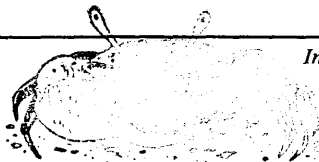


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**A Review of the Hermit Crab Genus *Calcinus* Dana
(Crustacea : Decapoda : Diogenidae) from Australia,
with Descriptions of Two New Species**

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Abstract

Seventeen species of the genus *Calcinus* are recorded from Australian waters, including Cocos (Keeling) and Christmas Islands in the Indian Ocean and Norfolk and Lord Howe Islands in the Tasman Sea, Pacific Ocean. Two new species, *C. inconspicuus*, sp. nov. and *C. sirius*, sp. nov., are described from the Tasman Sea. A key to Australian species of *Calcinus* is provided.

Introduction

Members of the genus *Calcinus* are a common component of intertidal and shallow subtidal marine habitats of tropical Australia, especially on hard substrates such as coral reefs and rock platforms. Temperate water representatives of the genus are less diverse but nevertheless sometimes very common (Morgan 1989).

Several papers have reviewed the species of *Calcinus* for relatively small geographical areas in the Indo-Pacific region (Wooster 1984; Mariana Islands; Haig & McLaughlin 1984; Hawaiian Islands). A number of workers include reference to *Calcinus* species in general reviews of hermit crabs from Indo-West Pacific localities (Alcock 1905; Yap-Chiongco 1938; Fize & Serène 1955; Forest 1958; Lee 1969; Ball & Haig 1972; Baba 1982; Haig & Ball 1988). Very little taxonomic work has been undertaken on hermit crabs from Australian waters and Australian species of *Calcinus* have received brief mention in only a few papers (Haswell 1882b; Grant & McCulloch 1906, 1907; McNeill 1926, 1968; Forest 1956a; Morgan 1989).

The present paper reviews the 17 species of *Calcinus* known from Australia, including the offshore territories of Cocos (Keeling), Christmas, Lord Howe and Norfolk Islands. Two new species are described, six species are new records for Australia, and major range extensions are noted for the nine species previously recorded from Australia.

Synonymies are not complete but include reference to authors of synonyms, together with papers useful in identifying species and references to the Australian fauna.

Species are diagnosed by characters selected from the literature and from examination of material. One diagnostic character requires some definition. Several species have a much heavier development of setae on the ventral margin of the dactylus and distal part of the propodus of the third pereiopod than on the corresponding margins of the second pereiopod. This dense setal 'brush' has been presented by several workers (e.g. Wooster 1984; Haig & McLaughlin 1984) as either present or absent. There are at least four species, however, which display an intermediate condition which clearly exceeds the setal development of the second pereiopod but which cannot be regarded as a true brush. The other diagnostic morphological characters pertain to the ornamentation of the chelipeds, ocular acicles and telson.

The diagnoses permit recognition of species; full descriptions have been included only for the two new species. Where examined material differs significantly from previous descriptions, reference is made to these differences in species' *Remarks*.

Notes on live coloration are included for all species. Colour patterns appear to be species-specific in *Calcinus* and facilitate identification. These notes and the illustrations of colour patterns are based on live specimens, transparencies and recently preserved material. Colours fade quite rapidly in ethanol, especially in small specimens, but some colour patterns are usually visible after many years of preservation, particularly in those species with strong pigmentation.

A key to the genus using morphological and colour characters is provided.

Over 1100 specimens of *Calcinus* were examined. Specimen sizes are cited as shield length (SL). Museums where specimens are deposited are abbreviated as follows: Australian Museum, Sydney (AM); Queensland Museum, Brisbane (QM); Museum of Victoria, Melbourne (NMV); Western Australian Museum, Perth (WAM); and the Nationaal Natuurhistorisch Museum (formerly Rijksmuseum van Natuurlijke Historie), Leiden (RMNH). The Australian Marine Photographic Index, proprietor Mr N. Coleman, is abbreviated as AMPI.

Systematics

Family *Diogenidae* Ortmann, 1892

Genus *Calcinus* Dana, 1852

Cancer.—Herbst, 1791: 25 [in part, misidentification, not *Cancer* Linnaeus].

Pagurus.—H. Milne Edwards, 1836: 277; Owen, 1839: 83; H. Milne Edwards, 1848: 63; Randall, 1839: 134 [in part, misidentifications, not *Pagurus* Fabricius].

Calcinus Dana, 1852: 456.—Stimpson, 1858: 234; Ortmann, 1892: 292; Alcock, 1905: 51; Fize & Serène, 1955: 38; Miyake, 1978: 53; Wooster, 1984: 125.

Type species: *Cancer tibicen* Herbst, 1791, subsequent designation by Stimpson, 1858: 234.

Diagnosis

Ocular peduncles elongate; ocular acicles slender. Rostrum small. Third maxillipeds with well developed crista dentata; accessory tooth absent. 13 phyllobranchiae. Left cheliped markedly larger than right; fingers moving obliquely, finger tips calcareous; carpus of left cheliped with prominent tubercle on dorsolateral surface. Pereiopods weakly spinose; setation light.

Key to Australian Species of *Calcinus*

1. Dactylus and distal part of propodus of third pereiopod with dense clumps of long setae forming distinct brush on ventral margin; much lighter development of setae on second pereiopod 2
2. Dactylus and propodus of third pereiopod with similar or only slightly greater development of setae than on second pereiopod, setae not forming distinct brush 5
3. Lateral face of left chela with 2 or 3 broad depressions; left and right posterior lobes of telson each with 1 marginal spine; pereiopods 2 and 3 banded in white, red-brown and olive *C. imperialis* Whitelegge
4. Lateral face of left chela lacking distinct depressions; posterior lobes of telson each with several marginal spines; coloration of pereiopods 2 and 3 not as above 3
5. Pereiopods 2 and 3 distinctly banded in bright blue and dark brown or black *C. elegans* (H. Milne Edwards)
6. Pereiopods 2 and 3 not banded 4
7. Pereiopods 2 and 3 rather uniformly brown or orange-brown, with tips of dactyls cream *C. gaimardii* (H. Milne Edwards)
8. Pereiopods 2 and 3 burgundy with numerous white dots *C. argus* Wooster
9. Dactylus and propodus of third pereiopod with greater development of setae than on second pereiopod 6
10. Dactylus and propodus of third pereiopod with no greater development of setae than on second pereiopod 9

6. Ocular acicles bi- or trispinose; very dark dorsal patch proximally on ocular peduncles ...
..... *C. vachoni* Forest
Ocular acicles simple; ocular peduncles lacking dark proximal patch 7
7. Telson with 1 marginal spine on each posterior lobe; pereopods 2 and 3 uniformly brown
with dactyli cream at tip *C. sirius*, sp. nov.
Telson with more than 1 marginal spine on left or both posterior lobe(s); pereopods 2 and
3 not uniformly coloured 8
8. Telson with numerous marginal spines on both posterior lobes; pereopods 2 and 3 with
dactyli and distal propodi purple *C. spicatus* Forest
Telson with several spines on left posterior lobe only, and 1 (rarely 2) on right posterior
lobe; proximal half of dactyli of pereopods 2 and 3 with several short red-purple
longitudinal stripes on slightly paler background *C. latens* (Randall)
9. Left chela massive, nearly operculate, rather smooth; right chela with smooth or very weakly
tuberculate dorsal margin 10
Left chela not massive; right chela with spinose or strongly tuberculate dorsal margin ... 11
10. Dactyli of pereopods 2 and 3 subequal to propodi; dorsolateral ridge on propodus of
pereopod 3; proximal dark band on dactyli, longitudinal dark stripe on carpi and
transverse dark band on meri of pereopods 2 and 3 *C. seurati* Forest
Dactyli of pereopods 2 and 3 distinctly shorter than propodi; dorsolateral ridge lacking on
propodus of pereopod 3; subproximal dark spot on dactyli, 2 longitudinal dark stripes
on carpi and longitudinal dark stripe on meri of pereopods 2 and 3
..... *C. laevimanus* (Randall)
11. Telson with 1 marginal spine on both posterior lobes; pereopods 2 and 3 banded in white,
red and brown *C. dapsiles* Morgan
Telson with several marginal spines on both posterior lobes; pereopods not banded ... 12
12. Ocular acicles simple; pereopods with fairly uniform brown coloration
..... *C. inconspicuus*, sp. nov.
Ocular acicles multispinose (except rarely simple on *C. minutus*); pereopods not uniformly
brown 13
13. Lateral and mesial faces of palms of both chelae with dark brown spot; pereopods 2 and
3 with longitudinal flecks or stripes 14
No dark brown spot on lateral and mesial faces of chelae; pereopods 2 and 3 not flecked
or striped 15
14. Pereopods 2 and 3 with short longitudinal flecks on all segments, each segment with dark
medial patch except carpus of pereopod 2, this being fose *C. pulcher* Forest
Pereopods 2 and 3 lacking flecks, propodi with dark brown or maroon longitudinal stripes
..... *C. lineapropodus* Morgan & Forest
15. Very dark band proximally on ocular peduncles and dactyli of pereopods 2 and 3
..... *C. guamensis* Wooster
No dark bands on ocular peduncles or pereopods 16
16. Body and pereopods predominantly white or cream, with dactyli and distal part of propodi
of pereopods 2 and 3 orange *C. minutus* Buitendijk
Chelipeds and pereopods 2 and 3 predominantly purple-brown; finger tips and tip of dactyli
cream; small orange dots especially visible on dactyli of pereopods
..... *C. haigae* Wooster

Calcinus argus Wooster

(Figs 1-3)

Calcinus argus Wooster, 1984: 133, fig. 3.

Material Examined

Western Australia: ♂, SL 4.9 mm; ♀, SL 5.4 mm; Cocos (Keeling) Is, 9.ii.1989, 15-30 m, WAM 510-89.

Type Specimens (not examined)

Holotype ♀, 7 paratypes, location unknown, not cited by Wooster (1984).

Type locality. Guam, Mariana Islands.

Diagnosis

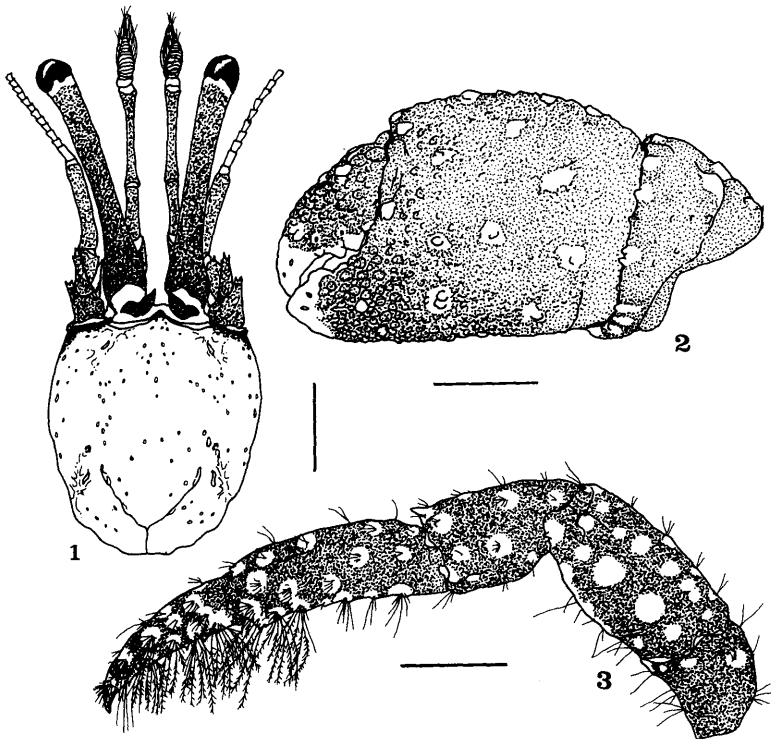
Ocular acicles simple or bispinose. Lateral face of palm of left cheliped bearing numerous small tubercles. Right cheliped with strong spines on dorsal margin of propodus and carpus. Brush of plumose setae on ventral margin of dactylus and distal part of propodus of third pereiopod. Telson with 1 marginal spine on both left and right posterior lobes. Shield predominantly white with thin burgundy band along anterior margin; chelipeds, second and third pereiopods burgundy with numerous white spots.

Live Coloration

Shield (Fig. 1) white with anterior edge burgundy; some pale burgundy on lateral faces; burgundy spot medially on cervical groove and smaller spot each side of median spot. Ocular peduncles burgundy; white line at base of black corneas; ocular acicles burgundy. Antennular and antennal peduncles burgundy; flagella orange. Chelipeds (Fig. 2) and second and third pereiopods (Fig. 3) burgundy with numerous scattered white or pale orange spots.

Remarks

Calcinus argus resembles *C. elegans* (H. Milne Edwards), *C. gaimardii* (H. Milne Edwards) and *C. imperialis* (Whitelegge) in possessing a strong brush of setae on the dactylus and distal part of propodus of the third pereiopods. The live coloration is distinctive and permits easy field recognition of the species. The Australian specimens agree well with the description by Wooster (1984) although the ocular peduncles are slightly more



Figs 1-3. *Calcinus argus* Wooster, ♂, WAM 510-89. 1, shield and cephalic appendages, dorsal view (setae omitted); 2, left cheliped, lateral view (setae omitted); 3, left third pereiopod, lateral view. Scales = 2.0 mm.

elongate and the distal setae on the dactylus and propodus of the third pereiopod are longer, denser and more plumose than illustrated by Wooster (1984, fig. 3).

Distribution

Known only from the Mariana Islands and Cocos (Keeling) Islands.

Habitat

Coral and dead coral rubble; subtidal to 25 m.

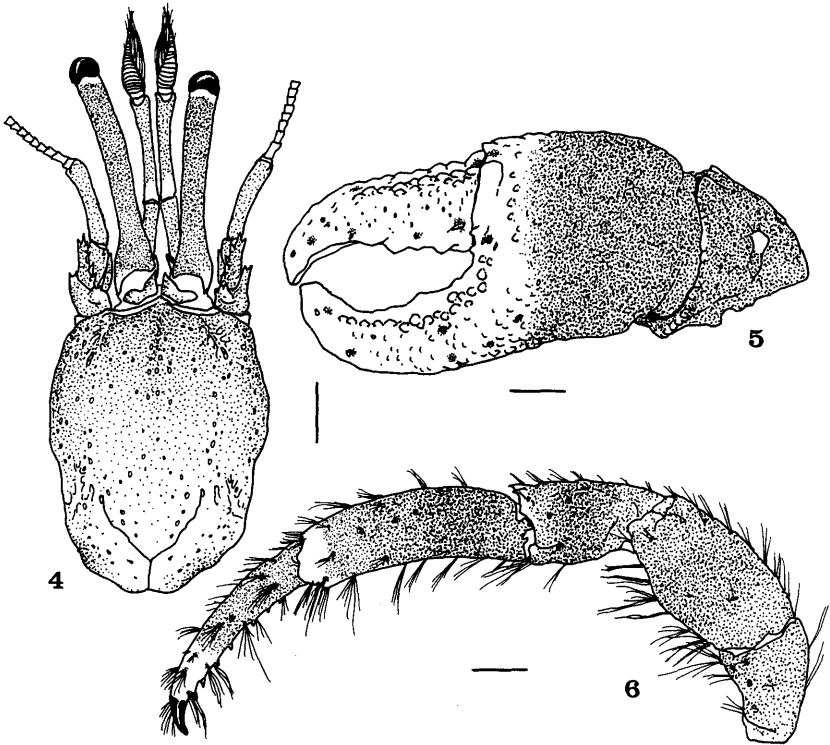
Calcinus dapsiles Morgan

(Figs 4-6)

Calcinus dapsiles Morgan, 1989: 407, fig. 4.

Material Examined

Western Australia: Holotype and paratypes: see Morgan (1989: 407-408); ♂, SL 2.7 mm, Warroora, S. end of Ningaloo Reef, 5.vi.1981, WAM 99-90; 36 specimens, SL 5.5-2.4 mm, Steep Point, Shark Bay, 11-13.iii.1986, WAM 100-90, 102-90, 111-90; 21 specimens, SL 4.7-1.7 mm, opposite Cape Ransonnet, Shark Bay, 9.iii.1986, WAM 101-90; 29 specimens, SL 6.5-1.9 mm, Monkey Rock, Shark Bay, 10-13.iii.1986, WAM 105-90, 107-90, 115-90; ♂, SL 4.0 mm, Port Gregory, 10-12.xii.1964, WAM 1163-86; 21 specimens, SL 10.3-1.7 mm, Dyer I., Rottnest I., 19.xii.1985, 5-15 m, WAM 407-86; 2♂, SL 7.8 mm, 3.4 mm, ♀, SL 3.5 mm, Little Armstrong Bay, Rottnest I., 14.ii.1985,



Figs 4-6. *Calcinus dapsiles* Morgan, holotype ♂, WAM 173-88. 4, shield and cephalic appendages, dorsal view (setae omitted); 5, left cheliped, lateral view (setae omitted); 6, left third pereiopod, lateral view. Scales = 2.0 mm.

0·3 m, WAM 2010-86; ♂, SL 7·0 mm, Cockburn Sound, 23.xi.1969, 6 m, NMV J18370; ♂, SL 5·3 mm, 2♀, SL 3·9 mm, 3·3 mm (ovig.), Whaling Cove, King George Sound, 16.i.1988, sand and *Posidonia*, WAM 151-88; ♂, SL 4·0 mm, Ataturk Entrance to Princess Royal Harbour, Albany, 25.i.1988, 4 m, in serpulid tube, WAM 564-88; 2♂, SL 2·4 mm, 1·1 m, ♀, SL 2·4 mm, False I., King George Sound, 15.iv.1984, 25 m, NMV J18376.

Diagnosis

Ocular acicles simple. Lateral face of palm of left cheliped bearing very small tubercles. Dorsal margin of carpus and propodus of right cheliped with pronounced spines. Brush of setae on dactylus and propodus of third pereopod absent. Telson with left and right posterior lobes each armed with 1 spine directed ventrally from posterior margin. Shield brown or salmon-brown, paler posteriorly; second and third pereopods banded in white, red and brown, with small orange dots at setal pores.

Live Coloration

Shield (Fig. 4) brown or salmon-brown, pale posteriorly. Ocular peduncles pale brown or salmon, tinged with pink proximally, thin cream band at base of corneas; acicles pale brown. Antennular and antennal peduncles cream and brown; antennular flagella cream with orange ventrally, antennal flagella pale orange. Chelipeds (Fig. 5) with fingers cream or white with small red or orange dots; palm cream distally, remainder dark brown; carpus dark brown with white on spines; merus paler than carpus. Second and third pereopods (Fig. 6) with dactylus white or cream distally, proximal half to $\frac{2}{3}$ pink; propodus white on distal margin, remainder red, brown or purple-brown, red proximally; carpus brown or purple-brown, paler distally and proximally; merus paler than carpus; scattered orange or red dots on all segments. Juveniles paler, sometimes almost entirely cream with orange spots on pereopods.

Remarks

This hermit crab is extremely abundant in south-western Australia and is the only species of *Calcinus* occurring south of Rottnest Island. *C. latens* (Randall) occurs with *C. dapsiles* north of Rottnest Island and is also the most similar congener morphologically. The two species are distinguished by spination of the telson and coloration, as discussed by Morgan (1989).

The specimen WAM 99-90, recently separated from a lot of mixed species, from Warroora north of Carnarvon, extends the known range of the species northwards by at least 200 km.

Distribution

From east of Albany to about 150 km north of Carnarvon, W.A., including Houtman Abrolhos Islands.

Habitat

Intertidal and subtidal to 97 m; rocky and coral reefs, sand, shell rubble, seagrass beds. A wide variety of gastropod shells (see Morgan 1989) and, rarely, serpulid worm tubes, are utilised.

Calcinus elegans (H. Milne Edwards)

(Figs 7-9)

Pagurus elegans H. Milne Edwards, 1836: 278, pl. 13, fig. 2, 2a.

Pagurus pictus Owen, 1839: 83, pl. 25, fig. 2, 2a.

Pagurus decorus Randall, 1839: 134.

Calcinus elegans.—Dana, 1852: 458, 1855, pl. 28, fig. 10a, b, c; Alcock, 1905: 55, pl. 5, fig. 2; Forest, 1956a: 47; Wooster, 1984: 128; Haig & Ball, 1988: 159.

Material Examined

Western Australia: 20 specimens, SL 8·6–2·6 mm, Christmas I., Indian Ocean, Feb. 1987, intertidal and shallow rocks, WAM 643-87 to 648-87; 16 specimens, SL 8·1–1·7 mm, Cocos (Keeling) Is, Feb. 1989, intertidal to 3 m, coral and rocks, WAM 345-89, 400-89, 500-89, 622-89, 221-90.

Type Specimen (not examined)

Muséum national d'Histoire naturelle, MNHN Pg1934.

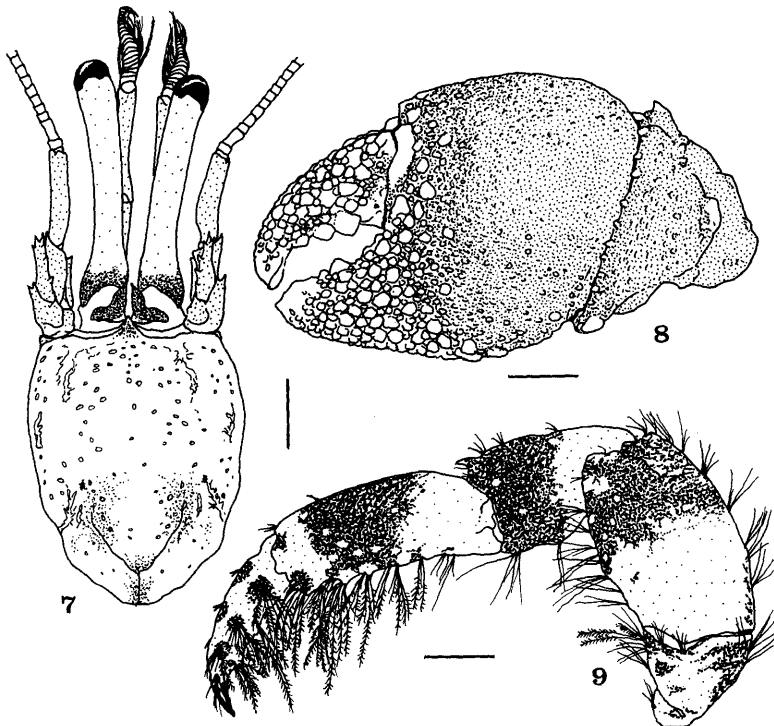
Type locality. New Ireland.

Diagnosis

Ocular acicles simple. Lateral face of palm of left cheliped densely tuberculate. Dorsal margin of propodus and carpus of right cheliped spinose. Brush of long setae present on ventral margin of dactylus and distal part of propodus of third pereiopod. Telson with several marginal spines on both left and right posterior lobes. Chelipeds brown or brown-green with white finger tips; second and third pereiopods banded in bright blue and dark brown or black.

Live Coloration

Shield (Fig. 7) cream with areas of pale brown and blue. Distal $\frac{2}{3}$ of ocular peduncles bright blue, proximal $\frac{1}{3}$ very dark brown; ocular acicles dark brown. Antennules and antennae orange. Chelipeds (Fig. 8) olive green or ochre with white finger tips and tubercles. Second and third pereiopods (Fig. 9) with dactylus blue with dark brown spots; propodus



Figs 7-9. *Calcinus elegans* (H. Milne Edwards), ♂, WAM 221-90. 7, shield and cephalic appendages, dorsal view (setae omitted); 8, left cheliped, lateral view (setae omitted); 9, left third pereiopod, lateral view. Scales = 2·0 mm.

bright blue distally and proximally with broad middle band of dark brown or black with blue spots at setal pores and some brown spots in distal blue band; carpus and merus distally dark brown with blue pores, proximally bright blue. Setae violet.

Remarks

The brilliant contrast of blue and dark brown or black bands on the ambulatory pereopods permits easy identification of live Australian specimens. It has been suggested that geographical variation can occur in the colours, if not the pattern, of this species. Haig & McLaughlin (1984) reported that *C. elegans* has orange-red rather than blue bands in Hawaii. Specimens from the Marianas Islands (Wooster 1984), Paumotu (= Tuamotu) Archipelago and Wake Island (Dana 1852), Indonesia (Haig & Ball 1988) and east Africa (Barnard 1950) would appear to be similarly coloured to Australian material, and Fize & Serène (1955) briefly recorded the pereopods as being banded in blue and red in specimens from Vietnam.

Pagurus pictus Owen and *P. decorus* Randall were synonymised with *C. elegans* by Dana (1852).

Distribution

East Africa throughout much of the Indian Ocean to Indonesia, New Guinea, Hawaii and Taumotu Archipelago; Cocos (Keeling) and Christmas Islands.

Habitat

Intertidal and subtidal to 10 m; coral, coral rubble, rock platforms.

Calcinus gaimardii (H. Milne Edwards)

(Figs 10-13)

Pagurus gaimardii H. Milne Edwards, 1848: 63.

Calcinus gaimardii.—Dana, 1852: 457, 1855: pl. 28, fig. 9; Alcock, 1905: 56, pl. 5, fig. 3; Grant & McCulloch, 1906: 35; McNeill, 1968: 27; Haig & Ball, 1988: 159.

Calcinus gaimardi.—Fize & Serène, 1955: 49, pl. 2, figs 5-8, text figs 7, 8; Wooster, 1984: 131; Haig & McLaughlin, 1984: 108.

Material Examined

Western Australia: 89 specimens, SL 9.5-2.0 mm, Christmas I., Indian Ocean, Feb. 1987, intertidal to 20 m, WAM 544-87 to 559-87; 15 specimens, SL 5.6-1.9 mm, Cocos (Keeling) Is, Feb. 1989, intertidal to 20 m, coral, coral rubble, rocks, WAM 353-89, 376-89, 378-89, 396-89, 635-89; 2♂, SL 8.1 mm, 6.3 mm, ♀, SL 3.7 mm, Cassini I., Kimberleys, 18.vii.1988, intertidal rocks and coral, WAM 2100-88; 40 specimens, SL 7.0-2.1 mm, Ashmore Reef, Sept. 1986, WAM 66-90 to 68-90, 132-90; ♀, SL 2.5 mm, Cartier I., Sept. 1986, WAM 69-90; 3♂, SL 6.9 mm, 5.3 mm, 5.2 mm, 3♀, SL 5.6 mm (ovig.), 5.2 mm (ovig.), 4.8 mm, Sandy Islet, Scott Reef, 7.ix.1984, WAM 711-85, 713-85, 715-85, 750-85; 2♂, SL 6.0 mm, 5.1 mm, 3♀, SL 5.8 mm (ovig.), 5.2 mm (ovig.), 4.7 mm, Seringapatam Atoll, 14.x.1978, reef ridge, WAM 1041-86, 1042-86; 2♂, SL 7.6 mm, 4.9 mm, 2♀, 5.8 mm, 4.0 mm, Clerke Reef, Rowley Shoals, 21.vii.1982, reef flat, WAM 805-86; 2♀, SL 7.3 mm, 5.0 mm, Mermaid Reef, Rowley Shoals, 20.vii.1982, WAM 807-86; ♂, SL 8.7 mm, Steep Point, Shark Bay, 13.iii.1986, WAM 102-90; ♀ (ovig.), SL 5.9 mm, Surf Point, Shark Bay, 9.iii.1986, WAM 114-90; 2♀, SL 10.6 mm, 9.2 mm, Coronation I., Houtman Abrolhos, 25.x.1985, coral slope, WAM 1377-85. **Queensland:** ♂, SL 4.9 mm, Murray I., Sept. 1907, AM P7531; ♂, SL 4.1 mm, Green I., 25.vi.1984, reef flat, QM W11432; ♂, SL 7.6 mm, Kenn Reef, east of Great Barrier Reef, 21.i.1960, AM P17486; 4♀, SL 7.8-6.1 mm, Heron I., 12-23.vi.1976, intertidal, QM Q11383; ♀ (ovig.), SL 7.7 mm, Heron I., 6.xii.1978, AM P31017; 2♂, SL 8.5 mm, 7.0 mm, Masthead I., AM G5729 (part); ♂, SL 7.9 mm, Lady Elliot I., 1964, AM P17465; ♂, SL 9.5 mm, Lady Musgrave I., 1977, QM W11380; ♂, SL 7.3 mm, ♀, SL 4.4 mm, Gillett Cay, Swain Reefs, Oct. 1962, AM P17450, P17459 (part); ♂, SL 8.6 mm, Point Cartwright, 2.viii.1922, AM P6373; ♀, SL 3.9 mm, Flinders Reef, off Cape Moreton, 10.iii.1989, 6-20 m, QM W16252; ♂, SL 9.1 mm, Flatrock, NE of Point Lookout, Stradbroke I., 28.vii.1981, 1-2 m, QM W11381. **New South Wales:** ♀, SL 6.2 mm, Angowrie, 12.iv.1941, AM P11355; ♀ (ovig.), SL 3.0 mm, Middleton Reef, Tasman Sea, 5.xii.1987, AM P38167; 2♀ (ovig.), 4.0 mm, 3.6 mm, Lord Howe I., AM P5271.

Type Specimen (not examined)

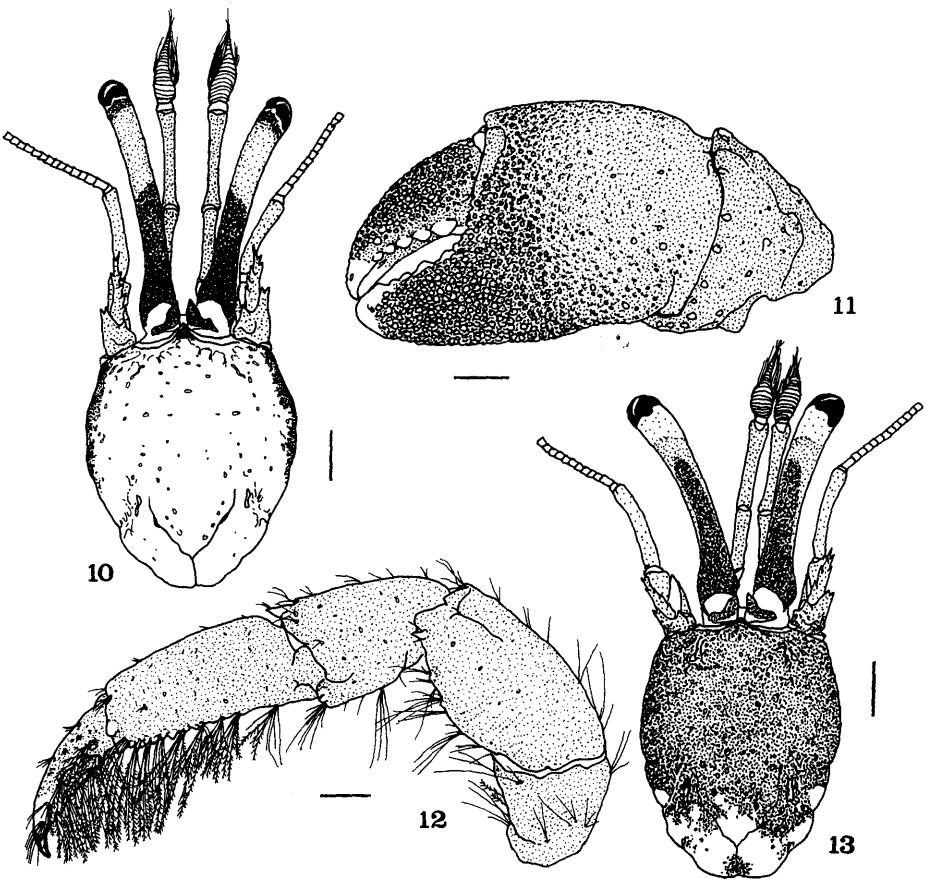
Muséum national d'Histoire naturelle, MNHN Pg656.

Type locality. Amboine.*Diagnosis*

Ocular acicles simple. Lateral face of palm of left cheliped bearing distinct dense tubercles. Dorsal margin of propodus and carpus of right cheliped spinose. Brush of long setae present on ventral margin of dactylus and distal part of propodus of third pereiopod. Telson with several spines on posterior margins of left and right posterior lobes. Chelipeds brown with fingers paler; second and third pereiopods fairly uniformly brown, dactyli with cream or white tips.

Live Coloration

Shield (Figs 10, 13) variously coloured, sometimes all dark or medium brown, or brown anteriorly and cream posteriorly or entirely cream with some scattered brown dots. Ocular



Figs 10-13. *Calcinus gaimardii* (H. Milne Edwards), 10-12, ♂, WAM 917-88; 13, ♂, WAM 2100-88. 10, shield and cephalic appendages, form I, dorsal view (setae omitted); 11, left cheliped, lateral view (setae omitted); 12, left third pereiopod, lateral view; 13, shield and cephalic appendages, form II, dorsal view (setae omitted). Scales = 2.0 mm.

peduncles dark brown or brown-green proximally and dorsally, paler orange-brown ventrally and distally, with bright blue distal band of variable extent proximal to corneas, sometimes diffuse black band at base of corneas; ocular acicles dark brown. Antennular peduncles dark brown or green-brown, ultimate segment distally orange; antennal peduncles orange and dark green-brown; antennular and antennal flagella orange. Chelipeds (Fig. 11) with fingers orange-brown with paler, often cream, tubercles and finger tips; palm darker red-brown or deep chocolate; carpus and merus brown with paler, often bluish white, tubercles. Second and third pereopods (Fig. 12) generally orange-brown; dactylus with cream tip and black claw, other segments with some cream tubercles. Pereopods paler on small specimens. Setae dark brown, paler distally.

Remarks

Calcinus gaimardii is one of the most common and ubiquitous species of hermit crab over much of the Indo-Pacific region and is especially abundant on rocky platforms and reef flats. It is the most sombrely coloured of those *Calcinus* species with a well developed brush of setae on the third pereopods. The nearly uniform coloration on the chelipeds and other pereopods, together with the distal blue band on the ocular peduncles, permit identification of live specimens, and the absence of distinct banding or spotting on pereopods is also evident on preserved material. Like *C. elegans*, *C. gaimardii* has rather obvious tubercles over the distolateral surfaces of the propodus of the left cheliped and lacks the distinct flattened depressions in this surface so evident in *C. imperialis* Whitelegge.

It is possible to recognise two colour forms of *C. gaimardii*, although both display some variation in distribution of colours. In the first, here designated form I (Fig. 10), the dark proximal area on the ocular peduncles abruptly borders the distal area of blue, and there is usually a distinct dark, if somewhat diffuse, band proximal to the corneas. The shield is predominantly cream with, at most, darker patches anteriorly and laterally and the second and third pereopods are notably paler than the chelipeds with scattered darker brown spots. In the second form, form II (Fig. 13), there is an intermediate brown area between the basal dark region and the distal blue band on the ocular peduncles. The blue band is consistently narrower than that of form I and no dark region abuts the corneas. The shield of form II specimens has a variable extent of brown, but at least the anterior $\frac{1}{3}$ and sometimes the entire shield is brown. The second and third pereopods are a similar colour to, or only slightly paler than, the chelipeds and scattered darker spots are not visible. Morphologically, the two forms appear identical although form II usually has fewer marginal spines on the telson and a stouter left cheliped. Both forms frequently co-occur and hence do not constitute geographically separated populations or subspecies. The consistency of the colour differences suggests that two cryptic species may be confused in the nominal *C. gaimardii*, but until specimens can be examined from across the entire range of this species it is best to regard the forms as conspecific.

Distribution

Mostly tropical; east Africa across the Indian Ocean to Indonesia, southern Japan, New Guinea, east to Hawaiian and Society Islands; Cocos (Keeling) and Christmas Islands, northern Australia from the Houtman Abrolhos in the west to Moreton Bay in the east and Lord Howe Island.

Habitat

Intertidal and subtidal to about 15–20 m; wide variety of habitats including rock platforms, coral and coral rubble and adjacent sand. Numerous gastropod shells and, occasionally, serpulid worm tubes are utilised by Australian specimens.

Calcinus guamensis Wooster

(Figs 14-16)

Calcinus latens.—Miyake, 1956: 331, figs 20, 21, [not *C. latens* (Randall), misidentification].*Calcinus vachoni*.—Forest, 1958: 286 [not *C. vachoni* Forest, misidentification in part].*Calcinus guamensis* Wooster, 1984: 141, fig. 4.—Haig & McLaughlin, 1984: 107; Haig & Ball, 1988: 159; Morgan, 1990: 9.*Material Examined*

Western Australia: 46 specimens, SL 3.5-1.2 mm, Christmas I., Indian Ocean, Feb. 1987, intertidal to 26 m, rocks, coral and rubble, WAM 560-87 to 573-87; ♂, SL 4.2 mm, 3♀, SL 3.3 mm, 2.4 mm, (ovig.), 2.4 mm (ovig.), Cocos (Keeling) Is, 11.ii.1989, surge channels, WAM 361-89, 480-89; ♂, SL 2.5 mm, Rob Roy Reef, Kimberleys, 15.vii.1988, 8-9 m, coral, WAM 2096-88; ♂, SL 4.5 mm, Adele I., Kimberleys, 22.ix.1986, WAM 1073-88.

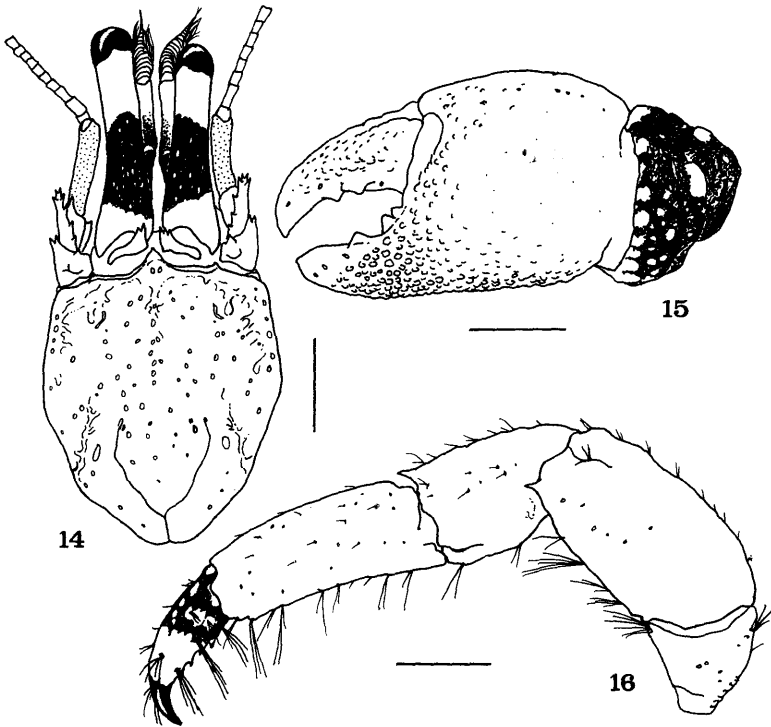
Type Specimens (not examined)

Holotype ♂, 26 paratypes, locations not cited by Wooster (1984); paratype ♂, Allan Hancock Foundation, AHF 759, remainder of types not located.

Type locality. Guam, Mariana Islands.

Diagnosis

Ocular acicles multispinose. Lateral face of palm of left cheliped with numerous small tubercles. Dorsal margin of propodus and carpus of right cheliped with small spines. Brush



Figs 14-16. *Calcinus guamensis* Wooster, ♂, WAM 564-87. 14, shield and cephalic appendages, dorsal view (setae omitted); 15, left cheliped, lateral view (setae omitted); 16, left third pereiopod, lateral view. Scales = 1.0 mm.

of setae on dactylus and propodus of third pereopod absent. Telson with row of spines on both left and right posterior lobes. Very dark broad band proximally on ocular peduncles and dactyli of second and third pereopods.

Live Coloration

Shield (Fig. 14) cream with some pink or brown tinges posteriorly; 2 black spots submedially on cervical groove. Ocular peduncles white proximally, broad central black band with minute white spots, white for distal $\frac{1}{2}$ to $\frac{1}{3}$; ocular acicles cream. Antennular peduncles very dark green or black proximally grading distally to blue-green; flagella green-orange. Antennal peduncles cream with ultimate segment orange; flagella orange. Chelipeds (Fig. 15) with fingers distally cream and proximally green-grey, tubercles cream or white; palm green-grey; carpus black with variously sized white spots on tubercles; merus cream with black distal band and white tubercles. Second and third pereopods (Fig. 16) with dactylus cream with broad black proximal band marked with white spots and patches especially at setal bases; propodus, carpus and merus cream or pale grey-green, propodus very pale distally. Setae pale yellow.

Remarks

This small species can be very abundant in shallow coral reef habitats and is probably more widespread than is suggested from the literature. It appears that *C. guamensis* has been confused previously with *C. latens* (Randall), a very common and widely distributed species (Haig & McLaughlin 1984: 108). It seems likely that *C. guamensis* has also been confused with *C. vachoni* Forest (Morgan, 1990).

The distinguishing characters of *C. guamensis* are discussed by Wooster (1984) and are applicable to Australian material. As is typical for *Calcinus*, coloration effectively separates the species from its congeners. The dramatic black bands on the ocular peduncles, carpi of chelipeds and bases of the dactyli of second and third pereopods are distinctive.

Distribution

Mariana and Hawaiian Islands, Indonesia, probably southern Japan (as *C. latens* in Miyake 1956) and Vietnam (as aberrant *C. vachoni* in Forest 1958); Cocos (Keeling) Islands, Christmas Island, on mainland Australia known only from the Kimberley region, northern W.A.

Habitat

Intertidal and subtidal to about 20 m; coral reef and rubble, often amongst branches of living coral. It inhabits numerous small gastropod shells.

Calcinus haigae Wooster

(Figs 17–20)

Calcinus haigae Wooster, 1984: 146, fig. 5.—Haig & McLaughlin, 1984: 110, 114.

Material Examined

♂, SL 3.6 mm, ♀ (ovig.), SL 2.8 mm, Cocos (Keeling) Is, 13–21.ii.1989, 10–30 m, coral, WAM 388-89, 567-89.

Type Specimens (not examined)

Holotype ♂, 7 paratypes, location not cited by Wooster (1984); paratype ♀, Alan Hancock Foundation, AHF 753, remainder not located.

Type locality. Guam, Mariana Islands.

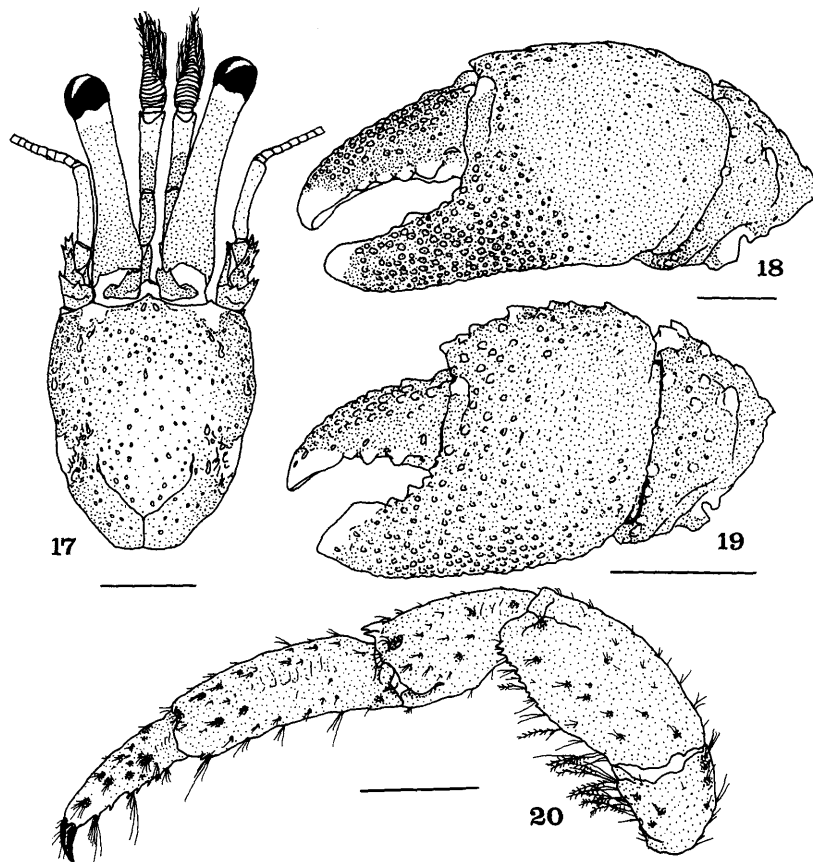
Diagnosis

Ocular acicles multispinose. Lateral face of palm of left cheliped with spaced minute tubercles. Dorsal margin of propodus and carpus of right cheliped moderately spinose.

Brush of long setae on ventral margin of dactylus and propodus of third pereiopod absent. Telson with several marginal spines on left and right posterior lobes. Chelipeds deep brown-purple with finger tips cream; second and third pereiopods brown or brown-purple with tip of dactylus paler, dactylus and propodus with scattered orange spots.

Live Coloration

Shield (Fig. 17) deep brown with pale brown patches anteriorly and posteriorly. Ocular peduncles purple-brown with thin band of pale orange or cream at base of corneas; acicles purple-brown. Antennular peduncles with proximal segments dark purple-brown, ultimate segment with distal half bright blue; flagella pale brown or orange. Antennal peduncles purple-brown or brown; flagella pale brown. Chelipeds (Figs 18, 19) with all segments predominantly purple-brown; finger tips and spines on carpus and merus cream; fingers with some scattered orange spots. Second and third pereiopods (Fig. 20) paler purple-brown; dactylus with cream tip; scattered orange spots on all segments but most numerous on dactylus and distal part of propodus, situated at setal pores.



Figs 17-20. *Calcinus haigae* Wooster, 17, 19, 20, ♀, WAM 388-89; 18, ♂, WAM 567-89. 17, shield and cephalic appendages, dorsal view (setae omitted); 18, left cheliped ♂, lateral view (setae omitted); 19, left cheliped ♀, lateral view (setae omitted); 20, left third pereiopod, lateral view. Scales = 1.0 mm.

Remarks

This small species appears to be uncommon in Australia, being known only from the Cocos (Keeling) Islands. In its original description from the Marianas, it is also noted as being 'not common' (Wooster 1984: 151).

Calcinus haigae is recognisable by its general coloration of brown or purple-brown with pale finger and dactylus tips and orange spots especially evident on the dactyli of pereopods. The present specimens agree well with the original description but for some minor differences. The ocular acicles bear up to four spinules and there are several differences in colour pattern. Wooster (1984) recorded the shield as being predominantly whitish with several darker purple areas. On the present specimens, the shield was predominantly deep brown in life, with paler brown and cream patches (Fig. 17). The darkest patches correspond with the purple areas behind the antennal peduncles noted by Wooster. It is not unusual for *Calcinus* species to show some variation in the colour patterns on the shield. In addition, Wooster recorded the antennular peduncles as 'dark bluish purple', while on these specimens the peduncles were dark purple-brown with the distal part of the ultimate segment bright blue.

Morphologically, *C. haigae* most closely resembles *C. minutus* Buitendijk. Live specimens of the two species can be easily distinguished by their coloration. There is a small female specimen (SL 2.7 mm, WAM 566-89) of an unidentified *Calcinus* from West Island, Cocos (Keeling) Islands, that resembles *C. haigae* very closely. The pereopods were pale purple-brown in life, consistent with the condition of *C. haigae*. However, the dactyli of the second and third pereopods were orange, thus converging upon the condition of *C. minutus*. It is uncertain whether this specimen is an atypical representative of *C. haigae*, a hybrid of *C. haigae* and *C. minutus*, or an undescribed species.

Distribution

Mariana and Hawaiian Islands; Cocos (Keeling) Islands.

Habitat

Subtidal, 7-30 m; coral, coral rubble.

Calcinus imperialis Whitelegge

(Figs 21-23)

Calcinus imperialis Whitelegge, 1901: 48, pl. 9. — Grant & McCulloch, 1907: 154.

?*Calcinus imperialis*. — Wooster, 1984: 130.

Material Examined

New South Wales: ♂, SL 6.9 mm, 3♀ (ovig.), SL 5.1 mm, 4.5 mm, 4.0 mm, Norfolk I., Dec. 1988, 2 m, WAM 827-89, 829-89, 133-90; 11 specimens, SL 6.1-2.9 mm, Norfolk I., 1.x.1892, NMV J15551; ♂, SL 3.8 mm, Norfolk I., 1902, NMV J18385; 7♂, SL 7.8-3.6 mm, Norfolk I., AM P5004, P5735; 9 specimens, SL 9.8-4.4 mm, Lord Howe I., AM P569, P1541, P5246, P5247, P5696, P6888 (1912), P7427; ♂, SL 5.9 mm, Woolgoolga, 1969, NMV J15552; ♀, SL 4.6 mm, Skenners Head, 25.ix.1981, intertidal, NMV J15553; ♀, SL 7.6 mm, Maroubra, AM P571; 2♀, SL 8.2 mm, 7.3 mm, Yamba, AM P10976, P11002; 3♂, SL 5.1 mm, 2.2 mm, 2.1 mm, Long Reef, Collaroy, AM P9411; 5♂, SL 8.1-5.3 mm, Middleton Reef, Tasman Sea, 9.v.1987, intertidal coral rubble, QM W13163; 2♂, SL 4.4 mm, 4.2 mm, 4♀, SL 6.5-3.2 mm, Middleton Reef, reef crest and flat, 6-9.xii.1987, AM P38149, P38160, P38163, P38166, P38168; ♂, shield damaged, ♀, SL 3.4 mm, Elizabeth Reef, Tasman Sea, 8-12 m, 11-14.xii.1987, AM P38155, P38157. **Queensland:** ♂, SL 11.8 mm, Lady Elliot I., AM P17469; 2♀, SL 17.0-19.0 mm, Flatrock, off Point Lookout, 12.x.1981, QM W11373.

Syntypes (not examined)

Australian Museum, AM G5455: Maroubra Bay; AM G5590, P570: Lord Howe Island.

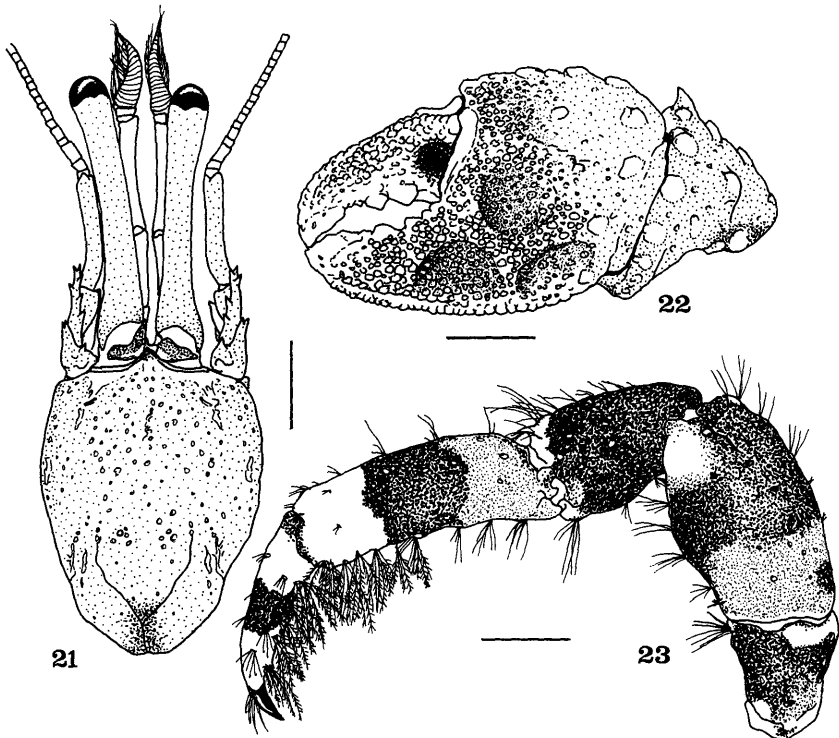
Diagnosis

Ocular acicles simple. Lateral face of palm of left chela with 2 or 3 broad shallow depressions. Dorsal margin of propodus and carpus of right cheliped spinose. Brush of long setae present on ventral margin of dactylus and distal part of propodus of third pereiopod. Telson with 1 marginal spine on both left and right posterior lobes. Dactylus of left cheliped with proximal dark red patch on lateral and mesial faces; second and third pereiopods banded in white, red-brown and olive.

Live Coloration

No live specimens examined; colour patterns in Figs 21–23. Live colours noted by Whitelegge (1901) as follows:

'Anterior region of carapace olive, spotted and margined anteriorly with azure blue. Ocular peduncles olive-green. Inner antennae greenish yellow. External antennae chlorine yellow. Granulation on chelipedes French gray, the spines purplish-blue. Hand brownish olive, upper finger with two deep red spots, one on each side near base. The ambulatory legs have the carpal joints dark brown; the propodal joints have an olive-green band at the base, a dark brown central band, and the distal extremity is yellowish-white. Dactylus white with a central dark brown band.'



Figs 21–23. *Calcinus imperialis* Whitelegge, σ , WAM 133-90. 21, shield and cephalic appendages, dorsal view (setae omitted, right ocular acicle deformed); 22, left cheliped, lateral view (setae omitted); 23, left third pereiopod, lateral view. Scales = 2.0 mm.

Remarks

On preserved specimens, the olive-green tones are orange and the dark chocolate intense red. The pattern of coloration is distinctive although preserved colours bear some resemblance to those of *C. elegans*.

Wooster's (1984) specimens from the Marianas were small and showed some morphological and colour differences from Whitelegge's description and the present material. In particular, the left chelipeds of his specimens do not show the distinct impressions on the lateral face and the carpi of the second and third pereopods are described as 'orange on proximal third; middle third dark red; distal third white'. It is possible that these differences may be merely ontogenetic but a specific difference should not be discounted.

Distribution

Lord Howe and Norfolk Islands, Middleton and Elizabeth Reefs, Tasman Sea, and eastern Australia from southern Great Barrier Reef to near Sydney; (Mariana Islands?).

Habitat

Intertidal and subtidal to about 2 m. Several specimens have been found in shells of *Harpa* spp. and sometimes in serpulid worm tubes.

Calcinus inconspicuus, sp. nov.

(Figs 24–29)

Material Examined

Holotype. ♀ (ovig.), SL 2.8 mm, Elizabeth Reef, (29°55'S., 159°00'E.), Tasman Sea, 10.xii.1987, 8 m, coral, AM P38142.

Paratypes. ♀ (ovig.), SL 2.7 mm, Elizabeth Reef, 12.xii.1987, WAM 220-90; ♀ (ovig.), SL 1.0 mm, Elizabeth Reef, 10.xii.1987, 12 m, AM P38140; ♀ (ovig.), SL 2.9 mm, Middleton Reef, 29°25'S., 159°00'E.), Tasman Sea, 9.xii.1987, 11 m, coral, AM P38139.

Diagnosis

Ocular acicles simple. Lateral face of palm of left cheliped minutely tuberculate. Dorsal margin of carpus and propodus of right cheliped spinose. Brush of plumose setae on lacylus and propodus of third pereopods absent. Telson with several spines on posterior margin of left and right posterior lobes, lateral margins unarmed. Shield darkly coloured anteriorly; ocular peduncles almost uniformly coloured except for white band proximal to corneas; chelipeds and pereopods uniformly coloured except for white finger tips on former and paler dactyli on latter.

Description

Shield (Fig. 24) 1.25 × as long as broad; anterior margin between rostrum and lateral projections weakly concave, rostrum broadly subtriangular and only slightly exceeding lateral projections. Lateral projections broadly triangular with minute terminal spinules. Dorsal surface of shield lightly punctate, more coarsely punctate anterolaterally; very sparsely setose dorsally and moderately setose laterally.

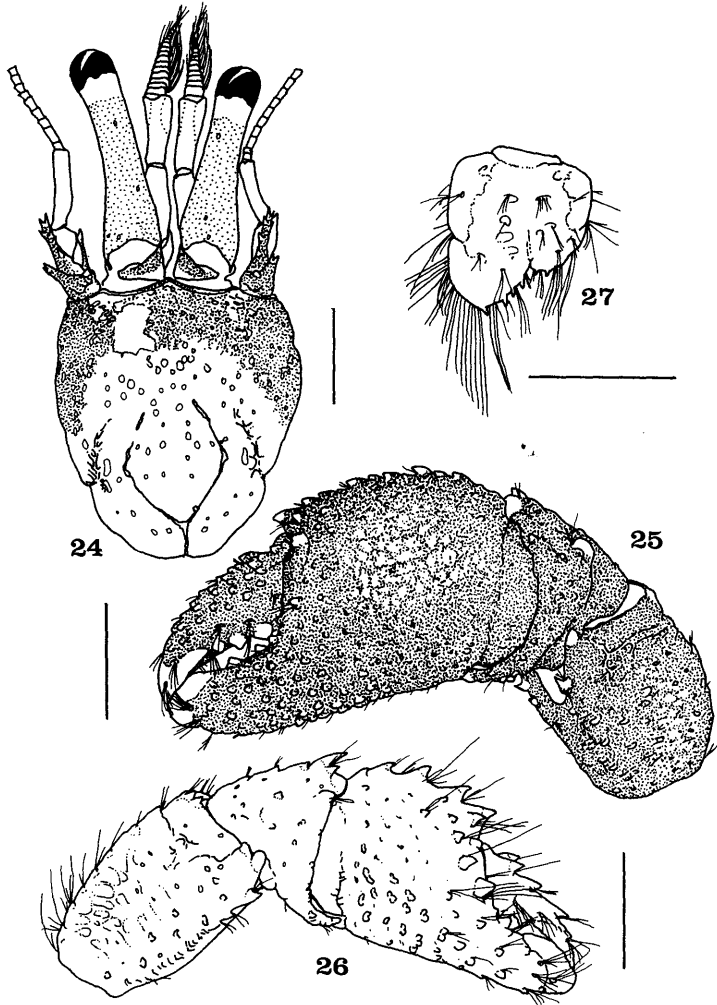
Ocular peduncles moderately long and slender, slightly shorter than shield, about as long as anterior margin of shield, left peduncle longer than right, peduncles strongly inflated proximally; very sparsely setose. Ocular acicles short, distolateral margin concave, proximal margin slightly convex; tipped by single spinule; acicles almost contiguous basally, widely separated distally.

Antennular peduncles only slightly shorter than ocular peduncles. Ultimate and penultimate segments unarmed; proximal segment with 3 or 4 spinules distolaterally.

Antennular peduncles reaching slightly beyond half length of ocular peduncles. Fifth segment unarmed; fourth segment with distodorsal spine; third with distinct distoventral spine and long setae; second with bifid distolateral spine and simple mesial spine, latter sometimes small; first segment with small lateral spinule, ventromesial angle with several

spinules. Antennal acicle reaching just beyond distal end of penultimate segment of peduncle; terminating in strong spine; mesial margin with 3 or 4 spines, distolateral margin with 2; scattered long setae, especially distally. Antennal flagellum longer than shield but shorter than carapace; minutely setose.

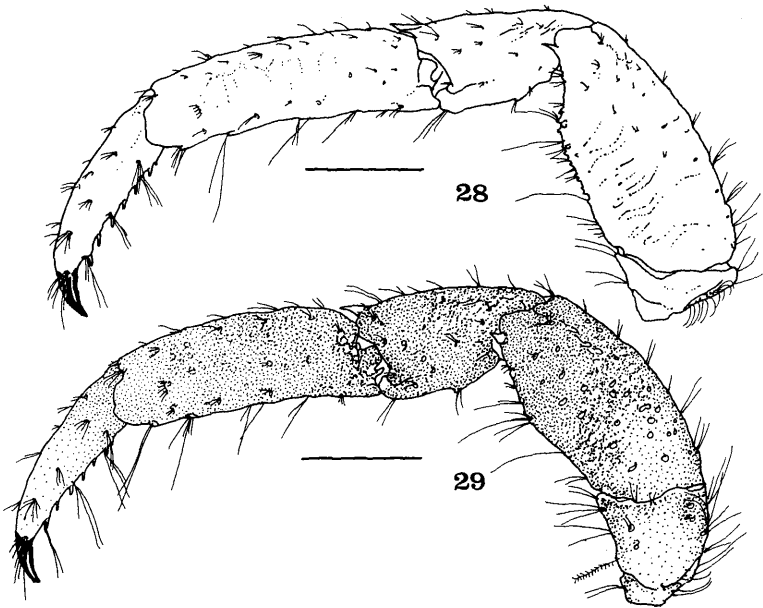
Left cheliped (Fig. 25) with propodus slightly less than $2\times$ as long as width of palm. Dactylus about $\frac{1}{2}$ length of propodus; cutting edge with 3 large teeth, largest proximally; lateral face strongly tuberculate, largest tubercles proximally and in dorsal row; mesial face mostly smooth with some tubercles near upper edge. Fixed finger recurved, touching dactylus only at tip, cutting edge with 2 large teeth; lateral face strongly tuberculate with irregular row of larger tubercles on ventral margin; mesial face almost smooth, some tubercles proximally. Both fingers with scattered clumps of long simple setae. Palm as broad as long and compressed laterally; lateral surface convex, tuberculate near bases of fingers, dorso-



Figs 24-27. *Calcinus inconspicuus*, sp. nov., holotype ♀, AM P38142. 24, shield and cephalic appendages, dorsal view (setae omitted); 25, left cheliped, lateral view; 26, right cheliped, lateral view (colour pattern omitted); 27, telson, dorsal view. Scales = 1.0 mm.

laterally and ventrally, lateral face with only minute tubercles; dorsal margin with row of irregularly sized spines; mesial face slightly convex, bearing scattered small tubercles and enlarged tubercle at base of setal tuft on ventromesial face. Carpus broad, subtriangular, much shorter than merus, compressed; lateral surface almost smooth with prominent tubercle placed slightly toward dorsal margin; distolateral margin bearing some small granules, 1 usually enlarged dorsolaterally, and several tubercles or blunt spinules ventrally; dorsal edge faintly granulate; 1 spine at distal angle; mesial and ventral faces almost smooth, with some scattered tubercles mesially. Merus almost as long as palm; lateral and ventral surfaces nearly flat, lateral with scattered small tubercles; ventrolateral distal angle with 1 large spine and usually 1 minute spinule more posteriorly; ventromesial margin with 3 or more spinules, 1 usually noticeably larger; dorsal margin merely uneven or with minute tubercles; mesial surface slightly convex, with scattered minute tubercles.

Right cheliped (Fig. 26) with propodal length approximately $\frac{2}{3}$ length of left propodus. Dactylus about $\frac{1}{2}$ length of propodus and strongly curved, dorsal margin and dorsolateral face each with irregular row of large acute corneous-tipped spines, diminishing in size distally; mesial surface unarmed; cutting edge with 2 proximal teeth. Fixed finger touching dactylus only at tip; ventral margin and lateral face with scattered prominent tubercles or blunt spines; mesial face with some blunt tubercles; cutting edge with 2 or 3 teeth. Palm slightly broader than long, with lateral surface weakly convex and with low tubercles especially ventrolaterally and 3 or 4 large spines proximal to articulation of dactylus; dorsal margin bearing 4 very large corneous-tipped spines and sometimes 1 smaller spine posterior to these; ventral surface with blunt tubercles; mesial face flat, with few scattered small tubercles. Carpus broad, much shorter than merus, compressed; lateral face with small granulations; distolateral edge finely granulate; dorsal edge with 4 or 5 spines, distalmost much enlarged; mesial face almost smooth, flattened. Merus slightly compressed, lateral surface slightly convex, nearly smooth except for scattered low tubercles; dorsal edge with some minute tubercles, distodorsal angle with 1 or 2 spinules; large spine at lateral disto-



Figs 28, 29. *Calcinus inconspicuus*, sp. nov., holotype ♀. 28, left second pereiopod, lateral view (colour pattern omitted); 29, left third pereiopod, lateral view. Scales = 1.0 mm.

ventral angle; mesial surface smooth, flat; ventromesial margin with several spinules, 1 usually enlarged. Tufts of sparse simple setae on all segments especially on dorsal and ventral edges and distolaterally on palm.

Second pereopods (Fig. 28) much longer than left cheliped, left and right pereopods of similar length. Dactylus shorter than propodus, moderately elongate, terminating in strong claw; ventral margin with row of 7 or 8 short corneous spines; scattered, sparse clumps of long simple setae, longer ventrally. Propodus unarmed except for minute spinule distodorsally, distoventrally and mesial to distoventral spinule; setation like that of dactyl. Carpus with large spine at distodorsal angle, sometimes 1 small spine lateral to this, sometimes second dorsal spinule; scattered setae, longer ventrally. Merus laterally compressed; 1 spine at lateral distoventral angle; ventral margin with row of small spines and tubercles; long simple setae ventrally, some plumose setae proximodorsally.

Third pereopods (Fig. 29) similar length to second; propodus slightly shorter and stouter than in second; merus slightly shorter and less laterally compressed; ischium longer. Spination and setation of third pereopods similar to that of second.

Sternite of pereopod 3 with anterior lobe broad and subrectangular, with rounded lateral projections; heavily setose.

Telson and uropods strongly asymmetrical, left uropod much larger than right; telson (Fig. 27) with left posterior lobe semicircular or subtriangular, right gradually convex and much smaller than left; both lobes armed with posterior spines, 4 or 5 on left, 3 or 4 on right, lateral margins unarmed; margins with fringe of long simple setae.

Coloration

No live material examined. Preserved specimens with shield (Fig. 24) anteriorly red-brown with patches of cream especially around lateral projections and on larger pores; shield posteriorly cream; extent of red-brown variable. Ocular peduncles rather uniform medium brown, slightly darker proximodorsally; broad white band proximal to corneas; ocular acicles deeper red-brown with distal spine cream. Antennular peduncles with proximal and penultimate segments pale brown, ultimate segment cream; flagella cream. Antennal peduncles mottled red-brown and pale brown; flagella translucent. Chelipeds (Fig. 25) deep red-brown, fingers slightly paler, finger tips cream; spines and larger tubercles on all segments cream or white. Second and third pereopods (Fig. 29) red-brown, paler than chelipeds; dactylus and proximal part of merus somewhat paler than other segments; spines cream.

Remarks

This small species is recognisable by the lack of a setal brush on the third pereopods, the simple ocular acicles, the presence of several spines on the posterior margins of the posterior telsonic lobes, and the uniform coloration of the chelipeds and second and third pereopods.

In most respects, *C. inconspicuus* resembles the widespread *C. gaimardii*. The latter bears a well developed setal brush on the third pereopods. The ocular peduncles of *C. gaimardii* are bright blue distally but the live colour of *C. inconspicuus* is unknown.

Of the Australian species of *Calcinus* without suboperculate left chelae and lacking a setal brush, only *C. dapsiles* of south-western Australia has simple ocular acicles. That species is characterised by only one marginal spine on both left and right posterior lobes of the telson, and a distinctive pattern of banding on the pereopods. *C. minutus* Buitendijk occasionally has simple ocular acicles but is uniformly cream or white with orange on the pereopod dactyli.

The four other species of *Calcinus* that occur on Elizabeth and Middleton Reefs have considerably larger ranges than that known for *C. inconspicuus* (see *Distribution* section). The small size and cryptic coloration of this species and the paucity of sampling at localities in the Tasman Sea have probably prevented its collection elsewhere.

Distribution

Elizabeth and Middleton Reefs, Tasman Sea.

Habitat

11–18 m; coral, dead coral rubble.

Etymology

From the Latin, 'inconspicuus', meaning 'not readily visible' or 'not prominent', referring to the small size and unremarkable coloration of the mature type specimens.

Calcinus laevimanus (Randall)

(Figs 30–33)

Pagurus tibicen.—H. Milne Edwards, 1836: 278 (not *Cancer tibicen* Herbst, 1791).

Pagurus laevimanus Randall, 1839: 135.

Pagurus lividus H. Milne Edwards, 1848: 63.

Calcinus tibicen.—Dana, 1852: 457; Stimpson, 1858: 234; Pocock, 1887: 520; Andrews *et al.*, 1900: 116; Stimpson, 1907: 208.

Pagurus levimanus.—Stimpson, 1858: 234.

Calcinus herbstii De Man, 1888: 437.—Alcock, 1905: 53, pl. 5, fig. 4; Grant & McCulloch, 1907: 155; Forest, 1951: 89, figs 2, 5, 6, 9; McNeill, 1968: 27.

Calcinus herbsti var. *lividus*.—Borradaile, 1898: 462.

Calcinus herbstii var. *lividus*.—Alcock, 1905: 55.

Calcinus laevimanus.—Rathbun, 1907: 208; Barnard, 1950: 437, fig. 80e, f; Ball & Haig, 1972: 100; Wooster, 1984: 156; Haig & Ball, 1988: 160.

Calcinus herbsti.—Fize & Serène, 1955: 41, pl. 2, figs 1–4, text fig. 6; Forest, 1956a: 47.

Material Examined

Western Australia: 11 specimens, SL 6.3–2.1 mm, Christmas I. (Indian Ocean), Feb. 1987, intertidal, rocks and sand, WAM 650-87, 653-87; 21 specimens, SL 6.6–1.9 mm, Cocos (Keeling) Is, Feb. 1989, intertidal sand, rocks and coral, WAM 344-89, 498-89, 508-89, 585-89, 638-89, 641-89; 16 specimens (including 5 ovig. ♀), SL 5.2–2.1 mm, Ashmore Reef, Sept. 1986, WAM 75-90; ♂, SL 7.3 mm, Cartier I., Sept. 1986, WAM 74-90; ♂, SL 6.5 mm, Sandy Islet, Scott Reef, 7.ix.1984, WAM 727-85; 3♂, SL 6.9 mm, 3.2 mm, 2.8 mm, 2♀ (ovig.), 7.1 mm, 4.9 mm, Seringapatam Reef, 12.ix.1984, reef flat, WAM 735-85, 736-85, 742-85; ♂, SL 7.4 mm, Sandy Cay, Clerke Reef, Rowley Shoals, 9.iv.1982, WAM 803-86; 3♀, SL 7.3–5.5 mm, Coronation I., Houtman Abrolhos, 25.x.1985, reef flat, WAM 1380-85. **Queensland:** 2♂, 6.6 mm, 6.6 mm, Maer I., Murray Is, 3.v.1977, WAM 1039-86; 7♂, SL 6.6–5.0 mm, 10♀, SL 6.5–4.5 mm, Murray I., Aug.–Sept. 1907, AM P2849, P7529; 2♂, SL 7.9 mm, 7.9 mm, Low Is, 27.vi.1973, NMV J11356; ♂, SL 7.3 mm, Magdalena Reefs, North Cay, Coral Sea, 26–27.iv.1979, QM W11378; ♀ (ovig.), SL 4.3 mm, Herald Cay, Coral Sea, 28.ix.1960, AM P17604; 4♂, SL 7.3–5.5 mm, 2♀ (ovig.), SL 6.0 mm, 6.0 mm, Green I., 1905, AM P3722; ♀, SL 5.3 mm, Lady Elliot I., Aug. 1980, intertidal, QM W11377; ♂, SL 6.3 mm, Flinders Reef, NE. of Cape Moreton, 12.viii.1981, QM W11379.

Type Specimens (not examined)

Location unknown, not cited by Randall (1839) or by subsequent workers.

Diagnosis

Ocular acicles simple. Lateral face of palm of left cheliped almost smooth and rounded. Dorsal margin of propodus and carpus of right cheliped smooth or only slightly granulate. Brush of long setae on dactylus and propodus of third pereopod absent. Telson with 1 marginal spine on both left and right posterior lobes. Dactylus of second and third pereopods with subdistal dark band and subproximal dark spot; carpus and merus with dark longitudinal stripe.

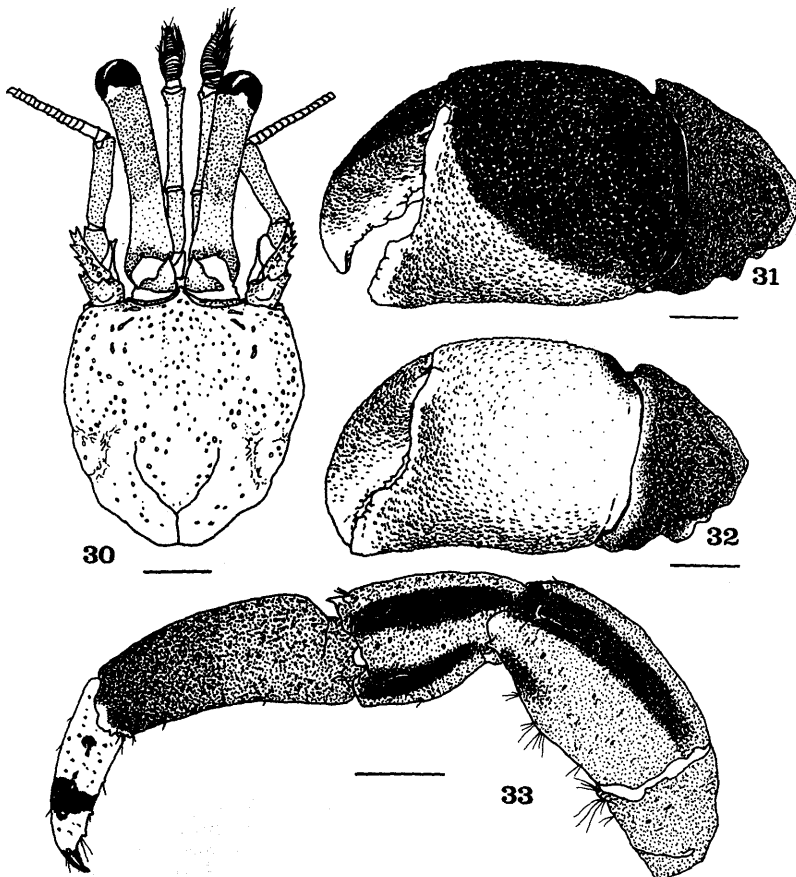
Live Coloration

Shield (Fig. 30) cream, pale orange, orange-green or grey-green. Ocular peduncles with thin orange proximal band, sky blue on proximal half or $\frac{1}{3}$, orange on distal half to $\frac{2}{3}$; ocular acicles pale orange or cream. Antennular peduncles pale blue, usually with orange ear articulations of segments; flagella orange. Antennae orange. Chelipeds (Figs 31, 32)

predominantly dark chocolate brown. Left cheliped with tip of dactylus, most of fixed finger and cutting edges white or cream, white extending some distance along ventral margin of palm and sometimes dorsally and covering most of propodus. Right cheliped with distal half of fingers and cutting edges white. Second and third pereiopods (Fig. 33) primarily orange or red-brown; dactylus white or cream with subdistal dark brown or green band and subproximal lateral and mesial dark spot; propodus rather uniform brown or darker distally; carpus with lateral and short ventral longitudinal brown, green or grey stripes; merus with diffuse distolateral and distoventral longitudinal stripes. Setae sparse, pale yellow.

Remarks

A very common and widespread intertidal and shallow subtidal hermit crab, *C. laevimanus* is most similar to *C. seurati* Forest, with which it can be confused. Morphologically, the two species can be distinguished by differences in relative lengths of the ocular and antennular peduncles, of the dactyli and propodi of the ambulatory pereiopods and the shape of the lateral face of the propodus of the left third pereiopods (Forest 1951; Wooster 1984). Coloration of the two species is generally similar but they differ in the pattern of bands and



Figs 30-33. *Calcinus laevimanus* (Randall), 30, 33, ♀, WAM 1168-86; 31, ♂, WAM 653-87; 32, ♂, WAM 641-89. 30, shield and cephalic appendages, dorsal view (setae omitted); 31, left cheliped, lateral view (setae omitted); 32, left cheliped, dorsal view (setae omitted); 33, left third pereiopod, lateral view. Scales = 2.0 mm.

stripes on the second and third pereopods. *Calcinus seurati* usually inhabits tidal pools higher upshore than the more ubiquitous *C. laevimanus*.

The extent of brown on the palm of the left cheliped is variable in *C. laevimanus* (Figs 31, 32). The palm may be almost entirely brown, with only a little white extending from the finger ventrally, or almost entirely white, the brown confined to the proximodorsal margin.

Calcinus laevimanus was confused with *Cancer tibicen* Herbst (= *Calcinus tibicen*) by H. Milne Edwards (1836). Herbst (1791) did not cite a type locality but, as was discussed by Provenzano (1959), *Calcinus tibicen* is confined to the western Atlantic from Florida to Brazil, and can be recognised by a distinct lateral groove in the propodus of the third pereopod. Randall (1839) named the West Pacific species *C. laevimanus* but his name was not widely used although Stimpson (1858) and Rathbun (1907) recognised the synonymy of *Pagurus tibicen sensu* H. Milne Edwards (1836) and Randall's species. The name *Calcinus herbstii* De Man was used extensively until the 1960s by workers either unaware of Randall's species or unsure of its correct identification. *Pagurus lividus* H. Milne Edwards was recognised as a pale colour variant of *C. herbstii* by Borradaile (1898) although, in fact, the name *P. lividus* has priority over the much more widely used *C. herbstii*.

Distribution

East Africa across Indian Ocean to Indonesia, Philippines, southern Japan, New Guinea, Marianas, east to Hawaiian Islands and Tuamotu Archipelago; Cocos (Keeling) and Christmas Islands, Norfolk Island, northern mainland Australia from Houtman Abrolhos Islands east to Moreton Bay.

Habitat

Intertidal and sometimes very shallow subtidal; rocky platforms, coral rubble, sand and mud flats. The species prefers globose gastropod shells such as nerites.

Calcinus latens (Randall)

(Figs 34–36)

Pagurus latens Randall, 1839: 135.

Pagurus cristimanus H. Milne Edwards, 1848: 64.

Calcinus latens.—Dana, 1852: 459, 1855: pl. 28, fig. 11; Heller, 1865: 88; Alcock, 1905: 58, pl. 5, fig. 5; Grant & McCulloch, 1906: 34, 1907: 155; McNeill, 1926: 304; Fize & Serène, 1955: 58, pl. 2, figs 9–11, text fig. 9; McNeill, 1968: 27; Lewinsohn, 1969: 48; Ball & Haig, 1972: 101; Wooster, 1984: 154; Haig & Ball, 1988: 160; Morgan, 1989: 406, 1990: 9.

Calcinus cristimanus.—Heller, 1862: 254; Stimpson, 1858: 234.

Calcinus intermedius De Man, 1881: 102.

Calcinus terrae-reginae Haswell, 1882a: 760.—Haswell, 1882b: 158; Alcock, 1905: 57, pl. 5, fig. 7.

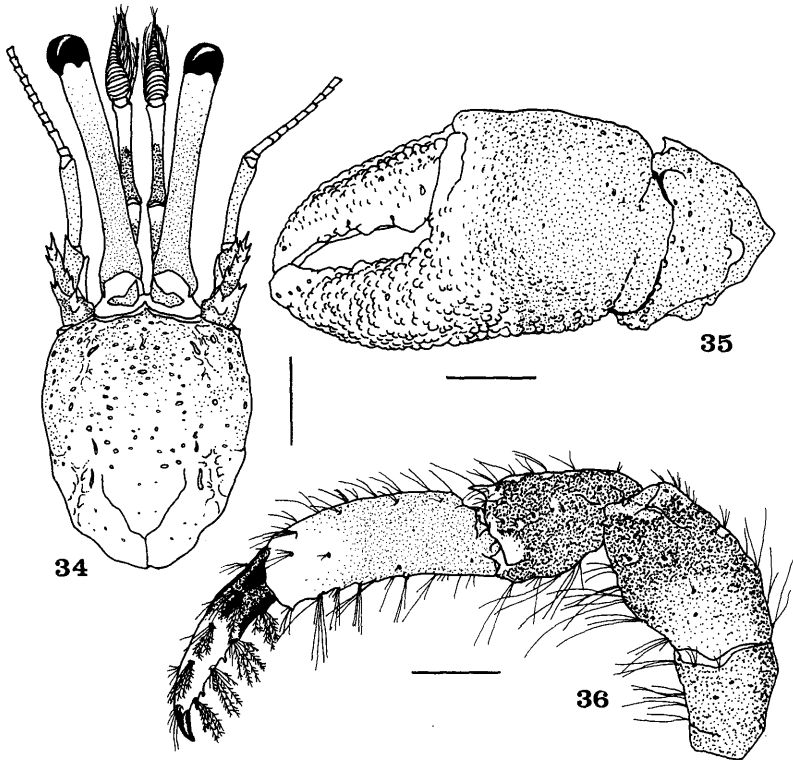
Calcinus latens var. *terrae-reginae*.—Buitendijk, 1937: 269.

Calcinus abroloensis Morgan, 1988: 218, fig. 1.

Material Examined

Western Australia: 29 specimens, SL 3.4–1.1 mm, Christmas I. (Indian Ocean), Feb. 1987, intertidal to 11 m, rocks and coral, WAM 574-87 to 579-87; 45 specimens, SL 4.9–1.4 mm, Cocos (Keeling) Is, Feb. 1989, intertidal to 12 m, sand, rock, coral and rubble, WAM 358-89, 369-89, 408-89, 409-89, 411-89, 489-89, 501-89, 589-89, 607-89, 623-89, 637-89, 649-89, 659-89; ♂, SL 4.3 mm, Albert I., Kimberleys, 14.vii.1988, intertidal rocks, RMNH D37805; ♀ (ovig.), SL 5.1 mm, Cassini I., Kimberleys, 18.vii.1988, intertidal rocks and coral, WAM 2101-88; 2♂, SL 6.1 mm, 3.7 mm, Adele I., N.W.A., 22.ix.1986, WAM 60–90; 29 specimens, SL 5.0–2.0 mm, Ashmore Reef, Sept. 1986, WAM 61-90, 63-90 to 65-90; 4♂, SL 5.1–4.4 mm, ♀, SL 5.5 mm, Cartier I., Sept. 1986, WAM 62-90; ♂, SL 4.1 mm, Sandy Islet, Scott Reef, 9.ix.1984, WAM 131-90; ♂, SL 5.0 mm, Passage I., Monte Bellos, 1.xii.1979, WAM 1319-86; ♀, SL 3.0 mm, Barrow I., 14.ix.1966, rock platform, WAM 1064-86; 2♂, SL 3.6 mm, 3.0 mm, ♀, SL 2.9 mm, North West Cape, 2.vi.1981, intertidal limestone platform, WAM 1395-86, 1404-86; ♀ (ovig.), SL 4.6 mm, Tantabiddi, North West Cape, Sept. 1981, WAM 1089-86; ♂, SL 4.0 mm, Mangrove Bay, North West Cape, 16–18.vii.1980, WAM 1118-86; 2♂, SL 3.3 mm, 2.3 mm, ♀, SL 1.9 mm, Warroora, S. of North West Cape, 5.vi.1981,

WAM 1367-86; 5♂, 3.7-2.6 mm, ♀, SL 3.8 mm, Monkey Rock, Shark Bay, 10-13.iii.1986, WAM 106-90, 108-90, 116-90; 13 specimens, SL 5.4-2.5 mm, opposite Cape Ransonnet, Shark Bay, 8.iii.1986, WAM 110-90; 18 specimens (including 3 ovig. ♀), SL 7.9-3.3 mm, Surf Point, Shark Bay, 9.iii.1986, WAM 112-90; 22 specimens, SL 4.7-2.3 mm, Sunday I., Shark Bay, 14.iii.1986, WAM 911-88; 3♂, SL 3.8-2.4 mm, 2♀, SL 5.5 mm, 4.0 mm, Coronation I., Houtman Abrolhos, 25-26.x.1985, intertidal reef flat, WAM 1515-85, 47-86; ♂, SL 3.9 mm, Beacon I., H.A., 19.iv.1974, under rocks, WAM 1063-86; 2♀, SL 4.4 mm, 4.0 mm, Seven Mile Beach, N. of Dongara, 22.iv.1986, WAM 207-88; 3♂, SL 4.3 mm, 3.7 mm, 3.5 mm, 2♀, SL 3.9 mm, 3.7 mm, Nancy Cove, Rottneest I., 5.iv.1986, intertidal, WAM 208-88. **Queensland:** 4♂, SL 4.3-3.6 mm, 5♀, SL 4.2-1.6 mm, Murray Is., Sept. 1907, AM P7530; ♂, SL 5.3 mm, Green I., 15.vi.1984, reef flat, QM W11430; 6♂, SL 6.4-4.6 mm, 3♀, SL 5.4 mm, 4.7 mm, 4.2 mm, Cairns Reef, 1905, AM P3817; ♂, SL 5.1 mm, ♀, SL 3.5 mm, High I., near Cairns, July 1924, AM P7983; ♂, SL 3.5 mm, Kenn Reef, Coral Sea, 2.x.1960, AM P17606; ♂, SL 5.9 mm, 2♀, SL 4.2 mm, 4.0 mm, Heron I., 12-23.vi.1976, intertidal, QM W11376; ♂, SL 5.3 mm, Heron I., 12.x.1962, AM P17608; 2♂, SL 6.5 mm, 4.3 mm, 3♀, SL 5.2 mm, 5.1 mm, 4.6 mm, Masthead I., Jan. 1911, AM G5729 (part), P7423; 2♀, SL 7.0 mm (ovig.), 2.3 mm, Lady Elliot I., 10-13.xi.1988, 12 m, WAM 824-89, 825-89; ♂, SL 7.9 mm, Lady Elliot I., AM P17468; ♂, SL 5.9 mm, North West I., Capricorn Group, Dec. 1931, AM P10355; ♂, SL 5.4 mm, ♀, SL 4.2 mm, Gillett Cay, Swain Reefs, Oct. 1962, AM P17459 (part); ♀, SL 3.5 mm, Myora Light, Moreton Bay, 21.ix.1981, intertidal, QM W11375; ♂, SL 2.6 mm, Queensland, AM P7513. **New South Wales:** 2♂, SL 3.9 mm, 3.8 mm, 2♀, SL 3.3 mm, 3.3 mm, Elizabeth Reef, Tasman Sea, 4.v.1987, intertidal coral rubble, QM W13162; ♂, SL 3.4 mm, Middleton Reef, Tasman Sea, 9.v.1987, intertidal coral rubble, QM W13160; 2♂, SL 3.6 mm, 3.1 mm, 3♀ (ovig.), SL 3.4 mm, 3.4 mm, 3.0 mm, Middleton Reef, 6-7.xii.1987, AM P38135, P38143; ♂, SL 4.5 mm, Lord Howe I., 1912, AM P7428; ♂, SL 5.2 mm, Lord Howe I., 19.ii.1980, low tide under rocks, AMPI 1020.



Figs 34-36. *Calcinus latens* (Randall), ♂, WAM 918-88. 34, shield and cephalic appendages, dorsal view (setae omitted); 35, left cheliped, lateral view (setae omitted); 36, left third pereiopod, lateral view. Scales = 2.0 mm.

Type Specimens (not examined)

Location unknown, uncited by Randall (1839) or by subsequent workers.

Diagnosis

Ocular acicles simple (rarely with additional spinule). Lateral face of palm of left cheliped smooth. Dorsal margin of propodus and carpus of right cheliped carinate and spinose. Third pereopods with slightly greater development of long setae on dactylus and distal part of propodus than on second pereopods. Telson with left posterior lobe bearing several marginal spines, right lobe with 1 spine (rarely unarmed or with 2) directed ventrally from posterior margin. Second and third pereopods with several short, dark red-purple stripes proximally on dactylus.

Live Coloration

Shield (Fig. 34) green-grey or deep green with pale areas. Ocular peduncles pale salmon-grey or orange, paler at base of corneas; acicles cream, pale orange or green. Antennular peduncles bright blue with darker green band proximally on ultimate and sometimes penultimate segments; flagella orange. Antennal peduncles green and cream, ultimate segment pale orange; flagella pale orange. Chelipeds (Fig. 35) with dactylus white or cream; propodus with finger and distal part of palm white or cream, remainder green, green-brown or green-grey; carpus and merus green or green-brown with cream tubercles. Second and third pereopods (Fig. 36) with dactylus cream with proximal dark red-purple or brown-purple band comprising several short longitudinal stripes on slightly paler background; propodus pale salmon-brown or grey-brown proximally grading to pale green or cream for distal $\frac{1}{3}$; carpus and merus green-grey with cream tubercles, merus with orange patch distally. Setae pale yellow.

Remarks

This is one of the most widespread and ubiquitous species of *Calcinus*. Colour variation in the species has been discussed by Fize & Serène (1955), Haig & McLaughlin (1984), Haig & Ball (1988) and Morgan (1990).

The synonymy of *C. latens* is rather complex and has been discussed in detail by Fize & Serène (1955). Although the description of *Pagurus cristimanus* H. Milne Edwards was very brief, there seems little doubt that the species is synonymous with *C. latens*. The name *C. intermedius* De Man appears to have been used only by its author. Alcock (1905) suggested that *Calcinus terrae-reginae* Haswell might be synonymous with *C. latens* and subsequently Grant & McCulloch (1906) synonymised the two species.

Reconsideration of *C. abrothensis* Morgan has resulted in its being here synonymised with *C. latens*. The type specimen of *C. abrothensis* shows a suite of unusual features for *C. latens*, in particular the trispinose ocular acicles and the shape and spination of the telson. Several specimens of *C. latens* have been examined for this study that bear a small secondary spine on one or both ocular acicles so the presence of two small additional spinules, although very rare, probably cannot be regarded as a specific difference. The telson of *C. latens* proves to be rather variable in shape and I now regard the presence of several small spines on the right posterior lobe as an aberration of the *C. latens* condition. The identical coloration of *C. latens* and *C. abrothensis* supports their synonymy as there is no other example in the genus of interspecific concoloration.

Distribution

East Africa and Persian Gulf, across Indian Ocean to Indonesia, Philippines, southern Japan, New Guinea, east to Hawaii and Tuamotu Archipelago; Cocos (Keeling) and Christmas Islands, Indian Ocean, Norfolk and Lord Howe Islands, Tasman Sea, mainland Australia from Rottnest Island, W.A., north and east to Sydney.

Habitat

Intertidal and subtidal to 5 m; wide variety of habitats including coral reef flats, rocky platforms, rubble and sand. Australian specimens have been taken from many gastropod shells.

***Calcinus lineapropodus* Morgan & Forest**

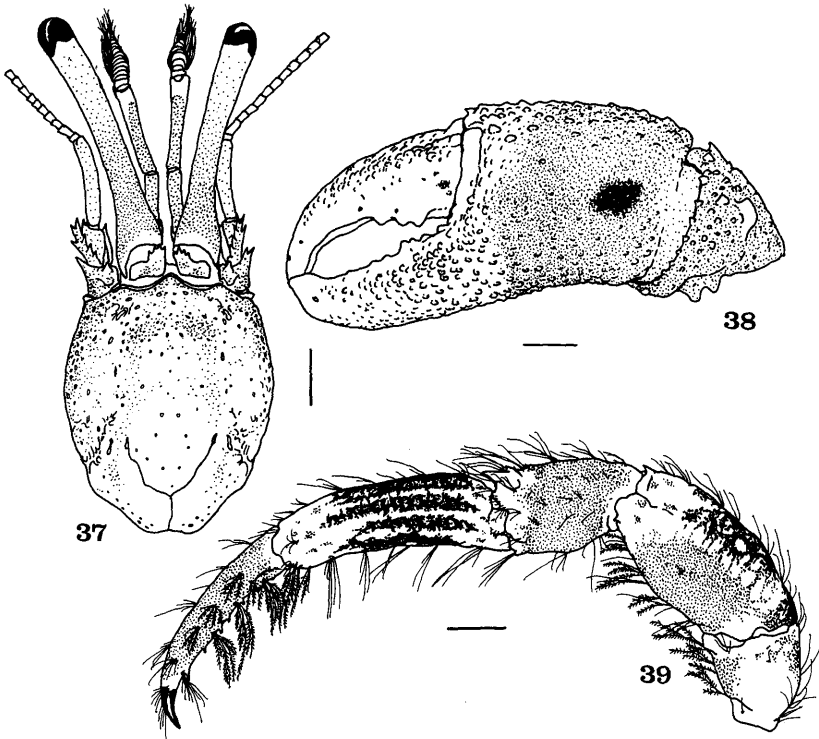
(Figs 37–39)

Calcinus sp. 1.—Wooster, 1984: 138.*Calcinus* undescribed sp.—Haig & Ball, 1988: 161.*Calcinus lineapropodus* Morgan & Forest, 1991: 650.**Material Examined**

Western Australia: Holotype and paratypes: see Morgan & Forest 1991; 19 specimens, SL 4.6–1.8 mm, Christmas I. (Indian Ocean), Feb. 1987, 1–26 m, coral and rubble, WAM 38-90 to 45-90; 4♂, SL 4.5–1.5 mm, ♀, SL 3.1 mm, Cartier I., Sept. 1986, WAM 77-90.

Diagnosis

Ocular acicles multispinose. Lateral face of palm of left chela minutely tuberculate. Dorsal margin of carpus and propodus of right cheliped carinate and spinose. Brush of long setae on dactylus and propodus of third pereiopods absent. Telson with numerous marginal spines on left and right posterior lobes. Palm of chelipeds with dark brown spot on lateral



Figs 37–39. *Calcinus lineapropodus* Morgan & Forest, holotype ♂, WAM 37-90. 37, shield and cephalic appendages, dorsal view (setae omitted); 38, left cheliped, lateral view (setae omitted); 39, left third pereiopod, lateral view. Scales = 1.0 mm.

and mesial faces; propodus of second and third pereiopods with brown or maroon longitudinal stripes.

Live Coloration

Shield (Fig. 37) cream or pale brown, darker laterally. Ocular peduncles rose pink, paler near corneas; acicles pink and cream. Antennular peduncles pale brown proximally, ultimate segment blue distally; flagella orange. Antennal peduncles cream and pale orange; flagella pale orange. Chelipeds (Fig. 38) with fingers cream with some orange dots; palm distally cream, remainder grey-brown with dark brown spot proximal to midlength on lateral and mesial faces; carpus and merus grey-brown with pale tubercles. Second and third pereiopods (Fig. 39) with dactylus rose pink with cream tip; propodus cream with scattered orange flecks and 3 longitudinal brown or maroon stripes on both lateral and mesial faces; carpus rose pink with some cream proximally and distally; merus cream with some orange dots and maroon patch mid-dorsally, rose pink patch laterally and ventrally. Setae clear.

Remarks

The nomenclatural history of this species was discussed by Morgan & Forest (1991). It can be distinguished readily from the similar *C. pulcher* Forest by the coloration of the ambulatory pereiopods.

Distribution

Indonesia, Mariana Islands, New Guinea; Cocos (Keeling), Christmas and Cartier Islands, Indian Ocean.

Habitat

Subtidal to 25 m; live coral, dead coral rubble, rocks.

Calcinus minutus Buitendijk

(Figs 40–42)

Calcinus minutus Buitendijk, 1937: 269, figs 13–15. – Forest, 1958: 185, figs 1, 6–8, 14, 18; Ball & Haig, 1972: 102; Wooster, 1984: 152; Haig & Ball, 1988: 160.

Calcinus minimus. – Forest, 1956b: 221 (mis-spelling).

Material Examined

Western Australia: 27 specimens, SL 4.0–1.7 mm, Christmas I. (Indian Ocean), Feb. 1987, 1–26 m, coral and rubble, WAM 631-87 to 642-87; 31 specimens, SL 4.3–1.8 mm, Cocos (Keeling) Is, Feb. 1989, to 28 m, coral and rubble, WAM 397-89, 482-89, 504-89, 560-89, 569-89, 683-89, 703-89; ♂, SL 4.4 mm, 2♀, SL 2.7 mm, 2.6 mm, ♀, SL 3.1 mm, Rob Roy Reef, Kimberleys, 15.vii.1988, 8–9 m, coral and rubble, WAM 2097-88; 2♂, SL 4.0 mm, 3.4 mm, Long Reef, Kimberleys, 17.vii.1988, to 15 m, WAM 2098-88; 14 specimens, SL 4.2–2.4 mm, Ashmore Reef, Sept. 1986, WAM 70-90, 72-90, 73-90; ♂, SL 2.3 mm, ♀, SL 2.1 mm, Cartier I., Sept. 1986, WAM 71-90. **Queensland:** 2♀, SL 5.9 mm, 5.0 mm, Lady Elliot I., 11.xi.1988, 10 m, WAM 822-89, 823-89; ♂, SL 3.6 mm, Flinders Reef, off Cape Moreton, 10.iii.1989, 6–20 m, QM W16251.

Type Specimens (not examined)

Two specimens (Muséum national d'Histoire naturelle, MNHN Pg781).

Type locality. Kear near Timor.

Diagnosis

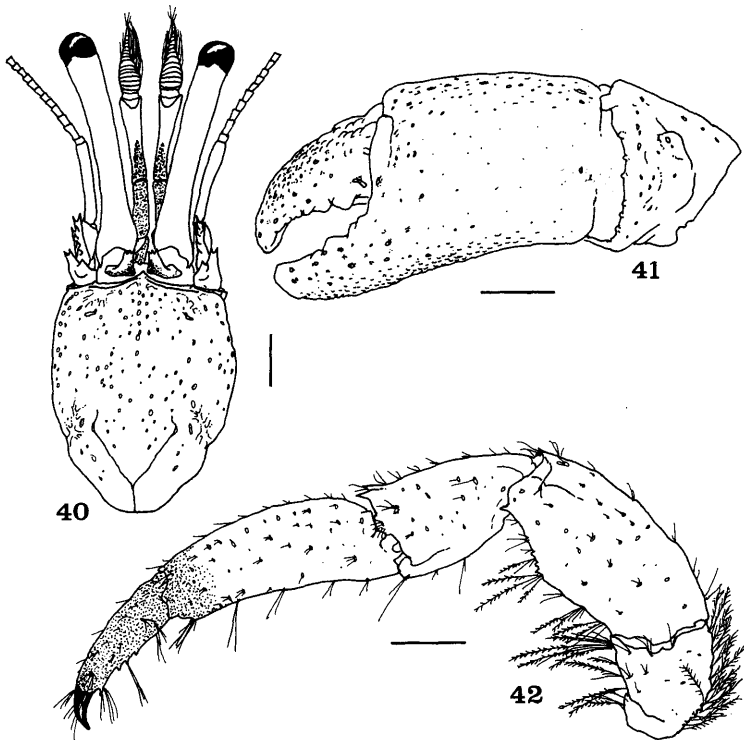
Ocular acicles with 1–4 spines. Lateral face of palm of left cheliped finely granular. Dorsal margin of propodus and carpus of right cheliped spinose. Brush of long setae on dactylus and propodus of third pereiopods absent. Telson with left and right posterior lobes bearing several marginal spines. Chelipeds and ambulatory pereiopods predominantly white or cream with small orange dots; dactylus and distal part of propodus of second and third pereiopods orange.

Live Coloration

Shield (Fig. 40) cream with some faint orange flecks; sometimes medial orange patch just anterior of centre. Ocular peduncles pale pink or orange; acicles cream with areas of brown. Antennular peduncles with penultimate segment dark green-brown, ultimate segment dark green-brown proximally, cream distally; flagella orange-green. Antennal peduncles green and cream, ultimate segment pale green; flagella pale orange. Chelipeds (Fig. 41) with fingers white with some orange dots; palm white, often with pale orange patch mesially; carpus white or cream, sometimes with orange patch dorsally; merus white or cream, sometimes pale orange patch laterally and mesially. Second and third pereiopods (Fig. 42) with dactylus orange; propodus orange distally, remainder of propodus, carpus and merus white with minute orange dots. Setae very pale orange.

Remarks

Calcinus minutus can be distinguished easily by colour from all congeners except *C. nitidus* Heller. As noted by Forest (1956*b*, 1958), *C. minutus* and *C. nitidus* are very similar. Forest observed three differences between the two species: (i) the ocular peduncles are longer than the shield and approximately 10 times as long as broad in *C. nitidus* while about equal to the shield length and stouter (length eight times breadth) in *C. minutus*; (ii) the pereiopods are more elongate in *C. nitidus*, the propodus of second and third pereiopods being five times and four times as long as broad respectively, while in *C. minutus* the corresponding segments are at most four and three times as long as broad; (iii) *C. nitidus* has more distinct and intensely coloured patches of red-orange on the shield, the dactyli of pereiopods and, most notably, on the mesial and lateral faces of the palms.



Figs 40–42. *Calcinus minutus* Buitendijk, 40, 42, ♀, WAM 683-89; 41, ♂, WAM 482-89. 40, shield and cephalic appendages, dorsal view (setae omitted); 41, left cheliped, lateral view (setae omitted); 42, left third pereiopod, lateral view. Scales = 1.0 mm.

In many respects, the Australian specimens lie between, or overlap, the above character extremes. Some specimens, especially those smaller than 3.0 mm SL, agree well with *C. minutus*. Others vary in either or both length of ocular peduncles and of propodi of pereopods. Some animals, especially amongst specimens larger than 3.0 mm SL, have ocular peduncles exceeding the shield length and certainly approximately 10 times as long as wide. Several specimens have the propodi of pereopods very elongate, occasionally exceeding even the length-width ratios of *C. nitidus*. There is no apparent correlation between these variables. No live specimens were observed to have intense patches of colour on the palms of the chelipeds, though several had faint areas of pale orange most evident on the mesial surfaces. Small mesial 'brown spots' on the chelae have also been noted for *C. minutus* by Ball & Haig (1972).

There is valid reason to suspect that *C. nitidus* and *C. minutus* are synonymous, a possibility noted by Forest (1958). The morphological differences between the two species are minor and small differences in coloration may be the only distinguishing features. Comparison of type material is advisable to clarify the identity of the two species although it is likely that colours will have faded in the types.

Several of the male specimens examined displayed rudimentary female gonopores. Intersexes, either functional or otherwise, appear to be rare in diogenids and the incidence of female pores on otherwise normal-looking males was notably higher in *C. minutus* than in other members of the genus.

Distribution

Malaysia, Indonesia, Vietnam, southern Japan, New Guinea, Mariana, Palau and West Caroline Islands; Cocos (Keeling) and Christmas Islands, inshore reefs from the Kimberley region east to southern Queensland.

Habitat

Intertidal to 30 m; usually associated with live coral, sometimes coral rubble, often amongst branching coral, especially acroporids. Australian specimens occur in many small gastropod shells.

Calcinus pulcher Forest

(Figs 43–45)

Calcinus pulcher Forest, 1958: 287, figs 4, 12, 13, 16.—Baba, 1982: 65; Haig & Ball, 1988: 161.

Material Examined

Western Australia: ♂, SL 3.5 mm, 4♀, SL 3.3 (ovig.)—2.0 mm, Cocos (Keeling) Is, Feb. 1989, subtidal to 37 m, WAM 357-89, 398-89, 402-89, 561-89; ♂, SL 1.5 mm, ♀, SL 5.1 mm, Ashmore Reef, Sept. 1986, WAM 76-90, 85-90.

Type Specimens (not examined)

Muséum national d'Histoire naturelle, holotype ♂, MNHN Pg813; allotype ♀, MNHN Pg814.

Type locality. Hon Lon, Nhatrang, Vietnam.

Disgnosis

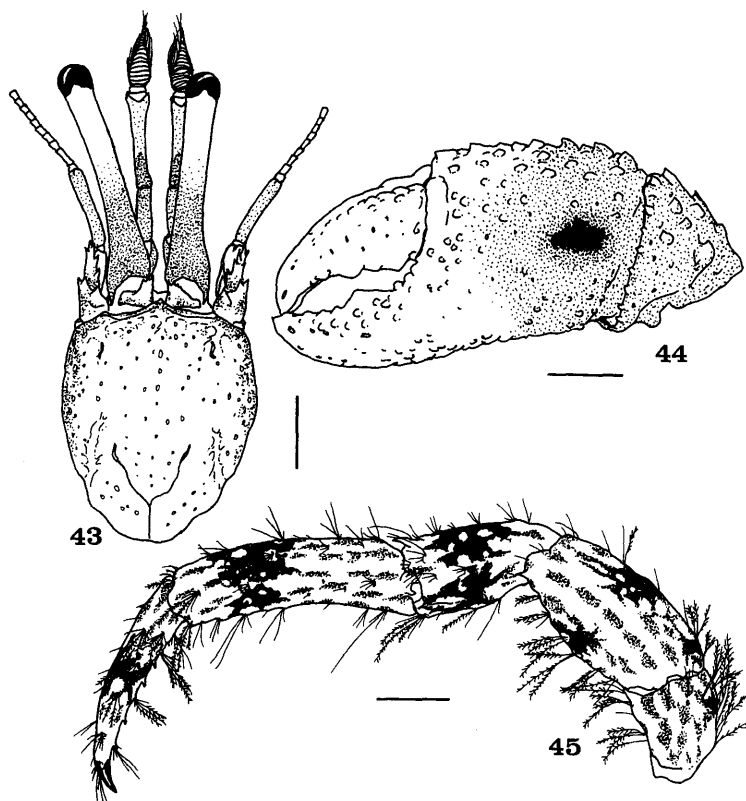
Ocular acicles multispinose. Lateral face of palm of left cheliped sparsely tuberculate. Dorsal margin of propodus and carpus of right cheliped spinose. Brush of long setae on dactylus and propodus of third pereopods absent. Telson with several spines along margins of left and right posterior lobes. Chelipeds with dark brown spot on lateral and mesial faces of palms; ambulatory pereopods with numerous grey-green flecks and very dark irregular bands at approximate midlength of dactylus and propodus and carpus of third pereopod; carpus of second pereopod rose.

Live Coloration

Shield (Fig. 43) cream, pale or medium brown, often darker anteriorly and laterally. Ocular peduncles rose-brown on proximal half, distally cream; ocular acicles brown or orange. Antennular peduncles with penultimate segment orange or brown, ultimate segment orange or brown proximally, distally blue; flagella orange. Antennal peduncles mostly cream with ultimate segment orange; flagella orange. Chelipeds (Fig. 44) with fingers cream or white; palm cream distally grading to grey-brown proximally; dark grey or brown spot on lateral and mesial faces of palms of both chelae; carpus and merus grey-brown. Second and third pereiopods (Fig. 45) cream with numerous short longitudinal grey-green or grey-brown flecks; broad band of very dark grey-blue or brown at approximate midlength of dactylus and subdistally on propodus; carpus of third pereiopod and merus of both pereiopods with similar dark band usually incomplete and mostly dorsal; carpus of second pereiopod mostly intense rose pink.

Remarks

Calcinus pulcher has not been found in mainland Australia. It has been collected only in the Cocos (Keeling) Islands and Ashmore Reef, and at these localities the species was not abundant. *Calcinus pulcher* resembles only *C. lineapropodus* in coloration and the two species can be distinguished by differences in colours of the pereiopods (Morgan & Forest 1991).



Figs 43–45. *Calcinus pulcher* Forest, ♂, WAM 561-89. 43, shield and cephalic appendages, dorsal view (setae omitted); 44, left cheliped, lateral view (setae omitted); 45, left third pereiopod, lateral view. Scales = 1.0 mm.

Distribution

Indonesia, Vietnam, southern Japan; Cocos (Keeling) Islands and Ashmore Reef.

Habitat

Subtidal to about 30 m; usually associated with coral and dead coral rubble.

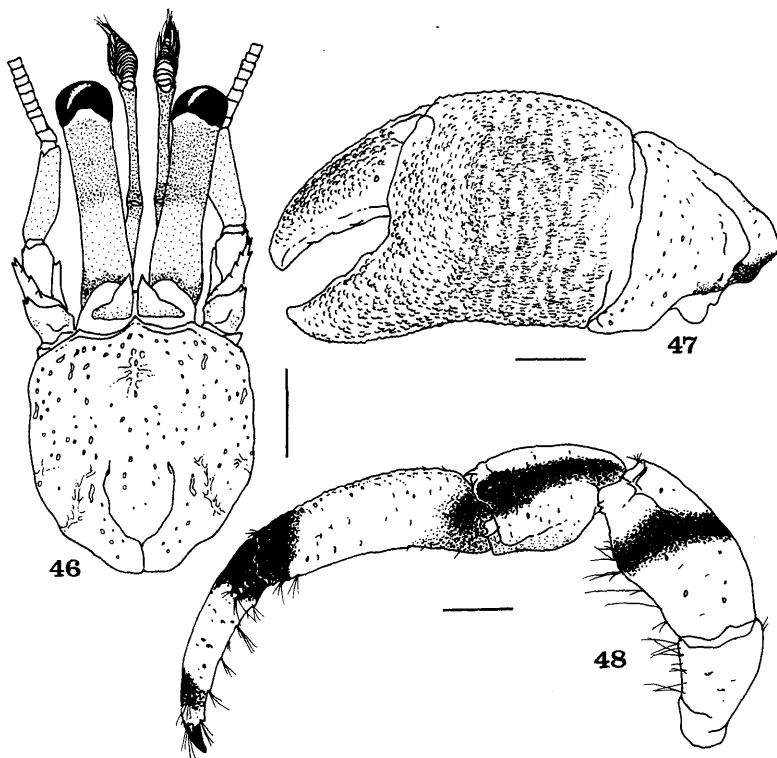
Calcinus seurati Forest

(Figs 46–48)

Calcinus seurati Forest, 1951: 84, figs 1, 3, 4, 7, 8.—Haig & McLaughlin, 1984: 108; Wooster, 1984: 158.

Material Examined

Western Australia: 9 specimens, SL 5·8–4·2 mm (including ovig. ♀), Christmas I. (Indian Ocean), Feb. 1987, supratidal rock pools, WAM 464-87; 3♂, SL 5·2 mm, 4·6 mm, 4·0 mm, 4♀, SL 4·5 mm (ovig.), 4·1 mm, 3·9 mm (ovig.), 3·9 mm (ovig.), Cocos (Keeling) Is, Feb. 1989, high tide pools of rock platforms, WAM 586-89, 856-89; ♂, SL 6·5 mm, Seringapatam Reef, 12.ix.1984, reef flat, WAM 734-85.



Figs 46–48. *Calcinus seurati* Forest, ♂, WAM 464-87. 46, shield and cephalic appendages, dorsal view (setae omitted); 47, left cheliped, lateral view (setae omitted); 48, left third pereopod, lateral view. Scales = 2·0 mm.

Syntypes (not examined)

23 specimens, Muséum national d'Histoire naturelle, MNHN Pg844.

Type locality. Hao, Tuamotu Archipelago.

Diagnosis

Ocular acicles simple. Lateral face of palm of left cheliped smooth. Dorsal margin of propodus and carpus of right cheliped smooth or slightly granulate. Brush of long setae on dactylus and propodus of third pereopods absent. Telson with single marginal spine on both left and right posterior lobes. Dactylus of second and third pereopods with dark proximal and faint subdistal bands; propodus with distal and proximal dark bands; carpus with dark longitudinal stripe; merus with oblique stripe.

Live Coloration

Shield (Fig. 46) cream, sometimes with pale diffuse submedian longitudinal green-grey stripes. Ocular peduncles with narrow green-orange band proximally, then broad pale blue band for half length, grading via green to orange distally; peduncles much paler ventrally; acicles white and pale blue-green. Antennular peduncles with penultimate segment pale blue with pale orange patch distally; ultimate segment deeper blue with orange proximally; flagella orange. Antennal peduncles white or cream with pale green-grey or green-blue patches, ultimate segment orange; flagella orange. Chelipeds (Fig. 47) with dactylus and propodus cream or white, sometimes tinged with pale green or grey-blue; carpus pale green or grey-blue, sometimes darker areas proximally and usually dark brown patch mesially; merus white distally, broad green or grey-blue area centrally and paler proximally. Second and third pereopods (Fig. 48) with dactylus white with proximal green-brown or green-grey band and paler subdistal band, tips white; propodus white with distal and proximal green-brown or green-grey bands, distal band darker; carpus white with longitudinal green-brown or green-grey stripe; merus white with broad oblique band just distal to midlength and paler green proximally. Bands variably tinged with blue. Setae very pale yellow on body; red-orange on pereopods.

Remarks

C. seurati resembles *C. laevimanus* in many respects. Forest (1951) recorded several differences between the two species, the most reliable being the relative lengths of the pereopod dactyli and the shape of the propodus of the third pereopods. In *C. seurati*, the pereopod dactyli are of similar length to the propodi and the propodus of the third pereopod is somewhat flattened laterally and surmounted by a dorsolateral ridge. In *C. laevimanus*, the pereopod dactyli are shorter than the propodi and the propodus of the third pereopod is rounded laterally. Coloration of the species also differs, the pattern of banding on the pereopods serving to distinguish the two.

Calcinus seurati appears to have a high tolerance to desiccation and elevated temperatures. It is usually found high on tropical rocky platforms, often in exposed hollow tide pools.

Distribution

Tuamotu, Society, Hawaiian and Mariana Islands; Cocos (Keeling) and Christmas Islands, Seringapatam Reef.

Habitat

High intertidal and splash zones; rocky platforms. The species shows a preference for globose gastropod shells such as nerites.

Calcinus sirius, sp. nov.

(Figs 49–55)

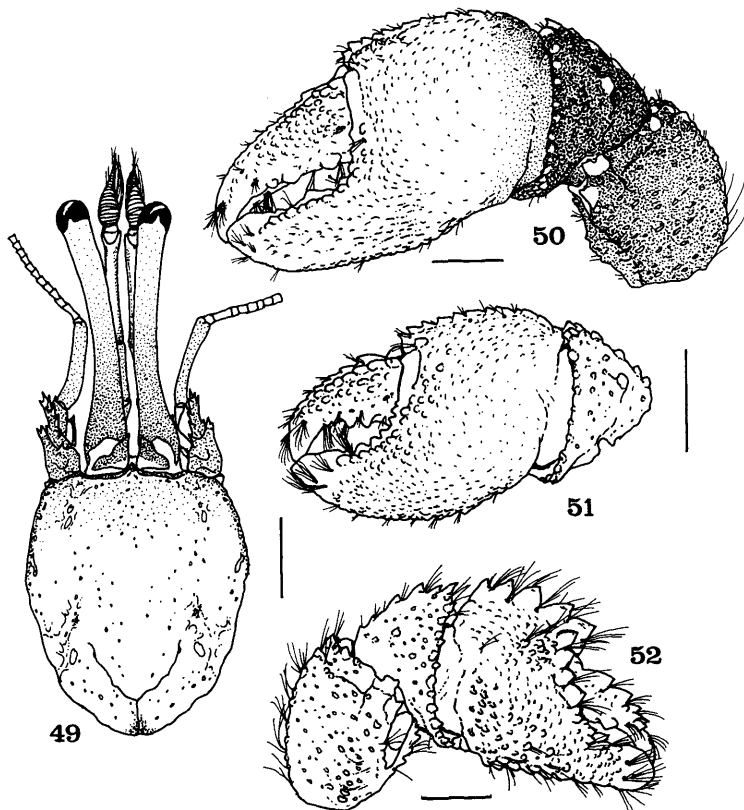
Material Examined

Holotype. ♂, SL 6.4 mm, Dunscombe Bay, Norfolk I., 15 m, cavern, 26.ix.1976, NMV J17025.

Paratypes. ♂, SL 6.4 mm, type locality and date, WAM 218-90; ♂, SL 3.4 mm, type locality and date, NMV J21360, J21361; ♂, SL 6.9 mm, ♀ (ovig.), SL 5.0 mm, Deakons Reef, Lord Howe I., 22 m, 30.xi.1979, WAM 219-90; 2♂, SL 4.7 mm, 3.1 mm, ♀, SL 3.6 mm, Deakons Reef, Lord Howe I., 22 m, 30.xi.1979, AMPI 992; ♂, SL 5.3 mm, Malabar, Lord Howe I., 10 m, 28.xi.1979, AMPI; ♂, SL 4.0 mm, Malabar, Lord Howe I., 12 m, reef, 18.xi.1980, AMPI 1030; 2♂, SL 3.4 mm, 3.3 mm, Sugarloaf I., Lord Howe I., 10 m, reef, 14.ii.1980, AMPI 1035; ♀ (ovig.), SL 3.5 mm, Middleton Reef, Tasman Sea, 11 m, coral, rubble, 9.xii.1987, AM P38138 (part); ♀, SL 3.5 mm, Middleton Reef, 2 m, coral, 8.xii.1987, AM P38137; ♀, SL 3.0 mm, Elizabeth Reef, Tasman Sea, Dec. 1987, AM P38141.

Diagnosis

Ocular acicles simple. Lateral face of palm of left cheliped minutely tuberculate. Dorsal margin of carpus and propodus of right cheliped carinate and spinose. Moderate development of brush of plumose setae on dactylus and distal part of propodus of third pereopods. Telson with 1 spine directed ventrally on posterior margin of both left and right posterior lobes. Palm and fingers of chelae cream, carpus and merus dark with pale tubercles and spines; second and third pereiopods uniformly coloured except for cream at tip of dactylus and on spines.



Figs 49-52. *Calcinus sirius*, sp. nov., 49, 50, 52, holotype ♂, NMV J17025; 51, paratype ♀, NMV J21360. 49, shield and cephalic appendages, dorsal view (setae omitted); 50, left cheliped ♂, lateral view; 51, left cheliped ♀, lateral view; 52, right cheliped ♂, lateral view. Scales = 2.0 mm.

Description

Shield (Fig. 49) slightly longer than broad; anterior margin between rostrum and lateral projections shallowly concave, rostrum triangular, exceeding lateral projections. Lateral projections weakly produced, with minute terminal spinules. Dorsal surface of shield lightly punctate, very sparsely setose dorsally and moderately setose laterally.

Ocular peduncles long, slender, as long as shield in most specimens larger than 5.0 mm SL, slightly shorter than shield in smaller animals, longer than anterior margin of shield, left peduncle longer than right, peduncles inflated proximally and slightly inflated distally; very sparsely setose. Ocular acicles short, distolateral margin concave, proximal margin convex; tipped by spinule (rarely with weak second spinule); acicles almost contiguous basally.

Antennular peduncles slightly shorter than ocular peduncles. Ultimate and penultimate segments unarmed; proximal segment with 5–7 spinules distolaterally.

Antennal peduncles reaching to distal half of ocular peduncles. Fifth segment unarmed; fourth segment with distodorsal spine; third with distinct distoventral spine and long setae; second with bifid distolateral spine and simple mesial spine, sometimes additional spinule on lateral margin; first segment unarmed except for some spinules on ventromesial angle. Antennal acicle reaching to or slightly exceeding beyond distal margin of penultimate segment; terminating in strong bifid spine; mesial margin with 3 or 4 spines, lateral margin with 1 spine distally and often 1 spine proximally; scattered long setae, especially distally. Antennal flagellum slightly shorter than thorax; minutely setose.

Left cheliped of holotype and males larger than 5.0 mm SL (Fig. 50) with propodus almost twice as long as width of palm. Dactylus approximately half length of propodus; cutting edge with several low teeth, largest proximally; lateral and dorsal faces finely tuberculate and densely punctate, larger tubercles proximally, particularly in a dorsolateral row; mesial face mostly smooth with some small granules on dorsal edge. Fixed finger recurved, touching dactylus only at tip, cutting edge with several large teeth; outer face finely tuberculate with diffuse row of larger tubercles parallel to cutting edge; ventral margin with irregular row of low tubercles. Both fingers with only scattered setal clumps, especially distally. Palm as broad as long and compressed laterally; lateral surface convex, finely tuberculate near bases of fingers and on dorsal surface, dorsal and ventral edges with row of low tubercles; mesial face slightly convex, minutely tuberculate with very prominent tubercle proximal to fixed finger. Carpus broad, subtriangular, much shorter than merus, compressed; lateral surface almost smooth with some scattered small tubercles and very prominent tubercle placed slightly toward dorsal margin; distolateral margin very finely dentate; dorsal edge faintly granulate, 1 spine at distodorsal angle and another spine mesial to this; mesial and ventral faces almost smooth with some minute tubercles, several small denticles on distoventral margin. Merus slightly compressed laterally; lateral surface nearly flat, with numerous minute tubercles; lateral distoventral angle with 1 moderately large and several smaller spinules; mesial distoventral margin with 3 or more spinules; dorsal margin with minute tubercles; mesial surface flat and almost smooth.

Females and most males smaller than 5.0 mm SL with fingers less attenuated and recurved, resulting in less distinct gape. Spines and tubercles better developed especially along dorsal and ventral margins of fingers, dorsal edge of palm and dorsal and ventral margins of carpus (Fig. 51).

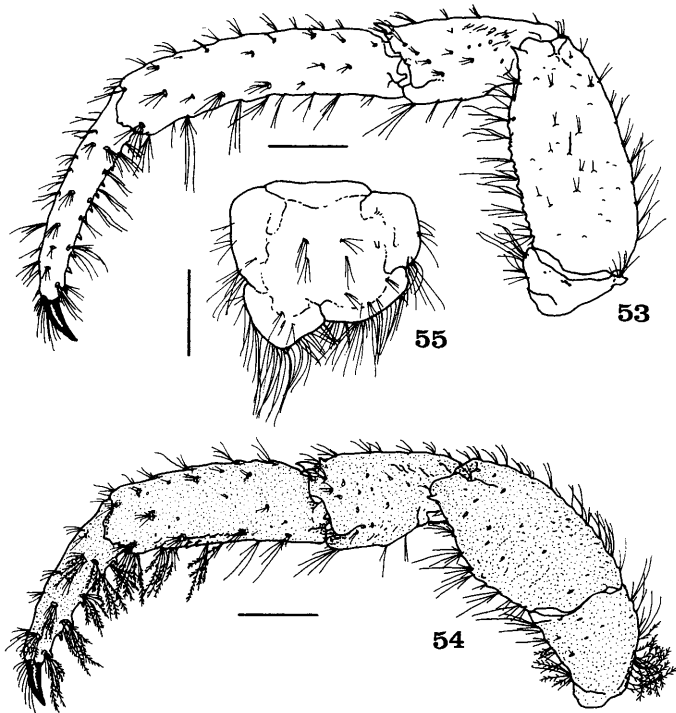
Right cheliped of males (Fig. 52) with propodal length approximately $\frac{2}{3}$ length of left propodus. Dactylus about half length of propodus; dorsal margin with 2 irregular rows of large acute corneous-tipped spines, diminishing in size distally; mesial surface with some scattered spines; cutting edge with about 2 proximal teeth. Fixed finger touching dactylus only at tip; ventral margin strongly tuberculate; lateral face granulate with row of tubercles and blunt spines parallel to cutting edge; mesial face weakly granulate; cutting edge with about 3 small teeth. Palm broader than long, with lateral surface convex and with low tubercles and 3 or 4 large spines in row proximal to articulation of dactyl; dorsal margin produced as crest with 5 very large corneous-tipped spines and sometimes 1 or 2 additional somewhat smaller spines; ventral edge with large blunt tubercles; mesial face flat and almost smooth with distinct tuberculate ridge separating palm from base of finger; palm with tufts

of setae especially along dorsal and lateral faces. Carpus broad, much shorter than merus, compressed; lateral face with small tubercles; distolateral edge dentate; dorsal edge with 3 or 4 strong spines and several spinules proximal to these; mesial face almost smooth, flattened; distomesial margin with 1-3 spines near distoventral angle; setae sparse on carpus except for clumps on distomesial margin. Merus slightly compressed, lateral surface slightly convex with numerous low tubercles; dorsal edge and distolateral outer margin with small tubercles and 1 or more spinules at distodorsal angle; 1 spine on lateral distoventral margin; mesial surface almost smooth, flat; ventromesial margin with several blunt spines or tubercles; tufts of sparse setae especially on dorsal and ventral edges.

Sexual and allometric differences less significant in right cheliped than in left; dorsal margin of palm of females most often with 1 or 2 additional spines.

Second pereiopods (Fig. 53) subequal in length, much longer than left cheliped. Dactylus as long as or slightly shorter than propodus, more elongate on large specimens, terminating in strong claw; ventral margin with row of 9-11 short corneous spines; scattered clumps of long simple setae, longer ventrally. Propodus unarmed except for minute spinule dorso-distally, 1 or 2 spinules ventrodistally and usually 1 distal spinule on lateral and mesial margins; setation like that of dactyl. Carpus with large spine at distodorsal angle and usually small spine lateral to this, sometimes additional spine posterior to distodorsal spine and sometimes a dorsomesial spine; scattered setae, longer ventrally. Merus compressed; 1 spine at distoventral angle; ventral margin dentate; long simple setae dorsally and ventrally.

Third pereiopods (Fig. 54) shorter than second, with shorter, stouter dactylus, propodus and merus. Spination of third pereiopods similar to that of second except dactyl with only 8-9 ventral corneous spines and propodus of most specimens larger than 5.0 mm SL with



Figs 53-55. *Calcinus sirius*, sp. nov., holotype σ . 53, left second pereiopod, lateral view (colour pattern omitted); 54, left third pereiopod, lateral view; 55, telson, dorsal view. Scales = 2.0 mm (53, 54); 1.0 mm (55).

several distoventral spinules. Setation heavier on dactyl and distal part of propodus than on second pereopods, with clumps of long finely plumose setae especially ventrally, these clumps not forming a distinct 'brush'; setation slightly heavier on carpus and merus than on second pereopod.

Sternite of pereopod 3 with anterior lobe broad and subrectangular, with rounded lateral projections; heavily setose.

Left uropod larger than right. Telson (Fig. 55) with left posterior lobe larger than right; both lobes armed with 1 spine directed ventrally from posterior margin, right spine smaller and not visible from dorsal aspect, lateral margins unarmed; margins with fringe of long setae.

Coloration

No live material examined. Preserved types with shield (Fig. 49) medium brown anteriorly, paler posteriorly, with darker anterior and lateral margins. Ocular peduncles deep brown on proximal half, grading to much paler distally; ocular acicles deep brown. Antennular peduncles with penultimate segment medium brown; ultimate segment medium brown laterally and ventrally, cream dorsally and ventrally; flagella pale. Antennal peduncles brown with cream spines; flagella pale brown. Chelipeds (Fig. 50) with fingers and palm cream with minute scattered orange dots, more numerous on right chela; posterior lateral face and dorsal margin of palm tinged with brown; carpus and merus deep brown with spines and tubercles white or cream. Second and third pereopods (Fig. 54) rather uniform medium brown, tip of dactylus cream, distal part of propodus somewhat paler brown; spines and tubercles paler, often cream; scattered darker orange or brown spots at setal pores.

Remarks

Calcinus sirius most closely resembles *C. gaimardii*, *C. latens* and *C. dapsiles*. From *C. gaimardii*, *C. sirius* differs in having more elongate dactyli and propodi on the ambulatory pereopods and a lesser development of the plumose setal 'brush' on these segments of the third pereopod, a single marginal spine on both the left and right posterior lobes of the telson and in the respective colour patterns. The live colours of *C. sirius* are unknown except that its chelae are predominantly cream or white in contrast to the brown of *C. gaimardii*, and there is no distinct demarcation of colours on the ocular peduncles, as is evident in *C. gaimardii*.

Calcinus latens is similar to *C. sirius* in the development of the setal brush on the third pereopods and the shape and colour of the chelae. *Calcinus latens* has several marginal spines on the left posterior lobe of the telson, however, and has a dark proximal band of short longitudinal stripes on the dactyli of ambulatory pereopods.

In most respects *C. sirius* is most similar to *C. dapsiles*, a species endemic to south-western Australia. *Calcinus dapsiles* has no development of the setal brush on the third pereopods and its ocular peduncles are rather uniformly coloured, not distinctly grading from dark proximally to pale distally.

Distribution

Known only from Norfolk and Lord Howe Islands, Middleton and Elizabeth Reefs.

Habitat

From 2–22 m; associated with coral reefs. No gastropod shells retained with types.

Etymology

Named after HMS 'Sirius', flagship of the First Fleet to Australia in 1788, wrecked at Norfolk Island in 1790.

Calcinus spicatus Forest

(Figs 56–59)

Calcinus spicatus Forest, 1951: 90, figs 10–13. — Haig & McLaughlin, 1984: 119.

Material Examined

Queensland: ♂, SL 8.2 mm, Saumarez Reef, Qld, 6.viii.1971, NMV J18377; ♂, SL 7.0 mm, ♀ (ovig.), damaged, Cato I., Coral Sea, AM P17650; ♂, SL 9.9 mm, Lady Elliot I., 1964, WAM 222-90; ♂, SL 8.3 mm, Gillett Cay, Swain Reefs, Oct. 1962, AM P17459 (part). **New South Wales:** 2♂, SL 6.3 mm, 3.7 mm, 2♀, SL 6.1 mm, 3.3 mm, Lord Howe I., Dec. 1979–Feb. 1980, to 17 m, AMPI 1002, 1003, 1028, 1037; 3♂, SL 9.1–5.8 mm, 4♀, SL 5.4–2.4 mm, Middleton Reef, Tasman Sea, 7–9.xii.1987, AM P38134, P38136, P38138 (part), P38144; 2♀, SL 7.3 mm, 3.0 mm, Middleton Reef, Apr. 1936, AM P10790; 2♂, SL 8.5 mm, 7.2 mm, 2♀ (ovig.), SL 9.1 mm, 7.2 mm, Elizabeth Reef, Tasman Sea, 10–12.xii.1987, AM P38145, P38146.

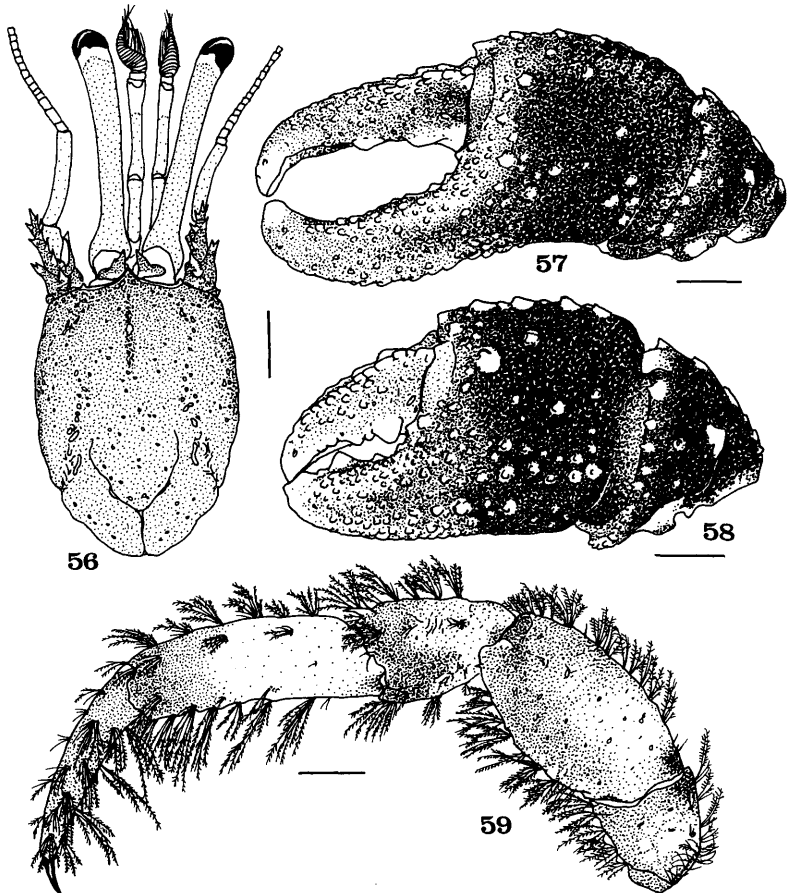
Holotype (not examined)

♀, Muséum national d'Histoire naturelle, MNHN Pg859.

Type locality. Mangareva, Tuamotu Archipelago.

Diagnosis

Ocular acicles simple. Lateral face of palm of left cheliped with spaced spines and tubercles. Dorsal margin of propodus and carpus of right cheliped spinose. Moderate



Figs 56–59. *Calcinus spicatus* Forest. 56, ♂, AM P38136; 57, 59, ♂, AM P38146; 58, ♂, QM J18377. 56, shield and cephalic appendages, dorsal view (setae omitted); 57, 58, left chelipeds, lateral view (setae omitted); 59, left third pereiopod, lateral view. Scales = 2.0 mm.

development of brush of long plumose setae on dactylus and propodus of third pereopods. Telson with numerous spines along entire margins of left and right posterior lobes. Chelipeds with fingers and distal part of palm purple-brown, remainder of palm black; second and third pereopods with dactylus and distal part of propodus purple, propodus orange proximally; carpus and merus orange-brown and dark purple-brown.

Live Coloration

Colour patterns in Figs 56–59.

From Haig & McLaughlin (1984):

'Shield is purplish brown; the ocular peduncles orange-brown with a broad white band next to cornea. The antennular peduncles are orange except for the distal portion of the ultimate segment which is bright blue; the flagellum is orange. The antennal peduncles appear brownish and the flagella orange. The fingers and distal portions of the palms of the chelipeds are purplish-brown, the remainder of the palms are black; the carpi and meri also are black with narrow purplish-brown areas distally. The dactyls of the ambulatory legs are purple, the proximal two thirds of the propodi are dull orange and the distal thirds purple; the carpi and meri are orange-brown proximally, dark purplish-brown distally, and each has a black streak or elongate spot on the outer surface near the upper margin.'

Remarks

Calcinus spicatus is represented from Australia by only a few specimens. Forest (1951) discussed the differences between this species and *C. nitidus* Heller, *C. latens* and *C. gaimardii*. Haig & McLaughlin (1984) compared *C. spicatus* with their newly described *C. laurentae* Haig & McLaughlin. Only preserved material was examined for the present work but the live colours noted by Haig & McLaughlin indicate some resemblance to those of *C. gaimardii*, although the latter is immediately recognisable by the blue coloration distally on the ocular peduncles.

Several of the specimens examined are considerably larger than any previously noted for the species (Forest 1951: carapace length of 11 mm; Haig and McLaughlin 1984: shield length up to 6.1 mm). Figures 57 and 58 represent the first illustrations of the left cheliped of male specimens of *C. spicatus*. As in a number of other *Calcinus* species, the left cheliped of large males can become much more elongated and angular than that of smaller males and females.

Distribution

Tuamotu Island, Vanuatu; Lord Howe Island, Middleton and Elizabeth Reefs and the Great Barrier Reef, Queensland.

Habitat

Apparently preferring coral reefs.

Calcinus vachoni Forest

(Figs 60–62)

Calcinus vachoni Forest, 1958: 285, figs 2, 3, 9, 10, 15, 19.—Wooster, 1984: 137; Morgan, 1990: 11, fig. 2.

Material Examined

Western Australia: ♂, SL 2.9 mm, Long Reef, Kimberleys, 17.vii.1988, to 15 m, WAM 2099-88; ♂, SL 2.0 mm, Steep Point, Shark Bay, 13.iii.1986, WAM 104-90; 3♂, SL 3.2 mm, 3.2 mm, 2.2 mm, 2♀, SL 2.6 mm, 1.7 mm, Monkey Rock, Shark Bay, 10–11.iii.1986, WAM 109-90, 117-90; ♂, SL 3.9 mm, Surf Point, Shark Bay, 9.iii.1986, WAM 113-90.

Type Specimens (not examined)

Muséum national d'Historie naturelle, holotype ♂, MNHN Pg896; allotype ♀, MNHN Pg897.

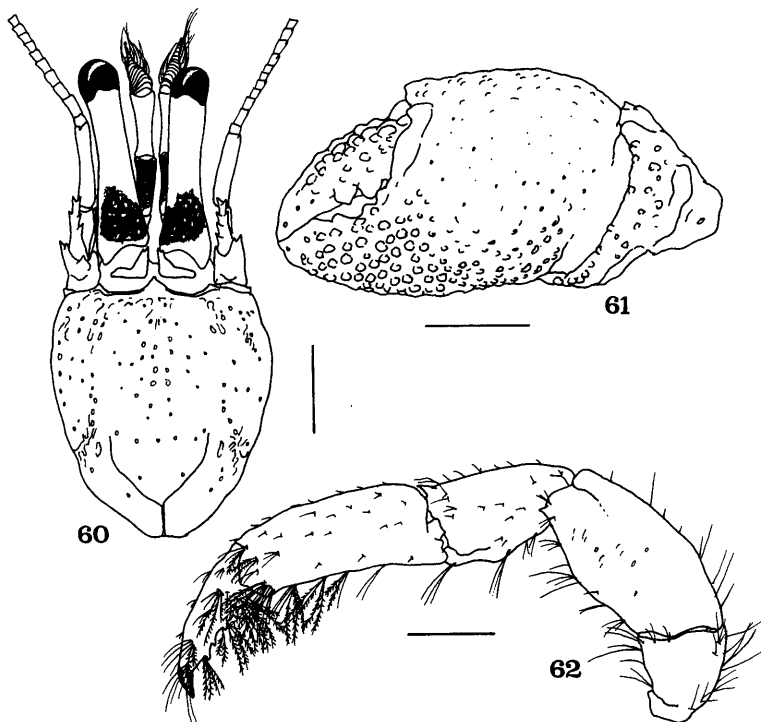
Type locality. Vietnam.

Diagnosis

Ocular acicles bi- or trispinose. Lateral face of palm of left cheliped rather smooth or finely tuberculate. Dorsal margin of propodus and carpus of right cheliped bearing low spines. Moderate development of brush of setae on ventral margin of dactylus and distal part of propodus of third pereiopods. Telson with several spines along margins of both left and right posterior lobes. Ocular peduncles with large very dark dorsal patches subproximally; chelipeds and second and third pereiopods cream and pale grey.

Live Coloration

Shield (Fig. 60) cream with some grey and grey-brown patches; 2 dark spots adjacent to cervical groove submedially. Ocular peduncles dark grey with large black patches on dorsal surface subproximally, these punctuated by small pale spots; cream or white proximal to black patches and thin white band at base of corneas; acicles grey. Antennular peduncles mostly grey, penultimate segment with black-brown band over most of surface; flagella pale orange. Antennal peduncles pale grey and cream, ultimate segment pale orange; flagella orange-red. Chelipeds (Fig. 61) with fingers cream, palm grey-green, carpus and merus grey. Second and third pereiopods (Fig. 62) with dactylus cream; propodus cream with grey tinge proximally; carpus and merus cream-grey, merus darker.



Figs 60–62. *Calcinus vachoni* Forest, ♂, WAM 2099-88. 60, shield and cephalic appendages, dorsal view (setae omitted); 61, left cheliped, lateral view (setae omitted); 62, left third pereiopod, lateral view. Scales = 1.0 mm.

Remarks

Few specimens of *C. vachoni* have been collected in Australia but these agree well with the description of Forest (1958), with some minor differences noted by Morgan (1990). Forest (1958) discussed the diagnostic characters distinguishing this species from *C. minutus*, *C. nitidus* and *C. rosaceus*. Heller and Morgan (1990) discussed the differences between *C. vachoni* and *C. guamensis*. With live or recently preserved material, coloration provides the easiest distinction as noted in detail by Morgan (1990). Several workers have confused the two species in the past and records of *C. vachoni* from Japan (Miyake 1978: 54) probably represent *C. guamensis*.

Distribution

Vietnam; north-western Australia south to Shark Bay.

Habitat

Subtidal to 20 m; coral and rocky reefs.

Other Species of *Calcinus*

In addition to the 17 species recorded from Australia, a further 16 species of *Calcinus* are known worldwide and are listed below with abbreviated synonymies and known ranges. None of these species was examined.

***Calcinus astathes* Stebbing**

Calcinus astathes Stebbing, 1924: 239.

Range. South Africa.

***Calcinus californiensis* Bouvier**

Calcinus californiensis Bouvier, 1898: 380.—Alcock, 1905: 164; Moran, 1984: 74.
? *Calcinus californiensis*.—Chase, 1962: 627, figs 5, 6.

Range. Gulf of California to Mexico, El Salvador, Clipperton Island.

***Calcinus chilensis* (H. Milne Edwards)**

Pagurus chilensis H. Milne Edwards, 1836: 279.

Calcinus chilensis.—Alcock, 1905: 164.

Range. Chile.

***Calcinus explorator* Boone**

Calcinus explorator Boone, 1932: 21, fig. 6.—Chase, 1962: 624, figs 3, 4.

Range. Galapagos, Cocos (Pacific) and Clipperton Islands, Mexico.

***Calcinus formosus* Neumann**

Calcinus formosus Neumann, 1878: 31.—Alcock, 1905: 164.

Range. Gulf of Mexico.

***Calcinus hazletti* Haig & McLaughlin**

Calcinus hazletti Haig & McLaughlin, 1984: 110, fig. 1.

Range. Hawaii.

***Calcinus laurentae* Haig & McLaughlin**

Calcinus laurentae Haig & McLaughlin, 1984: 115, fig. 2.

Range. Hawaii.

***Calcinus nitidus* Heller**

Calcinus nitidus Heller, 1865: 89, pl. 7, fig. 4.—Alcock, 1905: 163; Forest, 1956b: 218, figs 1-4.

Range. Tahiti.

***Calcinus obscurus* Stimpson**

Calcinus obscurus Stimpson, 1859: 83.—Holthuis, 1954: 20; Moran, 1984: 74.

Range. Central America.

***Calcinus paradoxus* Bouvier**

Calcinus paradoxus Bouvier, 1922: 16.

Range. Azores.

***Calcinus rosaceus* Heller**

Calcinus rosaceus Heller, 1861: 23.—Alcock, 1905: 163; Forest, 1956b: 222, figs 5-9; Lewinsohn, 1969: 50.

Range. East Africa, Red Sea.

***Calcinus talismani* A. Milne Edwards & Bouvier**

Calcinus talismani A. Milne Edwards & Bouvier, 1892: 225.—Alcock, 1905: 164; Fize & Serène, 1955: 40.

Range. Cape Verde Island.

***Calcinus tibicen* (Herbst)**

Cancer tibicen Herbst, 1791: 25, pl. 23, fig. 7.

Pagurus tibicen.—Bosc, 1801: 78.

Pagurus sulcatus H. Milne Edwards, 1836: 279.

Calcinus sulcatus.—Benedict, 1901: 141, pl. 5, figs 3, 3a; Alcock, 1905: 164.

Calcinus tibicen.—Alcock, 1905: 164; Provenzano, 1959: 363, fig. 4.

Range. South Florida, West Indies, Brazil.

***Calcinus tropidomanus* Lewinsohn**

Calcinus tropidomanus Lewinsohn, 1981: 147.—Reay & Haig, 1990: 582.

Range. Somalia, East Africa.

***Calcinus tubularis* (Linnaeus)**

Cancer tubularis Linnaeus, 1767: ? (not sighted).

Pagurus ornatus Roux, 1830: pl. 43.—H. Milne Edwards, 1836: 277.

Calcinus ornatus.—Alcock, 1905: 164.

Calcinus tubularis.—Holthuis, 1977: 59; Lewinsohn & Holthuis, 1986: 28.

Range. Mediterranean Sea, Azores, Canary Islands.

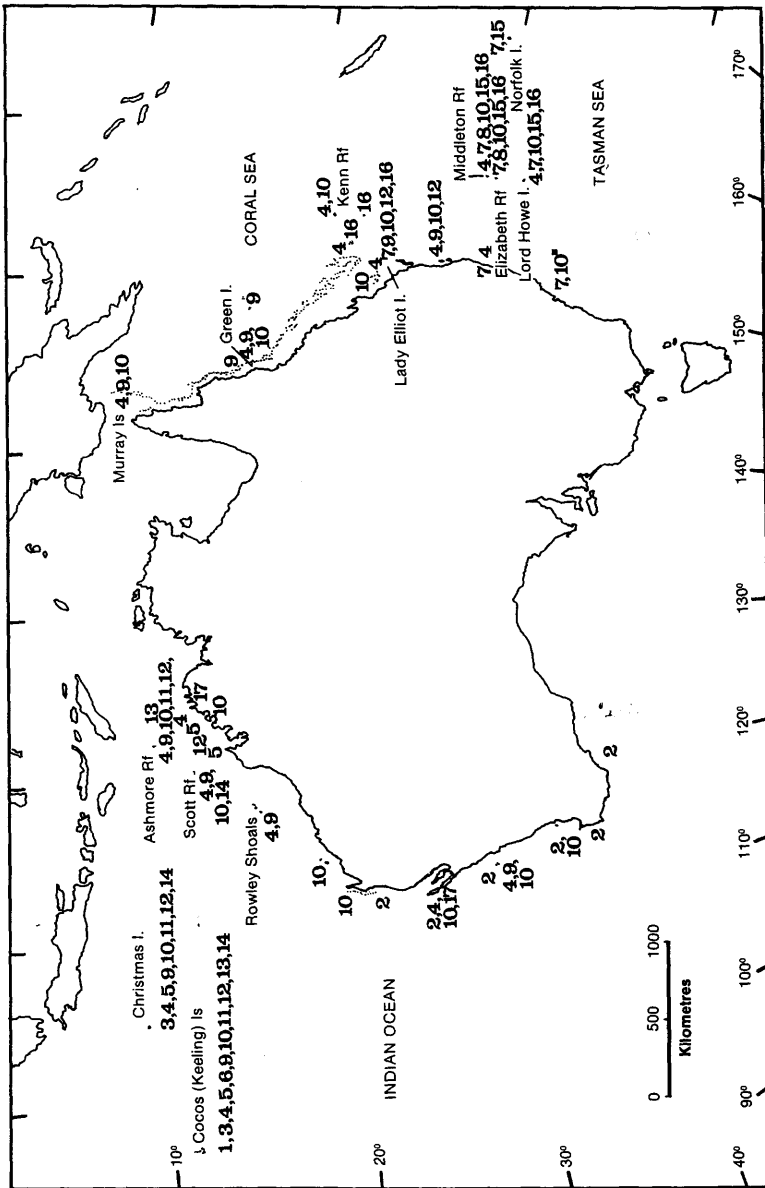


Fig. 63. Distributions of *Calcinus* species in Australia and territories. 1, *C. argus*; 2, *C. dapsiles*; 3, *C. elegans*; 4, *C. gaimardii*; 5, *C. guamensis*; 6, *C. haigae*; 7, *C. imperialis*; 8, *C. inconspicuus*; 9, *C. laevimanus*; 10, *C. latens*; 11, *C. lineapropodus*; 12, *C. minutus*; 13, *C. pulcher*; 14, *C. seurati*; 15, *C. sirius*; 16, *C. spicatus*; 17, *C. yachoni*. (■, from literature.)

Calcinus verrilli (Rathbun)

Clibanarius verrilli Rathbun, 1901: 328. — Verrill, 1908: 449, pl. 27, fig. 5, pl. 28, fig. 6; Alcock, 1905: 161.

Calcinus verrilli Provenzano, 1960: 120, fig. 1.

Range. Bermuda.

Distribution of Australian Species

Calcinus is a predominantly tropical intertidal and shallow subtidal genus, and the majority of Australian species occur in warm northern waters (Fig. 63). The genus prefers rocky and coral reef habitats and waters with relatively low turbidity (Wooster 1984; personal observation). Few, or no, species of *Calcinus* occur in highly turbid habitats even if coral reef is present (Morgan 1987).

On the western coast, the Houtman Abrolhos Islands appear to be the southern limit of the range of two widespread species (*C. gaimardii* and *C. laevimanus*) with another species (*C. latens*) extending somewhat farther south to Rottnest Island. Both the Abrolhos and Rottnest Islands experience warmer water temperatures than is to be expected at these latitudes due to the influence of the south-flowing Leeuwin Current (Hodgkin & Phillips 1969; Cresswell & Golding 1980).

Of the seven species that occur in mainland Western Australia, three (*C. guamensis*, *C. minutus*, *C. vachoni*) occur only north of Shark Bay or Exmouth Gulf. A further six species (*C. argus*, *C. elegans*, *C. haigae*, *C. lineapropodus*, *C. pulcher*, *C. seurati*) are recorded in Australian territory only from the tropical offshore Indian Ocean localities of Christmas and Cocos (Keeling) Islands and Ashmore and Scott Reefs.

Fewer species of *Calcinus* have been recorded from the east coast and eastern territories (Norfolk and Lord Howe Islands) than from corresponding areas in the west of Australia (8 species and 13 species respectively). This probably reflects more the relative intensity of sampling than real differences in diversity as several of the species recorded for the west coast, but not the east, are widely distributed species in the Indo-West Pacific. The genus extends as far south as the Sydney region (*C. imperialis*, *C. latens*) with Moreton Bay the southern limit for three species (*C. gaimardii*, *C. laevimanus*, *C. minutus*). *Calcinus spicatus* appears confined to oceanic coral reef habitats to the east of mainland Australia including Lord Howe Island.

Three species are known only from Australian territory: *C. dapsiles*, almost certainly endemic to south-western Australia, and *C. inconspicuus* and *C. sirius*, probably endemic to the Tasman Sea. *Calcinus inconspicuus* is known only from the isolated Elizabeth and Middleton Reefs while *C. sirius* occurs at those localities and Norfolk and Lord Howe Islands. The record of *C. imperialis* from the Mariana Islands by Wooster (1984) must be regarded as doubtful (see the account of this species). It is likely that this is a fourth species endemic to Australian territory, being confined to central eastern mainland Australia and the Tasman Sea. These four species are also the only exclusively temperate representatives of *Calcinus* in Australia.

Of the remaining 13 species, four (*C. elegans*, *C. gaimardii*, *C. laevimanus*, *C. latens*) range from eastern Africa to the West or Central Pacific, three (*C. guamensis*, *C. haigae*, *C. seurati*) range from the East Indian Ocean to West Pacific, five (*C. argus*, *C. lineapropodus*, *C. minutus*, *C. pulcher*, *C. vachoni*) are confined to the East Indian Ocean and South-East Asia (including northern Australia) and one species (*C. spicatus*) occurs only in the West Pacific.

Only four Indo-West Pacific species of *Calcinus* have not been recorded from Australian territory: *C. hazletti* and *C. laurentae* from Hawaii, *C. nitidus* (see *C. minutus*) from Tahiti and *C. rosaceus* from the western Indian Ocean and Rea Sea.

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