Seasonal abundance, distribution, and catch per unit effort using gill-nets, of fishes in the Sundays estuary

J.F.K. Marais
University of Port Elizabeth, Port Elizabeth

Catch per unit effort was obtained for the fish of the Sundays estuary by means of gill-netting. Fifty-five gill-net catches were made in which 1258 fish were caught in the mouth, middle and upper reaches of the estuary. Sea catfish, *Tachysurus feliceps* dominated catches numerically and kob *Argyrosomus hololepidotus* in terms of weight (31% of total). CPUE was 21 kg/standard net. Mean body weight of fish was 894 g. It seems that the food web in the Sundays estuary is based largely upon phytoplankton and dependent zooplankton grazers.

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Vangs per eenheid poging is bepaal vir visse van die Sondagsgetyrivier 35 km vanaf Port Elizabeth. Vyf-en-vyftig vangste, wat 1258 visse gelewer het, is gemaak in die mond, middel en boonste gedeeltes van die getyrivier. Seebarbers, *Tachysurus feliceps* het in die grootste getalle in die nette voorgekom terwyl kabeljoue, *Argyrosomus hololepidotus* die grootste gewig opgelewer het (31% van totale vangste). Vangs per eenheid poging was 21 kg/standaard net. Gemiddelde liggaamsgewig van visse was 894 g. Dit blyk dat die voedselketting in die Sondagsgetyrivier hoofsaaklik gebaseer is op fitoplankton en afhanklike soöplanktonvreters.

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J.F.K. Marais
University of Port Elizabeth, P.O. Box 1600,
Port Elizabeth 6000

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The Sundays river enters Algoa Bay approximately 40 km east of Port Elizabeth. The river originates in the Karoo, near Nieu Bethesda, and flows over typical Karoo deposits. From Kirkwood onwards the Bokkeveld group of Cretaceous origin is the main geological deposit. The upper and middle reaches of the estuary flow over the Sundays river formation. The eastern bank and escarpment are part of the Alexandria formation of the Tertiary whereas the sand dunes on the western bank are of the late Pleistocene. East of the escarpment the contour flattens out into a broad flood plain. The conspicuous clay deposits along the river originated from the Beaufort and Ecca groups whilst the sand is of Table Mountain sandstone and Witteberg origin.

The river is dammed by the Mentz Dam near Jansenville from where a steady flow of fresh water is released. The river drains the highly cultivated Sundays river valley but otherwise flows through undeveloped areas. In contrast to the Swartkops river estuary, the Sundays river does not have any salt marshes or extensive mud flats. Only a small *Zostera capensis* Setchell bed of 40 × 60 m is present on the eastern side near the mouth. From Mackay bridge (see Figure 1) upwards, *Phragmites communis* Trin. occur along the banks of the river, increasing in density as the salinity of the water decreases.

The Sundays estuary was described by Wooldridge & Melville-Smith (1979) as 'channel-like' along its entire length with only a narrow intertidal zone. Due to this characteristic, flushing of the estuary during floods is virtually complete (Baird & Erasmus, 1977). The estuary is permanently open to the sea.

The estuary is approximately 2,5 m deep near the mouth, but it increases gradually to a maximum of 5 m on the first bend of the lower reaches. It then becomes gradually shallower to 2,5 m at the limit of the tidal influence which is approximately 20 km from the mouth. At its widest point near the mouth the estuary is approximately 200 m wide from where it becomes progressively narrower to approximately 20 m wide at the head of the estuary. Little research has been carried out on the ecology of this estuary and the only published work is an article by Wooldridge & Melville-Smith (1979) on copepod succession.

This study of the larger fish in the Sundays estuary was carried out as part of a programme by the Zoology Department of the University of Port Elizabeth to

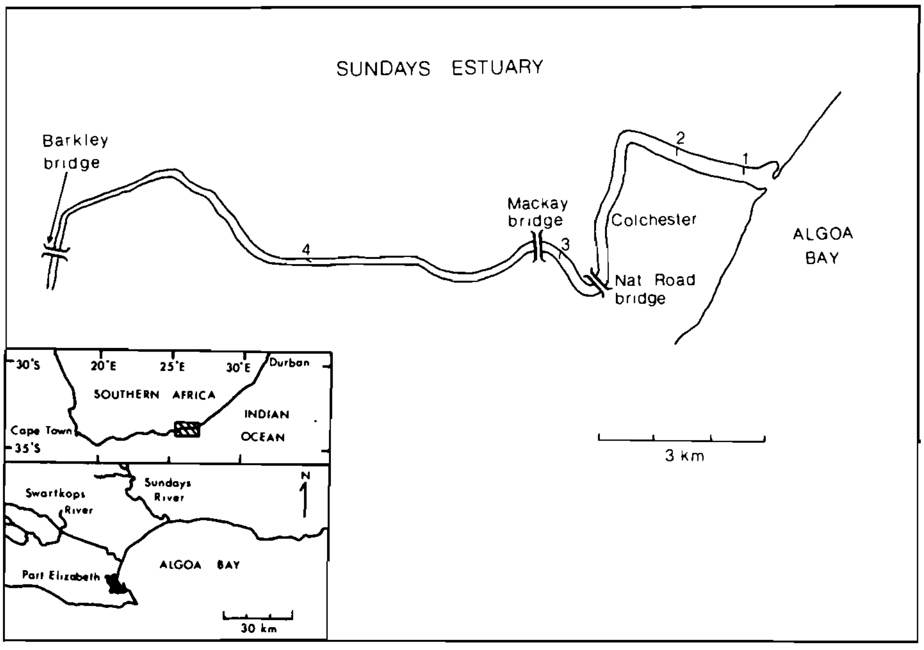

Figure 1 Geographical position of Sundays estuary and position of sampling sites.

evaluate factors that determine the relative abundance of species comprising the nekton community of Eastern Cape estuaries. A similar study on the fish of the Swartkops estuary (Marais & Baird 1980) supplies data for comparison between the two estuaries. Both estuaries open in Algoa Bay with the Sundays 25 km to the northeast of the Swartkops estuary (Figure 1).

Methods

Catch per unit effort (numbers and weight/net) of fish in the estuary was obtained from 55 gill-net catches. Gillnets were set occasionally from December 1976 to September 1978 and monthly from December 1978 to December 1979 except for July 1979 when heavy floods prevented sampling. Each gill-net consisted of five 10 m sections 3 m deep with stretched mesh sizes of 55, 70, 85, 110 and 150 mm. Each net covered 150 m^2 and was set for 12-h periods (dusk till dawn). One unit of effort is regarded as the number or weight of fish caught by the 150-m^2 net during a 12 h-period. Body weights of fish which were partly eaten by isopods were estimated from length-weight regressions calculated earlier from undamaged fish (Marais & Baird 1980).

Netting sites were selected to cause least interference with boat traffic on the estuary. Salinity was the main criterion taken into consideration to ensure that the sites were representative of the lower reaches (Stations 1 and 2, respectively 0,5 and 3 km from the mouth), middle (Station 3, 9 km from the mouth) and upper reaches (Station 4, 15 km from the mouth of the estuary). The positions of the nets are shown in Figure 1. Water depth at Stations 1, 3 and 4 were between 2 and 3 m and at Station 2 between 3 and 4 m. Only 4 catches were made in the upper reaches (representative of the area above the regular influence of the sea) because of poaching of nets and the later introduction of this area to the regular sampling programme.

Surface water temperature and salinity were measured on each occasion. CPUE is presented separately for each station and as monthly means, the data being pooled for all four stations. Data on individual species were recorded separately.

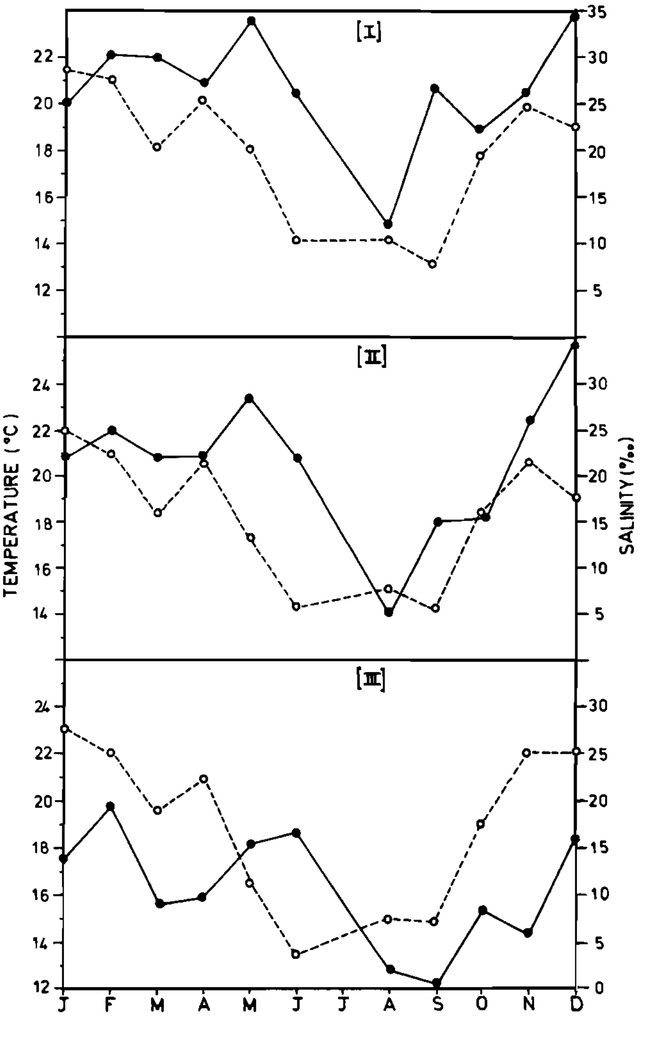

Figure 2 Graphical illustration of mean monthly temperature and salinity values recorded at Stations 1, 2 and 3 in the Sundays estuary. ●—● salinity; o---o temperature.

Results

Figure 2 reflects water temperature and salinity for Stations 1 – 3. On the two occasions that fish were netted at Station 4, the surface salinity was less than 5°/₀₀ and the temperature similar to that at Station 3. Figure 2 shows that highest temperatures were recorded during November – April and the lowest during June – September. A wider range (13 – 23 °C) was recorded at Station 3, it being further away from the sea.

Surface salinity values (Figure 2) were still less than 20°/₀₀ at Stations 1 and 2 seven weeks after the last of two successive floods during July and August 1979. As can be expected, salinity at Station 3 was influenced to a larger extent by freshwater inflow and was never higher than 20°/₀₀. It was also more affected by the July – August floods than Stations 1 and 2 (see Figure 2).

Table 1 presents mean CPUE (number and weight) for each species on a monthly basis. Lowest catches were made during May and September and highest during February and June. No definite pattern emerges from the results except that large differences were observed between months.

The length-frequency distribution of the ten most abundant species is shown in Figure 3. A much larger range of sizes were caught of *Lichia amia, Pomadasys commersonni* and *Argyrosomus hololepidotus* than of the mullet species, *Rhabdosargus holubi, Elops machnata* and *Tachysurus feliceps*. The former three species have a bigger circumference and normally grow to a larger size than the other species mentioned.

In Table 2, CPUE of different stations are compared. Total number and weight of each species caught are also given. Largest catches were made at Station 4. Unfortunately only 4 catches were made at this station during the study period which would represent the fish of the more freshwater upper regions of the estuary. Second largest catches were made at Station 3, followed by Station 1 (nearest to the mouth) and lastly Station 2, also in the lower reaches of the estuary.

Table 2 also shows that 475 of the 1258 fish caught by 55 gill-net efforts, were mullets and thus contributed 27% of the total catch in numbers. They contributed 15% in terms of weight. However, the most abundant single species was the sea catfish, *Tachysurus feliceps* (226), followed by the flathead mullet, *Mugil cephalus* (191), the southern mullet, *Liza richardsoni* (185) and the kob, *Argyrosomus hololepidotus* (175). *A. hololepidotus* dominated catches in terms of weight (351 kg), followed by the spotted grunter, *Pomadasys commersonni* (165 kg). Largest mean body weights were recorded for

Table 1 CPUE (number and mass) of fish caught monthly using gill-net over 12-h periods with 55 nettings at four localities in the Sundays river estuary

	January (3)*		February (4)*		March (4)*		April (9)*		May (5)*		June (5)*		August (3)*		September (4)*		October (6)*		November (3)*		December (9)*	
	n	mass (g)	*n*	mass (g)	*n*	mass (g)	*n*	mass (g)	*n*	mass (g)	*n*	mass (g)	*n*	mass (g)	*n*	mass (g)	*n*	mass (g)	*n*	mass (g)	*n*	mass (g)
M. cephalus	3,7	1540	4,8	2023	2,0	1216	1,7	708			21,4	6067			1,5	849			1,3	540	2,8	1870
L. richardsoni	0,3	104	4,0	1108	5,0	1819	3,2	1085	1,2	548	11,0	3924			0,5	194	1,0	260	4,0	998	3,8	1686
L. tricuspidens	1,0	1887	0,5	410	0,8	992	2,9	5550	2,2	4035	0,4	871					0,7	403	0,7	917	1,9	2040
L. dumerili			1,0	178			0,4	81			0,4	81							2,3	347	0,1	32
V. buchanani			0,3	28							0,2	502					0,2	292	0,3	57		
M. capensis																	0,2	44	0,7	311		
T. feliceps	5,3	2540	18,0	7848	4,0	1029	2,3	845	2,8	1072	0,4	156	17,3	9002	0,3	46	0,7	329	1,7	807	2,6	1238
A. hololepidotus	2,3	3846	2,3	4560	4,5	5847	5,1	9261	0,8	1118	4,0	4628	2,3	14143	2,3	10011	2,0	4746	1,3	1897	3,6	4253
P. commersonni	3,3	4011	1,5	2456	1,5	1044	0,4	402	0,4	568	0,8	570	7,0	8085	1,0	1625	6,0	12055	1,3	1233	2,8	2123
M. aquila	0,7	225	4,8	1617	0,5	160	0,9	229	0,2	61	0,2	24	0,3	95	0,5	114	0,5	112	3,7	1072	2,0	608
L. amia	2,0	2100	3,8	900	1,8	1098					0,4	202					0,3	615	6,3	12333	1,1	907
E. machnata	3,0	6277	1,3	3744	0,3	470	0,1	171			0,2	185	0,7	1667	0,5	1275	1,5	3653	4,3	9940	1,3	2240
R. holubi	0,3	17	2,0	101	0,3	20	0,2	18							1,0	66	0,2	13			0,9	43
M. falciformis			1,3	72	0,8	17	0,2	10					0,3	8							0,2	15
C. carpio																					1,0	2422
P. saltatrix	0,7	647									0,2	620			0,3	500	0,3	271			0,2	248
L. lithognathus									0,2	17	0,2	290			0,3	34	0,2	44			0,3	49
P. indicus			0,3	635	0,5	272			0,2	84					0,3	78					0,1	32
L. umbratus											0,4	80										
D. trifasciatus									0,2	8												
Caranx			0,3	9			0,1	8														
L. annulatus			0,3	365					0,2	8												
M. cyprinoides													0,3	417							0,1	42
D. sargus																						
T. vitrirostris											0,2	15										
D. cervinus															0,3	11						
Total	23	23194	46	26054	22	13984	18	18368	8	7511	40	18215	28	33417	9	14803	14	22837	28	30452	25	19848

*No. of nets

the carp *Cyprinus carpio* (2422 g), *E. machnata* (2158 g) and *A. hololepidotus* (2010 g). Lowest mean weights were found for the zebra, *Diplodus cervinus* (44 g) and the Cape moony, *Monodactylus falciformis* (48 g).

Discussion

The lowest temperature recorded during the study period was 12 °C (Station 1, September 1978) and highest 23 °C (Station 3, January 1979 and Stations 1 and 2, February, 1979). In both summer and winter months, the temperature in the Sundays river was 2 °C lower than in the Swartkops river (Figure 2 and Marais & Baird 1980). This is probably because the Sundays river is deep and channel-like whereas the temperature of water in the shallow flood plains of the Swartkops river is more readily increased by solar radiation. Warm water outflow from the power station at Swartkops could also be partly responsible for this situation (Malan 1979).

Stronger freshwater inflow is indicated by the lower salinities recorded at all Sundays river stations compared to Swartkops (Figure 2 and Marais & Baird 1980). During the study period salinity was only higher than 30°/∞ in the mouth area on two occasions (May and December 1979). At Station 3 it was never above 20°/∞.

A study of Table 1, which presents the data monthly, shows, as in the case of the Swartkops estuary (Marais & Baird 1980), an absence of definite seasonal trends. The fact that species belonging to the family Mugilidae shoal and could be caught by a particular net at any time, could elevate CPUE values for that month artificially without necessarily reflecting the abundance of that species in the estuary at that time. A few catch results will illustrate the point: In June 1977, 106 *Mugil cephalus* were caught at Station 3 and during April 1977, 53 *Liza richardsoni* at Station 3. The abundance of some other species may change considerably in a particular area and have a profound effect on catches. For example during February 1979, 34 *Tachysurus feliceps* were caught at Station 2, in November 1979, 18 *Lichia amia* were caught at Station 2 and during March 1979 12 *Argyrosomus hololepidotus* (21,5 kg) at Station 3. Whitfield & Blaber (1978) observed that *A. hololepidotus* occurs singly and in shoals. Shoaling may also be practised by *L. amia* and *T. feliceps* since this activity may aid feeding success as Redakov (1973) demonstrated. The occasional occurrence of exceptionally large fish in the nets may also increase catch returns for that particular month and station considerably. A few examples will illustrate this point. Dur-

Table 2 CPUE (number and mass) of fish caught per gill-net at four localities in the Sundays river estuary. Total number of fish caught, as well as individual body mass are also given

	Station 1 17*		Station 2 16*		Station 3 18*		Station 4 4*		Total			
Species	*n*	mass (g)	*n*	mass (g)	*n*	mass (g)	*n*	mass (g)	*n*	mass (g)	Mean per net	Mass(g) per ind.
M. cephalus	2,0	860	1,0	437	6,7	2066	5,3	3753	191	73813	1342	387
L. richardsoni	4,4	1222	0,9	379	5,2	2063	0,8	169	185	64643	1175	349
L. tricuspidens	0,7	691	0,2	146	2,2	337	4,8	9918	74	114425	208	1546
L. dumerili	0,3	53	0,6	107			0,8	142	18	3172	58	176
V. buchanani	0,2	267							4	4540	83	1135
M. capensis	0,1	39	0,1	42					3	1335	24	445
Mugildae	7,7	3131	2,8	1110	14,1	7500	11,7	13982	475	261928	4762	551
T. feliceps	3,7	1602	6,6	2921	2,9	1348	1,5	486	226	100168	1821	443
A. hololepidotus	1,7	358	2,0	4614	3,8	807	11,8	17928	175	351731	6395	20
P. commersonni	2,1	3506	2,3	395	2,8	2318	0,3	89	124	164946	2999	1330
M. aquila	2,8	8028	1,3	405	0,1	14			68	17884	370	290
L. amia	3,2	3845	0,4	498	0,2	139			62	75838	1379	1223
E. machnata	1,1	2157	0,9	2156	0,8	1715	0,3	384	48	103567	1883	2158
R. holubi	0,8	48	0,6	36	0,1	7			25	1527	28	61
M. falciformis	0,2	8	0,6	29					13	624	11	48
C. carpio							2,3	5450	9	21800	396	2422
P. saltatrix	0,4	619	0,1	24	0,1	35			9	11529	210	1281
L. lithognathus	0,1	13	0,3	135					7	2373	43	339
P. indicus	0,1	64	0,2	203	0,1	17			6	4649	85	775
L. umbratus					0,1	22			2	400	7	200
D. trifasciatus			0,1	8					2	125	2	63
Caranx spp.			0,1	2			0,3	17	2	105	2	53
L. annulatus	0,1	86	0,1	8					1	1460	27	1460
M. cyprinoides			0,1	78					1	1250	23	1250
D. sargus			0,1	23					1	374	7	374
T. vitrirostris			0,1	4					1	76	1	76
D. cervinus			0,1	2					1	44	1	44
	23,6	19466	18,3	16197	25,3	21192	28,2	38336	1258	1124872	20453	894

*No. of nets.

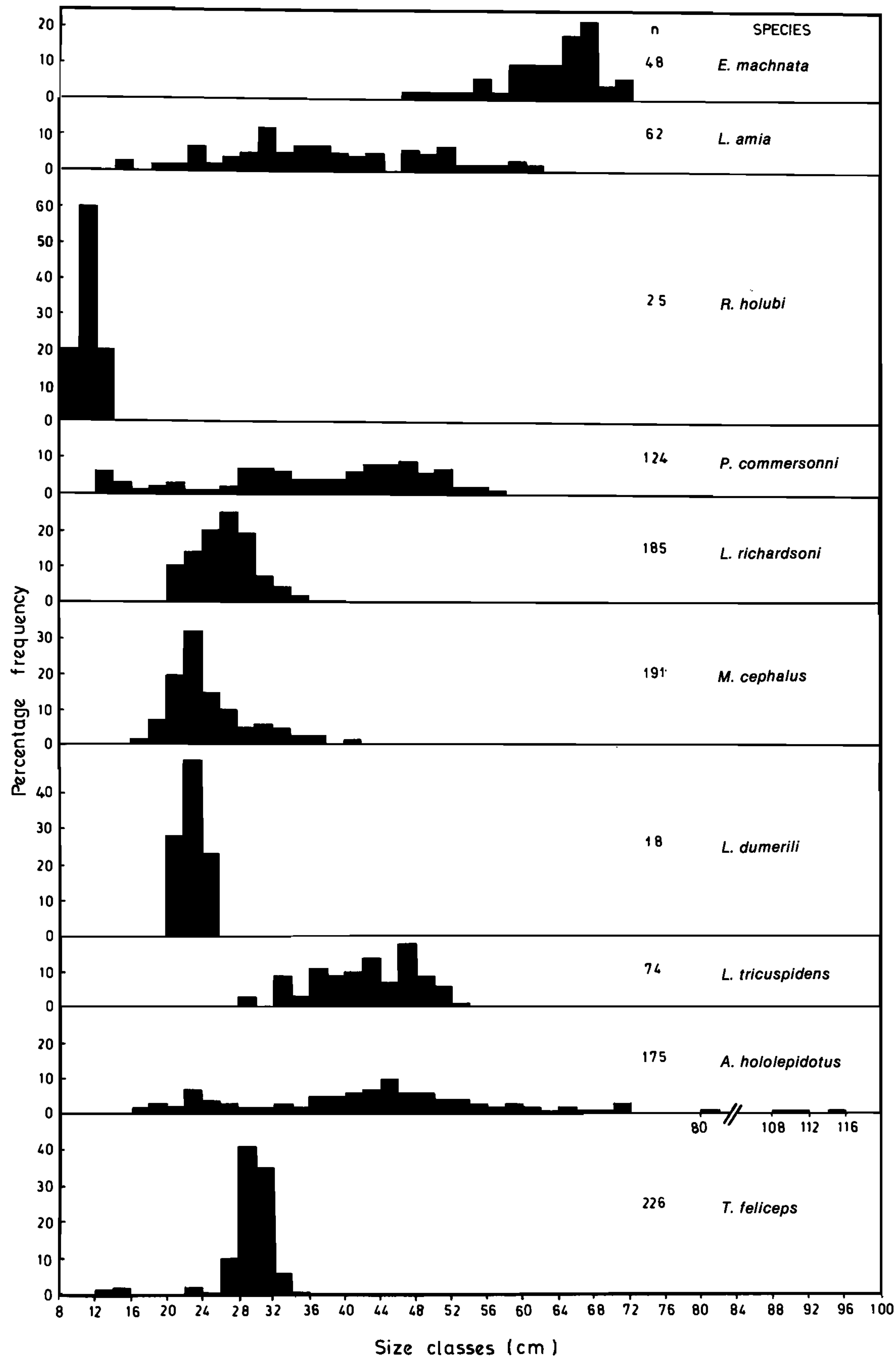

Figure 3 Size frequency distribution of ten most abundant species caught by means of gill-nets in the Sundays estuary.

ing April 1978 a kob of 24 kg was caught at Station 3 and during September 1979 one of 29 kg. A cob of 22 kg was caught at Station 2 during August 1979. A study of Table 1 shows that cob catches for these months were much higher than for any other month.

The mean CPUE of the Sundays river estuary (20,5 kg, Table 2) is 57% higher than that for the Swartkops river estuary (13,1 kg, Marais & Baird 1980). However, in the 55 gill-net catches made in the Sundays river, slightly fewer fish (1258) were caught than in 50 catches in the

Swartkops river (1269). High mean body weight of fish caught in the Sundays river (894 g per ind.) compared to the Swartkops river (515 g) explains this apparent discrepancy. This was especially evident in the mean weights of the following species: *L. tricuspidens*, 1546 g in the Sundays river cf. 261 g in the Swartkops; *A. hololepidotus*, 2010 cf. 628; *P. commersonni*, 1330 cf. 879; *L. amia*, 1223 cf. 502; and *Pomatomus saltatrix*, 1281 cf. 559 g. Only in a few species was the situation reversed: *T. feliceps* 443 g in the Sundays river cf. 561 g in the Swartkops; *R. holubi* 61 cf. 88 g, and *Monodactylus falciformis* 48 cf. 63 g.

Interesting differences are evident when fish abundance in the Sundays river (Table 2) is compared to the Swartkops river (Marais & Baird 1980). In both estuaries the family Mugilidae dominates the catches numerically and is second in terms of weight. However, sea catfish replace spotted grunter as the second most numerous species, followed by *Mugil cephalus, L. richardsoni, A. hololepidotus* and only then *P. commersonni.* In terms of weight *A. hololepidotus* contributed 31% of the total catch, followed by *P. commersonni* (15%), *L. tricuspidens* (10%) and *E. machnata* (9%).

An obvious reason why *P. commersonni* predominated in the catches (29% of weight and 17% of total number) in the Swartkops river, while it only contributed 10% to the Sundays river catches (15% of weight), is the relatively low standing crop and production (Baird pers. comm.) of the mudprawn, *Upogebia africana*, in the Sundays river estuary. *Upogebia africana* was shown to be the most important food item of spotted grunters in the Swartkops estuary (Van der Westhuizen & Marais 1977).

Numbers of sea catfish increased from 6% in the Swartkops river to 18% in the Sundays river. Apart from their scavenging mode of feeding, sea catfish also consume mysids, crabs, small fish and *U. africana* (J. Marais, unpubl. data). *Upogebia africana* was mostly found in the stomachs after floods. Wooldridge & Melville-Smith (1979) found that the zooplankton biomass, due largely to a bigger contribution of mysids, is greater in the Sundays river than in the Swartkops river. This as well as the large numbers of mullets at Stations 3 and 4 (see Table 2) probably also explains the relative increase in kob from the Swartkops estuary (4% total number, 5% of weight) to the Sundays estuary (14% in numbers and 31% in weight). Main prey items of kob smaller than 40 cm SL are mysids, *Gilchristella aestuarius* and juvenile mullet (J. Marais, unpubl. data). Talbot (pers comm. 1980) found relatively larger numbers of *G. aestuarius* in the Sundays river than in the Swartkops river. Whitfield & Blaber (1978), demonstrated that the percentage frequency of occurrence of fish was 91 and of Crustacea 15 in the diet of *A. hololepidotus* at Lake St. Lucia. Two of the important fishes found in the stomach were *G. aestuarius* and mullets. At Stations 3 and 4 larger catches of both cob and mullets were made than at Stations 1 and 2. The greater abundance of prey items like *G. aestuarius* and mysids thus seems to be partly responsible for the large numbers of kob and sea catfish in the Sundays river.

Largest CPUE were obtained at Stations 3 and 4, mainly because of the contribution of *A. hololepidotus* and *L. tricuspidens.* At Station 4, the fresh-water carp, *Cyprinus carpio*, also made a considerable contribution to the catches (see Table 2). At the moment the complete dominance of *T. feliceps* at Station 2 cannot be explained.

Species such as *Elops machnata, Lichia amia* and *Pomatomus saltatrix* seemed to be particularly stenohaline, occurred more in the mouth area and were not as evenly distributed throughout the estuary as in the Swartkops estuary. This could be due to the more pronounced salinity gradient found in the Sundays estuary (see Figure 2). Wallace (1974) showed that *E. machnata* was less euryhaline than species like *A. hololepidotus* and *Pomadasys commersonni* and Van der Elst (1976) gave the salinity tolerance of *Pomatomus saltatrix* as between 19,5 to 35°/₀₀. Spotted grunter occurred fairly evenly, probably because they are more euryhaline (Wallace 1974) and because narrow strips of substrate colonized by *U. africana* occur along most parts of the middle and lower reaches of the Sundays estuary. The scarcity of macrophytic vegetation in the largest part of the Sundays estuary probably explains the small number (0,5 per net) of *R. holubi* caught compared to Swartkops (2,0 per net).

From considerations of their own and other published studies, Odum & Heald (1975) concluded that there appear to be two basic types of estuarine food webs. The first type, characteristic of shallow, muddy estuaries, is based primarily upon vascular plant detritus (*Spartina, Zostera*, etc.) and macroalgae rather than on phytoplankton. The second type, according to Odum & Heald (1975) is found in deeper estuaries with clearer water where a grazing food web is more likely (in contrast to the first type where detritivores predominate) and based upon phytoplankton and dependent zooplankton grazers. With the limited amount of information available at present it seems that the Swartkops river conforms more to the first category and the Sundays river to the second.

Emmerson (unpubl. data) found that the nutrients NH_3, NO_2, total P and PO_4 are 10 – 15 times higher in the Sundays river than in the Swartkops. This high nutrient concentration could be responsible for the dense phytoplankton booms occurring in this estuary (Wooldridge, pers. comm.). During one such bloom (March 1980) Pearce (pers. comm.) found chlorophyll-a values of up to 35 times higher in the Sundays than in the Swartkops river during the same month. A higher standing crop of phytoplankton could lead to the greater zooplankton biomass in the Sundays river compared to the Swartkops river, as was found by Wooldridge (1980). However, this aspect of nutrient concentrations and phytoplankton production in the two estuaries is now being investigated and the results from these studies will hopefully shed light on these assumptions.

Both detritus and phytoplankton, utilized directly by *M. cephalus* (Odum 1970) are abundantly present in the muddier upper regions of the Sundays estuary area. Phytoplankton is the main food source of *L. tricuspidens* (Masson & Marais 1975). Emmerson (unpubl. data 1980) found much higher nutrient levels in the upper regions of the estuary with a decline towards the mouth. Wallace (1975) found that juvenile fishes abound in areas like the upper regions of the Sundays estuary where marginal vegetation in the form of reeds (*Phragmites communis*) becomes more prolific as the salinity decreases. The high CPUE (Table 2) reflects the richness of this area.

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