

# The Dromiidae of French Polynesia and a new collection of crabs (Crustacea, Decapoda, Brachyura) from the Marquesas Islands

Colin L. MCLAY

Zoology Department, Canterbury University,  
PB 4800, Christchurch (New Zealand)  
c.mclay@zool.canterbury.ac.nz

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## ABSTRACT

A collection (35-112 m) from the Marquesas Islands, French Polynesia, contains three new dromiid species. The distinctive characters of *Dromidiopsis richeri* n. sp. include three anterolateral teeth and a dense fringe of setae behind the frontal margin. For *Cryptodromia marquesas* n. sp., the distinctive characters are a strong subhepatic tooth visible dorsally and the presence of five swellings on the branchial area, which give the carapace surface a sculptured appearance and for *Cryptodromia erioxylon* n. sp., a covering of very fine, soft setae, a minutely denticulated orbital margin and a prominent tubercle behind the postorbital corner. There are three new records: *Dromia dormia* (Linnaeus, 1763), *Cryptodromiopsis unidentata* (Rüppell, 1830) and *Cryptodromia hilgendorfi* De Man, 1888. New keys are provided for the identification of the known species of *Dromidiopsis* and *Cryptodromia*. *Dromia wilsoni* (Fulton & Grant, 1902) and the first female specimen of *Cryptodromiopsis plumosa* (Lewinsohn, 1984) are reported from Hawaii. Sponges carried by the dromiids were identified to genus and most of these constitute new records for the Marquesas Islands. The fauna of French Polynesia now includes 11 dromiid and five dynomenids while the Hawaiian Islands have five and four species respectively. Four dromiids and three dynomenids are shared. Diversity is greatest in shallow (< 100 m) water. Sperm transfer in dromiids is poorly understood. The first gonopod is only tubular distally and cannot enter the female spermathecal aperture, while the second is longer and needle-like. The long, muscular extension of the vas deferens is the main conduit for sperm, thus taking over the role of the first gonopod in eubrachyurans.

## KEY WORDS

Crustacea,  
Decapoda,  
Brachyura,  
Dromiidae,  
Dynomenidae,  
Porifera,  
French Polynesia,  
Hawaii,  
Marquesas Islands,  
key,  
reproductive structures,  
sperm transfer,  
new species.

## RÉSUMÉ

*Les Dromiidae de Polynésie française et une nouvelle collection de crabes (Crustacea, Decapoda, Brachyura) des Îles Marquises.*

Une collection de crustacés récoltés entre 35 et 112 m aux Îles Marquises, Polynésie française, inclut trois nouvelles espèces de Dromiidae. Les caractères différentiels sont : pour *Dromidiopsis richeri* n. sp., la présence de trois dents antérolatérales et une frange dense de soies en arrière de la marge frontale ; pour *Cryptodromia marquesas* n. sp., une forte dent subhépatique visible dorsalement et la présence de cinq dilatations de l'aire branchiale qui donnent à la surface de la carapace un aspect sculpté ; pour *Cryptodromia erioxylon* n. sp., un revêtement de soies molles, très fines, une marge orbitale finement denticulée et un tubercule proéminent en arrière de l'angle post-orbital. On mentionne pour la première fois la présence de *Dromia dormia* (Linnaeus, 1763), *Cryptodromiopsis unidentata* (Rüppell, 1830) et *Cryptodromia hilgendorfi* De Man, 1888. Des nouvelles clés sont fournies pour l'identification des espèces connues de *Dromidiopsis* et de *Cryptodromia*. *Dromia wilsoni* (Fulton & Grant, 1902) et le premier spécimen femelle de *Cryptodromiopsis plumosa* (Lewinsohn, 1984) sont signalés d'Hawaïi. Les éponges transportées par les Dromiidae ont été identifiées au niveau générique et la plupart sont mentionnées pour la première fois des Îles Marquises. La faune de Polynésie française inclut maintenant 11 Dromiidae et cinq Dynomenidae alors que les Îles Hawaïi en ont respectivement cinq et quatre espèces. Quatre Dromiidae et trois Dynomenidae sont communes aux deux faunes. La diversité est la plus grande dans les eaux peu profondes (< 100 m). Le transfert du sperme est peu connu chez les Dromiidae. Le premier gonopode est tubulaire seulement à l'extrémité distale et ne peut pas pénétrer dans l'ouverture de la spermathèque de la femelle, alors que le second est plus long et en forme d'aiguille. Le prolongement long et musculéux du vas deferens est le conduit principal du sperme, qui remplit donc le rôle du premier gonopode des Eubrachyura.

## MOTS CLÉS

Crustacea,  
Decapoda,  
Brachyura,  
Dromiidae,  
Dynomenidae,  
Porifera,  
Polynésie française,  
Hawaïi,  
Îles Marquises,  
clés,  
structures reproductrices,  
transfert de sperme,  
nouvelles espèces.

## INTRODUCTION

An early paper by McLay (1991) dealt mainly with deep water dromiid crabs collected using baited traps from depths of 190-450 m. These localities were near Mururoa, Takapoto, Makemo and Tuanake in the Tuamotu Archipelago, Moorea, in the Society Islands, and Raevavae in the Austral Islands. Subsequently a major revision of the genera (McLay 1993) was undertaken, so that some of the names used earlier no longer apply. The present paper deals specifically with a collection from the Marquesas Islands: Eiao, Nuku Hiva, Ua Pou, Ua Huka, and Hiva Oa, taken from depths of 35-112 m.

The fauna of French Polynesia includes *Sphaerodromia ducousoi* McLay, 1991, *Dromia wilsoni* (Fulton & Grant, 1902), *Cryptodromiopsis tridens*

Borradaile, 1903, *Cryptodromia fallax* (Lamarck, 1818) (originally reported as *C. canaliculata* Stimpson, 1858) and *C. coronata* Stimpson, 1858. Together with the new species and records described herein, this makes a total of 10 species. Poupin (1996a, b) has summarized the records of Decapoda from French Polynesia and provides an excellent historical perspective of the exploration of these islands.

The first female specimen of *Cryptodromiopsis plumosa* (Lewinsohn, 1984) is reported from Hawaïi. This species was previously known only from the Seychelle Islands, Indian Ocean and the Chesterfield Islands near New Caledonia. With the recent completion of a revision of the Dynomenidae (McLay 1999), the opportunity is taken to compare the dromiid and dynomenid

faunas of French Polynesia with the Hawaiian Islands. The report by McLay (1999) of *Metadynomene devaneyi* (Takeda, 1977) being present in the Marquesas Islands was based on a specimen collected from Ua Huka during the MUSORSTOM 9 expedition.

Most of the material comes from the MUSORSTOM 9 expedition to the Marquesas Islands, August-September 1997, on N/O *Alis* by Philippe Bouchet, Bruno Dayrat, and Bertrand Richer de Forges.

The sponges carried by the dromiid crabs have been identified, as far as possible, by Professor Claude Levi. Most of the six sponge genera recorded are new for the Marquesas Islands.

Terminology follows that used by McLay (1993) except that sections of limbs are referred to as "articles", rather than "segments", and the female "sternal grooves" are referred to as "sternal sutures 7/8". These changes in terminology are consistent with those used by McLay (1999) for the dromiid sister group, the Dynomenidae.

#### ABBREVIATIONS

Stations refer to samples taken during the MUSORSTOM 9 Expedition to the Marquesas Islands. Most of the material was obtained by Beam Trawl (CP) or Warren Dredge (DW). Carapace width and length are abbreviated as cw and cl respectively. Measurements of each specimen are given as cw × cl. The ratio of the area of the camouflage cap, carried by the crab, to cw × cl is referred to as the cover ratio, cr.

Institutions where specimens have been deposited are abbreviated as follows:

QM	Queensland Museum, Brisbane;
MNHN	Muséum national d'Histoire naturelle, Paris;
USNM	National Museum of Natural History, Smithsonian Institute, Washington DC.

#### SYSTEMATICS

##### Genus *Dromidiopsis* Borradaile, 1900

*Dromidiopsis* – McLay 1993: 135.

#### REMARKS

This genus contains dromiids which are typically small crabs (cw < 40 mm) having the following

characteristics: carapace width less than or equal to carapace length; anterolateral teeth small; female sternal sutures 7/8 usually end together on tubercles between the bases of the chelipeds or first walking legs; an epipod is present on the cheliped; the joint between the last two abdominal segments may be fused; uropods are small and visible externally; and a spine is present on the dactyl of the last leg. A more detailed account of *Dromidiopsis* Borradaile, 1900 can be found in McLay (1993). The addition of the new species brings to seven the total number of species in this genus.

Until now, species of the genus *Dromidiopsis* were known from the Indian Ocean, the coast of Australia, New Caledonia and Japan, and as far East as Fiji.

#### *Dromidiopsis richeri* n. sp.

(Figs 1; 4A)

TYPE MATERIAL. — Holotype, MUSORSTOM 9, stn CP 1160, 1 ♀ 15.4 × 15.0 mm (MNHN B26471).

ETYMOLOGY. — This new species is named in recognition of Bertrand Richer de Forges, IRD, Noumea, a member of the MUSORSTOM 9 Expedition, for the contribution that his indefatigable collecting has made to improving knowledge about the diversity and distribution of the Pacific decapod fauna.

MATERIAL EXAMINED. — **Marquesas Islands.** MUSORSTOM 9, Eiao Island, stn CP 1160, 7°57.80'S, 140°2.00'W, 49-55 m, 23.VIII.1997, 2 ♀ ♀ 8.4 × 8.4 mm, 15.4 × 15.0 mm (right cheliped fixed finger damaged, right third and part of left fourth leg missing) (MNHN B26471, 26472).

DISTRIBUTION. — The report of the new species from the Marquesas Islands greatly extends the range of this genus to the East.

#### DESCRIPTION

Carapace approximately as wide as long, surface smooth under dense layer of short, fine setae. Only branchial groove evident. Distinctive feature is presence of an irregular band of longer setae curving across carapace between first anterolateral teeth separating distinct frontal area, where only short setae present, and posterior area where tomentum grades into shorter setae; especially prominent long tufts of setae on cheliped

KEY TO THE SPECIES OF *DROMIDIOPSIS*  
(Species dealt with in this paper are in bold)

- 1. Carapace distinctly longer than wide ..... 2
- Carapace approximately as long as wide ..... 3
- 2. Last two abdominal segments not fused, no spine on outer margin of dactyl fourth leg, large posteriorly directed tooth mid-way along cheliped dactyl .....  
..... *Dromidiopsis dubia* Lewinsohn, 1984
- Last two segments of abdomen fused, spine present on outer margin of dactyl of fourth leg ..... *Dromidiopsis australiensis* (Haswell, 1882)
- 3. Last two segments of abdomen not fused ..... 4
- Last two segments of abdomen fused or partially fused ..... 5
- 4. Anterolateral margin with single tooth, carapace with dense fringe of setae extending transversely across front ..... *Dromidiopsis globosa* (Lamarck, 1818)
- Anterolateral margin with three teeth, dense fringe of setae on carapace set back from frontal margin ..... *Dromidiopsis richeri* n. sp.
- 5. Inner margins of first two pairs of legs armed with four-five spines, two spines on outer propodal margin of third leg, dactyl of fourth leg opposed by two spines .... 6
- Inner margins of dactyli of first two pairs of legs armed with two spines, no spines on outer propodal margin of third leg, dactyl of fourth leg opposed by single spine ....  
..... *Dromidiopsis lehrinusae* (Takeda & Kurata, 1976)
- 6. Last leg long, almost reaching supraorbital margin when extended forward .....  
..... *Dromidiopsis tridentata* Borradaile, 1903
- Last leg short, not reaching supraorbital margin when extended forward .....  
..... *Dromidiopsis edwardsi* Rathbun, 1919

carpal tubercles, basis-ischia of first two pairs of legs and on abdominal segments 4-6; same long setae fringe limbs. Front strongly tridentate, median tooth deflexed, but visible dorsally, shorter than lateral rostral teeth which continue eave-like above orbits. Anterolateral margin begins at level of suborbital margin, armed with three evenly spaced subacute teeth, first largest, second smallest, all teeth directed anterolaterally;

branchial notch distinct, followed by strong laterally directed posterolateral tooth. Supraorbital margin curved but without a tooth, postorbital margin not produced. Deep fissure separates suborbital margin that bears strong subacute tooth visible dorsally. First article of antennae much wider than long, beaked medially, upper lobe of beak much shorter than lower lobe; second article much longer than

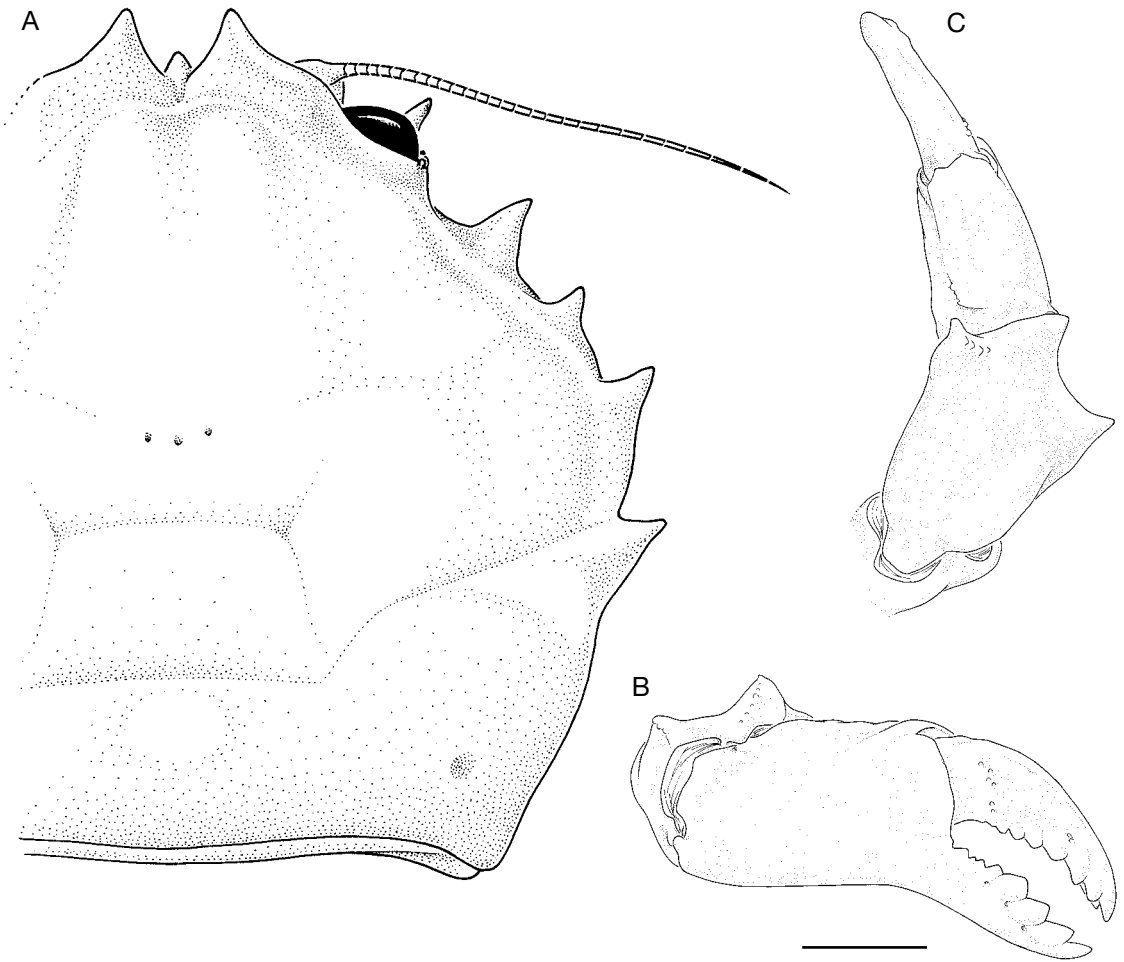


FIG. 1. — *Dromidiopsis richeri* n. sp., holotype ♀ 15.4 × 15.0 mm, Eiao Island, Marquesas, MUSORSTOM 9, stn CP 1160, 49-55 m (MNHN B26471); **A**, dorsal view of right half of carapace; **B**, outer face of right cheliped; **C**, dorsal view of right cheliped. Scale bar: 2 mm.

wide, surface convex, distomedial margin produced, blunt, on which third article is inserted at an angle. Exopod extending almost as far as joint between third and fourth articles, tip bilobed. Ratio of length of antennal flagella to cw = 0.60. Epistome triangular, surface smooth, and concave. Subhepatic area convex, smooth. Crista dentata has 12 or 13 acute teeth. Holotype is an immature female and sternal sutures 7/8 end separately, but close together, without tubercles, between second walking legs. In adult female, these sutures may well terminate more anteriorly.

Chelipeds small, merus trigonal, borders armed with a few small tubercles; outer face of carpus convex, smooth, two prominent subacute distal tubercles; surface of propodus smooth, fingers white, with seven to eight teeth increasing in size distally, interlocking over distal half.

First two pairs of legs shorter than chelipeds, articles not knobbed, dactyli strongly curved, inner margins armed with six small spines increasing in size distally.

Last two pairs of legs shorter than first two pairs, fourth pair longest, subdorsal, reaching almost as

far as last anterolateral tooth, third pair ventrally placed. Dactyl of third pair strongly curved, opposed by single well-developed spine. Dactyl of fourth leg also strongly curved, opposed by two unequal propodal spines, with spine on outer propodal margin and another small proximal spine on outer margin of dactyl.

Abdomen composed of six free segments, surface smooth. Telson of female longer than wide, narrowing posteriorly. Uropod plates well-developed visible externally. Abdominal locking mechanism consists of proximal concave margin of penultimate abdominal segment fitting around curved, tuberculate flange on coxa of first walking leg. Uropods fill more distal concavity and lie in front of flanges. Male characters unknown.

#### Size

Size ranges from 8.4 to 15.4 mm cw. In both of the present specimens the pleopods are poorly developed, especially in the smaller individual, which lacks gonopores on the coxae of the second legs. Whether either or both of these specimens has been parasitized is not clear. In *Dromidiopsis dubia* Lewinsohn, 1984, females greater than 8–10 mm cw would be sexually mature, but this is clearly not the case with the new species. The collection of further larger specimens will help to resolve this question.

#### Camouflage

No camouflage material was associated with the crabs, but it appears from the construction of their last two pairs of legs, that they are capable of carrying soft camouflage such as pieces of sponge and ascidians.

#### Depth

Both specimens came from a depth of 49–55 m.

#### DISCUSSION

McLay (1993) provided a key for the identification of the six species of *Dromidiopsis*. The new species comes out in the third couplet with *D. globosa* (Lamarck, 1818) but clearly differs from this species by virtue of having three strong anterolateral teeth (*versus* only one tooth). It is

interesting to note that a feature of *D. globosa* (known only from Australia) is the presence of dense fringe of setae across the front of the carapace. This feature is also present in *D. richeri* n. sp. but the fringe is not so dense and is set back from the frontal carapace margin. The new species should not be confused with *Cryptodromiopsis unidentata* (Rüppell, 1830) which occurs in the same habitat (see below under *C. unidentata*) and also has a frontal fringe, but lacks an epipod on the cheliped.

Specimens of other species in the genus *Dromidiopsis* all come from less than 100 m, so the material of the new species fits in well with the established habitat of *Dromidiopsis* spp.

#### Genus *Dromia* Weber, 1795

*Dromia* – McLay 1993: 149.

#### REMARKS

Species belonging to the genus *Dromia* are characterized by having: a carapace much wider than long; anterolateral teeth are well-developed; an epipod is present on the base of the cheliped; female sternal sutures 7/8 usually end apart behind chelipeds; no spine present on the dactyl of the last pair of legs; all abdominal segments are free; and uropods small and visible externally. The genus contains 10 species, three of which occur in the Indo-West Pacific (McLay 1993).

#### *Dromia dormia* (Linnaeus, 1763)

*Dromidiopsis dormia* – Lewinsohn 1984: 95, pl. 2.

*Dromia dormia* – McLay 1993: 151, fig. 16c. — Ng *et al.* 2000: 159, fig. 2a.

MATERIAL EXAMINED. — **Marquesas Islands.** MUSORSTOM 9, stn CP 1177, 8°45.10'S, 140°15.10'W, 108–112 m, 25.VIII.1997, 1 ♀ (ovig.) 137.3 × 104.0 mm, (carrying the sponge *Hyattella* sp.) (MNHN B26490). — Stn CP 1179, 8°46.70'S, 140°13.40'W, 58–62 m, 25.VIII.1997, 1 ♂ 94.5 × 78.3 mm (MNHN B26517).

DISTRIBUTION. — From the East coast of Africa, Red Sea, Indo-West Pacific (including Japan and New Caledonia). *D. dormia* is known from Hawaii (Lenz 1901) and now from French Polynesia.

## DESCRIPTION

*Distinctive characters*

Carapace width much greater than length, strongly convex, and covered by a short, even, velvety tomentum (not shaggy). Rostrum is tridentate, median rostral tooth large, and extending further forward than lateral teeth. There are four unequal anterolateral teeth on the carapace with the first tooth much larger. The posterolateral tooth is strong and tends to be directed anteriorly. The inner margins of the dactyli of the first two walking legs are armed with four or five small spines. None of the abdominal segments are fused and the uropods are small but visible externally.

*Size*

Maximum size for females is  $cw = 172$  mm and for males it is  $cw = 200$  mm. *Dromia dormia* is the largest dromiid known. The ovigerous female ( $137.3 \times 104.0$  mm) in the present collection provides only the second set of reproductive data for *D. dormia*. This crab carried approximately 129 600 new eggs, 0.5 mm diameter. This is considerably more than the female reported by McLay (1993) but the egg size is the same. *D. dormia* is a dromiid that produces large numbers of relatively small eggs. The entrances to the spermathecae of the present female were blocked externally by soft brown material.

*Camouflage*

One carried a sponge cap made from *Hyattella* sp. (Spongiidae), clearly insufficient for the purpose of concealment: while the dimensions of the crab were  $137.3 \times 104.0$  mm, the piece of sponge was only  $112.0 \times 51.0$  mm giving a cr of only 0.4. The cap only covered the posterior third of the carapace. Edmondson (1946) provides several records and some interesting examples of the use of diverse varieties of camouflage carried by Hawaiian *D. dormia*: in one case a hollowed out piece of wood and in another an old shoe sole!

*Depth*

Although *D. dormia* has been collected quite frequently, often from shallow waters, accurate

depth records are available for only a few specimens. McLay (1993) summarized these depth records which gave a range of 8-50 m. The Marquesas specimens, from Nuku Hiva Island, came from 58-112 m and so extend the known depth range for *D. dormia*.

## DISCUSSION

McLay (1993) provides a detailed synonymy of *D. dormia*. Because of its large size and occurrence in shallow waters, *D. dormia* was one of the earliest dromiids collected, but because there are several large Indo-West Pacific dromiids, there was a lot of confusion, about the identity of these species. The main problem was the separation of *D. dormia* (Linnaeus, 1763) from "*Dromia rumphii*" Weber, 1795. Rathbun (1923) pointed out that these two names had been used rather indiscriminately for two different species and provided a partial answer to the difficulties by erecting "*Dromidiopsis dehaani*" Rathbun, 1923 for some of the specimens that had been called "*Dromia rumphii*". Lewinsohn (1984) also helped to clarify the situation but placed *Dromia dormia* in "*Dromidiopsis dormia*". The revision of the Dromiidae by McLay (1993) showed that the genus *Dromidiopsis* in fact contains only rather small dromiids (see above) and should not include either of the two problem species. *Dromia dormia* (Linnaeus, 1763) was shown to be a member of the genus *Dromia*, and the erection of the genus *Lauridromia* McLay, 1993 allowed "*Dromia rumphii*" and "*Dromidiopsis dehaani*" to be placed in *Lauridromia dehaani* (Rathbun, 1923). This allowed all the large dromiids to be properly classified. *Lauridromia dehaani* has been recorded from Sala y Gomez (c. 26°S, 105°E) and so may well be found in French Polynesia (see Zarenkov 1990). This species is easily separated from *D. dormia* because it has a rather shaggy tomentum, three large anterolateral carapace teeth, about 16 small spines on the inner margins of the first two pairs of legs, and the joint between the fifth and sixth abdominal segments is partially fused. In mature female *L. dehaani*, the sternal sutures 7/8 end on large conical tubercles just behind the bases of the chelipeds.

*Dromia wilsoni* (Fulton & Grant, 1902)

*Cryptodromia wilsoni* Fulton & Grant, 1902: 61: pl. 9.

*Petalomera wilsoni* – McLay 1991: 470, pl. 1b, figs 6a-d; 7a-c; 8a-c.

*Dromia wilsoni* – McLay 1993: 156, fig. 16e.

MATERIAL EXAMINED. — **Hawaii.** *Albatross* Expedition, Laysan Island, stn 3955, c. 25°46'N, 171°44'W, 37-55 m, 21.V.1902, 1 ♂ 13.1 × 10.2 mm (USNM 55973).

DISTRIBUTION. — *D. wilsoni* has the widest distribution of any dromiid crab. It occurs in the South Atlantic, Indian Ocean, and in both the northern and southern Pacific. In the eastern Pacific, *D. wilsoni* is known from the Tubai Islands, Marquesas Islands, and Tuamotu Islands in French Polynesia. The record from Laysan Island, Hawaii, extends the range of this species into the northeast Pacific.

Genus *Cryptodromiopsis* Borradaile, 1903

*Cryptodromiopsis* – McLay 1993: 187.

## REMARKS

Species of *Cryptodromiopsis* Borradaile, 1903 are characterized by: a carapace wider than or equal to carapace length; the anterolateral teeth are usually well-developed but may be absent; the female sternal sutures 7/8 end together or apart (see Discussion below) between chelipeds or first or second legs; there is no epipod on the base of the chelipeds; the dactyl of third walking legs is opposed by up to two propodal spines, with up to two spines on the outer propodal margin; the dactyl of the fourth walking legs is opposed by two propodal spines, with up to three spines on the outer propodal margin, and up to two spines on the outer margin of the dactyl; all abdominal segments are free; and the uropods are small but visible externally. The genus contains six species for certain and may also include the two Chinese species *C. dubia* Dai, Yang, Song & Chen, 1981 and *C. planaria* Dai, Yang, Song & Chen, 1981.

*Cryptodromiopsis unidentata* (Ruppell, 1830)

*Dromidia unidentata* – Lewinsohn 1984: 107.

*Cryptodromiopsis unidentata* – McLay 1993: 192, figs 7a-k; 18a.

MATERIAL EXAMINED. — **Marquesas Islands.** MUSORSTOM 9, stn CP 1160, 7°57.80'S, 140°2'W, 49-55 m, 23.VIII.1997, 1 ♂ 8.4 × 8.1 mm (MNHN B26522). — Stn CP 1177, 8°45.10'S, 140°15.10'W, 108-112 m, 25.VIII.1997, 1 ♀ 10.0 × 9.4 mm (carrying the sponge *Cinachyrella* sp.) (MNHN B26518). — Stn CP 1188, 8°48.60'S, 140°3.40'W, 35-55 m, 26.VIII.1997, 1 ♂ 9.0 × 8.5 mm (MNHN B26521). — Stn DW 1204, 9°52.60'S, 139°3.20'W, 60-62 m, 28.VIII.1997, 2 ♀ 4.5 × 4.3, 5.0 × 4.7 mm (carrying an ascidian cap) (MNHN B26523). — Stn CP 1227, 9°42.20'S, 138°58.50'W, 4-85 m, 30.VIII.1997, 1 ♂ 12.2 × 11.6 mm (carrying the sponge *Cinachyrella* sp.) (MNHN B26520). — Stn CP 1264, 9°21.30'S, 140°7.70'W, 53-57 m, 3.IX.1997, 1 ♂ 6.2 × 5.9 mm (carrying the sponge *Dendrilla* sp.) (MNHN B26519).

DISTRIBUTION. — *C. unidentata* is a very widespread Indo-West Pacific species known from the east coast of Africa and the Red Sea, through the Indian Ocean, Indonesia, Australia, Japan and across the Pacific to Hawaii and Easter Island and now from French Polynesia.

## DESCRIPTION

*Distinctive characters*

Carapace approximately as wide as long, evenly convex, and smooth beneath a dense mat of fine setae. These give the crab the appearance of a hairy ball that fits tightly into its piece of camouflage. The "face" of the crab is surrounded on top by a dense, continuous fringe with the eyes peering out through the forest of setae. Rostrum tridentate, and no anterolateral teeth. Sternal sutures 7/8 end together between bases of first walking legs. No epipod on the cheliped and no abdominal segments fused. The uropods are small but visible externally. Dactyli of last two pairs of legs opposed by single propodal spines with another two spines on the outer margin.

*Camouflage*

There are many records of the camouflage material carried by *C. unidentata* ranging from sponges, to soft corals, as well as compound and solitary ascidians (McLay 1993). This species is very catholic in its use of camouflage material and probably uses whatever is available. The Marquesas collection included one crab carrying an ascidian cap, and three crabs carrying sponge caps. The sponges included two *Cinachyrella* sp.



(Tetillidae) and one *Dendrilla* sp. (Darwinellidae). The cover ratio (cap area/cw × cl) ranged from 2.6 to 4.8 (mean = 3.6) indicating that the crabs were carrying adequate camouflage.

#### Size

The maximum size for *C. unidentata* is cw = 34.0 mm for males and 31.0 mm for females. All of the Marquesas specimens were much smaller than the maximum recorded sizes.

#### Depth

The depth range of the present material ranges from 35–122 m. The maximum previously reported depth is 100 m (Lewinsohn 1984) so the female reported from stn CP 1177, 108–122 m, increases the lower depth limit for *C. unidentata*. However most specimens have been taken in depths less than 50 m.

#### *Cryptodromiopsis plumosa* (Lewinsohn, 1984)

?*Dromidiopsis plumosa* Lewinsohn, 1984: 104, fig. 3a–g.

*Cryptodromiopsis plumosa* – McLay 1993: 190, fig. 17f. — Hoover 1998: 266, colour photo.

MATERIAL EXAMINED. — **Hawaii**. Oahu, Palea Point, 21°27'N, 158°W, 15.2 m, 11.VII.1996, 1 ♀ ovig. 10.5 × 9.5 mm, carrying the sponge ?*Epipolasis* sp. (QM W21890) (J. Hoover coll.).

DISTRIBUTION. — Until recently *C. plumosa* was known only from the type-locality in the Seychelles Islands. McLay (1993) reported a second male specimen from the Chesterfield Islands, New Caledonia. Thus the new material from Hawaii is important, not only because it represents a major range extension, but also because it is the first female specimen. A second female from Guam was reported by McLay (submitted).

#### DESCRIPTION

##### Camouflage

*Cryptodromiopsis* uses sponges for concealment. The Hawaiian specimen carried a white sponge cap made from *Epipolasis* sp. (Halichondriidae) of more than adequate size, cr = 5.3.

##### Size

The specimen reported herein does not exceed the size (13.3 × 11.7 mm) of the male from the Chesterfield Islands but, as it is the only known fe-

male, its dimensions (10.5 × 9.5 mm) are interesting. As this small female was sexually mature, it suggests that this species does not grow to a very large size. *Cryptodromiopsis unidentata* matures at a similar size and females grow to around 30 mm cw (McLay 1993: 194). The *C. plumosa* female was carrying around 240 newly laid eggs 0.6 mm diameter. This egg size suggests that *C. plumosa* has a planktonic larval stage. *C. unidentata* females carry a similar number of eggs but they are somewhat larger at 0.9 mm diameter. The ends of the *C. plumosa* sternal sutures were covered by dark brown material.

#### Depth

The type specimen came from 55 m while the Chesterfield Islands specimen came from 16–26 m. The Hawaiian specimen, from 15.2 m, comes from near the shallow end of the known depth range. The female reported by McLay (submitted) came from 3–6 m. Thus the depth range for *C. plumosa* is now 3–55 m.

#### REMARKS

The description given here concentrates on female characters and any differences from males (see McLay 1993: 190). The sternal sutures 7/8 end apart on raised tubercles between the second pair of walking legs. The female is ovigerous and therefore sexually mature. The abdomen is triangular and slightly wider than long rather than as wide as long in the male. The abdominal locking mechanism found in the male (i.e. serrated ridge on coxae of first legs against lateral margins of penultimate segment) is absent. The median rostral tooth and anterolateral teeth are as found in the male, but the lateral rostral teeth are blunt rather than acute. There is a deep notch interrupting the supraorbital margin that is a useful character for identifying this species. The inner margins of the dactyli of the first two pairs of walking legs are armed with five spines increasing in size distally. The third pair of legs has two spines opposing the dactyl and two spines on the outer propodal margin while the fourth pair has two spines opposing, three on the outer margin and a large spine on the outer margin of the

dactyl itself, near the base. These spines are part of the equipment that the crab uses to carry its camouflage and they are all well-developed, especially the dactyli, which are long and talon-like.

#### DISCUSSION

The definition of the genus *Cryptodromiopsis* given by McLay (1993) states that the female sternal grooves (i.e. sternal sutures 7/8) “end together between chelipeds, first or second legs, with or without tubercles”. This genus was created by Borradaile (1903) so that species of *Cryptodromia* with convergent sternal sutures could be kept separate from those in which they ended apart. Now that a female *Cryptodromiopsis plumosa* has been discovered, we find that its sternal sutures in fact end apart between the second legs. Rather than referring it to *Cryptodromia*, the original definition of *Cryptodromiopsis* needs to be modified so as to include species that might have such sternal sutures. The reason for this is that, like the other species of *Cryptodromiopsis*, *C. plumosa* has very well-developed propodal spines on the last two pairs of legs, in addition to a well-developed spine on the outer margin of the dactyli of the last legs. In some dromiids, the sternal sutures show strong ontogenetic changes, gradually becoming longer and closer together as the female matures, but it seems unlikely that larger *C. plumosa* females will have sternal sutures 7/8 that end closer together. Therefore the following line needs to be inserted into the generic definition in place of the present statement: “Female sternal sutures 7/8 end together or apart between chelipeds, first or second legs, with or without tubercles”. This detracts somewhat from the usefulness of the sternal sutures as a generic character, but keeps species with the same overall appearance and camouflage-carrying equipment together.

The sternal sutures of *C. plumosa* end more posteriorly than in other species of the genus. This means that the ends of the sutures are just below the female gonopores, only about 1 mm away. If the sperm, stored in the spermathecae, is expelled from the ends of the sternal sutures it they can more easily rendezvous with the eggs.

Hoover (1998), who has observed *C. plumosa* while diving, comments that it emerges after dark in search of food. If interfered with, the crab becomes immobile, folds its legs closely against the edge of its underside, and holds itself closely to the substrate until the disturbance has passed (Catala 1979: 184, fig. 42). In this way it can appear to be just another piece of sponge. Hoover (1998) coined the name, “Shaggy Sponge Crab”, which seems very appropriate considering that the covering of long plumose setae is so characteristic of this crab.

#### Genus *Cryptodromia* Stimpson, 1858

*Cryptodromia* – McLay 1993: 197.

#### REMARKS

The species belonging to *Cryptodromia* Stimpson, 1858 are characterized by: a carapace width greater than or equal to carapace length; anterolateral teeth are always present, blunt or subacute; the female sternal sutures 7/8 end apart between or behind the first pair of walking legs; an epipod is usually absent from base of cheliped; the articles of the first two pairs of legs may be lobed, nodular or tuberculate; the dactyli of the last two pairs of legs are opposed by a single propodal spine, and there may be up to one (third leg) or up to two (fourth leg) spines on the outer propodal margin; the abdominal segments are free and the uropods are small but visible externally.

With the two new species described below there are now 16 species included for certain in *Cryptodromia*. The genus may also include *C. nipponensis* Yokoya, 1933 and *C. protuberata* Dai, Yang, Song & Chen, 1981, but these species are poorly known. Changes since McLay (1993) are that *C. pileifera* Alcock, 1901 is treated as a valid species, not a synonym of *C. tuberculata* Stimpson, 1858, *C. nierstraszi* Ihle, 1913 and *C. laevis* Ihle, 1913 are also valid species and not synonyms of *C. pentagonalis* (see McLay 1993: 198). The sub-species *C. tumida bispinosa* Sakai, 1936 and *C. tumida trispinosa* Sakai, 1936 may well be valid species but this question needs further investigation. In the meantime they are included in the key as sub-species.

KEY TO THE SPECIES OF *CRYPTODROMIA*  
(Species dealt with in this paper are in bold)

1. Carapace significantly wider than long ..... 2
  - Carapace approximately as wide as long ..... 15
2. Single anterolateral tooth ..... 3
  - More than one anterolateral tooth ..... 4
3. Anterolateral tooth small, almost concealed under margin .....
  - ..... *Cryptodromia pentagonalis* Hilgendorf, 1879
  - Anterolateral tooth prominent, laterally directed .....
    - ..... *Cryptodromia protubera* Dai *et al.*, 1981
4. Two anterolateral teeth, carapace surface canaliculated .....
  - ..... *Cryptodromia fallax* (Lamarck, 1818)
  - Two or more anterolateral teeth, carapace surface not canaliculated ..... 5
5. Rostrum bluntly tridentate, small supraorbital tooth ..... 6
  - Rostrum truncate, no supraorbital tooth .... *Cryptodromia nipponensis* Yokoya, 1933
6. Median rostral tooth more prominent than lateral teeth, margins of carpi and propodi of first two pairs of legs sharply verrucose .....
  - ..... *Cryptodromia tuberculata* Stimpson, 1858
  - Median rostral teeth less prominent than lateral teeth, distal margins of carpi and propodi of first two pairs of legs lobed, but not sharply verrucose ..... 7
7. Carapace surface minutely granular and with two anterolateral teeth, or carapace surface with scattered tubercles, especially behind supraorbital margin, and three anterolateral teeth ..... 8
  - Carapace surface smooth, three anterolateral teeth ..... 9
8. Carapace surface minutely granular, two anterolateral teeth, third and fourth abdominal segments armed with four tubercles .....
  - ..... *Cryptodromia coronata* Stimpson, 1858
  - Carapace surface with scattered tubercles, three anterolateral teeth, third and fourth abdominal segments unarmed ..... *Cryptodromia* sp. McLay, submitted
9. Posterolateral tooth well-developed almost as large as preceding anterolateral teeth....
  - ..... 10
  - Posterolateral tooth only weakly developed or absent ..... 12
10. Outer propodal margin of last pair of legs without small spine .....
  - ..... *Cryptodromia marquesas* n. sp.
  - Outer propodal margin of last pair of legs has a small spine ..... 11

11. Prominent, acute tooth-like structure on carapace behind postorbital corner .....  
 ..... *Cryptodromia erioxylon* n. sp.
- No tooth-like structure behind postorbital corner .....  
 ..... *Cryptodromia pileifera* Alcock, 1901
12. Lateral cardiac grooves deeply marked, anterolateral teeth unequal (first largest,  
 third smallest), outer face of cheliped propodus denticulated, superior face tends to  
 have ridge-like margins ..... *Cryptodromia fukuui* (Sakai, 1936)
- Lateral cardiac grooves not marked, anterolateral teeth equal, outer face of cheliped  
 propodus marked by some lines of small granules ..... 13
13. Posterior margin of telson with three spines .....  
 ..... *Cryptodromia tumida trispinosa* Sakai, 1936
- Posterior margin of telson with two spines ..... 14
14. Spines on telson short, separated by a broad concavity .....  
 ..... *Cryptodromia tumida typica* Stimpson, 1858
- Spines on telson long, separated by a narrow concavity .....  
 ..... *Cryptodromia tumida bispinosa* Sakai, 1936
15. Single anterolateral tooth ..... 16
- More than one anterolateral tooth ..... 18
16. Anterolateral tooth well-developed and close to postorbital corner .....  
 ..... *Cryptodromia hilgendorfi* De Man, 1888
- Anterolateral tooth only weakly developed separated from postorbital corner by a  
 broad concavity ..... 17
17. Sub-hepatic tubercle visible dorsally between postorbital corner and first anterolateral  
 tooth ..... *Cryptodromia laevis* Ihle, 1913
- No sub-hepatic tubercle visible dorsally ..... *Cryptodromia nierstraszi* Ihle, 1913
18. Two anterolateral teeth ..... 19
- Three anterolateral teeth ..... 20
19. Small tubercle close to postorbital corner, above level of anterolateral margin .....  
 ..... *Cryptodromia amboinensis* De Man, 1888
- No tubercle close to postorbital corner ..... *Cryptodromia longipes* McLay, 1993
20. Lateral rostral teeth triangular, anterolateral teeth sharp, not flattened, first two  
 pairs of legs very nodular ..... *Cryptodromia mariae* Ihle, 1913
- Lateral rostral teeth truncate, anterolateral teeth blunt, flattened, first two pairs of  
 legs not strongly nodular ..... *Cryptodromia trituberculata* Buitendijk, 1939

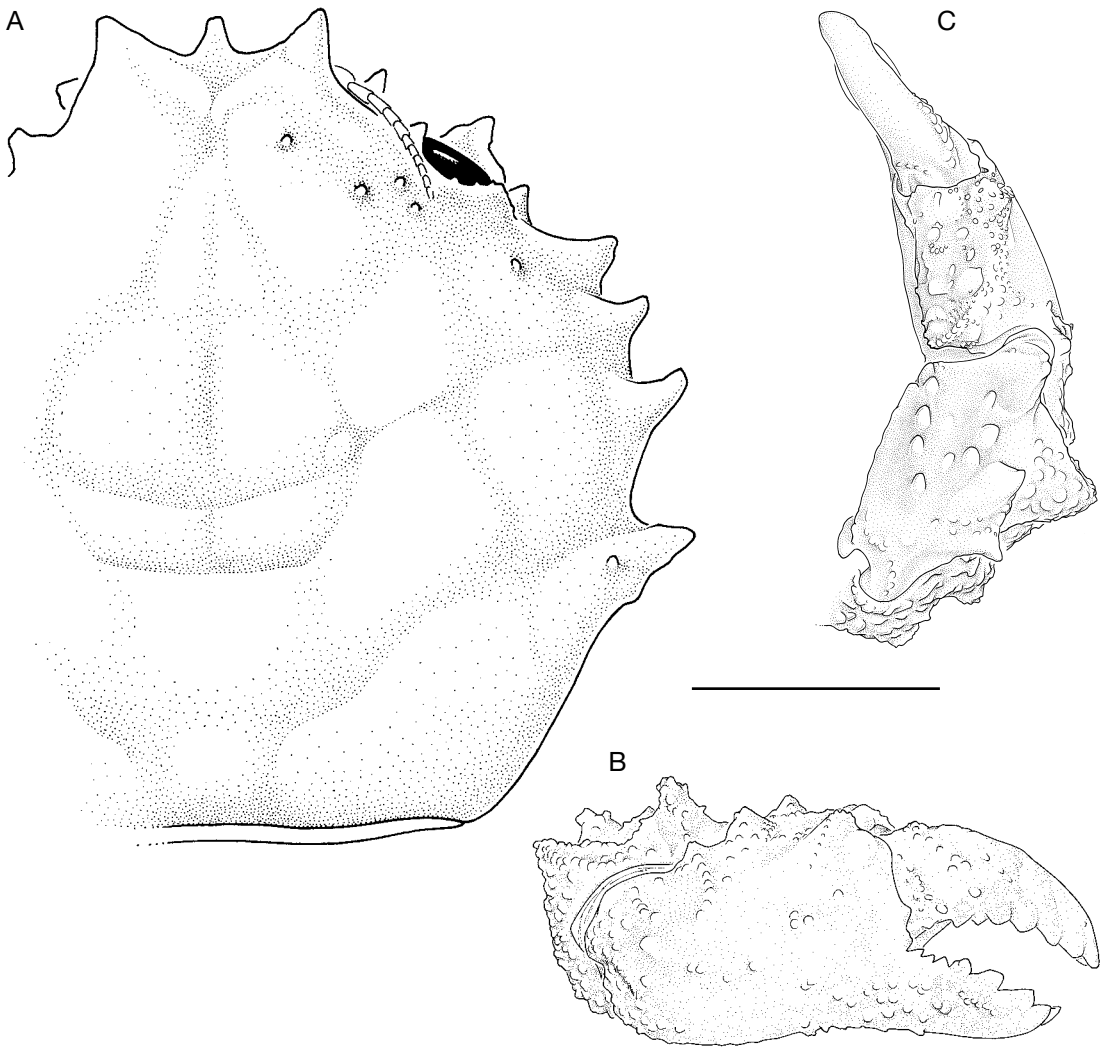


FIG. 2. — *Cryptodromia marquesas* n. sp., holotype ♀ 7.8 × 6.9 mm, Va Pou Island, Marquesas, MUSORSTOM 9, stn CP 1265, 90-92 m (MNHN B2646); **A**, dorsal view of right half of carapace; **B**, outer face of right cheliped; **C**, dorsal view of right cheliped. Scale bar: 2 mm.

*Cryptodromia marquesas* n. sp.  
(Figs 2; 4B)

TYPE MATERIAL. — Holotype, MUSORSTOM 9, stn CP 1265, 1 ♀ 7.8 × 6.9 mm (MNHN B26469). Paratype, stn DW 1203, 1 ♂ 6.5 × 5.7 mm (MNHN B26470).

ETYMOLOGY. — The specific name is derived from the region of the type locality, Ua Poa Island, the Marquesas Islands.

MATERIAL EXAMINED. — **Marquesas Islands.** MUSORSTOM 9, stn CP 1154, 7°58.50'S,

140°43.70'W, 102 m, 23.VIII.1997, 1 ♀ 7.5 × 6.5 mm (MNHN B26466). — Stn CP 1188, 8°4.6'S, 140°3.40'W, 35-55 m, 26.VIII.1997, 1 ♀ (ovig.) 6.5 × 6.2 mm (MNHN B26467). — Stn CP 1203, 9°5.7'S, 139°2.20'W, 60-61 m, 28.VIII.1997, 1 ♀ 5.7 × 5.1 mm, 2 ♂ ♂ 6.4 × 5.7, 6.5 × 5.7 mm (MNHN B26468, 26470). — Stn DW 1204, 9°5.6'S, 139°2'W, 60-62 m, 28.VIII.1997, 2 ♀ ♀ 5.3 × 4.8, 6.8 × 5.8 mm (MNHN B26465). — Stn CP 1265, 9°20.40'S, 140°7.30'W, 90-92 m, 3.IX.1997, 1 ♀ 7.8 × 6.9 mm (MNHN B26469).

**DISTRIBUTION.** — Specimens of *Cryptodromia marquesas* n. sp. were collected from five localities near the islands of Eiao, Nuku Hiva, Ua Poa and Hiva Oa in the Marquesas group.

#### DESCRIPTION

Carapace wider than long, surface smooth, convex, rising steeply from anterolateral margins, branchial area with five distinct low swellings. Short fine setae on carapace arranged in groups that emphasize sculptured surface appearance. Frontal groove prominent, cervical and anterior cardiac grooves cross mid-line, branchial groove faint. Rostrum tridentate, median tooth deflexed, slightly shorter than lateral teeth. Anterolateral margin begins below level of suborbital margin, bearing three similar, evenly spaced blunt teeth, directed anterolaterally, third tooth largest. Branchial notch faintly marked, followed by strong posterolateral tooth directed laterally.

Supraorbital margin interrupted by small tooth, some small denticles near postorbital corner; deep fissure separates suborbital margin, bearing strong central blunt tooth, visible dorsally, and smaller acute tooth medially.

Subhepatic area convex, bearing single strong tooth visible dorsally between suborbital and first anterolateral tooth. Epistome triangular, margins minutely denticulate. Crista dentata has seven or eight small acute teeth. Female sternal sutures 7/8 end apart, without tubercles, just behind first legs.

First article of antenna much wider than long, medially beaked, upper lobe slightly longer than lower lobe. Second article longer than wide, surface convex with prominent median distal tubercle present; distomedial corner produced, on which third article is inserted at an angle. Exopod fixed to second article, curving over eyestalk and bearing prominent tubercle. Ratio of length of antennal flagella to cw = 0.56.

Chelipeds moderately developed. Merus trigonal ventral borders minutely denticulate. Carpus outer face convex, armed with pair of small proximal blunt, tubercles and two similar larger distal tubercles. Propodus superior face with series of four small blunt tubercles along inner margin,

and two larger proximal tubercles medially. Outer propodus face smooth, fingers usually coloured pink, bearing seven blunt teeth, increasing in size distally, interlocking only at tips.

First two pairs of legs smaller than chelipeds. Distal borders of meri, carpi and propodi bluntly produced; carpi bearing prominent lobes on posterior borders; inner margins of dactyli armed with four or five similar small spines.

Last two pairs of legs reduced, third pair shortest, dactyl opposed by single propodal spine; fourth pair also bearing single propodal spine.

Abdomen of six free segments, tip of telson rounded in both male and female. Uropod plates well-developed and visible externally. Abdomen locked in place by uropods fitting in front of small serrated flange on coxae of first legs.

First male pleopod setose at tip; second pleopod simple, needle-like and as long as first.

#### Size

A total of eight specimens of *Cryptodromia marquesas* n. sp. was collected: six females ranged in size from 5.3 to 7.8 mm and two small males were cw = 6.4 and 6.5 mm. The smallest female, cw = 5.3 mm had an immature-sized abdomen, while a female of cw = 5.7 mm had undergone a pubertal moult, attaining a relatively larger abdomen, as had all the other larger females. Three of the females showed signs of reproductive activity: the female, cw = 5.7 mm and another female, cw = 6.8 mm, had mated because both had the ends of sternal sutures 7/8 covered with brown material, and one female was ovigerous. This female, cw = 6.5 mm, was carrying around 130 eggs (0.45 mm diameter). The number of eggs is similar to that carried by a comparably sized female *C. hilgendorfi*, but the egg size is somewhat smaller (McLay 1982). Maturation at a small body size is a feature of the reproductive strategy of the species of *Cryptodromia*. *C. marquesas* n. sp. seems to be a rather small dromiid perhaps having a similar maximum size to *C. hilgendorfi*.

#### Camouflage

Although none of the *Cryptodromia marquesas* n. sp. specimens were carrying pieces of camou-

flage, the last two pairs of legs are large enough, and equipped with propodal spines similar to sponge and ascidian-carrying species such as *Cryptodromia hilgendorfi* (see below). Therefore it is certain that this dromiid normally carries camouflage material. Often these small pieces of camouflage are lost during capture or sorting.

#### Depth

The depth range of *Cryptodromia marquesas* n. sp. is 5–102 m. This is similar to most of the other *Cryptodromia* which are shallow water species, normally found down to around 100 m (McLay 1993).

### *Cryptodromia erioxylon* n. sp. (Figs 3; 4C)

TYPE MATERIAL. — Holotype, MUSORSTOM 9, stn CP 1228, 1 ♀ 11.9 × 9.6 mm (MNHN B26473).

ETYMOLOGY. — The specific name “*erioxylon*” refers to the most distinctive feature of this new species, the covering of long, soft setae, like cotton wool. From the Latin “*erioxylon*” (from the Greek “*erioxylon*”) meaning cotton-like hair (used as a noun in apposition).

MATERIAL EXAMINED. — **Marquesas Islands.** MUSORSTOM 9, stn CP 1228, 9°44.60'S, 138°51.50'W, 107–108 m, 30.VIII.1997, 1 ♀ 11.9 × 9.6 mm (MNHN B26473).

DISTRIBUTION. — Known only from the type locality off Hiva Oa Island, Marquesas.

#### DESCRIPTION

Carapace wider than long, evenly convex, surface mostly smooth except for scattered fine denticles. Covered with long, soft “silky” setae entirely obscuring denticles. Frontal groove evident, anterior and lateral cardiac grooves also apparent and branchial groove deeply incised. Rostrum tridentate, median tooth small deflexed but visible dorsally; lateral teeth blunt directed almost vertically, margins minutely denticulate. Anterolateral margin begins at level well below suborbital lobe armed with three blunt evenly spaced teeth, last tooth directed almost laterally. Behind postorbital corner a large tubercle which, in dorsal view, lies between first two anterolateral teeth. Well-developed posterolateral tooth smaller than anterolateral teeth.

Supraorbital margin concave, denticulated, interrupted by small tooth. Orbital fissure present. Suborbital margin bears well-developed tooth visible in dorsal view. Subhepatic area convex, well-developed tubercle present; along with another tubercle at corner of buccal frame, subhepatic tubercle and anterolateral teeth form curved line of five structures. Crista dentata consists of seven or eight small acute teeth. Female sternal sutures 7/8 end apart just behind first legs on small tubercles. First article of antenna much wider than long, medial margin beaked, upper lobe overhanging lower lobe. Second article longer than wide, surface convex, prominent median distal tubercle present; distomedial corner produced, on which third article is inserted at an angle. Exopod fixed to second article, curving over eyestalk and bearing prominent tubercle, making tip bilobed. Ratio of length of antennal flagella to cw = 0.57. Epistome triangular, surface smooth, margins finely denticulate.

Chelipeds moderately developed, merus trigonal, borders minutely denticulated. Outer face of carpus convex, two large distal tubercles, surface covered with small scattered granules except that a line of three granules runs to base of largest tubercle and another three granules form a line on inner superior border; inner distal border of carpus bears blunt tubercle. Outer face of propodus smooth, superior face with several small scattered granules and a line of four granules along inner superior border. Fingers almost straight, borders armed with seven or eight almost obsolete teeth, fingers closing for about two-thirds their length.

First two pairs of legs shorter than chelipeds, distal margins of meri and carpi produced as lobes, dactyli curved, inner margins armed with four small spines increasing in size distally.

Last two pairs of legs reduced, fourth pair longest reaching almost to last anterolateral tooth. Third leg dactyl opposed by single spine, fourth leg dactyl opposed by one spine with another on outer propodal margin.

Abdomen of six free segments, uropod plates well-developed, visible externally. Telson rounded. Abdominal locking mechanism and male characters unknown.

*Size*

Only known from the female type specimen 11.9 × 9.6 mm.

*Camouflage*

The specimen was not accompanied by a piece of camouflage, but the last two pairs of legs are well-equipped to carry material, such as sponges or ascidians, as found with other species of *Cryptodromia* (McLay 1993).

*Depth*

The type specimen came from 107-108 m, which is towards the deepest part of the range for the genus *Cryptodromia*.

## DISCUSSION

Besides the soft setae covering the crab, the minutely denticulated supraorbital margin and the prominent tubercle behind the postorbital corner are very distinctive characters for this species. The blunt, closely spaced denticles begin on the anterior margin of the lateral rostral tooth, but are not found on the apex of the tooth. Just behind the apex they begin again and continue along the supraorbital margin to the postorbital corner, interrupted only by the blunt supraorbital tooth. After the orbital fissure the denticles continue until the base of the suborbital tooth. The tubercle behind the postorbital corner is about half the size of the anterolateral teeth. *C. amboinensis* De Man, 1888 also has an additional tubercle close to the postorbital corner, but its carapace is as long as wide.

*Cryptodromia hilgendorfi* De Man, 1888

*Cryptodromia hilgendorfi* – Lewinsohn 1984: 109. — McLay 1993: 205, fig. 18d.

MATERIAL EXAMINED. — **Marquesas Islands.** MUSORSTOM 9, stn CP 1156, 7°59'S, 140°43.70'W, 80 m, 23.VIII.1997, 1 ♀ (ovig.) 3.9 × 3.8 mm (carrying the sponge *Phoriospongia* sp.) (MNHN B26527). — Stn DW 1170, 8°45.10'S, 140°13.10'W, 104-105 m, 25.VIII.1997, 1 ♀ (ovig.) 4.3 × 3.9 mm (MNHN B26528). — Stn CP 1188, 8°48.60'S, 140°3.40'W, 35-55 m, 26.VIII.1997, 1 ♂ 3.9 × 3.6 mm (carrying the sponge *Dactylia* sp.) (MNHN B26530). — Stn CP 1212,

9°49.90'S, 139°2.20'W, 50-80 m, 29.VIII.1997, 1 ♀ 3.7 × 3.0 mm, 2 ♂ 4.3 × 3.9, 6.1 × 5.8 mm (all with pieces of the sponge *Phoriospongia* sp.) (MNHN B26525). — Stn CP 1227, 9°44.2'S, 138°52.50'W, 84-85 m, 30.VIII.1997, 1 ♀ (ovig.) 5.2 × 4.3 mm (carrying the sponge *Strongylacidon* sp.) (MNHN B26529). — Stn CP 1237, 9°42.50'S, 139°4'W, 95-305 m, 31.VIII.1997, 1 ♀ (ovig.) 6.2 × 5.4 mm (carrying the sponge *Dactylia* sp.) (MNHN B26526). — Stn CP 1239, 9°42.20'S, 139°3.60'W, 89-85 m, 31.VIII.1997, 1 ♀ 5.3 × 4.2 mm, 3 ♀ (ovig.) 5.8 × 4.9, 5.8 × 5.0, 6.0 × 5.2 mm (all three carrying pieces of the sponge *Phoriospongia* sp.) (MNHN B26524).

DISTRIBUTION. — Until now the distribution of *C. hilgendorfi* has included areas of the Indo-West Pacific, as far east as the Gilbert and Ellice Islands, so the specimens from the Marquesas Islands represent a considerable eastward expansion of the species' range to French Polynesia.

## DESCRIPTION

*Camouflage*

Sponges and ascidians. All the crabs carrying caps were using three different sponges for camouflage, including *Phoriospongia* sp. and *Strongylacidon* sp. (Desmacciidae), and *Dactylia* sp. (Callyspongiidae). Their cover ratios ranged from 1.9 to 5.0 (mean cr = 3.2) indicating that they had adequate camouflage.

*Size*

The size range of *Cryptodromia hilgendorfi* collected from the Marquesas Islands ranged from 3.9 × 3.6 mm to 6.1 × 5.8 mm for males; 3.7 × 3.0 mm to 5.3 × 4.2 mm for non-ovigerous females; and 3.9 × 3.8 to 6.0 × 5.2 mm for ovigerous females. In fact all the females had undergone the pubertal moult and had mature-sized abdomens. Egg numbers ranged from 25 to 200, mean = 91.1, and egg size ranged from 0.4 to 0.66 mm, mean diameter 0.54 mm. All these females were caught between August 23-31, 1997, at 80-105 m, but the stages of egg development varied from newly laid to eyed, and ready to hatch. Some aspects of the reproductive biology differ from the results obtained from a study of *C. hilgendorfi* in Queensland, Australia (McLay 1982). While the number of eggs carried by each female was similar, the mean egg size was smaller in the Marquesas specimens (0.54 mm vs 0.73 mm diam-



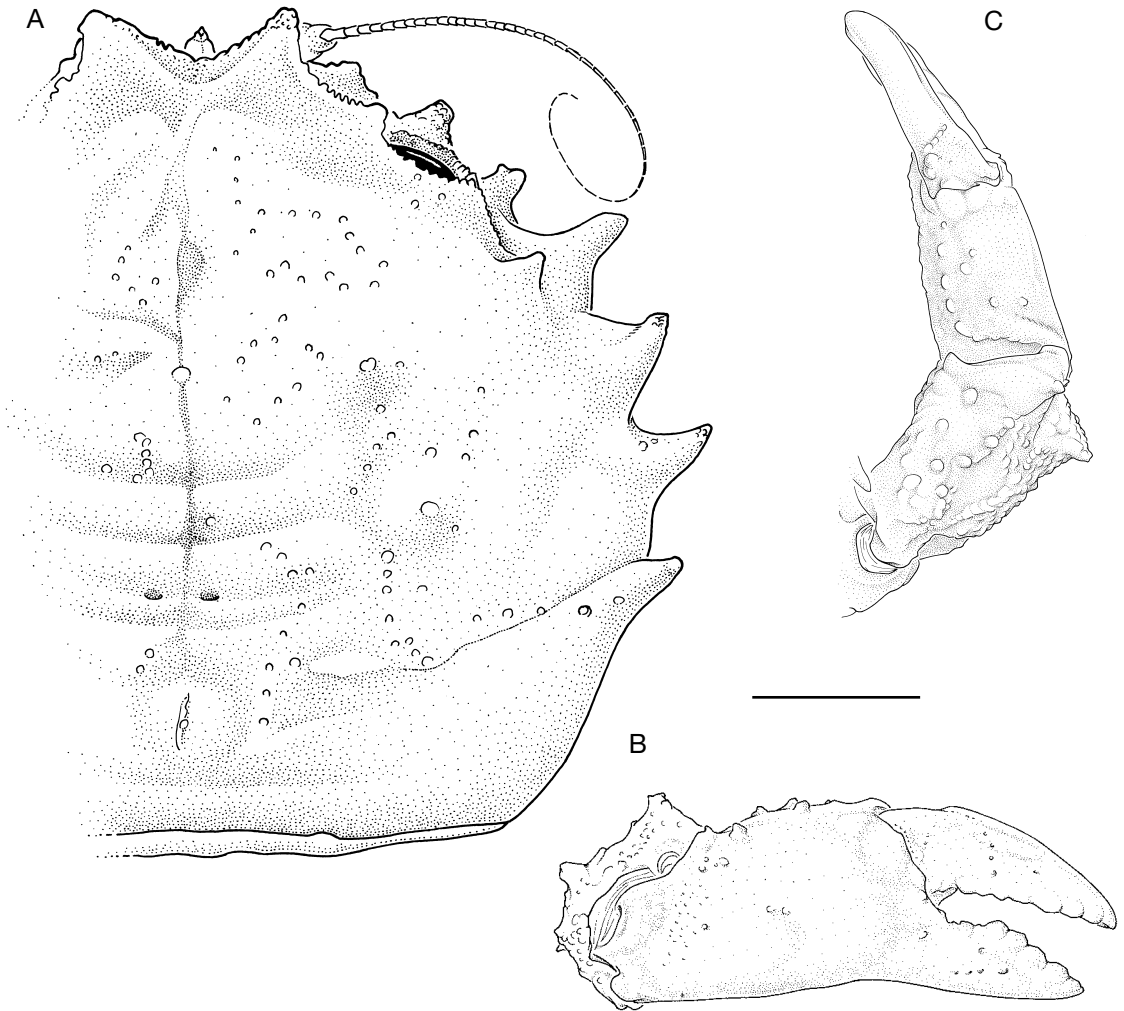


FIG. 3. — *Cryptodromia erioxylon* n. sp., holotype ♀ 11.9 × 9.6 mm, Hiva Oa Islands, Marquesas, MUSORSTOM 9, stn CP 1228, 107-108 m (MNHN B26473); **A**, dorsal view of right half of carapace; **B**, outer face of right cheliped; **C**, dorsal view of right cheliped. Scale bar: 2 mm.

eter). Also the size at sexual maturity was smaller (cw = 3.7 mm vs cw = 6.0 mm). The more precocious maturation of the Marquesas *C. hilgendorfi* is close to the smallest size of maturation for any brachyuran. Manning & Felder (1996) reported an ovigerous pinnotherid female, *Nannothers moorei* Manning & Felder, 1996, of cw = 1.5 mm. It seems that size at maturity and egg size can be adjusted by this species according to where it lives. The Marquesas Islands are almost 18° closer to the equator than Moreton Bay, Queensland.

#### Depth

The previously recorded depth range of *Cryptodromia hilgendorfi* is 0-88 m (McLay 1993). The present material comes from between 35 and 105 m thus extending the maximum depth. The specimen from station CP 1237, from a depth range of 95-305 m, does not seem to justify the assumption that the range of the species should be extended. In view of the fact that all the other specimens came from 105 m, or less, it seems safer to assume that the maximum depth is somewhere around 105 m.

TABLE 1. — Comparison of the dromiid and dynomenid faunas of French Polynesia and Hawaii. Depth range (in m) given for each species is for all occurrences. “?” Indicates that the depth limit is uncertain.

Species	French Polynesia	Hawaii	Depth range
Dromiidae			
<i>Sphaerodromia ducoussoi</i> McLay, 1991	+	-	400-450
<i>Dromidiopsis richeri</i> n. sp.	+	-	49-55
<i>Dromia dormia</i> (Linnaeus, 1763)	+	+	8-112
<i>Dromia wilsoni</i> (Fulton & Grant, 1902)	+	+	0-520
<i>Cryptodromiopsis plumosa</i> (Lewinsohn, 1984)	-	+	15-55
<i>Cryptodromiopsis unidentata</i> (Ruppell, 1830)	+	+	0-122
<i>Cryptodromiopsis tridens</i> Borradaile, 1903	+	+	0-75
<i>Cryptodromia coronata</i> Stimpson, 1858	+	-	0-47
<i>Cryptodromia fallax</i> (Lamarck, 1818)	+	-	0-755
<i>Cryptodromia hilgendorfi</i> De Man, 1888	+	-	0-105
<i>Cryptodromia marquesas</i> n. sp.	+	-	35-102
<i>Cryptodromia erioxylon</i> n. sp.	+	-	107-108
Total number of Dromiidae (12 species)	11	5	0-520
Dynomenidae			
<i>Dynomene hispida</i> Guérin-Ménéville, 1832	+	+	0-30
<i>Dynomene praedator</i> A. Milne-Edwards, 1879	+	+	0-50
<i>Dynomene pilumnoides</i> Alcock, 1900	-	+	18-400
<i>Hirsutodynemene spinosa</i> (Rathbun, 1911)	+	-	0-15
<i>Metadynemene devaneyi</i> (Takeda, 1977)	+	+	367-448
<i>Metadynemene tanensis</i> (Yokoya, 1933)	+	-	205-500
Total number of Dynomenidae (6 species)	5	4	0-500
Total number (18 species)	16	9	0-520

## COMPARISON OF THE DROMIIDAE AND DYNOMENIDAE FAUNAS OF FRENCH POLYNESIA AND HAWAII

Before the MUSORSTOM 9 collection became available, the only dromiids known from French Polynesia were *Cryptodromia coronata* (Nobili, 1907), *C. fallax* (Holthuis, 1953 as *C. canaliculata*), *Sphaerodromia ducoussoi*, *Cryptodromiopsis tridens*, *Dromia wilsoni* (McLay, 1991, the last species reported as *Petalomera wilsoni*). The collection reported by McLay (1991) came from Mururoa, Takapoto, Makemo and Tuanake in the Tuamotu Archipelago, Moorea in the Society Islands, and Raevavae in the Austral Islands. Thus the total number of species stood at five. The present paper adds six species, more than doubling the total number of species, and bringing the number of genera to five (Table 1). The larger number of dromiids from French Polynesia probably reflects more intensive sampling, but there are still large areas unexplored so we might

expect to find even more species. For example, *Lauridromia dehaani* has been recorded from Sala y Gomez (c. 26°S, 105°E) and so may well be found in French Polynesia (Zarenkov 1990).

The first dromiid recorded from Hawaii was *Dromia dormia* (see Lenz 1901) as *Dromia rumphii* (Fabricius, 1798). Species added later were *Cryptodromiopsis unidentata* and *C. tridens* (Edmondson 1922 and Eldredge 1977). Another species in the same genus, *C. plumosa*, is reported herein as well as *Dromia wilsoni*. While 11 dromiid species are known from French Polynesia only five have been recorded from Hawaii so far. Four of the Hawaiian species are also known from French Polynesia, with only *Cryptodromiopsis plumosa* being as yet unrecorded. The absence of any *Cryptodromia* species from Hawaii is surprising, because they are shallow water species, and five are known from French Polynesia. With three species of *Cryptodromiopsis* known from Hawaii, one would expect some species of *Cryptodromia*. Both *Dromia dormia* and *D. wilsoni* are two very

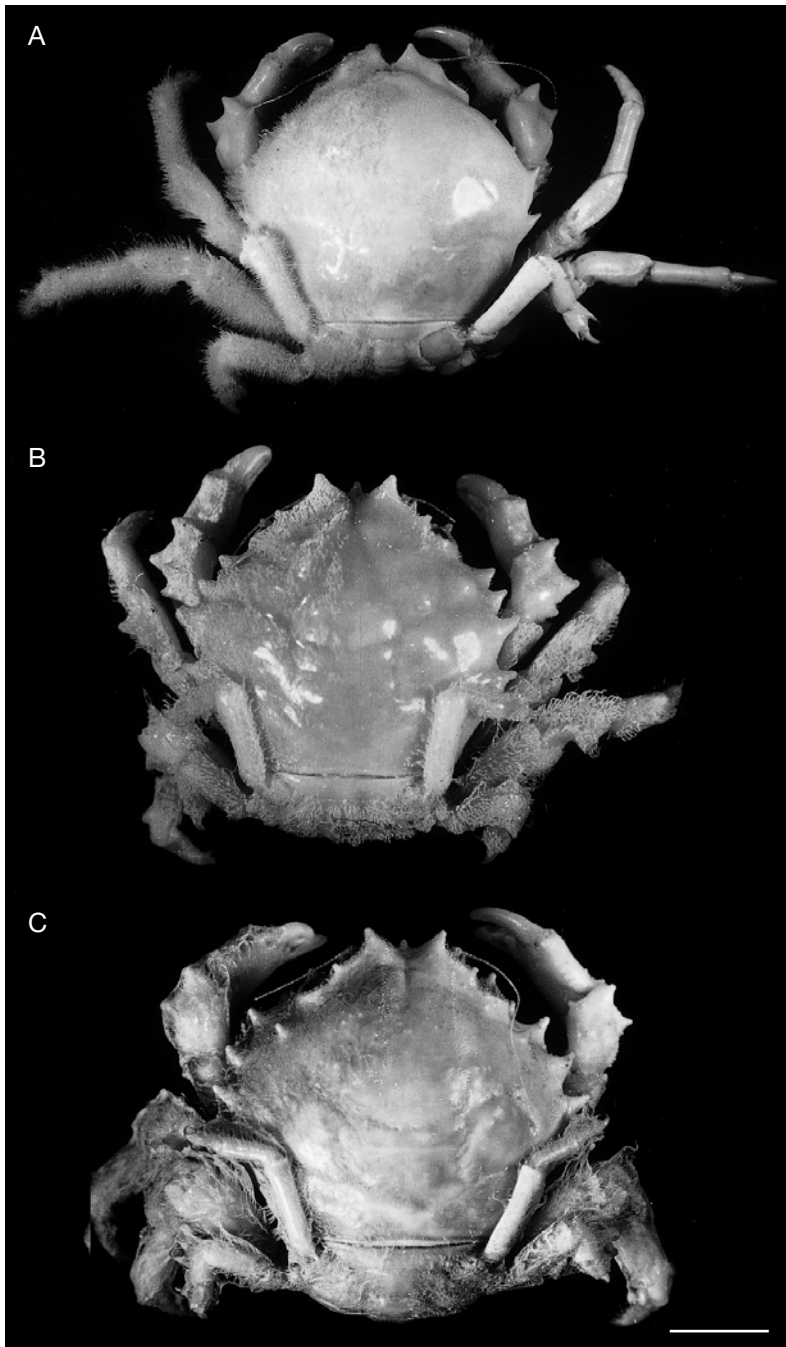


FIG. 4. — **A**, *Dromidiopsis richeri* n. sp., holotype ♀ 15.4 × 15.0 mm, Eiao Island, Marquesas, MUSORSTOM 9, stn CP 1160, 49–55 m (MNHN B26471), dorsal view of whole crab, setae removed from right hand side, right third leg and part of the left fourth leg missing; **B**, *Cryptodromia marquesas* n. sp., holotype ♀ 7.8 × 6.9 mm, Va Pou Island, Marquesas, MUSORSTOM 9, stn CP 1265, 90–92 m (MNHN B26469), dorsal view of whole crab, setae removed from right hand side; **C**, *Cryptodromia erioxylon* n. sp., holotype ♀ 11.9 × 9.6 mm, Hiva Oa Islands, Marquesas, MUSORSTOM 9, stn CP 1228, 107–108 m (MNHN B26473), dorsal view of whole crab, setae removed from right hand side, right first leg missing. Scale bar: A, 5 mm; B, 2 mm; C, 3 mm.

widespread species in the Indo-West Pacific and now both are known from Hawaii and French Polynesia. *D. wilsoni* occupies a wide range of depths and it is the only dromiid known in cooler waters, e.g., from New Zealand. In higher latitudes it occurs intertidally, but in tropical waters it is only found in deeper waters, presumably where temperatures are colder.

The dynomenid faunas of the two island groups are more similar. Five species are recorded from French Polynesia and four from Hawaii. Of the six species, three are shared and the only Hawaiian dynomenid as yet unknown from French Polynesia is *Dynomene pilumnoides*. We might anticipate that this species would be found in French Polynesia because it is found throughout the Indo-West Pacific. There are no Hawaiian or French Polynesian dromiid and dynomenid species shared with the eastern Pacific coasts (Hendrickx 1995, 1997; Holthuis 1953). However, some genera are shared: in the Dromiidae, *Cryptodromiopsis sarraburei* (Rathbun, 1910) (previously known as *C. larraburei*, see Boyko 1998) and in the Dynomenidae, *Hirsutodynomene ursula* (Stimpson, 1860) occur along the eastern Pacific coastline.

The vertical distributions of dromiids and dynomenids fall into three categories. Both families have 1) species restricted to shallow waters; 2) species restricted to deep waters; 3) one species which covers the whole range from surface to deep waters. Among the Dromiidae the following species are mostly confined to depths less than 100 m: *Dromidiopsis richeri* n. sp., *Dromia dormia*, *Cryptodromiopsis plumosa*, *C. unidentata*, *C. tridens*, *Cryptodromia coronata*, *C. fallax*, *C. hilgendorfi*, *C. marquesae* n. sp. and *C. erioxylon* n. sp. *Sphaerodromia ducoussi* is only found below 400 m, and *Dromia wilsoni* spans the whole depth range from 0 to 520 m. Similarly, among the Dynomenidae the shallow water species are *Dynomene hispida*, *D. praedator*, and *Hirsutodynomene spinosa*, while *Metadynomene devaneyi* is only found below 360 m, and *M. tanensis* below 200 m. *D. pilumnoides* lives from shallow waters to 400 m. It is apparent that both families have their greatest diversity in shallow water.

The similar diversity pattern with depth is probably a reflection of the availability of suitable habitats. The two families have completely different habitats. Dromiids are usually associated with sponges and ascidians while dynomenids are associated with corals. For dromiids their association with sponges and ascidians is primarily because these are used for manufacturing camouflage caps carried by the crabs. In shallow waters dynomenids often occur in dead coral rubble while in deeper waters they are found in association with precious corals. Thus the high diversity of these crabs is probably a result of more diverse and abundant habitats in shallow depths.

#### COMMENTS ON DROMIID REPRODUCTIVE STRUCTURES

Little is known about how the reproductive apparatus of dromiid crabs functions (Hartnoll 1973). Like all other podotreme crabs, sperm is stored in spermathecal pouches, which lie between the seventh and eighth sternites, separate from the female gonopores that open in the coxal articles of the second pereopods. Fertilization is external, occurring in the incubation chamber formed by the female abdomen and sternum.

Judging by the structure of the male gonopods, sperm transfer in dromiids is unlike anything found in eubrachyurans. The left and right gonopods must transfer sperm independently. Both gonopods are uniramous and made up of three articles (see for example the gonopods of *Dromia personata* Guinot, 1979: fig 60A-D, or *Sphaerodromia ducoussi* McLay, 1991: fig. 3a-c). The second article of the first gonopod is flattened and concave, while on the third article the margins gradually fold over to meet near the tip, forming a short tube surrounded by dense erect setae. Thus for most of its length the first gonopod is open. The second gonopod consists of a flattened base (made up of two articles) and a stout needle-like third article. When these appendages are assembled in their natural position, the needle of the second gonopod fits into the tube at the tip of the first. By themselves

these appendages would not be able to transfer the sperm. The other integral part of the male apparatus is the very long extension tube (the so-called “penis”) from the male gonopore, on the coxa of the last pair of legs. When the three parts are together in the mating position, with the gonopods at about 45°, the extension of the vas deferens, lying beside the second gonopod, fits neatly into the beginning of the short tube near the tip of the first gonopod. Thus, in dromiids the main conduit for the sperm is not the first gonopod, as in other brachyurans, but the extension of the vas deferens. In the male *Dromia dormia* specimen reported here the extension of the vas deferens measures 18 mm and reaches almost half way along the posterior face of the first gonopod. What the role of the second gonopod is in sperm transfer is not immediately obvious. Clearly it cannot act as a plunger in an “injection device” (Bauer 1986) so we must look elsewhere for a means of getting the sperm from the male into the female. In fact, by blocking the sperm aperture in the first gonopod, the needle of the second is more of a hindrance than a help. It may be that muscular contractions of the extension tube are sufficient to propel sperm out of the tip of the first gonopod. This might be called the “toothpaste tube” model of sperm transfer.

Brandis *et al.* (1999) showed that about half the length of the first gonopod of *Potamon gedrosianum* Alcock, 1909 is folded to form a channel, into which the second gonopod is inserted. This channel is primarily for stabilizing the second gonopod. The second gonopod is longer than the first and is introduced into its partner by sliding sideways into the suture formed by the folded edges of the first gonopod. The second gonopod has a spoon-like process at about two thirds of its length and distal to the process, the gonopod is folded into a narrow tube, in a similar way to the first gonopod. Thus there is a tube within a tube. When the second gonopod is fully inserted, its flattened proximal widening closes the proximal opening of the first gonopod. They argue that the ejaculate from the “penis” is transported to the beginning of the tube on the second gonopod and thence to the

tip of the first gonopod, inserted into the female, where it enters the spermatheca. Since the second gonopod is longer than the first, it must always block the aperture at the tip of the first gonopod. However, the tube on the distal portion of the second gonopod must provide a route for the ejaculate to reach the spermatheca inside the female. Thus, in *P. gedrosianum*, it is the second gonopod which is the organ of sperm transfer. It is assumed that the “penis” can develop enough pressure to push sperm into and out of the gonopod, because they believe that pumping movements of the second gonopod are not possible so it cannot act as a plunger. They suggest that the rosette glands lining the interior wall of the first gonopod may provide additional pressure.

It is puzzling that Brandis *et al.* (1999) argue that pumping movements of the second gonopod in *P. gedrosianum* are not possible, because these have been observed in *Cancer borealis* Stimpson, 1859, which has similar long, but non-tubulated, second gonopods (see Elner *et al.* 1985). The spoon-like process on the second gonopod may make a seal with the wall of the first gonopod and ensure that some pressure can be developed to force sperm into the female. A distal narrowing of the internal diameter of the first gonopod may augment this.

Although they have similar gonopods, the same sperm transfer mechanism cannot work in dromiids because the first gonopod is not tube-like, except near the tip, and the second gonopod lacks the spoon-like process and it is not folded to form a tube. The only similarity to *P. gedrosianum* is the role of the “penis” in delivering sperm to the first gonopod that acts as a guide for the second gonopod. Once the sperm is emitted from the tip of the dromiid male gonopod, we still have the problem of how it gets into the female. Gordon (1950: figs 24; 25) showed that, in *Dromia personata*, the spermathecal apertures, at the level of the second pereopod, lead via a tube formed by the walls of sternal segments seven and eight, to the spermathecae situated at the back of the sternum. If the sperm enter the female at the ends of sternal sutures 7/8 how does it get from there into the spermathecae? Clearly,

the male gonopods are incapable of applying any pressure that might force sperm into the spermathecae. The tip of the first gonopod is too large to fit into the small spermathecal aperture so that it cannot form a tight seal. Gordon (1950) claimed that dromiids have a hollow second gonopod that can enter the spermathecal aperture and, acting like a hypodermic needle, inject sperm into the spermathecae. However this is not possible because there is no way for the sperm to enter the base of the gonopod and the tip is not open. Thus these gonopods cannot act as a conduit for sperm.

In the ovigerous female *Dromia dormia* specimen reported here, approximately the last 8 mm of the sternal sutures 7/8 are blocked by soft, semi-transparent material and posterior to the blockage about 4 mm of the suture is open (total length of the sternal suture is approximately 50 mm). This soft material might be termed a "sperm plug" but its origin is not clear. Since the female is carrying eggs, she must have mated and fertilized her eggs, but was the blockage formed after mating or after fertilization? We do not know how sperm gets into the spermathecae or, perhaps more importantly, how it gets out again. If the material blocking the ends of the sutures forms after mating, how does the sperm get out and fertilize the eggs? On the present female some 40 mm separates the gonopores, where the eggs must emerge, from the anterior ends of the sternal sutures. In fact the gonopores are much closer (20 mm) to the posterior ends of the sutures. Interestingly, at the posterior end of the right suture there appears to be a spermatophoric mass (8 mm long by 0.6 mm diameter) attached, part way along its length, beside the closed suture. This small tube is filled with white opaque material, presumably sperm, and the ends seem to be the pinched off parts of a chitinous exterior lining. Whether this is a misplaced spermatophore is not clear.

One unusual feature of gonopods of *D. dormia* should be noted: the needle-like male second gonopod is stout and the tip is flattened like a chisel. The tip is a darker colour, indicating that it is sclerotized and hardened. When inserted

the second is long enough to emerge through the sperm aperture on the first gonopod. Thus during mating both gonopods can make contact with the female and the second one may have a role in preparing the spermathecal openings to receive sperm. In homolodromiids it is clear that the second gonopod can make contact with the female because Guinot (1995) found broken-off tips inserted into the sternal suture openings. However, these have never been observed in dromiids or dynomenids (which have similar gonopods). An examination of the other species of *Dromia* shows that they all have second gonopods with an acute tip. The second gonopod is normally stoutly built except in *Dromia wilsoni*, where it is very fine, flexible and almost thread-like. This perhaps indicates that, in this species, it has a different role in sperm transfer.

Thus, many questions remain to be answered about the mechanics of mating and fertilization in dromiids. Perhaps we have paid undue attention to the role of the male and more attention should be concentrated on how the female side of things works. We should not assume that the female role is purely passive. Brandis *et al.* (1999) also emphasize the need to understand the role of the female. One thing that needs to be established is whether mating in dromiids is always linked to moulting, which seems most likely, or whether it can occur at any time during the intermoult. The observations of Hartnoll (1973) of mating in *Dromia personata* are rather unsatisfactory and do not help us to find answers to these questions.

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