A case of associated occurrence of the crab *Lauridromia intermedia* (Laurie, 1906) (Crustacea: Decapoda: Dromiidae) and the actinian *Nemanthus annamensis* Carlgren, 1943 (Anthozoa: Actiniaria: Nemanthidae)

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Key words: Crustacea Decapoda Dromiidae; *Lauridromia intermedia*; Actiniaria Nemanthidae; *Nemanthus annamensis*; association; first record; Kenya; review.
Members of the crab family Dromiidae tend to cover their carapace mostly with sponges or colonial tunicates. More rarely are used other objects or organisms such as solitary Tunicata, Zoantharia (= encrusting anemones), valves of Bivalvia, etc.; a review of these is presented.
A new association of a dromiid crab *Lauridromia intermedia* (Laurie, 1906) and an actinian *Nemanthus annamensis* Carlgren, 1943, is described and discussed. *Lauridromia intermedia* is recorded for the first time from the continental shelf of East Africa.

Introduction
(table 1)

It is a well known fact that many representatives of the crab family Dromiidae carry a camouflage cover on top of their carapace. This cover, consisting generally of sponges or compound ascidians, is clutched by specially adapted fourth and fifth pereiopods. Species of some genera (*Hypoconcha* Guérin-Méneville, 1854; *Conchocoetes* Stimpson, 1858) use an empty bivalve shell. Less common are camouflage covers of other origin, such as solitary ascidians, seaweeds, barnacles, anthozoans and artificial material (see table 1). Among anthozoans, zoanthids and soft corals (*Xenia*) have occasionally been reported to serve as cover. So far, documented records of dromiid crabs carrying Actiniaria have not been published. Kerstitch (1989: 96), indeed, mentioned that the crab *Dromidia* (= *Cryptodromiopsis*) *larraburei* "...usually carries a sponge on its back, but occasionally will be found with a sea anemone or tunicate.", but he did not explicitly state this sea anemone to be an actinian. However, in a letter dated 5.x.1994, Mr Kerstitch kindly provided the following information: "I have only seen this dromiid crab occasionally with *Calliactis polypus* but most of the time associated with various sponges. In captivity I have observed *D. larraburei* actually remove small *C. polypus* from the gastropod shell of [the hermit crab] *Dardanus sinistripes* and 'plant' them on its carapace."

The present paper deals with a record of a single specimen of the dromiid crab

Lauridromia intermedia (Laurie, 1906) carrying a specimen of the actinian *Nemanthus annamensis* Carlgren, 1943, dredged off the coast of Kenya during the Netherlands Indian Ocean Expedition, 1992-1993.

Table 1. Summary of genera and species of Dromiidae with recorded cover-objects and organisms other than sponges or compound ascidians, and the most relevant references. Added are some unpublished records from the RMNH Decapoda collection. Crab nomenclature updated according to McLay (1993).

Associated organism or object	Crab species	Reference
Valve of Bivalvia		
Unidentified	*Conchocoetes* spec.	McLay, 1993: 175
Unidentified	*Conchocoetes artificiosus*	Morton & Morton, 1983: 95; Barnard, 1950: 309
Unidentified	*Hypoconcha arcuata*	Arnold, 1901: 264
Unidentified	*Hypoconcha lowei*	Brusca, 1980: 319
Pectinidae	*Hypoconcha lowei*	Kerstitch, 1989: 97
Cardiidae	*Hypoconcha panamensis*	RMNH D 23540
Trachycardium, Anadara	*Hypoconcha parasitica*	RMNH D 12147
Glycymeridae, Veneridae	cf. *Hypoconcha spec.*	Mauritania 1978, personal observ. and photos
Solitary Tunicata		
Ascidia mentula	*Dromia personata*	Carlisle, 1953: 142
Ascidiella aspersa	*Dromia personata*	Carlisle, 1953: 143
Microcosmus sulcatus	*Dromia personata*	Carlisle, 1953: 142
Phallusia mammillata	*Dromia personata*	Carlisle, 1953: 143
Unidentified	*Cryptodromiopsis unidentata*	Sakai, 1936: 14
Ascidia sydneyensis	*Cryptodromia hilgendorfi*	McLay, 1983: 24, 27
Anthozoa		
Zoantharia	*Cryptodromiopsis antillensis*	Kaplan, 1982: 162
Zoanthid polyps	*Cryptodromiopsis antillensis*	Chace et al., 1986: 340
Zoanthus spec.	*Cryptodromia fallax*	RMNH D. 13203
Palythoa nelliae	*Cryptodromiopsis unidentata*	Barnard, 1950: 324
Octocorallia (soft coral)	*Cryptodromiopsis unidentata*	Ortmann, 1894: 34
Xenia spec.	*Cryptodromiopsis unidentata*	Lewinsohn, 1984: 107
Sea anemone/*Calliactis polypus*	*Cryptodromiopsis larraburei*	Kerstitch, 1989: 96/ in litt. 5.x.1994
Other organisms or objects		
Seaweed	*Dromia personata*	George & George, 1979: 79
Seaweed (*Padina*)	*Cryptodromia fallax*	Stimpson, 1907: 176
Barnacle (*Balanus crenatus*)	*Dromia personata*	Zirpolo, 1926
Artificial (paper/plastelin)	*Dromia personata*	Dembowska, 1926: 164-166
Artificial	*Dromia personata*	Fenizia, 1935
Anything from algal fronds to pieces of newspaper	*Cryptodromiopsis larraburei*	Brusca, 1980: 319

Description of the newly discovered association
(figs 1, 4, 5)

Material.— NIOP-expedition 1992-1993, RV "Tyro", leg A2, sta. 511, 29.xi.1992, beam-trawl 1, off the Kenyan coast, 3° 09.37' S 40° 13.86' E, depth 53 m; 1 male specimen of *Lauridromia intermedia* (Laurie, 1906) (RMNH D 46132), carapace width 20 mm, carrying an actinian, *Nemanthus annamensis* Carlgren, 1943 (RMNH Coel. 18779).

In spite of the impact of the dredging activities and the accumulation in the net of ca 0.5 m^3 of benthic material (mostly fish, crabs and gastropods), followed by roughly shaking the catch from the end of the net onto the deck, the crab had not lost its anemone cover (fig. 1). This indicates that it had a solid grip on its relatively slippery partner. No other species or specimens of Actiniaria or dromiid crabs were found among the catch.

Before being preserved the crab lived for over a week in a small container, keeping the anemone on its back.

In dromiid crabs the legs of the fourth and fifth pairs are oriented dorsally or sub-dorsally, often in such a way that the fifth legs are above and in front of the

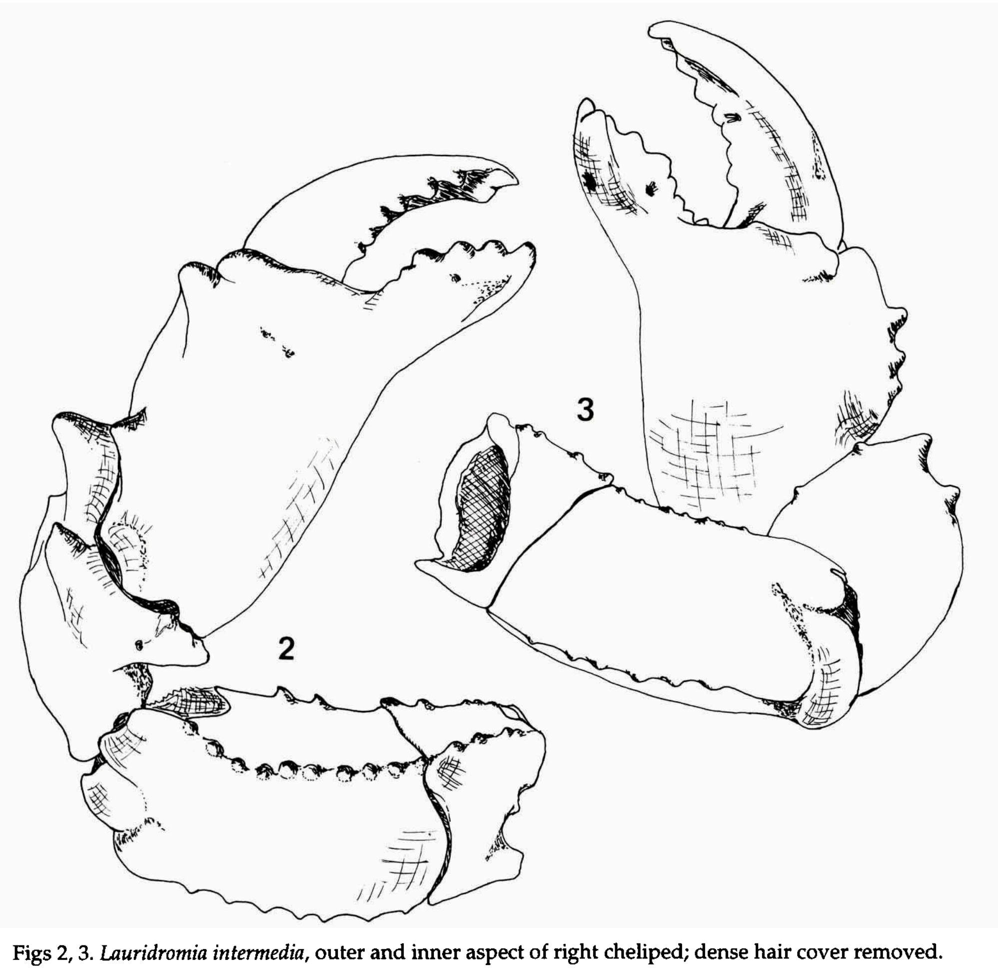
Fig. 1. Dorsal view of *Lauridromia intermedia* carrying the actinian *Nemanthus annamensis*. Dredged off the coast of Kenya. Carapace width 20 mm. Drawing after a photograph.

fourth legs. In *Lauridromia intermedia* the ends of the fifth legs have three sharp thorns, two fixed and one movable, acting as nippers (fig. 5); the ends of the legs of the fourth legs, too, have a cheliped-like structure (fig. 4). In our specimen the four cheliped-like structures of these legs held the anemone firmly by piercing its limbus, the base of the anemone being stretched over the carapace by action of the legs. Apparently undisturbed, the anemone was most of the time fully expanded, showing considerable variation in body form. After the crab died the anemone attached itself to the wall of the container.

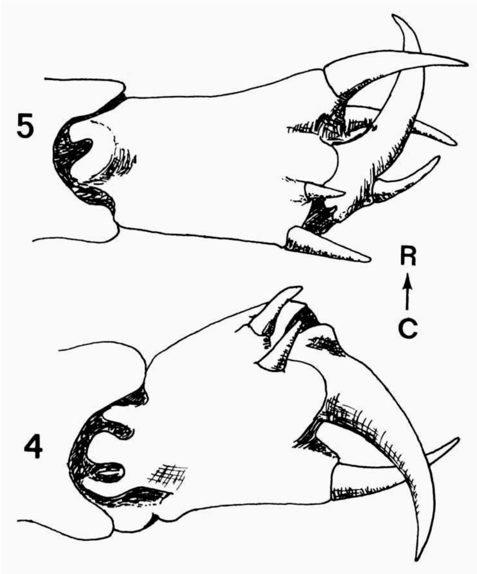
Descriptive notes on te crab

Lauridromia intermedia (Laurie, 1906)
(figs 1-5)

The crab, a male specimen with a carapace width of 20 mm, agrees very well with the description of *Lauridromia intermedia* given by McLay (1993: 147-148). There are,



Figs 2, 3. *Lauridromia intermedia*, outer and inner aspect of right cheliped; dense hair cover removed.



Figs 4, 5. *Lauridromia intermedia*, dorsal view of distal, cheliped-like parts of fourth (fig. 4) and fifth pereiopods (fig. 5) and their position relative to each other (C—R = caudal-rostral axis); dense hair cover removed.

however, some small differences, notably in the number of tubercles on the meri of the chelipeds (figs 2-3). These differences are listed below (McLay's data added in square brackets). The signs (R) and (L) refer to the right and left cheliped, respectively.

The superior margin of the merus bears 7 larger tubercles on the right cheliped and 6 on the left cheliped [McLay: 4 to 5]. The outer inferior border bears 10 (R) and 11 (L) tubercles [McLay: 7 to 8], and the inner inferior border 8 (one bilobed) (R) and 10 (L) [McLay: 9 to 10] small tubercles. Furthermore the lowest one of 3 small tubercles [McLay: 2] on the distal border of the inner face of the carpus of the chelipeds deviates by being bilobed [McLay: simple]. The upper border of the propodus of the right cheliped has 3 tubercles [McLay: 2]. The base of the dactylus does not have a prominent subacute tubercle. The fingers of the chelipeds are armed with 8 (9 if the very blunt tooth on the inside of the tip is included) teeth [McLay: 7]; the first 4 teeth are large, the rest small. The propodial part of the nipper has 5 large and 4 small tubercles. The dactyli of the second and third pereiopods are shorter than the propodi [McLay: equally long].

In all, the differences are rather small and are here considered to lie within the range of variation of the species. The differences may be due to the small size of the individual, well under the mean carapace width of 26.2 mm for males given by McLay (1993: 148). Furthermore pereiopods of crabs may easily be lost by autotomy (e.g. following attack by a predator) and will regenerate after one or more successive moultings. As a result the character of the newly grown legs may deviate from the original condition. Added to this the fact that in our specimen the right and left cheliped differ from each other in the number of tubercles, it may be obvious that cheliped characters should be used with reserve. The differences may also be linked to the specimen representing an extra-distributional record, the first from the continental shelf of East Africa. So far, this wide-spread Indo-West Pacific species had not been recorded further westward than the Seychelles and Madagascar (McLay, 1993).

Descriptive notes on the anemone

Nemanthus annamensis Carlgren, 1943
(fig. 1, table 2)

Morphology.— Body rather firm but variable in shape. Base (after attachment to wall of container) irregular in outline, ca 30 × 20 mm across. Column low and spreading, except for the slightly expanding distal part carrying the oral disc. Mouth a slit with 2 siphonoglyphs. Tentacles ca 120-130, entacmaceous and apparently irregularly arranged, the inner ones of variable size but much better developed than the outer ones.

Colour.— Column and tentacles entirely opaquely white. Oral disc semi-transparent, showing insertions of mesenteries.

Anatomy.— Not studied. Only three so-called acontioids were found (and removed for study).

Cnidom.— See table 2. The data presented in the table are in general agreement with specimens from the Seychelles (RMNH Coel. 18768, 18769) and the Maldives (RMNH Coel. 18797).

Table 2. Survey of the cnidom of *Nemanthus annamensis* (RMNH Coel. 18779), the actinian partner of *Lauridromia intermedia*.. N = number of nematocysts measured. Frequency indicated by: - - - = sporadic, - - = rare, - = uncommon, + = rather common, ++ = common.

Organ	Nematocyst type	Mean and range (in parentheses) of length and width of nematocyst capsules in µm	N	Frequency
Pedal disc	Spirulae	15.4(8.0 - 21.4) x 2.8(2.0 - 4.2)	60	++
	Penicilli B2	16.9 x 3.3	1	- - -
Column	Spirulae	18.0(12.5 - 20.5) x 2.9(2.0 - 3.6)	50	++
	Penicilli B2	24.8(22.3 - 27.6) x 4.1(3.6 - 4.5)	10	- -
Tentacle tip	Spirocysts	ca. 22 - 46 x 2.9 - 5.6	—	++
	Spirulae	10.0(8.9 - 12.5) x 2.4(2.2 - 2.7)	20	- - /-
	Spirulae	17.0(13.4 - 20.0) x 2.5(2.2 - 2.7)	12	- - -
	Spirulae	28.8(23.1 - 32.0) x 3.8(3.3 - 4.5)	30	+/++
	Penicilli B2	19.0(15.1 - 21.4) x 3.7(3.3 - 4.0)	25	-/+
Stomodaeum	Spirulae	24.7(18.7 - 26.7) x 3.1(2.7 - 3.3)	30	++
	Penicilli B2	22.2(19.6 - 24.9) x 4.0(3.6 - 4.5)	20	+
Filaments	Spirulae	10.3(8.5 - 12.9) x 2.7(2.4 - 3.1)	20	-/+
	Penicilli B1	18.3(16.9 - 19.6) x 3.6(3.1 - 4.0)	25	++
Acontioids	Spirulae	10.7(8.9 - 12.5) x 2.6(2.2 - 2.9)	20	-
	Penicilli B2	ca. 17.8 - 21.4 x 3.6 - 4.2	3	- - -

Discussion.— The monotypic family Nemanthidae and the genus *Nemanthus* were proposed by Carlgren (1940: 212-214) to include forms of which the mesenteries may form thread-like structures referred to as acontioids, which, unlike true acontia, are not heavily laden with nematocysts but instead with numerous glandular cells and few nematocysts only. The three species of the genus *Nemanthus* described so far, viz. *N. nitidus* (Wassilieff, 1908) (Sagami Bay and Bonin Islands, Japan), *N. californicus* Carlgren, 1940 (California, Sea of Cortez) and *N. annamensis* Carlgren, 1943 (Gulf of

Tonkin) are unidentifiable on the basis of the available descriptions. The morphological and anatomical differences given by Carlgren (1940: 212-217, figs. 1-5; 1943: 36-38: fig. 26) are in degree rather than substantial, and therefore possibly just individual variation. Hence, we are much inclined to regard these three nominal species as a single biological species with a wide Indo-Pacific distribution. Carlgren's data on the cnidom of the three species are also reasonably in agreement, both as regards the types present and the length-ranges of the main categories. On the other hand, the width-ranges do not quite match, but these differences might prove fictitious (due to the condition of the material examined and/or inaccurate measurements). By way of precaution and pending a re-examination of the types, we here refrain from synonymizing the three species recognized by Carlgren. In the context of the present note it also would seem undesirable to propose any nomenclatural changes. For geographical reasons we identify the Kenya specimen with *Nemanthus annamensis*. Coincidentally(?), the details of the cnidom of the Kenya specimen are also best in agreement with the data given by Carlgren for *N. annamensis* (Carlgren, 1943: 37).

General discussion and conclusions

The function of carrying foreign objects by dromiid crabs is generally explained as camouflage against predators (Gerstaecker & Ortmann, 1881-1901: 1217, 1256; Morton, 1989: 22; Zann, 1980). Predation experiments in aquaria with *Octopus* on covered and naked crabs are strongly in support of this explanation (Polimanti, 1911). A distasteful or repellent character (due to the toxic character of secondary metabolites) of the cover material may provide an extra protective function (Yonge, 1966; Branch & Branch, 1981). In most cases the cover consists of sponges or ascidians. These are not generally foraged upon by potential crab predators such as fish and cephalopods. A third protective function of the cover can be that of a decoy (Carlisle, 1953): when attacked, a crab can instantly let loose its camouflage and leave the predator alone with it. This trick, possibly of some importance in the case of fast moving crabs such as species of Dorippidae, is not likely to produce much effect in the case of the rather slow dromiid crabs.

An actinian used as cover would not only seem to provide good camouflage to the crab, but also form an effective means of defence on account of the potentially harmful nematocysts. Hence, it is not surprising that there are many examples to illustrate that decapod crustaceans readily associate with sea anemones.

The common Mediterranean-Lusitanean *Anemonia sulcata* (Pennant, 1777) offers shelter to a variety of crab species which tend to hide against its column under cover of the long tentacles (personal observations). It is obvious that this form of association is more obligate in some species than in others, and a number of species found with *A. sulcata* are probably just occasional visitors, seemingly accepting the shelter of the anemone just as they would accept camouflage by algae, or the relative safety under a stone or in a crevice. Be that as it may, they clearly do not avoid the actinian as shelter and apparently suffer no harm from its nematocysts. Among the species found associated with *Anemonia sulcata* also figures a dromiid crab, viz. *Dromia marmorea* Forest, 1974 (personal record, 1 specimen with sponge cover, Canary Islands, 1986; RMNH D 41673; identification C.H.J.M. Fransen).

Notably in tropical waters, a host of shrimp species are obligate actinian symbionts that live among the tentacles of their hosts (mostly medium-large to large zooxanthellate species belonging to the families Stichodactylidae, Thalassianthidae and Actinodendronidae). The spider crab *Cyclocoeloma tuberculata* (Miers, 1880) covers its carapace with corallimorpharian anemones of the genus *Discosoma* Rüppell & Leuckart, 1828 (den Hartog, 1988). Boxer crabs (*Lybia* ssp.) carry small actinians in their claws which are used against potential predators. Also well known is the protection of hermitcrabs against predators like *Octopus* by symbiotic actinians.

Many more examples could be listed, but a survey of crab/sea anemone associations is beyond the scope of the present note. However, in view of the above, it strikes that associated occurrence of dromiid crabs and Actiniaria has not been recorded more often. Speculating about the reasons, this may not be due primarily to intrinsic depreciation by the crab, but possibly rather to the behaviour of the anemones. With the exception of burrowing species, most Actiniaria tend to attach actively to underlying substrata by means of an often flexible pedal disc. This habit may not be compatible with the usual habit of dromiid crabs to hold passive, unattached cover subjects and might be a reason why Actiniaria are not favoured as camouflage. Be that as it may, the association here described shows that this particular crab specimen, presumably in the absence of more suitable associates, could nonetheless cope with the anemone.

Members of the family Dorippidae and in particular of the subfamily Dorippinae, which, in accordance with dromiid crabs, cover themselves with unattached organisms, generally have more specific, and often more fancy associations. They are found associated with e.g. sea urchins (personal observations, Amboina, December 1990), jellyfish of the genus *Cassiopea* (observation B.W. Hoeksema, N. Sulawesi, October 1995), holothurians, solitary ascidians, dead or living crabs, fish heads, etc. (zur Strassen, 1918: 692-693). At least one species of this family, the SE Asiatic *Dorippoides facchino* (Herbst, 1785) is practically always found associated with the actinian *Cancrisocia expansa* (Stimpson, 1855) (see e.g. Holthuis & Manning, 1990: 58-63). However, in this association the base of the anemone is invariably carried along with its substratum, viz. a valve or valve-fragment of a bivalve mollusc, so that the crab does not face the supposed problem of handling a soft, flexible body of variable shape. Moreover, the base of the anemone secretes a rather thick plate of a velvety substance, which partly takes over the function of the shell once the growing anemone exceeds the outline of the shell (Delsman, 1925: 175).

Dromiid crabs generally seem to have a preference for sponges and compound ascidians. In a recent monograph of the Dromiidae of New Caledonia and the Philippines, 14 species are mentioned that have been found with sponge covers and 15 species carrying compound ascidians (McLay, 1993). Nine of these species are recorded to associate with both, indicating a low specific preference at best. Dembowska (1926: 163) already demonstrated that the eastern Atlantic *Dromia personata* will take a variety of organisms and materials for cover, including artificial matter. A certain preference, however, was shown for sponges. Crabs will drop an artificial cover when a sponge cover is available.

So far, *Lauridromia intermedia* had only been recorded uncamouflaged or with a sponge cover (McLay, 1993; RMNH D 35228 from Seychelles). However, data on the species are scarse, and it therefore is difficult to say whether associated occurrence with Actiniaria is accidental or not. We are inclined to consider the case here described as an exception. In the first place, no substantial fragments of sponges or compound ascidians were present in the trawl catch yielding the crab. Moreover, members of the genus *Nemanthus* normally live attached to gorgonians, their bases surrounding the branches, and hence are sometimes referred to by the vernacular name "gorgonian wrappers" (Kerstitch, 1989: 24). It is puzzling, therefore, how the crab obtained the anemone. The trawl catch came from a sandy-muddy bottom and did neither contain any gorgonians nor any suitable hard substratum for these. Besides, the colour of the anemone was unusually pale, almost ghostly white, the usual variegation all but faded, suggesting less favourable conditions of living. Representatives of *Nemanthus* normally are yellowish to orange, as a rule more or less distinctly variegated with dark patches.

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