Identity of two hermit crabs, *Calcinus vachoni* Forest, 1958, and *Calcinus seurati* Forest, 1951, from the coral reefs of Taiwan (Crustacea: Decapoda: Anomura)

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摘 要

施習德　李信徹　兩種臺灣珊瑚礁產之硬殼寄居蟹類，瓦氏硬殼寄居蟹和塞氏硬殼寄居蟹(甲殼綱：十足目：異尾類)　臺灣省立博物館半年刊　50(1)：21-31

本報告描述兩種臺灣海域珊瑚礁產的硬殼寄居蟹，分別是瓦式硬殼寄居蟹*Calcinus vachoni* Forest, 1958和塞氏硬殼寄居蟹*Calcinus seurati* Forest, 1951。這兩種寄居蟹都具有顯著的體色，很容易和其他種寄居蟹區分。瓦氏硬殼寄居蟹爲臺灣新記錄種的寄居蟹，分布在低潮間帶岩石下方至深達3公尺的淺亞潮帶珊瑚枝上，全身爲乳白或淡青色，無特殊斑紋，唯近眼柄基部有不同大小的黑色斑塊，但亦有無黑斑的個體。塞氏硬殼寄居蟹棲息在高潮間帶石灰岩潮池中，目前在臺灣海域的分布僅限於蘭嶼島上，大螯足乳白或灰青色，步足有棕綠色條紋，步足腕節有單一縱向條紋，長節則有斜向條紋；而近似種光螯硬殼寄居蟹*Calcinus laevimanus* (Randall, 1839)的步足腕節和長節均有數條縱向條紋。瓦氏硬殼寄居蟹常被誤認爲塞氏硬殼寄居蟹，本報告除比較這兩種寄居蟹的外部形態特徵、體色和棲息場所之外，並討論其在動物地理學上的分布。

關鍵詞：甲殼類，異尾類，新記錄，分類，生態。

Abstract

Two *Calcinus* hermit crab species were collected from the coral reefs of Taiwan. *Calcinus vachoni* Forest, 1958, new to Taiwan, was collected under large rocks or on the branches of corals at about 0 to 3 m depth, while *C. seurati* Forest, 1951, was found on the high intertidal pool of the coral reefs. These two species are easily recognized by their apparent coloration (shown on the living color plates). Further discussion is made of the color variation of eyestalks of *C. vachoni*. Since the nomenclature of these two species adopted in some previous publications is misleading, we define their taxonomic status and delimit their distributions correctly.

Key words: Crustacea, Anomura, new record, taxonomy, zoogeography.

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Introduction

Two hermit crabs, *Calcinus vachoni* Forest, 1958, and *C. seurati* Forest, 1951, from Taiwanese waters are revised. *C. vachoni* is new to Taiwan. There are a total of ten *Calcinus* species currently recorded from Taiwan: *C. laevimanus*, *C. elegans*, *C. gaimardii*, *C. latens*, *C. minutus*, *C. seurati*, *C. guamensis*, *C. lineapropodus*, *C. pulcher* and *C. vachoni* (Terao, 1913; Lee, 1969; Yu, 1987; Foo, 1989; Yu and Foo, 1991; Shih and Yu, 1995; this study). *C. vachoni* lives in the low intertidal and shallow subtidal areas of reefs and has been misidentified as *C. seurati* by many authors (Miyake, 1963; Minei, 1973; Utinomi, 1975; Miyake, 1978; Miyake and Imafuku, 1980; Miyake, 1982; Kamezaki *et al.*, 1988; Murata *et al.*, 1991; Chang and Chen, 1992), although their color patterns differ distinctly from each other. In Taiwan, the distribution of *C. seurati* is confined to the high intertidal area of limestone pools in Lanyu Island (Foo, 1989; Yu and Foo, 1991; this study). The above mentioned information will contribute to the updating of our knowledge regarding the distributional limits of the above two species. This issue is also discussed in the present paper.

Calcinus vachoni shows variable color pattern on eyestalks, which as previously adopted as a main species-diagnostic feature in *C. vachoni* (Morgan, 1991).

In this paper, the morphological characters including color patterns are discussed in comparison with other closely-related *Calcinus* species. The living coloration of the above two species is described in detail with color plates provided to help species identification in the field. Shield length (SL) measurements were made from the tip of the rostrum to the posterior edge of the shield. The color pattern on eyestalks in *C. vachoni* was illustrated with the help of a drawing tube attached to a Carl Zeiss Jena stereo microscope. Specimens are now deposited in the Institute of Marine Biology, National Sun Yat-sen University (NSYSU).

Calcinus vachoni Forest, 1958 (Figs. 1, 2, 3)

Calcinus vachoni Forest, 1958: 285, figs. 2, 3, 9, 10, 15, 19 – Wooster, 1984: 137; Morgan 1990: 11, fig. 2; Morgan, 1991: 905, figs. 60–62; Gherardi and McLaughlin, 1994: 624.

Calcinus seurati – Miyake, 1963: 63; Minei, 1973; 53, fig. 19; Utinomi, 1975: 113; Miyake, 1978; 54; Miyake and Imafuku, 1980: 5; Miyake, 1982: 217; Kamezaki *et al.*, 1988: 113; Murata *et al.*, 1991: 23, fig. 1D, E; Chang and Chen, 1992: 108, 109 [not *C. seurati* Forest, misidentification].

Material examined:

Houwan, Pingtung County, 10♂♂ (SL 2.0–4.0 mm), 5♀♀ (SL 1.7–3.6 mm) (incl. 2 ovig. ♀♀), Aug. 12, 1992, NSYSU 920812; 13♂♂ (SL 2.0–3.5 mm), 5♀♀ (SL 1.9–4.2 mm), Mar. 27, 1993, NSYSU 930327; 12♂♂ (SL 1.4–3.6 mm), 8♀♀ (SL 1.4–3.4 mm) (incl. 1 ovig. ♀), Mar. 28, 1993, NSYSU 930328; 7♂♂ (SL 1.4–4.1 mm), 6♀♀ (SL 1.6–3.0 mm), Feb. 18, 1997, NSYSU 970218.

Diagnosis:

Ocular acicles with 2 to 5 spines at distal margin. Antennal flagella short, not exceeding 2nd pereiopod. Left cheliped slightly larger than right; palm and fingers minutely tuberculate; carpus tuberculate, with 1 large submedian tubercle on lateral surface. Right cheliped more spinous and hirsute; palm and carpus with spines on dorsal margin. Second and 3rd pereiopods smooth, with setae on dactyl and propodus of 3rd pereiopods more densely distributed than those on 2nd; dactyls shorter than propodi, with 5–7 small spines along ventral margin; carpus with 1–3 spines on distodorsal margin; merus with 1 small spine at lateral distoventral angle. Telson with several short spines and long hairs on terminal margin of both lobes.

Color in life:

Shield cream, with 2 small black spots

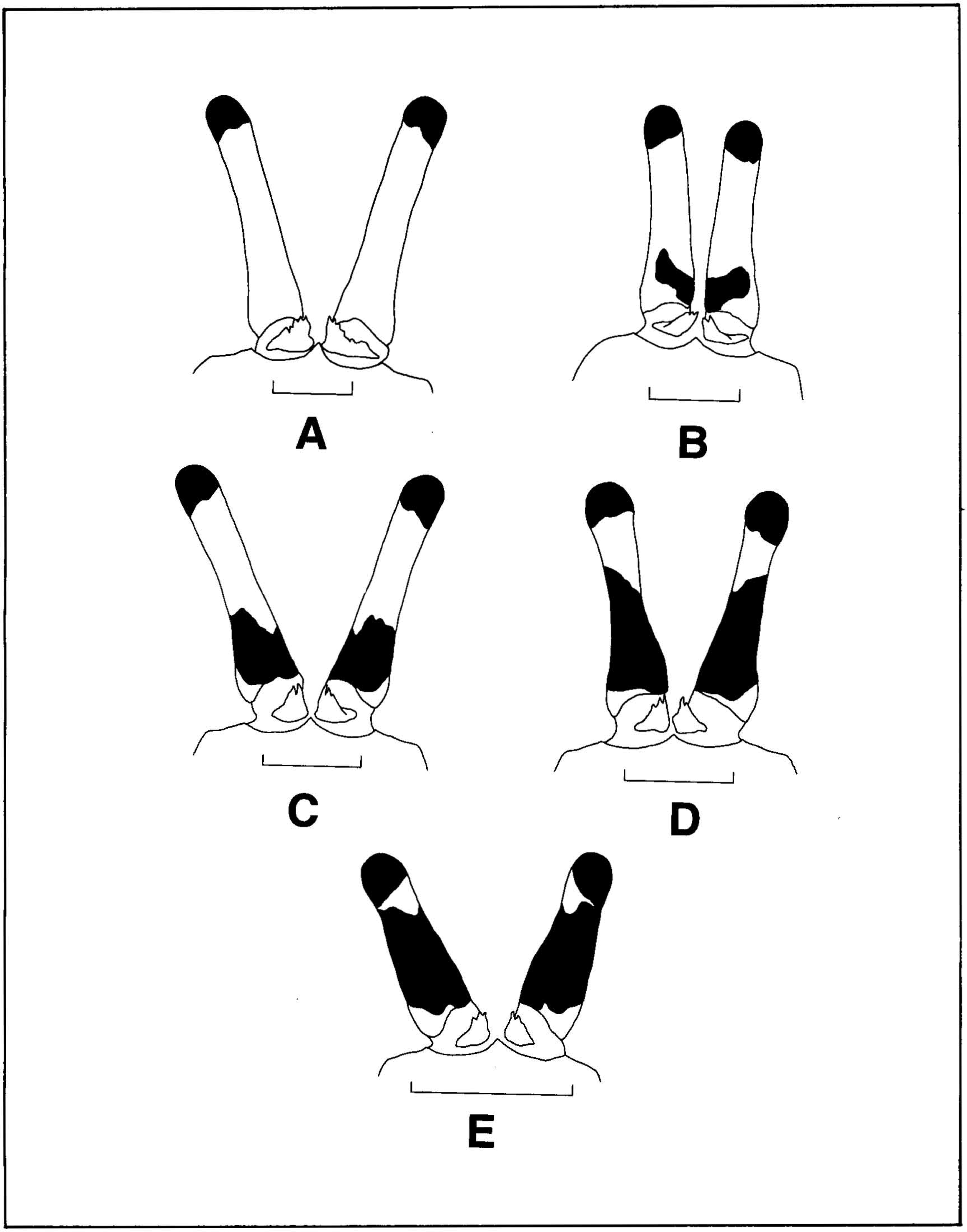

Fig. 1. Color patterns of eyestalks in *Calcinus vachoni* Forest. A, ♂, SL 4.1 mm, NSYSU 970218; B, ♂, SL 3.2 mm, NSYSU 930327; C, ♂, SL 2.8 mm, NSYSU 970218; D, ♂, SL 2.7 mm, NSYSU 970218; E, ♂, SL 1.4 mm, NSYSU 970218. Scale = 1 mm. See text for explanation.

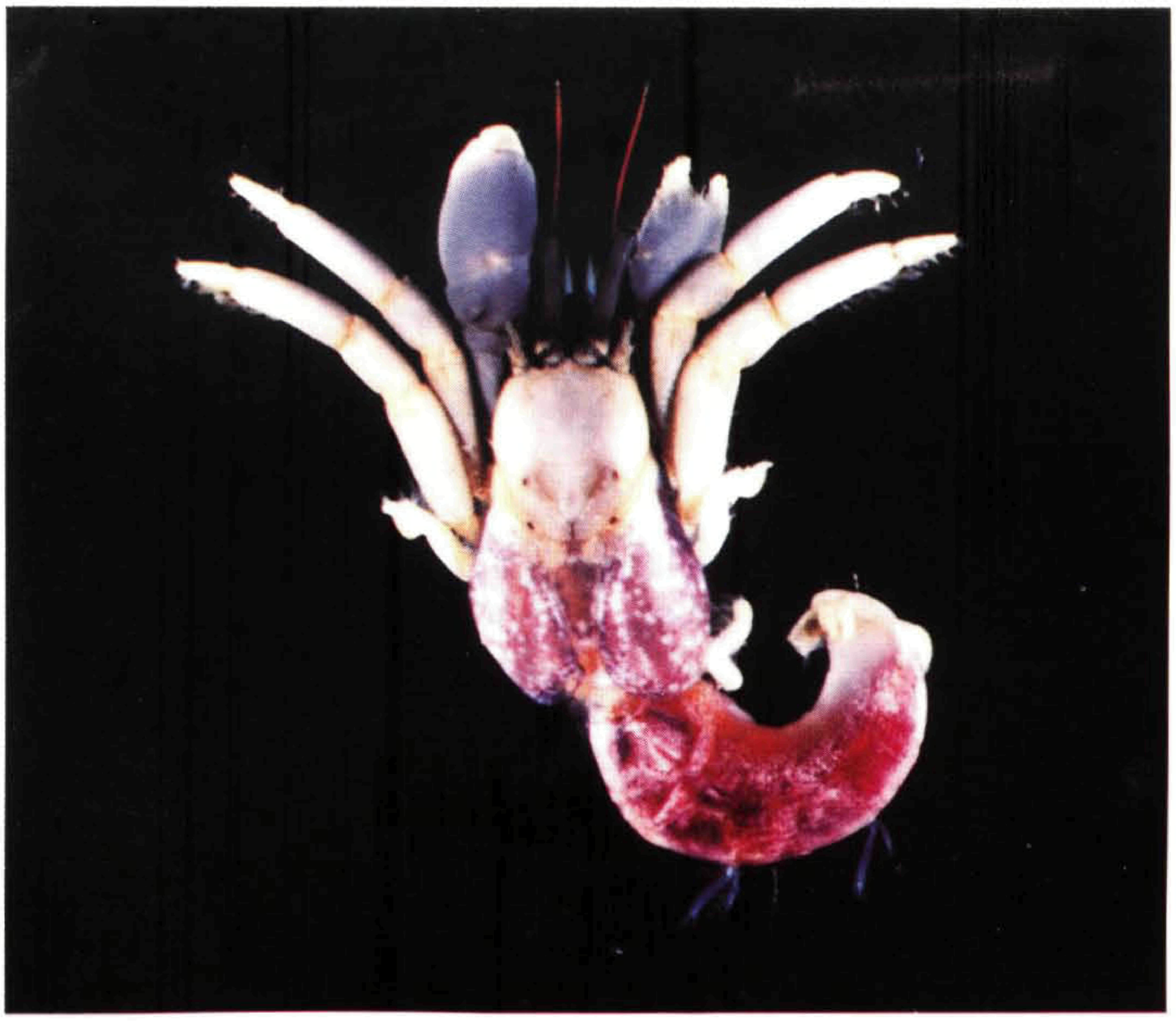

Fig. 2. *Calcinus vachoni* Forest (♂, SL 4.1 mm, NSYSU 970218).

Fig. 3. *Calcinus vachoni* Forest with its shell.

along cervical groove, roughtly loxated below the site of lateral projections from middle. Ocular peduncles gray with a wide black band proximally, a black patch on base, or without black area (see Remarks); ocular acicles gray. Antennal acicles and proximal segment of peduncle cream, distal segment of peduncle and flagellum orange. Antennular peduncles gray-blue, 2nd segment black-brown, flagellum pale orange. Chelipeds with fingers cream, palm, carpus and merus gray-green; 2nd and 3rd pereiopods uniformly cream.

Habitat:

Calcinus vachoni lives on the branches of corals in the shallow subtidal to about 3 m depth or under large rocks in the low intertidal. The gastropod shells inhabited include *Drupa* spp., *Drupella* spp., *Conus* spp., *Mitra* spp, *Latirus* spp., *Cymatium* spp., *Coralliophila* spp. and *Cronia* spp. *Calcinus vachoni* lives sympatrically with *C. latens*, *C. gaimardii*, *C. minutus*, *C. guamensis*, and *Dardanus lagopodes*.

Distribution:

Northwestern Australia south to Shark Bay, Mauritius, Vietnam, Taiwan, Ryukyu Islands, mainland Japan.

Remarks:

Calcinus vachoni resembles *C. guamensis* and easily confused with the latter (Forest, 1958: 286; Miyake, 1978: 54; Baba, 1982: 65). They are very similar in the external features, but still can be distinguished in that *C. vachoni* has greater development of setae of dactyls and propodi on the 3rd pereiopods than those on the 2nd. *C. guamensis* has similar development of setae on the 2nd and 3rd pereiopods. The two species can also be separated by differential color patterns. The carpi and meri of chelipeds, and the dactyls of the 2nd and 3rd pereiopods in *C. guamensis* are black with white spots, while the dark pigmentation is absent in *C. vachoni*. *C. vachoni* is also always misidentified as *C. seurati* (see Discussion) and the difference in color pattern together with other easily confused external features are shown in Table 1.

The black dorsal patch at the base of eyestalks in *C. vachoni* is a main character adopted by Forest (1958) and Morgan (1991). However, the color pattern of eyestalks is variable among the materials collected from Kenting area. Different degrees of the black patches on eyestalks (Fig. 1A–E) are expanded from initial absence of black patches (Fig. 1A) to the presence of small black patches at the base (Fig. 1B) with a further extension to cover nearly proximal half (Fig. 1C, D) or ever to the entire eyestalks (Fig. 1E). It is noted that most very small individuals have black patches occupied nearly entire eyestalks (Fig. 1E). Such variable black patches on eyestalks is not recommended as a key character for specific identification.

Calcinus seurati Forest, 1951

(Figs. 4, 5, 6)

Calcinus seurati Forest, 1951: 84, figs. 1, 3, 4, 7, 8.– Forest, 1953: 556; Holthuis, 1953: 44; Haig and McLaughlin, 1984: 108; Wooster, 1984: 158; Reay and Haig, 1990: 582, 584; Morgan, 1991: 898, figs. 46–48; Asakura *et al.*, 1994: 279; Poupin, 1994: 19, fig. 15, pl. 2d; Poupin, 1996: 15.

Material examined:

Lanyu Island, Taitung County, 6♂♂ (SL 1.6–6.3 mm), 7♀♀ (SL 2.9–4.4 mm) (incl. 1 ovig. ♀), Apr. 16, 1996, NSYSU 960416; 4♂♂ (SL 2.6–3.3 mm), 4♀♀ (SL 2.0–3.5 mm), Apr. 1, 1997, NSYSU 970401; 2♂♂ (SL 4.1, 5.2 mm), Apr. 2, 1997, NSYSU 970402.

Diagnosis:

Ocular acicles with 1 spine at distal margin. Antennal flagella long, exceeding 2nd pereiopod. Left cheliped much larger than right; palm and fingers smooth, fingers with cutting edge toothless; carpus smooth, with 1 large submedian tubercle on lateral surface. Right cheliped smooth or slightly granulous; palm and

Table 1. Comparison of external characters and coloration between *Calcinus vachoni* and *Calcinus seurati*

Characters	*C. vachoni*	*C. seurati*
Ocular acicles	multispinose	simple
Left chela	not massive, cutting edge of fingers with teeth	massive, cutting edge of fingers without teeth
Dorsal margin of right chela	spinose/tuberculate	smooth/granulous
Setae of 2nd and 3rd pereiopods	Setae of dactyl and propodus of 3rd pereiopod more dense than 2nd	Setae of dactyls and propodi of 2nd and 3rd pereiopods with similar sparsity
Posterior lobes of telson	both with several spines	both with 1 spine
Coloration	Shield cream, with 2 small black spots along cervical groove below lateral projections; eyestalks with different degree of black patch or without patch; antennular peduncles gray-blue, 2nd segment black-brown, flagellum pale orange; first 3 pereiopods cream to gray-green.	Shield cream, with 2 longitudinal green-gray stripes below lateral projections; eyestalks with 2 colors not separated distinctly; antennular peduncles with 2nd segment pale blue with orange distally, 3rd segment blue with orange proximally, flagellum orange; chelipeds cream to gray-blue, 2nd and 3rd pereiopods cream, with dactyls and propodi with green-brown band proximally and distally, carpi with longitudinal stripe, meri with oblique band.

Fig. 4. *Calcinus seurati* Forest (♂, SL 6.3 mm, NSYSU 960416).

Fig. 5. *Calcinus seurati* Forest, carrying its typical shell, *Nerita* sp., in the tide pool.

carpus slightly granulous on dorsal margin. Second and 3rd pereiopods smooth; dactyls slightly shorter than propodi, with 11–12 small spines along ventral margin; propodus of left 3rd pereiopods flattened laterally with a definite ridge on dorsal margin; carpus with 1 prominent spine on distodorsal margin; merus with 1 small spine at lateral distoventral angle. Telson with a single marginal spine and long hairs on terminal margin of both lobes.

Color in life:

Shield cream, with 2 longitudinal green-gray stripes roughly located below the site of lateral projections. Ocular peduncles with green-orange at base and followed progressively by a wide pale blue band in the middle, and via green-orange to orange distally; ocular acicles cream; cornea black with many light blue specks. Antennal acicles and proximal segment of peduncle cream, with pale green-gray patches, distal segment of peduncle and flagellum orange. Antennular peduncles with 2nd segment pale blue with orange distally; 3rd segment blue with orange proximally; flagellum orange. Chelipeds with palm cream; carpus gray-blue, darker proximally and mesially; merus white distally, distal ½ gray-blue, proximal ½ paler. Second and 3rd pereiopods with dactyls cream with green-brown band proximally and subdistally, tips pale blue, claws dark red-brown; propodi cream with green-brown band proximally and distally; carpi cream with longitudinal green-brown stripe; meri white with ob-oblique band subdistally; the stripe grading to pale green on mesial surface of proximal propodi, carpi and meri of 2nd and 3rd pereiopods. Setae of pereiopods with base red, distal part pale red.

Habitat:

High intertidal, in tide pool on the limestone shore (Fig. 6). The gastropod shells inhabited are *Nerita* spp., *Drupa* spp., *Morula* spp. and *Tectarius* spp. In Lanyu Island, *Calcinus seurati* lives sympatrically with *C. laevimanus*, *C. gaimardii* and *Clibanarius corallinus*.

Distribution:

Gambier, Society, Tuamotu, Seringapatam Reef, Cocos (Keeling) Island, Christmas Island, Somalia, Marshall Islands, Mariana Islands, Hawaiian Islands, Taiwan.

Remarks:

Calcinus seurati resembles *C. laevimanus* in morphology and color pattern. Morphologically, the most reliable distinctive characters are the relative length of dactyls and the propodi of the 2nd and 3rd pereiopods and the shape of the propodus of 3rd pereiopods (Forest, 1951; Wooster, 1984; Morgan, 1991). In *C. seurati*, the dactyls and propodi on the 2nd and 3rd pereiopods are similar in length and the propodus of the left 3rd pereiopod is flattened laterally with a definite ridge on the dorsal margin. These ridges are absent on the propodus of the right 3rd pereiopod in the materials examined. In *C. laevimanus*, the dactyls of the 2nd and 3rd pereiopods are shorter than the propodi and are rounded laterally and smooth on dorsal margin. They can also be easily separated by their coloration, especially the color patterns of the 2nd and 3rd pereiopods. In *C. seurati*, a single longitudinal black stripe on the outer surface of the carpi and a oblique black stripe on the meri of the 2nd and 3rd pereiopods. In *C. laevimanus*, several longitudinal dark brown stripes present on both the carpi and meri of the 2nd and 3rd pereiopods.

C. vachoni was previously misidentified as *C. seurati* (see Discussion) and their difference is shown in Table 1.

Discussion

After reviewing the previous literature in Japan and Taiwan, we found many confusions on the taxonomic status between *C. vachoni* and *C. seurati*. The first record of "*C. seurati*" in Japan by Miyake (1963) should be a misidentification of *C. vachoni* based on the color

patterns described. Then, many subsequently published illustrations (Utinomi, 1975; Kamezaki *et al.*, 1988, and scientific papers (Minei, 1973; Miyake, 1978; Miyake and Imafuku, 1980; Miyake, 1982; Murata *et al.*, 1991) made the same error. Haig and McLaughlin (1983) have pointed out that the presumed Japanese "*C. seurati*" of Miyake (1978) does not agree with the description by Forest's (1951). The Japanese name "Usuirosango-yadokari" for "*C. seurati*", meaning "pale coral hermit crab", also implies that Japanese "*C. seurati*" is exactly identical with the real *C. vachoni*. Therefore, we consider that there is no any distributional record of *C. seurati* in Japan and we suggest that the northern limit of distribution of this species extends only to Lanyu Island, Taiwan (22°N) and Oahu, Hawaii (21°N) (Reese, 1969). From the studies of Forest (1951, Holthuis (1953), Morgan (1991) and Poupin (1994, 1996), the southern limit of *C. seurati* ranges only to northwestern Australia (approx. 10° S), Tuamotu, Society and Gambier (23.5° S). In addition, *C. seurati* lives in high intertidal pool of limestone where the higher temperature enables it to tolerate the temperature as high as 40 to 43°C (Reese, 1969) in the tropical area. Therefore, it is possible that *C. seurati* is prone to be a tropicopolitan species distributed between the tropic of Cancer (23.5° N) and the tropic of Capricorn (23.5° S).

For misidentifications of the two species mentioned above, the distribution of *C. vachoni* can be well revised. The northern limit of the

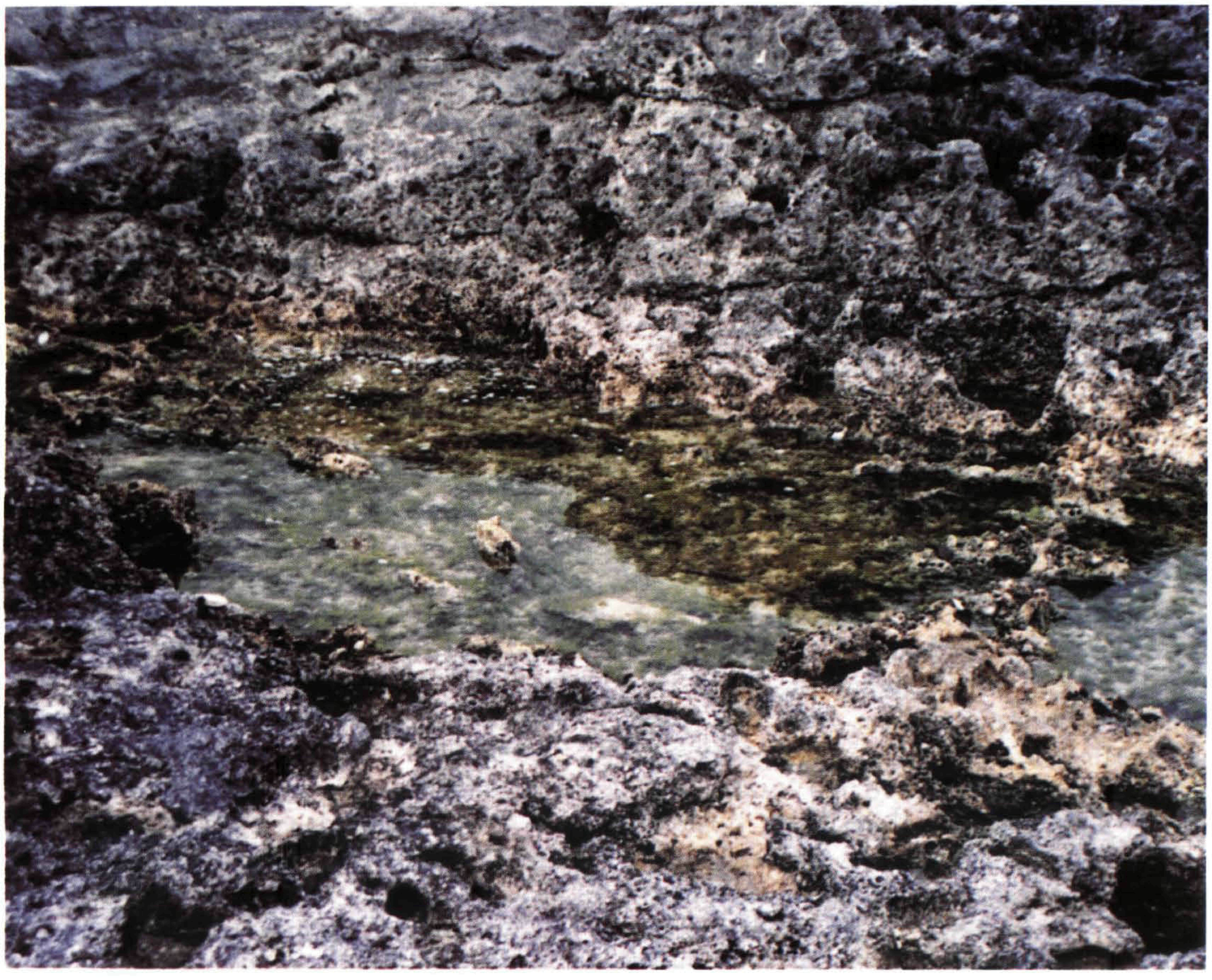

Fig. 6. Atypical habitat of *Calcinus seurati*, the intertidal pool of the coral reef.

distribution of *C. vachoni* may be the central mainland Japan (Boso Peninsula, 35°N) (Murata *et al.*, 1991) and it is also possible that the southern limit would be extended from Shark Bay, Western Australia (25° N) (Morgan, 1991), to the southern part of Australia.

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