 1) is located 3,5 km from the Natal border. It has a relatively small catchment area of 505 km^2 confined to the coastal belt, a MAP of 1021 mm at the coast and a nett MAR of 69 Mm^3 (Eksteen *et al.* 1979). The estuary enters the sea across a sill of cretaceous deposits where a rocky headland (Figure 2) prevents the mouth from moving southwards. A lagoon (*sensu* Day 1981b) fringed with a dense growth of *Juncus* is found inland of a southward projecting sandspit and there are stable dunes on the northern shore of the estuary. One kilometre inland the lagoon narrows, from where the estuary continues for a further kilometre ending abruptly in a series of rapids.

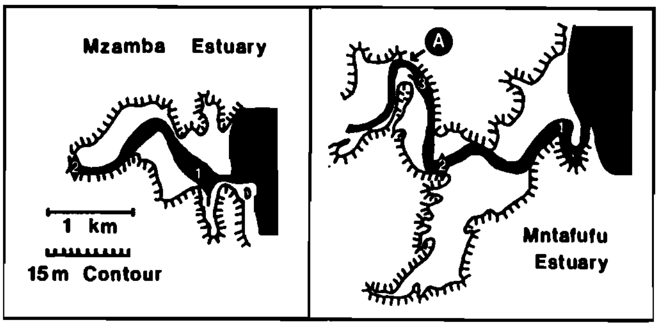

Figure 2 The Mntafufu and Mzamba estuaries with positions of sampling sites indicated (A — rockfall).

Methods

Monthly sampling of the Mntafufu estuary took place from November 1980 to December 1981 with additional samples taken in February, April, June and September 1982, whereas monthly sampling of the Mzamba estuary extended from January 1981 to February 1982. Sampling stations representative of the lower, middle and upper reaches of the Mntafufu estuary were established 1,0 km, 2,5 km and 3,8 km, respectively, from the mouth (Figure 2). Two sampling stations, 400 m and 2 km from the mouth were selected for the small Mzamba estuary (Figure 2). A description of the gear and methods used to collect the physico-chemical and biological data is given in Plumstead, Prinsloo & Schoonbee (1985). Fish were identified according to Smith (1977) and Smith & Heemstra (1986).

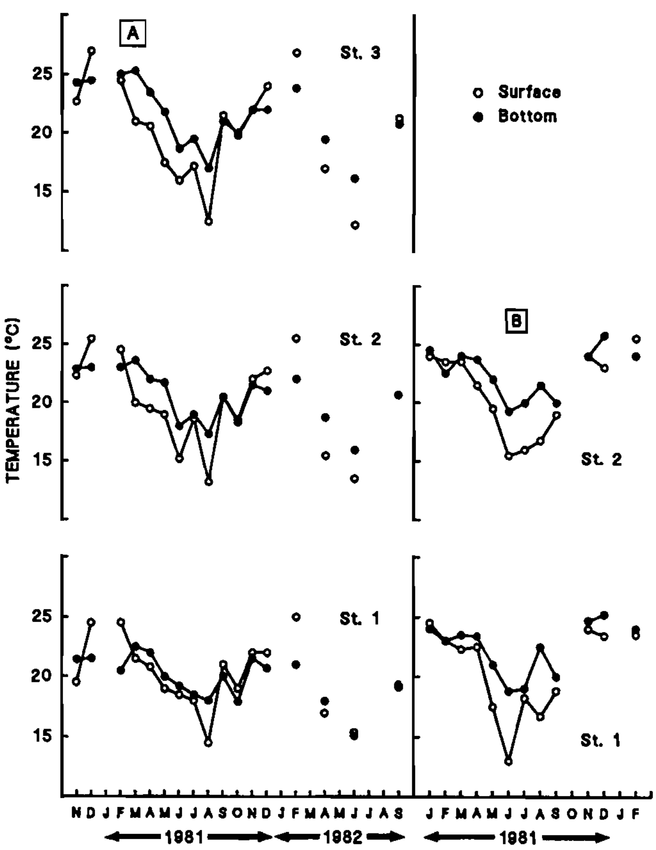

Figure 3 Monthly temperatures (°C) recorded at selected sampling stations in the Mntafufu (A) and Mzamba (B) estuaries.

Table 1 Physico-chemical properties measured in the lower (Station 1), middle (Station 2) and upper (Station 3) reaches of the Mntafufu estuary

		Station 1				Station 2				Station 3			
		$\bar{x}$	*SD*	Range	*n*	$\bar{x}$	*SD*	Range	*n*	$\bar{x}$	*SD*	Range	*n*
Temperature (°C)	Surface												
	Summer	22,3	2,3	19,0–25,0	8	22,6	2,5	18,5–25,5	8	23,5	2,6	19,8–27,0	8
	Winter	18,2	2,2	14,5–21,0	9	17,3	3,0	13,5–20,7	9	17,3	3,5	12,2–21,5	9
	Bottom												
	Summer	20,9	1,3	17,9–22,5	8	21,9	1,7	18,3–23,6	8	23,4	1,8	20,0–25,3	8
	Winter	18,9	1,9	15,1–22,0	9	19,3	2,0	16,0–22,0	9	19,8	2,3	16,2–23,5	9
Salinity (‰)	Surface												
	Summer	21,5	12,2	4,0–34,0	8	14,8	8,8	4,0–25,0	8	12,8	5,6	4,0–20,0	8
	Winter	30,4	8,7	14,0–46,0	9	25,7	7,8	14,0–40,0	9	17,3	6,1	6,0–22,0	9
	Bottom												
	Summer	35,0	2,2	32,0–38,0	8	35,0	2,0	32,0–38,0	8	30,6	11,1	4,0–38,0	8
	Winter	37,4	3,5	34,0–46,0	9	37,8	3,5	33,0–46,0	9	36,9	3,6	34,0–46,0	9
Oxygen (mg/l)	Surface	7,2	0,9	5,3– 8,6	15	6,8	1,0	4,8– 8,5	15	7,1	1,7	5,2–11,7	15
	Bottom	7,1	0,7	5,7– 8,3	15	6,3	0,9	4,2– 7,4	15	6,2	1,9	2,5–10,8	15
pH	Surface	8,12	0,25	7,70– 8,48	13	8,03	0,16	7,74– 8,24	13	7,79	0,22	7,15– 7,98	13
	Bottom	8,18	0,22	7,71–8,57	13	8,05	0,24	7,55– 8,32	14	7,91	0,23	7,37– 8,19	13
Secchi disc (cm)		142,5	47,7	16,0–217,0	17	111,6	32,5	9,5–143,0	17	111,6	37,6	9,0–160,0	15
Depth (cm)		241,0	40,9	169,0 –340,0	17	208,7	68,6	76,0–379,5	17	197,9	69,1	108,0 –327,0	17

Results

Physico-chemical properties of the estuaries

Mntafufu

In the Mntafufu estuary recorded water temperatures ranged from 12,2–27,0°C over the study period with mean summer temperatures usually above 20°C (Table 1). Annual fluctuations were smallest in the bottom waters while vertical temperature gradients were more pronounced at Stations 2 & 3 in winter and at Station 1 in summer (Figure 3). Highest temperatures were recorded in December, January and February with the coldest conditions prevailing in June and August.

In the upper reaches, recorded bottom salinities only fell below 30‰ on two occasions (Figure 4). Surface salinities were more variable, usually ranging between 4 and 30‰ with the exception of 46‰ in the lower reaches in June 1982. Mean oxygen concentration in this estuary exceeded 6,0 mg l^{-1} with surface concentrations higher than those in the bottom layers (Table 1). Light penetration was good in the Mntafufu estuary with secchi disc readings usually in excess of 50% of the mean depth at all stations (Table 1). Transparency was reduced to less than 10 cm at Stations 2 & 3 on only one occasion, during rains when the salinity of both surface and bottom waters in the upper reach was less than 10‰. Bottom water had a higher average pH than the surface water with the values decreasing upstream (Table 1).

Mzamba

Recorded water temperatures in the Mzamba estuary ranged from 13,0–25,8°C with surface temperatures usually lower than those of the bottom water while the maximum vertical stratification was 3,0°C and 0,6°C for winter and summer, respectively (Table 2). The vertical salinity gradient in this estuary was very marked (Figure 4) with the difference greater at Station 2 where bottom salinities usually varied between 30 and 36‰ and surface salinities rarely exceeded

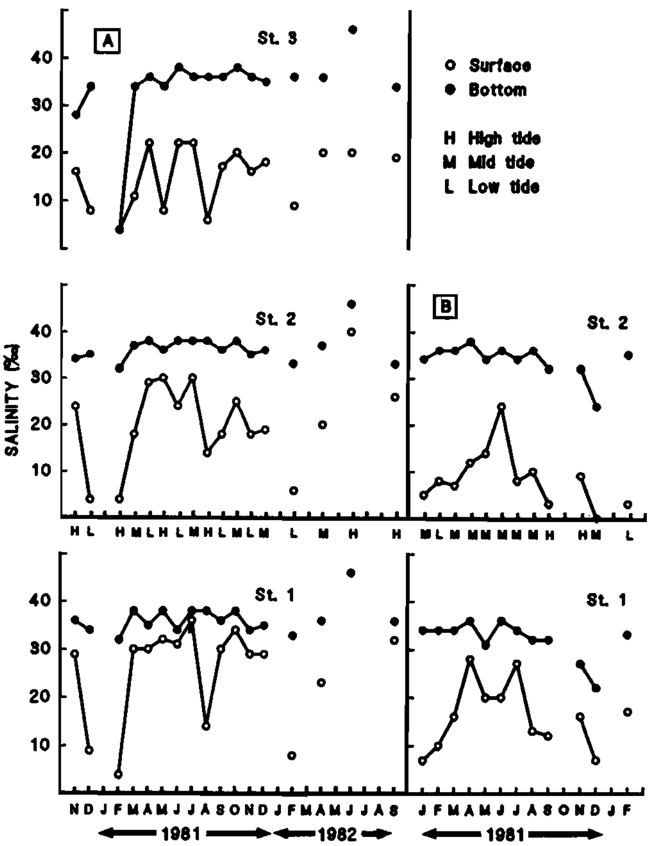

Figure 4 Monthly salinities (‰) recorded at selected sampling stations in the Mntafufu (A) and Mzamba (B) estuaries.

Table 2 Physico-chemical properties measured in the lower (Station 1) and upper (Station 2) reaches of the Mzamba estuary

		Station 1				Station 2			
		$\bar{x}$	*SD*	Range	*n*	$\bar{x}$	*SD*	Range	*n*
Temperature (°C)	Surface								
	Summer	23,5	0,8	22,3–24,5	6	23,9	0,9	23,0–25,5	6
	Winter	17,8	3,1	13,0–22,5	6	18,1	2,3	15,5–21,5	6
	Bottom								
	Summer	24,1	0,8	23,0–25,2	6	24,1	1,1	22,5–25,8	6
	Winter	20,8	1,9	18,8–23,4	6	21,1	1,6	19,3–23,7	6
Salinity (‰)	Surface								
	Summer	12,2	4,7	7,0–17,0	6	5,3	3,4	0,0–9,0	6
	Winter	20,0	6,7	12,0–28,0	6	11,8	7,1	3,0–24,0	6
	Bottom								
	Summer	30,7	5,0	22,0–34,0	6	32,8	4,6	24,0–36,0	6
	Winter	33,5	2,2	31,0–36,0	6	35,0	2,1	32,0–38,0	6
Oxygen (mg/l)	Surface	7,8	0,8	6,2– 8,9	9	8,2	1,0	6,5– 9,9	9
	Bottom	6,0	1,2	4,1– 7,6	9	5,2	1,3	3,8– 7,7	9
pH	Surface	8,03	0,55	6,33– 8,40	12	8,04	0,26	7,29– 8,25	12
	Bottom	7,85	0,48	6,56– 8,38	12	7,77	0,39	6,73– 8,34	12
Secchi disc (cm)		131,9	80,8	20,0–300,0	12	147,6	55,6	26,0–255,0	11
Depth (cm)		289,2	39,2	223,5 –366,0	12	200,6	38,5	141,0 –278,0	12

15‰. Surface salinities were highest in winter, the dry season, when inflow was at its lowest. Bottom water salinities in the upper reaches always exceeded or equalled those of the lower reaches which formed a small lagoon where mixing of surface and bottom water was probably aided by wind and tidally generated currents (Branch & Grindley 1979; Day 1981c; Hill 1966). Dissolved oxygen concentrations in the bottom layers were considerably lower than at the surface (Table 2). Water transparency was very good in the Mzamba estuary (Table 2). The average secchi disc reading for Stations 1 & 2 were 132 and 148 cm, respectively, which represented 74% and 47% of the average depth at these stations. Surface water was slightly more alkaline than bottom water (Table 2).

Fish fauna

Mntafufu

The total catch in the Mntafufu numbered 1043 fish, representing 42 species (Table 3), of which 14 species accounted for 88,4% of the catch (Table 4). Numercially *Thryssa vitrirostris* (Gilchrist & Thompson) (18,9%) and *Valamugil cunnesius* (Valenciennes) (13,5%) were the most abundant fish caught. Fifteen species contributed 89,7% of the total fish biomass (385,8 kg) caught (Table 4). The two mullet species *Valamugil buchanani* (Bleeker) and *Mugil cephalus* (Linnaeus) together with the kob *Argyrosomus hololepidotus* (Lacepede), made up 35,5% of the catch. The smaller fish species, e.g. *T. vitrirostris*, although dominating numerically, were displaced by the less numerous but larger fish.

If the mean number or biomass of fish caught per season (summer — December, January, February; autumn — March, April, May; winter — June, July, August; spring — September, October, November) is used as an indicator of the number of fish occurring within that season, the total number ($\bar{x}$ = 20,2; *SD* = 1,6) and biomass ($\bar{x}$ = 7580 g; *SD* = 772 g) caught remained fairly constant. However seasonal changes in abundance and biomass of nine species each accounting for 3% or more of the catch, were observed. Abundance of *Valamugil cunnesius, Liza macrolepis* (Smith), *Myxus capensis* (Valenciennes) and *Thryssa vitrirostris* peaked in winter; *Valamugil buchanani* in winter/spring; *Mugil cephalus* and *Leiognathus equula* (Forsskal) in summer and *Hilsa kelee* (Cuvier) in spring. Many small *A. hololepidotus* ($\bar{x}$ = 297 g) were present in the estuary in autumn when kob numbers were at their highest but mass at a minimum. The largest ($\bar{x}$ = 641 g) kob were caught in summer (maximum biomass) while numbers were lowest in winter. A further five species each accounting for less than 3% of the catch also showed changes in seasonal abundance. Both *Liza tricuspidens* (Smith) and *Monodactylis falciformis* (Linnaeus) were most abundant in autumn, *Liza alata* (Steindachner) in winter and *Elops machnata* (Forsskal) in summer. *Lichia amia* (Linnaeus) were absent in winter but present in constant numbers during the remaining seasons. Numerically and gravimetrically the biggest fish catches were made at Station 1 (27,4 fish weighing 9,6 kg) followed by Station 2. At Station 3 the number of fish caught decreased by 68% (*cf.* Station 1) but the mean biomass of the fish increased from 351 g at Station 1 to 575 g at Station 3 thereby maintaining the biomass at 52% of that caught in the lower reaches. In terms of biomass *V. buchanani*, *Caranx* spp. and *Liza alata* were more abundant in the upper and middle reaches; *T. vitrirostris* and *M. falciformis* in the middle reaches; *E. machnata* and *H. kelee* in the middle and lower reaches; *M. cephalus, A.*

Table 3 Mean number and biomass (g) of fish caught monthly using gill nets over 12-h periods with 17 nettings at each of three localities in the Mntafufu estuary

		11/80	12/80	2/81	3/81	4/81	5/81	6/81	7/81	8/81	9/81	10/81	11/81	12/81	2/82	4/82	6/82	9/82
Mugil cephalus	No.	2,0	1,3	2,0	2,3		1,3	1,3	0,3	0,7	2,7	0,3	0,3	5,3	0,3	2,7	0,7	0,3
	Mass	969	733	1931	1340		865	2209	193	174	1453	233	78	4204	645	1283	386	582
Valamugil buchanani	No.	4,7	0,7	1,7	0,7	0,3	0,3	1,3	3,3	0,7	0,7	1,7		0,3		3,0	0,7	1,0
	Mass	3830	660	1542	197	142	993	1438	2275	599	681	1101		87		1637	351	242
Argyrosomus hololepidotus	No.	0,7	1,0	4,3	3,7	2,7	1,0	0,7	1,7	0,7	1,3	1,0	1,0	1,7	3,3	3,7		2,0
	Mass	270	434	4686	576	838	177	379	582	105	291	555	2097	541	959	1262		639
Caranx spp.	No.	1,3	1,0	1,0	4,7	1,3	3,3	1,3	1,3	0,3	1,3	1,7	1,3	0,3	0,3	0,3		1,3
	Mass	1890	2125	426	2199	420	1029	1329	559	415	124	202	1103	515	96	223		680
Valamugil cunnesius	No.	0,3	2,3	1,0	4,7		3,0	6,7	4,7	3,7	1,0	7,0	2,0	3,3	0,7	2,0	3,0	1,7
	Mass	23	394	232	698		432	961	803	496	114	1191	291	585	136	344	359	180
Elops machnata	No.	0,3	0,7	1,3		0,3			1,0	0,3		0,3						0,3
	Mass	628	966	2086		164			921	778		461						752
Hilsa kelee	No.	9,0	1,7	0,3	0,3	1,3	1,7	2,3	0,3	1,3	1,3	0,3	0,3	1,0	1,3	0,3		0,7
	Mass	2371	435	133	89	409	436	612	111	399	443	109	120	360	354	44		102
Myxus capensis	No.		0,3			0,3		8,0	1,3		0,3	1,0	2,7	4,3	1,0	0,3	0,7	0,7
	Mass		97			143		2678	452		117	309	876	897	174	91	215	159
Pomadasys commersonnii	No.			1,7			0,3		0,7	0,3		0,3		0,3		0,3		1,3
	Mass			232			1605		931	108		111		395		816		1873
Thryssa vitrirostris	No.	6,3	3,7	3,7	9,3	2,0	1,0	5,0	9,0	5,7	5,3	0,7	1,3	8,7		1,3	0,7	2,0
	Mass	374	213	244	653	169	78	389	665	412	451	62	124	724		106	69	254
Lichia amia	No.	0,7		0,3	0,3	1,3					0,3		0,3	1,0	0,3	0,3		0,3
	Mass	1161		74	171	1121					206		496	849	46	137		379
Liza alata	No.		0,3	1,3			1,3	1,3	0,7		0,3						0,3	
	Mass		296	508			915	1229	790		434						75	
Chanos chanos	No.								0,3	0,3	0,3							
	Mass								1154	1376	1433							
Liza tricuspidens	No.	0,3			0,3		1,3				3,7	0,3			0,3	0,7	0,3	0,3
	Mass	45			67		351				1053	215			34	259	45	71
Rhabdosargus sarba	No.		0,3	0,3				0,3			0,3			0,3	0,3	0,3		
	Mass		397	93				364			10			409	269	398		
Liza macrolepis	No.				2,3			7,0						1,0		0,3		
	Mass				439			1065						171		24		
Sphyraena acutipinnis	No.	0,3			0,3						0,7	0,3	0,3	0,3	0,3		0,3	
	Mass	260			79						412	18	403	58	187		169	
Pomatomus saltatrix	No.	0,7							1,0				0,3	0,7				0,3
	Mass	660							359				103	253				167
Plectorhinchus gibbosus	No.																0,3	
	Mass																1167	
Lutjanus argentimaculatus	No.				0,3	0,3					0,3							
	Mass				234	615					286							
Drepane longimanus	No.	0,3	0,7					0,3				0,3						
	Mass	253	167					293				225						
Leiognathus equula	No.	1,0	1,0	4,7		1,3		1,0			0,3	1,7		2,0	1,0	1,0	0,3	3,3
	Mass	58	93	9		34		49			27	92		113	34	41	11	146
Pomadasys kaakan	No.			0,3	0,7			0,3								0,3		
	Mass			65	434			30								183		
Platycephalus indicus	No.											0,3		0,3			0,3	
	Mass											197		104			172	
Liza dumerilii	No.							0,3		0,3					0,3	1,7	0,3	
	Mass							67		72					58	234	36	
Lithognathus lithognathus	No.									0,3								
	Mass									465								
Valamugil robustus	No.							0,3			0,3			0,3		1,7		
	Mass							34			39			43		278		
*Etrumeus teres**	No.				0,3										0,3			
	Mass				336										34			
Crenimugil crenilabis	No.														0,3	0,3		
	Mass														58	260		

Table 3 Continued

		11/80	12/80	2/81	3/81	4/81	5/81	6/81	7/81	8/81	9/81	10/81	11/81	12/81	2/82	4/82	6/82	9/82
Muraenesox bagio	No.							0,3										
	Mass							235										
Valamugil seheli	No.							0,7										
	Mass							201										
Monodactylus falciformis	No.	0,3		0,3	0,7	0,3	0,3		0,3		0,3			0,3		1,0	0,7	0,7
	Mass	8		7	19	10	21		11		12			27		22	14	33
Carcharhinus leucas	No.				0,3													
	Mass				191													
Torpedo sinuspersici	No.																	0,3
	Mass																	124
Epinephelus fario	No.				0,3						0,3				0,3			
	Mass				25						51				22			
Gerres acinaces	No.	1,0			0,3													
	Mass	43			28													
Rhabdosargus holubi	No.			0,7				0,3				0,3	0,3					
	Mass			18				7				15	28					
Scomberoides tol	No.		0,3															
	Mass		67															
Sarpa salpa	No.													0,3				
	Mass													56				
Trachurus capensis	No.													0,3				
	Mass													20				
Diplodus sargus	No.							0,3										
	Mass							15										
Ambassis spp.	No.					0,3												
	Mass					13												
Totals		29,2	15,3	24,9	31,8	11,7	14,8	39,0	25,9	14,6	21,0	17,5	10,1	32,0	10,7	21,5	8,6	13,2
		12843	7077	12286	7775	4078	6902	13584	9806	5399	7637	5096	5719	10411	3106	7642	3069	6383

* Smith 1977

Table 4 Mean number and biomass (g) of fish caught by gill net at three sampling stations in the Mntafufu estuary (results based on 17 nettings per station)

	Station 1		Station 2		Station 3		Total				Mean mass	
Species	*n*	Mass (g)	*n*	Mass (g)	*n*	Mass (g)	*n*	%N	Mass (g)	%B	Per net	Per individual
Mugil cephalus	2,41	1711,8	1,29	945,7	0,53	392,9	72	6,9	51 856	13,4	1016,8	720,2
Valamugil buchanani	0,76	599,7	1,35	1085,5	1,76	1099,3	66	6,3	47 387	12,3	928,2	717,2
Argyrosomus hololepidotus	1,53	1379,4	2,82	866,4	0,82	293,9	88	8,4	43 176	11,2	846,6	490,6
Caranx spp.	0,65	278,6	1,88	1025,5	1,35	1002,0	66	6,3	39 204	10,2	768,7	594,0
Valamugil cunnesius	5,53	850,4	2,35	381,1	0,41	47,1	141	13,5	21 735	5,6	426,2	154,1
Elops machnata	0,35	562,3	0,41	589,4	0,06	40,5	14	1,3	20 268	5,3	397,4	1447,8
Hilsa kelee	2,35	621,5	1,76	493,6	0,12	36,3	72	6,8	19 574	5,1	383,8	271,9
Myxus capensis	2,65	740,0	1,0	330,6	0,06	19,5	63	6,0	18 532	4,8	363,4	294,2
Pomadasys commersonnii	0,29	452,9	0,35	138,9	0,29	480,1	16	1,5	18 223	4,7	357,3	1138,9
Thryssa vitrirostris	3,71	263,2	7,24	557,6	0,65	59,6	197	18,9	14 968	3,9	293,5	76,0
Lichia amia	0,65	644,8	0,24	174,4			15	1,5	13 927	3,6	273,1	928,5
Liza alata			0,41	295,8	0,59	454,5	17	1,6	12 755	3,3	250,1	750,3
Chanos chanos	0,06	242,8	0,06	203,7	0,06	252,9	3	0,3	11 891	3,1	233,2	3963,7
Liza tricuspidens	0,82	234,5	0,47	135,4	0,06	7,9	23	2,2	6 423	1,7	125,9	279,3
Rhabdosargus sarba	0,18	187,9	0,24	154,5			7	0,7	5 823	1,5	114,2	831,9
Liza macrolepis	1,71	267,6	0,12	28,1	0,06	4,2	32	3,1	5 098	1,3	100,0	159,3
Sphyraena acutipinnis	0,29	171,9	0,12	32,1	0,12	75,8	9	0,9	4 756	1,2	93,3	528,4
Pomatomus saltatrix	0,35	183,1	0,12	59,4	0,12	29,4	9	0,9	4 622	1,2	90,6	513,6
Plectorhinchus gibbosus					0,06	205,9	1	0,1	3 501	0,9	68,6	3501,0
Lutjanus argentimaculatus			0,06	50,4	0,12	149,8	3	0,3	3 403	0,9	66,7	1134,0
Drepane longimanus			0,12	84,4	0,18	80,8	5	0,5	2 810	0,7	55,1	562,0
Leiognathus equula	2,29	100,4	0,88	32,8	0,12	6,7	56	5,4	2 380	0,6	46,7	42,5
Pomadasys kaakan			0,24	120,4	0,06	5,3	5	0,5	2 137	0,6	41,9	427,4

Table 4 Continued

	Station 1		Station 2		Station 3		Total				Mean mass	
Species	*n*	Mass (g)	*n*	Mass (g)	*n*	Mass (g)	*n*	%N	Mass (g)	%B	Per net	Per individual
Platycephalus indicus					0,18	82,9	3	0,3	1 410	0,4	27,6	470,0
Liza dumerilii	0,06	12,6	0,41	63,4	0,06	6,4	9	0,9	1 400	0,4	27,5	155,6
Lithognathus lithognathus					0,06	82,0	1	0,1	1 394	0,4	27,3	1394,0
Valamugil robustus	0,18	34,4	0,29	35,1			8	0,8	1 183	0,3	23,2	147,9
Etrumeus teres *	0,06	6,1	0,06	59,3			2	0,2	1 111	0,3	21,8	555,5
Crenimugil crenilabis			0,06	10,24	0,06	45,9	2	0,2	954	0,2	18,7	477,0
Muraenesox bagio	0,06	41,5					1	0,1	705	0,2	13,8	705,0
Valamugil seheli			0,12	35,4			2	0,2	603	0,2	11,8	301,5
Monodactylus falciformis	0,18	5,4	0,41	14,4	0,35	13,1	16	1,5	559	0,2	11,0	34,9
Carcharhinus leucas			0,06	27,8			1	0,1	473	0,1	9,3	473,0
Torpedo sinuspersici						21,9	1	0,1	372	0,1	7,3	372,0
Epinephelus fario	0,06	4,4	0,06	3,9	0,06	9,1	3	0,3	294	0,1	5,8	98,0
Gerres acinaces					0,24	12,6	4	0,4	215	0,1	4,2	53,8
Rhabdosargus holubi	0,12	3,2	0,12	3,9	0,06	5,0	5	0,5	206	0,1	4,0	41,2
Scomberoides tol			0,06	11,8			1	0,1	200	0,1	3,9	200,0
Sarpa salpa	0,06	9,9					1	0,1	168	< 0,1	3,3	168,0
Trachurus capensis	0,06	3,6					1	0,1	61	< 0,1	1,2	61,0
Diplodus sargus			0,06	2,6			1	0,1	45	< 0,1	0,9	45,0
Ambassis spp.			0,06	2,4			1	0,1	40	< 0,1	0,8	40,0
Totals	27,42	9613,9	25,3	8055,9	8,73	5 023,3	1043		385 792		7 564,7	

* Smith 1977

hololepidotus, V. cunnesius, M. capensis, L. amia, L. tricuspidens, L. macrolepis, Sphyraena acutipinnis (Day) and *L. equula* in the lower reaches.

Mzamba

A total of 389 individuals representing 25 species (Table 5) constituted the catch in this small estuary. Nine species made up 89,6% of the catch (Table 6), the rest (16 species) contributed 1,5% or less of the catch per individual species. The kelee shad *H. kelee* was the most numerous fish caught (34,4%) followed by *M. cephalus* (16,7%) and *L. alata* (13,4%). In terms of biomass, six species were responsible for 89,5% of the 241,4 kg of fish caught (Table 6). Two mullet species, viz. *L. alata* and *M. cephalus* comprised 49% of the total biomass caught whilst the milkfish *Chanos chanos* (Forsskal) and leervis *L. amia* despite low numbers, contributed substantially to the total biomass. As in Mntafufu estuary there was no clear seasonal pattern with regard to total numbers and biomass caught. *L. alata* and *A. hololepidotus* were most common in summer; *M. cephalus* in autumn; *L. macrolepis* in winter and *L. amia* in spring. *Hilsa kelee, V. buchanani* and the *Caranx* spp. occurred in almost constant numbers throughout the year. Spatially the largest numbers and biomass of fish occurred at Station 1. Table 6 indicates that either numerically or gravimetrically *L. alata, M. cephalus, V. buchanani* and *A. hololepidotus* were more abundant in the upper reaches; *C. chanos* in the upper and lower reaches; *H. kelee, L. amia, Caranx* spp. and *L. macrolepis* in the lower reaches. Although fewer than 10 *T. vitrirostris* were caught, they usually occurred in the lower reaches, as did *Scomberoides tol* (Cuvier) and *L. equula* while *M. capensis* and *Pomadasys commersonnii* (Lacepede) were most abundant in the upper reaches.

Discussion

Physico-chemical properties of the estuaries

Some aspects of the temperature characteristics recorded in the Mntafufu and Mzamba estuaries differed from those reported for estuaries in the eastern Cape (Marais & Baird 1980; Marais 1981; Marais 1983a; b) and Transkei (Plumstead *et al.* 1985; 1989a; b). With the exception of the winter surface water of the Mntafufu, the mean upper estuarine temperatures in both estuaries exceeded those in the lower reaches. Furthermore, the mean temperature of the bottom layer of water in Mzamba was greater than that of the surface in both winter and summer. The distribution of the estuarine fauna, being largely of marine origin, is influenced more by sea than riverine temperatures (Day 1981d) and Branch & Grindley (1979) have shown that bottom waters of estuaries have more stable temperatures because of the intrusion of sea water, than those measured at the surface. Based on the mean winter bottom water temperatures of the lower reaches of the five estuaries investigated during this study, it becomes evident that they may be divided into three regions:

(i) the Kei estuary with a mean temperature of 16,3°C
(ii) the Mbashe, Mtata and Mntafufu estuaries with mean temperatures of 18,9–19,0°C
(iii) the Mzamba estuary with a mean temperature of 20,8°C.

This division corresponds to that found by Stephenson & Stephenson (1972) and Day, Blaber & Wallace (1981), viz. that a faunistic transition zone occurs along the central part of Transkei.

The two estuaries under consideration are short and have small catchment areas. The MAP is in excess of 1000 mm

Table 5 Mean number and biomass (g) of fish caught monthly using gill nets over 12-h periods with 12 nettings at each of two localities in the Mzamba estuary

		1/81	2/81	3/81	4/81	5/81	6/81	7/81	8/81	9/81	11/81	12/81	2/82
Liza alata	No.	8,5	2,0	1,5	1,0			5,5	0,5	0,5	1,0	1,0	4,5
	Mass	13472	3199	1008	1116			3105	159	650	1449	1555	6818
Mugil cephalus	No.	6,5	2,0	8,0	4,0	2,5		3,0	0,5		2,5	2,0	1,0
	Mass	5298	1280	6675	4247	1258		1816	228		1902	2081	921
Hilsa kelee	No.	3,0	7,5	5,5	5,5	5,5		5,0	6,0	4,5	7,0	9,5	3,5
	Mass	902	1721	1428	1298	1465		1631	1879	1218	1794	2578	1032
Chanos chanos	No.	0,5				1,5				1,0	1,5		
	Mass	1500				4955				2829	4998		
Lichia amia	No.	2,0				0,5			0,5		2,5		
	Mass	3979				175			647		3189		
Caranx spp.	No.	2,0	0,5	2,0	1,0	1,0		1,5	1,0	0,5	2,5	1,5	
	Mass	514	1792	512	27	645		86	79	29	588	502	
Valamugil buchanani	No.	1,5		1,5			0,5		1,0		1,0	0,5	
	Mass	1252		1034			196		381		628	449	
Argyrosomus hololepidotus	No.	0,5	2,5	2,5	0,5			0,5		1,0	3,5	1,0	1,0
	Mass	159	1532	300	59			43		247	795	420	26
Liza macrolepis	No.				1,0	0,5	2,0	1,0	0,5		0,5		
	Mass				116	145	412	238	115		148		
Myxus capensis	No.			2,0					0,5			0,5	
	Mass			439					135			219	
Pomadasys commersonnii	No.	0,5									1,0		
	Mass	125									516		
Sphyraena acutipinnis	No.		0,5									0,5	
	Mass		120									275	
Elops machnata	No.									0,5			
	Mass									253			
Thryssa vitrirostris	No.				0,5		0,5		1,0			0,5	0,5
	Mass				45		66		112			45	22
Scombroides tol	No.						0,5		0,5		1,0	0,5	
	Mass						64		46		75	48	
Pomatomus saltatrix	No.					0,5	0,5	0,5			0,5		
	Mass					30	77	34			33		
Leiognathus equula	No.	0,5		0,5				0,5				0,5	0,5
	Mass	44		27				39				8	45
Valamugil seheli	No.							0,5					
	Mass							138					
Pomadasys kaakan	No.												0,5
	Mass												95
Diplodus cervinus	No.										0,5		
	Mass										70		
Liza dumerilii	No.						0,5						
	Mass						61						
Rhabdosargus globiceps	No.									0,5			
	Mass									36			
Rhabdosargus holubi	No.				0,5	0,5							
	Mass				12	13							
Ambassis spp.	No.	0,5											
	Mass	24											
Gerres acinaces	No.										0,5		
	Mass										10		
Totals		26,0	15,0	23,5	14,0	12,5	4,5	18,0	12,0	8,5	25,5	18,0	11,5
		27269	9644	11423	6920	8686	876	7130	3781	5227	16165	8180	8959

p.a. but, owing to the coastal forests and minimal agriculture, the nett MAR is only 46 Mm^3 and 69 Mm^3 for Mntafufu and Mzamba, respectively. During this study only minor floods were recorded in the Mntafufu as the lowest salinity recorded was 4‰ although at times there was evidence of more serious flooding which may have reduced the salinity to 0‰. The vertical salinity gradient was well established in both the Mntafufu and Mzamba estuaries, particularly the latter system where surface waters rarely exceeded 25‰ while bottom salinities usually varied between 30 and 36‰. In accordance with the findings of Hill (1966), bottom waters of the Mntafufu estuary did on occasion exhibit a

Table 6 Mean number and biomass (g) of fish caught by gill net at two sampling stations in the Mzamba estuary (results based on 12 nettings per station)

	Station 1		Station 2		Total				Mean mass	
	n	Mass (g)	*n*	Mass (g)	*n*	%N	Mass (g)	%B	Per net	Per individual
Liza alata	1,83	2203,6	2,5	3226,3	52	13,4	65 158	27,0	2714,9	1253,0
Mugil cephalus	2,08	1550,6	3,33	2863,3	65	16,7	52 966	21,9	2206,9	814,9
Hilsa kelee	8,4	2345,0	2,67	736,8	134	34,4	36 982	15,3	1540,9	276,0
Chanos chanos	0,42	1463,8	0,42	1296,7	10	2,6	33 126	13,7	1380,3	3312,6
Lichia amia	0,83	1334,2	0,17	210,8	12	3,1	18 540	7,7	772,5	1545,0
Caranx spp.	1,50	627,5	0,75	164,8	27	6,9	9 507	3,9	396,1	352,1
Valamugil buchanani	0,5	263,5	0,58	435,4	13	3,3	8 387	3,5	349,5	645,2
Argyrosomus hololepidotus	1,08	270,8	1,0	345,8	25	6,4	7 399	3,1	308,3	296,0
Liza macrolepis	0,67	151,7	0,25	44,0	11	2,8	2 348	1,0	97,8	213,5
Myxus capensis	0,17	59,0	0,33	73,2	6	1,5	1 586	0,7	66,1	264,3
Pomadasys commersonnii	0,08	20,8	0,17	85,9	3	0,8	1 280	0,5	53,3	426,7
Sphyraena acutipinnis	0,17	65,8			2	0,5	790	0,3	32,9	395,0
Elops machnata	0,08	58,8			1	0,3	705	0,3	29,4	705,0
Thryssa vitrirostris	0,42	43,1	0,08	5,0	6	1,5	577	0,2	24,0	96,2
Scomberoides tol	0,17	20,2	0,17	18,6	4	1,0	465	0,2	19,4	116,3
Pomatomus saltatrix	0,25	23,5	0,08	5,5	4	1,0	348	0,1	14,5	87,0
Leiognathus equula	0,42	27,0			5	1,3	324	0,1	13,5	64,8
Valamugil seheli	0,08	22,9			1	0,3	275	0,1	11,5	275,0
Pomadasys kaakan	0,08	15,8			1	0,3	189	0,1	7,9	189,0
Diplodus cervinus	0,08	11,7			1	0,3	140	0,1	5,8	140,0
Liza dumerilii	0,08	11,0			1	0,3	132	0,1	5,5	132,0
Rhabdosargus globiceps			0,08	6,0	1	0,3	72	< 0,1	3,0	72,0
Rhabdosargus holubi			0,08	4,2	2	0,5	50	< 0,1	2,1	25,0
Ambassis spp.			0,08	3,9	1	0,3	47	< 0,1	2,0	47,0
Gerres acinaces	0,08	1,6			1	0,3	20	< 0,1	0,8	20,0
Totals	19,57	10 592,0	12,74	9526,2	389		241 413		10 058,9	

reversed salinity gradient. Although fairly rare elsewhere (Branch & Grindley 1979; Plumstead *et al.* 1985; 1989a; b), this phenomenon was the norm in Mzamba bottom waters.

Fish fauna

The number of species recorded in an estuary is dependent on the duration and intensity of collecting (Day 1981e) and the type of gear utilized (Plumstead *et al.* 1985). Gill netting in eastern Cape estuaries yielded an average of 24 fish species per system (Marais & Baird 1980; Marais 1981; 1983a; b) whilst in the turbid Transkei estuaries 26–27 fish species were caught (Plumstead *et al.* 1985; 1989a; b). The small clear Mntafufu and Mzamba estuaries in the present study yielded 42 and 25 species respectively.

An analysis of the data from the Kei (Plumstead *et al.* 1985), Mbashe (Plumstead *et al.* 1989a), Mtata (Plumstead *et al.* 1989b), Mntafufu and Mzamba reveals that a number of fish species are near the limits of their distributional range. Many of the subtropical and tropical species including *Valamugil seheli*, *Valamugil robustus*, *Crenimugil crenilabus* and *Pomadasys kaakan* were rarely caught, particularly in the three southern estuaries and were probably at the southern limits of their distribution. Two tropical species, viz. *T. vitrirostris* and *H. kelee* became progressively more abundant moving from the Kei estuary northwards. In the Mntafufu 71% of fish had subtropical (13 species) and tropical (17 species) affinities while 68% of those in Mzamba had similar affinities (32% subtropical; 36% tropical) (Branch & Grindley 1979; Plumstead 1984). Day (1981c) mentions that the majority of the fish in southern Mozambique (80%), Natal (70%) and Transkei (59%) extend northwards and are termed tropical, while Branch & Grindley (1979) found that 53% of the fish fauna in the Mngazana estuary have tropical affinities.

In comparison to estuaries in the eastern Cape (Marais & Baird 1980; Marais 1981; 1983a; b) and others in Transkei (Plumstead *et al.* 1985; Plumstead *et al.* 1989a; b) the Mntafufu estuary has a much greater species diversity. Mzamba estuary, similar in that it also originates in the coastal belt of Transkei, has very clear water, salinities close to those of seawater and seldom experiences severe floods, had only 25 species (*cf.* 42 species — Mntafufu). The high diversity of fish in the Mntafufu may be due to one or more of several factors. Since species diversity may be related to environmental stability (Day & Grindley 1981) the high diversity could be indicative of the equable physical conditions encountered. Fish do not have to contend with turbid water and the clarity of the water suggests that phytoplankton is probably not important (Branch & Grindley 1979). Whitfield (1983) suggests that habitat variation is frequently overlooked when species diversity is being assessed. Certainly Mntafufu with its mangrove swamps and creek, lagoon fringed with rocks on the south bank and upper reaches fringed by *Phragmites* sp. offers a wide variety of habitats. *Zostera* beds which have been shown to attract many juvenile fish (Branch & Grindley 1979) were not found in the Mntafufu estuary despite the lack of severe floods during the sampling period, which often bury submerged macrophytes under a layer of silt (Day & Grindley 1981). The mangrove swamps in the lower reaches and extensive reed beds above the upper reaches could be expected to result in a high detrital input (Day & Grindley 1981; Whitfield 1980), which would probably be trapped within the system for prolonged periods owing to mild, infrequent floods and the narrow configuration of the mouth (Figure 2). Smaller estuaries usually have a lower species diversity, especially if coupled with closure of the mouth (Whitfield 1983). Mzamba estuary is both smaller (2 km long) than Mntafufu (5 km long) and the mouth is reported to close during winter (Begg 1986). Although this did not occur during this investigation, the mouth was very shallow at times (less than 75 cm deep), possibly resulting in a restricted tidal exchange with the sea.

Numerically and gravimetrically the mean monthly catches in the Mntafufu (20,5 fish and 7,2 kg/net) and the Mzamba (16,2 fish and 10,1 kg/net) were very much less than catches from the Kei (31,7 kg/net, Plumstead *et al.* 1985), Gamtoos (33,3 kg/net, Marais 1983b), Sundays (20,5 kg/net, Marais 1981) and the Krom (17,9 kg/net, Marais 1983a) but similar to that of the Swartkops (13,1 kg/net, Marais & Baird 1980) and the Mtata (9,1 kg/net, Plumstead *et al.* 1989b) estuaries. The catch composition resembled that found in the eastern Cape (Marais & Baird 1980; Marais 1981; 1983a; b) and Natal (Whitfield 1980; Blaber, Hay, Cyrus & Martin 1984) in that the family Mugilidae dominated the catches (41,7% numerically or 45,8% gravimetrically — Mntafufu; 38,3% numerically or 54,2% gravimetrically — Mzamba). In the Mntafufu 11 species of mullet were caught, *V. cunnesius*, a small species, being particularly abundant, followed by *M. cephalus*, *M. capensis* and *V. buchanani*. *Mugil cephalus* and *L. alata* dominated the seven mullet species netted in the Mzamba estuary.

In the Kei (Plumstead *et al.* 1985), Mbashe (Plumstead *et al.* 1989a), Mtata (Plumstead *et al.* 1989b) and several eastern Cape estuaries (Marais & Baird 1980; Marais 1981; 1983a; b) the highest catch returns in terms of number or biomass were made in the middle and upper reaches. The Mntafufu and Mzamba, two clear water estuaries, produced their biggest catches in the lower reaches. Similar results were obtained by Whitfield (1980) in Mhlanga and Blaber *et al.* (1984) in the Tongati and Mdloti estuaries, where the largest catches were made in either the middle or lower reaches. In both Mntafufu and Mzamba these areas were characterized by being wide and lagoon-like, surrounded by mangroves in the case of Mntafufu and by dense stands of *Juncus* and *Hibiscus tiliaceus* at Mzamba. These plants provide a rich detrital input which Whitfield (1983) has suggested is important in southern African estuarine food webs. It is therefore not surprising to find a large proportion of the catch coming from the lower reaches of these two estuaries.

Acknowledgements

We acknowledge the following individuals and institutions for their assistance and financial support: Dr J.F.K. Marais for advice and help in the planning of the project; Mr E. Makanandana and Mr A. Qina for their help in the field and laboratory; the University of Transkei; the Department of Agriculture and Forestry of the Republic of Transkei and the Department of Co-operation and Development and Department of Foreign Affairs of the Republic of South Africa for funding the project.

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