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THE EPIBENTHOS OF THE BACKWATERS OF A TROPICAL MANGROVE CREEK (TUDOR CREEK, MOMBASA, KENYA)

by

ENOCK O. WAKWABI[1,2,*] and JAN MEES[2]

([1] *Kenya Marine & Fisheries Research Institute, P.O. Box 81651, Mombasa, Kenya*; [2] *Marine Biology Section, Zoology Institute, University of Gent, K.L. Ledeganckstraat 35, B-9000 Gent, Belgium*)

ABSTRACT

The epibenthos of the backwaters of Tudor creek (Mombasa, Kenya), a mangrove-bordered seasonal estuary, was sampled fortnightly with a beam trawl from May 1995 to April 1996. A total of 6396 specimens was collected in 96 tows. Almost 63% of these specimens belonged to 72 species of teleost fish (in 37 families). Penaeid (4 species) and caridean shrimp constituted 27% and 8% of the total catch respectively, while stomatopods and squids were quite rare. At family level, Penaeidae contributed most to the total catch. Gobiidae (15%), Lutjanidae (9%), Plotosidae (9%), Acropomatidae (6%), Gerreidae (5%), and Synodontidae (4%) were the most important fish families. Gobiidae was the most diverse family with 8 species, followed by Apogonidae and Lutjanidae with 5 species each, and Penaeidae with 4 species. *Yongeichthys nebulosus* (Gobiidae), *Penaeus monodon*, *P. semisulcatus* and *Metapenaeus monoceros* (Penaeidae), *Plotosus lineatus* (Plotosidae), *Lutjanus fulviflamma* (Lutjanidae), *Acropoma japonicum* (Acropomatidae), *Gerres oyena* (Gerreidae), and *Saurida undosquamis* (Synodontidae) were the dominant species (each contributed for more than 4% to the total catch).

A TWINSPAN of the catch data identified three monsoon driven communities. *Penaeus monodon*, *Lutjanus fulviflamma* and *Gerres oyena* were the dominant species in the dry period (January to April), while *P. semisulcatus* and Caridea dominated the community in the long rainy season (May to August), and *Acropoma japonicum* and *Plotosus lineatus* were important during the short rains (September to December). *Metapenaeus monoceros* was abundant in all seasons and *Yongeichthys nebulosus* reached high densities in both short rainy and dry seasons. The short rains community had the highest numbers of species and densities, while those of the long rainy season were lowest. The three communities had very strong dominance of only a few species, conforming to the general observation that tropical estuarine or coastal ecosystems tend to be very diverse but with very low densities for the majority of species. The restricted size ranges for all individuals caught during this study may be due to two processes: selectivity of the gear and/or dynamic replacement of the populations through seasonal recruitment and fast size progression. All individuals collected during this study were juveniles. This fact and the observed monthly size distributions suggest that most species utilise the area as a nursery.

KEY WORDS: epibenthos, backwaters, tropical mangrove creek, seasonal communities, diversity.

* For communications and offprints.

INTRODUCTION

Tudor creek is located to the Northwest of Mombasa Island, Kenya (4°S, 40°E). It extends some 10 km inland, has a surface of approximately 20 km^2 at mean sea level and comprises shallow channels, mudbanks and mangrove forests (WAKWABI & JACCARINI, 1993). The seasonal pattern of the equatorial currents (the South Equatorial Current and the Equatorial counter Current) across the western Indian Ocean, and the reversing longshore East African Coastal Current together with the monsoon winds (Northeast monsoons in November to March and the Southeast monsoons in April to October), influence the magnitude and velocity of the tidal currents in Tudor creek (NORCONSULT, 1975) and the rainfall seasonality in the region. This influence predetermines the tidal flux, and productivity on Tudor creek (WAKWABI & JACCARINI, 1993). The creek (Fig. 1) can be divided into three sections: a marine mouth area, the middle creek area, and the upper hinterland end. The mouth area is a deep (ca 30 m) river-like channel with extensive rocky substrata and unvegetated sandy sediments and banks, receiving direct marine influence through tidal fluxing. The upper end is shallow (generally < 1 m) and split into different channels, some ending into river mouths. Three seasonal rivers (Kombeni, Tsatu and Mtsapuni) flow into the creek. This upstream area is bordered with a dense mangrove forest (mostly *Rhyzophora mucronata* Lamk., and *Avicenia marina* (Forsk) Vierh.) on extensive silty mudbanks and mudflats. The surface water salinity and temperature here vary seasonally, diurnally and tidally; and the area supports brackish to freshwater species. In the middle area, the creek is not split into different channels. It is on average 1-2 km wide but shallow (< 5 m) except for the deep (> 20 m) mid channel. Tidal influence is greatly reduced, and salinity (34-36 psu), surface water temperature (24-32°C), dissolved oxygen concentration (78-84% saturation) and turbidity (1.5-2.5 m secchi disc depth) are quite different from the respective parameters at the mouth are (*i.e.*, 35 psu, 25-29°C, 92-95% and 3-6 m, respectively) (LITTLE *et al*. 1988, WAKWABI & JACCARINI, 1993). This study focuses on the middle area of the creek, more specifically on two shallow channels with soft silty substrates that are bordered with dense mangrove forests. Its selections was based on earlier observations on the distribution of freshly settled penaeid postlarvae and juveniles: this area was found to be an important nursery area for several species of penaeids and — probably — teleost fish (WAKWABI, 1996).

Research findings have consistently pointed to the important role shallow areas and estuaries play in the early life histories of different marine and brackish organisms (*e.g.,* LAEGDSGAARD & JOHNSON, 1995;

POLLARD & HANNAN, 1994; WILLIAMSON *et al.*, 1994; and BLABER *et al.*, 1992 on the Australian mangrove associated systems; SCHMITTER-SOTTO & GAMBOA-PEREZ, 1995 on the Yucatan peninsular, Mexico; HUSSAIN & SAMAD, 1995 and FOUDA & AL-MUHARRAMI, 1995 on the Arabian sea coasts of Pakistan and Oman; and SEDBERRY & CARTER, 1993 on the tropical laggons Belize, Central America; are but few explicit references to the nursery role of mangrove lined coastal ecosystems). GILLANDERS & WHITFIELD (1997), HARRIS & CYRUS (1996), CYRUS & FORBES (1996), KNEIB & KNOWLTON (1995), HERKE (1995), and WHITFIELD & KOK (1992) are valuable accounts on the importance of estuaries as nursery grounds. Recently, MARGUILLIER *et al.*, (1997), DE TROCH *et al.* (1996), and KIMANI *et al.* (1996) reported on the trophic relationships, and the fish communities of Gazi Bay, Kenya. They seem to agree on high diversity and suggest the importance of the mangrove — seagrass beds — coral reef interlinkage to juveniles of marine fishes on the bay. The only study on the fish fauna of Tudor creek is a beach seine and plankton survey reported in LITTLE *et al.* (1999). WAKWABI (1988) and WAKWABI & JACCARINI (1993) focused on the penaeids. Early postlarval and juvenile fish were observed to migrate into the creek. The species composition differed significantly between the mouth area and inner reaches of the creek, but no clear temporal variation in the community structure was observed. Like many other studies in estuarine areas (QUINN, 1980), the fish community of Tudor creek was found to be very diverse but with very few dominant species. The creek was found to be an important nursery and feeding ground for — often commercially important — teleost fishes (especially carangids, clupeids, haemulids, lethrinids, lutjanids and siganids) (LITTLE *et al.*, 1988) and penaeids (WAKWABI, 1988; WAKWABI & JACCARINI, 1993).

The objectives of this study were: (1) to describe the structural characteristics (species composition, density, diversity, size composition) of the epibenthic community (*i.e.* demersal fish and invertebrates) of the shallow, mangrove-bordered areas in the middle reaches of the creek and (2) to investigate seasonal variation in these communities.

MATERIALS AND METHODS

A 1.5 m beam trawl with a 2 mm meshed inner bag was towed on foot by wading through shallow shore waters of 0.5-1 m depth in two adjacent tidal channels (Fig. 1). Samples were always taken during daytime from 2 hours before to 2 hours after low water spring tide between May

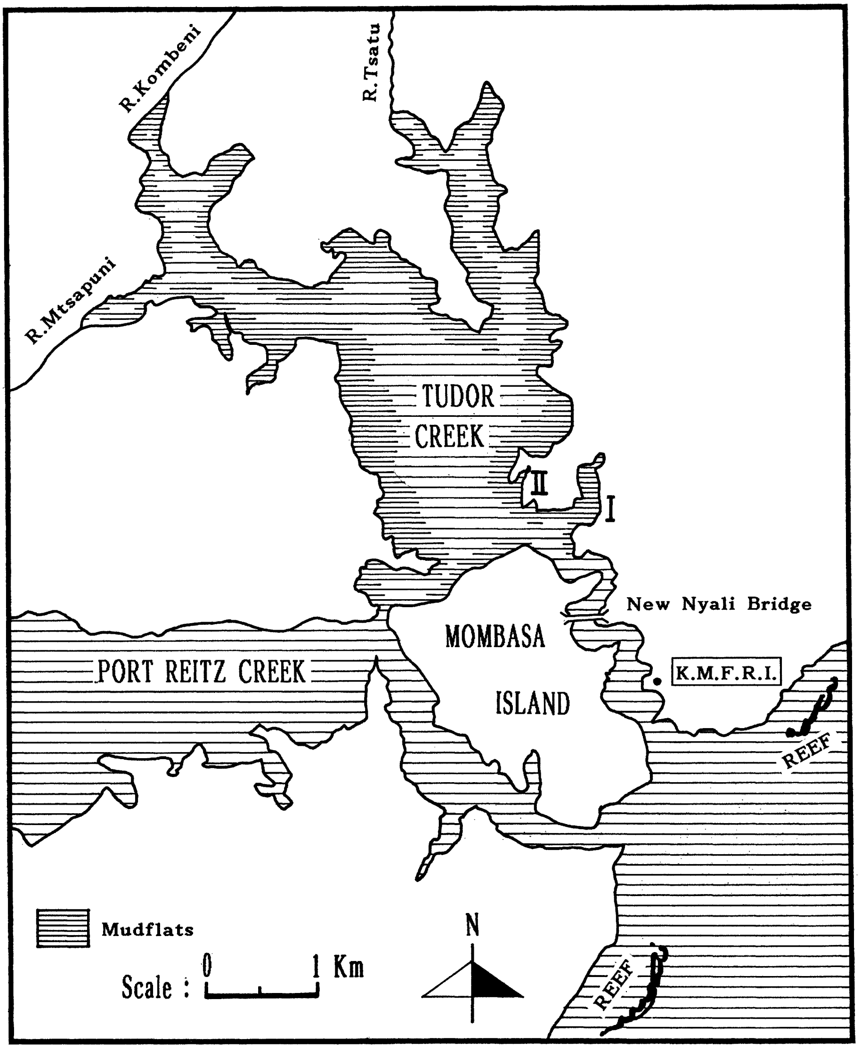


Fig. 1. Map of Tudor creek showing the tidal flats/mangrove cover, the seasonal rivers (Tsatu, Kombeni and Mtsapuni) and the sampling sites I and II.

1995 and April 1996. Two replicate tows were made in each channel making a total of four tows on each sampling date and a total of eight tows for each month, excepting June 1995, August 1995 and February 1996 when only one spring tide was sampled. On each occasion the net was towed for about 20 m, sweeping a surface area of approximately 30 m^2.

In the field, all animals caught in the net were sorted out of the debris and preserved in a 8% formaldehyde-seawater solution for storage. In the laboratory, the animals were later sorted, identified, counted and measured to the nearest 1 mm. All fish and penaeids were identified to species level using the keys provided by MOTOH (1981), SMITH &HEEMSTRA (1986), FISCHER & BIANCHI (1984) and BIANCHI (1985). All other invertebrate groups, together accounting for less than 10% of the total catch, were only identified to higher taxonomic levels: Stomatopoda, Cephalopoda and Caridea were recorded as such. Standard body length was measured for all fishes (distance from the tip of the snout to the base of the tail), except for representatives of the Plotosidae (total length). Total lengths were taken for all crustacea (stomatopods, penaeid and caridean shrimp): distance from the tip of the rostrum to the end of the telson. For squids, the total body length was measured excluding the arms.

Prior to multivariate analyses, the data of each sampling date were pooled (4 samples: 2 stations and 2 trawls per station) and fourth-root transformed. Rare species, *i.e.* species constituting less than 0.5% of the total catch of any one sample, were eliminated from the data matrix. These reduced pooled catch data were then subjected to TWINSPAN (Two Way Indicator Species Analysis, a divisive classification technique) and a correspondence analysis (an indirect ordination technique). After the identification of seasonally defined communities, these were characterised by their average density and diversity. Diversity was calculated as the Hill's diversity numbers of the order 0 and 1 (HILL, 1973):

N_0 is the number of species in a sample;

N_1 is the equivalent to the Shannon-Weaver diversity index, *i.e.*,

$N_1 = \exp(H')$ with $H' = -\sum p_i(\log p_i)$, and $p_i = N_i/N_t$, where N_i is the abundance of the i^{th} species in the sample and N_t is the total abundance of the sample.

RESULTS

Species composition

For a complete species list and the total numbers of individuals caught for each species or taxon per sampling date we refer to the Appendix. The data reported in this study are summarised and compared with those reported by LITTLE *et al.* (1988). From a total of ninety six tows, 6396 specimens were collected, belonging to 79 species or higher taxa. 4023 (62.9%) of the specimens belonged to 72 species of teleost fish (in 37 families). Penaeid shrimps (4 species) and caridean shrimps constituted 27.45% and 8.02% of the total catch respectively, while stomatopods and cephalopods were quite rare (0.36% and 1.27% respectively).

At the family level, Penaeidae contributed most to the total catch. Gobiidae (15.35%), Lutjanidae (8.65%), Plotosidae (8.61%), Acropomatidae (6.24%), Gerreidae (5.00%), and Synodontidae (4.32%) were the most important fish families. Gobiidae was the most diverse family with 8 species, followed by Apogonidae and Lutjanidae with 5 species each, and Penaeidae with 4 species. *Yongeichthys nebulosus* (Gobiidae), *Penaeus monodon, P. semisulcatus* and *Metapenaeus monoceros* (Penaeidae), *Plotosus lineatus* (Plotosidae), *Lutjanus fulviflamma* (Lutjanidae), *Acropoma japonicum* (Acropomatidae), *Gerres oyena* (Gerreidae), and *Saurida undosquamis* (Synodontidae) were the dominant species: each contributed for more than 4% to the total catch.

Seasonality

The catch in number of individuals and species was generally quite variable. On a monthly basis (Appendix), the highest number of species (41) was recorded in November and the lowest (14) in June. The rest of the months had an intermediate number of species, varying between 18 and 35. In the short rainy season (September through December) the mean number ($\pm$ SE of the mean, N = 4 months) of species (34.25 ± 2.29) was high as compared to the dry season (January through April: 29.25 ± 2.95) and the long rainy season (May through August: 22.0 ± 3.56). Mean monthly density (catch in numbers per 30 m^2 $\pm$ SE of the mean, N = 8 tows) was lowest (15.75 ± 0.02) in August and highest (123.63 ± 42.19)

TABLE 1

Catch rates (numbers caught in a standard 30 m^2 tow) of the epibenthos collected during the monthly beam trawl study of the backwaters of Tudor creek, Mombasa, Kenya in May 1995 through April 1996 (means estimated on eight tows per month).

Month	Total catch	Catch/30 m^2 ($\pm$ SE of mean)
May 95	628	78.50 ± 17.38
June 95	135	16.88 ± 8.40
July 95	508	63.50 ± 21.54
August 95	126	15.75 ± 8.02
September 95	540	67.50 ± 20.21
October 95	955	119.38 ± 36.41
November 95	614	76.75 ± 31.25
December 95	500	62.50 ± 17.71
January 96	620	77.50 ± 17.99
February 96	989	123.63 ± 42.19
March 96	563	70.38 ± 19.40
April 96	222	27.75 ± 12.77

TABLE 2

The minimal (min), maximal (max), modal (M) and the maximum attainable size (L8) sizes (mm SL) of the abundant and common species and/or taxa caught (with > 0.3% of the total catch) during the beam trawl study (May 1995 through April 1996) on Tudor creek.

Species	Abbrevation	Number	min	max	M	L8
Spratelloides delicatulus	Spra deli	112	16	39	16-20	70§*
Plotosus lineatus	Plot line	552	20	155	71-75	300§*
Saurida undosquamis	Saur undo	277	20	125	46-50	450§*
Hemirhamphus far	Hemi far	65	17	135	21-25	440§*
Syngnathus acus	Syng acus	19	84	151		300*
Cociella crocodila	Coci croc	9	63	80		500*
Apogon lateralis	Apog late	61	8	85	46-50	100*
Acropoma japonicum	Acro japo	400	9	88	16-20	200*
Plectorhynchus gaterinus	Plec gate	16	14	99		500§*
Lutjanus fulviflamma	Lutj fulv	547	14	105	36-40	350§*
Monodactylus argenteus	Mono arge	74	10	36	16-20	250§*
Gerres oyena	Gerr oyen	309	12	63	31-35	250§*
Leiognathus equula	Leio equu	65	10	42	16-20	420§*
Caranx ignobilis	Cara ingo	5	31	50		1650§*
Valemugil saheli	Vale sahe	21	23	39	16-20	500§*
Sphyraena jello	Sphy jell	182	21	20	26-30	1500§*
Petroscrites sp	Petr spec	21	17	44		70*
Amblygobius albimaculatus	Ambl albi	21	17	35		180*
Oligolepis keiensis	Olig keie	162	15	110	46-50	70*
Yongeichthys nebulosus	Yong nebu	747	11	100	16-20	180*
Bothus mancus	Both manc	43	23	155		420*
Caridea	Cari mix	625	10	67	16-20	30§
Metapenaeus monoceros	Meta mono	625	15	105	56-60	200§
Penaeus indicus	Pena indi	107	18	178	31-35	230§
Penaeus monodon	Pena mono	727	8	152	51-55	340§
Penaeus semisulcatus	Pena semi	297	13	130	56-60	230§
Cephalopoda	Squi mix	76	7	144	26-30	900§

§ and * respectively, denote BIANCHI (1985) and/or SMITH & HEEMSTRA (1986) as source of the L8.

in February (Table 1). The short rainy season again had a higher mean density (652.25 ± 103.6) compared to the long rainy season (394.25 ± 128.7) and the dry season (598.5 ± 157.9) based on the pooled monthly totals (N = 4 months).

Size composition

The minimum and maximum sizes recorded for the most abundant and characteristic species recorded in this study are presented together with their adult size in Table 2. It is apparent that all landed individuals were juveniles. All individuals caught in this study fall within restricted size ranges which may reflect on the selectivity of the gear. This limited size range may also suggest an apparent restriction of the life stages of the species in these backwaters pointing more to a transitional population as opposed to a residential one. Note that even the gobies, which should have larger size ranges in this area, display the same limited size range. Since this study did not undertake selectivity assessment of the used gear, it may not be easy to fully explain the observed size ranges. The transition pattern may however strongly suggest the role of these backwaters as nursery grounds, especially for the penaeids and for most commercially important fish species.

Multivariate analyses

Three distinct epifauna communities, clearly corresponding to the "short rains-dry-long rains" seasonal pattern, emerged from the TWINSPAN (Fig. 2) and correspondence analysis (Fig. 3a, b). In the first TWINSPAN division, all long rain samples are split off from the rest, with *Metapenaeus monoceros*, Caridea, *Penaeus semisulcatus* and *Lutjanus fulviflamma* as indicator species. In a second division, the dry season samples

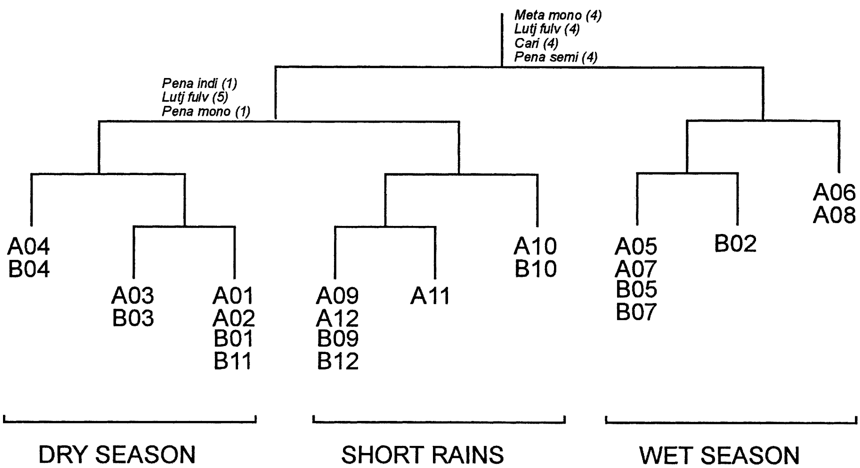


Fig. 2. A dendrogram from the Two Way Indicator Species Analysis (TWINSPAN) treatment of the epibenthos data collected during the beam trawl study on Tudor creek, Mombasa, Kenya in May 1995 through April 1996. A and B denote first and second spring tide of the month. Months were progressively denoted by 1 for January to 12 for December. Names of species and taxa are abbreviated as in Table 2. The numbers against the indicator taxa denote the cut level.

TABLE 3

Estimated seasonal Hill's diversity indices (N_0 and N_1) on the epibenthos collected with a beam trawl from Tudor creek, Mombasa Kenya, in May 1995 through April 1996. Details in the text.

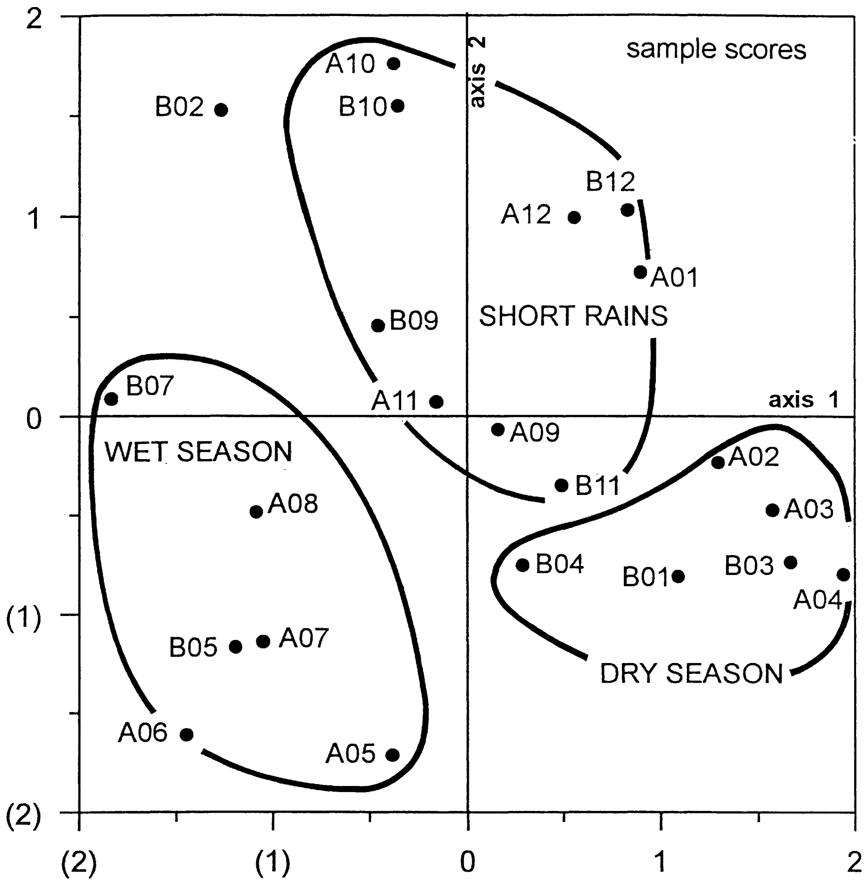
Season	N_t	N_0	H'	N_1
Long rains	1269	39	0.218	1.243
Short rains	2607	67	0.162	1.176
Dry	2394	48	0.191	1.211

are separated from the short rains samples. *P. monodon*, *P. indicus* and *L. fulviflamma* are indicator species for dry season. The three communities are characterised in figures 3 and 4. The dry season (January-April) community was characterised by high densities of *Penaeus monodon*, *Lutjanus fulviflamma* and *Gerres oyena*. The long rains (May-August) community was dominated by *Penaeus semisulcatus* and Caridea, while the short rains (September-December) community was dominated by *Acropoma japonicum* and *Plotosus lineatus*. *Metapenaeus monoceros* was abundant in all seasons and *Yongeichthys nebulosus* reached high densities in both short rains and dry seasons. The short rains community had the highest number of species (N_0) and density, though the diversity index (N_1) was rather uniform and low for all the seasons (Table 3). The three communities are therefore based on the seasonal occupancy of a few species which recruit in this area only during a limited period of stay determined by the seasonal and temporal environmental fluctuations in the creek.

DISCUSSION

The recorded numbers of 72 fish species in 37 teleost families are comparable to those recorded by LITTLE *et al*. (1988) (83 species in 38 families). Five teleost families (Acropomatidae, Monodactylidae, Percorphidae, Serranidae, and Dactylopteridae) caught in this study were, however, not reported by LITTLE *et al*. (1988). This difference is carried further at the species level: only 24 species are shared between the two studies. The observed differences can be attributed to differences in sampling strategy and gears: we sampled 2 muddy, intertidal channels with a beam trawl net, while LITTLE *et al*. (1988) used a beach seine over sandy substrata.

Leaving out the invertebrate component, it is evident that the fish community of Tudor creek is a typical, tropical shallow-water community where few species constitute the bulk of the catch ($> 70\%$)

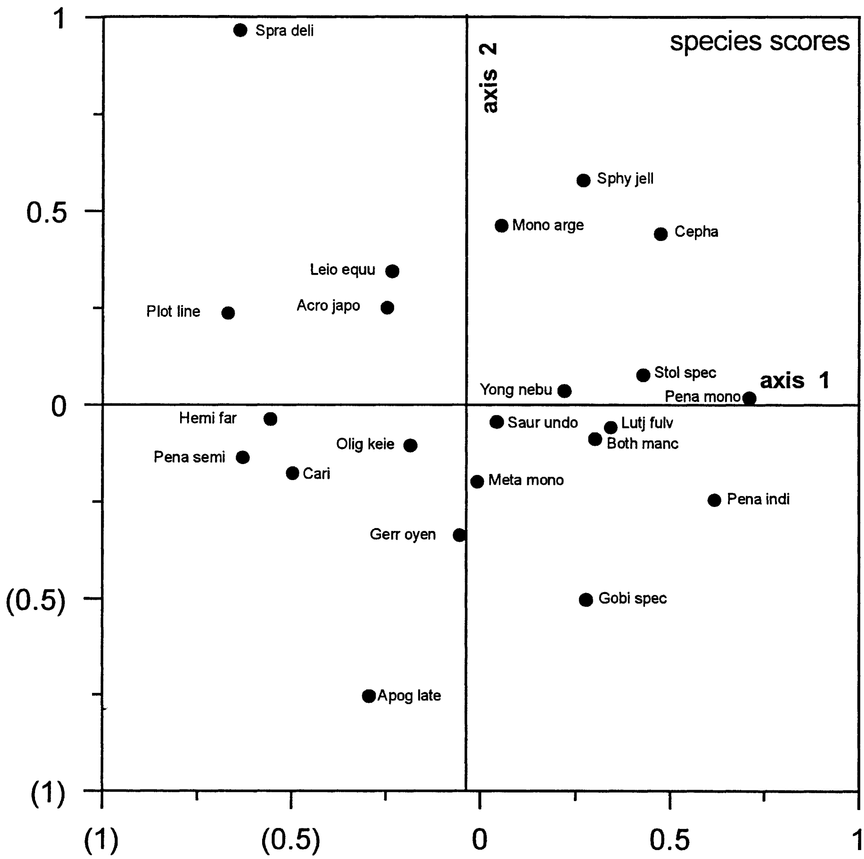


(a)

Fig. 3. Results of the correspondance analysis (CA) with the ordination plots for (a) sample scores and (b) species scores; depicting the three seasonal epibenthic communities on Tudor creek, Mombasa, Kenya, during the beam trawl study (May 1995 through April 1996). Names of months, tide number, and species and taxa abbreviated as in Fig. 3 and Table 2.

despite the large number of species (QUINN, 1980). Indeed, only six fish species (*Yongeichthys nebulosus, Plotosus lineatus, Lutjanus fulviflamma, Acropoma japonicum, Gerres oyena,* and *Saurida undosquamis*) together constituted over 70% of the total fish catch. Most of the reported species (61 species = 85%) were each less than 1% of the total catch.

The multivariate statistical techniques employed on the catch data for the beam trawl study in the backwaters of Tudor creek identified three



(b)

Fig. 3. (Continued).

communities of the epibenthos tied to the rainfall pattern. The short rainy season had more species while the long rainy season had the least diversity. In terms of numbers, the three communities had very strong dominance of few species conforming to the general observation that tropical estuarine or coastal ecosystems tend to be very diverse but with very low densities for the majority of species (QUINN, 1980). The restricted size ranges for all individuals caught during this study may be largely due to two processes: selectivity of the gear and/or dynamic replacement of the populations through seasonal recruitment, fast size progression and emigration. Only juvenile stages of most (in fact all) species were caught. The different species probably occupy these waters for a very limited period to feed and/or to escape from

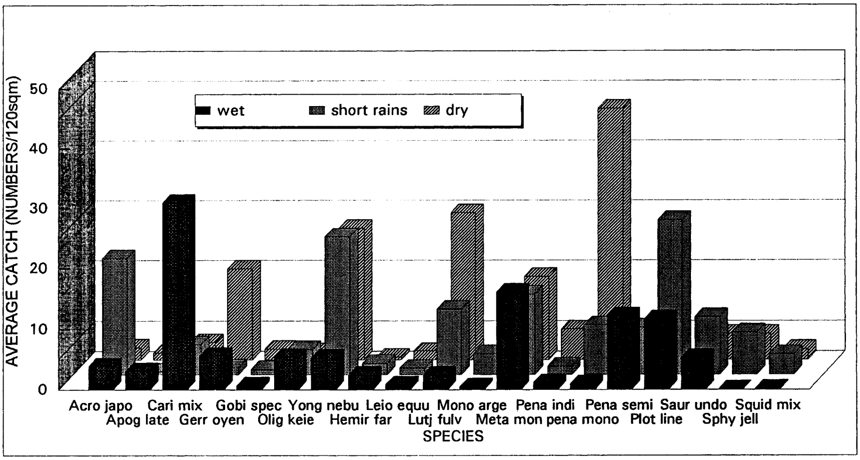


Fig. 4. Seasonal (long rainy season, short rainy season and dry season) epibenthic communities of Tudor creek including only species with an average catch of > 3 individuals in the monthly tows (total 120 m^2) of the beam trawl study (May 1995 through April 1996). Names of species and taxa as in Fig. 2.

predation. For the penaeid component of the epibenthos, the backwaters are an important nursery for their newly settling postlarvae and juvenile stages (WAKWABI, 1988, 1996, WAKWABI & JACCARINI, 1993). Most abundant juvenile fishes are second and third consumer species (LITTLE *et al.*, 1988), confirming the feeding and protection roles of this area. Though the emerging community structure is based on the rainfall pattern, rains *per se* are not necessarily the causative factor. They probably determine the resultant food and protective conditions in these waters, which are perhaps the most important and overriding requirements of the juvenile stages of the fish and crustacean populations encountered here.

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APPENDIX

	May 95	Jun 95	Jul 95	Aug 95	Sep 95	Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96	Apr 96	Total	%
Acropomatidae														
Acropoma japonicum	9	4	26	7	5	230	29	44	9	22		15	400	6
Antennariidae														
Antennarius hispadus								2					2	0
Apogonidae*														
Apogon lateralis	20	9	5	3	6		2		4	10	2		61	1
Apogon nigripes								2			6	2	10	0
Apogon savayensis					1	3					11		15	0
Apogon sp	3		2	2		1	1			3	1		13	0
Fowleria aurita							2		4	8			14	0
Atherinidae*														
Atherinomorus duodecimalis						4	3						7	0
Belonidae*														
Tylosurus acus							4						4	0
Blenniidae*														
Petroscirtes sp			3		7	5		2			2	2	21	0
Bothidae*														
Bothus mancus	3		2		10	7	1	5	3	1	2	9	43	1
Pseudorhombus arsius			2		1								3	0
Carangidae*														
*Caranx ignobilis**	1		1				1			2			5	0
Clupeidae*														
Spratelloides delicatulus	2		3		4	34		1		67	1		112	2
*Paraplagusia bilineata**							2						2	0
Dactylopteridae														
Dactyloptena orientalis							1		1				2	0
Engraulidae*														

	May 95	Jun 95	Jul 95	Aug 95	Sep 95	Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96	Apr 96	Total	%
*Stolephorus indicus**	2					1							3	0
Stolephorus sp						1	31		1	10			43	1
Ephippudae*														
Platax obicularis				2							1		3	0
Gerreidae*														
*Gerres filamentosus**					3						7		10	0
*Gerres oyena**	24	17	20	6	9	1	7	2	100	84	5	34	309	5
Gerres sp							1						1	0
Gobiidae*														
Acentrogobius audax							7						7	0
Amblygobius albimaculatus							1		2	9	4	7	23	0
Cryptocentrus octofaciatus							2						2	0
Gnatholepis sp					3								3	0
Gobius sp		1	7		2		12		20	5	1		48	1
Oligolepis keiensis	24	12	21	8	19	21	12	15	3	9	6	2	152	2
Oxyurichthys ophthalmonema							4						4	0
Yongeichthys nebulosus	29	6	25	3	68	40	65	192	73	106	136	2	745	12
Haemulidae*														
Plectorhynchus gaterinu	3					1		4	2	2	3	1	16	0
Pomadasys olivaceum						8							8	0
Hemiramphidae*														
*Zenarchopterus dispar**			13										13	0
*Hemirhamphus far**	2		27			27	3			1		5	65	1
Leiognathidae*														
*Leiognathus equula**	1		9		5	12			4	32		2	65	1
Leiognathus bindu					2								2	0
Lethrinidae*														
*Lethrinus harak**	1							2			3		6	0
Lethrinus sp										2			2	0
Lutjanidae*														

	May 95	Jun 95	Jul 95	Aug 95	Sep 95	Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96	Apr 96	Total	%
Lutjanus argentimaculat	1									1			2	0
*Lutjanus fulviflamma**	22	2	5		33	42	72	27	95	151	89	9	547	9
Lutjanus ehrenbergii			1										1	0
Lutjanus sp					2					1			3	0
Lutjanus fulvus							1						1	0
Monodactylidae														
Monodactylus argenteus	2		4		6	41	2	7	8	3	1		74	1
Mogilidae*														
Valemugil saheli						3		15	1	2			21	0
Mullidae*														
*Upeneus tragula**	2							3	1				6	0
Upeneus vittatus						4			1				5	0
Ostraciidae*														
*Lactoria cornuta**								2					2	0
Lactoria fornasini						1	1						2	0
Platycephalidae*														
*Cociella crocodila**	2		2	1	2		1		1				9	0
*Papilloculiceps longiceps**					1			5					6	0
Platycephalus sp									3	3	2	3	11	0
Percorphidae														
Bembrops platyrhynchus					1								1	0
Plotosidae*														
*Plotosus lineatus**		14	77	49	167	226	15	2	1		1		552	9
Pomacentridae*														
Chrysoptera annulata						1							1	0
Plectroglyphidodon lacry	11	1	3					1					16	0
Scorpaenidae*														
Dendrochirus brachypterus						2	2	8					12	0
*Parascorpaena mossambica**							1						1	0
Synanceia verrucosa							1						1	0

	May 95	Jun 95	Jul 95	Aug 95	Sep 95	Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96	Apr 96	Total	%
Serranidae														
Cephalopholis argus				1									1	0
Epinephelus tauvina										1			1	0
Siganidae*														
Siganus canaliculatus					1				7	2	1		11	0
Sillaginidae*														
*Sillago sihama**			3										3	0
Sphyrianidae*														
*Sphyraena jello**					10	54	13	35	46	22		2	182	3
Syngnathidae*														
Syngnathus acus	3		7	2			1	1					14	0
*Syngnathus biaculeatus**									1				1	0
Syngnathus sp									2	2				40
Synodontidae*														
Saurida undosquamis	32	5	24	2	64	43	16	30	22	15	21	3	277	4
Teraponidae*														
*Terapon jarbua**	1	1		1									3	0
Tetraodontidae*														
Arothron immaculatus						3		1	1			1	6	0
Arothron nigripunctatus							1						1	0
Canthigaster solandri							1						1	0
Caridea	218	26	119	9	31	7	29	13	33	21		7	513	8
Penaeidae														
Metapenaeus monoceros	128	19	41	6	39	61	103	10	23	41	89	65	625	10
Penaeus indicus	14				9	4	5	4	4	25	23	19	107	2
Penaeus monodon				11	8	29	61	33	135	292	134	24	727	11
Penaeus semisulcatus	65	18	54	9	11	23	89	3		21		4	297	5
Stomatopoda	3		2		1			5	3	1	4	4	23	0
Cephalopoda				2	9	14	7	24	6	12	7		81	1
Total	628	135	508	124	540	954	613	500	620	989	583	222	6396	
Number of species	28	14	28	18	32	33	41	31	33	35		27	22	