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A NEW GENUS AND SPECIES OF TREE-CLIMBING CRAB (CRUSTACEA: BRACHYURA: SESARMIDAE) FROM TAIWAN WITH NOTES ON ITS ECOLOGY AND LARVAL MORPHOLOGY

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***ABSTRACT.* –** A new genus and species of sesarmid crab, *Scandarma lintou*, is described from Taiwan. This crab has a semi-terrestrial habit: adults and juveniles thrive in wind-protected and vegetated habitats in close vicinity of fresh water and up to one kilometer from the sea. In southern Taiwan, this species was most commonly found hiding in leaf axils or climbing on the thorny leaves of the screw pine *Pandanus odoratissimus* Linnaeus. During the reproductive season (June to January), ovigerous females migrate to estuaries, where small and free-swimming pelagic larvae are released into the brackish waters and probably washed into the sea. Morphologically, this species is superficially similar to species of other semi-terrestrial sesarmid genera, but differs from these taxa by the shape of the anterolateral carapace region, by the markedly flattened fingers, by the presence of a row of tubercles on the dorsal border of the dactylus, a row of ventral spines on the pollex, and a granular ridge on the dorsal face of the palm. The first zoeal stage of the new genus shows two autapomorphies in the morphology of antennae and first maxillipeds. Otherwise, this stage presents the combination of features that are typical of sesarmid zoeae, i.e. absence of lateral carapace spines, a 2,3 setation of the maxillar endopod, a 2,2,3,3 setation on the basis of the first maxilliped, and a characteristic setation pattern of antennae and telson.

***KEY WORDS.* –** Sesarmidae, taxonomy, morphology, ecology, zoea larva.

INTRODUCTION

The brachyuran family Sesarmidae Dana, 1851, is known to comprise many genera of semi-terrestrial, terrestrial, and limnic crabs (Hartnoll, 1964; Ng & Davie, 1995; Ng & Tan, 1995; Schubart et al., 2000). These ecological terms are often used in the scientific literature and are meant to distinguish those crabs that spend part of their life cycle in the sea (semi-terrestrial) from those that are completely independent from the sea (terrestrial or limnic). However, the use of these terms is not consistent and crabs often referred to as "terrestrial", like the Gecarcinidae, are actually semi-terrestrial, due to the fact that gravid females migrate to the sea for larval release, and the larvae undergo a typical marine planktonic development through several zoeal stages. Trying to establish a more consistent nomenclature, Schubart et al. (2000) introduced the following terms for describing non-marine life forms in decapod Crustacea: 1) adults terrestrial (e.g. *Cardisoma*), 2) adults limnic (e.g. *Eriocheir*), 3) entirely inland (e.g. *Potamon*), where the first two groups comprise all the crabs that spend part of their life cycle in the sea and the third group includes all land dwellers that are completely independent from the sea. Among the land dwellers, it is often difficult to distinguish between a terrestrial and a limnic existence, because many of these crabs live in close vicinity of fresh water or have an amphibious life style (e.g. Schubart & Diesel, 1999).

All "entirely inland" crabs are characterized by producing large yolk-rich eggs and undergoing an abbreviated or a direct development. In the process of reconstructing phylogenetic relationships of thoracotreme crabs, Schubart et al. (2000) showed that among the Grapsoidea sensu Martin & Davis (2001) and Schubart et al. (2002) (consisting of the families Gecarcinidae, Glyptograpsidae, Grapsidae, Plagusiidae, Sesarmidae, and Varunidae) only the Sesarmidae have representatives with large eggs (e.g. genera *Geosesarma*, *Metopaulias*, *Sesarma*) and thus include

entirely inland forms. Other adult terrestrial forms like *Geograpsus*, *Cardisoma*, and *Gecarcoidea*, or adult limnic forms like *Eriocheir*, *Varuna*, and *Platychirograpsus* have small eggs and thus spend the larval phase of their life cycle in the sea. However, also among the Sesarmidae we find several cases in which apparent land-dwelling forms have small eggs and return to the sea for larval release (Anger et al., 1990; Diesel & Schuh, 1998; Ng et al., submitted).

The fauna of Taiwan is reasonably well studied and many species of littoral sesarmid crabs are known from the coasts of Taiwan (Ng et al., 1996, 2001; Wang & Liu, 1998). Nevertheless, only recently the ecological work of the second author revealed a number of undescribed coastal crab species belonging to the Sesarmidae. One of them (to be described by Schubart & Ng, in preparation) is a rocky shore inhabitant and has large eggs, suggesting that larval development takes place in rock pools as previously described for *Armases miersii* (see Schuh et al., 1995; Cuesta et al., 1999). Two other new species were found in vegetated inland habitats in close vicinity of fresh water. Despite the inland habitat, both species have small eggs and return to the sea for larval release. The first species is a member of the genus *Geosesarma* according to its morphology and was described in Ng et al. (submitted). The second species occurs sympatrically, but can be distinguished by a morphology that differs considerably from all other known sesarmid genera and is therefore here described as a new genus and species.

MATERIAL AND METHODS

Crabs belonging to the new species have been collected by the second author in southern and eastern Taiwan since 1999. A total of 614 crabs were collected throughout the last years for size comparisons and assessment of the reproductive status and other ecological factors. Most of the crabs were released after taking measurements. Others were preserved in ethanol and distributed among various museums. The holotype and a number of paratypes were deposited at the National Taiwan Museum (TMCD), Taipei, Taiwan. Other paratypes were donated to the Institute of Zoology, Academia Sinica (ASIZ), Nankang, Taipei, Taiwan; Zoological Reference Collection (ZRC) of the Raffles Museum of Biodiversity Research, National University of Singapore; and the Senckenberg Museum (SMF), Frankfurt a. M., Germany. Measurements of the studied material represent the carapace width and length in millimetres. The abbreviations G1 and G2 are for the male first and second gonopods respectively.

Ovigerous crabs of the new species were collected from the Kangkou and Meilun river mouths as well as from Green Island (Luidau) between 1999 and 2000. First stage zoea larvae hatched in plastic containers with sea water and were preserved directly in 70% ethanol or fixed in 4% formalin for one day, previous to storage in ethanol. Larval appendages were dissected under a Wild MZ8 binocular microscope, and drawings were made using an Olympus BH-2 microscope equipped with Nomarski interference contrast and an attached camera lucida. Semipermanent mounts were made of whole larvae and dissected appendages. Permanent mounts were made using polyvinyl lactophenol, and cover slips were sealed with nail varnish. All measurements were made by an ocular micrometer. Drawings and measurements were based on 10 larvae from each of 3 hatches originating from three different localities (Kangkou River mouth, Meilun River mouth, Green Island). The following measurements were made: rostro-dorsal length (rdl) was measured from the tip of the rostral spine to the tip of the dorsal spine; carapace length (cl) from the base of the rostrum to the posterior margin; carapace width (cw) as the greatest distance across the carapace. Descriptions and figures are arranged according to the standard proposed by Clark et al. (1998). The plumose natatory setae of the maxilliped exopods (Figs. 7C, D) and the terminal part of the furcal arms of the telson (Fig. 8C) are drawn truncated. Parental vouchers and samples of larvae have been deposited at the National Taiwan Museum, Taipei (TMCD 3278) and at the Institute of Zoology, Academia Sinica, Nankang, Taiwan (ASIZ 72745).

TAXONOMY

Scandarma, new genus

Type species. – *Scandarma lintou*, new species, by present designation.

***Diagnosis.* –** Carapace squarish to gently sinuous, lateral carapace margin relatively narrow at exorbital teeth, continuously widening posterior to blunt anterolateral teeth. Palm of male chelae inflated, dorsal surface with longitudinal line of granules, no pectinated crests; dactylus dorsally with longitudinal row of horny tubercles and pollex with ventral row of spiny granules. G1 relatively short and stout; distal chitinous part short and spatulate; G2 short, with elongated distal segment.

***Etymology.* –** The name is derived from the arbitrary combination of the Latin word "scandere" for climbing and the ending of the name "*Sesarma*", alluding to the tree- and rock-climbing habit of the type species. The gender of the new genus is neuter.

***Remarks.* –** *Scandarma*, new genus, shares the carapace and some chelipedal characters of *Pseudosesarma* Serène & Soh, 1970 and *Sesarmops* Serène & Soh, 1970, in its lateral carapace margin having one anterolateral tooth and a male chelar palm without pectinated crests. However, *Scandarma lintou* differs from all known species of *Pseudosesarma* and *Sesarmops* in the shape of the carapace and the tuberculation of the male chelae: the dorsal surface of the propodus carries one longitudinal line of granules, the dactylus one longitudinal row of horny tubercles and the pollex is characterized by a row of ventral spiny granules. Furthermore, all known species of *Pseudosesarma* and

Sesarmops have proportionately much broader and shorter ambulatory legs.

***Scandarma lintou*, new species**
(Figs. 1-8)

Material examined. – Holotype - male (17.55 by 16.9 mm) (TMCD 3276), Taiwan, Luidau (Green Island), coll. H.-C. Liu et al., 11 Sep.1999.

Paratypes – 1 male (13.8 by 13.6 mm), 2 females (16.2 by 15.7, 16.05 by 14.75 mm) (TMCD 3277), 1 male (19.20 by 18.7 mm), 1 female (18.55 by 16.7 mm) (SMF 28099), Taiwan, Pingtung County, Manchow, Kangkou River mouth, (21° 59' 26" N, 120° 50' 09" E), coll. H.-C. Liu, 2 Sep.1999; 2 males (14.8 by 14.3 mm, 13.4 by 12.7 mm), 6 females (17.2 by 15.8 mm, 17.1 by 16.1 mm, 16.8 by 15.5 mm, 16.6 by 15.4 mm, 15.5 by 14.3 mm, 13.9 by 13.0 mm) (TMCD 3278), same locality, coll. H.-C. Liu, 1 Sep.1999 (4 females parental vouchers); 1 male (16.8 by 16.5 mm) (ZRC 2000.1830), same locality, coll. C.D. Schubart & H.-C. Liu, 14 Sep.1999 (DNA voucher); 1 male (16.2 by 15.75 mm), 2 females (17.25 by 16.5, 18.4 by 17.9 mm) (ZRC 2001.0026), 1 juvenile male (8.2 by 8.15 mm) (ZRC 2001.0027), same locality, coll. P. K. L. Ng, 8 Nov.2000; 1 male (15.6 by 15.0 mm), 1 female (15.8 by 15.0 mm) (ASIZ 72746), 1 male (14.9 by 14.95 mm), 1 female (16.7 by 15.95 mm) (ZRC 2002.0164), same locality, coll. H.-C. Liu, 20 Jun.2001; 3 males (14.05 by 13.80, 13.3 by 12.6, 12.40 by 12.05 mm), 1 female (11.35 by 10.8 mm) (ASIZ 72744), Taiwan, Hualien County, Hualien, Meilun R. mouth, (23° 58' 54" N, 121° 36' 37" E), coll. H.-C. Liu, 17 Jun.2000; 1 ovigerous female (12.7 by 11.85 mm) (ASIZ 72745), same locality, coll. H.-C. Liu, 21 Sep.2000 (parental voucher); 1 male (13.8 by 13.55 mm), 1 female (18.1 by 17.25 mm) (ZRC 2002.0165), 1 male (18.3 by 18.1 mm) (ZRC 2002.0169), 1 male (19.25 by 18.85 mm) (ZRC 2002.0168), same locality, coll. H.-C. Liu, 17 Jun.2001; 1 male (19.3 by 18.5 mm); 1 female (14.5 by 13.5 mm) (TMCD 3288), same locality, coll. H.-C. Liu, 27 Oct.2001.

Others – 1 female (13.9 by 13.2 mm) (TMCD 3279), Taiwan, Pingtung County, Manchow, Kangkou R. mouth, (21° 59' 26" N, 120° 50' 09" E), coll. H.-C. Liu, 1 Dec.1999; 1 ovigerous female (18.5 by 16.2 mm), same locality, coll. H.-C. Liu, 5 Oct.1999; 1male (14.7 by 14.2 mm); 4 ovigerous females (18.4 by 17.2 mm, 17.8 by 16.4 mm, 15.0 by 13.8 mm, 14.3 by 13.8 mm), 2 females (18.5 by 17.6 mm, 7.9 by 7.1 mm) (TMCD 3280), same locality, coll. H.-C. Liu, 5 Oct.1999; 1 male (14.6 by 14.1 mm); 2 females (19.1 by 17.7 mm, 18.0 by 17.0 mm) (TMCD 3281), same locality, coll. H.-C. Liu, 11 Dec.1999; 2 females (18.9 by 18.0 mm, 14.4 by 13.8 mm) (ASIZ 72747), Taiwan, Pingtung County, Manchow, Kangkou R., 1 km from mouth, (21° 59' 24" N, 120° 49' 29" E), coll. H.-C. Liu, 20 Jun.2001; 1 female (13.2 by 11.1 mm) (TMCD 3282) Taiwan, Pingtung County, Hengchun, Hsiangchiaowan, (21° 55' 32" N, 120° 49' 33" E), coll. H.-C. Liu, 5 Oct.1999; 2 males (13.9 by 13.5 mm, 9.6 by 8.9 mm), 4 females (13.2 by 12.2 mm, 12.6 by 11.7 mm, 12.5 by 11.5 mm, 10.0 by 9.4 mm) (TMCD 3283) Taiwan, Pingtung County, Checheng, Paoli R. mouth, coll. H.-C. Liu, 7 Oct.1999; 10 males (18.7 by 18.1 mm, 13.5 by 13.1 mm, 13.4 by 12.8 mm, 12.0 by 11.4 mm, 10.2 by 9.9 mm, 9.4 by 9.1 mm, 9.1 by 8.7 mm, 9.1 by 8.4 mm, 8.1 by 7.6 mm, 6.6 by 6.1 mm); 6 females (14.1 by 13.3 mm, 10.0 by 9.1 mm, 9.4 by 8.9 mm, 9.1 by 8.5 mm, 8.7 by 8.1 mm, 6.4 by 6.2 mm), (TMCD 3284) Taiwan, Hualien County, Hualien, Meilun R. mouth, (23° 58' 54" N, 121° 36' 37" E), coll. H.-C. Liu, 17 Jun.2000; 1 male (19.0 by 17.9 mm); 2 ovigerous females (15.5 by 14.6 mm, 15.0 by 14.6 mm), 2 females (20.5 by 18.7 mm, 10.7 by 10.0 mm) (ASIZ 72748), same locality, coll. H.-C. Liu, 5 Aug.2000; 2 ovigerous females (13.7 by 11.0 mm, 14.5 by 13.3 mm) (TMCD 3285), same locality, coll. H.-C. Liu, 15 Nov.2000 (parental vouchers); 2 ovigerous females (14.7 by 13.4 mm, 13.3 by 12.6 mm) (TMCD 3286), same locality, coll. H-C Liu, 21 Sep.2000 (parental vouchers); 1 ovigerous female (13.2 by 12.2 mm) (TMCD 3287), same locality, coll. H.-C. Liu, 17 Aug.2000; 1 male (8.9 by 8.5 mm); 1 female (12.8 by 12.0 mm) (TMCD 3289), same locality, coll. H.-C. Liu, 18 May.2000.

Diagnosis. – Carapace squarish to gently sinuous, lateral carapace margin relatively narrow at exorbital teeth, continuously widening posterior to blunt anterolateral teeth, broadest at ventral extension. Dorsal surface of male chelar palm with one longitudinal line of granules, outer surface angular with tubercular protuberance at outermost point and conspicuously flattened fingers; dactylus dorsally with longitudinal row of horny tubercles, pollex ventrally with row of spines. Legs long and slender. G1 relatively short and stout; distal chitinous part short and spoon-shaped; G2 short, with thin and long distal segment.

Description of male holotype. – Carapace squarish to gently sinuous, slightly broader (17.55 mm) than long (16.9 mm), and flattened (9.05 mm height); dorsal surface smooth and glabrous; regions distinct, separated by prominent grooves; branchial regions with faint indication of oblique striae (Figs. 1A, B). Frontal margin strongly deflexed, two inner frontal lobes broad and distinct, outer lobes less than half as broad as inner lobes; deep fissure between inner lobes extending posteriorly to mesogastric region, flanked by swollen postfrontal regions (Fig. 1B). Front relatively narrow (7.7 mm), clearly less than half (0.44) of maximum carapace width, concave, ventral border strongly deflexed and bent outwards (Fig. 1C). Posterior border of orbits slightly directed postero-laterally; external orbital tooth low, directed anteriorly, outer margin of tooth curved, posteriorly bending into shallow but prominent notch; anterolateral tooth elevated and blunt, second anterolateral tooth only indicated as slight elevation; carapace margins posterior to second carapace teeth continuously widening (Fig. 1B); lateral border of carapace broadest at most ventral extension, where it touches base of walking legs between pereiopods 3 and 4.

Eyes pigmented, cornea wider than eyestalk; suborbital ridge prominent and setose with tufts of long setae at medial end; epistome flat and granulate, upper row of setae delimiting Verwey's groove absent (Fig. 1C). Pterygostomial and epibranchial regions granulate and covered by dense mat of long and geniculate setae, dorsally separated from lateral carapace border by row of long setae grouped into three short anterior rows and one long posterior one. Third maxillipeds with median gape, uncovering mandibles; ischium with shallow median sulcus; meri of third maxilliped longitudinally ovate, touching each other distally; inner margin straight with thickened ledge (Fig. 1C); exopod completely covered, slender, with short and thin flagellum that does not extend across width of merus.

Male chelipeds subequal, left chela slightly smaller, probably regenerated; outer surface (mostly carpus and palm) with numerous rounded granules. Ventral margins of merus