

## COASTAL HERMIT CRABS (DECAPODA: ANOMURA) FROM KENYA, WITH A REVIEW AND KEY TO EAST AFRICAN SPECIES

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### ABSTRACT

A collection of hermit crabs from supralittoral, intertidal and shallow sublittoral areas of the Kenya coast between latitudes 3°50'S and 4°30'S, revealed the occurrence of 24 species belonging to the genera *Coenobita*, *Diogenes*, *Dardanus*, *Calcinus*, *Clibanarius*, *Trizopagurus* and *Paguristes*. One of the *Calcinus* species is undescribed, three of the other species constitute new records for the East African mainland, and all but one are strictly new records for Kenya whose hermit crab fauna has received no attention in the literature. The species are discussed in terms of habitat and their occurrence at the five main collecting sites; the occurrence and distribution of 52 coastal hermit crab species from the whole of East Africa and adjacent islands is also reviewed, and a key for identifying the mainland species is presented.

Other than the *Coenobita violascens* (= *C. cavipes*) noted by Hilgendorf (1869) from Mombasa, there appear to be no records of hermit crabs from the Kenya coast in the literature (cf Somalia, and, using cited literature, Tanzania and Mozambique (Lewinsohn, 1982)). Nevertheless, from Barnard (1950), Lewinsohn (1969, 1982) and others, it can be deduced that forty species have been recorded from the East African mainland as a whole. A further seven are added by Dechancé (1964) for the Comoro Islands and Madagascar, and another by Forest (1984) for the Seychelles. The omission of Kenya must be interpreted as a historical accident since, as in most tropical coastal areas, the hermit crabs there are a common, conspicuous and diverse element of the intertidal and shallow sublittoral marine fauna (Brown, 1975). Nevertheless, it is only when systematically collected that substantial species lists emerge (Lewinsohn (1982) for Somalia, and Dechancé (1964) for Madagascar and the Comoros). General surveys of intertidal marine fauna have tended to ignore, or grossly underestimate, the number of hermit crab species present on the East African coast (Hartnoll, 1976; Ruwa, 1984).

In view of the absence of published information on Kenyan hermits, and in order to provide a comparison with Lewinsohn's (1982) results for slightly more northern latitudes in Somalia, systematic collections were made by the first author between January and March in both 1983 and 1985.

### STUDY AREA, MATERIALS AND METHODS

A fringing reef exists along much of the Kenya coast, generating beaches of coral sand, lagoons (with sea-grass beds and coral heads), areas of reef-flat and a reef crest. Sometimes the beaches are backed by low limestone cliffs which may extend seawards as a rocky platform (the reef flat) punctuated by interconnecting pools. At intervals along the coast the system is broken by estuaries, or more usually by the openings of fully saline mangrove creeks, such as Tudor Creek and Port Reiz which surround Mombasa Island.

The main collecting sites are shown in Figure 1. In both years collecting activity was most intense in the small strip, about 1 km long, forming the northern side of the mouth of Tudor Creek, between Mackenzie Point and English Point. This area (called Mkomani for the present purposes) provided a mixture of soft and hard intertidal substrates. In 1983, in fact, hermit crabs were collected only from the Mkomani area, but in 1985 collections were also made from Diani, Shelly Beach and Kanamai (all of these are on the open coast), Tudor Creek and Gazi Creek. Both of the creeks consisted of areas of mud and mangroves, but in addition there were extensive areas of intertidal sand at Gazi.

All specimens but one were collected by hand, either from the intertidal area at low tide, or by

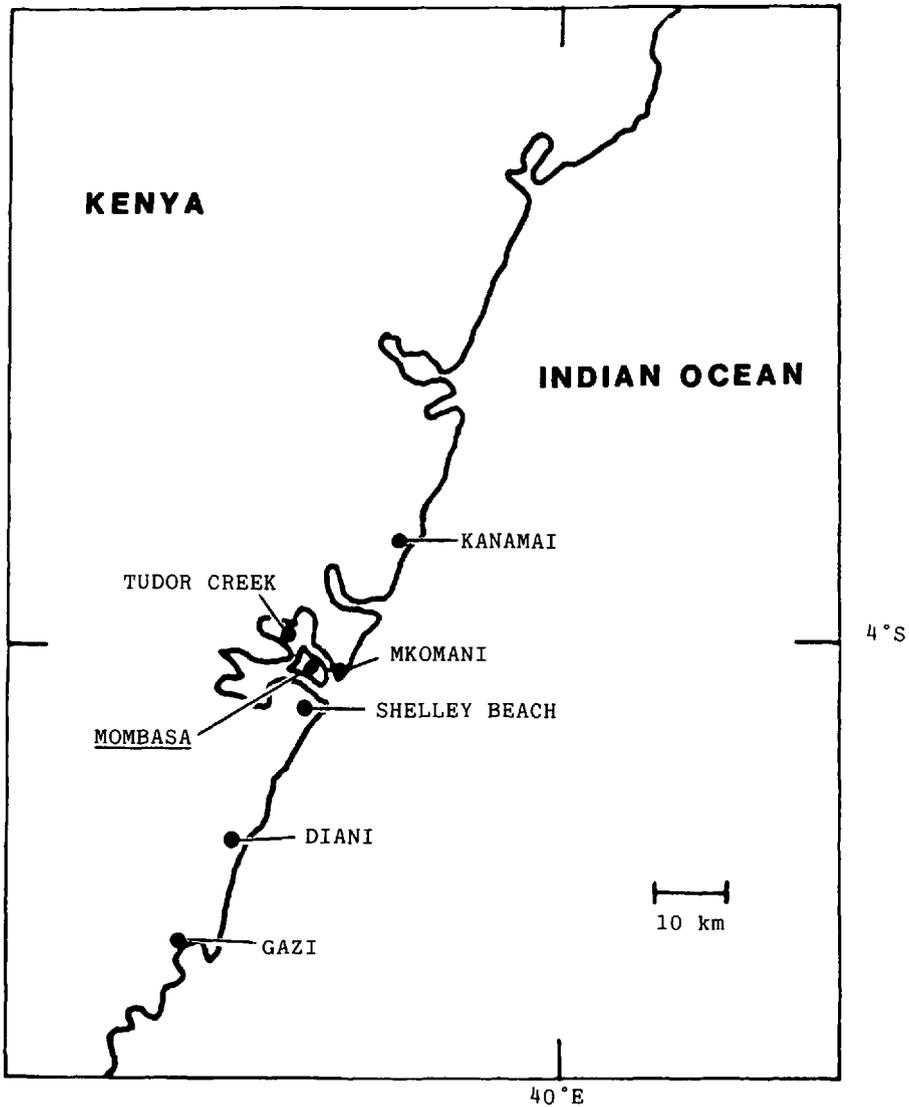


Figure 1. Map of the Kenya coast, showing the six collecting sites.

snorkelling in depths up to 3 m; the exception was a hermit crab caught in the fine-meshed seine-net operated in Tudor Creek to catch juvenile fish. After collection, the main coloration was recorded from the live or freshly dead crabs. Subsequent preservation was in 10% formalin. Initially, identification was carried out using Barnard (1950), but most identifications were later checked from more recent literature or by either L. B. Holthuis or P. A. McLaughlin. A key was prepared for all species of hermit crabs recorded from the mainland coast of East Africa.

## RESULTS

In 1983, ten species were found in the Mkomani area at the mouth of Tudor Creek. The number of species from this area was increased to 19 in 1985 by searching the shallow sublittoral, and the lower littoral zone of the sandy beaches at low tide. It was also at Mkomani that an undescribed species of hermit crab

Table 1. Occurrence of Kenyan hermit crabs under six main habitat divisions; present study. (a = abundant; c = common; o = occasional; r = rare)

Supralittoral sand and scrub		<i>Clibanarius laevimanus</i>	(c)
<i>Coenobita rugosus</i>	(c)	<i>Clibanarius merguensis</i>	(o)
<i>Coenobita cavipes</i>	(o)	<i>Calcinus laevimanus</i>	(a)
		<i>Calcinus latens</i> †	(o)
Wet sand (intertidal pools and shallow sublittoral)		Reef-crest (lower shore hard substrates)	
<i>Paguristes ?jousseaumei</i>	(r)	<i>Calcinus gaimardii</i>	(c)
<i>Paguristes ?abbreviatus</i>	(o)	<i>Calcinus elegans</i>	(r)
<i>Dardanus pedunculatus</i>	(o)	<i>Dardanus guttatus</i>	(r)
<i>Dardanus deformis</i>	(o)	<i>Dardanus lagopodes</i>	(o)
<i>Dardanus scutellatus</i>	(r)	<i>Dardanus megistos</i>	(o)
<i>Diogenes costatus</i>	(c)		
<i>Diogenes gardineri</i>	(c)	Shallow sublittoral (coral heads in lagoons)	
Mangrove creek		<i>Calcinus latens</i>	(c)
<i>Clibanarius longitarsus</i> *	(c)	<i>Calcinus</i> sp. nov.	(r)
<i>Clibanarius laevimanus</i> *	(o)	<i>Trizopagurus strigatus</i>	(o)
<i>Diogenes custos</i> †	(r)	<i>Dardanus lagopodes</i>	(o)
Reef-flat (upper and mid-shore hard substrates)		<i>Dardanus megistos</i>	(o)
<i>Clibanarius eurysternus</i>	(c)		
<i>Clibanarius virescens</i>	(a)		

\* intertidal; † sublittoral; ‡ pools only.

was discovered (Haig and Reay, in prep.). In addition, one other species was found only in Tudor Creek itself and another four only at other collecting sites.

The 24 species in the total list belong to two families and seven genera: Coenobitidae (*Coenobita*) and Diogenidae (*Diogenes*, *Paguristes*, *Trizopagurus*, *Calcinus*, *Clibanarius*, and *Dardanus*).

The distribution of the species between six major habitat types, together with

Table 2. Hermit crab genera, and the number of species recorded from East Africa

	So	Ke	Ta	Mo	Se	Ma	Total
Family Coenobitidae							
<i>Birgus</i>			1		1	1	1
<i>Coenobita</i>	3	2	4	2	4	4	5
Family Diogenidae							
<i>Aniculus</i>			1	1	2	1	3
<i>Calcinus</i>	8	5	2	3	3	5	9
<i>Clibanarius</i>	4	5	2	5	1	6	7
<i>Dardanus</i>	5	6	5	6	5	9	11
<i>Diogenes</i>	3	3	1	5	1	2	10
<i>Paguristes</i>	1	2				1	2
<i>Trizopagurus</i>		1		1			1
Family Paguridae							
<i>Pagurixus</i>	2					1	2
<i>Pagurus</i>	1				1	1	1
Total	27	24	16	23	18	31	52

Key and references (also applying to Tables 3-9): So = Somalia; Lewinsohn (1981), Lewinsohn (1982), McLaughlin and Haig (1984). — Ke = Kenya; present study. — Ta = Tanzania; Forest (1984), Lewinsohn (1982), Reyne (1939), Nobili (1905), Ortmann (1894), H. Milne Edwards (1848). — Mo = Mozambique; Forest (1984), Lewinsohn (1982), Reyne (1939), Nobili (1905), Ortmann (1894), H. Milne Edwards (1848). — Se = Seychelles; Forest (1984), Lewinsohn (1982). — Ma = Comoros/Madagascar; Dechanceé (1964), Hoffman (1874).

a rough indication of abundance, is given in Table 1. Hermit crabs were particularly common and conspicuous on intertidal hard substrates, with *Calcinus laevimanus* and *Clibanarius virescens* co-dominant in such areas.

In the supralittoral zone of sandy beaches, daytime aggregations of *Coenobita rugosus* were sometimes found in the shade of debris or vegetation, and *Clibanarius laevimanus*, *C. eurysternus*, *C. longitarsus*, *Calcinus latens*, *C. gaimardii*, *Diogenes costatus* and *D. gardineri* were also sometimes locally common in their appropriate habitats. Other species were less common and less predictable in their occurrence. Brief details for each species are given below, in the context of their occurrence and distribution on the East African coast (Somalia to Mozambique on the mainland, together with the Seychelles islands, Madagascar and the Comoro islands). The distribution of genera is summarized in Table 2.

KEY TO HERMIT CRABS REPORTED FROM THE EAST COAST OF AFRICA  
(Kenyan species are marked with an asterisk)

1a.	Crabs terrestrial or semiterrestrial; antennular flagella truncated at tip: COENOBITIDAE	2
1b.	Crabs marine; antennular flagella terminating in a filament	7
2a.	Rostrum prominent; posterior carapace greatly extended laterally; abdomen well calcified, straight and symmetrical	<i>Birgus latro</i> (Linnaeus)
2b.	Rostrum almost obsolete; posterior carapace not much expanded laterally; abdomen soft, spirally coiled	3
3a.	Antennal acicle not fused with second segment of peduncle; eyestalks subcylindrical; brush of setae on inner surface of right chela only	<i>Coenobita brevimanus</i> Dana
3b.	Antennal acicle fused with second segment of peduncle; eyestalks strongly compressed laterally; brush of setae on inner surface of both chelae	4
4a.	Propodus of left 3rd pereopod with outer surface convex	<i>Coenobita perlatus</i> H. Milne Edwards
4b.	Propodus of left 3rd pereopod with outer surface flattened and marked off from upper surface by sharp ridge	5
5a.	Left chela without stridulating apparatus on upper part of outer surface	<i>*Coenobita cavipes</i> Stimpson
5b.	Left chela with stridulating apparatus on upper part of outer surface	6
6a.	Merus of right cheliped with tuft of long setae on mesial face near ventral margin	<i>Coenobita scaevola</i> (Forskål)
6b.	No tuft of setae ventromesially on merus of right cheliped	<i>*Coenobita rugosus</i> H. Milne Edwards
7a.	Outer maxillipeds usually contiguous at bases; chelipeds equal or subequal, or left distinctly the larger: DIOGENIDAE	8
7b.	Outer maxillipeds widely separated at bases; left cheliped never larger than right, right usually much the larger: PAGURIDAE	41
8a.	Left cheliped larger than right	9
8b.	Chelipeds equal or subequal	30
9a.	Telson without median transverse constriction; intercalary rostral process between eyescales: <i>Diogenes</i>	10
9b.	Telson with median transverse constriction; no intercalary process between eyescales	15
10a.	Rostral process with spines along lateral margins; antennal acicle bifurcate	<i>*Diogenes custos</i> (Fabricius)
10b.	Rostral process unarmed laterally; antennal acicle not bifurcate	11
11a.	Antennal peduncles not reaching end of eyestalks	12
11b.	Antennal peduncles surpassing end of eyestalks	13
12a.	Distal margin of telson with shallow indentation	<i>*Diogenes gardineri</i> Alcock
12b.	Distal margin of telson entire	<i>Diogenes leptocerus</i> Forest
13a.	Left chela heavily setose; rostral process very small, sometimes obsolete	<i>Diogenes jousseaumei</i> (Bouvier)
13b.	Left chela not heavily setose; rostral process well developed	14
14a.	Left chela with obliquely longitudinal ridge on outer surface	<i>*Diogenes costatus</i> Henderson
14b.	Left chela without longitudinal ridge on outer surface	<i>Diogenes avarus</i> Heller
15a.	Fingertips corneous and darkened: <i>Dardanus</i>	16
15b.	Fingertips calcareous: <i>Calcinus</i>	23

16a.	Cornea not occupying more than one-third of eyestalks .....	17
16b.	Cornea occupying more than one-third of eyestalks .....	21
17a.	Chelipeds covered with strong corneous spines .....	18
17b.	Chelipeds covered with small spines .....	19
18a.	Left cheliped distinctly longer than right; shield and pereopods with pale ocellate spots .....	
	..... * <i>Dardanus megistos</i> (Herbst)	
18b.	Left cheliped not much longer than right; no ocelli on shield and pereopods .....	
	..... * <i>Dardanus lagopodes</i> (Forskål)	
19a.	Propodus and dactyl of left 3rd pereopod without transverse striations .....	
	..... * <i>Dardanus scutellatus</i> (H. Milne Edwards)	
19b.	Propodus and dactyl of left 3rd pereopod with transverse striations on outer surface .....	20
20a.	Carapace depressed, broadened posterior to shield .....	* <i>Dardanus guttatus</i> (Olivier)
20b.	Carapace not depressed, portion posterior to shield not conspicuously broadened .....	
	..... <i>Dardanus crassimanus</i> (H. Milne Edwards)	
21a.	Dactyl of left cheliped with upper surface sharply cristate .....	
	..... * <i>Dardanus deformis</i> (H. Milne Edwards)	
21b.	Dactyl of left cheliped with upper surface non-cristate, bearing longitudinal rows of granules .....	22
22a.	Propodus of left 3rd pereopod with dorsolateral margin cristate .....	<i>Dardanus tinctor</i> (Forskål)
22b.	Propodus of left 3rd pereopod without crest on dorsolateral margin .....	
	..... * <i>Dardanus pedunculatus</i> (Herbst)	
23a.	Right chela with upper margin smooth or granulate .....	24
23b.	Right chela with upper margin spinous or tuberculate .....	25
24a.	Dactyl of pereopods 2 and 3 with subdistal colored ring and proximal spot; carpus and merus each with longitudinal colored stripe .....	* <i>Calcinus laevimanus</i> (Randall)
24b.	Dactyl of pereopods 2 and 3 with proximal colored ring; carpus with longitudinal colored stripe, merus with oblique colored stripe .....	<i>Calcinus seurati</i> Forest
25a.	Dactyl and distal part of propodus of 3rd pereopods with dense tufts of closely placed setae ventrally, forming an obvious brush .....	26
25b.	Dactyl and propodus of 3rd pereopods without dense brush of setae ventrally .....	27
26a.	Merus, carpus, and propodus of pereopods 2 and 3 each with broad colored bands .....	
	..... * <i>Calcinus elegans</i> (H. Milne Edwards)	
26b.	No bands of color on pereopods 2 and 3 .....	* <i>Calcinus gaimardii</i> (H. Milne Edwards)
27a.	Eyescales simple; pereopods 2 and 3 with colored bands .....	28
27b.	Eyescales multidentate; pereopods 2 and 3 without colored bands .....	29
28a.	Dactyl of pereopods 2 and 3 with colored band proximally; no colored markings on other segments .....	* <i>Calcinus latens</i> (Randall)
28b.	No proximal colored band on dactyl of pereopods 2 and 3; dactyl with 2 submedian colored spots, propodus with irregularly shaped distal band, and carpus with 2 elongate distal spots .....	<i>Calcinus tropidomanus</i> Lewinsohn
29a.	Left eyestalk longer than right (in life, ground color of crab purple/brown) .....	* <i>Calcinus</i> , undescribed sp.
29b.	Eyestalks about equal in length (in life, ground color of crab dark violet) .....	
	..... <i>Calcinus rosaceus</i> Heller	
30a.	Males with 2 pairs of pleopods, females with 1 pair: <i>Paguristes</i> .....	31
30b.	No paired pleopods in either sex .....	32
31a.	Eyescales relatively narrow; eyestalks strongly dilated in proximal half, reaching basal third of distal article of antennal peduncles .....	* <i>Paguristes ?jousseaumei</i> Bouvier
31b.	Eyescales moderately broad; eyestalks not strongly dilated proximally, reaching nearly to end of distal article of antennal peduncles .....	* <i>Paguristes ?abbreviatus</i> Dehancé
32a.	Pereopods 1-3 with transverse striations .....	33
32b.	No transverse striations on pereopods 1-3: <i>Clibanarius</i> .....	35
33a.	No transverse groove on cardiac region of carapace; inner surface of chelae with stridulating apparatus .....	* <i>Trizopagurus strigatus</i> (Herbst)
33b.	Cardiac region of carapace with transverse groove; no stridulating apparatus on inner surface of chelae: <i>Aniculus</i> .....	34
34a.	Eyestalks and pereopods 2 and 3 with longitudinal stripes .....	<i>Aniculus retipes</i> Lewinsohn
34b.	No longitudinal stripes on eyestalks and pereopods 2 and 3 .....	<i>Aniculus ursus</i> (Olivier)
35a.	Pereopods 2 and 3 with longitudinal colored stripes on merus, carpus, and propodus; dactyl of 3rd pereopod usually longer than propodus, sometimes about same length as propodus or slightly shorter .....	36
35b.	No longitudinal colored stripes on pereopods 2 and 3; dactyl of 3rd pereopod distinctly shorter than propodus .....	40

Table 3. Species of the genera *Birgus* and *Coenobita* recorded from East Africa

	So	Ke	Ta	Mo	Se	Ma
<i>B. latro</i> (Linnaeus, 1767)			+		+	+
<i>C. brevimanus</i> Dana, 1852			+		+	+
<i>C. cavipes</i> Stimpson, 1858	+	+	+	+	+	+
<i>C. perlatus</i> H. Milne Edw., 1837			+		+	+
<i>C. rugosus</i> H. Milne Edw., 1837	+	+	+	+	+	+
<i>C. scaevola</i> (Forskål, 1775)	+					

36a. Eyestalks with longitudinal colored stripe .....	37
36b. No longitudinal colored stripe on eyestalks .....	38
37a. Carapace flattened; coxae of pereopods 4 and 5 broadly separated .....	
..... * <i>Clibanarius eurysternus</i> (Hilgendorf)	
37b. Carapace not flattened; coxae of pereopods 4 and 5 approximated .....	
..... <i>Clibanarius padavensis</i> De Man	
38a. Upper margin of palm with pointed tubercles; outer face of pereopods 2 and 3 with 2 longitudinal colored stripes .....	* <i>Clibanarius laevimanus</i> Buitendijk
38b. Upper margin of palm with row of distinct spines .....	39
39a. Antennal peduncles and eyestalks about equal in length; outer face of pereopods 2 and 3 with 1 pale stripe with colored margins .....	* <i>Clibanarius longitarsus</i> (De Haan)
39b. Antennal peduncles shorter than eyestalks; outer face of pereopods 2 and 3 with 2 colored stripes on paler background .....	<i>Clibanarius striolatus</i> Dana
40a. Propodus of pereopods 2 and 3 with well defined pale area distally on outer face; on 2nd pereopod this confined to distal end, on pereopod 3 forming broad pale band, this frequently extending along entire length of segment .....	* <i>Clibanarius merguensis</i> De Man
40b. Propodus of pereopods 2 and 3 solidly colored, usually more deeply so at distal end; dactyl pale, with or without submedian colored ring .....	* <i>Clibanarius virescens</i> (Krauss)
41a. Pereopods 1-3 heavily setose .....	<i>Pagurus hirtimanus</i> Miers
41b. Pereopods 1-3 non-setose or nearly so .....	<i>Pagurixus anceps</i> (Forest)

*Coenobita* (and *Birgus*).—Semi-terrestrial hermit crabs were characteristic of the supralittoral zone of sandy beaches, where they were most commonly found as daytime aggregations under bushes and among debris. Tracks suggested nocturnal activity extending onto the maritime zone of the low cliff tops and into the littoral zone.

Around Mombasa, *Coenobita rugosus* was much more commonly encountered than *C. cavipes*. Small specimens were typically found in shells of *Nerita* species.

From the literature, three other species of *Coenobita* have been recorded from East Africa (Table 3) but only *C. rugosus* and *C. cavipes* have been found in all areas. *C. scaevola* may reach its southern limit on the Kenya coast (L. B. Holthuis, pers. comm.) but it was not found in the present study.

Although there is a record for *Birgus latro* in Tanzania (Reyne, 1939), there is some doubt as to whether it still survives on the mainland; certainly there are no recent records from Kenya (R. K. Ruwa, pers. comm.), whereas there are from the western Indian Ocean islands (Taylor, 1971: Diego Garcia).

*Aniculus*, *Paguristes* and *Trizopagurus*.—These three genera are represented by very few species on the East African coast, and only *Paguristes* and *Trizopagurus* were found in the present study (Table 4). The presence of *Aniculus retipes* in Tanzania (Forest, 1984) suggests, however, that it may also occur in Kenya.

Only two specimens of *Paguristes* were obtained (from the muddy sand on the lower shore at Mkomani); each represented a different species, tentatively identified as *P. abbreviatus* and *P. jousseaumei*, the two species already recorded from the East African coast (Dechancé, 1964; Lewinsohn, 1982). More than any other hermit crabs, this genus is likely to have been overlooked.

Table 4. Species of the genera *Aniculus*, *Paguristes* and *Trizopagurus* recorded from East Africa

	So	Ke	Ta	Mo	Se	Ma
<i>A. ursus</i> (Olivier, 1811)				+	+	+
<i>A. maximus</i> Edmondson, 1952					+	
<i>A. retipes</i> Lewinsohn, 1892			+			
<i>P. abbreviatus</i> Dechancé, 1963		+?				+
<i>P. jousseaumei</i> Bouvier, 1892	+	+?				
<i>T. strigatus</i> (Herbst, 1804)		+		+		

*Trizopagurus strigatus* was uncommon and restricted to the shallow sublittoral. Nevertheless, several specimens of this conspicuous flattened species were seen underwater (typically in *Conus* shells), and it is surprising that the only other records are from Mozambique (Barnard, 1950; Hilgendorf, 1879).

*Calcinus*.—Of the five species of *Calcinus* found, *C. laevimanus* was easily the most common, and together with *Clibanarius virescens*, it dominated the intertidal hermit crab fauna. It was characteristic of the hard substrate littoral zone, and particularly of the area of shallow pools and ridges towards the top of the shore where algal growth was sparse. The most frequently occupied shells were those of *Nerita* and *Cerithium* species.

In contrast, *Calcinus latens* was widespread and common in the shallow sublittoral, especially on coral heads in lagoons, and also in rock pools on the lower shore.

*Calcinus gaimardii* was mostly found on the seaward side of the reef crest pools or the shallow sublittoral. Characteristic localities were Kanamai, Malindi and Shelly Beach, but it was also found at Mkomani. The only specimen of *C. elegans* was found among *C. gaimardii* at Kanamai.

The undescribed species of *Calcinus* was only collected from Mkomani, on isolated coral heads in the shallow sublittoral of the small sandy bay. In this restricted situation, however, it was not uncommon.

The number of species and their identities were broadly typical of the East African coast (Table 5), but the absence of *Calcinus rosaceus*, which occurred in the detailed collections of both Lewinsohn (1982) from Somalia and Dechancé (1964) from Madagascar and the Comoros, was conspicuous. The eight species of *Calcinus* recorded for Somalia suggests that more could be found by searching carefully in Kenya, particularly among coral rubble where Lewinsohn's (1982) additional species were encountered.

Table 5. Species of the genus *Calcinus* recorded from East Africa

	So	Ke	Ta	Mo	Se	Ma
<i>C. elegans</i> (H. Milne Edw., 1836)	+	+			+	+
<i>C. gaimardii</i> (H. Milne Edw., 1848)	+	+	+	+		+
<i>C. laevimanus</i> (Randall, 1839)	+	+	+	+	+	+
<i>C. latens</i> (Randall, 1839)	+	+		+	+	+
<i>C. rosaceus</i> Heller, 1861	+					+
<i>C. seurati</i> Forest, 1951	+					
<i>C. tropidomanus</i> Lewinsohn, 1981	+					
<i>C. vachoni</i> Forest, 1958	+					
<i>C. undescribed</i> sp.		+				

Table 6. Species of the genus *Clibanarius* recorded from East Africa

	So	Ke	Ta	Mo	Se	Ma
<i>C. eurysternus</i> (Hilgendorf, 1879)	+	+		+		+
<i>C. laevimanus</i> Buitendijk, 1937	+	+				+
<i>C. longitarsus</i> (De Haan, 1849)	+	+	+	+		+
<i>C. merguensis</i> De Man, 1888		+				+
<i>C. padavensis</i> De Man, 1888				+		
<i>C. striolatus</i> Dana, 1852				+	+	+
<i>C. virescens</i> (Krauss, 1843)	+	+	+	+		+

*Clibanarius*.—*Clibanarius virescens* co-dominated with *Calcinus laevimanus* in the upper littoral (reef-flat) zone of all rocky shores, being particularly abundant in areas with a turf of algae. It often formed very dense aggregations around the edges of small pools at low tide, and could also be found aggregating under stones. The most common shells occupied were those of *Cerithium* and *Cypraea* species. Among *C. virescens* at Mkomani were small numbers of small (juvenile?) *C. merguensis*; this species was possibly overlooked elsewhere.

The dorsoventrally flattened *Clibanarius eurysternus*, typically inhabiting *Conus* shells, was found in the same habitat as *C. virescens*. It was widespread, but much less common and did not aggregate. *C. laevimanus*, however, did aggregate but was locally distributed both in the mangroves of Tudor Creek (associated with *C. longitarsus*) and on the rocky shores of Kanamai, Mkomani and Shelly Beach.

The fifth species of *Clibanarius* found was *C. longitarsus* which was characteristic of, and often abundant in, the muddy mangrove areas of Tudor Creek and Gazi (where the abdomens of this species were used as fishing bait by children). Isolated specimens were collected from the marine beaches at Mkomani and Kanamai, at the latter locality associated with a single mangrove tree.

Unlike *Calcinus*, this genus was represented only by intertidal species. Four of these species were also found in Somalia (Lewinsohn, 1982), but *Clibanarius merguensis* represents a new record for the East African mainland coast. From the literature (Table 6) it is possible that *C. striolatus* and *C. padavensis* might also occur as far north as Kenya.

*Dardanus*.—All six species recorded from Kenya were essentially sublittoral in distribution, although several specimens were found on the lower shore at low water on spring tides. *Dardanus megistos*, the most common species, was characteristic of hard substrates of the shallow sublittoral, including coral heads in lagoons. *D. lagopodes* was almost as common and occurred in the same habitat as *D. megistos*. *D. guttatus*, the third of the large colorful *Dardanus* species was, however, represented by only one specimen, taken from shallow water on the seaward side of the reef crest of Shelly Beach.

The dull-colored *Dardanus scutellatus* was found in a similar habitat to the *Paguristes* species, *Diogenes gardineri* and *Diogenes costatus*; that is, on the sandy substrate of the lower shore and shallow sublittoral perhaps associated with seagrass. Individual specimens were found at Mkomani, Diani and Kanamai.

Also present on soft substrates were *Dardanus pedunculatus* and *D. deformis*. All specimens of these two species carried commensal Actinaria on their shells (up to four per shell), and they were the only species of Kenyan hermit crab participating in this association. The single specimen of *D. pedunculatus* was found under a stone on the reef flat at Diani, whereas the four specimens of *D. deformis* came from Mkomani and Kanamai.

Table 7. Species of the genus *Dardanus* recorded from East Africa

	So	Ke	Ta	Mo	Se	Ma
<i>D. brachyops</i> Forest, 1963						+
<i>D. crassimanus</i> (H. Milne Edw., 1836)				+		
<i>D. deformis</i> (H. Milne Edw., 1836)	+	+	+	+	+	+
<i>D. gemmatus</i> (H. Milne Edw., 1846)						+
<i>D. guttatus</i> (Olivier, 1811)	+	+	+	+	+	+
<i>D. lagopodes</i> (Forskål, 1775)	+	+	+	+	+	+
<i>D. megistos</i> (Herbst, 1804)	+	+	+	+	+	+
<i>D. pedunculatus</i> (Herbst, 1804)	+	+		+	+	+
<i>D. setifer</i> (H. Milne Edw., 1836)						+
<i>D. scutellatus</i> (H. Milne Edw., 1848)		+	+	+		+
<i>D. tinctor</i> (Forskål, 1775)			+			

From Table 7 it can be seen that the *Dardanus* species found were almost identical to those recorded for Somalia, Tanzania, Mozambique and the Seychelles. For Madagascar and the Comoros, however, Dechancé (1964) recorded nine species including the six Kenyan ones. It seems likely that one or two more species could reasonably be expected to occur along the Kenyan coast.

*Diogenes*.—Three species were identified among the small amount of *Diogenes* material collected. The single specimen of *D. custos* was found in a beach-seine catch from shallow water over mud in Tudor Creek at low tide. The few specimens of both *D. gardineri* and *D. costatus* came from Gazi and Mkomani, and were collected from shallow sublittoral sands and sandy pools higher up the shore. *D. gardineri* was more frequent in weedy pools, whereas *D. costatus* was characteristic of bare pools.

Although a total of ten *Diogenes* species may have been recorded from the East African coast (Table 8), the number from any one country is much fewer. The record of *D. gardineri* from Kenya confirms the existence of this species in the region, there being some uncertainty over the Hilgendorf (1879) and Barnard (1955, as *D. senex*) records from Mozambique. It is likely that more than three species occur along the Kenya coast, judging by the ease with which the three recorded species were encountered.

*Pagurixus* and *Pagurus* spp.—Although no pagurids were found in the present study, their existence to the north and south of Kenya (Table 9) suggests that they might also occur there.

Table 8. Species of the genus *Diogenes* recorded from East Africa

	So	Ke	Ta	Mo	Se	Ma
<i>D. avarus</i> Heller, 1865			+	+		
<i>D. costatus</i> Henderson, 1893		+		+	+	
<i>D. spp.</i> (2), aff. <i>costatus</i>	+					
<i>D. crosnieri</i> Dechancé, 1964						+
<i>D. custos</i> (Fabricius, 1798)		+		+		
<i>D. gardineri</i> Alcock, 1905		+		+		
<i>D. jousseaumei</i> (Bouvier, 1897)				+		
<i>D. leptocerus</i> Forest, 1957	+					
<i>D. planimanus</i> Henderson, 1893						+

Table 9. Species of the genera *Pagurixus* and *Pagurus* recorded from East Africa

	So	Ke	Ta	Mo	Se	Ma
<i>Pagurixus anceps</i> (Forest, 1954)	+					
<i>Pagurixus</i> sp.	+					+
<i>Pagurus hirtimanus</i> Miers, 1880	+				+	+

## DISCUSSION

Since records of hermit crabs from the Kenya coast seem to be all but absent from the published literature, and since no systematic collections or studies appear to have been undertaken from that area, the present work is of at least local significance. All but one of the twenty-four species are officially new records for the country. However, the list of species has to be examined in the context of the East African coast as a whole and perhaps, indeed, of the Indo-Pacific region.

The summary of the records appearing in Lewinsohn (1969, 1982), Barnard (1950), Dehancé (1964), and others, together with those from the present study (Tables 2–9), involves 52 species. Eleven genera have been recorded, and these are distributed among the families Coenobitidae, Paguridae, and Diogenidae, with the latter dominant and consisting mostly of the typical tropical genera *Clibanarius*, *Calcinus*, *Dardanus* and *Diogenes* (see, for example, Alcock (1905), Fize and Serène (1955), Wooster (1984), and Haig and Ball (1988) for high diversity of these genera in other tropical Indo-Pacific areas).

The present study has revealed at least two species not previously recorded from the mainland coast of East Africa (*Paguristes ?abbreviatus*, *Clibanarius merguensis*, and possibly also *Diogenes gardineri*), in addition to the as yet undescribed species of *Calcinus*. Thirteen species without records from neighboring Tanzania were recorded. It should be noted, however, that the Kenya records now fill a gap on the East African coast and that ten species can be seen to be distributed from Somalia to Mozambique.

As part of a study of anomurans from Oman, Hogarth (1988) analyzed hermit crab faunas from fourteen regions of the western Indian Ocean using the Ochiai Coefficient of Similarity followed by cluster analysis. East Africa (implicitly Tanzania and Kenya, but excluding the results of the present study) showed a closer affinity with Mozambique and South Africa than with the group including Somalia, Mauritius, the Seychelles, Sri Lanka and the Maldives.

Nevertheless, it seems particularly appropriate to compare the results of the present study with those of Lewinsohn (1982) for the Somali coast, at similar latitudes on the northern side of the equator; in fact the hermit crabs recorded by Lewinsohn were collected from 0°80'S to 2°30'N. Table 2 reveals a similar number of species in the two studies (27 in Somalia as against 24 in Kenya) and the same representation of genera (apart from the absence of *Pagurus* in Kenya and the absence of *Trizopagurus* in Somalia). Sixteen species were common to the two areas. In Kenya there were no records of *Coenobita scaevola*, *Calcinus ?vachoni*, *C. seurati*, *C. rosaceus*, *C. tropidomanus* and the pagurids. In Somalia, *Paguristes ?abbreviatus*, *Clibanarius merguensis*, *Trizopagurus strigatus*, *Dardanus scutellatus*, and our undescribed *Calcinus* were unrecorded "Kenyan" species. *Diogenes* species have been omitted from these lists because of uncertainties over identification, but three species were present in both areas. It is difficult to assess whether the small differences between the hermit crab faunas described for the two countries reflect real differences in species distributions or differences in

collecting. However, it is possible that the absence of *Coenobita scaevola*, *Pagurus hirtimanus*, *Pagurixus* spp. and *Calcinus rosaceus* from the Kenyan collection is due to Kenya being beyond the southern limit of their geographical ranges. In contrast, the species which have a wide distribution along the East African coast are clearly not so constrained, and indeed 16 of the 24 species recorded by Lewinsohn (1982) have a wide distribution in the Indo-West Pacific region. There were, therefore, few surprises among the Kenyan samples in terms of genera present and overall number of species, when comparing the results with previous literature for East Africa. However, the existence of 19 species from a one-kilometer stretch of coast (Mkomani) does seem particularly high, and is possibly without precedent in the hermit crab literature.

This paper has concentrated on reporting the occurrence of species as a basis for carrying out further work on the ecology of hermit crabs in Kenya. However, the brief notes on distribution have revealed habitat differences between the species, and there is a clear zonation from the supralittoral to the sublittoral and also a difference between hard and soft substrates in terms of hermit crab communities. An interesting series is provided by the genus *Calcinus* whose species range from the sublittoral to the upper littoral zone; in contrast, *Clibanarius* species are all intertidal and *Diogenes* and *Dardanus* species are effectively sublittoral in their distributions. Clearly there is scope for a great deal of further investigation, which will also no doubt reveal the existence of even more species than those reported here.

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