A survey of the fish fauna of Transkei estuaries. Part 1. The Kei River estuary

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During the period of survey the 8 km long Kei estuary was subjected to periodic floods which reduced salinities to 0‰ and decreased light penetration to a few centimetres. Species composition, and temporal and spatial abundance were determined for fish samples collected by means of gill nets. Twenty-six species of fish were caught with *Mugil cephalus, Liza tricuspidens* and *Argyrosomus hololepidotus* predominating, in that order. The family Mugilidae comprised 67,8% of the numbers and 66,6% of the fish biomass caught. Definite seasonal patterns could not be determined for many of the fish although *M. cephalus, L. richardsoni* and *A. hololepidotus* were more abundant in summer. The effect of river flooding had unpredictable results on Mugilidae catches which either decreased or increased after floods while catches of *P. commersonii* and *A. hololepidotus* usually increased. Largest catches were made in the middle reaches although species diversity was greatest in the lower reaches of the estuary.

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Die Keiriviermonding wat oor 'n afstand van ongeveer 8 km strek, is tydens die opname-periode periodiek oorstroom wat tot 'n drastiese verlaging in die soutgehalte en 'n verhoging in die sliklading gelei het. Die visspesiesamestelling asook die seisoensverspreiding en voorkeurgebiede van die vis is met behulp van kiefnette vasgestel. Ses en twintig visspesies, wat deur *Mugil cephalus, Liza tricuspidens* en *Argyrosomus hololepidotus* oorheers is, is geïdentifiseer. Die familie Mugilidae het 67,8% van die aantal visse, wat 66,6% van die totale biomassa uitgemaak het, verteenwoordig. Alhoewel geen duidelik afgebakende seisoenspatroon vir die onderskeie visspesies bepaal kon word nie, het *M. cephalus, L. richardsoni* en *A. hololepidotus* geneig om meer volop in die somermaande voor te kom. Vloede het 'n onvoorspelbare effek op die aantal Mugilidae teenwoordig gehad, terwyl *P. commersonii*-en *A. hololepidotus*-vangste gewoonlik vermeerder het. 'n Gemiddeld van 56,6 vis, waarvan die gemiddelde massa 31,7 kg was, is per net gevang. Die middelste gedeelte van die riviermonding het die beste vangsresultate opgelewer terwyl die grootste verskeidenheid visspesies in die mondgedeelte voorgekom het.

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Many studies have been made of the biology and ecology of the fish fauna in the estuaries of the eastern Cape (Van der Horst 1976; Winter 1979; Marais 1976, 1981, 1982, 1983a, 1983b; Marais & Baird 1980) and Natal (Wallace 1975a, 1975b Wallace & van der Elst 1975; Blaber 1976, 1977, 1979; Blaber & Cyrus 1983; Whitfield 1980a, 1980b; Whitfield & Blaber 1978a, 1978b). Apart from occasional surveys (Blaber 1977; van der Elst 1978; Branch & Grindley 1979; Marais & Prinsloo 1980), very little is known about the fish fauna occurring in the estuaries of Transkei which fall within a transition zone between the subtropical estuaries of Mozambique and Natal, and the warm-temperate estuaries of the eastern and southern Cape (Day 1981c). The degradation of Transkei estuaries by siltation resulting from poor agricultural practices in their catchment areas (Wallace & van der Elst 1975; Branch & Grindley 1979) and the commercial exploitation of some of the estuaries, further emphasized the necessity to obtain baseline data. The major objectives of this study were to determine the species composition, seasonal distribution and abundance of fish caught in gill nets in five Transkei estuaries, this paper dealing with the Kei River estuary.

Study area

The Kei River estuary (32°40′S/28°23′E) forms part of the southern boundary of Transkei (Figures 1A & 1B) and of the subtropical estuarine region (Day 1981b). It has a catchment

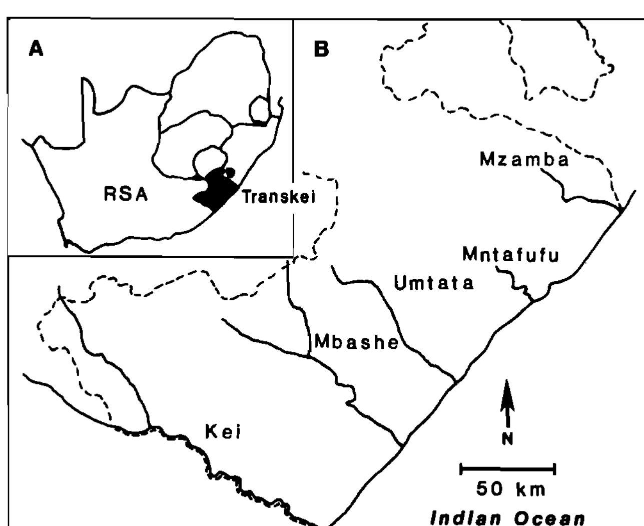

Figure 1 Geographical position of the Republic of Transkei (A) and estuaries (B) investigated, within the confines of southern Africa.

area of 20 673 km^2 (Eksteen, van der Walt & Nissen 1979) which drains water from the Transkei interior, resulting in a heavy deposition of silt in the estuary. The mean annual precipitation and nett mean annual runoff are 646 mm and 720 Mm^3, respectively (Eksteen, van der Walt & Nissen 1979). The head and upper reaches of the Kei estuary are surrounded by densely forested, steep hills, and have a narrow floodplain whereas a much wider floodplain is present on the eastern bank of the middle and lower reaches. For most of the estuary the western bank is steep and well wooded. Mudflats are exposed at low tide in the middle and upper reaches which are generally very shallow (depth < 1 m, high tide). The mouth opens into the sea against a rocky promontory east of the old mouth. Maps drawn in 1976 and supplied by the Surveyor General (R.S.A.) show the mouth to be 0,75 km to the west of the existing mouth. This shift adds weight to Day's (1981b) suggestion that the lack of reefs and rocks to anchor the exit channel of this estuary causes the latter to vary with time. A narrow channel 8 km upstream from the mouth delimits the upper extent of saline water in this estuary.

Methods

The monthly sampling of the Kei estuary extended from December 1980 to January 1982 with additional samples taken in April 1980, April, June and September 1982. Three sampling stations 1, 4 and 8 km from the mouth were chosen as representative sites for the lower, middle and upper reaches, respectively, (Figure 2) at which fleets of nets were set during the survey period. Nets were usually set at neap-tides in the evening and removed 12 h later. All fish were collected by means of brown 60 m multi-filament gill nets. Each fleet of nets comprised six 10 m panels, 3 m deep with stretched mesh sizes of 45, 57, 73, 93, 118 and 150 mm (twine thickness (210/4, 210/6, 210/6, 210/9, 210/9 and 210/9 respectively), covering an area of 180 m^2. Floats were of cork, each having a bouyancy of 141 g and spaced 140 cm apart. The 49 g lead weights on the footrope were spaced 88 cm apart. Nets were laid perpendicular to the river bank when width, depth and obstructions permitted, or else diagonally.

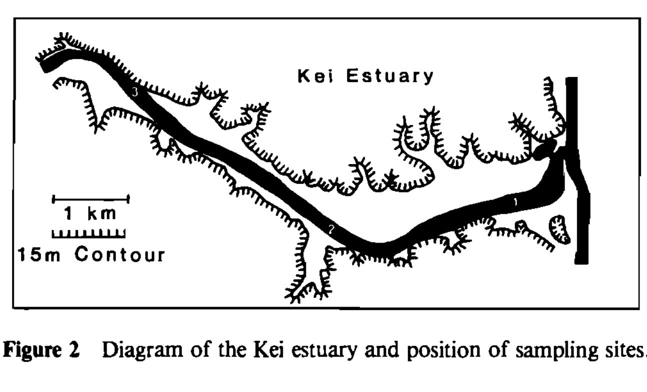

Figure 2 Diagram of the Kei estuary and position of sampling sites.

Samples of surface and bottom waters, collected for the measurement of physical data were taken from the middle of the channel, in the morning, prior to removing each net. Bottom water samples were collected by lowering a stoppered, weighted bottle (250 ml), which was filled when resting on the sediment by jerking the cord to remove the stopper. Salinity was measured on an Atago 0 – 10% sodium chloride salinometer accurate to 1‰ and adjusted to 0‰ with distilled water. Temperature was measured using a mercury thermometer accurate to 0,1 °C. Dissolved oxygen concentrations were measured with a calibrated KENT EIL 7130 oxygen meter accurate to 0,1 mg/ℓ with results being corrected for salinity and temperature. Hydrogen ion concentration was determined on a METROHM model E604 pH meter using an EA/62/2 probe accurate to 0,01 pH units. A 20 cm diameter secchi disc was used to measure water transparency.

All fish were identified according to Smith (1975), Jackson (1975) and Smith (1977). This paper presents the results on the physical and chemical characteristics of the surface and bottom waters, species composition, mean monthly catch [numbers (N) and biomass (B)] per species (temporal abundance) and the mean catch per species per station (spatial abundance).

Results

Physico-chemical properties of the estuary

The pattern of surface and bottom water temperatures is given in Figure 3 with the mean values for the various reaches in Table 1. Mean summer temperatures were between 5 – 6 °C (Table 1) warmer than in winter, with the widest annual range being experienced in the upper reaches. A slight horizontal temperature gradient was evident, the lower reaches being cooler than the upper in summer with a reversal of the situation in winter. The vertical temperature gradient was usually small, the largest difference between surface and bottom water occurring in summer at Station 1.

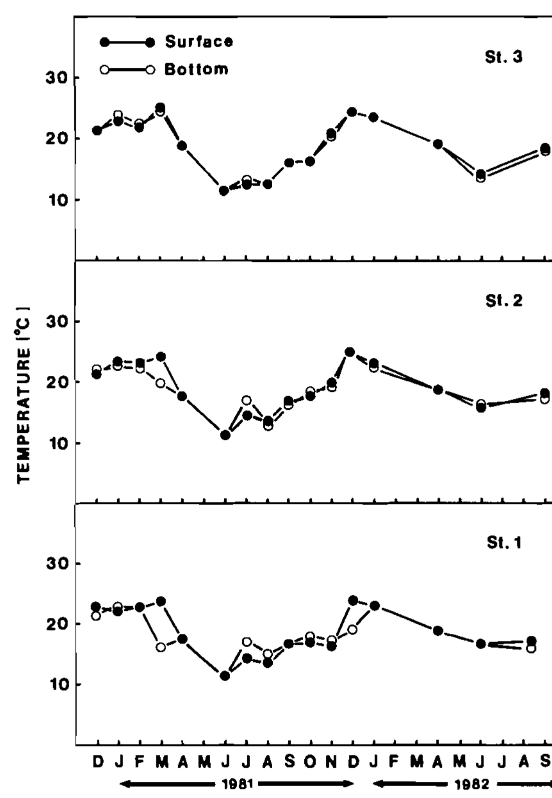

Figure 3 Monthly temperatures (°C) recorded at three stations in the Kei estuary.

The Kei estuary was characterized by extreme fluctuations in salinity (Figure 4). Severe floods reduced the entire estuary to fresh water on three occasions during the survey. In March, August and December 1981 when the river was running strongly, the upper layers were fresh (0‰) although the bottom waters of the lower reach remained at or near 35‰. During the drier periods, salinities at Stations 1 and 2 were

Table 1 Physico-chemical properties measured in the lower (Station 1), middle (Station 2) and upper (Station 3) reaches of the Kei 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	21,6	3,0	(16,5 – 24,0)	8	22,3	2,3	(18,0 – 25,0)	8	22,1	2,8	(16,2 – 24,5)	8
Winter	15,9	2,5	(11,5 – 19,0)	8	16,0	2,6	(11,5 – 18,8)	8	15,5	3,1	(11,5 – 19,4)	8
Bottom												
Summer	20,1	2,8	(17,0 – 23,0)	8	21,6	2,2	(18,2 – 23,0)	8	22,0	3,0	(15,5 – 24,5)	8
Winter	16,3	2,2	(11,5 – 18,8)	8	16,1	2,5	(11,5 – 18,8)	8	15,6	3,0	(11,5 – 19,4)	8
Salinity (‰)												
Surface												
Summer	18,3	19,6	(0,0 – 40,0)	8	9,6	11,2	(0,0 – 29,0)	8	2,1	3,6	(0,0 – 10,0)	8
Winter	18,6	15,0	(0,0 – 39,0)	8	12,3	12,5	(0,0 – 33,0)	8	0,5	0,9	(0,0 – 2,0)	8
Bottom												
Summer	26,8	16,7	(0,0 – 41,0)	8	19,0	16,4	(0,0 – 36,0)	8	6,3	10,3	(0,0 – 27,0)	8
Winter	31,3	12,9	(0,0 – 40,0)	8	20,5	14,4	(0,0 – 36,0)	8	3,1	5,4	(0,0 – 14,0)	8
Oxygen (mg/ℓ)												
Surface	8,3	1,2	(6,6 – 10,5)	14	8,9	1,6	(7,1 – 13,0)	14	9,4	1,2	(7,8 – 11,4)	14
Bottom	7,9	1,0	(6,0 – 10,5)	14	8,7	1,9	(6,9 – 13,5)	14	9,3	1,5	(7,7 – 12,2)	14
pH												
Surface	8,26	0,28	(7,82 – 8,83)	13	8,30	0,30	(7,77 – 8,80)	13	8,32	0,24	(7,81 – 8,77)	13
Bottom	8,14	0,26	(7,82 – 8,63)	13	8,20	0,26	(7,76 – 8,70)	13	8,23	0,28	(7,82 – 8,63)	13
Secchi disc (cm)	65,7	61,9	(2,0 – 174,0)	15	33,4	31,5	(2,0 – 98,0)	14	14,0	10,2	(2,0 – 33,0)	14
Depth (cm)	169,8	50,8	(100,0 – 320,0)	15	118,1	37,6	(64,0 – 179,0)	14	115,2	42,3	(45,0 – 219,0)	14

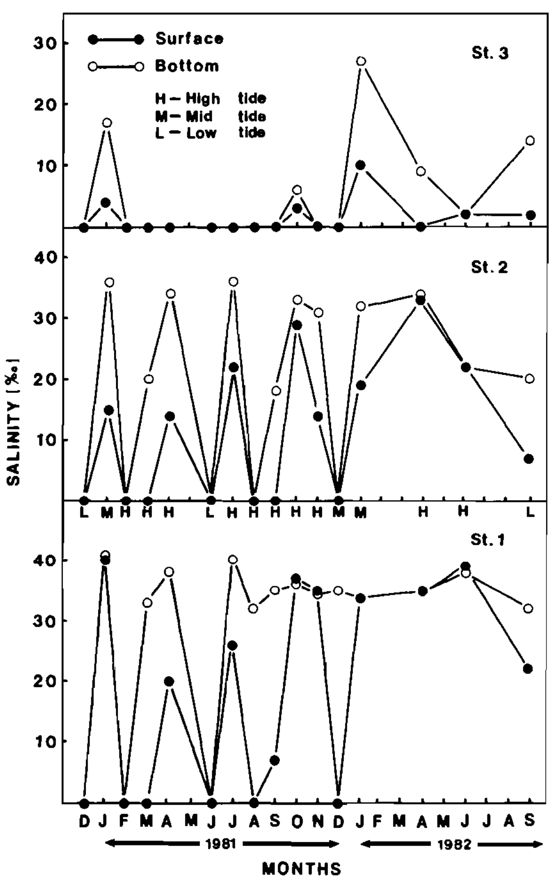

Figure 4 Monthly salinities (‰) recorded at three stations in the Kei estuary.

usually close to that of seawater, while the upper estuary, influenced more by the inflowing fresh water varied between 0 and 10‰, occasionally becoming more saline.

Mean dissolved oxygen concentrations (Table 1) were generally high with values ranging from 7,9 mg/ℓ (Station 1) to 9,4 mg/ℓ (Station 3). Values for bottom samples were usually slightly lower than those at the surface, increasing upstream.

Water in this estuary was relatively turbid (Table 1). At Station 3 transparency was usually less than 25 cm and varied between 2 cm and 98 cm at Station 2. Light penetration was reduced to 11,0 cm or less, at all stations on six occasions during this investigation.

The Kei estuary was alkaline, with mean pH values ranging from 8,1 – 8,3.

Fish fauna

The total catch consisted of 2 716 fish representing 26 species (Table 2), with six species alone accounting for 93,9% of that total (Table 3). In terms of biomass, the six species comprised 90% of the total catch (1 523 kg) although the order and percentage contribution differed compared to the numerical data (Table 3). The temporal abundance of fish in the Kei estuary is given in Table 2. With the exception of June 1982 the largest monthly catches were made during the warmer months. Catches of *Liza tricuspidens* (Smith) and *Myxus capensis* (Valenciennes) were too variable to enable definite seasonal patterns to be ascertained. The flathead mullet *Mugil cephalus* (Linnaeus), kob *Argyrosomus hololepidotus* (Lacépède), spotted grunter *Pomadasys commersonii* (Lacépède) and the southern mullet *Liza richardsoni* (Smith) appeared to be more abundant in summer. Of the remaining species too few were caught to determine their temporal abundance.

The spatial distribution of fish at Stations 1 – 3 is given in Table 3. The biggest catches, having a mean of 73,01 fish per netting and weighing 41,23 kg, were taken from Station 2 (*cf.* 36,59 fish weighing 29,72 kg at Station 1; 58,36 fish weighing 23,45 kg at Station 3). In terms of biomass

Table 2 Mean number and biomass (grams) of fish caught monthly using gill nets over 12-h periods with 16 nettings at each of three localities in the Kei estuary

		5/80	12/80	1/81	3/81	4/81	6/81	7/81	8/81	9/81	10/81	11/81	12/81	1/82	4/82	6/82	9/82
Mugil cephalus	No.	17,3	10,3	37,0	6,0	12,3	2,7	8,7	12,0	7,7	16,0	7,0	32,7	14,3	32,7	69,3	8,0
	Mass	12730	5964	16381	3502	4961	1129	2057	6758	4549	8537	5730	14210	7645	11853	26288	3453
Liza tricuspidens	No.	5,3	3,7	1,0	1,0	2,3	4,3	9,7	5,7	25,0	2,7	5,0	19,3	5,7	5,0	18,0	2,7
	Mass	3916	3966	882	964	2365	5220	11089	7113	25627	2299	5676	21102	6362	5308	27661	2263
Argyrosomus hololepidotus	No.	14,0	5,3	12,7	4,0	4,3		2,7	3,0	7,3	8,0	6,3	14,3	24,3	27,3	17,0	18,0
	Mass	8146	2600	2649	10993	9106		3324	1180	4711	6742	8110	4780	5127	5217	5215	5780
Myxus capensis	No.	10,7	0,7	3,7	3,3	5,7	1,0	3,0	4,0	4,3	6,0	2,3	1,0	3,7	5,0	27,3	20,0
	Mass	3581	231	1444	1430	2723	337	1090	2425	2058	1633	644	360	777	1774	10319	7895
Pomadasys commersonii	No.	2,0	13,0	23,3	0,3				3,0	1,0	1,0	8,3	19,7	5,0	10,7	0,3	1,3
	Mass	188	5439	1917	21				477	150	539	9075	15268	633	1402	211	1092
Liza richardsoni	No.	4,3	0,7		0,7						2,0	0,3	12,3	6,3	5,0	22,3	41,3
	Mass	1370	669		276						1473	259	6496	1576	1374	6394	10273
Cyprinus carpio[a]	No.	0,7		0,3	0,7		0,3		0,3	0,3	1,0	2,0	0,7	0,3		0,3	
	Mass	1413		850	1047		921		718	740	2263	3960	1709	1265		913	
Cyprinus carpio[b]	No.	0,7		0,3						1,0	0,7	0,3	0,3			0,7	0,3
	Mass	1413		917						2584	1197	627	1000			1601	568
Tachysurus feliceps	No.	0,3		0,3	0,3	0,3		0,3	0,3	2,7	1,0	0,3	1,3	2,7	2,3	3,0	0,3
	Mass	205		220	204	205		197	219	1599	669	164	712	1529	1193	1478	253
Lithognathus lithognathus	No.		0,7							0,7			2,3			0,7	
	Mass		238							6544			1227			369	
Lichia amia	No.	0,3	1,0	2,0	0,3	0,3					0,3		0,3	0,3	1,0	0,3	
	Mass	89	792	483	161	258					232		12	250	1164	156	
Elops machnata	No.		0,7							0,3					0,3	1,3	
	Mass		238							97					23	139	
Valamugil buchanani	No.					0,3										0,3	0,3
	Mass					647										406	28
Acanthopagrus berda	No.	0,3			0,3			0,3	0,3				0,7				
	Mass	61			120			215	95				340				
Rhinobatus annulatus	No.	0,7						0,3									
	Mass	359						338									
Liza dumerili	No.	0,3									0,7		0,3		1,3		
	Mass	142									151		38		125		
Valamugil cunnesius	No.	0,7		0,3		0,3						0,3	1,0	0,3	0,7		
	Mass	139		22		19						27	136	32	75		
Platycephalus indicus	No.									0,3							
	Mass									4,3							
Labeo umbratus	No.												0,3				
	Mass												301				
Pomatomus saltatrix	No.											0,3			0,3	0,3	
	Mass											161			324	34	
Johnius belengerii	No.				0,3								0,3				
	Mass				46								74				
Rhabdosargus holubi	No.	0,7				0,3		0,3	0,3				0,3		0,7	0,3	0,3
	Mass	27				10		10	13				101		30	10	13
Liza macrolepis	No.				0,3												
	Mass				83												
Thryssa vitrirostris	No.							0,3									0,3
	Mass							19									24
Monodactylis falciformis	No.						0,3								0,7		
	Mass						7								31		
Oreochromis mossambicus	No.						0,3										
	Mass						2										
Caranx spp.	No.														0,3		
	Mass														18		
Total	No.	58,3	36,1	80,9	17,5	26,1	8,9	25,6	28,9	50,6	39,4	32,4	106,5	63,5	93,3	161,8	92,8
Total	Mass	33779	20138	25865	18847	20327	7616	18333	18998	49072	25735	33833	67691	25371	29911	81194	31642

[a]Aischgrund; [b]Full scale

M. cephalus and *M. capensis* showed a preference for the middle and upper reaches of this estuary; *Cyprinus carpio* Linnaeus, *Valamugil buchanani* (Bleeker) and *Valamugil cunnesius* (Valenciennes) for the middle reaches; *L. richardsoni, L. tricuspidens* and *A. hololepidotus* for the middle and lower reaches; *P. commersonii, Tachysurus feliceps* (Valenciennes) *Lithognathus lithognathus* (Cuvier) and *Lichia amia* (Linnaeus) for the lower reaches.

Table 3 Mean number and biomass of fish caught by gill net at three sampling stations in the Kei estuary (results based on 16 nettings per station)

	Station 1		Station 2		Station 3		Total				Mean mass	
Species	*n*	mass (g)	*n*	mass (g)	*n*	mass (g)	*n*	%	mass (g)	(%)	per net	per individual
M. cephalus	2,19	1 376,8	20,88	11 117,9	32,06	12 863,4	882	32,5	405 731	26,6	8 452,7	460,0
L. tricuspidens	9,75	11 273,3	11,06	12 497,7	0,75	944,1	345	12,7	395 440	26,0	8 238,4	1 146,2
A. hololepidotus	8,31	6 258,8	13,88	6 760,8	6,25	2 670,3	455	16,8	251 037	16,5	5 229,9	551,7
M. capensis	1,94	834,7	7,0	2 887,0	10,13	3 538,6	305	11,2	116 164	7,6	2 420,1	380,9
P. commersonii	4,75	3 947,1	11,19	2 776,3	0,81	106,3	268	9,9	109 274	7,2	2 276,6	407,7
L. richardsoni	4,25	1 830,8	7,5	2 653,7	6,13	1 170,4	286	10,5	90 477	5,9	1 885,0	316,4
C. carpio[a]	0,25	608,8	0,69	1 423,3	0,25	665,6	19	0,7	43 162	2,8	899,2	2 271,7
C. carpio[b]	–	–	0,38	990,3	0,44	867,4	13	0,5	29 724	2,0	619,2	2 286,5
T. feliceps	1,81	995,4	0,56	341,4	0,56	322,0	47	1,7	26 541	1,7	552,9	564,7
L. lithognathus	0,75	1 503,3	0,06	67,6	–	–	13	0,5	25 134	1,7	523,6	1 933,4
L. amia	0,63	349,6	0,38	172,6	0,19	152,1	19	0,7	10 788	0,7	224,8	567,8
E. machnata	0,13	186,3	0,06	7,3	0,31	41,3	8	0,3	3 757	0,2	78,3	469,6
V. buchanani	0,06	76,1	0,06	121,4	0,06	5,3	3	0,1	3 244	0,2	67,6	1 081,3
A. berda	0,13	55,5	0,19	88,6	0,06	11,4	6	0,2	2 489	0,2	51,8	414,8
R. annulatus	0,19	130,6	–	–	–	–	3	0,1	2 089	0,1	43,5	696,3
P. saltatrix	0,19	97,3	–	–	–	–	3	0,1	1 556	0,1	32,4	518,7
L. dumerili	0,19	41,1	0,31	50,1	–	–	8	0,3	1 459	0,1	30,4	182,4
V. cunnesius	0,13	17,1	0,50	53,1	0,06	14,1	11	0,4	1 348	0,1	28,1	122,5
P. indicus	0,06	77,5	–	–			1	< 0,1	1 240	0,1	25,8	1 240,0
L. umbratus	–	–	–	–	0,06	56,4	1	< 0,1	903	0,1	18,8	903,0
R. holubi	0,50	18,7	0,06	2,1	0,06	18,9	10	0,4	636	0,1	13,2	63,6
J. belengerii	0,06	13,8	0,06	8,6	–	–	2	0,1	359	< 0,1	7,5	119,7
L. macrolepis	0,06	15,6	–	–	–	–	1	< 0,1	249	< 0,1	5,2	249,0
T. vitrirostris	0,13	8,2	–	–	–	–	2	0,1	131	< 0,1	2,7	65,5
M. falciformis	0,13	4,0	–	–	0,06	1,4	3	0,1	86	< 0,1	1,8	28,7
Caranx spp.	–	–	–	–	0,06	3,4	1	0,1	54	< 0,1	1,1	54,0
O. mossambicus	–	–	–	–	0,06	0,4	1	0,1	7	< 0,1	0,1	7,0
	36,59	29 720,4	73,01	41 229,9	58,36	23 452,8	2 716		1 523 079			

[a]Aischgrund; [b]Full scale

Discussion

Physico-chemical properties

Variations in temperatures recorded in the Kei estuary are consistent with those reported for other estuaries in southern Africa by Connell (1974), Branch & Grindley (1979), Marais & Baird (1980), Day (1981c) and Branch & Day (1984) in that upper estuarine summer temperatures were warmer than at the mouth and *vice versa* during winter and a wider annual fluctuation occurred in the upper reaches with surface temperatures usually warmer in summer and colder in winter than bottom temperatures. Measurements of physico-chemical properties were usually made beteen 06h00 and 08h00 and the surface temperatures given are therefore cooler than midday recordings would have been. Nevertheless temperatures (surface and bottom) ranged from 11,5 – 24,0 °C and 11,5 – 24,5 °C in the lower and upper reaches respectively (Table 1). These maxima and minima are a few degrees lower than those reported by Day (1981c) for the Transkei, which falls within the southern limits of the subtropical estuaries. Values recorded (Table 1) suggest that this estuary should be included in the warm-temperate estuaries of the eastern and southern Cape, which have a seasonal range of about 12 to 26 °C (Day 1981b).

The extreme monthly salinity variations in the Kei estuary are unlike any of the data reported from the east and south coast estuaries (Connell 1974; Wooldridge 1974, 1975; Wallace 1975a; Whitfield 1980b; Marais & Baird 1980; Marais 1981, 1983a & 1983b). Floods, which reduced salinities to 0‰, were not restricted to the summer rainfall season but occurred in winter and early spring as well. During periods of low flow a normal salinity regime existed, with salinities decreasing with increasing distance from the mouth. This estuary, being shallow (Table 1) and perennially open, had high oxygen levels, comparable to those reported for the Mntentu estuary in Pondoland, Transkei (Connell 1974) but higher than those of the Krom (Kromme) estuaury (Hecht 1973).

High turbidity readings have been reported from the Transkei and southern Natal estuaries (Day 1981d). This estuary was no exception as values as low as 2,0 cm were recorded during floods and mean values did not exceed 66 cm. The Kei River drains the Transkei interior where mismanagement of the veld is a major source of silt (Branch & Grindley 1979) causing the high turbidities recorded.

Fish fauna

Before comparing the fish fauna in different estuaries cognizance of the type of gear used, fishing intensity and survey period must be taken. Because the selectivity of gill nets precludes the capture of some fish species, particularly the smaller ones, species diversity found during this survey was much lower than those given for estuaries where a wider variety of fishing gear had been used (Wallace 1975a; Branch & Grindley 1979; Winter 1979). In 48 samples collected from the Kei estuary, 2 716 fish comprising 26 species (*cf.* 21 to 25 species/estuary from the eastern Cape) were caught. Fifteen of these were warm temperate (6) and subtropical (9) species with only three (13%) of tropical origin (Branch & Grindley

1979; Plumstead 1984). Branch & Grindley (1979) reported that 52,5% of the fish in the mangrove-dominated Mngazana estuary had tropical affinities although the invertebrate fauna present consisted mainly of warm temperate species.

In the samples from the Kei estuary, many of the fish were recorded in low numbers (12 species 0,2% or less), 95,1% of the catch consisting of only 7 species and 98% of the biomass (16 species 0,2% or less) due to 10 species.

Researchers have shown the family Mugilidae to be a large component of the eastern Cape estuarine fish fauna (Krom 12% N or 6% B, Marais 1983a; Gamtoos 25% N or 14% B, Marais 1983b; Swartkops 42% N or 25% B, Marais & Baird 1980; Sundays 27% N or 15% B, Marais 1981). In the Mhlanga estuary (Whitfield 1980a) Mugilidae also dominated the fish fauna comprising 72% of the fish biomass but only 29% of the numbers present. Results obtained in the Kei estuary where eight mugilid species were netted, *M. cephalus, M. capensis, L. tricuspidens* and *L. richardsoni* being particularly abundant, indicated that this family accounted for 67,8% of the catch and 66,6% of the biomass. It is interesting to note that the same four species i.e. *M. cephalus, M. capensis, L. tricuspidens* and *L. richardsoni* dominated the seven mullet species caught in the estuaries surveyed by Marais & Baird (1980) and Marais (1981, 1983a & 1983b) and that the remaining three species, *V. buchanani, V. cunnesius* and *L. dumerili* were not common in these estuaries and very rare in the Kei (0,4% or less numerically). According to Blaber (1977) the diet of mullet species is similar but varies from one estuary to another depending on the occurrence of particular food items. The domination of the Mugilidae in Mhlanga estuary was ascribed to the large amounts of benthic floc present which accounted for 83% of the measured food resources and supported 93% of the fish biomass (Mugilidae and *Oreochromis mossambicus*) (Whitfield 1980a). *Mugil cephalus* feeds mainly on plant material but Blaber (1976) showed that in St Lucia this fish preferred animal material such as *Assiminea* sp. and Foraminifera. Whitfield & Blaber (1978a) found that large amounts of nutrients and detritus entered False Bay (Lake St Lucia) via the Mzinene, Hluhluwe and Nyalazi rivers resulting in increased primary productivity and therefore food resources. Although the food resources available to the mullet in the Kei were not investigated, parts of the middle and upper reaches are shallow thus providing a substrate for the growth of epiphytic and benthic diatoms, dinoflagellates, blue-green algae and filamentous algae, all of which form part of the diet of members of the family Mugilidae (Blaber 1976). In addition large amounts of marine algae were found in the nets set in the lower and middle reaches of this estuary. Some red and green algae have been reported to form part of the diet of *L. tricuspidens* (Blaber 1977) and are introduced into the lower reaches of estuaries by means of tidal movements (Blaber 1974).

Gravimetrically the kob (*A. hololepidotus*) was very abundant in the Sundays (31% B, Marais 1981) and Gamtoos (49% B, Marais 1983b) but less so in the clearer Krom (10% B, Marais 1983a) and Swartkops (5% B, Marais & Baird 1980) estuaries. In the Kei which is a turbid estuary (Table 1) *A. hololepidotus* did not prove as abundant (*cf.* 17% B Kei, this study; 30% B, Marais & Prinsloo 1980) as the survey of Marais & Prinsloo (1980) suggested. *Tachysurus feliceps*, the sea catfish which is a fairly common fish in the Krom (21% N or 16% B, Marais 1983a), Gamtoos (25% N or 15% B, Marais 1983b) and Sundays (18% N or 9% B, Marais 1981), formed a small part of the Kei catch (1,7% N and B). This species was not reported from the Kei by Marais & Prinsloo (1980) and according to Day, Blaber & Wallace (1981) only occurs as far north as the Keiskamma estuary although it is present along the entire South African coast (Smith 1977; van der Elst 1981). The minikob *Johnius belengerii* (Cuvier) and the large scale mullet *Liza macrolepis* (Smith) were the only fish from the Kei estuary not recorded in the eastern Cape gill-net surveys (Marais & Baird 1980; Marais 1981, 1983a & 1983b) and Day *et al.* (1981) give their southern limits as the Keiskamma and Bushmans estuaries, respectively. Four species, namely *Myliobatus aquila* (Linnaeus) (n = 143), *Aetobatus narinari* (Euphrasen) (n = 1), *Dasyatis brevicaudatus* (Hutton) (n = 5) and *Pomadasys olivaceum* (Day) (n = 1) present in eastern Cape estuaries (Marais & Baird 1980, Marais 1981, 1983a & 1983b), were absent from gill nets set in Transkei estuaries (Plumstead 1984).

Total catch data from the Swartkops and Sundays estuaries (Marais & Baird 1980; Marais 1981) showed no seasonal trends; in the Krom (Marais 1983a) the catch was highest in summer and in the Gamtoos (Marais 1983b) a negative correlation between catch and floods was noted. During the period January 1981 to January 1982 the largest catches in the Kei were made during the summer months and no correlation between floods and fish catches was apparent. It has been suggested that various factors may be responsible for changes in estuarine biota following floods (Marais 1982). This author (Marais 1982) found that the effects of flooding on fish populations are dependent on the intensity and duration of the flood, type of estuary and the ichthyofaunal composition. After floods, marked increases in mullet catches were observed in the middle and upper reaches of the Swartkops estuary whereas numbers dropped considerably in the channel-like Sundays estuary and did not reappear for up to four months. In both estuaries the spotted grunter *P. commersonii* also increased considerably.

The effects of floods on the fish of the Kei estuary were varied. In January 1981, one month after the entire estuary had been reduced to 0‰ the number of fish caught had increased from 36,1/net to 80,9/net. This was mainly due to *M. cephalus* increasing from 10,3/net to 37,0/net, *A. hololepidotus* increasing from 5,3/net to 12,7/net, *M. capensis* increasing from 0,7/net to 3,7/net and *P. commersonii* increasing from 13,0/net to 23,3/net. Similar increases in numbers did not occur following severe floods in February 1981, when nets could not be set, and June 1981 when salinities were again reduced to 0‰ throughout the estuary. In December 1981 nets were again set while a flood, which reduced surface salinity in the lower reaches to 0‰ but left the bottom water salinity above 30‰, was in progress. Number and biomass of fish were in excess of any caught during the previous 11 nettings in this estuary and were largely due to *M. cephalus, L. tricuspidens, L. richardsoni, A. hololepidotus* and *P. commersonii.*

During this investigation it was impossible to determine how long floods had been taking place but it was assumed that if nets could be set, the flood was either relatively mild or abating. Results of floods in the channel-like Kei estuary (Marais 1983b) differed from those obtained in the Sundays (Marais 1982) and Gamtoos (Marais 1983b). The family Mugilidae responded by appearing more abundant during and after some floods (January and December 1981) and decreasing during and after others (March and June 1981). The effect on *P. commersonii* and *A. hololepidotus* was usually to increase their numbers and biomass in the nets. Marais (1982) suggests that the increase in *P. commersonii* is related to the increased food (*Upogebia africana*) availability during the periods of high rainfall and that the increase in *A. hololepidotus* numbers in the Swartkops could be due to the increased abundance of mullet although *Gilchristella aestuarius* appeared most often in the kob stomachs.

It is evident that the floods did affect the fish population of this estuary but that the adverse conditions did not occur to the same extent as Marais (1982) found in the Sundays estuary.

Graphic representation of the data did seem to indicate that *M. cephalus, P. commersonii, L. tricuspidens* and *A. hololepidotus* were more abundant during the warmer months. The kob, more abundant in the Swartkops estuary during summer (Winter 1979) moves north-east to Natal in winter (Wallace 1975a) and its presence in the Kei during summer may indicate that the Kei should be considered with the estuaries of the eastern Cape. Evidently various factors including shoaling of fish, the occasional presence of large fish and especially floods (Marais & Baird 1980; Marais 1981 & 1982) in the case of the Kei estuary, may obscure any seasonal trends the fish may have.

The distribution of fish in the Kei was very similar to that found in the Sundays (Marais 1981) and Gamtoos (Marais 1983b) estuaries in which *M. cephalus* and *M. capensis* (Gamtoos) were most abundant in the upper reaches and *A. hololepidotus, P. commersonii* and *L. amia* (Sundays) in the middle and lower reaches. In the Mhlanga estuary Whitfield (1980b) found low numbers of mullet in the upper reaches and assumed that the high silt deposition was responsible. However, during the present study, mullet were abundant in the middle reaches where silt deposition was also high. Factors which have been associated with distribution patterns of fish in estuaries such as the available food resources (Whitfield 1980b), organic matter (Payne 1976; Blaber 1977) and silt content (Whitfield 1980b) of the sediment were not covered by this investigation. It was also apparent that many of the species decreased in size with increasing distance from the sea and that the greatest species diversity was found at the mouth.

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References

BLABER, S.J.M. 1974. Field studies of the diet of *Rhabdosargus holubi* (Pisces: Teleostei: Sparidae). *J. Zool., Lond.* 173: 407 – 417.

BLABER, S.J.M. 1976. The food and feeding ecology of Mugilidae in the St Lucia lake system. *Biol. J. Linn. Soc.* 8: 267 – 277.

BLABER, S.J.M. 1977. The feeding ecology and relative abundance of mullet (Mugilidae) in Natal and Pondoland estuaries. *Biol. J. Linn. Soc.* 9: 259 – 275.

BLABER, S.J.M. 1979. The biology of filter feeding teleosts in Lake St Lucia, Zululand. *J. Fish Biol.* 15: 37 – 59.

BLABER, S.J.M. & CYRUS, D.P. 1983. The biology of Carangidae (Teleostei) in Natal estuaries. *J. Fish Biol.* 22(2): 173 – 188.

BRANCH, G.M. & DAY, J.H. 1984. Ecology of southern African estuaries: Part XIII. The Palmiet River estuary in the south-western Cape. *S. Afr. J. Zool.* 19(2): 63 – 77.

BRANCH, G.M. & GRINDLEY, J. 1979. The ecology of South African estuaries. Part XI. Mngazana, a mangrove estuary in Transkei. *S. Afr. J. Zool.* 14(3): 149 – 170.

CONNELL, A.D. 1974. Mysidacea of the Mntentu River estuary, Transkei, South Africa. *Zool. Afr.* 9(2): 147 – 159.

DAY, J.H. 1981a. The estuarine fauna. In: Estuarine ecology with particular reference to southern Africa, (ed.) Day, J.H., A.A. Balkema, Cape Town.

DAY, J.H. 1981b. Summaries of current knowledge of 43 estuaries in southern Africa. In: Estuarine ecology with particular reference to southern Africa, (ed.) Day, J.H., A.A. Balkema, Cape Town.

DAY, J.H. 1981c. Estuarine currents, salinities and temperatures. In: Estuarine ecology with particular reference to southern Africa, (ed.) Day, J.H., A.A. Balkema, Cape Town.

DAY, J.H. 1981d. Estuarine sediments, turbidity and the penetration of light. In: Estuarine ecology with particular reference to southern Africa, (ed.) Day, J.H., A.A. Balkema, Cape Town.

DAY, J.H., BLABER, S.J.M. & WALLACE, J.H. 1981. Estuarine fishes. In: Estuarine ecology with particular reference to southern Africa, (ed.) Day, J.H., A.A. Balkema, Cape Town.

EKSTEEN, VAN DER WALT, & NISSEN, Inc. 1979. Report on the general hydrological properties of Transkei. Volume 2. Department of Agriculture and Forestry, Republic of Transkei.

HECHT, T. 1973. The ecology of the Kromme estuary with special reference to *Sesarma catenata*. M.Sc. thesis, University of Port Elizabeth, South Africa.

JACKSON, P.B.N. 1975. Common and scientific names of the fishes of southern Africa. Part II. Freshwater fishes. *Spec. Publ. J.L.B. Smith Inst. Ichthyol.* (14): 179 – 213.

MARAIS, J.F.K. 1976. Comparative studies on the nutritional ecology of mullet in the Swartkops estuary. Ph.D. thesis, University of Port Elizabeth, South Africa.

MARAIS, J.F.K. 1981. Seasonal abundance, distribution and catch per unit effort using gill-nets of fishes in the Sundays estuary. *S. Afr. J. Zool.* 16(3): 144 – 150.

MARAIS, J.F.K. 1982. The effect of river flooding on the fish populations of two eastern Cape estuaries. *S. Afr. J. Zool.* 17(3): 97 – 104.

MARAIS, J.F.K. 1983a. Seasonal abundance, distribution and catch per unit effort of fishes in the Krom estuary, South Africa. *S. Afr. J. Zool.* 18(2): 96 – 102.

MARAIS, J.F.K. 1983b. Fish abundance and distribution in the Gamtoos estuary with notes on the effects of floods. *S. Afr. J. Zool.* 18(2): 103 – 109.

MARAIS, J.F.K. & BAIRD, D. 1980. Seasonal abundance, distribution and catch per unit effort of fishes in the Swartkops estuary. *S. Afr. J. Zool.* 15(2): 66 – 71.

MARAIS, J.F.K. & PRINSLOO, J.F. 1980. Species composition and catch per unit effort of fishes in four Transkeian estuaries. Unpublished report.

PAYNE, A.J. 1976. The relative abundance and feeding habits of the grey mullet species occurring in an estuary in Sierra Leone, West Africa. *Mar. Biol.* 35: 277 – 286.

PLUMSTEAD, E.E. 1984. The occurrence and distribution of fish in selected Transkei estuaries. M.Sc. thesis, University of Transkei, Transkei.

SMITH, J.L.B. 1977. Smith's sea fishes. 4th impression. Valient Publishers, Sandton.

SMITH, M.M. 1975. Common and scientific names of the fishes of southern Africa. Part I: Marine fishes. *Spec. Publ. J.L.B. Smith Inst. Ichthyol.* (14): 1 – 178.

VAN DER ELST, R.P. 1978. Notes on the teleost fauna of the Kobole estuary Transkei. *S. Afr. J. Wildl. Res.* 8: 83 – 85.

VAN DER ELST, R.P. 1981. A guide to the common sea fishes of southern Africa, (ed.) Borchert, P., C. Struik, Cape Town.

VAN DER HORST, G. 1976. Aspects of the reproductive biology of *Liza dumerili* (Steindachner, 1869) (Teleostei: Mugilidae) with special reference to sperm. Ph.D. thesis, University of Port Elizabeth, South Africa.

WALLACE, J.H. 1975a. The estuarine fishes of the east coast of South Africa. I. Species composition and length distribution in the estuarine and marine environments. II. Seasonal abundance

and migrations. *Investl Rep. Oceanogr. Res. Inst.* 40: 1 – 72.
WALLACE, J.H. 1975b. The estuarine fishes of the east coast of South Africa. III. Reproduction. *Investl Rep. Oceanogr. Res. Inst.* 41: 1 – 51.
WALLACE, J.H. & VAN DER ELST, R.P. 1975. The estuarine fishes of the east coast of South Africa. IV. Occurrence of juveniles in estuaries. V. Ecology, estuarine dependence and status. *Investl Rep. Oceanogr. Res. Inst.* 42: 1 – 63.
WHITFIELD, A.K. 1980a. A quantitative study of the trophic relationships within the fish community of the Mhlanga estuary, South Africa. *Estuar. Coast. Mar. Sci.* 10: 417 – 435.
WHITFIELD, A.K. 1980b. Distribution of fishes in the Mhlanga estuary in relation to food resources. *S. Afr. J. Zool.* 15(3): 159 – 165.
WHITFIELD, A.K. & BLABER, S.J.M. 1978a. Distribution, movements and fecundity of Mugilidae at Lake St Lucia. *The Lammergeyer* 26 (August): 55 – 63.
WHITFIELD, A.K. & BLABER, S.J.M. 1978b. Food and feeding ecology of piscivorous fishes in Lake St Lucia, Zululand. *J. Fish Biol.* 13: 675 – 691.
WINTER, P.E.D. 1979. Studies on the distribution, seasonal abundance and diversity of the Swartkops estuary ichthyofauna. M.Sc. thesis, University of Port Elizabeth, South Africa.
WOOLDRIDGE, T. 1974. A study of the zooplankton of two Pondoland estuaries. M.Sc. thesis, University of Port Elizabeth, South Africa.
WOOLDRIDGE, T. 1976. The zooplankton of Msikaba estuary. *Zool. Afr.* 11(1): 23 – 44.