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Food Habits of the Blue Swimming Crab *Portunus pelagicus* along the Coast of Dar es Salaam, Tanzania

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***Abstract*—**The food habits of the blue swimming crab *Portunus pelagicus* were investigated using the stomachs of 3948 crabs collected from Kunduchi sub-littoral shallow waters, Msasani Bay and Mzinga creek along the coast of Dar es Salaam. The main food items included molluscs (51.3%), crustaceans (24.1%), fish bones (18%) and unidentified food items (6.6%). The dominant food item was the bivalve *Arcuatula arcuatula* Hanley, 1844. Other molluscs included the gastropod genera *Nassarius, Littoraria* and *Conus* sp. There was no significant difference in the frequency of occurrence of food items among sexes and sizes of *P. pelagicus*, or according to season. There were, however, significant differences between the different food items and the frequency of their occurrence in the stomachs of ovigerous and non-ovigerous females.

INTRODUCTION

A knowledge of an animal's dietary habits is essential for studies of nutritional requirements, interactions with other organisms and for its culture (Santos & Borges, 2001). Crabs include filter feeders, sand cleaners, mud, plant and carrion feeders, predators, commensals and parasites (Dall & Moriarty, 1983). They inhabit many different niches (Chande et al., 1999; Kyomo, 1999; Dahdouh-Guebas et al., 1999; Bryceson & Massinga, 2002) and this is reflected in the diversity of food eaten. *Portunus pelagicus* (L.), feeds on macroscopic food and its mouthparts and gastric mill ossicles reduce the food to fragments, making the identification and estimation of its quantities difficult. Researchers therefore use the contents of the foregut to identify the food consumed (e.g. Williams, 1981; Cannicci et al., 1996).

There is as yet no established methodology for the quantitative description of gut contents in crustaceans that feed on macroscopic food items. Several studies of foregut contents have used the percentage of occurrence of food types as the only measure of relative intake of different food items (Donaldson, 1975; Hill, 1976; Williams, 1982; Dahdouh-Guebas et al., 1999). Other studies have used the points method (Hynes, 1950; Hyslop, 1980), in which each food category is awarded points proportional to its estimated contribution to stomach volume, taking into account the size and abundance of the food item.

The food habits of *P. pelagicus* have been widely studied. Patel et al. (1979) working in India reported pieces of crabs, gastropods and bivalve shells, and sometimes fish to be its main food types, while Williams (1982) in Moreton Bay, Queensland, reported benthic invertebrates such as bivalves, polychaetes and crustaceans as its diet.

The importance of food types in the diet differs depending on the nature of the habitat. The size of a predator may determine the size of food items it selects in order to maximise the energy gained.

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Furthermore, ovigerous and non-ovigerous females have different feeding habits; the former spend more time grooming their eggs than feeding (Sumpton & Smith, 1990).

Despite its fishery importance, there is as yet no information on the diet and relative importance of food types of *P. pelagicus* in Tanzanian coastal waters (Chande & Mgaya, 2003). The aim of the present study, therefore, was to investigate the food habits of *P. pelagicus* along the coast of Dar es Salaam with respect to sex, size, reproductive state, as well as season.

MATERIALS AND METHODS

Study area

The study was carried out at three sites off the Dar es Salaam coast: Kunduchi sub-littoral shallow waters, Msasani Bay and Mzinga creek (Fig. 1) The climate of the area is influenced by monsoon winds, namely the southeast monsoon, which prevails between April and October, and the northeast monsoon between November and March (McClanahan, 1988). The surface water temperature ranges between 24.5 and 33.0 ºC and the substrate is sandy or sandy/muddy.

Diet composition

Crabs of 1.0–13.0 cm carapace width were collected monthly from the three sites between January 1995 and December 1996. Soft-shelled crabs were not collected. The field sampling methods were as described in Chande & Mgaya (2003). After recording morphometric data, the crabs were dissected, their foreguts removed and preserved in 70% ethanol and examined within two weeks of collection.

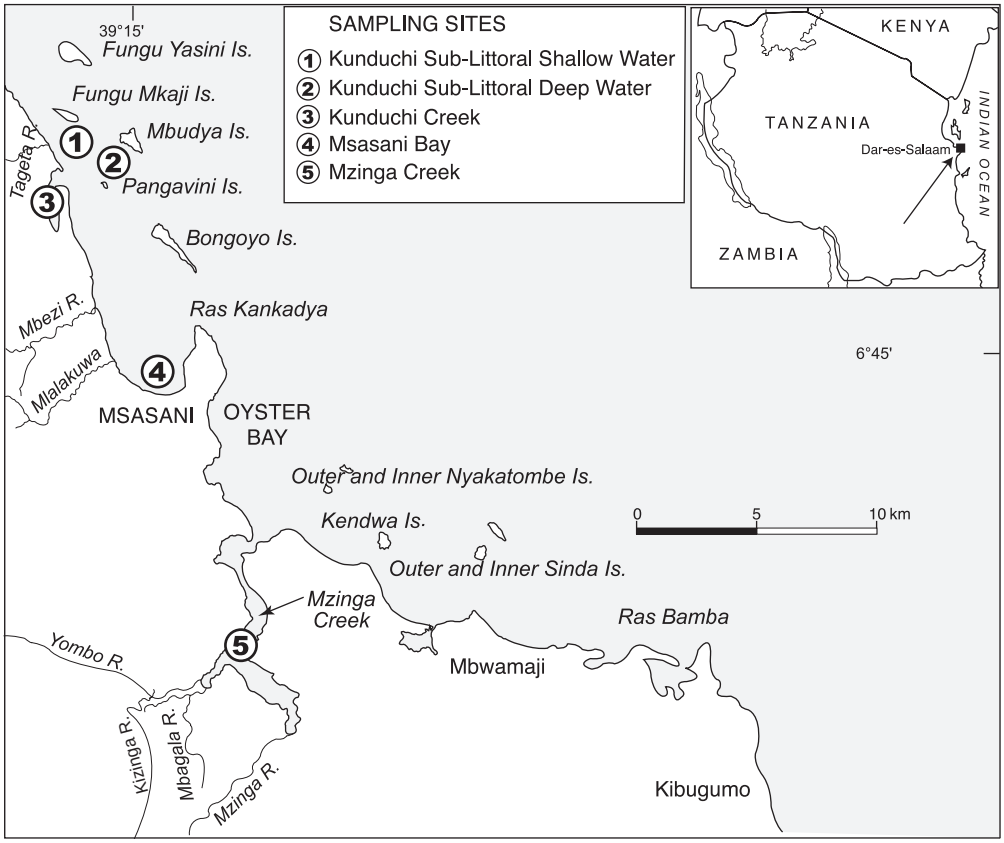

Fig. 1. Map of Dar es Salaam coastal area showing sampling sites 1–5

The foregut contents were emptied into Petri dishes containing freshwater. The individual food organisms were sorted and identified to the lowest possible taxonomic level. For the molluscs, manuals by Spry (1964, 1968) were used. As fish and crustaceans were macerated, they could only be identified and grouped as fish, prawns, crabs and other crustaceans using bones for fish and appendages for the crustaceans. The frequency of occurrence method was used for the analysis of food items (Williams, 1981, 1982). The method is widely used in dietary studies of fish and crabs, and it gives a measure of the regularity with which food has been taken up in the sample or population and "it is specifically recommended when different food items contribute to the diet" (Dahdouh-Guebas et al., 1999). This method entailed recording the number of stomachs containing individuals of each food category, expressed as percentage of all the stomachs examined according to the formula

Percentage occurrence = (b/n) x 100

where b is the number of crab stomachs that had a food item and n is the number of crab stomachs dissected, excluding those that were empty. The food item with the highest value was taken as the most important one.

Variations in food habits

Variations in food habits were investigated in relation to sex, crab size and seasons. The amount of stored organic material in ovigerous and non-ovigerous females was compared using a hepatosomatic index (HSI). Crabs were grouped into four size classes: < 5.0 cm, 5.0 – 8.0 cm, 8.0 – 11.0 cm and > 11.0 cm carapace width. The months which constituted the wet season were October, November, December, March, April and May. The data for the remaining months constituted the dry season. The hepatosomatic index (HSI) was calculated from the formula

$$HSI = \frac{DHW \times 100}{DBW}$$

where DHW = dry hepatopancreas weight and DBW = dry body weight.

Statistical analysis

Variation of food habits with respect to seasons, sex and size were analysed using two-way analyses of variance followed by Student-Newman-Keuls (SNK) test, where significant differences were present at $P < 0.05$ (Zar, 1999). The data remained heterogeneously varied despite arcsine-transformation. ANOVA was nevertheless chosen in preference to non-parametric alternatives due to its robust nature even where the data do not perfectly conform to the assumptions underlying parametric tests (Underwood, 1981). The differences of food habits with regard to ovigerous and non-ovigerous females were tested using χ^2 test. Differences were recorded as significant at $P < 0.05$.

RESULTS

Diet composition

A total of 3948 crabs were examined out of which 79.1% had stomachs with food items. The identifiable food items included molluscs (51.3%), crustaceans (24.1%), and fish bones (18.0%). The molluscs comprised mainly the species *Arcuatula arcuatula*. Other molluscs included gastropod genera *Nassarius, Littoraria* and *Conus*. Unidentifiable food items constituted 6.6% of the foregut contents.

Food habits

No significant differences in food types were seen among seasons, sexes and size classes, but significant differences were recorded among the various food items (Table 1). The SNK test revealed that there were differences in all sample means. All size classes and both male and female crabs during both seasons consumed similar food items but with slight variations in magnitude. However, the largest crabs (>11.0 cm carapace width) did not consume the small gastropods, *Nassarius, Littoraria* and *Conus* spp.

Analysis of monthly variation in food habits

Table. 1. Two-way Analyses of variance for the seasonal variation of percentage occurrence of food items of *Portunus pelagicus* during 1995 and 1996 (pooled data)

Source of variation	DF	MS	F	P
Season				
Season	1	1.377	0.156	ns
Food items	3	8316.464	942.803	*
Seasons x Food	3	18.579	2.106	ns
Error	40	8.821		
Total	47			
Sex				
Sex	1	4.434	0.689	ns
Food items	3	8279.056	1286.167	*
Sex x Food	3	2.784	0.432	ns
Error	40	6.437		
Total	47			
Size				
Size	1	12683.068	722.888	*
Food items	3	27.877	1.589	ns
Size x Food	3	9.632	0.549	ns
Error	24	17.545		
Total	31			

ns = No significant variation ($p > 0.05$); * = Significant variation ($p < 0.05$)

of the crab showed that molluscs and crustaceans were the most commonly ingested items throughout the year at all sampling sites (Fig. 2) with molluscs dominating the diet (~50% occurrence) in most months.

A comparison of the food habits of ovigerous and non-ovigerous females is presented in Table 2. There was no significant difference in the hepatosomatic indices between the two groups of females ($\chi^2 = 0.212$, $p = 0.645$). However, significant differences were found in the food habits in the frequency of occurrence and the percentage of empty stomachs (Table 2). Only molluscs whose sample size was considered to be adequate were tested.

DISCUSSION

At Kunduchi *P. pelagicus* was predominantly carnivorous. The crab fed on benthic invertebrates, which were either sessile or slow moving, as also observed by Patel et al. (1979) in India, Williams (1982) in Moreton Bay, Queensland and Sukumaran & Neelakantan (1997) in southwest India. Fish and prawns also formed part of the diet of the crabs in the present study, albeit at a smaller scale. The few occurrences of fish and prawn in the stomach of the crabs are probably more due to scavenging activity on dead individuals, than to active predation (Wassenberg & Hill, 1987). Plant materials were very rare in the diet and could have been ingested when crabs were feeding on macrofauna that were amongst algae and seagrasses. Molluscs, particularly the bivalve *Arcuatula arcuatula*, were the most important food items in all the study sites. *Arcuatula arcuatula* is a predominant infaunal species in the intertidal region at the sampling locations (Mlay et al., 2001; Mgaya, unpublished observations) and assuming that this tendency extends downwards to the subtidal, this species is a predominant food item as a consequence. In a study carried out in Western Australia, Edgar (1990) reported that the gastropod *Cantharidus lepidus* was the most common both in the guts of lobster and in their habitat.

Arcuatula arcuatula is a small bivalve—the largest recorded in the present study had a 17-mm shell length. It has a softer shell compared to the closely related *Modiolus* spp. and therefore, can be ingested easily. Williams (1982) reported that *P. pelagicus* in Australia fed on small bivalve species of between 10 and 20 mm shell length.

Comparison of ovigerous and non-ovigerous females revealed that both groups fed on the same food items, but the frequency of occurrence of the food items was lower for ovigerous females and many stomachs were empty. This is partly explained by the fact that ovigerous females spend more time grooming their eggs than feeding (Sumpton & Smith, 1990)—ovigerous *P. pelagicus* spent approximately 50% of their active time grooming their eggs. During this period they most likely utilise materials reserved in the hepatopancreas as a source of energy.

There was no variation in the diet of *P. pelagicus* in relation to sex, crab size and season. The crabs probably change to larger-sized food items of the same taxa as they grow. In the sub-tropical

Table 2. Percentage empty stomachs, frequency of occurrence of food types and hepatosomatic indices (HSI) of ovigerous and non-ovigerous females of *Portunus pelagicus*

Category	Non–ovigerous females	Ovigerous females	χ^2	P
% Empty stomachs	40.79	72.09	8.130	0.004
% Occurrence (Mollusca)	27.96	20.14	5.321	0.021
HSI	1.99	1.90	0.212	0.645

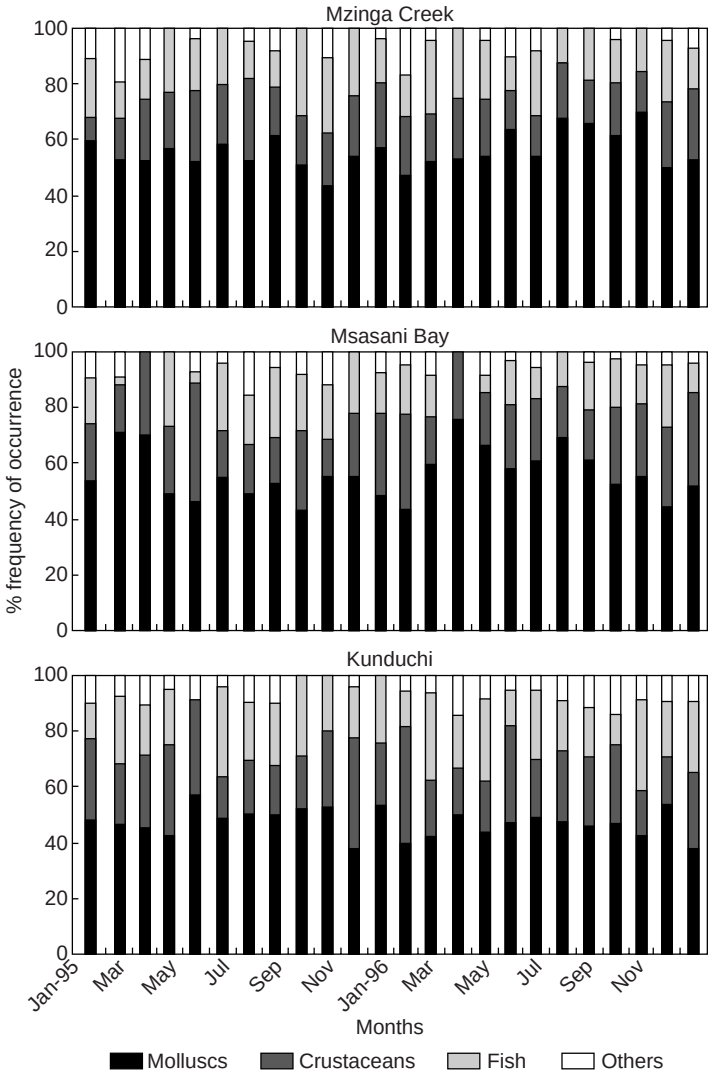

Fig. 2. Monthly variation in the frequency occurrence of main food items of *Portunus pelagicus* during 1995 and 1996

Moreton Bay, Williams (1982) also reported similarity in diet between sexes and among crabs of different sizes. The high density of the available prey species within each designated food taxon was taken as the most plausible explanation (Stephenson et al., 1970).

This study shows, for the first time, the preponderance of *A. arcuatula* in the diet of *P. pelagicus.* As *P. pelagicus* consume a variety of food items it is suggested that a major reduction in availability of one prey group would not have a major effect on the crab population.

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