

FEEDING HABITS OF NON-OCYPODID CRABS FROM TWO MANGROVE FORESTS IN KENYA

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ABSTRACT

The stomachs of 194 crabs belonging to 11 species, commonly inhabiting mangrove areas, were collected in two Kenyan mangrove forests, in Gazi Bay and Mida Creek, and their contents were analyzed. Both the stomach fullness (a subjective estimation) and the composition (the plant:animal matter ratio) of the food ingested were recorded. Results show that few species are either strictly herbivorous (*Sesarma ortmanni* and *Selatium elongatum*) or strictly carnivorous (*Eurycarcinus natalensis*), while most of the species are non-specialized and normally eat a wide range of plant items, mangrove leaf litter and algae, and animal prey, mostly bivalves, gastropods, anomurans and other brachyurans. Crab stomachs with a higher percentage of mangrove leaf litter and algae were significantly fuller than those with animal items. Most of the crabs display an omnivore feeding habit and feed on a wide range of items. Among the Sesarminae, the most herbivorous group, the only species showing a significant degree of specialization is *Sesarma leptosoma*, which is able to reach the mangrove canopy to feed on fresh leaves.

Among the macrofauna commonly colonizing mangrove forests, brachyuran crabs are one of the most important taxa with regard to both the number of species and the total biomass (Macintosh, 1988). For this reason their feeding habits and the position each species occupies in the food web are of great importance for the understanding of the ecology of the mangrove ecosystem.

Many species of mangrove crabs are known to be herbivorous. *Chiromanthes onychophorum* de Man in Malaysia (Malley, 1978), *Neosarmatium meinerti* de Man (= *Sesarma meinerti*, re-diagnosed by Davie (1994) as the *Neosarmatium* genus) in South Africa (Emmerson and McGwynne, 1992) and Kenya (Dahdouh-Guebas et al., 1997), and *Sesarma smithii* H. Milne Edwards (Giddins et al., 1986), *S. messa* Campbell (Robertson, 1986; Micheli, 1993) and *S. erythrodactyla* Hess (Camilleri, 1989) in Australia, can consume a great amount of leaf litter of various mangrove species. These crabs probably play an important role in the process of leaf degradation, making mangrove leaves more rapidly available to meiofauna. Ocypodid species can feed on mangrove pneumatophores, eat bark and macro-algae (Wada and Wowor, 1989).

The herbivorous crabs, which are strongly linked to roots and mangrove leaves, some predators, such as *Scylla serrata* (Forskål) (Hill, 1976) and *Goniopsis cruenata* (Latreille) (Von Hagen, 1977), and other species of Grapsidae have been reported to feed mostly on plant matter in situ, but also on dead crabs and fishes in captivity (Von Hagen, 1977). The natural diet of *Aratus pisonii* (H. Milne Edwards) includes fresh *Rhizophora mangle* L. leaves as well as caterpillars, crickets and beetles (Beever et al., 1979). Little is known about the feeding habits of most crabs colonizing the mangrove habitats of the Kenyan coast, with the exception of some *Uca* species, which are known to be micro-algal feeders (Icely and Jones, 1978), and *N. meinerti* and *Cardisoma carnifex* (Herbst) (Micheli et al., 1991), both important consumers of fallen leaves.

Table 1. Nomenclature and number of individuals of the species analysed in the present study.

Family	Subfamily	Species	number
Gecarcinidae		<i>Cardisoma carnifex</i> (Herbst, 1794)	(n = 10)
Xanthidae	Menippinae	<i>Epixanthus dentatus</i> (White, 1847)	(n = 20)
	Pilumninae	<i>Eurycarcinus natalensis</i> (Krauss, 1843)	(n = 11)
Grapsidae	Grapsinae	<i>Metopograpsus oceanicus</i> (Jacquinot, 1852)	(n = 7)
		<i>Metopograpsus thukuhar</i> (Owen, 1839)	(n = 14)
	Sesarminae	<i>Selatium elongatum</i> A. Milne Edwards, 1869	(n = 16)
		<i>Sesarma guttatum</i> A. Milne Edwards, 1869	(n = 17)
		<i>Sesarma leptosoma</i> Hilgendorf, 1869	(n = 29)
		<i>Neosarmatium meinerti</i> deMan, 1887	(n = 20)
		<i>Sesarma ortmanni</i> Crosnier, 1965	(n = 32)
Portunidae		<i>Thalamita crenata</i> A. Milne Edwards, 1834	(n = 18)

The present study focuses on the feeding habits of 11 crab species (from the Grapsidae, Xanthidae and Portunidae families) inhabiting the mangrove forests of the Kenyan coast, and reports some information that may be potentially interesting to trophic studies in mangroves.

MATERIALS AND METHODS

Between seven and 32 individuals of 11 species were analyzed (Table 1). All individuals were collected at Gazi Bay (04°25'S–39°50'E) and Mida Creek (03°20'S–40°00'E) during four missions that took place between December 1991 and August 1993. Other Sesarminae were also found in the same ecosystem, in particular *Selatium brockii* de Man, *Sesarma longipes* Krauss, *S. villosum* A. Milne Edwards, *S. eulimene* de Man and *S. smithii* but these crabs were too rare or too difficult to catch in large numbers (this was true especially for *S. smithii*). Six species of the genus *Uca* (Ocypodidae) were also found very commonly in these Kenyan mangrove swamps but they were not considered here. Icely and Jones (1978) clearly showed, just in the same locality, that *Uca* species were micro-algal feeders.

Immediately after collection sex and carapace width of all specimens were recorded and then they were preserved in 70% alcohol. The stomach contents analyses took place within 1 mo of sampling. The crabs were dissected and the stomachs carefully prepared. The degree of fullness of the stomach was estimated subjectively and expressed as follows: class 0 for an empty stomach, class 1 for a half-full stomach and class 2 for a full stomach. Then, the stomach contents were washed with alcohol into a Petri dish and examined under a binocular microscope using the percentage occurrence method as described by Williams (1981). This method, widely used in diet studies of fish and crabs, gives a measure for 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. The occurrence of different food items belonging to a certain category is counted, divided by the total number of individuals with a non-empty stomach and multiplied by 100 in order to obtain the frequency of occurrence. For each species, the plant:animal matter ratio was calculated and plotted against the average stomach fullness, in order to view a possible correlation between both variables. The degree of association between the two variables was measured using the non-parametric Spearman's rank correlation.

An attempt was made to identify plant and shell matter in the stomachs to species level by investigating the fragments with a microscope.

In order to help the interpretation of the stomach contents analysis, the feeding behavior of the 11 crab species under study were occasionally observed and recorded in their natural environment

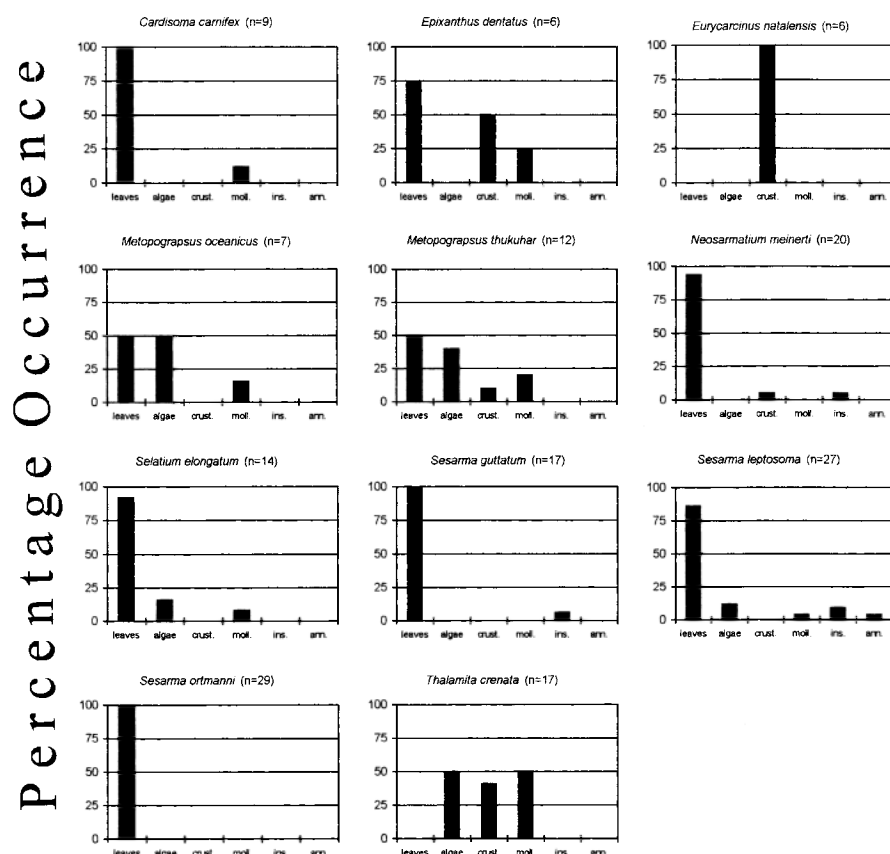


Figure 1. Percent occurrence of the various food items, i.e., the relative frequency of stomachs containing a specified item, in the 11 species analyzed. n = number of non-empty stomachs (cf. Tab. 1 which indicates the total number of stomachs); crust. = crustaceans; moll. = molluscs; ins. = insects; ann. = annelids.

during the field missions. The place of the crab species within the mangrove zonation was recorded visually by walking along belt transects parallel with the topographic gradient. Also other mangrove crabs and mangrove trees were recorded.

RESULTS

The diet of five out of the 11 species analyzed was based almost totally on mangrove leaves (Fig. 1). *Sesarma ortmanni* Crosnier, *N. meinerti*, and *C. carnifex* eat principally *Avicennia marina* (Forsk.) Vierh. leaves, identified based on stomatal features, but the last two species seem to include in their diet gastropods and crustaceans. Stomachs of *S. guttatum* A. Milne Edwards, contained mostly *Rhizophora mucronata* Lam. leaves, while *Selatium elongatum* A. Milne-Edwards eat also algae, in particular *Bostrichia tenella* (Vahl), which is very common on the aerial roots of *R. mucronata*. *Metopograpsus oceanicus* (Jacquinot) and *M. thukuhar* (Owen) are less dependent on leaves (Fig 1). More than 40% of their diet was composed of macro-algae, principally *B. tenella* and

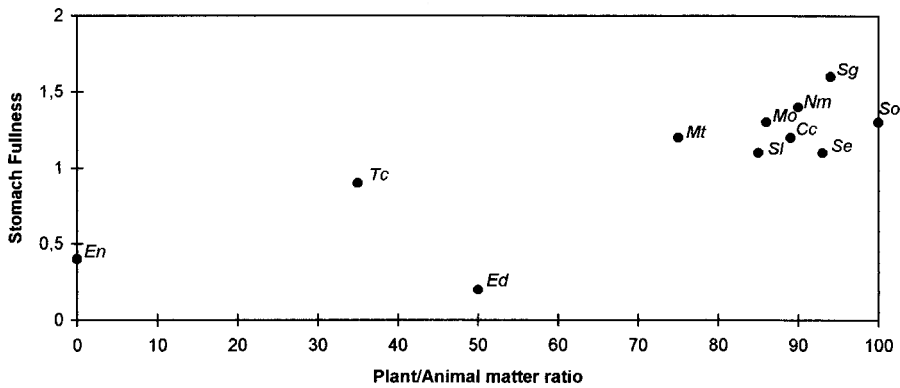


Figure 2. Association between the plant:animal matter ratio and the average stomach fullness of the species analyzed.

Spyridia spp., and animal items were more common in their stomachs. *Sesarma leptosoma* Hilgendorf is the only species which migrates and forages on fresh leaves of *R. mucronata* and displays one of the most opportunistic diets (Fig. 1), preying on small crabs, molluscs and insects, as well as feeding on the lichens that grow on the upper part of *R. mucronata* branches. *Epixanthus dentatus* (White) and *Eurycarcinus natalensis* (Krauss) are typical ambush predators, both waiting their prey with chelipeds wide open, but hiding themselves in different ways; the former species was often recorded waiting on the aerial roots of *R. mucronata*, at a maximum of 1 m from the mud, sometimes hanging upside down, whereas the latter was always observed in the mud, within small crevices at the base of the same roots. *E. natalensis* was the only strictly carnivorous crab, with no record of plant matter in its stomach, at least in the six non-empty stomachs analyzed (Fig. 1).

Thalamita crenata A. Milne Edwards is a swimming crab which colonizes in great numbers the intertidal mud platform in front of the mangrove. Among all species analyzed, it is the only one not spending all its time in the swamps. Its diet is composed of algae (about 35%), and of bivalves, gastropods, hermit crabs of the genus *Clibanarius* and small crabs (Fig. 1).

Figure 2 shows the association between the plant:animal matter ratio in the stomach of each species and the relative stomach fullness. The association between the two variables is highly significant ($r = -0.76$; $df = 9$; $P < 0.005$).

DISCUSSION AND CONCLUSION

Fallen leaves, of different tree species and at different stages of degradation, are the most important source of food for crabs colonizing the mangrove swamps of the Kenyan coast. In this area, as shown also by Micheli et al. (1991), *N. meinerti*, *C. carnifex* and according to our data also *S. ortmanni* and *S. guttatum* seem to play an ecological role similar to those played by *Chiromanthesony choporum* in Malaysia (Malley, 1978) and *S. messa* (Robertson, 1986; Micheli, 1993), *S. erythrodactyla* (Camilleri, 1989) and *S. smithii* (Giddins et al., 1986) in Australia. In fact more than 90% of the stomach contents of the above species is composed of mangrove leaves. Taking into account the large number of crabs observed—Micheli et al. (1991) found, for *N. meinerti* in the *Avicennia* fringe,

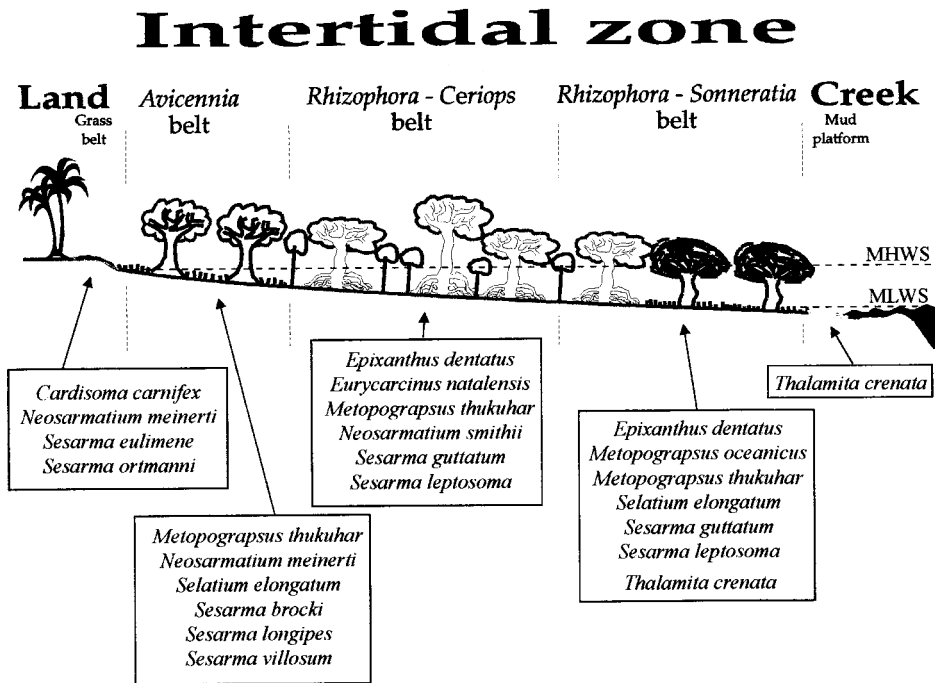


Figure 3. Schematic representation of the zonation of some non-ocypodid crab species in Kenyan mangrove ecosystems.

an average of about 5 burrows m^{-2} —their role in accelerating the degradation of fallen leaves must be of primary importance. This was also confirmed by Dahdouh-Guebas et al. (1997) who noted through visual observation that every mangrove leaf (of different tree species) in the vicinity of *N. meinerti*'s home range was removed from the mangrove floor in a very short time.

Metopograpsus oceanicus, *M. thukuhar* and *Selatium elongatum* are also leaf consumers, but they seem also to depend on macro-algae, mostly on those commonly growing on the aerial roots of *R. mucronata* and on the pneumatophores of *Sonneratia alba* Sm., such as *B. tenella* and *Spyridia* spp. The relative importance of algae in the diet of these species, compared with *N. meinerti*, *C. carnifex*, *S. ortmanni* and *S. guttatum*, can be understood considering the different distributions of these species as shown in Figure 3. The possible preference for *A. marina* leaves, shown by *N. meinerti*, *C. carnifex* and *S. ortmanni*, rather than for *R. mucronata*, as shown by *S. guttatum* and *S. longatum*, can obviously also be due to the above-mentioned differences in zonation (Fig. 3).

An important behavioral and foraging specialization is shown by *S. leptosoma*, which is the only species of the Indo-Pacific region to migrate to the top of mature tall trees (Vannini and Ruwa, 1994; Cannicci et al. 1996a,b) and feed directly on fresh leaves, while other *Episesarma* species of this region are known to climb and feed only on young mangrove trees (Sivasothi et al., 1994).

It is important to note that it is not uncommon to find animal matter in the stomachs of all the "herbivorous" Grapsidae species mentioned. This highly opportunistic feeding habit, known also for West Indies Grapsidae (Von Hagen, 1977), seems to be a common

feature of mangrove crabs. Most of them, in fact, should be defined as omnivorous rather than herbivorous, since they eat practically any item, even if in different proportions. This is probably due to the low nitrogen content of fallen mangrove leaves (Giddins et al., 1986), which forces the crabs to catch food with a higher protein content.

Carnivorous crabs are also present within Kenyan mangrove fauna, but they also, at least *E. dentatus* and *T. crenata*, are not strictly carnivorous. As shown by the association between plant:animal matter ratio and average stomach fullness (Fig. 2), carnivorous crab species seem to gather less food than herbivorous ones and the probability of a good catch seems rather low. For this reason carnivorous crabs may occasionally need to supplement their diet with plant matter. Also, studies done by Cannicci et al. (1996c) showed leaf litter to constitute an considerable part of the diet of *T. crenata*.

Finally, the results for *E. natalensis* and *E. dentatus* should be interpreted with caution, considered the large amount of empty stomachs (Table 1, Fig. 1). Related to this, it should indeed be recalled that there is a potential pitfall in extrapolating from gut contents while studying the actual diet of animals, since appearance of an item in the stomach can be strongly affected by the time required for digestion, just as the difference in handling time of prey may influence the apparent diet of predators.

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