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Family group structure in mysids, commensals of hermit crabs (Crustacea)

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Two commensal crustaceans, *Heteromysis harpax* Hilgendorf 1878 (Mysidacea) and *Aretopsis amabilis* De Man 1910 (Decapoda Alpheidae) were found inhabiting the shells of hermit crabs (five species of *Dardanus* Paulson 1875) collected in Somalia and Kenya. The two species were never found together in the same shell. In Kenya, where alpheids seem to be absent, the relative frequency of shells inhabited by mysids is greater than in Somalia. These findings suggest that the two commensals are in competition with each other, at least in sympatric areas. Mysids were particularly common in Kenya and detailed observations were made on this species. No relationship seems to exist between the sex, size and species of hermit and the probability of its shell being inhabited by the mysids. Several females were ovigerous, the average brood size being about 7.7 with a positive correlation between the size of the female and number of eggs. The mysids were usually found living as a pair of adults, or in about in 1/8 of cases, together with a large crowd of smaller individuals (up to 77). In adult pairs, the male was often smaller than the female. No sexual dimorphism seems to exist regarding the large claws, typical of this genus of mysid. The crowds of young were composed of individuals belonging to several distinct age classes, which presumably correspond to separate broods of similar or different age produced by the resident adult pair, thus forming a true family.

KEY WORDS: *Heteromysis*, *Aretopsis*, *Dardanus*, Alpheidae, Mysidacea, family groups, commensalism.

INTRODUCTION

Most Mysidacea are known as free living Crustacea, but some members of the genus *Heteromysis* Smith 1874 (over 45 species) have adopted a commensal life style, living in association with several marine invertebrates.

TATTERSALL (1962) described the habits of two Indo-West-Pacific species living as commensals of an ophiuroid (*H. gymnura* Tattersall 1922) and a sponge (*H. zeylanica* Tattersall 1922).

In the West-Atlantic region (Bermuda), *H. bermudensis* Sars 1885 is known to live as a commensal of a sea anemone (quoted in TATTERSALL 1962). CLARKE (1955) reported *H. actiniae* Clarke 1955 in the Bahamas as a commensal of a sea anemone; he also observed its feeding habits and discovered that this mysid feeds on the waste material ejected by the sea anemone.

Some species, mostly those of the subgenus *Gnathomysis*, show a distinct specialization towards hermit crabs.

H. odontops Walker 1898 is known to inhabit hermit crabs shells in Panama (TATTERSALL 1962).

H. (Gnathomysis) stellata Bacescu & Bruce 1980, found on Heron Island, Australia, has been described as a commensal of *Aniculus* Dana 1852 hermit crabs (BACESCU & BRUCE 1980). *H. (Gnathomysis) harpaxoides* Bacescu & Bruce 1980, also from Heron Island, has been found in *Dardanus megistos* (Herbst 1804) hermit shells (BACESCU & BRUCE 1980).

H. (Gnathomysis) harpax (Hilgendorf 1879) (Fig. 1 top) is a species which occurs from the Red Sea to Zanzibar. It was discovered by HILGENDORF (1879) in Mozambique and redescribed from the Red Sea by KOSSMANN (1880). In 1902, it was described again (under a different name) by BONNIER & PEREZ as inhabiting a *Dardanus* shell in the Red Sea and bright red in colour (quoted from TATTERSALL 1962); COIFMANN (1937) also gave a description but did not offer any ecological comments.

In 1962 TATTERSALL described more specimens of *H. harpax*, collected in Zanzibar by A.J. Bruce, which were found inhabiting *Dardanus deformis* (H. Milne Edwards 1836), *D. megistos*, *D. gemmatus* (H. Milne Edwards 1848) and *D. lagopodes* (Forskål 1775) (= *D. sanguinolentus*). Usually there were two individuals to each shell but in one case 40 were found. The number of eggs or embryos carried by the female in the marsupium varied from 1 to 5.

BRUCE (quoted in TATTERSALL 1962) suggested that the mysids lived attached to the hermit abdomen rather than to the shell itself. About 75% of the *Dardanus* shells were inhabited by mysids. BRUCE did not find any mysids in the shells of small *Dardanus* and suggested that, since this group of *Dardanus* is the largest species of hermit in the area, the mysids may not be specifically attracted towards *Dardanus* itself but simply by the largest hermits available in their habitat. TATTERSALL (1962) suggested that *H. harpax* may feed on hermit waste material.

In this subgenus, the gnathopods (III thoracopod) are equipped with a real subchela and not just a movable fang-like dactyl (typical of the whole genus). BACESCU & BRUCE (1980) wrote: «it is difficult to see which factors had determined the evolution towards amphipodoid type of subchela of thoracopod III in these *Heteromysis*, which never leave the shells with pagurids. As long as we don't know anything about the physiology of these commensals, the new structures of the thoracopod III as

Fig. 1. — Pairs of (top) freshly fixed *Heteromysis harpax* (left ♀, right ♂) from Mombasa and (bottom) live *Aretopsis amabilis* (♂) from Mogadishu.

against the same limb in the other species must have originated in a peculiar behaviour of these mysids. It is certainly a group having followed a particular evolution, as compared with the over 45 species known of the heteromorph genus *Heteromysis* s.l.».

Another species of commensal, *Aretopsis amabilis* De Man 1910 (Fig. 1 bottom), an alpheid shrimp, is also known to inhabit *Dardanus* hermit crab shells. This species was described (De Man 1910) from the material collected during the Siboga expedition. It was later found by Ramadan (1936) in the Red Sea, Holthuis (1958) (quoted by Bruce 1969), by Miyake & Miya (1967) from Ryu Kyu Islands, by Bruce (1969) from the Seychelles, by Suzuki (1971) and Nomura (1986) from Japan.

Bruce's specimens of *Aretopsis amabilis* consisted of three pairs of males and females, living in *Dardanus megistos* (two pairs) and *D. lagopodes* shells. None of the shells contained mysids, and Bruce suggested that mysids and alpheids may occupy the same role in cleaning the hermit shell. However, there is no apparent specialization in this sense: «The mouth parts of *Aretopsis* ... show no special features and are typical of the family Alpheidae.» (Bruce 1969).

More recently, a further eight species of *Dardanus* were recorded (Haig & Ball 1988); again no mysids were found while a *D. lagopodes* shell did contain *A. amabilis*.

In the course of various expeditions to Somalia, from 1976 to 1986, several hermit crabs were collected (genus *Dardanus* Paulson 1875) whose shells were inhabited by either mysids or alpheids. The species were identified by M. Murano and A.H. and D.M. Banner and proved to be *Heteromysis harpax* and *Aretopsis amabilis* respectively.

Because of the rarity of these two species and the particular interest of their habit and behaviour, we planned to collect more specimens of *Dardanus* during an EEC research project in Kenya (STD-2), to investigate the relationships between the commensals and the hermit crabs and collect data on their biology.

MATERIAL AND METHODS

In Somalia, species of *Dardanus* were collected from Sar Uanle (20 km S Kysmayo, near the Kenyan border) and Gesira, 18 km S Mogadishu). In Kenya, specimens were collected from Kanamai (20 km N Mombasa) and in other localities near Mombasa.

The *Dardanus* were taken to the laboratory where their shells were carefully opened with a vice. Any pieces of shell which had become detached during transport and the main fragments obtained with the final breakage were all thoroughly rinsed in a container full of sea water together with the intact «naked» hermit in order to collect all the commensals, including any young larval stages. The size (shield length), sex and species of hermit was recorded; it was not always possible to record the sex and size (carapace length) of the commensals. The commensals were usually found inhabiting the empty coils at the end of the shell.

In Kenya, the above procedure was performed in the laboratory of the Kenyan Marine Fisheries Research Institute (KMFRI), Mombasa.

Data frequencies were compared by applying the G-test (with Williams correction for $n < 50$; Sokal & Rohlf 1981). Other statistics employed are: SE (standard error); V (variation coefficient); b (regression coefficient), r (correlation coefficient). When necessary, corrections for small samples were applied to the SE and V calculations (Gurland & Tripathi 1971; quoted in Sokal & Rohlf 1981). The figures in brackets following averages (±) indicate the confidence limits (c.l.), which were always computed at 95% probability level.

RESULTS

Main commensals

Somalian samples. A total of 33 *Dardanus*, belonging to five species (Table 1) were collected in Somalia. The two commensals were never found living together, suggesting that some form of mutual exclusion may exist. About 58% of all shells were inhabited (19/33), 46% by mysids and 12% by the alpheids. In other words, of the 19 inhabited shells about 1/5 were occupied by the alpheid and 4/5 by the mysids.

A. amabilis was found exclusively in pairs. *H. harpax* were mostly found in adult pairs (plus one young in three cases and five young in one case). In four cases, one single adult was found (three females and one male).

Kenyan samples. A total of 73 *Dardanus* were collected in Kenya, belonging to the above species (Table 2). About 66% (48/73) of the hermits proved to be inhabited by *H. harpax*. In seven of the 48 inhabited shells, a large number of individuals were found while in most of the other cases a pair of adults was alone present.

Table 1.
Occurrence of the two species of commensals in *Dardanus* shells from Somalia.

Hermit sp.	Total	Number of shells inhabited by			
		A. amabilis	*H. harpax*	Both	None
D. deformis	7	0	0	0	7
D. guttatus	3	1	2	0	0
D. lagopodes	15	2	9	0	4
D. megistos	4	1	2	0	1
D. scutellatus	2	0	0	0	2
Dardanus sp.	2	0	2	0	0
Total	33	4	15	0	14
Frequency %	100	12.1	45.5	0	42.4

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Table 2.
Occurrence of the two species of commensals in *Dardanus* shells from Kenya.

Hermit sp.	Total	Number of shells inhabited by			
		A. amabilis	*H. harpax*	Both	None
D. deformis	2	0	1	0	1
D. guttatus	4	0	4	0	0
D. lagopodes	35	0	24	0	11
D. megistos	31	0	18	0	13
D. scutellatus	1	0	1	0	0
Total	73	0	48	0	25
Frequency %	100	0	65.8	0	34.2

A comparison between the Kenyan and Somalian samples shows that there is no significant difference between the frequency of shell occupation in the two areas (19/33 vs 48/73; G = 0.635, $P > 0.1$).

If mysids only are considered, however, there is a significant difference in shell occupation between the *Dardanus* collected from Somalia and Kenya (15/33 vs 48/73; G = 3.848, $P = 0.05$).

Other commensals

Other invertebrates, much smaller than mysids, were seldom found inhabiting *Dardanus* shells; they all belonged to taxa which are known to live in any kind of crevice and cannot be considered true commensals. These were some species of copepods (Cyclopoida and Harpacticoida), and of very small isopods, amphipods (*Gammaropsis atlanticus* Stebbing 1888) and annelids. They did not seem to interfere with the two main commensals. The only exceptions were a pair of *Mesacturoides fimbriatus* (Lenz 1905) and a juvenile *Gonodactylus*, two stomatopod species quite common in all sorts of crevices in coastal rock-pools, which were found in two *Dardanus lagopodes* shells in Somalia. These two hermits were not computed in Table 1 because of the probability that the stomatopods had eaten or evicted any other commensals.

Relationships between Heteromysis harpax and Dardanus hermit crabs

An analysis was computed to determine whether the presence of mysids was related to the sex, size or species of hermit crab. Hermits were classified into three size classes (< 8 mm shield length, from 8 to 11, and > 11), two sexes and three taxa (*D. lagopodes*, *D. megistos* and «other species») but there was no evidence of any kind of preference. Mysids, at least in Kenya, simply seem to occupy any *Dardanus* shell with no relationship to size, sex or species of the occupant (Table 3).

Table 3.
Occurrence of *H. harpax* in the Kenyan *Dardanus* hermit crab shells.

TAB.3

Hermit		Mysids		G-test	P
		Absent (n = 25)	Present (n = 48)		
Sex	females	11	25	0.42 df = 1	NS
	males	14	23		
Size	small	10	19	0.55 df = 2	NS
	medium	11	18		
	large	4	11		
Species	*D. lagopodes*	11	24	2.23 df = 2	NS
	D. megistos	13	18		
	other spp.	1	6		

Number of occupants

A total number of 323 mysids were found in the 48 Kenyan *Dardanus* whose distribution is shown in Table 4.

Most of the shells were inhabited by pairs of adults, five by single individuals (a large male in one case, and undetermined medium size in four cases) and seven by adults and a crowd of young (Table 5).

The occurrence of crowds was not related to the species of hermit (G = 0.103, df = 2, P = NS), nor was the number of young mysids correlated with the size of the hermit (r = − 0.099, df = 5, P = NS).

Six of the seven crowds of young were found in female hermits (Table 5), even though the sex ratio of hermits hosting commensals approached 50% (25/48). Although this difference was almost significant (G = 3.819, df = 1, P = 0.05), it should be emphasized that the largest crowd was found in the shell of a male.

> 25/23

Of the five ovigerous females (all *D. lagopodes*), two were inhabited by mysids and both of them housed a crowd of young.

Brood size

Out of the total of 52 female adult *H. harpax*, collected from both Kenya and Somalia, 30 carried eggs in their marsupium (with a similar frequency in the two collections, 21/30 and 17/22 respectively, which allowed the data to be pooled). The distribution of brood size in 25 females is given in Fig. 2. The modal class is 6 and the average is 7.7 (c.l.: 6.2-9.2).

TAB4

Table 4.
Frequency distribution of the *H. harpax* found in the Kenyan *Dardanus*. N = number of *H. harpax* found in each hermit.

N	0	1	2	3	> =10
Frequency	25	5	35	1	7

TAB.5

Table 5.
Presence of *H. harpax* crowds and sex, size and species of *Dardanus* in Kenya.

Species of *Dardanus*	Sex	Size in mm (carapace length)	No. of *H. harpax*
lagopodes	OF	8.5	41
lagopodes	F	10.0	15
lagopodes	OF	7.7	58
guttatus	F	6.3	24
megistos	F	9.8	20
megistos	M	13.5	77
megistos	F	17.4	10

M, males; F, females; OF, ovigerous females.

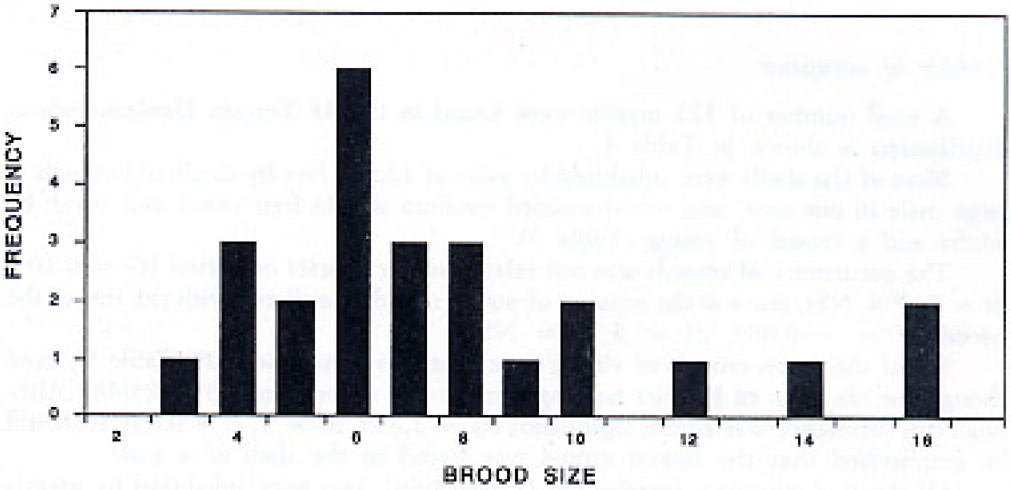

Fig. 2. — Brood size of 25 female *H. harpax* both from Kenya and Somalia.

The eggs measured approximately 0.50 mm (± 0.02) in diameter, with no apparent relationship between egg size and the length of the female ($r = -0.125$; df $= 10$; $P =$ NS). The carapace length of the largest larvae, presumably at the stage where they were ready to hatch, was 0.62 mm (± 0.05).

A correlation exists between the size of the mother and the number of eggs ($r = 0.631$, df $= 23$, $P < 0.01$) (Fig. 3). The regression coefficient is very consistent: b =

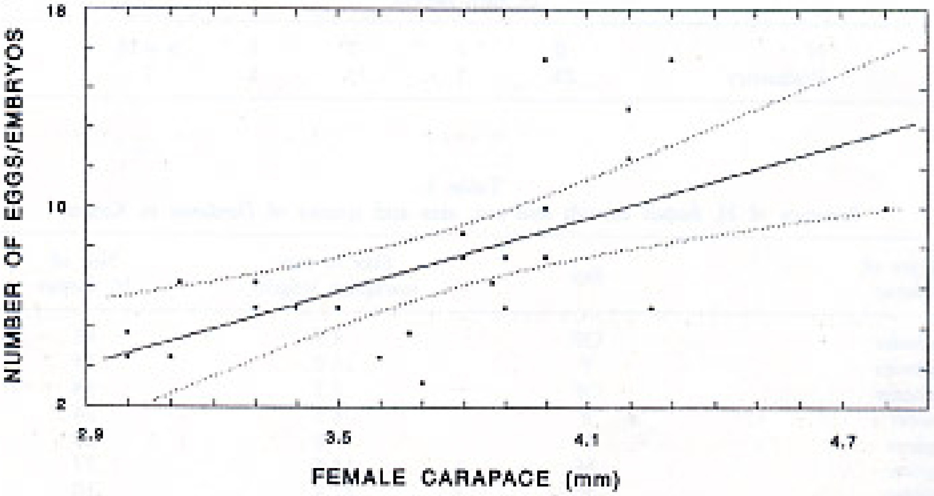

Fig. 3. — Correlation between female carapace length and number of eggs or larvae carried in the marsupium by *H. harpax*, both from Kenya and Somalia.

4.96; this means, for instance, that a female with a carapace length of 3 mm will produce an average of 4-5 eggs while a female 1 mm longer will produce about 9-10 eggs.

Size distribution

The size (carapace length) of 332 mysids from Kenya (the above 323 plus nine from unrecorded shells) ranged from 0.7 to 4.8 mm (Fig. 4). If the various peaks are taken with their four adjacent classes, there appear to be eight distinct stages (Table 6), although the size of the eighth cannot be established with certainty because it is represented by only one large individual. The size increase of 0.5 mm in each of the first seven stages is practically constant and presumably corresponds to distinct moulting stages.

The size of 0.61 mm corresponds to larvae still in the marsupium, thus the 1 mm stage is likely to correspond to the first free living stage.

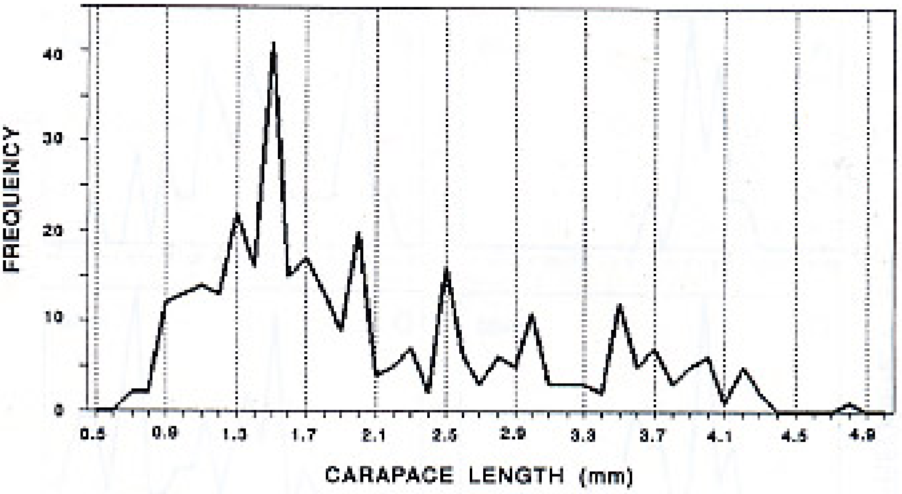

Fig. 4. — Size frequency distribution of 332 *H. harpax*, from Kenya.

Table 6.
Size (carapace length, mm × 10) and frequency of 332 *H. harpax* of both sexes, from Kenya.

TAB.6

Stages (peaks)	1		2		3		4		5		6		7	8
No. of individuals	45		136		33		39		27		28		23	1
Average size	10.0		15.0		19.9		24.7		29.8		35.3		40.1	48.0
Size increase		5.0		4.9		4.8		5.1		5.5		4.8		
Size increase %		33.2		24.8		19.3		17.2		15.7		12.0		

Average size increase = 5.0 (c.l.: 4.7-5.3); V = 5.5.

Families

There is no direct evidence that all the young (from 8 to 77, see *Number of occupants*) found living in the same hermit shell were the offspring of the same coexisting pair of adults. The six largest groups of young were studied in detail (Fig. 5) and their size distribution clearly shows that individuals of different age classes occur in the same crowd. The young in each group can be separated into five distinct age classes (Table 7), following the same criteria applied to the data in Table 6.

Considering the size of the six resident adult females and the number of eggs that three of them were actually carrying and/or which could be calculated from the regression line for the number of eggs and female carapace length (see *Relationships between Heteromysis harpax and Dardanus hermit crabs*), then several generations (up to 6-7) and in certain cases of the same age, must coexist if all the young in the same shell are members of the same family. Family no. 6, for example, probably consists of two broods at stage one, three at stage two and one at stage three (Table 7, Fig. 5F).

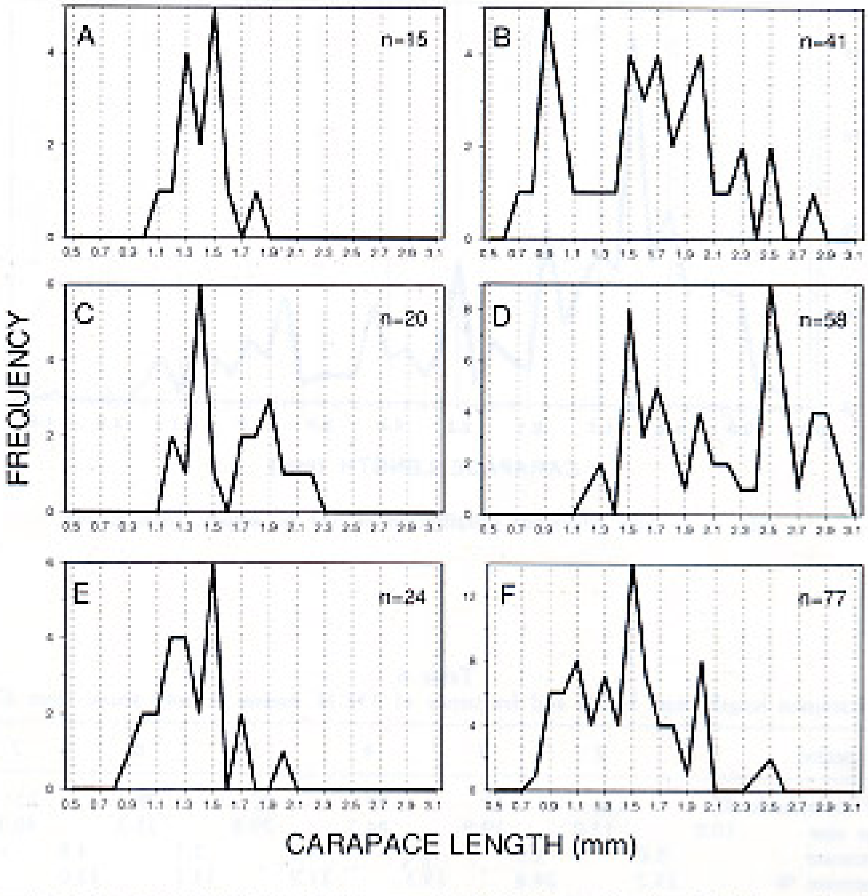

Fig. 5. — Size frequency distribution of the young in the six largest families of *H. harpax* from Kenya. Abscissae, carapace length in mm; ordinates, absolute frequency.

Pairs

In 30 cases where an adult pair was found living alone in a shell, it was possible to measure both animals (Fig. 6). The correlation between carapace length in the males and females is highly significant and the males were always smaller than the females ($r = 0.661$, $df = 28$, $P < 0.01$). The regression coefficient is $b = 0.67$, not significantly different from 1 ($t = 2.29$, $df = 28$, $P =$ NS), i.e. the observed regression line is not significantly non-parallel to the regression line expected for $b = 1$. As a rule, the carapace length in adult females (average length 3.58 mm) is about 6-7% longer than in males (average length 3.36 mm).

Table 7.
Number of *H. harpax* in the five smallest stages, in the six largest families from Kenya.

TAB. 7

Stages	1	2	3	4	5	Tot	SF	ONE	ENE	INB
Family										
(1)	2	12	1	0	0	15	4.2	12	10	1
(2)	2	9	9	0	0	20	3.5	—	7	2
(3)	9	14	1	0	0	24	3.7	—	8	2-3
(4)	12	13	11	4	1	41	4	8	9	4
(5)	1	18	12	17	10	58	4.3	—	11	5-6
(6)	25	36	13	3	0	77	4.8	10	13	6-7
	51	102	47	24	11	235				

SF, size of the female (carapace length, mm); ONE, observed number of eggs; ENE, expected number of eggs applying regression equation (see *Pairs and families* and Fig. 5); INB, inferred number of broods.

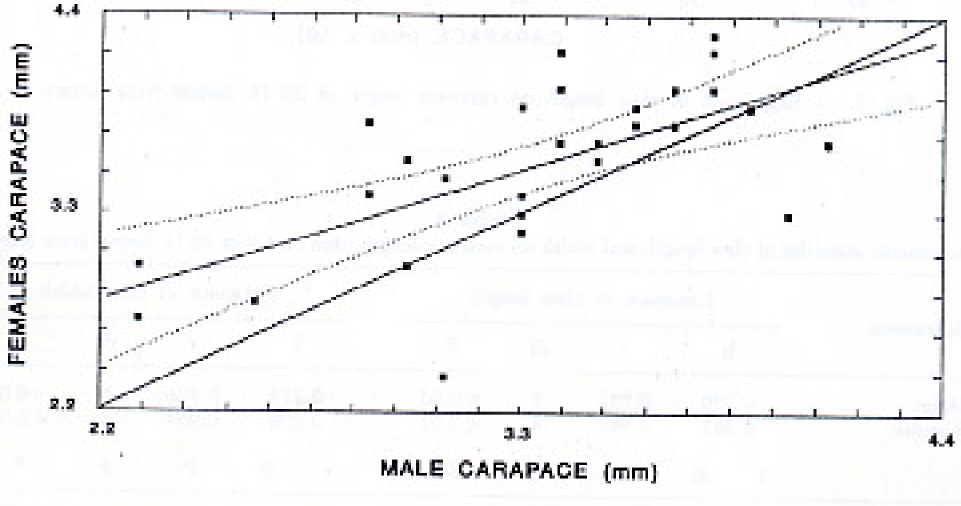

Fig. 6. — Carapace length of 30 pairs of *H. harpax*, both from Kenya and Somalia.

Claw sexual dimorphism

The length and width of the claw were measured in 20 adults (carapace length between 2.7 and 4.0 mm) of both sexes. There was no asymmetry between the two claws, nor any trace of sexual dimorphism (Fig. 7). The growth pattern of both claw measurements, obviously correlated with carapace length, appeared to be the same in both sexes with no difference either in the slope (b_m vs b_f) or in the distance from the X-axis (Table 8).

Hermit size and H. harpax size

A feeble (but significant) relationship also exists (Fig. 8) between the size (carapace length) of the hermit and the size (carapace length) of the adult mysids ($r = 0.359$, df $= 37$, $P < 0.05$, $b = 0.073$).

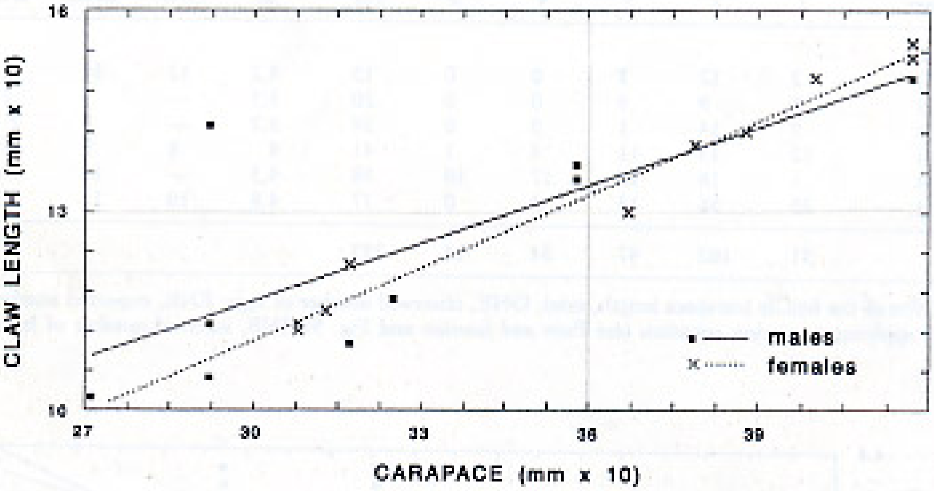

Fig. 7. — Regression of claw length on carapace length in 20 *H. harpax* from Kenya.

Table 8.
Regression statistics of claw length and width on carapace length (mm × 10) of 20 *H. harpax* from Kenya.

Tab 8

Regression	Carapace vs claw length					Carapace vs claw width				
	b	r	df	*P*		b	r	df	*P*	
Males	0.290	0.753	8	<0.01		0.174	0.806	8	<0.01	
Females	0.367	0.987	8	<0.01		0.206	0.954	8	<0.01	
	t	df	*P*	F	*P*	t	df	*P*	F	*P*
b_m vs b_f	0.85	17	NS	0.37	NS	1.48	17	NS	2.18	NS

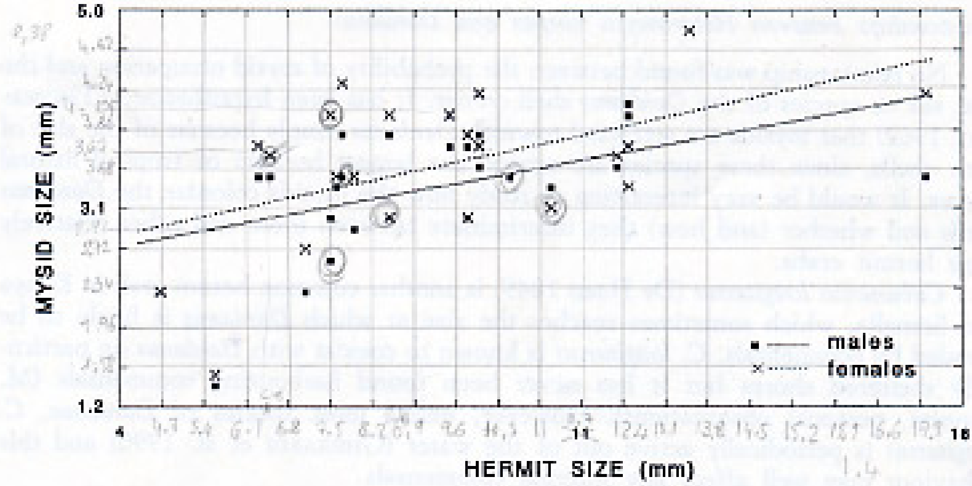

Fig. 8. — Correlation between hermit size (shield length in mm) and *H. harpax* size (carapace length in mm), in 39 adults from Kenya.

CONCLUSIONS AND DISCUSSION

Distribution and competition

Aretopsis amabilis (Decapoda Alpheidae) and *Heteromysis harpax* (Mysidacea) are both commensals of hermit crabs belonging to the genus *Dardanus* and live inside their shells.

A. amabilis has been reported from the Red Sea and from Somalia as far as the Seychelles, Indonesia, Japan and Ryu Kyu Islands, while *Heteromysis harpax* has a more restricted distribution, from the Red Sea to Zanzibar. Both species, therefore, exist in the Red Sea and East Africa, but their distribution is not easy to understand. In his collection from Zanzibar, A.J. Bruce only found mysids (Tattersall 1962) as we did in our Kenyan samples, but in the Seychelles the same author only found alpheids but no mysids (Bruce 1969). At present, Southern Somalia seems to be the only place where both species coexist, but even so the two commensals were never found living together in any of the 36 *Dardanus* shells collected from this area. In Somalia, about 58% of our samples were inhabited by commensals (i.e. by either one of the species) against approximately 66% in Kenya (i.e. only by mysids), but the difference is not significant. Bruce found a similar frequency, 75%, in Zanzibar (quoted by Tattersall 1962). *A. amabilis* was never found in any of our Kenyan samples and the relative frequency of *H. harpax* was significantly higher in Kenya than in Somalia (66% versus approximately 46%).

We may possibly conclude that the two species coexist along the East African coast and are evenly distributed; where they are truly sympatric they compete for hermit shells and are mutually exclusive. Where alpheids are absent, e.g. in Kenya, the mysids reach the same levels of shell occupation as both species do in Somalia. Experimental studies on which species excludes which and how, promise to be most interesting.

Relationships between Heteromysis harpax and Dardanus

No relationship was found between the probability of mysid occupation and the size, sex or species of the *Dardanus* shell owner. It has been hypothesized (Tattersall 1962) that mysids are attracted towards *Dardanus* simply because of the size of their shells, since these species are among the largest hermits of tropical littoral waters. It would be very interesting to study how the mysids colonize the *Dardanus* shells and whether (and how) they discriminate between these and other relatively large hermit crabs.

Clibanarius longitarsus (De Haan 1849) is another common hermit crab in Kenya and Somalia, which sometimes reaches the size at which *Dardanus* is likely to be invaded by commensals. *C. longitarsus* is known to coexist with *Dardanus* on particularly sheltered shores but it has never been found harbouring commensals (M. Vannini, personal observations). However, unlike most species of *Dardanus*, *C. longitarsus* is periodically active out of the water (Gherardi et al. 1990) and this behaviour may well affect any internal commensals.

H. harpax has been presumed to be a faeces feeder (Bruce 1969) but we have no direct evidence of this fact. Along with commensalism, the peculiar claw («amphipodoid type», Bacescu & Bruce 1980) is also typical of this subgenus, but it is hard to see any connection between these two characteristics.

Pairs and families

The number of mysids per shell is usually two (one pair of adults), but in a few cases just one adult was found. In 1/8 of the cases the adult pair coexisted with a crowd of young, the maximum number 77 (Bruce found one case of 40 young; quoted in Tattersall 1962), although the average brood size of *H. harpax* was 7.7 (modal class 6 and with a positive correlation between female size and number of eggs).

These crowds showed an obvious multimodal distribution, indicating that each crowd could represent several coexisting broods, in some cases of the same size. For example, in group no. 6 (see Fig. 5 and Table 6) the female had a carapace length of 4.8 mm with an inferred brood size of 13, while the actual number of eggs she carried was 10. To explain the presence of 77 young, we would have to presume that there are at least two broods at stage one, three at stage two and one at stage three, giving a total of at least six coexisting broods at three different stages.

The smallest free-living specimens found in the hermit shells (approximately 1 mm carapace length), are probably young which are freshly moulted just after hatching. From this size onwards, all the size stages are represented up to the size at which the adults start to reproduce.

The hypothesis that all the coexisting young are offspring of the same resident pair of adults seems highly plausible; thus all the individuals found in the same hermit shell may form a true multi-generation family.

Alternatively, we could imagine the newborn mysids leaving the shell inhabited by their parents early in their life cycle and later forming these occasional crowds simply because they are attracted towards some particular *Dardanus*.

A similar explanation has been offered for the distribution of some crab commensals of pocilloporid corals (Vannini et al. 1981), belonging to genus *Trapezia* Latreille 1825. Most of the corals harboured a single pair of adults, but in a minority of coral heads crowds of young crabs (usually between 10 and 20) of different ages were found together with the resident pair. These crabs produce 2-3000 eggs at a time (Preston 1973) from which pelagic larvae (zoeas) are released. There is no possible explanation for these crowds other than invasion by young unrelated megalopes (the last larval stage) which are attracted towards some special feature of the coral or towards a coral already hosting other young (a «contagious» distribution).

As convincing as this explanation may be for a brachyuran distribution, it cannot be so easily applied to a peracarid only producing 7.7 eggs per female, like our mysids. The young would first have to be carried in the marsupium, then dispersed from the marsupium and out of the *Dardanus* home and finally manage to invade en masse another hermit at random, moreover a species of *Dardanus* which are among the most «unsocial» hermits of these seas. Several species of *Calcinus*, *Clibanarius* and even the terrestrial *Coenobita* from the same geographical areas are known to live in large crowds or even in tight clusters (Vannini 1976, Gherardi & Vannini 1989, Gherardi et al. 1991), but *Dardanus* probably only meet for copulation.

Larger mysids are statistically more commonly found inhabiting larger hermits, which suggests that the hermit offers some sort of resource for which the mysids must compete, i.e. the space for hosting large crowds of young (the larger mysid, the larger the brood, whilst larger hermits live in larger shells). The size of the seven observed crowds, however, was not at all correlated with hermit size.

Broods of 8-20 eggs are quite common among mysids (Wittmann 1984). In particular, the size and number of eggs of *H. harpax* seem to fit perfectly the values expected for free-living species from tropical waters (about 0.5 mm and roughly between 7 and 14 eggs, depending on female size; Mauchline 1980, quoted in Wittmann 1984).

Do these mysids depend specifically on species of *Dardanus* or simply on any large intertidal hermit? Is family formation simply the result of several generations coexisting with their parents? Does the family group imply some sort of parental care? Parental care is rare among crustaceans but it has been proved to exist in terrestrial isopods [*Hemilepistus reaumuri* (Audouin & Savigny 1826), Linsenmair 1972, 1987], marine isopods (*Sphaeroma* sp., G. Messana in preparation) and even in a grapsid crab (*Metopaulias depressus* Rathbun 1896, Diesel 1989). Large gnathopods and strict commensalism with hermits both seem to be typical features throughout the whole *Heteromysis* subgenus, to which *H. harpax* belongs. What are the relationships between claw shape and the mysid life-style? How do the mysids invade new *Dardanus* shells? For the time being, it is impossible to give an answer to any of these questions; we should certainly take a closer look at the diet and biology of *H. harpax* and investigate what kind of resource the hermit shell represents for these mysids.

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REFERENCES

Bacescu M. & Bruce A.J. 1980. New contribution to the knowledge of the representatives of the genus *Heteromysis* s.l. from the Australian coral reefs. *Travaux du Muséum d'Histoire Naturelle Grigore Antipa* 21: 63-72.

Bonnier J. & Pérez C. 1902. Sur un Crustacé commensal des Pagures *Gnathomysis gerlachei* nov. sp., type d'une famille nouvelle de Schizopodes. *Comptes Rendus Academie des Sciences, Paris* 134: 117-119.

Bruce A.J. 1969. *Aretopsis amabilis* De Man, an alpheid shrimp commensal of pagurid crabs in the Seychelles islands. *Journal of Marine Biological Association of India* 11 (1-2): 175-181.

Clarke W.D. 1955. A new species of the genus *Heteromysis* (Crustacea, Mysidacea) from the Bahama Islands, commensal with a sea-anemone. *American Museum Novitates* 1716: 1-13.

Coifmann I. 1937. I Misidacei del mar Rosso. *Regio Comitato Talassografico Italiano, Memorie* 233: 1-52.

De Man J.G. 1910. Diagnoses of new species of macrurous decapod Crustacea from the 'Siboga Expedition', 5. *Tijdschrift der Nederlandsche Dierkundige Vereeniging* 11: 287-319.

Diesel R. 1989. Parental care in an unusual environment. *Metopaulias depressus* (Decapoda: Grapsidae), a crab that lives in epiphytic bromeliads. *Animal Behaviour* 38: 561-575.

Gherardi F., Micheli F. & Vannini M. 1990. Movement patterns and dispersal of the hermit crab *Clibanarius longitarsus* in a mangrove swamp. *Marine Behaviour and Physiology* 16: 209-223.

Gherardi F., Micheli F. & Vannini M. 1991. Preliminary observations on the clustering behaviour of the tropical hermit crab *Clibanarius laevimanus*. *Ethology Ecology & Evolution, Special Issue* 1: 151-153.

Gherardi F. & Vannini M. 1989. Field observations on activity and clustering in two intertidal hermit crabs, *Clibanarius virescens* and *Calcinus laevimanus* (Decapoda, Anomura). *Marine Behaviour and Physiology* 14: 145-159.

Gurland J. & Tripathi 1971. A simple approximation for unbiased estimation of the standard deviation. *American Statistics* 25: 30-32.

Haig J. & Ball E.E. 1988. Hermit crabs from North Australian and Eastern Indonesian waters (Crustacea Decapoda: Anomura: Paguroidea) collected during the 1975 *Alpha Helix* expedition. *Records of Australian Museum* 40: 151-196.

Hilgendorf F. 1879. Die von Hrn. W. Peters in Moçambique gesammelten Crustaceen. *Monatsberichte der Königlich Prüssischen Akademie der Wissenschaften zu Berlin*: 781-849.

Holthuis L.B. 1958. Crustacea Decapoda from northern Red Sea (Gulf of Aqaba and Sinai Peninsula). I. Macrura. *Bulletin Fisheries Research Station Israel* 17 (8-9): 1-40.

Kossmann R. 1880. III. Malacostraca, Anomura, Mysidacea. *Zoologische Ergebnisse einer... Reise in die Küstengebiete des Rothen Meeres, Leipzig* 2 (1): 87-98.

Linsenmair K.E. 1972. Die Bedeutung familienspezifischer 'Abzeichen' für den Familienzusammenhalt bei der sozialen Wüstenassel *Hemilepistus reaumuri* Audouin u. Savigny (Crustacea, Isopoda, Oniscoidea). *Zeitschrift für Tierpsychologie* 31: 131-162.

Linsenmair K.E. 1987. Kin recognition in subsocial arthropods, in particular in the desert isopod *Hemilepistus reaumuri*, pp. 121-208. In: Fletcher D.J.C. & Michener C.D., Edits. Kin recognition in animals. *Wiley & Sons*, X + 465 pp.

Mauchline J. 1980. The biology of mysids and euphasiids. *Advances in Marine Biology* 18: 1-681.

Miyake S. & Miya Y. 1967. A rare alpheid shrimp *Aretopsis amabilis* from the Ryukyu Island (Decapoda Crustacea). *Journal of Faculty of Agriculture, Kyushu University* 14: 267-273.

Nomura K. 1986. Description of a shrimp *Aretopsis amabilis* De Man (Decapoda Alpheidae) from

Kushimoto, the Kii Peninsula, with some remarks on the genus *Aretopsis* from Japan. *Nanki Seibutsu* 28: 7-10.

PRESTON E.M. 1973. A computer simulation of competition among five sympatric congeneric species of xanthid crabs. *Ecology* 54: 469-483.

RAMADAN M.M. 1936. Report on a collection of Stomatopoda and Decapoda from Ghardaqa, Red Sea. *Bulletin of the Faculty of Science of Egypt University* 6: 1-43.

SOKAL R.R. & ROHLF F.J. 1981. Biometry, 2nd Edition. *New York: Freeman & Co.*, 859 pp.

SUZUKI H. 1971. Freshwater and commensal crustacean decapods from the Bonin Island. *Science Reports of the Yokohama University (Section 2)* 19: 1-26.

TATTERSALL O.S. 1962. Report on a collection of Mysidacea from South African offshore and coastal water (1957-59) and from Zanzibar (1961). *Proceedings of the Zoological Society of London* 139: 221-247.

VANNINI M. 1976. Researches on the coast of Somalia. The shore and the dune of Sar Uanle. 7. Field observations on the periodical transdunal migrations of the hermit crab *Coenobita rugosus* Milne Edwards. *Monitore Zoologico Italiano (Nuova Serie) Supplemento* 7: 145-185.

VANNINI M., CARAMANTE S. & VACCAI P. 1981. Ricerche preliminari sulle associazioni faunistiche delle Scleroattinie in Somalia. *Bollettino di Zoologia, Supplemento* 48: 113.

WITTMANN K.J. 1984. Ecophysiology of marsupial development and reproduction in Mysidacea (Crustacea). *Oceanography and Marine Biology: an Annual Review* 22: 393-428.