

臺灣藤壺誌 I: 圍胸總目

(不含塔藤壺科和綿藤壺亞科)

CRUSTACEAN FAUNA OF TAIWAN:
BARNACLES, VOLUME I – CIRRIPIEDIA: THORACICA
EXCLUDING THE PYRGOMATIDAE AND ACASTINAE

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Darwin's original illustrations of Thoracican barnacles.

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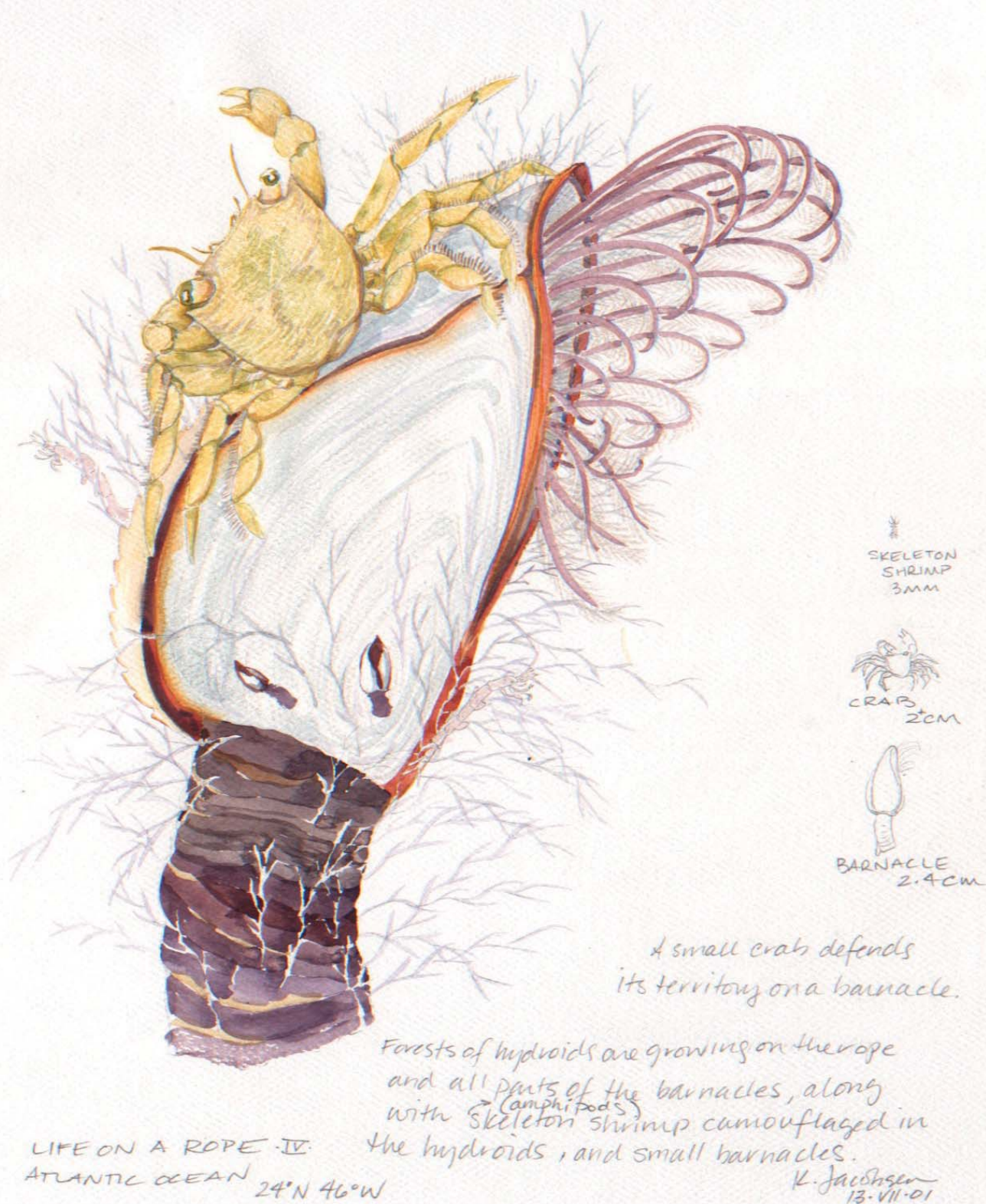
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序

藤壺是甲殼動物亞門、蔓足亞綱的生物，身體長有六對蔓足。藤壺幾乎會出現在每一種海洋環境中，在紅樹林的樹幹上、礁岩表面、珊瑚上、海龜背上、鯨的表皮、蝦蟹的鰓上，以及深海環境中，都找得到它們的蹤跡。臺灣擁有豐富的海洋環境，所以藤壺的多樣性也很高。臺灣最早的藤壺記錄是由德國學者Weltner於1897年發表紋藤壺在淡水海邊，往後之研究都比較零碎，較完整的記錄只有日本學者弘富士夫（Fujio Hiro）於1939年的30種和作者在2007年發表的52種。經由行政院國家科學委員會補助的研究計畫「編撰臺灣無脊椎動物誌—臺灣甲殼類」，臺灣藤壺誌的編撰亦得以積極進行。因為臺灣的藤壺多樣性十分豐富，臺灣藤壺誌將分成兩部份出版，第一卷記錄圍胸總目不含塔藤壺科和綿藤壺亞科的種類，第二卷為針對與珊瑚及海綿共生的塔藤壺科和綿藤壺亞科。本冊為第一卷，共整理出4目18科47屬95種，雖然沒有台灣特有的藤壺，但其中5科21屬47種為台灣新紀錄。

本誌之編輯及印刷為行政院國家科學委員會補助 (NSC96-2621-B-019-008-MY2)，由國立臺灣海洋大學出版，誌中對全部記錄的種類都有提供型態描述、重要特徵線繪圖及檢索等，大部分亦附有彩色標本照和以電子或光學顯微鏡拍攝的口器特寫以利參考鑑別。本誌之出版獲得行政院國家科學委員會及國立臺灣海洋大學水產生物科技頂尖研究中心大力支持及補助，謹致上由衷謝意。第一作者感謝Graham Walker博士，Gray A. William教授及已故之Alan Southward教授在藤壺及海洋生物學之教導。筆者感謝Jens Høeg 教授之繪圖，海洋生物學家倉谷うらら小姐及Jose Antonio Lopez (智利 JAL fishery) 提供部分之照片及沈伯倫先生在英文之潤稿，蔡佩珍、李欣縈、王展豪和張政弘在編輯及標本解剖之協，及洪和田先生在採集標本之幫助。全世界圍胸總目之藤壺有800多種，本誌記錄的藤壺佔全世界約八分之一，可見台灣之海洋生物多樣性十分豐富。希望透過本誌能讓國內外人士更深入了解臺灣豐富的海洋生物，進而關懷及永續利用這些珍貴的大自然資源。

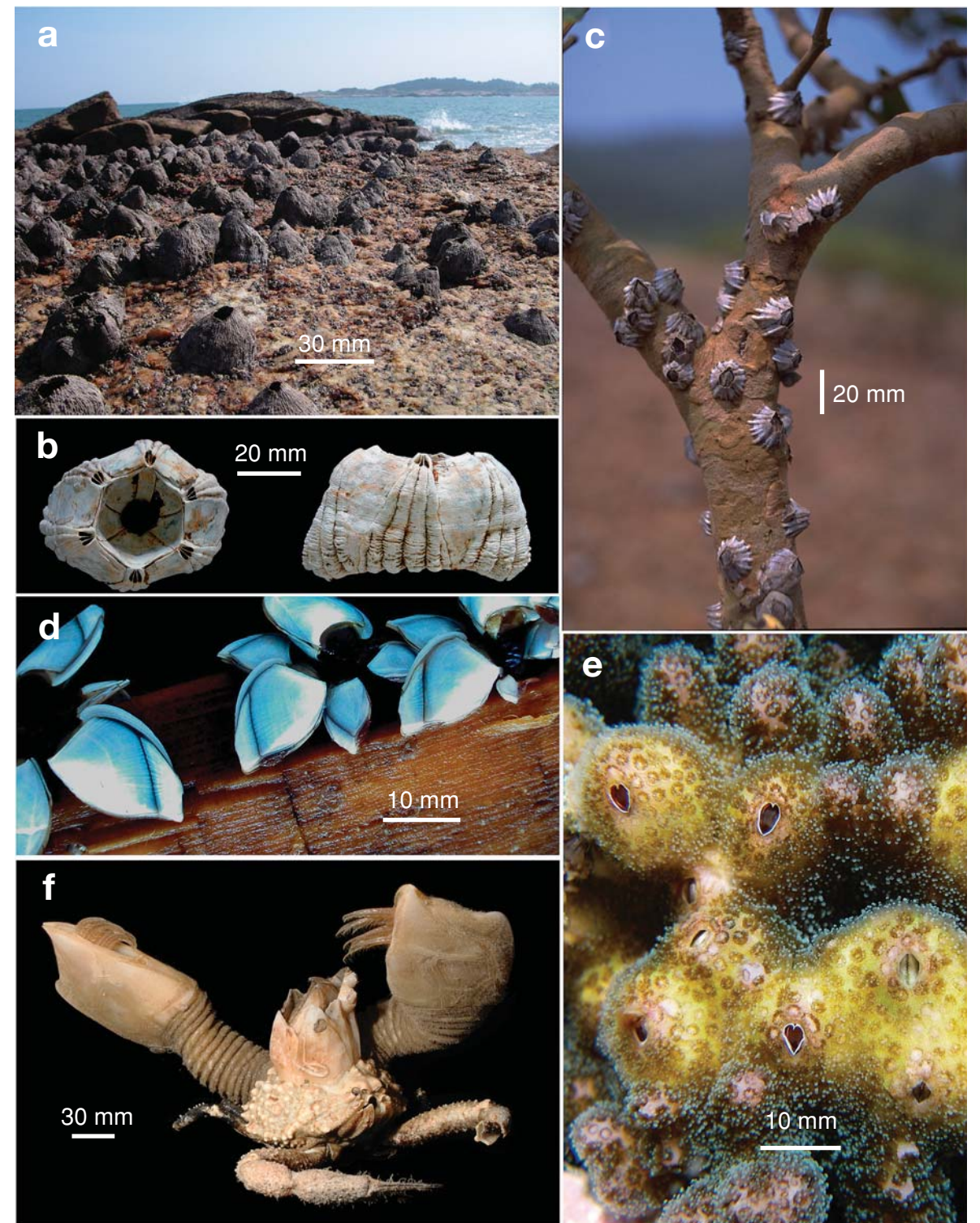


INTRODUCTION

Barnacles belong to the subclass Cirripedia of the class Thecostraca in the Crustacea. Cirripedes are further divided into 3 main superorders: the Acrothoracica are barnacles that bore into gastropod shells; the Rhizocephala are endoparasites in crustacean hosts; and the Thoracica are free-living barnacles that are comprised of stalked and sessilian species and live from the intertidal to the deep sea. Thoracican barnacles are very successful in marine ecosystems as they exist in almost every marine habitat and exhibit a high variety of morphological forms. In the intertidal, acorn barnacles in the families Tetraclitidae and Chthamalidae are often the major space occupiers on rocky shores. Stalked barnacles of *Ibla*, *Capitulum*, and *Pollicipes* live inside intertidal rock crevices. The acorn barnacles *Fistulobalanus albicostatus* and *Euraphia withersi* live on tree trunks of mangroves. Species of *Lepas* are stalked barnacles with long, naked and soft peduncles that are common on floating objects in the world's oceans. *Megabalanus* and *Striatobalanus* are shallow-water sessilian species, living on rocks or epibiotic on the shells of molluscs. Coral barnacles of the family Pyrgomatidae live inside skeletons of corals. Species of *Octolasmis* are stalked barnacles that are obligate on gorgonian corals, on decapod crustaceans surfaces, or on gill filaments of crabs. The capitular plates of *Octolasmis* are highly reduced. *Chelonibia* lives on the shell surfaces of sea turtles, whereas *Platylepas* is embedded in the skins of sea turtles. The whale barnacle *Coronula* is obligate on skin surfaces of whales. *Paralepas* (without shell plates) and *Megalasma* (with a very short stalk) are species epibiotic on the spines of sea urchins. In the deep sea, Scalpelliformes and Verrucomorpha barnacles are common. In deep-sea hydrothermal vents, *Neoverruca* and *Ashinkailepas* are obligate residents.

Barnacles are both ecologically and economically important. In marine systems, thoracican barnacles are suspension feeders and play important roles in food chains. In the intertidal, high densities of barnacles can affect the abundance and ecology of other associated intertidal species. From an economic point of view, barnacles are one of the fouling species that create problems for marine industries. On the contrary, barnacles can be useful. In Japan, China, outlying islands of Taiwan, Chile, Spain and Portugal, barnacles are often considered a major local seafood. In Japan, certain barnacles shells are regarded as antiques or decorative accessories.

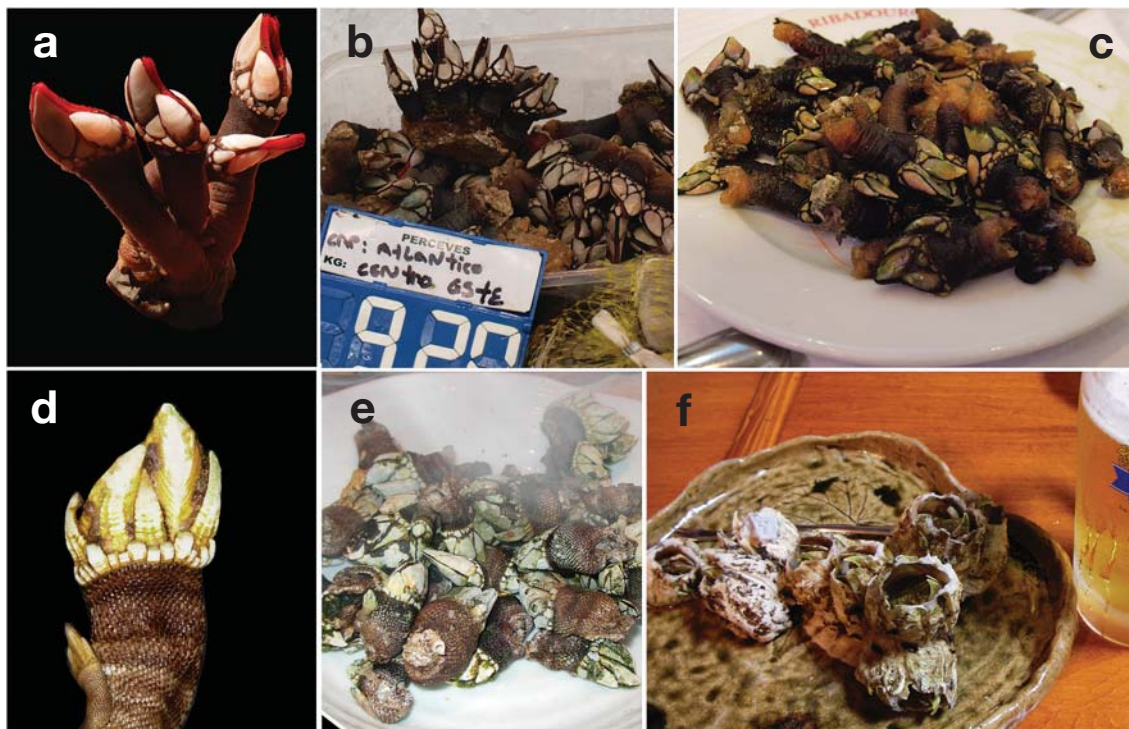
Adults of all thoracican barnacles are sessile, but their larvae are planktonic. The life cycle of thoracican barnacles is therefore composed of planktonic larval stages and a sessile adult stage. The larval cycle of thoracican barnacles comprises 6 naupliar stages and 1 cypris stage. Naupliar larvae of barnacles are composed of a head shield with 2 frontal horns and a trunk. Naupliar larvae have 3 pairs of appendages, the antennules, antenna, and mandibles, responsible for swimming or feeding. Planktotrophic species have a labrum for ingesting food, while lecithotrophic nauplii often have a reduced labrum, and they have lipid stored inside the body as energy reserves. Feeding modes of naupliar larvae vary among species, taxonomic levels, and habitats. Most scalpellid naupliar larvae are lecithotrophic, while sessilian species often have planktotrophic larvae. Deep-sea barnacle larvae are often large, are produced in small numbers, and are lecithotrophic. Shallow-water species produce their larvae in large quantities but in smaller sizes. Cyprids of thoracican barnacles have a bivalved carapace, 6 pairs of thoracopods for swimming, and a pair of antennules which are responsible for searching suitable substratum for settlement. The antennules are composed of 4 segments. The second segment often carries a single seta, the third segment has an attachment disc with a number of radial setae, and the fourth segment consists of an array of sensory setae, usually with 5 terminal setae (TS-A, B, C, D, and E) and 4 short sub-terminal setae (STS1~4). Bielecki et al. (2009) produced standardized terms to describe cyprid antennules, based on *Megalobalanus rosa*. The morphology of cyprid antennules varies among species from different taxonomic levels. The carapace surface of cyprids has 5 pairs of lattice organs, with 2 pairs on the anterior region and 3 pairs on the posterior region. These were proposed as useful characters in thoracican polygenetic



Barnacles can be found in a high variety of marine habitats. a. *Tetraclita* are common species on the rocky intertidal (Kinmen, Taiwan). b. The whale barnacle *Coronula* are epibiotic on whale skin (Gueishan Island, Taiwan). c. *Fistulobalanus albicostatus* often attached on mangroves tree trunks in mangroves (Hong Kong). d. *Lepas* are common on floating objects in open oceans (Keelung, Taiwan). e. *Cantellius* are coral barnacles (Hualien, Taiwan). f. *Scalpellum stearnsii* and *Striatobalanus* are common deep-sea species (Donggang, Taiwan).



Barnacles are considered as important seafood in Chile. a. *Megabalanus pittacus* are common on rocky shores in Chile. b. *M. pittacus* cooked in soup. c. *M. pittacus* are cultured in Chile for food. d. Cooked *M. pittacus* are sold as cans in Chile. Photo courtesy by Jose Antonio Lopez; JAL Fisheries S.A.



a, b, c. The stalked barnacle *Pollicipes pollicipes* are famous seafood in Spain and Portugal. d, e, f. The stalked barnacle *Capitulum mitella* and *Balanus rostratus* are famous seafood in Japan.

studies and can reflect trends of barnacle evolution.

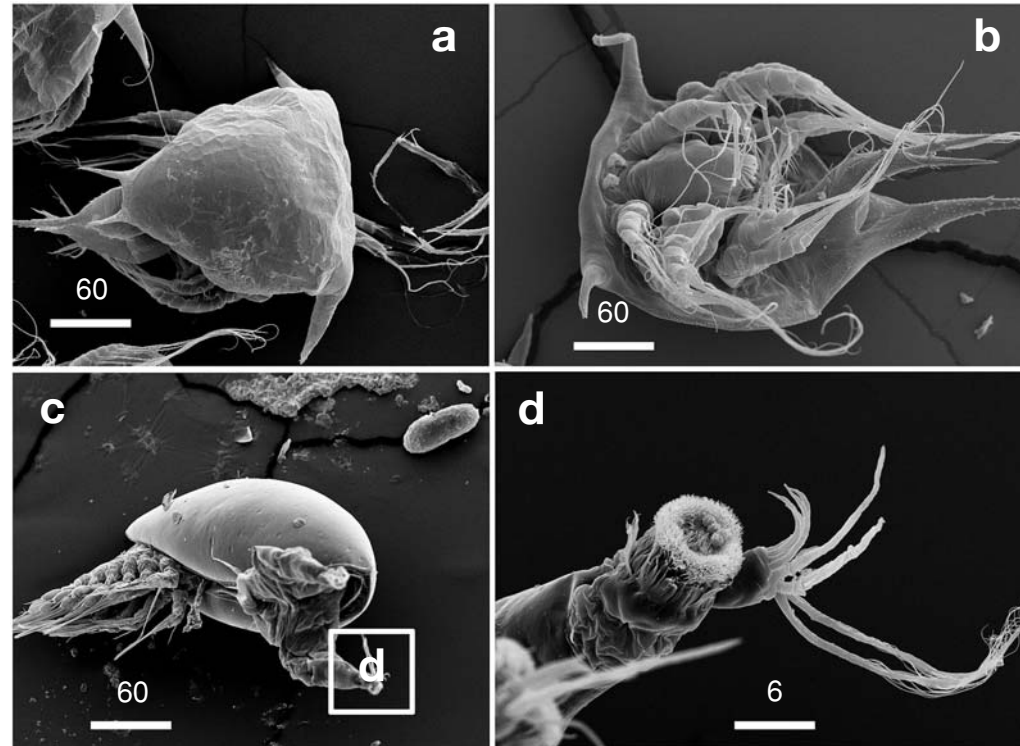
Thoracican barnacles exhibit a high diversity of sexual systems, and such systems vary at different taxonomic levels. Ibliformes and Scalpelliformes have dwarf males with large females or hermaphrodites (dioecy or androdioecy). Scalpellid barnacles often have a pocket in the lower region of the capitulum to house dwarf males. Whether cyprid larvae metamorphose to a dwarf male, a hermaphrodite, or a female depending on the site of settlement on the capitulum (Svan, 1986). Most sessilian species are hermaphrodites, with no dwarf males. The evolutionary pattern of thoracican sexual systems can be traced from the modern molecular phylogenetic analysis of thoracican taxa by Pérez-Losada et al. (2008), showing that the presence of dwarf males is a plesiomorphic character, of which the dioecy and androdioecy systems in the Scalpellidae evolved secondarily from a purely hermaphroditic ancestor.

The ancestor of the thoracican cirripedia is believed to be a stalked-form barnacle because many fossil stalked barnacles appeared far before sessilian barnacles. The oldest fossil belongs to the order Cyprilepadiformes Buckeridge & Newman, 2006, containing the *Cyprilepas*, in which the capitulum is composed of 2 chitinous plates and the peduncle is naked; the fossil is known from the Silurian (~ 443 Ma; Wills, 1962, 1963). Classical views of plate evolutionary patterns of stalked barnacles suggest that the capitulum began from 5 capitular plates and then evolved to 6, 8, and 12 plates (see Broch, 1922; Newman, 1987; Anderson, 1994; Buckeridge & Newman, 2006). This hypothesis is based on observations of the ontogenic development of stalked barnacles. After settlement from cyprids, the growth of plates simultaneously began from 5 primordial chitinous plates, and additional plates appeared in a sequence of 6-8-12+ patterns. Foster (1978) and Buckeridge (1983) proposed that naked stalked barnacles, including *Paralepas* and *Heteralepas* which have no plates on the capitulum, should be the most primitive, and stalked barnacles with higher numbers of plates should be placed at higher levels of the phylogenetic tree. However, modern intensive molecular and morphological analyses (Pérez-Losada et al., 2008) showed the ontogenetic pattern with 5-6-8-12+ plates does not reflect thoracican shell evolution, and naked barnacles are not ancestral. From the maximum-likelihood and Bayesian analysis of DNA sequence divergence of more than 76 thoracican barnacles, the Calanticidae (13 capitular plates) diverged basally to most thoracicans and was the first group to diverge after the Ibliformes (the most-basal group). Pérez-Losada et al. (2008) showed that 5- (*Lepas*, *Octolasmis*, *Oxynaspis*, and *Megalasma*) and 8-plated (*Neolepas*, *Ashikailepas* and *Volcanolepas*) taxa are nested within multi-plated forms in the phylogenetic trees. Such results suggest that 5- and 8-plated forms should have been derived from multi-plated forms. From the phylogenetic analysis of Pérez-Losada et al. (2008), the Heterolepadidae is not ancestral to the phylogenetic tree, but has evolved at least twice from plated forms.

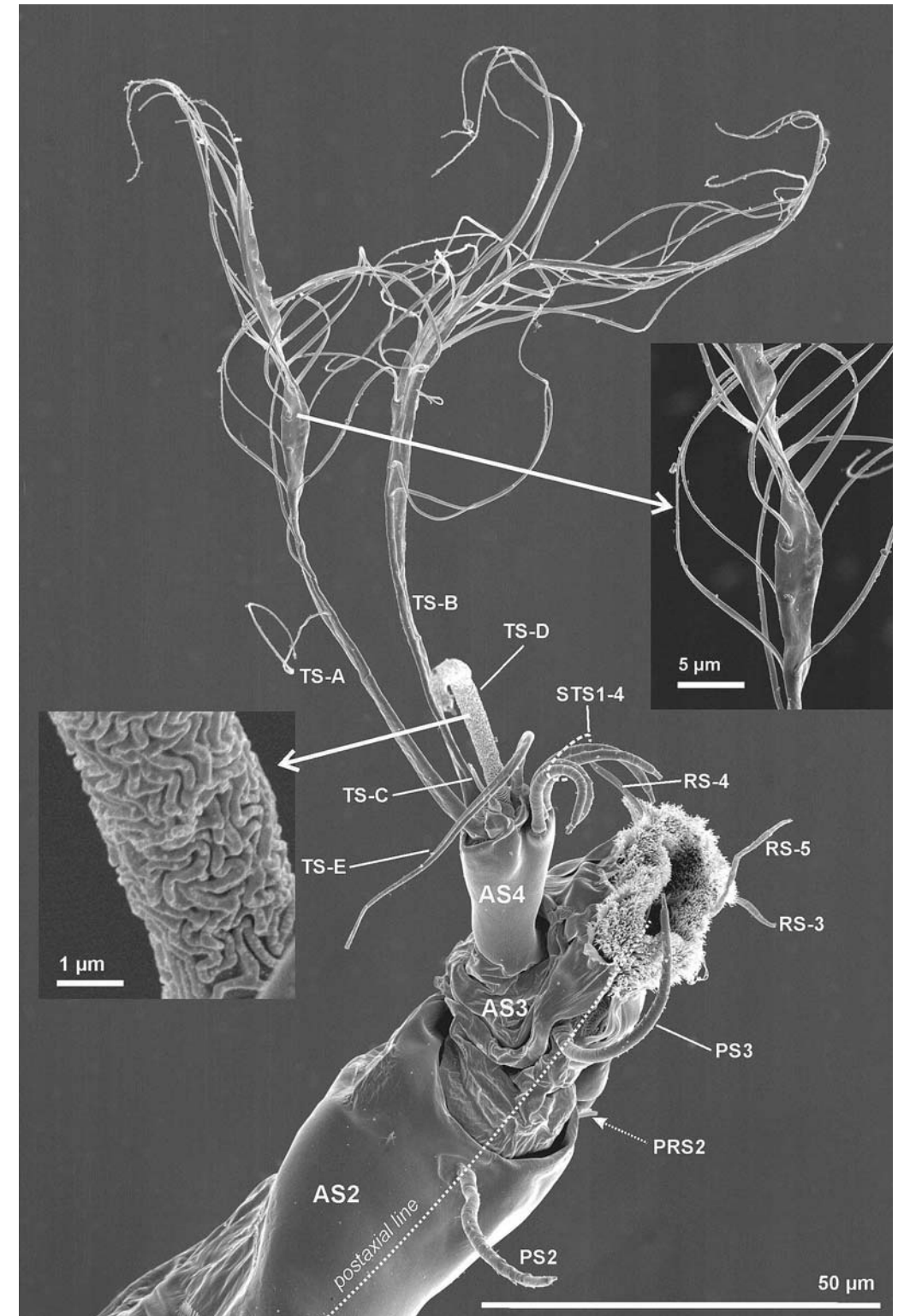
Several controversial classical views on the evolutionary patterns of balanomorph barnacles have been proposed, i.e., that balanomorph barnacles originally were monophyletic or polyphyletic, based on morphological variations and fossil records. The monophyletic hypothesis began from Darwin (1854), who proposed that the Chthamalidae was primitive and was derived from scalpelliform barnacles, and this hypothesis appears to be supported by fossil records. Fossils of the primitive chthamalid *Catophragmus* appeared in the late Cretaceous (145-65 Ma), far before the appearance of the Balanidae in the early Eocene (55-33 Ma). Darwin proposed that the barnacle *Pachylasma* (the shell structure of which resembles the Balanidae, but the somatic body is more similar to the Chthamalidae) is the point of contact between balanid and chthamalid barnacles. However, fossil records show that this hypothesis is not correct because *Pachylasma* appeared in the Miocene (5-23 Ma), after the appearance of the Balanidae in the fossil record. Hoek (1883) identified a barnacle in which the shell resembles the Balanidae but the labrum and third cirrus are closer to the Chthamalidae. Hoek (1883) placed this species in a new genus, *Hexelasma*, but included it as a balanid. Pilsbry (1916) suggested that *Hexelasma* should be a chthamalid and was closer to *Pachylasma*. Zullo (1963) suggested that the Balanidae should have been derived from the *Pachylasma* group including *Hexelasma*. On the contrary, the polyphyletic



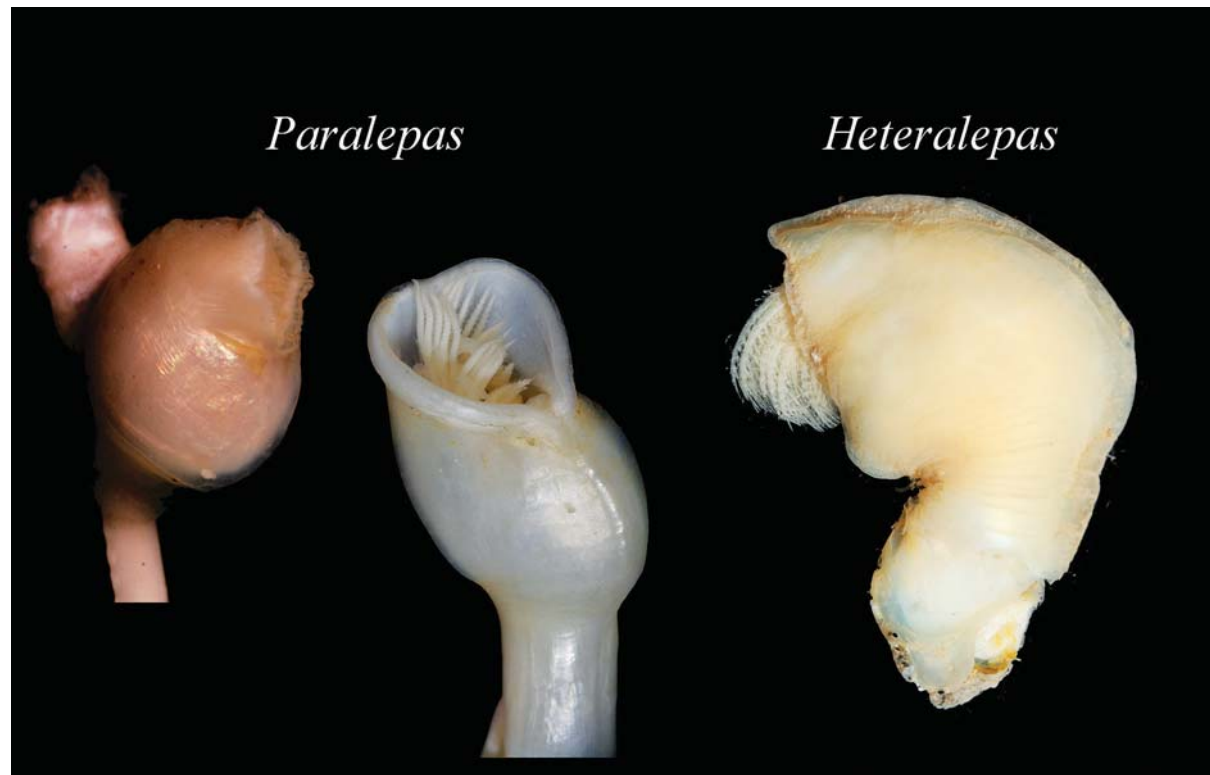
In Japan, Barnacle shells are considered as antiques and accessories. Photo courtesy, Urara Kuratani.



Scanning Electron Microscopy showing the structure of barnacle (*Tetraclita japonica*) naupliar larvae, a. Dorsal view, b. Ventral view. c. Cyprids and d. Magnified view of the cyprid antennule.



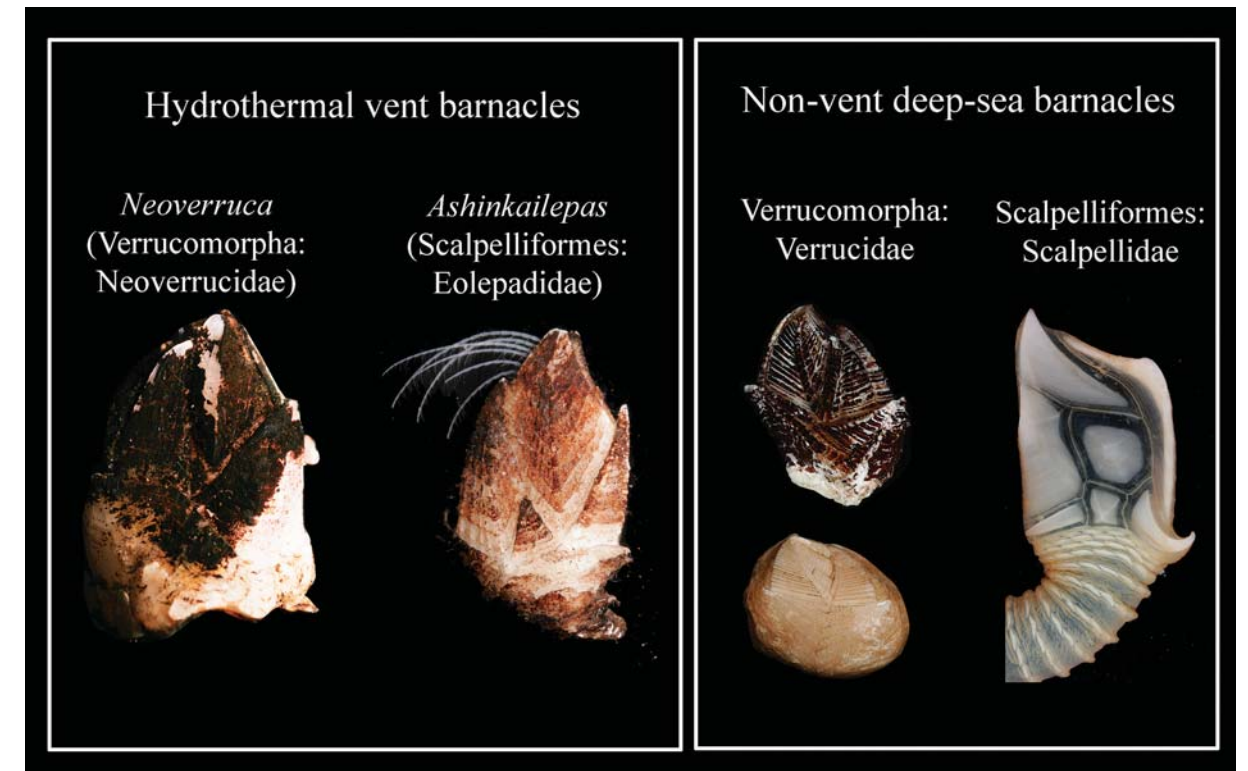
Antennules of *Megabalanus rosa* cyprids. Segment 3 consists of an attachment disc, segment 4 is composed of an array of terminal and sub-terminal setae. AS2-4, antennular segments 2-4; PRS2, pre-axial seta 2; PS2, post-axial seta 2; PS3, post-axial seta 3; RDS3-5, radial setae 3-5; STS1-4, subterminal setae 1-4; TS-A-D, terminal setae A-D (see Bielecki et al. 2009 for details).



Classical views considered the naked barnacle *Heteralepas* and *Paralepas* (Heteralepadidae) are primitive forms of stalked barnacles, but recent molecular analysis in Pérez-Losada et al., 2008 showed that Heterolepadidae is not ancestral to the phylogenetic tree, but is evolved at least twice from plated forms.

hypothesis suggests that the Verrucomorpha and Balanomorpha were derived from different pedunculated groups, in which the peduncle has been convergently lost. There are suggestions that even the Balanomorph evolved polyphyletically (Withers, 1924; also see Newman & Ross, 1976). From recent and modern molecular and morphological phylogenetic analyses of thoracican taxa by Pérez-Losada et al. 2008, the Verrucidae and Sessilia are not monophyletic, based on the taxon definitions of Newman (1996) and Martin & Davis (2001), because vent-associated verrucids (Verrucomorpha: Neoverrucidae) cluster in the pedunculated barnacle clade, and the traditional verrucomorphs and balanomorphs formed another monophyletic clade. The traditional classification of the Verrucidae-Balanomorpha relationship (without the Neoverrucidae) and the monophyly of these 2 groups are supported by Pérez-Losada et al. (2008). The overall results of Pérez-Losada et al. (2008) suggest that the currently recognized thoracican taxa, including order and family levels, are not monophyletic, and a further revision of the taxonomy of thoracican barnacles is certainly needed. In the present study, we still adopt the present taxonomic classification scheme of thoracican barnacles before any new revisions of thoracican taxonomy are conducted.

Taxonomic studies of barnacles date back to the 16th century, when barnacles (stalked barnacles, *Lepas* attached to floating wood) were first identified as eggs of barnacle geese (see Anderson, 1994). In the 17th century, barnacles were classified by Linnaeus as molluscs. Burmeister (1834) noted morphological differences between barnacles and typical mollusks, and classified barnacles in the subclass Cirripedia of the arthropod class Crustacea. Charles Darwin began research on the taxonomy of barnacles soon after they were classified as



In the deep-sea, the vent and non vent Scalpelliformes and Verrucomorph barnacle were shown to have polyphyletic origins (Pérez-Losada et al., 2008), in which the vent and non-vent barnacles undergo separate evolutions.

crustaceans. From 8 years of work, Darwin published 2 monographs on living barnacles and 2 monographs on fossil barnacles, which forms one of the barnacle foundation references nowadays. Barnacles can be regarded as the first model organisms in evolutionary biology in Darwin's works (Darwin, 1851, 1854). Following Darwin, there were numerous taxonomic works published by famous barnacle taxonomists including Annandale, Aurivillius, Broch, Gruvel, Hoek, Krüger, and Nilsson-Cantell and more-recent ones including Anderson, Hiro, Foster, Newman, Ross, Zevina, Kolbasov, Southward, Zullo, Withers, Yamaguchi, Jones, and Buckeridge.

Taxonomic studies on the Taiwanese cirripedian fauna date back to the early reports of expeditions to the Indo-Pacific (Weltner, 1897; Nilsson-Cantell, 1921; Broch, 1931; Hiro, 1938). Taiwan, as defined in this catalog, includes the entire island of Taiwan, as well as the islands under its jurisdiction, including Kinmen, Matsu, the Dongsha (Pratas) Islands, and Taiping Island. Weltner (1897) was the first to record *Balanus amphitrite* from Danshuei (= Tansui), northern Taiwan. Krüger (1911) reported 4 species from Taiwan, including *Heteralepas (Heteralepas) quadrata* [Magong (=Makung), Penghu; Danshuei, and Kaohsiung (=Takao)], *Balanus amphitrite niveus* [Magong], *Tetraclita porosa nigrescens (=T. squamosa japonica)* [Magong], and *T. porosa viridis (=T. squamosa viridis)* [Magong]. Nilsson-Cantell (1921) and Broch (1931) mentioned *Calantica scorpio* and *Octolasmis orthogonia* from the Taiwan Strait. Nilsson-Cantell (1938) recorded *Octolasmis lowei* (Darwin, 1851) from Taiwan.

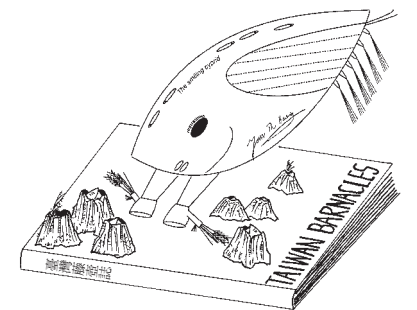
Hiro (1939c, d) who updated the cirripedes of Taiwan and reported 30 species, including 2 new species. Records on Taiwan barnacles were relatively scattered after Hiro. Wu (1967) was the first Taiwanese scholar to

report on the cirripedian fauna of Taiwan, including 2 new records of the Octolasmid cirripeds, *Octolasmis warwickii* and *O. neptuni neptuni*, from the carapace of crabs. Soong et al. (1981) studied the larval settlement of *Balanus amphitrite albicostatus* in Hsinchu, northwestern Taiwan. Soong & Chang (1983) reported 15 new records of coral-inhabiting barnacles from southern Taiwan. Soong & Changlai (1992) further recorded *Megabalanus stultus*, a fire coral symbiont, from southern Taiwan but later this record was corrected to *M. ajax* by Ross (1999). In 1996, 8 species of rhizocephalan barnacles were reported by Huang & Lützen (1996), and a further description of the biology of *Polyascus plana* was given by Liu & Lützen (2000). Ross & Newman (1999) erected a new genus and a new species of coral barnacle, *Cionophora soongi*, from southern Taiwan. However, the genus name was subsequently replaced by *Cionophorus* (Ross & Newman, 2001). Liu & Ren (2007) published a monograph of the barnacles (Thoracica) from China and Taiwan, but all except one of the Taiwanese species mentioned were based on previous reports. Liu & Ren (2007) claimed the barnacle *Oxynaspis cellata* was recorded from the Taiwan Strait, but no detail was given how this record was based. Therefore, the record of *O. cellata* from Taiwan needs to be verified. Chan et al. (2007a, b) studied the taxonomy and diversity of *Tetraclita* and identified 1 new species, *T. kuroshioensis* (originally described as *T. pacifica*) in Taiwan. Tsang et al. (2007) studied the molecular divergence of *T. formosana* and *T. japonica*. *Tetraclita formosana* was repositioned as a subspecies of *T. japonica*, based on a lack of significant divergence of DNA sequences between *T. japonica* and *T. formosana*. Chan & Lee (2007) published a field guide to the barnacles of Taiwan (including Kinmen and Matsu) and reported a total 52 shallow-water and deep-sea species. Chan et al. (2008b), who reported the biogeography of *Tetraclita* in the Northwest Pacific, documented that the northeast coast of Taiwan had both *T. kuroshioensis* and *T. japonica formosana*, while the east coast of Taiwan had mainly *T. japonica formosana*. Most previous species descriptions of Taiwanese barnacles focused on intertidal and shallow-water species, while deep-sea cirripedian fauna received very scant attention. In recent years, several biodiversity surveys on intertidal, shallow-water, and deep-sea “TAIWAN” expeditions (sampling up to 5011m) were conducted to investigate the Taiwanese marine fauna. Results from deep-sea expeditions and shallow-water surveys yielded a high diversity of barnacle species.

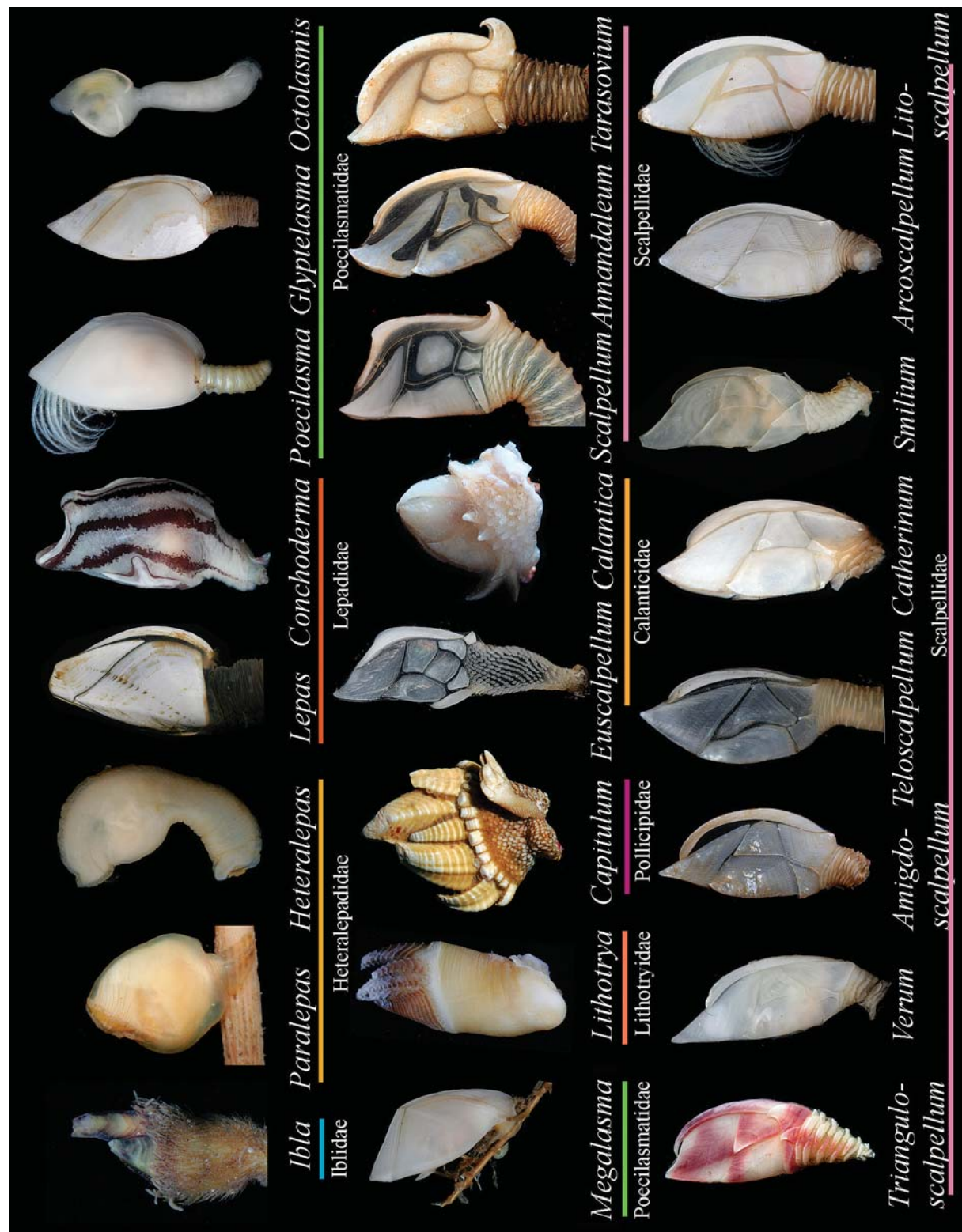
With support from the National Science Council (NSC), Taiwan, funding was granted to author a series of crustacean catalogs, including barnacles. However, due to their high biodiversity in Taiwanese waters, the Taiwanese barnacle catalog is divided into at least 2 volumes. This is the first volume of the Taiwanese barnacle catalog series which includes thoracican barnacles, except for coral barnacles (Pyrgomatidae) and sponge barnacles (Acastinae). Coral and sponge barnacles are associated with their coral and sponge hosts, and from preliminary surveys, they have very high diversity in Taiwan. These commensal barnacles will be presented in the second volume of Taiwanese barnacles. There are currently 4 orders, 18 families, 47 genera and 95 species of thoracican barnacles (excluding sponge and coral barnacles) recorded so far. These records are based on formal scientific publications. Records from lists, internal reports, and magazines are not considered as there are no voucher specimens which can be traced (e.g. the report of *Oxynaspis cellata* by Liu & Ren, 2007 in a list as discussed above is not considered as a valid record). Intertidal and shallow waters species have been extensively reported in the present catalog. Species in the deep-sea were presently collected in relatively smaller numbers and it is expected that more species of deep-sea barnacles will be found in Taiwan. Foster & Buckeridge (1987) reviewed and estimated that there are about 800 species of Thoracican barnacles worldwide.

The collections in the present catalog, therefore, covered at least 12% of the world Thoracican fauna as the Taiwanese species in Pyrgomatidae and Acastinae are not included in this volume. Although there are no endemic species in Taiwan, the present catalog includes 2 recently described new species (Chan et al., 2009) and 47 new Taiwan records (see also Cai et al., in press; Chan et al., 2009). These new records from Taiwan cover 1 new order, 5 new families, and 21 new genera records. The species are illustrated with color photographs, and the morphology of the mouth parts were also illustrated by light microscopy or scanning electron microscopy photographs except for some species the cirral morphology are depicted by line drawings. There are, however, 12 species (namely, *Octolasmis lowei*, *O. scuticosa*, *Paralepas quadrata*, *Megabalanus occator*, *Striatobalanus krugeri*, *S. taiwanensis*, *Conopea granulatus*, *Amphibalanus poecilotheca*, *Conchoderma auritum*, *Smilium scorpio*, *Nesochthamalus intertextus*, and *Oxynaspis pacifica*) which were previously recorded, but no specimens were available for the present study. The morphology of those species was illustrated from redrawing the original diagrams of Taiwanese specimens (*S. taiwanensis* in Hiro, 1939, *Smilium scorpio* in Broch, 1931) or from redrawing illustrations from Micronesia (for *O. lowei*), China (for *A. poecilotheca*), the Philippines (for *M. occator*) or Japan (other remaining species). The majority of the specimens reported herein are housed in the collections of the Biodiversity Research Museum, Academia Sinica (ASIZCR), the National Museum of Natural Science (NMNS), and the Coastal Ecology Laboratory of the Biodiversity Research Center, Academia Sinica (CEL). The terminology used is illustrated under the section "Morphological terms". Specimen size is indicated by the capitulum length (CL), capitulum width (CW), and peduncle length (PL) for stalked barnacles and rostral carinal basal diameter (BD) for sessilian barnacles. For specimens collected by the “TAIWAN” cruises, gear types are abbreviated as the 4-m French beam trawl (CP), the 2.5-m French beam trawl (PCP), and the 3-m ORE beam trawl (OCP), and are indicated before the station number. The synonymies cited for each species are not exhaustive for the taxon, and we restricted the synonymies to include only the original citation, major works, and previous records in Taiwan.

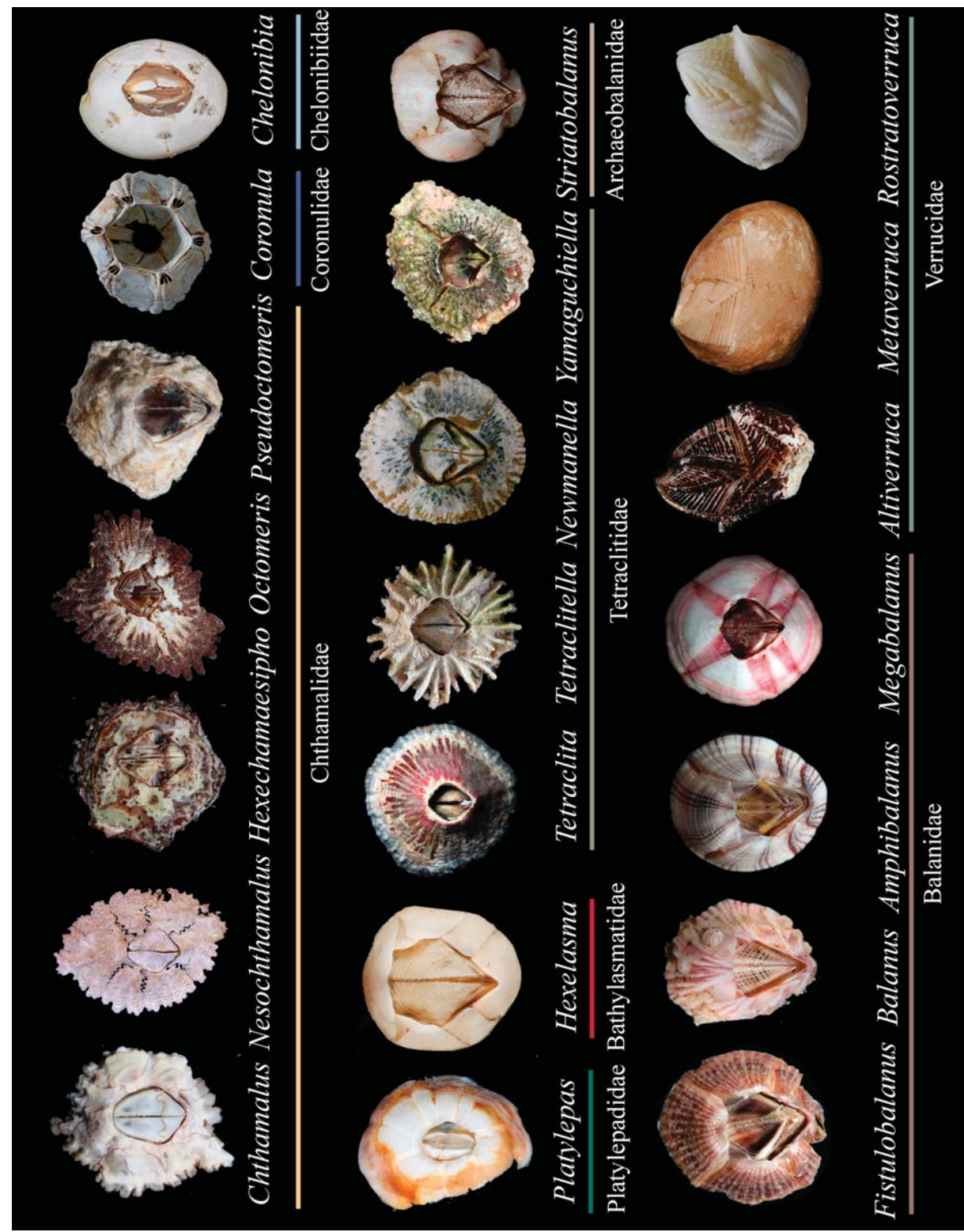
The authors would like to acknowledge Prof. Tin-Yam Chan (National Taiwan Ocean University, Keelung, Taiwan) for providing part of the specimens and support for the present study. The authors are indebted to Ms. Pei-Chen Tsai, Hsin-Ying Lee, Mr. Cheng-Hung Chang, and Kingsley Wong for editorial work and dissections of specimens and Mr. Ho-Tian Hung for collection of a part of the specimens. BKK Chan would like to thank Graham Walker (University of Wales Bangor, UK) and the late Prof. Alan Southward (Marine Biological Association of the UK), for teaching taxonomic techniques for barnacles. BKK Chan is indebted to Prof. Gray A Williams (University of Hong Kong) for introducing him to the field of marine ecology. The authors would like to thank Ms. Urara Kuratani and Dr. Jose Antonio Lopez (JAL Fishery, S.A., Chile) for providing some valuable photos, Ms. Karen Jacobsen (in situ scientific illustration) for allowing the use of 2 illustrations, Prof. Jens Høeg for his smiling cyprids and Mr. Daniel P. Chamberlin for editing the text. The authors sincerely thank the Center for Marine Bioscience and Biotechnology of National Taiwan Ocean University for support in publishing this work. This catalog is a contribution from a project (NSC96-2621-B-019-008-MY2) granted by the National Science Council, Taiwan, R.O.C.



A smiling cyprids (by Jens T. Høeg) on the Taiwan barnacle catalog (by Kingsley Wong).



The stalked barnacle genera collected in the present study.



The sessile barnacle genera collected in the present study.

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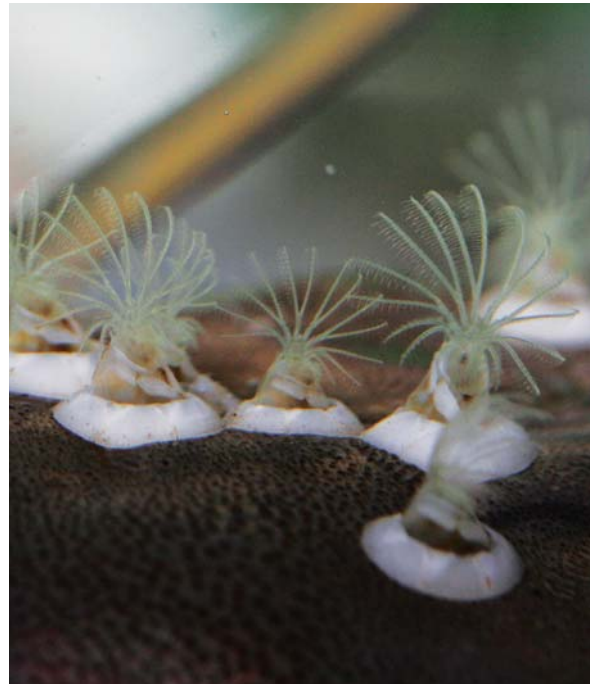
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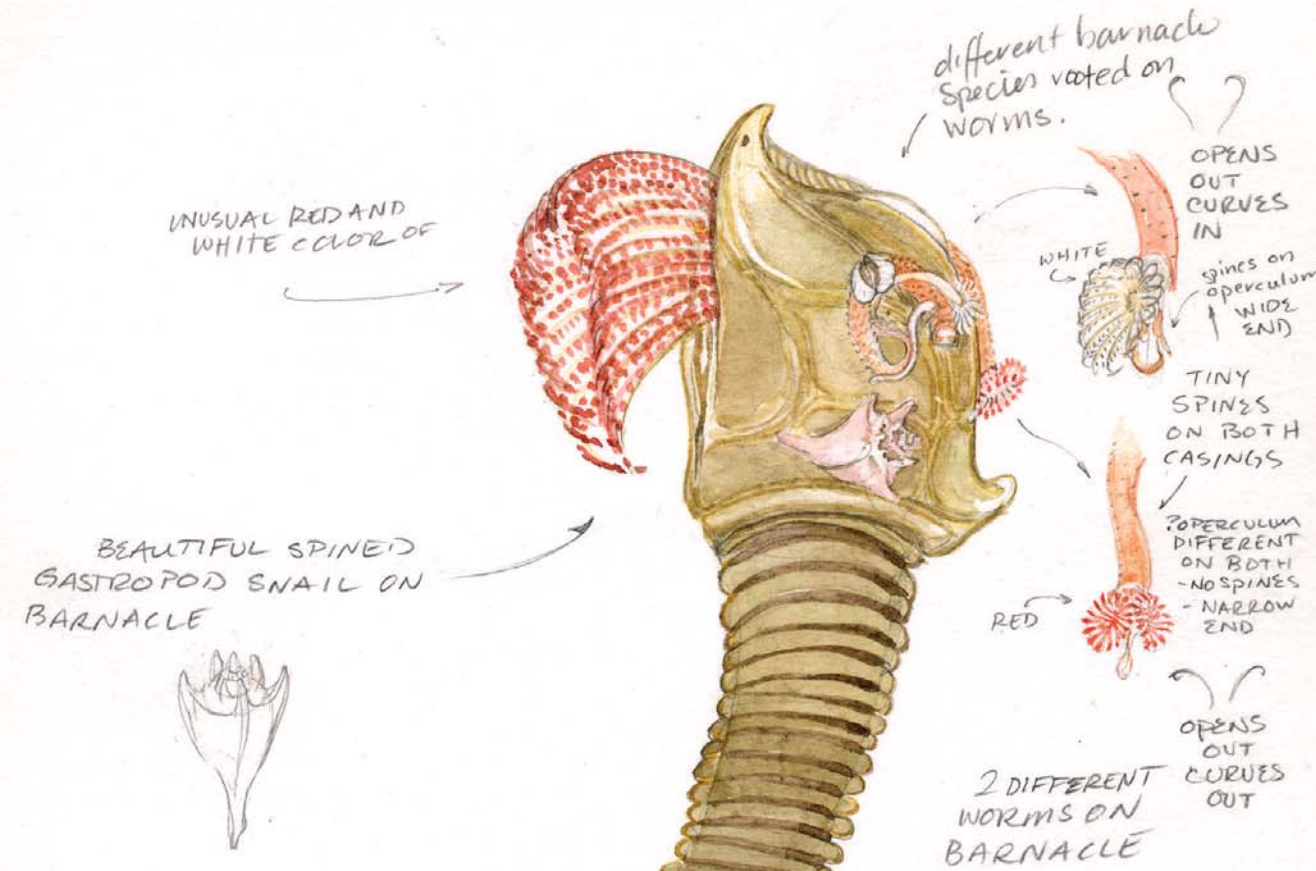
Settlement of the cyprids of the deep-sea barnacle *Megalamsa minus*, showing the formation of 3 primordial plates.



Chelonibia patula are epibiotic on carapace surface of crabs.




Lepas testudinata, on floating woods.



GIANT BARNACLE
40cm
Drawn @ 100%

HD. DIVE #194, whale #12
Barnacle from open sea floor with numerous other animals living on and around it.

Phylogenetically old species (stalked) vs.  exterior shell type (newer)

The deep-sea barnacle *Scalpellum stearnsii* in the Pacific Ocean. © Karen Jacobsen, In Situ Science Illustration 2009, insituart@gmail.com

SYSTEMATICS

Class Maxillopoda

Subclass Cirripedia

Superorder Thoracica

In the present study, classification of the orders of stalked barnacles follows the latest revision in Buckeridge & Newman (2006), which separates the previous order Pedunculata into 3 new orders, the Ibliformes, Lepadiformes, and Scalpelliformes. Classification of the families of the Scalpelliformes follows the revision by Zevina (1981). Classification of sessilian barnacles basically follows Newman (1996), and that of the Balanidae and Tetraclitidae follows Pitombo (2004) and Ross & Perreault (1999).

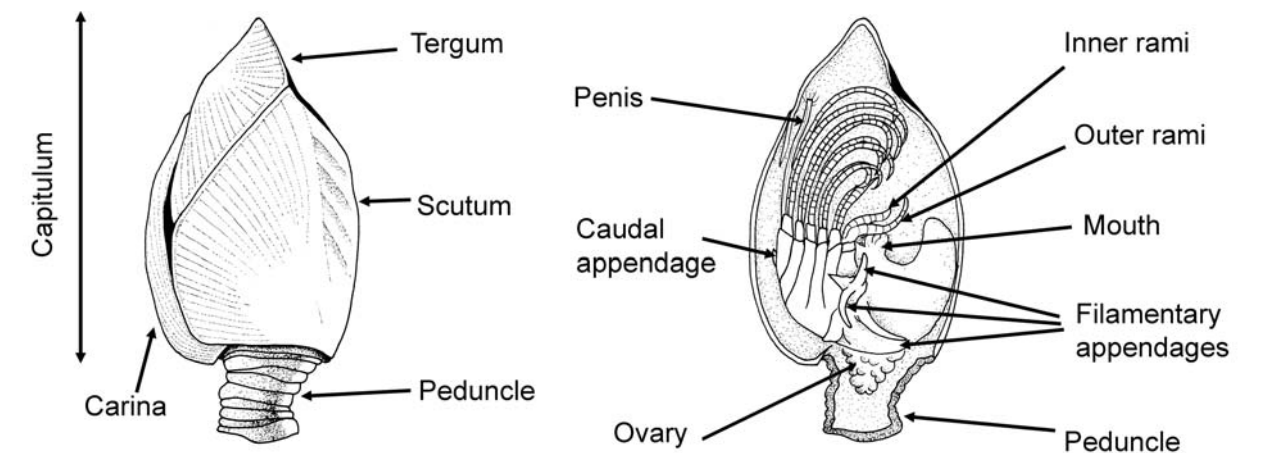
Key to Orders of Cirripedia from Taiwan

- 1. Stalked barnacles 2
 - Barnacles without a stalk Order Sessilia
- 2. Capitulum with 5 or 2 or no plates Order Lepadiformes
 - Capitulum with 4 plates Order Ibliformes
 - Capitulum with more than 5 plates Order Scalpelliformes



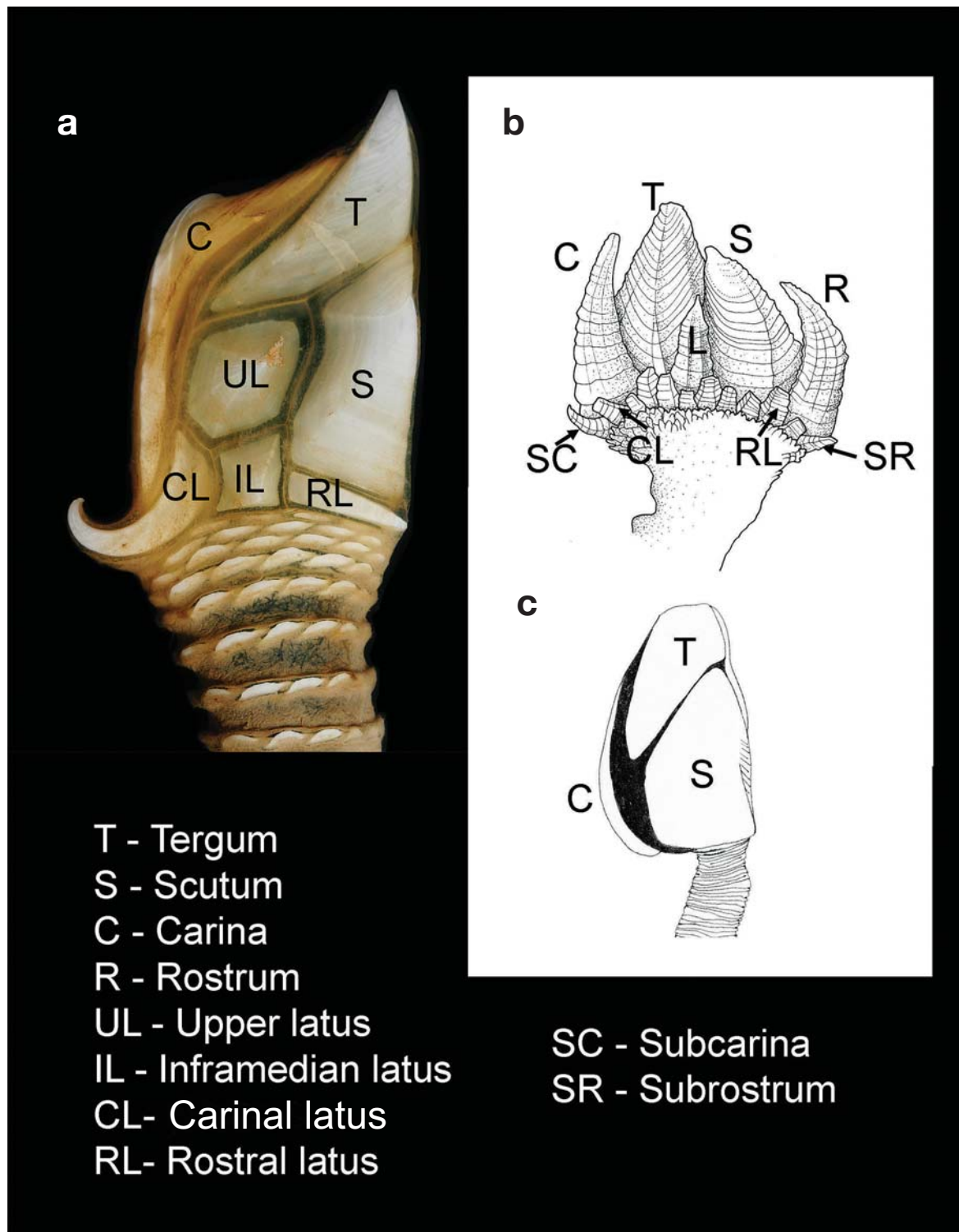
A colony of *Tetracita* on the N.E. Coast, Taiwan.

MORPHOLOGICAL TERMS

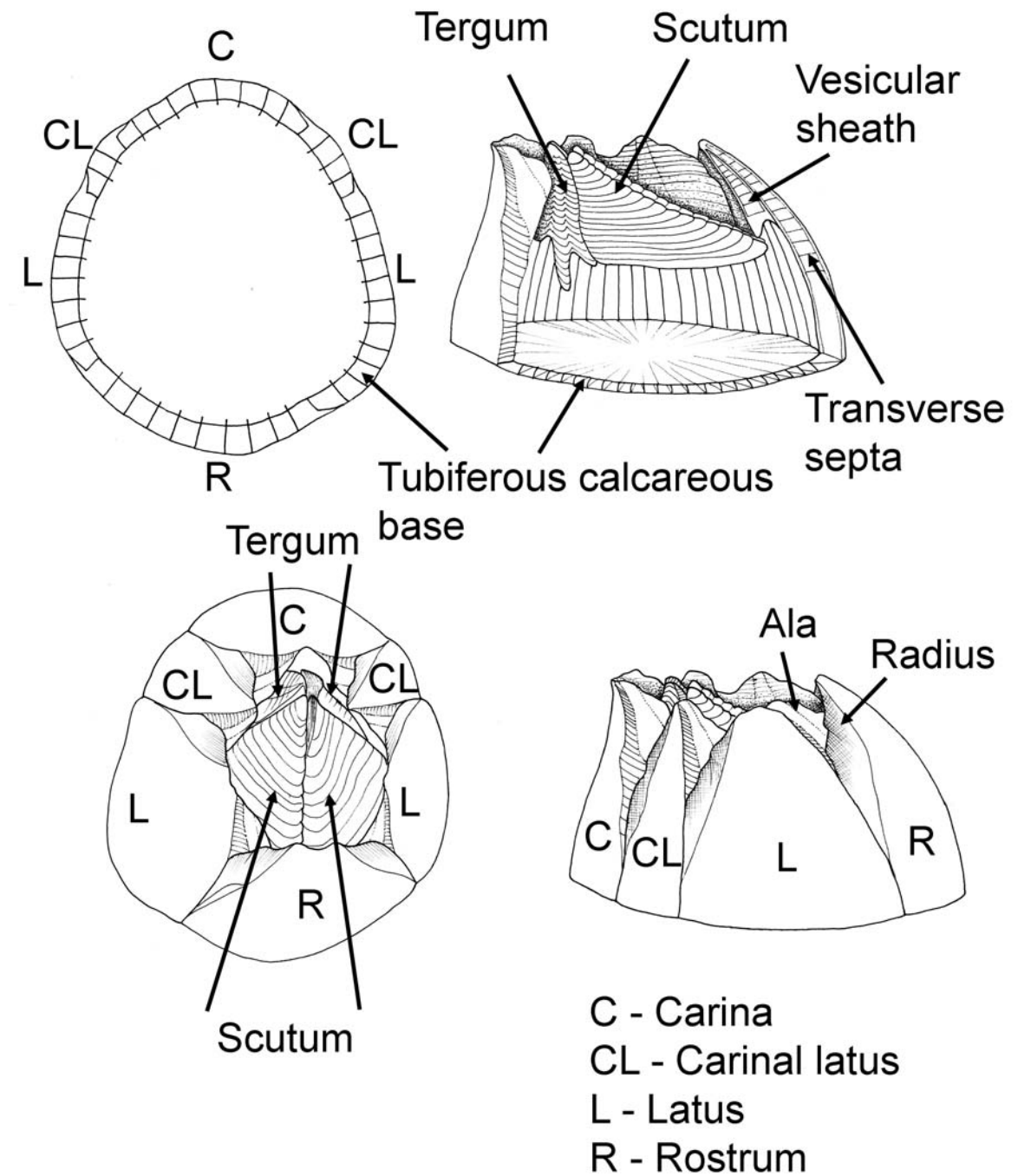


Morphology of the stalked barnacle *Lepas anserifera*.

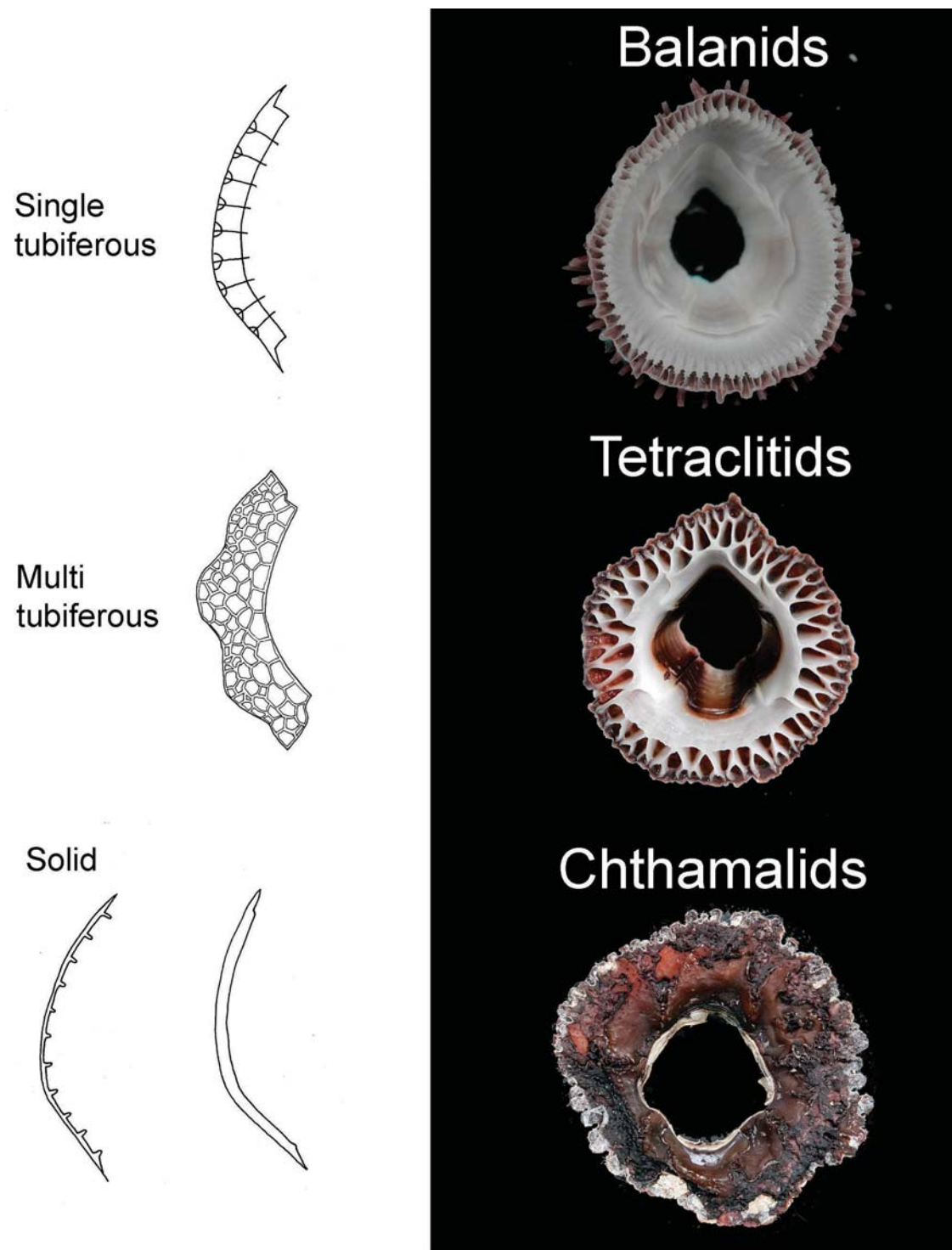
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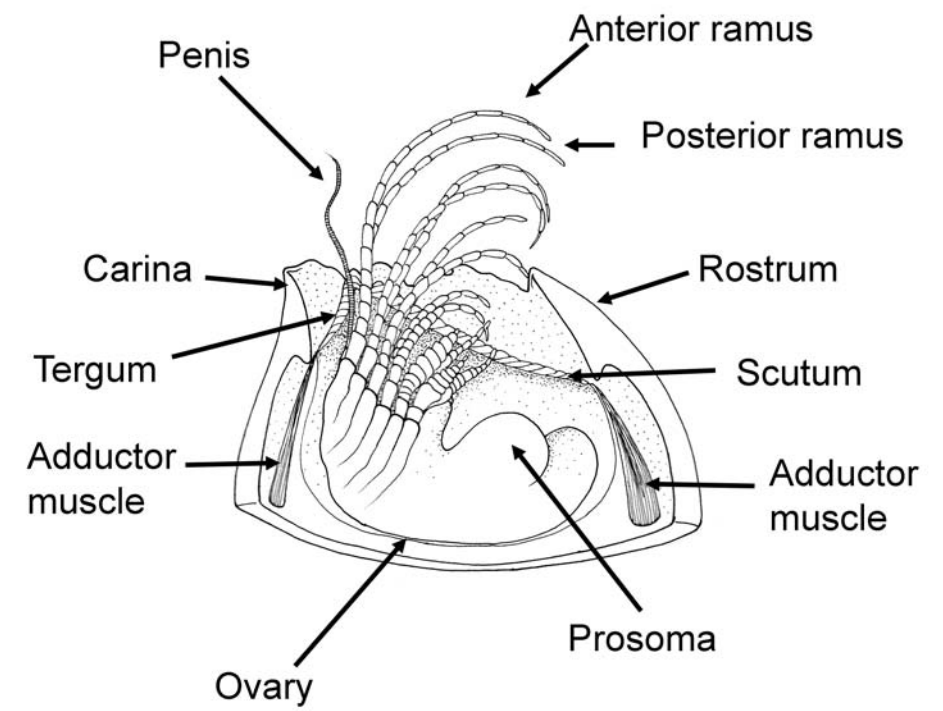


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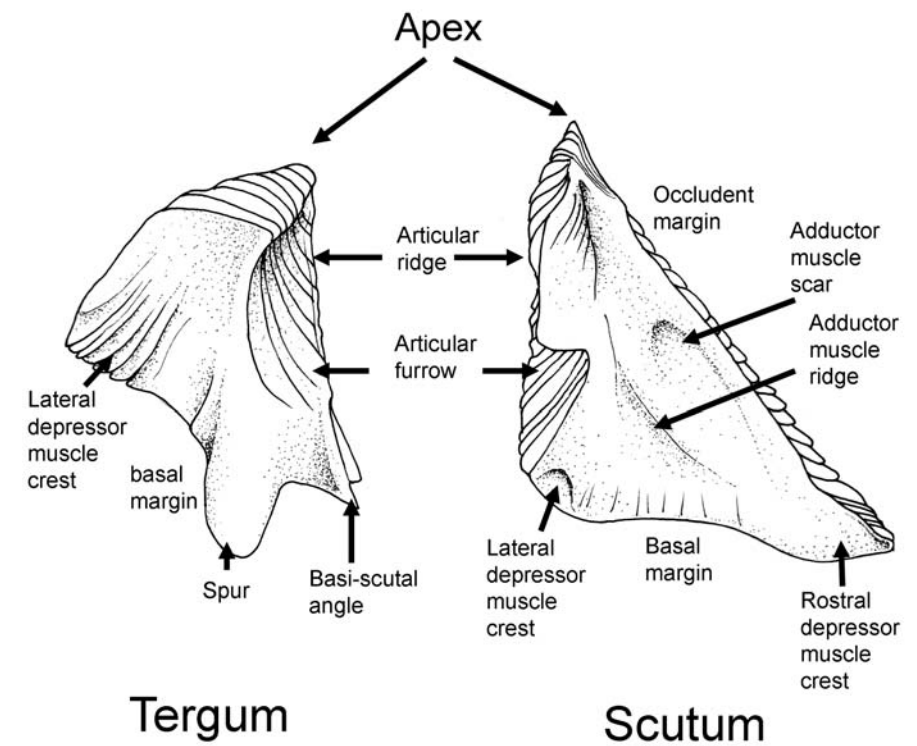


Variation in the shell wall structure of balanomorph barnacles.

MORPHOLOGICAL TERMS

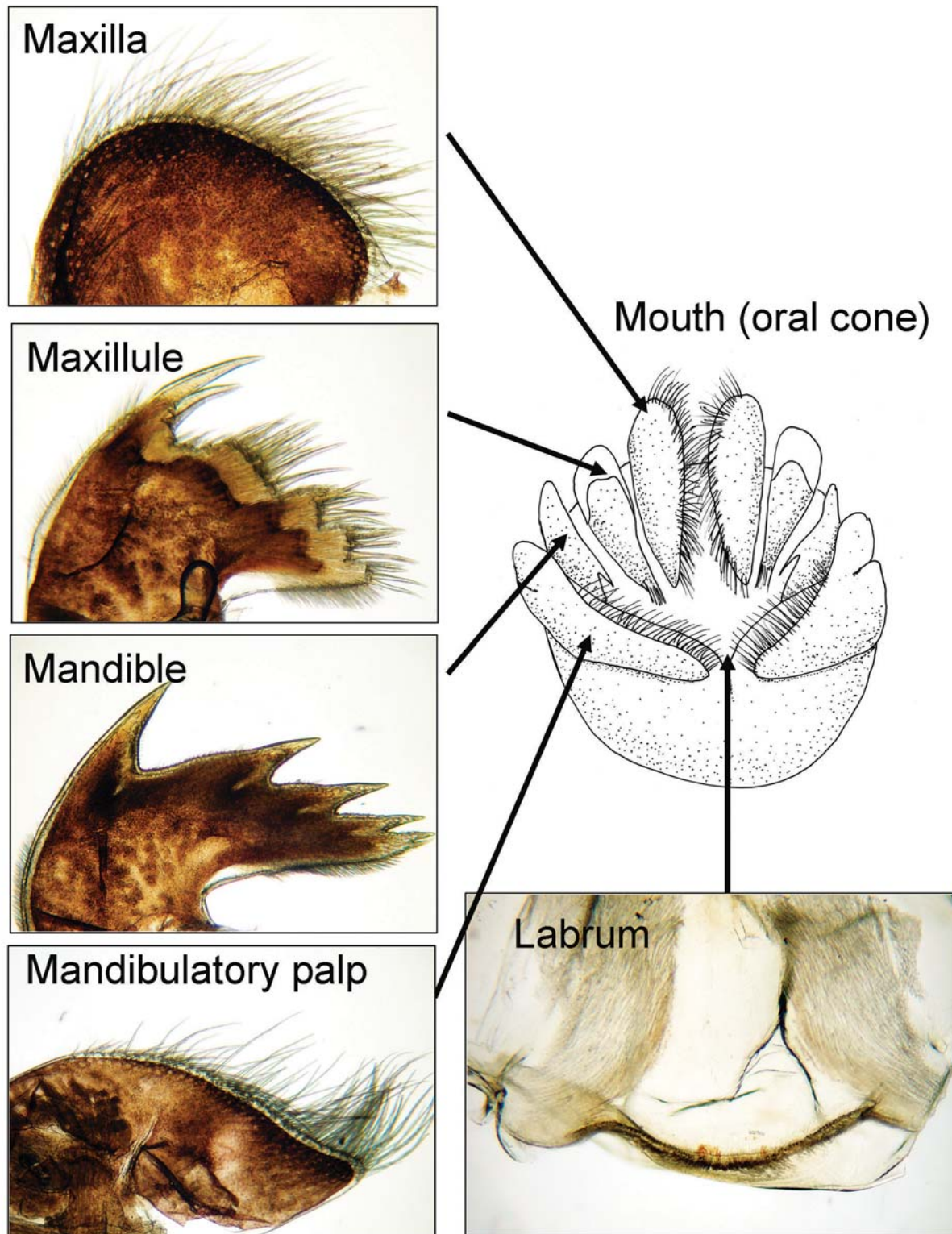


Morphology of a sessilian barnacle.



Morphological parts of scutum and tergum of balanomorph barnacles.

MORPHOLOGICAL TERMS



Morphology of the oral cone, showing the maxilla, maxillule, mandible, mandibulatory palp and labrum.

Order IBLIFORMES Buckeridge & Newman, 2006

鳥嘴目

Diagnosis.—Stalked barnacles with 4 chitinous plates of capitulum, often composed of carbonate hydroxylpatite; carina lacking; terga umbo apical; scuta umbo apical or subapical; adductor muscle post-esophageal; peduncle with dense chitinous spines.

Remarks.—Ibliformes differ from all other Thoracica by having a post-esophageal adductor muscle instead of pre-esophageal adductor muscles. The plates are made of chitin. The post-esophageal adductor muscle and chitinous plates are considered to be plesiomorphic characters in barnacle phylogenetic studies. The Ibliformes is distributed in tropical and subtropical oceans, including the west coast of Africa, Red Sea, Persian Gulf, and Indo-West Pacific waters. At present, 2 families are included in this order, the Iblidae and Idioblidae. In Taiwan, only 1 species from the Iblidae has been recorded. This is a new record for Taiwan (see Cai et al. in press).

Family IBLIDAE Leach, 1825

鳥嘴科

Iblidae Leach, 1825: 209.

Diagnosis.—Large-sized Ibliformes, with peduncle covered by dense and long chitinous spines; basal margin of terga broad. Large-sized female and dwarf males capable of feeding. Dwarf males often located in wall of mantle cavity.

Genus *Ibla* Leach, 1825

鳥嘴屬

Ibla Leach, 1825: 209. Type species *Ibla cumingi* Darwin, 1851: 183.

Diagnosis.—Capitulum with 4 chitinous plates (paired scutum and tergum). Tergum long and extending far beyond scutum, basal margin of tergum broad; peduncle brown and covered by dense setae. Caudal appendage present; adductor muscle post-esophageal; dwarf males present.

Ibla cumingi Darwin, 1851

毛鳥嘴

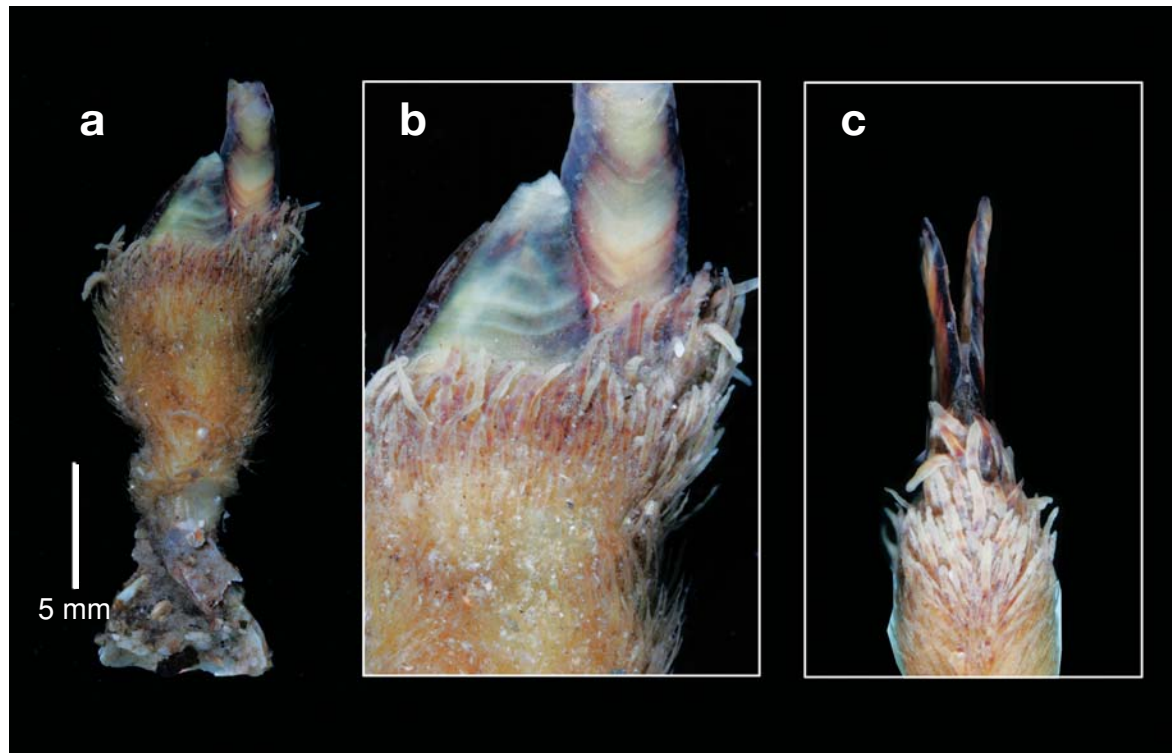


Fig. 1. *Ibla cumingi*, Shihtiping, Hualien County, 27 Dec 2007. a. Side view of the whole organisms. b. Close-up view of the scutum and tergum. c. Carinal view showing the tergum.

Ibla cumingi Darwin, 1851: 183, pl. 4, fig. 8 [type locality: Guimavas Island, Philippines].—Weltner, 1897: 251.—Hoek, 1907: 47.—Nilsson-Cantell, 1921: 222, fig. 36.—Hiro, 1936a: 215.—1937b: 393, fig. 1.—1937a: 49, fig. 41.—Rosell, 1972: 152, pl. 1, fig. 1.—Liu & Ren, 1985: 215, fig. 18, pl. 5:1-4.—Liu & Ren, 2007: 134, fig. 45.—Buckeridge & Newman, 2006: 9.

Ibla sibogae Hoek, 1907: 48, pl. 4, figs 20-22, pl. 5, figs. 1-8.

Ibla cumingi sibogae.—Newman, 1960: 100, figs. 1-2.

Material examined.—Shihtiping, Hualien County, 27 Dec 2007: 1 specimen (CL 6.32 mm, CW 4.44 mm, PL 2.09 mm) (CEL-BB-90).

Diagnosis.—Capitulum with 4 chitinous plates. Terga and scuta umbo apical. Peduncle covered with dense setae; filamentous appendages absent, caudal appendage present, 8-segmented. Sex dioecious, with dwarf male. Cirrus I maxillipede shorter than other cirri, segment counts for cirrus I (anterior ramus 10, posterior ramus 11); cirri II-VI similar in morphology; segments of cirri II-VI counts as II (16, 13), III (16, 18), IV (18, 18), V (18, 17), and VI (18, 18). Mandible with 3 teeth, with no multiple dentations on large tooth; maxillule not notched, with 10 large spines on cutting edge; maxilla circular; mandibulatory palps elongated

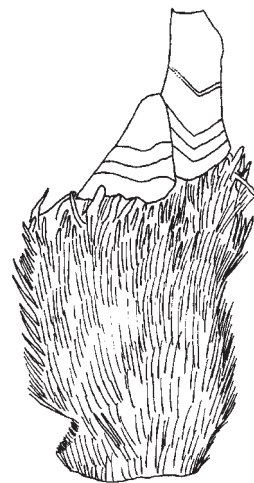


Fig. 2. *Ibla cumingi*, Shihtiping, Hualien County, 27 Dec 2007. Line drawing of the side view.

with serrulate setae; labrum concave with fine teeth.

Size.—CL to 9 mm.

Coloration.—Opercular plates black to brown. Peduncle brown.

Habitat.—Intertidal, inside rock crevices and gaps within oyster shells.

Distribution.—Indo-Pacific region.

Remarks.—New record for Taiwan.

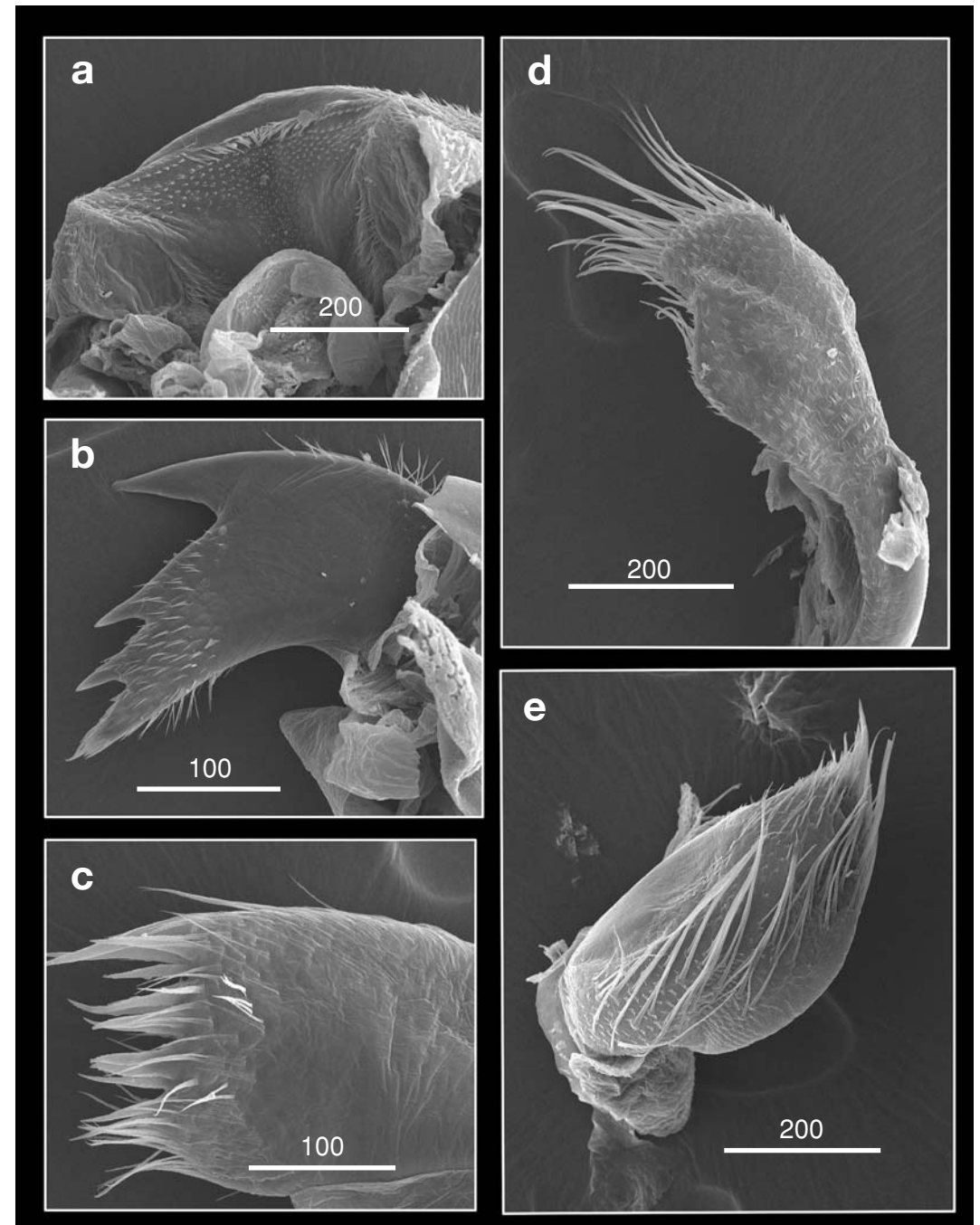


Fig. 3. *Ibla cumingi*, Shihtiping, Hualien County, 27 Dec 2007. Scanning Electron Microscope on the mouth parts. a. Labrum, b. Mandibles, c. Maxillule, d. Mandibulatory palp, e. Maxilla. Scale bars in µm.

Order LEPADIFORMES Buckeridge & Newman, 2006 茗荷目

Diagnosis.—Hermaphroditic but some species possibly accompanied by complementary male; stalk distinct; capitulum with 5 calcareous plates, 5 or 2 reduced plates, or no plates; caudal appendages variable.

Remarks.—Results from a molecular phylogenetic analysis (Pérez-Losada et al., 2004) and larval morphology (Newman & Ross, 2001) suggest that the Lepadomorpha is distinguished from other members of the Thoracica. Buckeridge & Newman (2006) revised the taxonomy of stalked barnacles, rearranging Lepadomorph barnacles into a separate order, the Lepadiformes, which accommodates both suborders Lepadomorpha and Heteralepadomorpha, based on morphological similarities of the 2 groups. The separation of the Lepadiformes from the remainder of the Thoracica was further supported by a recent molecular analysis (Pérez-Losada et al., 2008). Foster (1978) considered the reduction of opercular plates in the capitulum to be a plesiomorphic character for stalked barnacles. However, molecular genetics in Pérez-Losada et al. (2008) showed that the Heteralepadomorpha is not ancestral, but has evolved at least twice from plated pedunculated barnacles. Revision of the systematics of heteralepadomorph barnacles requires further attention.

Key to families of Lepadiformes

1. Capitulum with plates **Lepadomorpha**
Capitulum without plates **Heteralepadomorpha**

Suborder LEPADOMORPHA Pilsbry, 1916 茗荷亞目

Diagnosis.—Stalked barnacle, capitulum with 5 or 3 reduced plates, or no opercular plates; peduncle often naked; hermaphroditic with no complementary males.

Remarks.—The Lepadomorpha is composed of 3 families, the Oxynaspididae, Poecilasmataidae, and Lepadidae.

Key to families of Lepadomorpha from Taiwan

1. Umbo of scutum at middle region of occludent margin, umbo of carina not at base **Oxynaspididae**
Umbo of scutum not at middle region of occludent margin, umbo of carina at base 2
2. Base of cirrus I without filamentary appendage, caudal appendages with 1-2 segments and mandibles 4 teeth, excluding the inferior angle **Poecilasmataidae**
Base of cirrus I has more than 1 filamentary appendages, caudal appendage 1 segment or none, mandible 5 teeth, excluding the inferior angle **Lepadidae**

Family OXYNASPIDIDAE Pilsbry, 1907 刺茗荷科

Oxynaspidinae Gruvel, 1905: 102.

Oxynaspidinae Pilsbry, 1907a: 79.

Oxynaspididae Nilsson-Cantell, 1921: 225.

Diagnosis.—Hermaphroditic; capitulum with 5 plates, umbo of scutum in middle region of occludent margin.

Remarks.—The family Oxynaspididae consists of 1 genus, *Oxynaspis* Darwin, 1851.

Genus *Oxynaspis* Darwin, 1851 刺茗荷屬

Oxynaspis Darwin, 1851: 133.—Gruvel, 1905: 102.—Nilsson-Cantell, 1921: 225.—1934: 46, 51.—Newman et al., 1969: 279.—Liu & Ren, 2007: 137. Type species. *Oxynaspis celata* Darwin, 1851.

Diagnosis.—Hermaphroditic, plate surface often covered by spines. Capitulum with 5 plates, plates closely or loosely packed. Carina bowed with angle. Scutum umbo at occludent margin or median region. Often commensal with Antipatharia corals.

Remarks.—There are at least 20 species of *Oxynaspis* worldwide, and 1 species has been recorded in Taiwan.

Oxynaspis pacifica Hiro, 1931
太平洋刺茗荷

Family POECILASMATIDAE Annandale, 1909
花茗荷科

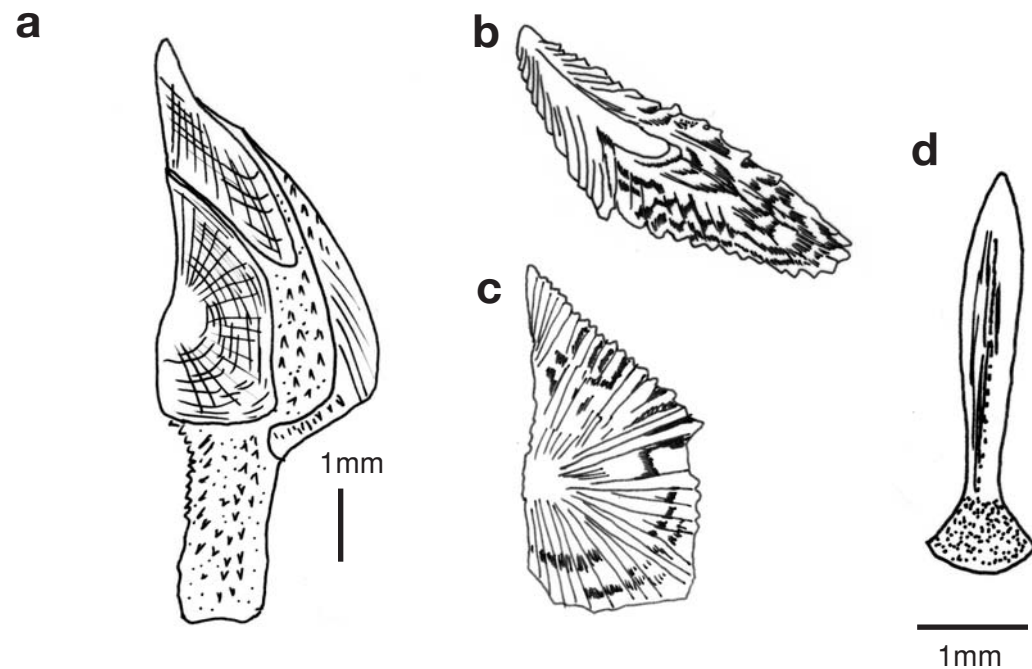


Fig. 4. *Oxynaspis pacifica*, Japan. a. Side view of the capitulum. b. Tergum. c. Scutum, showing umbo at the middle region of the occludent margin. d. Carina. Redrawn from Hiro (1931).

Oxynaspis pacifica Hiro, 1931: 143, fig. 1, pl. 11, figs. 1-1c.—1937b: 393.—1939d: 247.

Material examined.—Taiwan Strait (data from Hiro, 1939d).

Diagnosis.—Capitulum with 5 plates, plates white, surface with striations, covered by small spines. Tergum with apex formed, umbo apical; scutum quadrangular, with umbo in medial region of occludent margin; carina strongly bowed, with a spatula disc in basal region.

Size.— Not available.

Coloration.— White.

Distribution.— Taiwan Strait, Japan.

Remarks.—We have not yet collected this species in Taiwanese waters.

Lepadinae Gruvel, 1905: 104.

Lepadidae Pilsbry, 1907a: 79.

Poecilasmatinae Annandale, 1909a: 64, 86.

Poecilasmatidae Nilsson-Cantell, 1921: 253.—Hiro, 1933: 54.—Utinomi, 1958: 292.—Newman et al., 1969: 276.—Foster, 1978: 24.—Zevina, 1980: 692.—Liu & Ren, 1985: 230.—Liu & Ren, 2007, 148.

Trilasmatidae Nilsson-Cantell, 1934a: 59.—Withers, 1935: 74.—1953: 336.—Hiro, 1937a: 79.— Krüger, 1940: 29.

Diagnosis.—Hermaphroditic, capitulum with 5 fully calcified plates, umbo of scuta and carina basal; carina narrow, not extending beyond terga. Filamentary appendage absent from bases of cirrus I; caudal appendages single-jointed; peduncle naked or covered with calcareous plates.

Remarks.—The family Poecilasmatidae is composed of 8 genera, *Poecilasma*, *Glyptelasma*, *Megalasma*, *Temnaspis*, *Octolasmis*, *Dichelaspis*, *Pagurolepas* and *Trilasmis*. 4 genera have been recorded in Taiwan so far.

Key to genera of Poecilasmatidae from Taiwan

1. Capitulum partially calcified, with large gaps between plates *Octolasmis*
 Capitulum fully calcified 2
2. Base of carina expand in horizontal directions 3
 Base of carina not expanding in horizontal directions *Poecilasma*
3. Basal margin and occludent margin of the scutum forms a straight line *Megalasma*
 Basal margin and occludent margin of the scutum perpendicular to each other *Glyptelasma*

Genus *Octolasmis*, Gray, 1825

板茗荷屬

Octolasmis Gray, 1825: 100.—Pilsbry, 1907a: 93.—Krüger, 1911: 39.—Nilsson-Cantell, 1921: 268.—Broch, 1922: 279.—Broch, 1931: 38.—Broch, 1947: 13.—Barnard, 1924: 56.—Hiro, 1937a: 86.—Newman et al., 1969: 281.—Liu & Ren, 1985: 245.

Dichelaspis Darwin, 1851: 115.—Aurivillius, 1894: 15.—Gruvel, 1905: 123.—Hoek, 1907: 16.—Annandale, 1909a: 98.—Stubbings, 1936: 7.

Trichelaspis Stebbing, 1894: 443. Type species *Octolasmis warwickii* Gray, 1825.

Diagnosis.—Capitulum with 5, 3, or 2 incompletely calcified plates; mandible with 4 teeth, filamentary appendage absent. Peduncle naked.

Remarks.—*Octolasmis* often attaches onto the carapace surface or gill chambers of decapod crustaceans. Hiro (1939b) recorded *O. scuticosta* from Taiwan, but we did not collect this species in the present collection. There are 28 species of *Octolasmis* worldwide, and 8 species are recorded in the present collection. 4 species are new to Taiwan (see Cai et al., in press).

Key to genera of *Octolasmis* from Taiwan

1. Scutum 2-lobed, basal lobe branch2
 Scutum 'L' shaped, basal lobe narrow and horizontally extended4
2. Base of carina separated into 2 parts3
 Base of carina not separated into 2 parts·*Octolasmis scuticosa*
3. Tergum axe-shaped (Liu & Ren, 2007), umbo at carinal-lateral margin, often attach on decapod crustaceans ··
 ·*Octolasmis warwickii*
 Tergum T-shaped, umbo apex, attaching on gorgonian corals·*Octolasmis nierstraszi*
4. Tergum present5
 Tergum absent7
5. Basal region of carina oval shaped·*Octolasmis orthogonia*
 Basal region of carina forked6
6. Tergum U-shaped·*Octolasmis lowei*
 Tergum irregular·*Octolasmis neptuni*
7. Scutal basal lobe narrow and basal part of carina forked·*Octolasmis angulata*
 Scutal basal lobe broad, oblong·*Octolasmis cor*

Octolasmis warwickii Gray, 1825 斧板茗荷



Fig. 5. *Octolasmis warwickii*, Bozihliao, Yunlin County, 13 April 2009. Side view showing the arrangement of plates.

Octolasmis warwickii Gray, 1825: 100.—Zevina & Tarasov, 1963: 77, fig. 1.—Wu, 1967: 274.—Zevina, 1968: 36.—Liu & Ren, 1985: 247, fig. 38.

Dichelaspis warwickii Darwin, 1851: 120, pl. 2, figs. 6, 6a, b.—Annandale, 1909a: 110.

Dichelaspis warwicki Aurivillius, 1894: 15, pl. 8, figs. 26, 27.—Gruvel, 1905: 124, fig. 141.

Dichelaspis equina Lanchester, 1902: 375, pl. 35, figs. 7-7d.—Annandale, 1906a: 139.

Octolasmis warwicki Barnard, 1924: 58.—Nilsson-Cantell, 1925: 18, figs. 6, 7.—1928: 18.—1934b: 40, fig. 3.—Hiro, 1937a: 89, fig. 72.—1937b: 478.—Broch, 1947: 15, fig. 3.

Material examined.—Dasi fishing port, Yilan County, on crab *Myra fugax*, 3 Sep 1998: 2 specimens (CL5.3-6.5 mm, CW3.3-4.5 mm) (NMNS 004323-00006).—Bozihliao fishing port, Yunlin County, on crab *Charybdis japonica*, 13 Apr 2009: 2 specimens (CL 6.42-7.91 mm, CW 4.69-5.03 mm, PL 4.32-4.87 mm) (CEL-BB-122).

Diagnosis.—Capitulum 5-plated, oval, apex produced. Scutum divided into 2 portions at rostral angle, 1 portion triangular and the other L-shaped and narrow; tergum axe-shaped (see Liu & Ren, 2007) and notched at basal margin; carina curved and divided into 2 parts in basal region; peduncle naked and cylindrical. Mandible with 4 teeth excluding interior angle; maxillae slightly notched, 2 large and 1 smaller setae above notch and about 8 setae below notch; caudal appendage 3-segmented, short, not extending beyond 1st segment of basipod of cirrus VI.

Size.— CL to 8 mm.

Coloration.— When fresh, capitulum brown, when preserved in ethanol, capitulum turns white.

Habitat.— This species is epibiotic on surfaces of decapod crustaceans.

Distribution.— Indo-West Pacific.

Octolasmis nierstraszi (Hoek, 1907)

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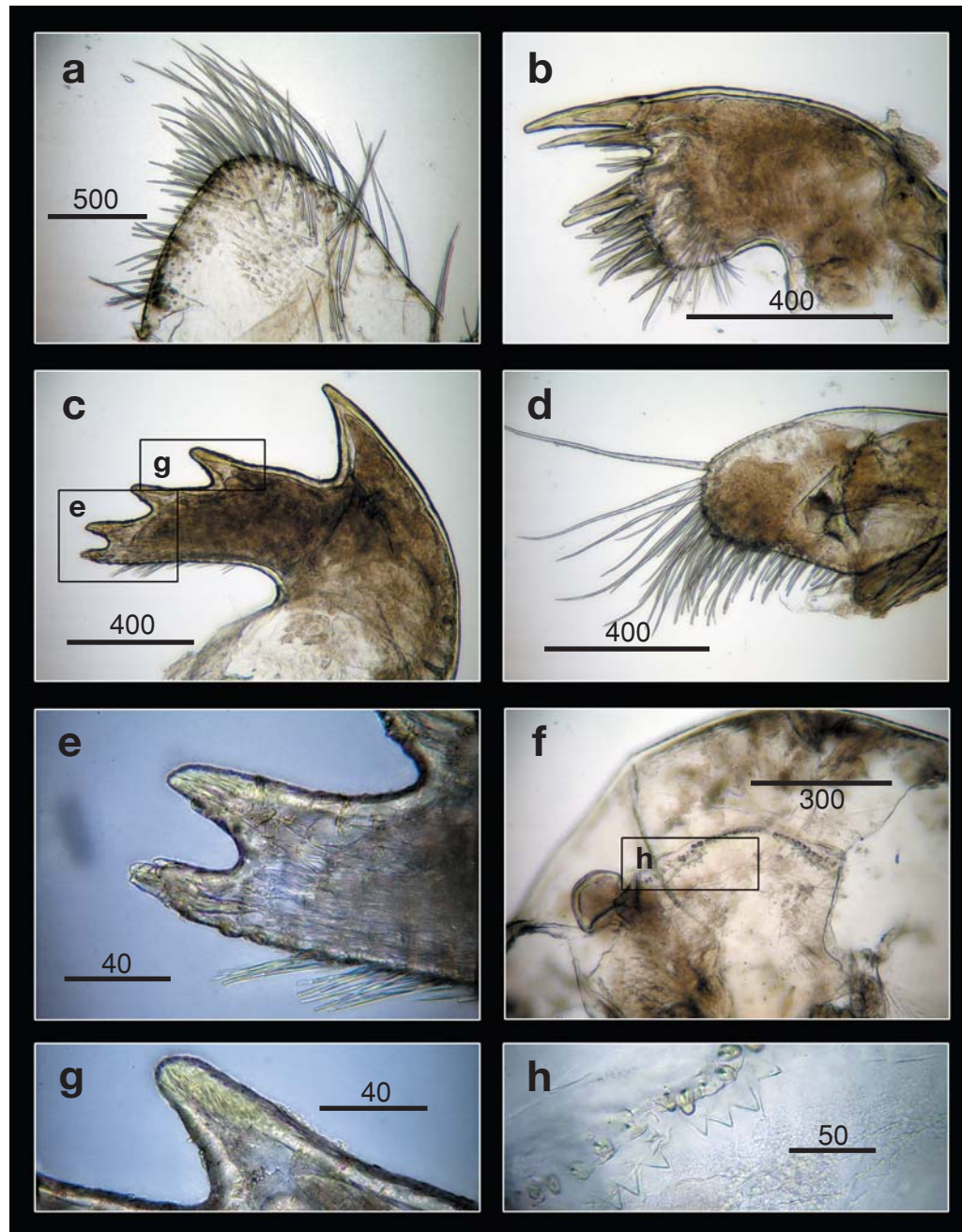


Fig. 6. *Octolasmis warwickii*, Dasi fishing port, Yilan County, 3 Sep 1998. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the teeth of labrum. Scale bars in µm.



Fig. 7. *Octolasmis nierstraszi*, Jhongyun, Kaohsiung County, 24 Feb 2000. Side view showing the opercular plates.

Dichelaspis nierstraszi Hoek, 1907: 21, pl. 2: figs. 1-7.

Dichelaspis (Octolasmis) nierstraszi.—Stubbings, 1936: 8.

Octolasmis nierstraszi.—Nilsson-Cantell, 1921: 268.—1927: 762.—1934a: 42.—1934b: 60.—Broch, 1931: 40, fig. 15.—Hiro, 1937b: 414.—Zevina, 1982: 66, text-fig. 58.—Rosell, 1991: 26, fig. 3e.—Liu & Ren, 1985: 248, fig. 39.

Material examined.—Jhongyun, Kaohsiung County, on gorgonium, 10-20 m, 24 Feb 2000: 2 specimens (CL 4.2-5.2 mm, CW 2.4-2.7 mm) (NMNS 003328-00017).

Diagnosis.—Capitulum flattened, oval, apex produced. Scutum composed of 2 separate portions, divided at rostral angle, occludent portion triangular and inner portion L-shaped; tergum narrow, wider than high, notched in basal region; carina strongly curved, and divided into 2 portions in basal region, basal portion L-shaped. Peduncle cylindrical and naked. Mandible with 4 teeth excluding inferior angle; maxillule notched, 3 setae above and 7 setae below notch, notch wide. Caudal appendage short, single-segmented, not extending beyond 1st segment of basipod of cirrus VI. Penis

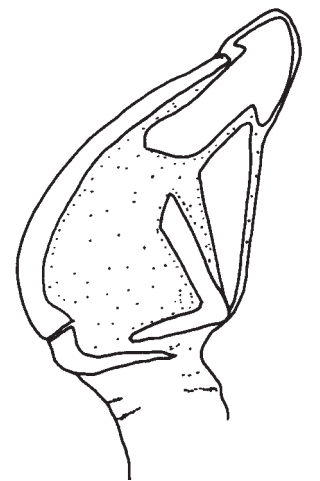


Fig. 8. *Octolasmis nierstraszi*, Jhongyun, Kaohsiung County, 24 Feb 2000. Line drawing of the side view of the capitulum.

short and thick, terminating in a bundles of setae.

Size.—CL to 6 mm.

Coloration.—Capitulum pale-yellow.

Habitat.—Attaches onto gorgonian corals.

Distribution.—Indo-West Pacific from East Africa to Japan.

Remarks.—New record for Taiwan.

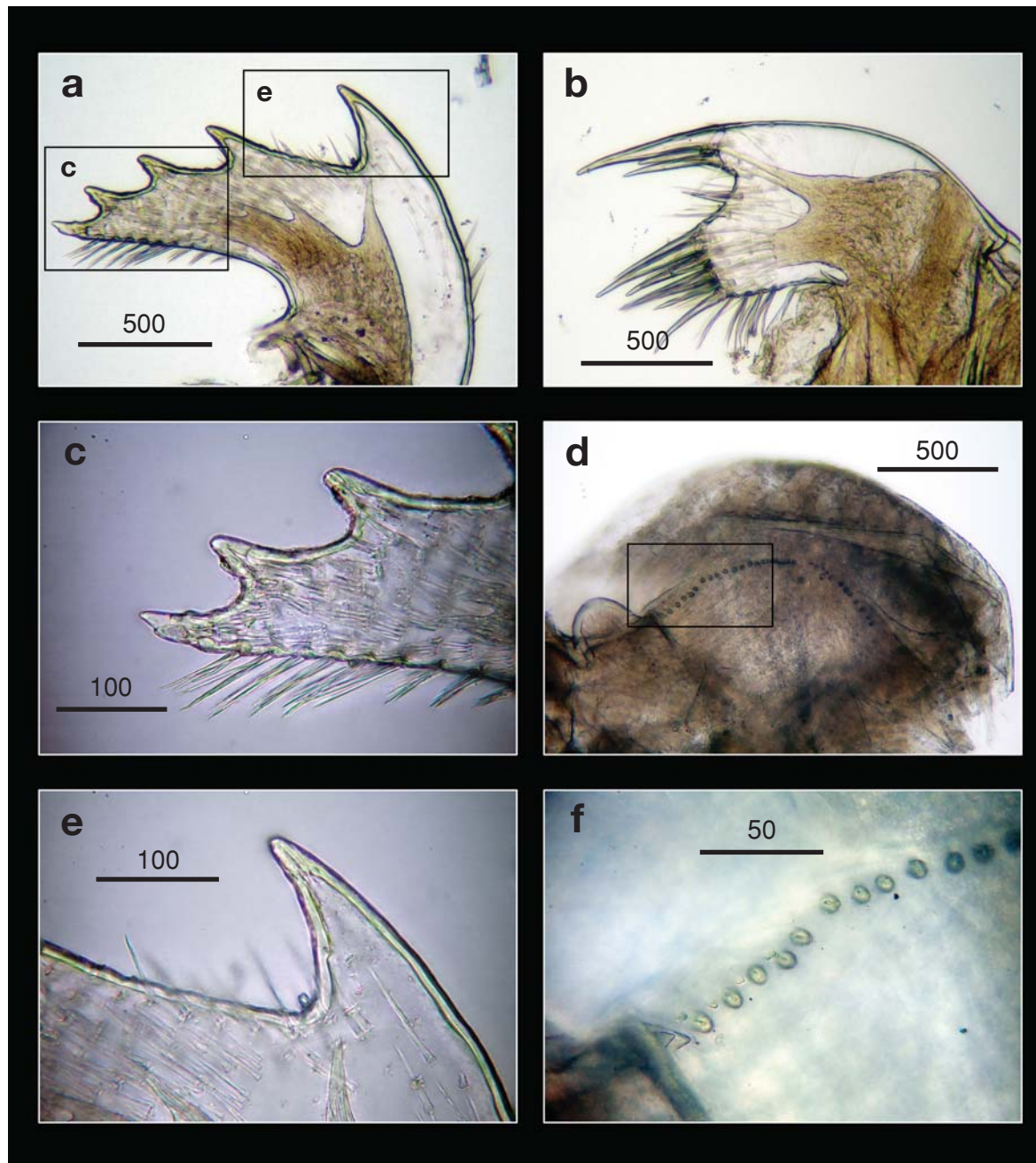


Fig. 9. *Octolasmis nierstrazi*, Jhongyun, Kaohsiung County, 24 Feb 2000. Light microscopy on the mouth parts. a. Mandible, b. Maxillule, c. Inferior angle of mandible, d. Labrum, e. Teeth on mandible, f. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in µm.

Octolasmis orthogonia (Darwin, 1851)

直板茗荷



Fig. 10. *Octolasmis orthogonia*, Jhongyun, Kaohsiung County, 24 Feb 2000. Side view showing the opercular plates.

Dichelaspis orthogonia Darwin, 1851: 130, pl. 2: fig. 10.—Weltner, 1922: 81.—Gruvel, 1905: 138, fig. 163.—Hoek, 1907: 25, pl. 2, figs. 14-18, pl. 3, figs. 1, 1a, b, 10b.

Dichelaspis versluysi Hoek, 1907: 28, pl. III, figs. 8-13.

Dichelaspis weberi Hoek, 1907: 26, pl. III, figs. 2-7.

Octolasmis weberi.—Krüger, 1911: 42, pl. 3, fig. 27.—Barnard, 1924: 60.—Hiro, 1933: 58, fig. 17, pl. 2, figs. 6-8.—1937a: 92, fig. 75.—1939b: 206.

Octolasmis orthogonia.—Broch, 1922: 279.—1931: 28.—Nilsson-Cantell, 1925: 21, fig. 8.—1928: 18, fig. 8.—1938: 29.—Hiro, 1933: 55, fig. 16, pl. 2, figs. 5a, 5.—1937a: 91, fig. 71.—1937b: 415.—Zevina, 1968: 36.—1982: 61, fig. 53.—Utinomi, 1970: 342.—Liu & Ren, 1985: 249, fig. 40, pl. 9: 3-10.—Rosell, 1991: 26, fig. 3a.—Liu & Ren, 2007: 177, fig. 69.

Material examined.—Jhongyun, Kaohsiung County, on gorgonian, 10-20 m, 24 Feb 2000: 5 specimens (CL 8.5-10.2 mm, CW 3.9-5.1mm) (NMNS 003328-00017).

Diagnosis.—Capitulum oval, with 5 valves, orangish-yellow. Scutum narrow and L-shaped; tergum triangular, with 3 prominent ridges at scutal margin; 3rd ridge

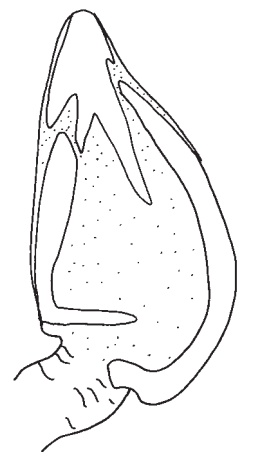


Fig. 11. *Octolasmis orthogonia*, Jhongyun, Kaohsiung County, 24 Feb 2000. Line drawing showing the side view of capitulum.

longest; carina smooth, base oval. Peduncle yellow and smooth. Maxilla globular; maxillule notched, 2 large setae on upper notch and 5 or 6 setae on lower notch; mandible with 4 major teeth, lacking double dentations; labrum concave, with more than 11 small sharp teeth; mandibulatory palp elongated with fine setae. Cirrus I with sub-equal rami, posterior ramus 5-segmented, anterior ramus 3-segmented; cirri II-VI with rami of similar length, 7- or 8-segmented.

Size.—CL to 13.9 mm.

Coloration.—Capitulum pale-brown to yellow.

Habitat.—Attaches onto gorgonians, urchin spines, and surfaces of the stalked barnacle *Heteralepas japonica*.

Distribution.—Tropical to subtropical oceans.

Remarks.—New record for Taiwan.

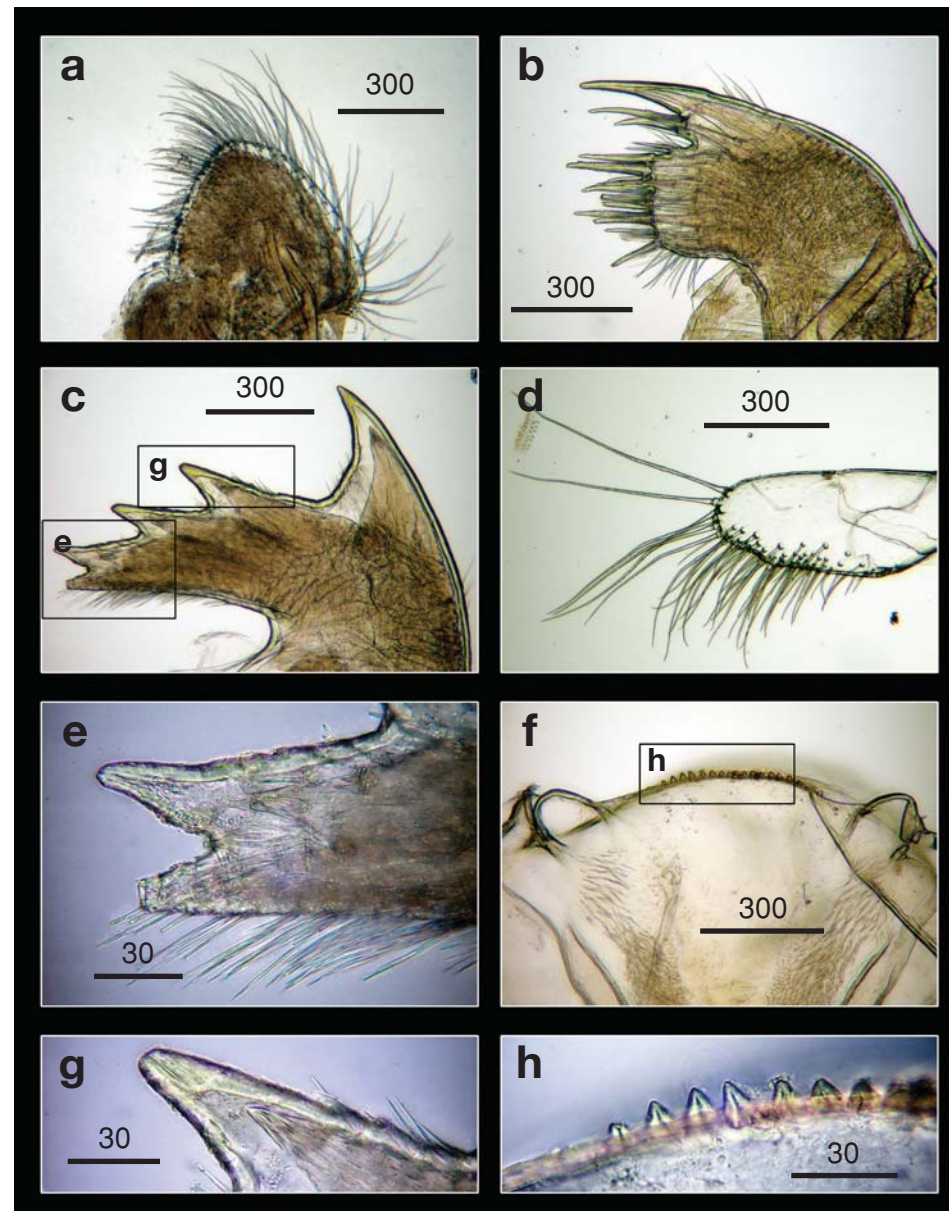


Fig. 12. *Octolasmis orthogonia*, Jhongyun, Kaohsiung County, 24 Feb 2000. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in µm.

Octolasmis cor (Aurivillius, 1892)
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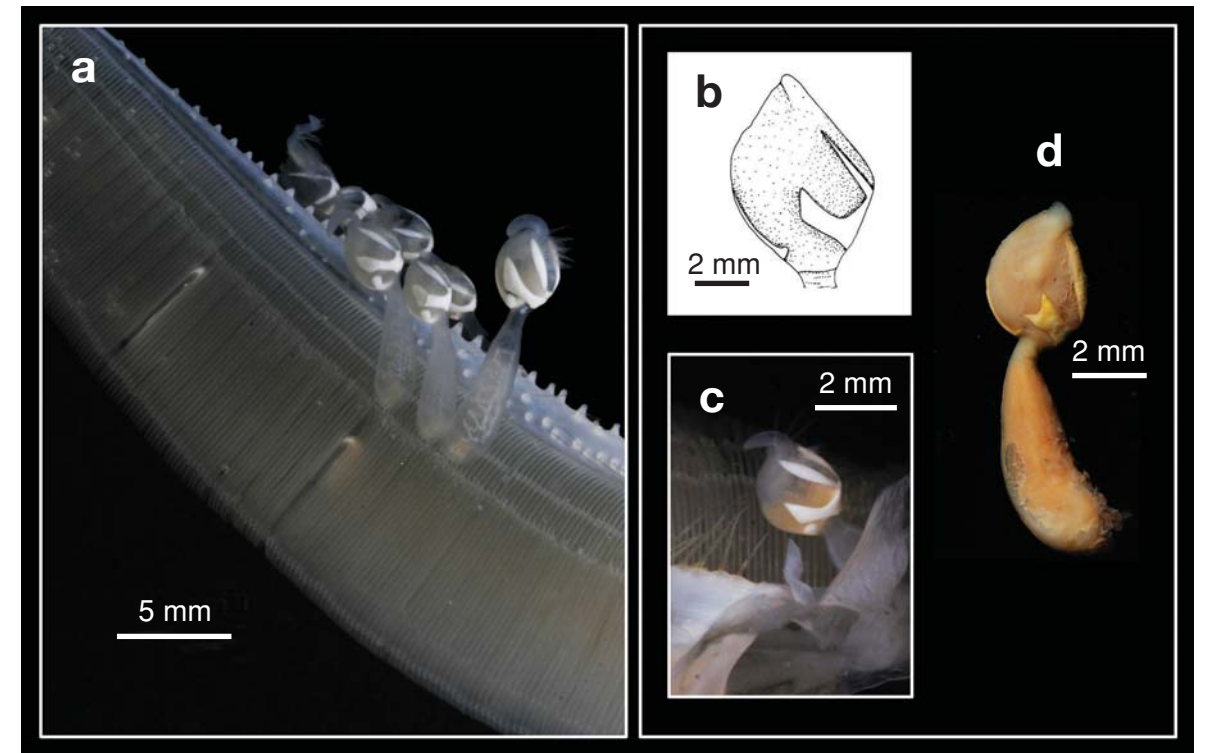


Fig. 13. *Octolasmis cor*, Taipei county. a. A colony of *Octolasmis cor* on the gill filaments of crabs. b. Line drawing of the side view of the capitulum. c. Side view of the capitulum, showing the tergum and scutum. d. Another morphological forms of *Octolasmis cor*, showing the bi-fid scutum.

Dichelaspis cor Aurivillius, 1892: 124 (not seen) [type locality: South Africa].—1894: 20, pl.2, figs. 1-2.—Gruvel, 1905: 136, fig. 158.—Annandale, 1909a: 119, pl. 6, figs. 7-10.

Octolasmis cor.—Stebbing, 1910: 565.—Barnard, 1924: 58.—Newman, 1960: 104, fig. 3.—Zevina, 1968: 40.—1982: 46, fig. 34.—Liu & Ren, 1985: 257, fig. 46.—2007: 185, fig. 74.

Material examined.—Taipei County, on the gill chambers of the crab *Scylla olivacea*, collected at a local fishing market. 46 specimens (CL 1.89-2.51mm, CW 1.62-1.90mm, PL 1.93-4.25mm) (CEL-BB-71).

Diagnosis.—Capitulum oval, with 3 plates, carina T-shaped. Penis thick and tapered at tip. Maxillule notched, with 2 large spines on upper notch. Cirrus I shorter than other cirri; cirri II-VI long and slender.

Size.—CL to 13 mm.

Coloration.—Capitulum pale-yellow.

Distribution.—Epizoid on mangrove crab gills, Indo-Pacific region.

Remarks.—New record for Taiwan.

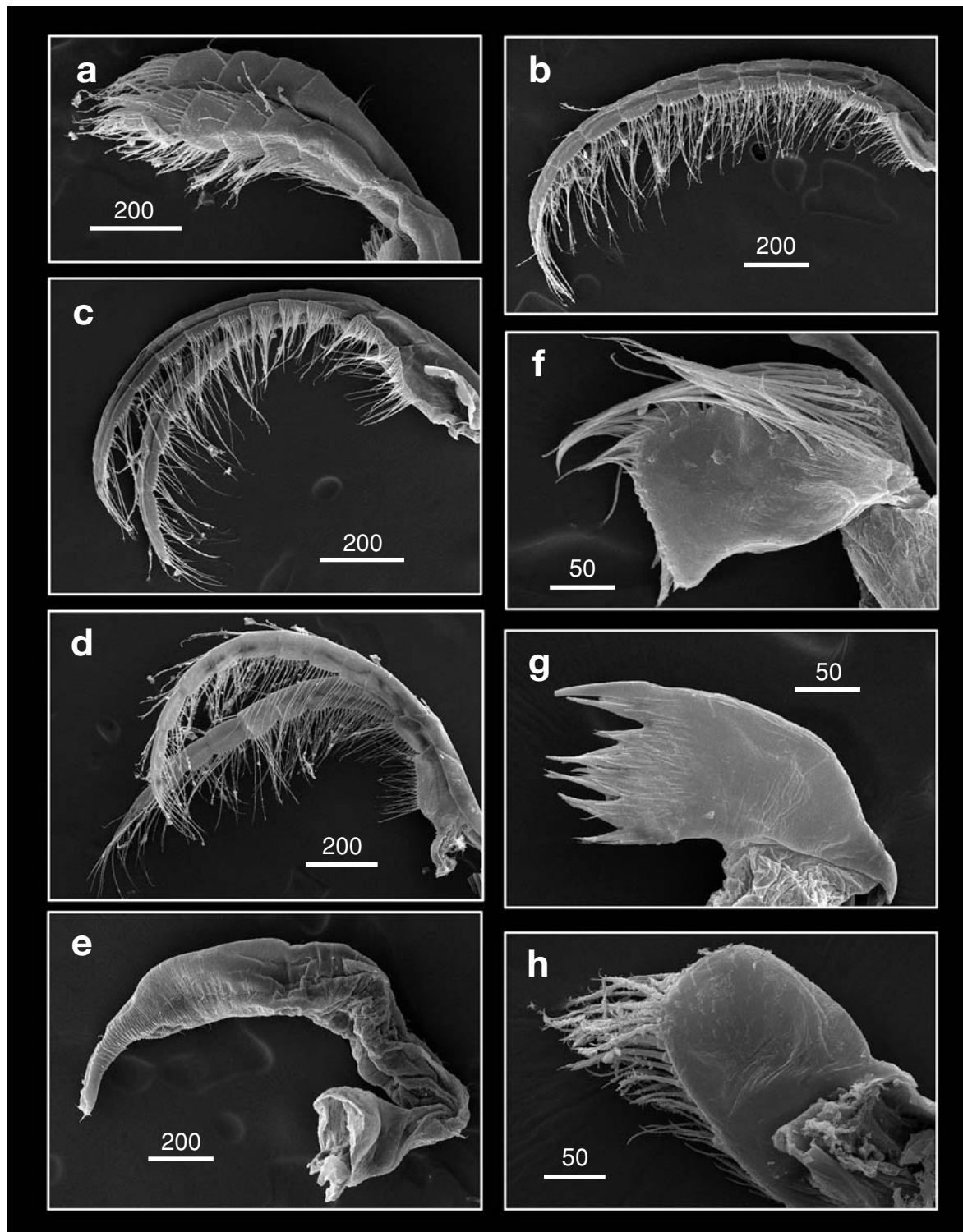


Fig. 14. *Octolasmis cor*, Taipei county. Scanning Electron Microscopy on mouth parts a. Cirrus I, b. Cirrus II, c. Cirrus III, d. Cirrus IV, e. Penis, f. Maxilla, g. Maxillule, h. Mandibulatory palp. Scale bars in µm.

Octolasmis angulata (Aurivillius, 1894)
角板茗荷

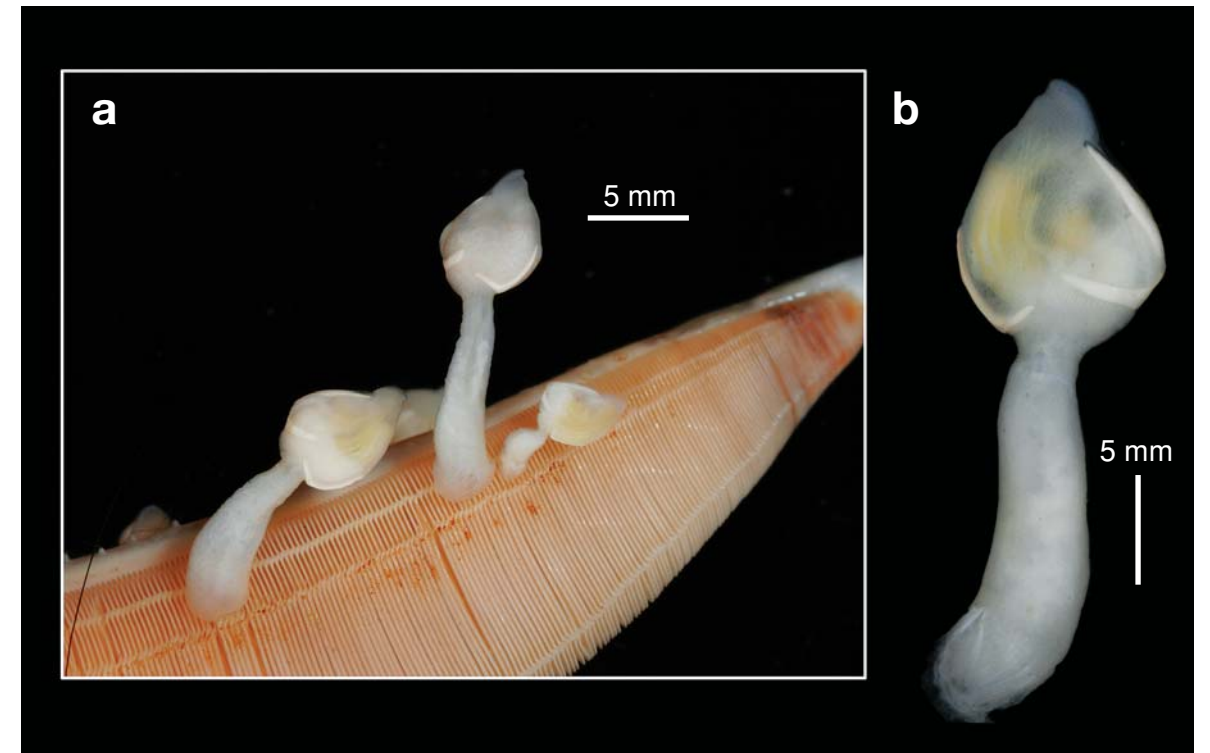


Fig. 15. *Octolasmis angulata*, Bisha fishing market, Keelung City, Jul 2006. a. A colony on a gill filament of crab. b. Side view of the capitulum showing the opercular paltes.

Dichelaspis angulata Aurivillius, 1894: 22, pl. 2, figs. 9-11, pl. 8, figs. 18, 24.—Gruvel, 1905: 138, fig. 162.—Annandale, 1909a: 122.

Dichelaspis aperta Aurivillius, 1894: 24, pl. 1, figs. 14-16.—Gruvel, 1905: 137, fig. 160.

Dichelaspis cuneata Aurivillius, 1894: 25, pl. 1, figs. 17-19.—Gruvel, 1905: 137, fig. 161.

Octolasmis angulata.—Nilsson-Cantell, 1934a: 46, figs. 7-8.—Hiro, 1937b: 426, figs. 17a-d, 18h-j.—Zevina, 1968: 36.—Liu & Ren, 1985: 254, fig. 44.—Liu & Ren, 2007: 182, fig. 72.

Material examined.—Bisha fishing market, Keelung City, on gills of crab *Portunus pelagicus*, Jul 2006: 107 specimens (CL 1.34-2.56 mm, CW 1.24-2.32mm, PL 1.15-4.06 mm) (CEL-BB-14).

Diagnosis.—Capitulum oval and partially calcified, with 3 plates. Tergum lacking; scutum very narrow and L-shaped; carina narrow and expanded in horizontal directions in basal region. Maxilla globular with setae evenly distributed on edge; maxillule narrow, not notched, with 5-7 large cuspidate setae on cutting edge; mandible with 4 teeth excluding inferior

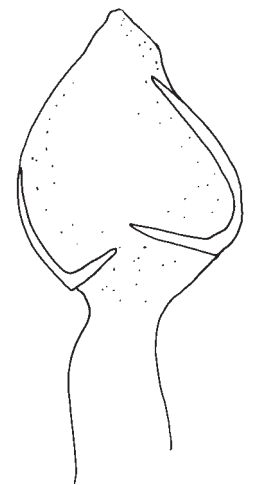


Fig. 16. *Octolasmis angulata*, Bisha fishing market, Keelung City, Jul 2006. Line drawing of the side view of the capitulum.

angle; mandibulatory palp with dense setae; labrum cutting edge short, circular, with 11 large sharp teeth.

Size.—CL to 13.9 mm.

Coloration.—Capitulum pale-brown to yellow.

Habitat.—Attaches onto gills of species of *Portunus* and *Charybdis*.

Distribution.—Tropical to subtropical oceans.

Remarks.—New record for Taiwan.

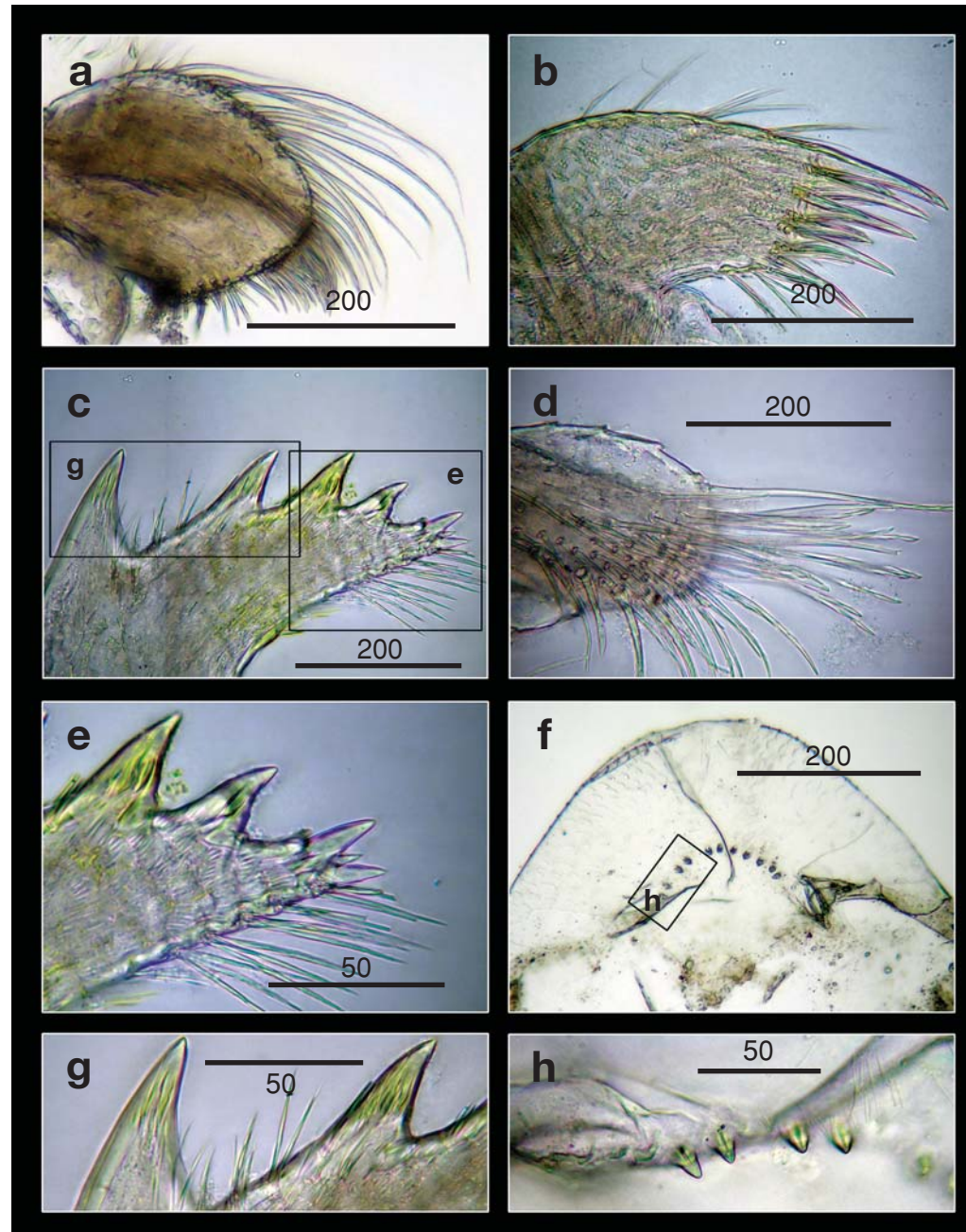


Fig. 17. *Octolasmis angulata*, Bisha fishing market, Keelung City, Jul 2006. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in µm.

Octolasmis neptuni (MacDonald, 1869)

蟹板茗荷

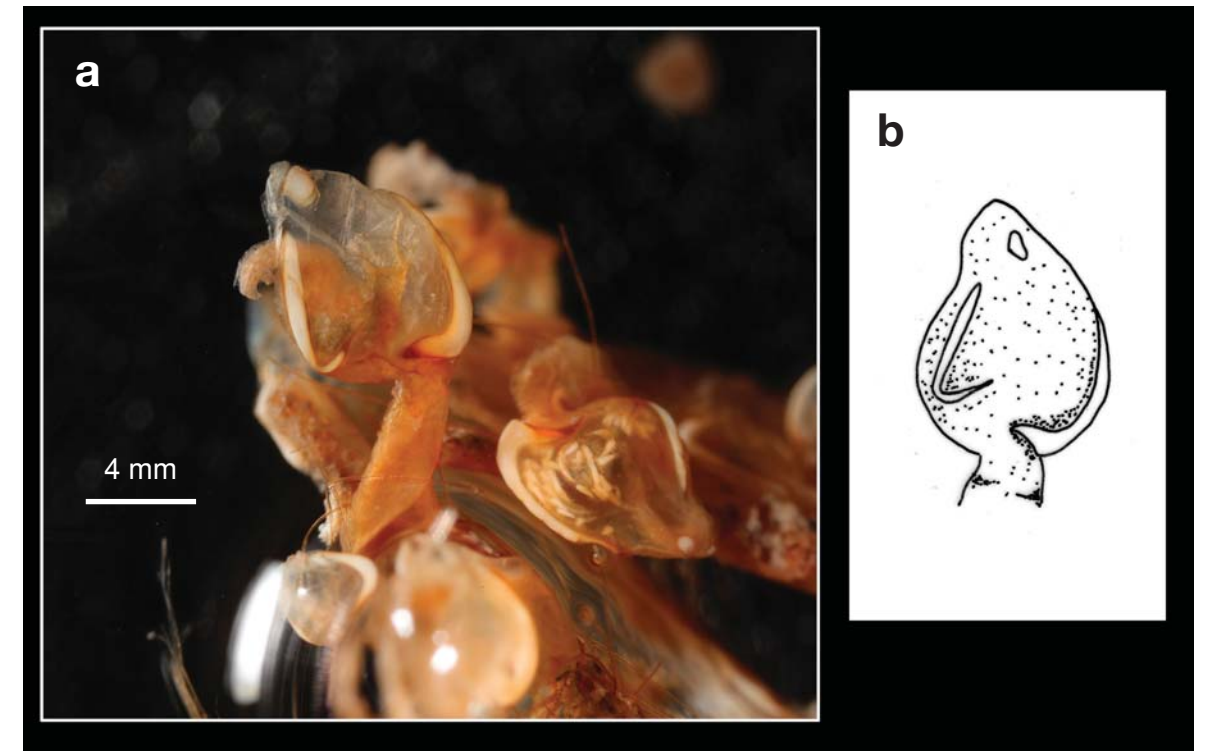


Fig. 18. *Octolasmis neptuni*, fish market, Keelung City, 29 May 1965. a. view of a clump of barnacles on a crab gill. b. line drawing on the side view of the capitulum.

Paradolepas neptuni MacDonald, 1869: 440-442, fig. 1, pl. 33-34 (not seen).

Dichelaspis neptuni.—Gruvel, 1905: 127, fig. 147.

Octolasmis neptuni.—Barnard, 1924: 60.—Utinomi, 1970: 343, fig. 1

Octolasmis neptuni neptuni.—Newman, 1961: 100-102, pl. 21, figs. 1-9.—Wu, 1967: 276, fig. 2.

Material examined.—Fish market, Keelung City, 29 May 1965: >50 specimens, on crab gills (ASIZCR000160).

Diagnosis.—Capitulum ovoid, with 3 incomplete calcified plates. Tergum small, triangular; scutum L-shaped, ending in a very sharp point, carina curved with forked basal area.

Size.—CL to 5 mm.

Coloration.—Capitulum milky-white, plates white.

Distribution.—Yellow Sea, South China Sea, Australia, South Africa.

Octolasmis lowei (Darwin, 1851)

樓氏板茗荷

Dichelaspis lowei Darwin, 1851: 128, pl. 2, fig. 8.

Octolasmis lowei Nilsson-Cantell, 1927: 766, fig. 10.—

1938: 11.—Newman, 1960: 106, fig. 4.—Zevina, 1982: 59, fig. 50.

Material examined.—Formosa (Nilsson-Cantell, 1938).

Diagnosis.—Capitulum with 5 plates. Tergum U-shaped, carina and scutum L-shaped; scutum not ending in a sharp point.

Size.—CL to 5 mm.

Coloration.—Capitulum pale-yellow, plates white.

Distribution.—Taiwan, Japan, Malay Archipelago, Australia, Indo-Pacific.

Remarks.—We have not yet collected this species in Taiwan.

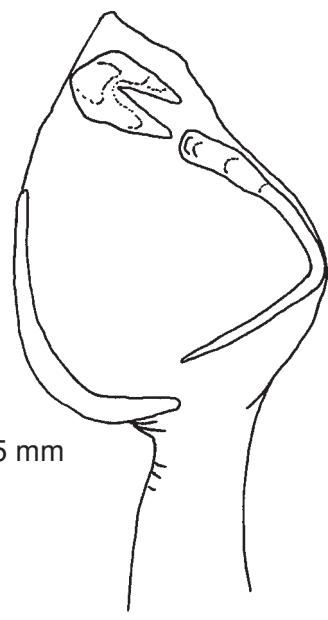


Fig. 19. *Octolasmis lowei*, Kapingamarangi Atoll, Micronesia. Redrawn from Newman (1960).

Octolasmis scuticosa Hiro, 1939

楯肋板茗荷

Octolasmis scuticosa Hiro, 1939a: 238, fig. 1.—1939d: 249.

Material examined.—Su-ao, Yilan County, 29 May 1938 on maxillipeds of *Ranina ranina* (data from Hiro, 1939d).

Diagnosis.—Capitulum with 5 moderately developed plates. Scutum large and composed of 2 branches, 1 narrow branch at occludent margin and another broad branch in basal region; tergum quadrangular, carinal narrow and bowed, with a long spatulate disc at base.

Size.—CL to 5 mm (Hiro, 1939a).

Coloration.—Integument orange but fades out when preserved in ethanol.

Habitat.—On crabs.

Distribution.—Japan, Taiwan.

Remarks.—We have not yet collected this species in Taiwan.



Fig. 20. *Octolasmis scuticosa*, Tanabe Bay, Japan. Redrawn from Hiro (1939d).

Genus *Poecilasma* Darwin, 1851
花茗荷屬

Poecilasma Darwin, 1851: 99.—Aurivillius, 1894: 9.—Gruvel, 1905: 113.—Hoek, 1907: 3.—Annandale, 1909a: 90.—Nilsson-Cantell, 1921: 254.—Broch, 1931: 28.—Hiro, 1937a: 82.—1937b: 408.—Newman et al., 1969: 279. Type species *Poecilasma kaempferi* Darwin, 1851.

Diagnosis.—Hermaphroditic, capitulum with 5 fully calcified plates. Umbo of scuta and carina basal; carina narrow not extending beyond terga. Filamentary appendages absent; caudal appendages short, 1-segmented. Peduncles naked.

Remarks.—2 species of *Poecilasma* have been recorded in Taiwanese waters, and they are new records for Taiwan (see Cai et al., in press).

Key to species of *Poecilasma* from Taiwan

- 1. Occludent margin of scutum convex, area in front of the occludent ridge running to the apex wide *Poecilasma litum*
- Occludent margin of scutum less convex, area in front of the occludent ridge running to the apex narrow *Poecilasma kaempferi*

***Poecilasma litum* Pilsbry, 1907**
杖花茗荷



Fig. 21. *Poecilasma litum*, Dasi fishing port, Yilan County, 17 Nov 1998. Capitulum, side view.

Poecilasma kaempferi litum Pilsbry, 1907a: 85, pl. 6, figs. 1-2.—Annandale, 1909a: 91.—Zevina, 1972: 61.

Poecilasma kaempferi var. *litum*.—Krüger, 1911: 36, figs. 68-71, pl. 3, figs. 24-25.

Poecilasma litum.—Liu & Ren, 1985: 234, fig. 29.

Material examined.—Dasi fishing port, Yilan County, on crab, 17 Nov 1998: 3 specimens (CL 9.36-11.39 mm, CW 5.79-6.62 mm, PL 3.00-4.23 mm) (NMNS 003031-00047).

Diagnosis.—Capitulum oval, flattened, with 5 plates, surfaces of plates with faint striations and growth lines. Tergum triangular and narrow; scutum oval, higher than wide, occludent margin protruding and area in front of occludent ridge to apex wide; carina very narrow,

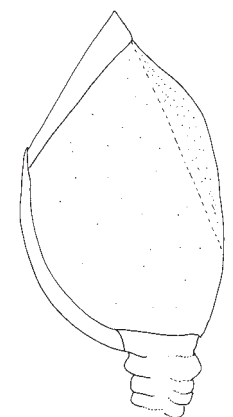


Fig. 22. *Poecilasma litum*, Dasi fishing port, Yilan County, 17 Nov 1998. Line drawing of the side view of the capitulum.

straight, base not extending in horizontal direction. Mandible with 4 teeth excluding inferior angle; maxillule weakly notched, 3 cuspidate setae above notch. Caudal appendage short, not longer than basal segment of basipod of cirrus VI.

Size.—CL to 15 mm.

Coloration.—Capitulum white, peduncle yellow to orange.

Habitat.—Attaches onto surfaces of decapod crustaceans.

Distribution.—Pacific and Caribbean waters.

Remarks.—New record for Taiwan.

Poecilasma kaempferi Darwin, 1851

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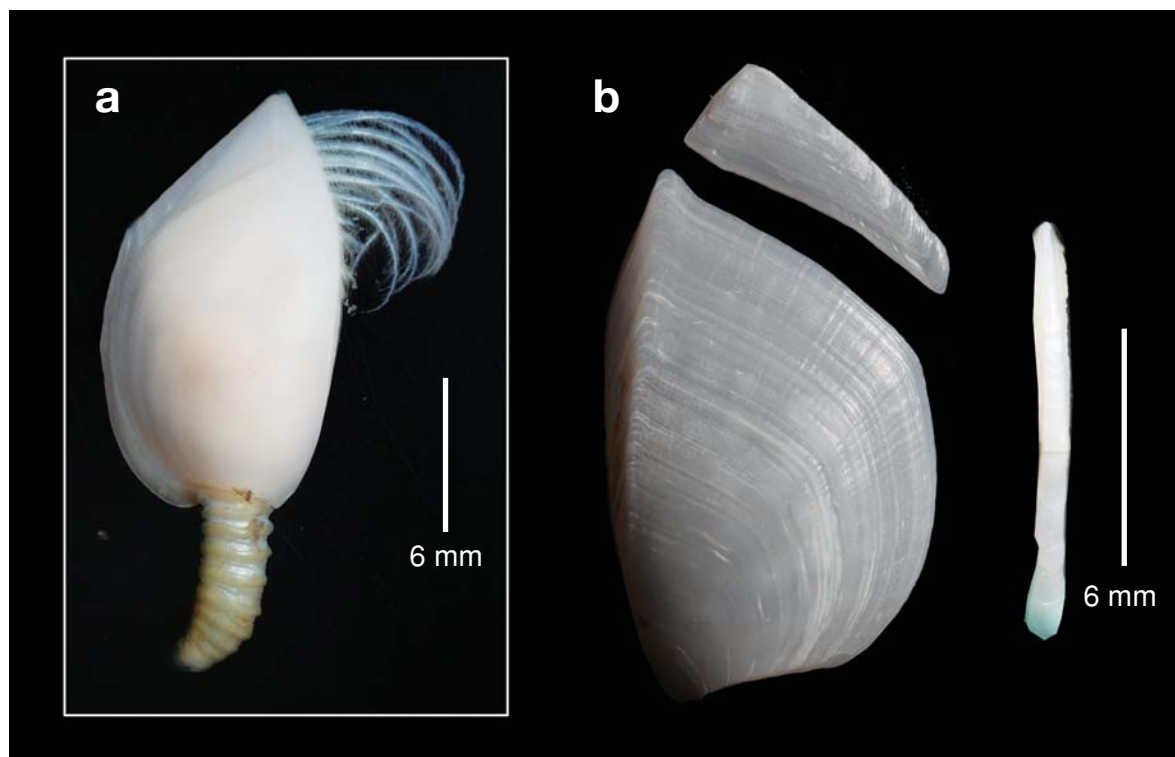


Fig. 23. *Poecilasma kaempferi*, Dasi fishing port, Yilan County, 17 Nov 1998. a. Side view of capitulum. b. The capitular plates, showing the tergum, scutum and carina.

Poecilasma kaempferi Darwin, 1851: 102, pl. 2, fig. 1.

Poecilasma aurantia Darwin, 1851: 105, pl. 2, fig. 2.

Poecilasma kaempferi.—Gravel, 1905, pl. 114.—Pilsbry, 1907a: 84, pl. 5, figs. 10, 11, pl. 6, figs. 3-5.—1907b: 183.—Annandale, 1909a: 90 (in part).—Krüger, 1911: 36.—Nilsson-Cantell, 1921: 254, fig. 46.—1927: 761, fig. 8.—Weltner, 1922: 79.—Broch, 1922: 270.—Barnard, 1924: 51.—Gordon, 1970: 57, fig. 19.—Liu & Ren, 1985: 232, fig. 28.

Poecilasma dubium Hoek, 1907: 6, pl. 1, figs. 2-4, pl. 10, figs. 1a-d.

Poecilasma kaempferi novaeangliae Pilsbry, 1907a: 85, pl. 6, figs. 13, 14.

Poecilasma inaequilaterale Pilsbry, 1907a: 85, pl. 6, 7, 11, 12.

Poecilasma kaempferi var. *dubium* Krüger, 1911: 37, fig. 26, figs. 72-76, pl. 3.

Poecilasma kaempferi forma *eu-kaempfer* Broch, 1931: 29.—Hiro, 1933: 54.

Poecilasma (*Poecilasma*) *kaempferi*.—Hiro, 1937a: 82, fig. 37.—1937b: 408.—Stubbings, 1967: 241.—Foster, 1978: 24

Material examined.—Dasi fishing port, Yilan County, 17 Nov 1998: 5 specimens (CL 8.60-12.24 mm, CW 5.21-7.29 mm, PL 6.16-7.15 mm) (NMNS 003031-00047).—Dasi fishing port, Yilan County, 22 Feb 2000: 1 specimen (CL 18.45 mm, CW 10.68 mm, PL 4.53 mm) (NMNS 003328-00044).—Pengjiayu, Keelung City,

14 May 1998: 19 specimens (CL 8.57-15.53 mm, CW 5.47-9.13 mm, PL 4.87-8.92 mm) (CEL-BB-58).

Diagnosis.—Capitulum oval, with 5 plates, plate surfaces smooth with faint striations. Scutum oval, higher than wide, occludent margin not strongly protruding and area from occludent ridge to apex narrow; carina very narrow, straight, base not extending in horizontal direction. Mandible with 4 teeth excluding inferior angle; maxillule notched, 3 cuspidate setae above notch. Caudal appendage short, not longer than basal segment of basipod of cirrus VI.

Size.—CL to 10 mm.

Coloration.—Capitulum white and peduncle pale-yellow.

Habitat.—Attaches onto decapod crustaceans.

Distribution.—Cosmopolitan, tropical and subtropical oceans.

Remarks.—New record for Taiwan.

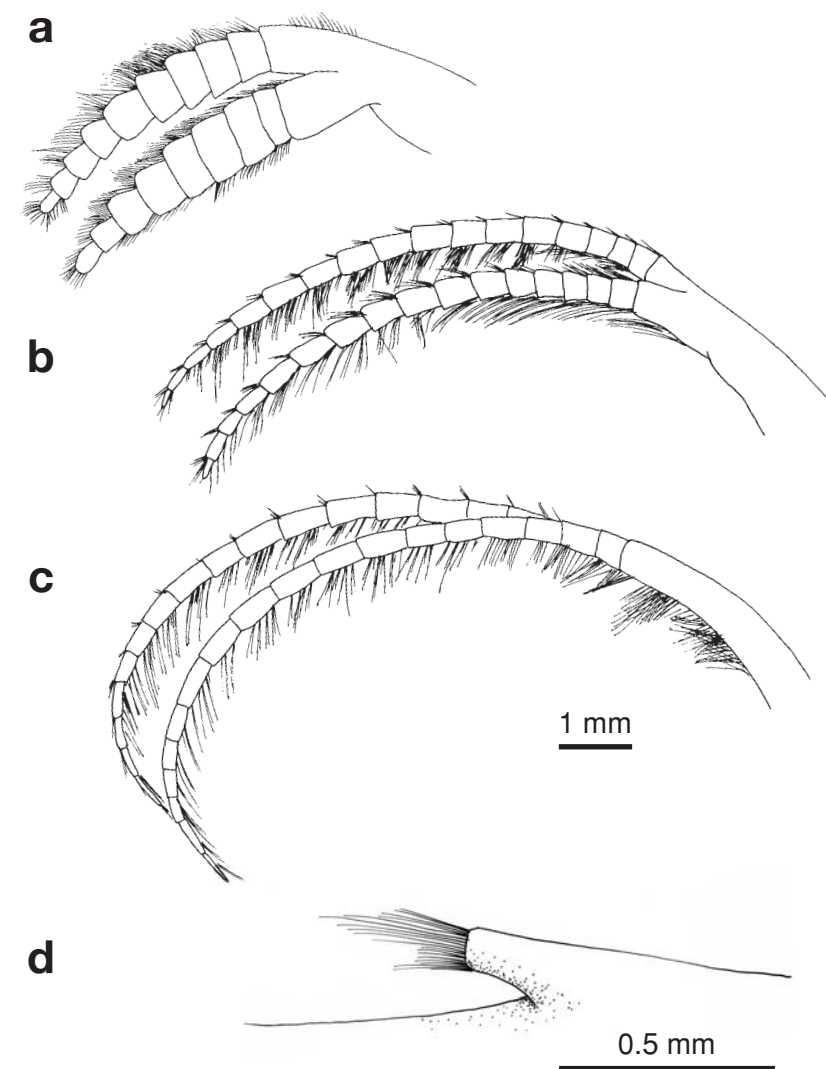


Fig. 24. *Poecilasma kaempferi*, Dasi fishing port, Yilan County, 17 Nov 1998. Line drawing of a. Cirrus I, b. Cirrus II, c. Cirrus VI and d. Caudal appendage.

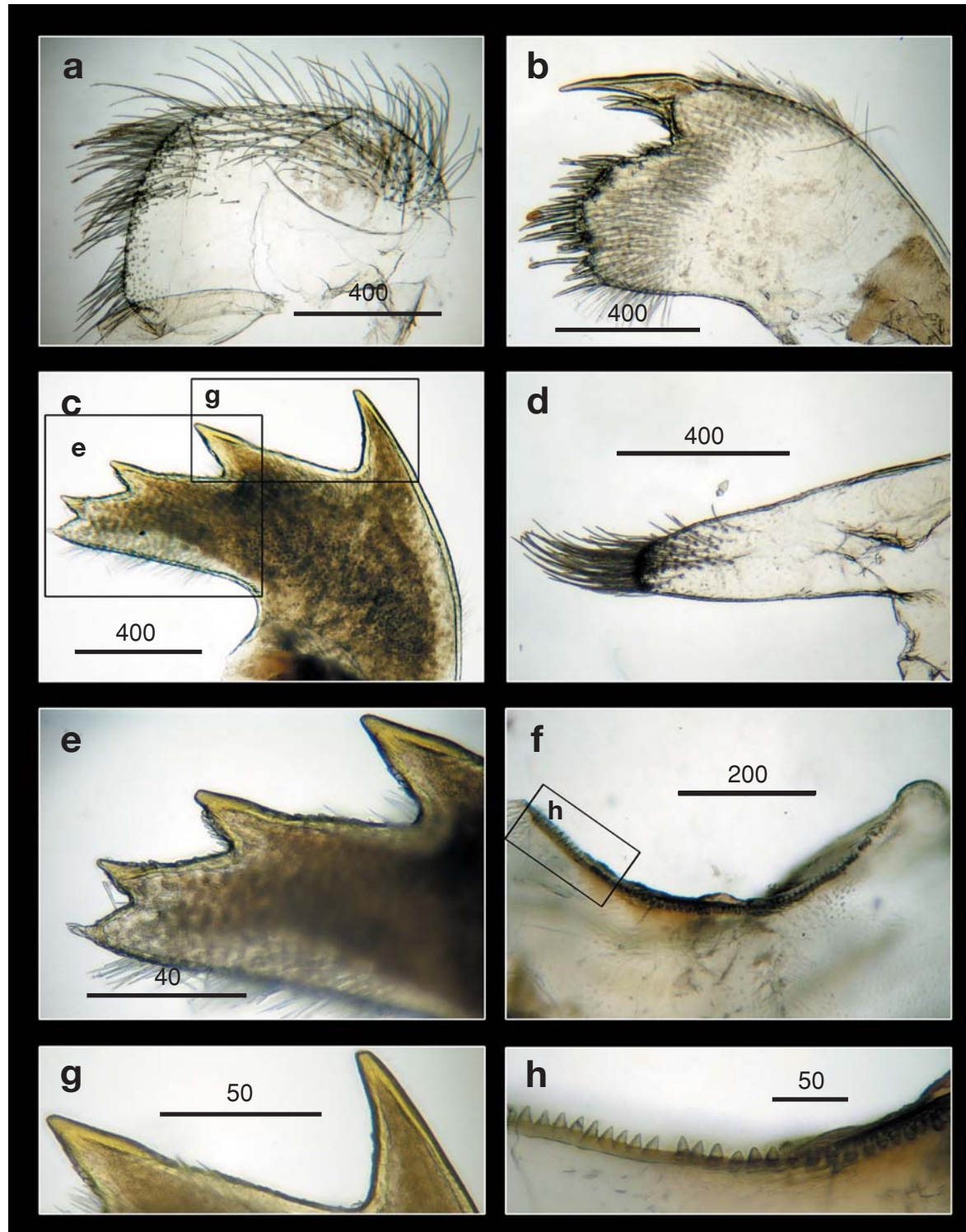


Fig. 25. *Poecilasma kaempferi*, Dasi fishing port, Yilan County, 17 Nov 1998. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Genus *Megalasma* Hoek, 1883

大茗荷屬

Megalasma Hoek, 1883: 50.—Hiro, 1937a: 99.—Newman et al., 1969: 280.—Zevina, 1982: 78.—Liu & Ren, 1985: 257.—Liu & Ren, 2007: 159. Type species *Megalasma striatum* Hoek, 1883.

Diagnosis.—Capitulum with 5 calcified plates, closely packed, surface striated or smooth, basal region of carina extended horizontally; scutum triangular or subtriangular, umbo far distant from rostral angle. Peduncle short and naked; mandible with 4 teeth excluding inferior angle; caudal appendage uniarticulate and short.

Remarks.—In a review by Zevina (1982), there are 4 species of *Megalasma*. In Taiwan, we recorded 2 species, and these are new records for Taiwan (see Cai et al., in press).

Key to species of the *Megalasma* from Taiwan

1. Capitular plates white and strongly striated *Megalasma striatum*
- Capitular plates white and surface relatively smooth, with faint lines *Megalasma minus*

Megalasma striatum Hoek, 1883
紋大茗荷

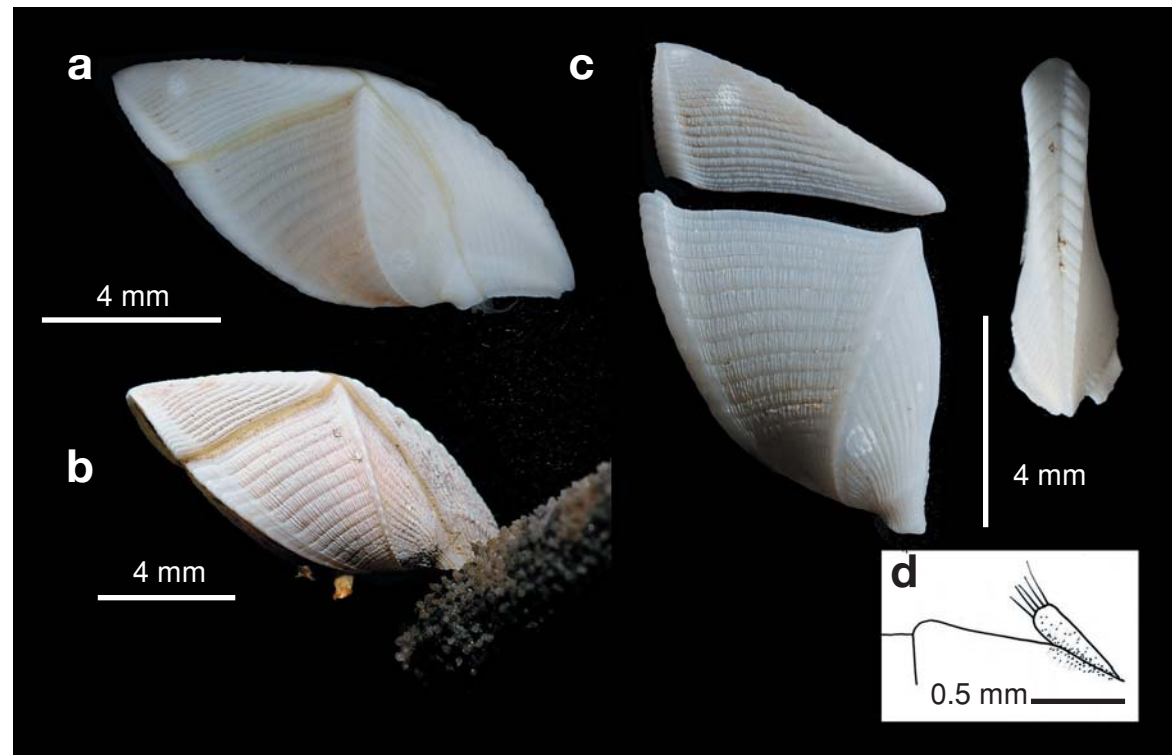


Fig. 26. *Megalasma striatum*, Donggang fishing port, Pingtung County, Jul 2001. a., b. Side view of the capitulum. c. Capitular plates showing the tergum, scutum and carina. d. Line drawing of the caudal appendage.

Megalasma striatum Hoek, 1883: 51, pl. 2, figs. 5-9, pl. 7, figs. 8-9 [type locality: the Philippines].—1907: 3.—Gruvel, 1905: 112, fig. 126.—Broch, 1922: 271, figs. 29, 30.—1931: 33.—Hiro, 1937a: 99, fig. 81.—Nilsson-Cantell, 1938: 29.—Utinomi, 1958: 292, fig. 4.—Foster, 1978: 27, pl. 3c.—Liu & Ren, 1985: 258, fig. 47.

Megalasma (Megalasma) elegans Zullo & Newman, 1964: 355, figs. 2a-i.

Material examined.—Donggang fishing port, Pingtung County, on spine of sea urchin *Stylocidaris reini*, 3 July 2001: 4 specimens (NMNS 003624-00004).—Donggang fishing port, Pingtung County, 3 specimens (NMNS 003328-00075).—Donggang fishing port, Pingtung County, 200 m, 26 Apr 2001: 5 specimens (CL 7.0-11.5 mm, CW 3.5-5.5 mm) (NMNS 003636-00003).—Donggang fishing port, Pingtung County, 250 m, 8 Dec 1999: 4 specimens (CL 4.2-9 mm, CW 3.3-6 mm) (NMNS 003275-00003).—Donggang fishing port, Pingtung County, 200 m, 3 July 2001: 2 specimens (CL 14-15.5 mm, CW 6-8.0 mm) (NMNS 003624-00003).—Donggang fishing port, Pingtung County, 2 Jan 2002: 10 specimens (CL 8.5-11.0 mm, CW 4.2-5.5 mm) (NMNS 003736-

00002).—Donggang fishing port, Pingtung County, 19 Nov 1998: 2 specimens (CL 2.55-9.87 mm, CW 1.18-5.43 mm) (NMNS 003031-00054).

Diagnosis.—Capitulum white with 5 plates, plates closely packed, plate surfaces strongly striated; peduncle short and naked. Scutum triangular, basal margin and occludent margin forming a straight line; tergum triangular, occludent and scutal margins almost forming a right angle; carina short and spoon-shaped, basal region expanded horizontally. Maxilla flattened and margin with dense setae; maxillule slightly notched, with 2 cuspidate setae above notch and at least 15 setae below notch, notch region with 6-8 setae; mandibles with 4 sharp teeth excluding interior angle, teeth simple, lower margin short; mandibulatory palp triangular with dense setae on superior region; labrum concave with sharp teeth, teeth simple or bidentated.

Size.—CL up to 13 mm.

Coloration.—Capitulum white, peduncle pale-yellow.

Habitat.—Attaches onto spines of sea urchins.

Distribution.—Indo-Pacific region.

Remarks.—New record for Taiwan.

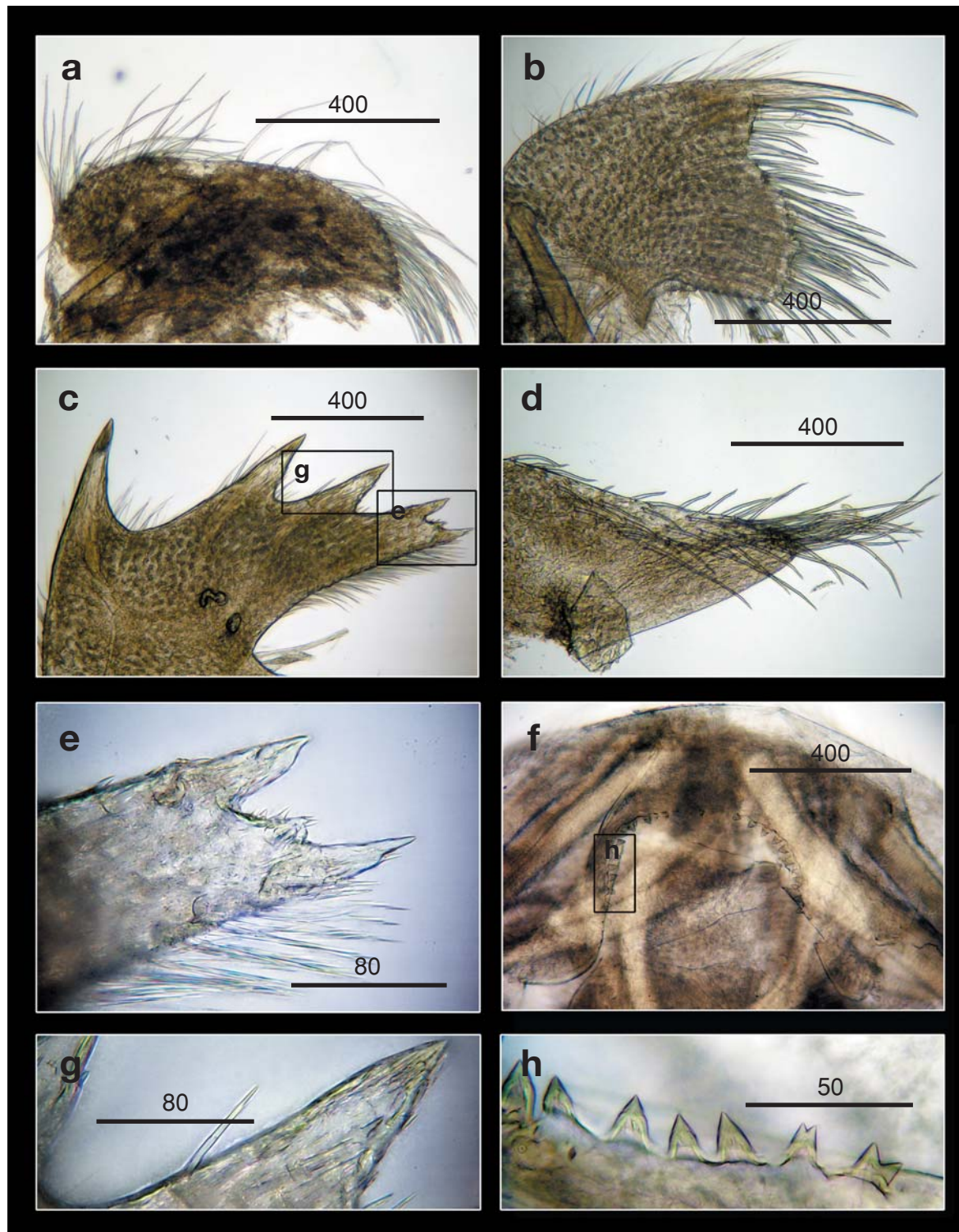


Fig. 27. *Megalasma striatum*, Donggang fishing port, Pingtung County, Jul 2001. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Megalasma minus (Annandale, 1906)
平滑大茗荷

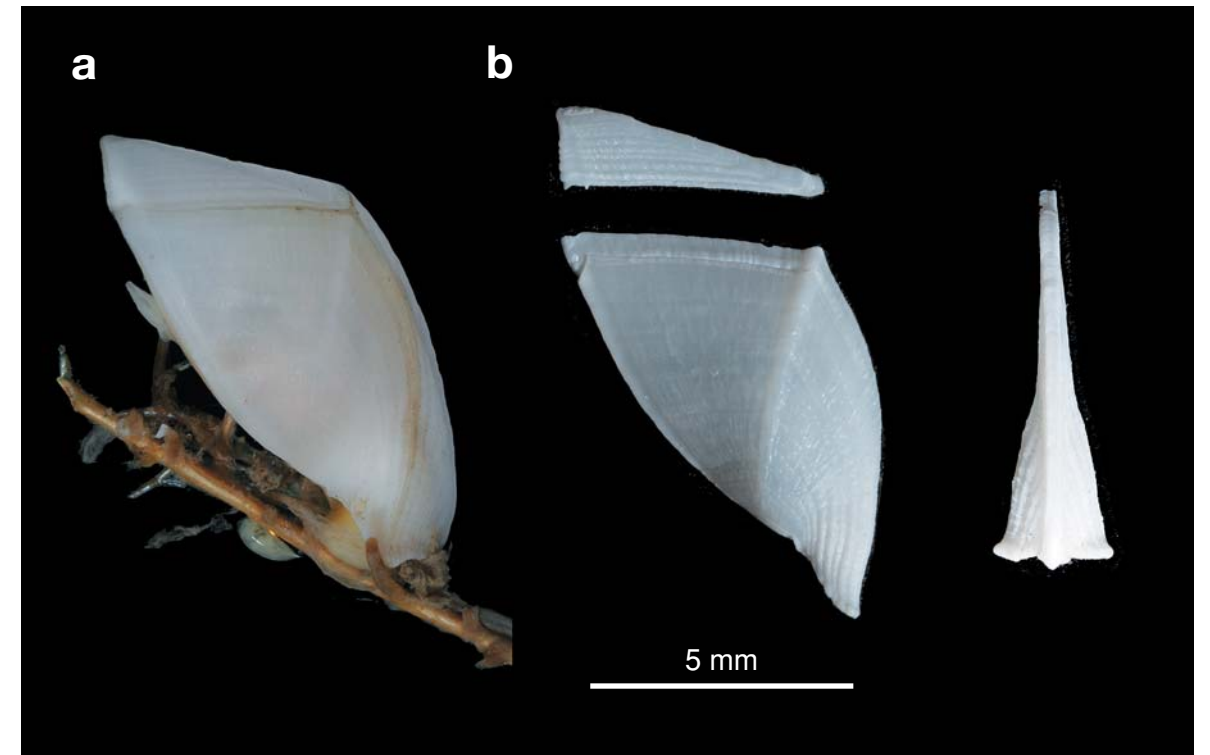


Fig. 28. *Megalasma minus*. CD132, 21 Nov 2001. a. Side view of the capitulum. b. Capitular plates showing the scutum, tergum and carina.

Megalasma striatum minus Annandale, 1906b: 399.

Megalasma bellum Pilsbry, 1907a: 93.

Poecilasma bellum.—Pilsbry, 1907b: 183, pl. IV, fig. 6.

Megalasma lineatum Hoek, 1907: 31, pl. IV, figs. 1-8.

Megalasma minus race I, II Annandale, 1909a: 96.

Megalasma minus.—Calman, 1919: 362.—Broch, 1922: 273, fig. 31.—Barnard, 1924: 55.—Nilsson-Cantell, 1928: 20.

Material examined.—Siaoliouciou, Pingtung County, 8 specimens (CL 7.4-11.0mm, CW 4.0-6.0 mm).—CD132, 22°20.98'N, 120°6.73'E, 690-700 m, 21 Nov 2001: 3 specimens.—CD230, 22°19.32'N, 120°3.3'E, 795-840 m, 30 Aug 2003: 1 specimens (CL 7.0 mm, CW 4.0 mm, PL 1.0 mm).—CD311, 21°40.373'N, 117°43.415'E, 506-515m, 17 Aug 2005: 7 specimens (CL 3.45-7.53mm, CW 1.44-3.32 mm, PL 0.26-1.18 mm) (CEL-BB-47).—CP314, 21°40.072'N, 117°43.123'E, 506.2-509.2 m, 17 Aug 2005: 13 specimens (CL 2.1-11.58 mm, CW 1.07-5.29 mm, PL 1.18 mm) (NMNS 005087-00084).

Diagnosis.—Capitulum white, elongated, wider than high, with 5 fully calcified plates, plate surfaces smooth and with faint lines. Scutum triangular, ocludent and basal margins forming a straight line; tergum narrow and triangular, carina narrow at apex and broader at base, basal region extending horizontally and forming 2 basal points; peduncle short, naked, and yellow. Maxilla globular with dense setae on margin; maxillule strongly notched, with 2 large setae above notch and at least 15 setae below notch; mandible with 4 teeth excluding inferior angle, teeth simple, lower margin short; mandibulatory palp triangular, with dense setae on superior margin; labrum concave, with 22 sharp teeth.

Size.—CL to 10 mm.

Coloration.—Capitulum white, peduncle yellow.

Habitat.—Attaches onto sea urchin spines or deep-sea cable.

Distribution.—Indo-Pacific region.

Remarks.—New record for Taiwan.

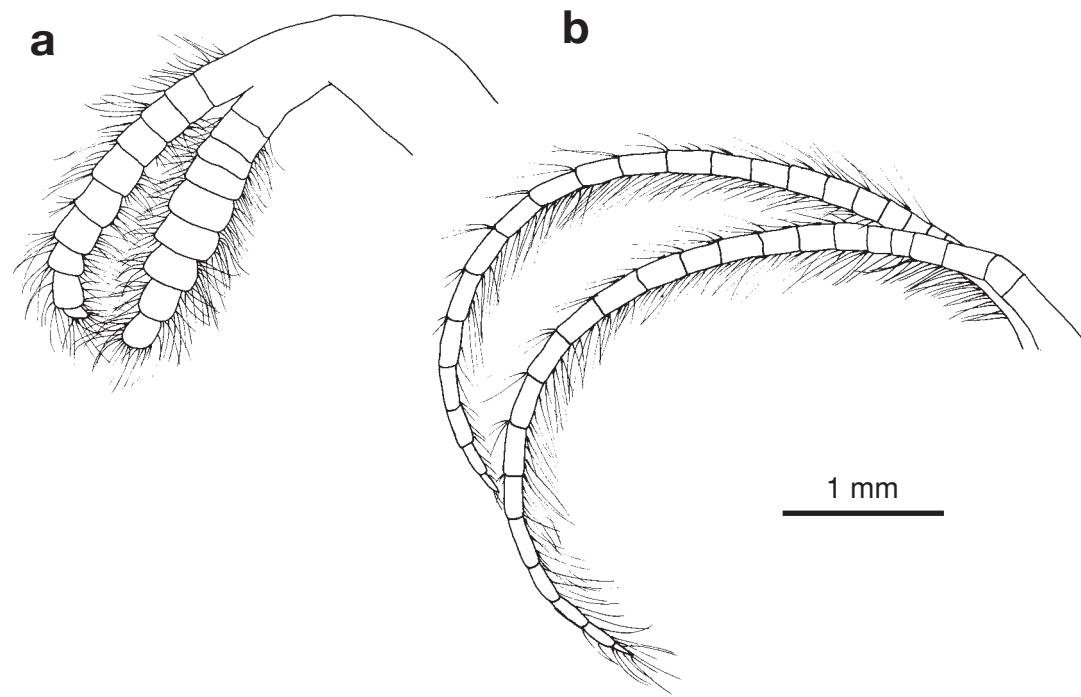


Fig. 29. *Megalasma minus*. CD132, 21 Nov 2001. Line drawings of a. Cirrus I and b. Cirrus VI.

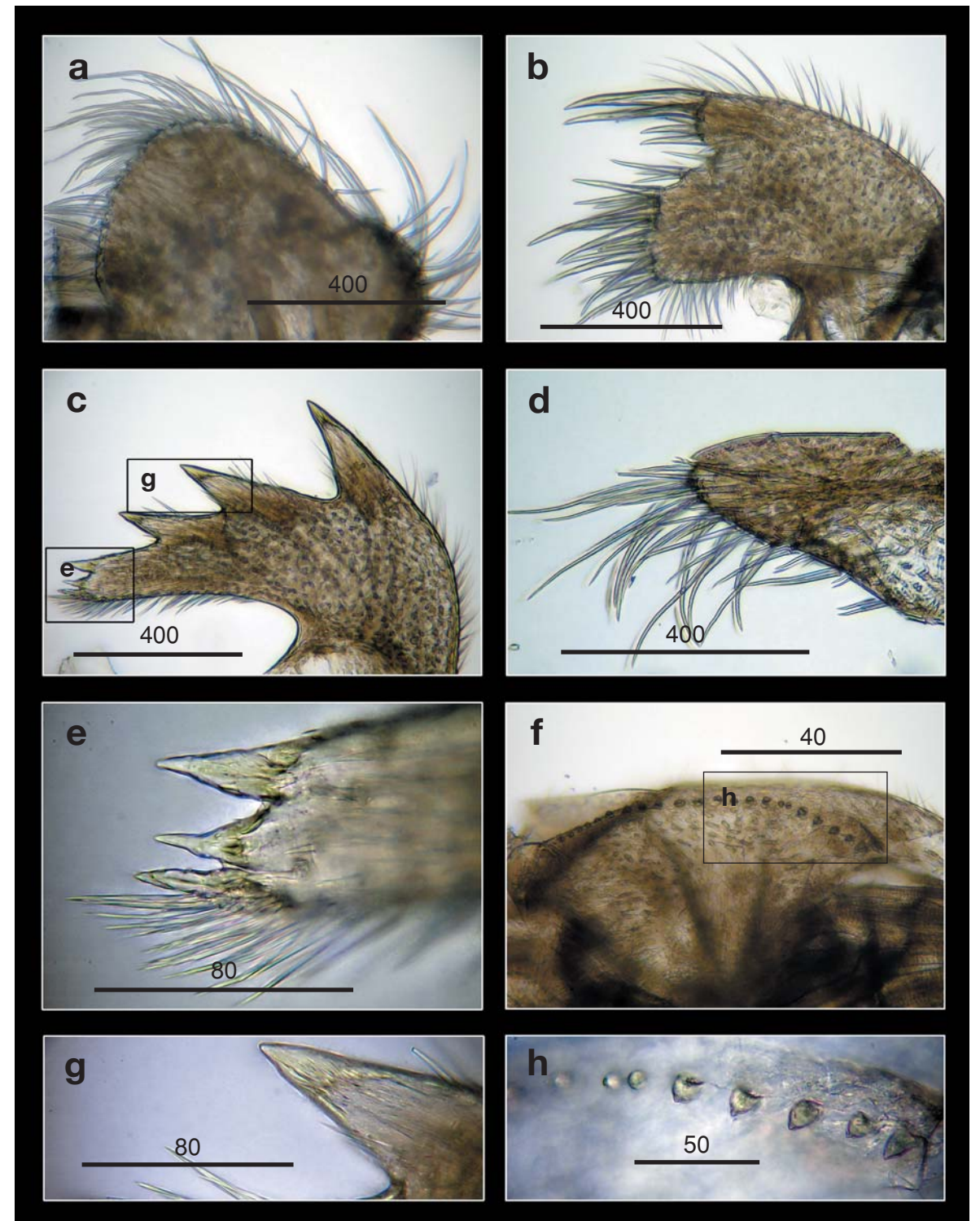


Fig. 30. *Megalasma minus*. CD132, 21 Nov 2001. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Genus *Glyptelasma* Pilsbry, 1907

雕茗荷屬

Glyptelasma Pilsbry, 1907a: 87.—Broch, 1931: 32.—Newman et al., 1969: 280.—Zevina, 1982: 84.—(as subgenus) Liu & Ren, 1985: 257.—Liu & Ren, 2007: 154. Type species. *Megalasma subcarinatum* Pilsbry 1907.

Diagnosis.—Capitulum with 5 fully calcified plates, surface smooth or striated. Scutum quadrangular, basal and occludent margins intersected at right angle, umbo of scutum at basi-carinal angle; carina extending horizontally in basal region. Mandible with 4 teeth excluding inferior angle. Peduncle short, yellow, and naked.

Remarks.—*Glyptelasma* and *Megalasma* were previously considered to be subgenera of *Megalasma*. In Liu & Ren (2007), these 2 subgenera were considered to be separate genera in the Poecilasmataidae.

Glyptelasma gigas (Annandale, 1916)

巨雕茗荷

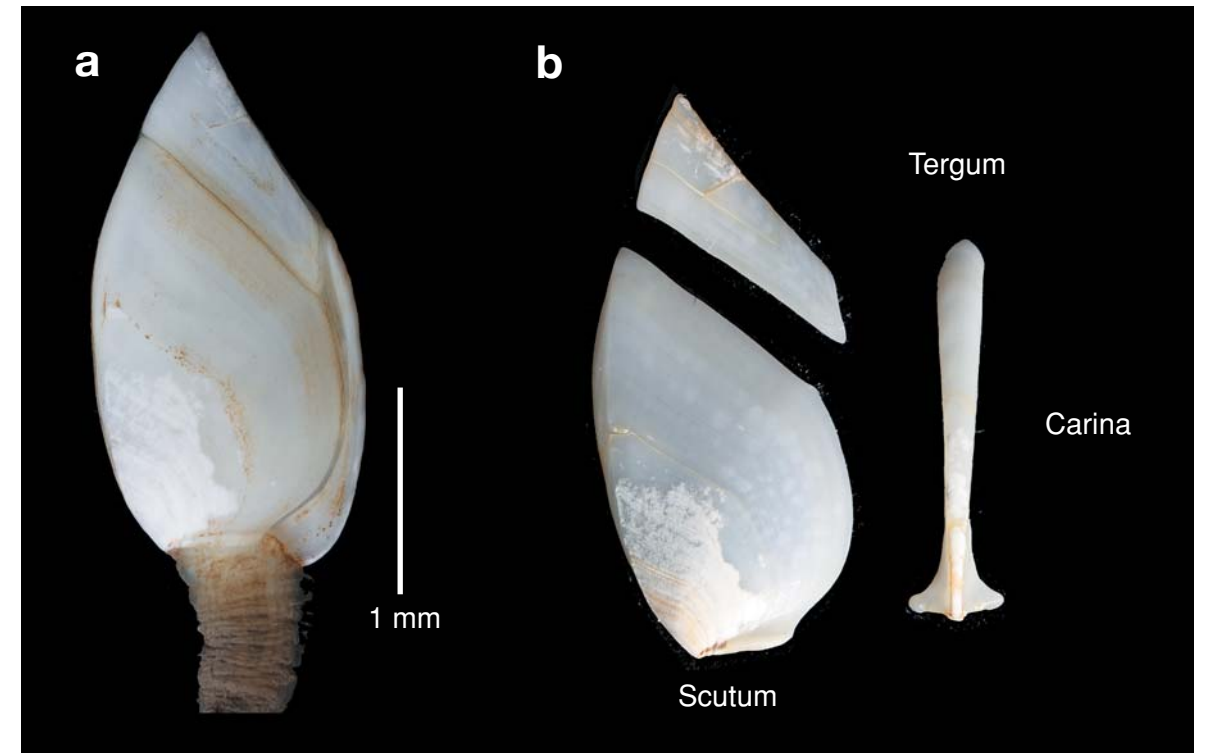


Fig. 31. *Glyptelasma gigas*, CD132, 21 Nov 2001. a. Side view showing the capitulum. b. Capitular plates showing the tergum, scutum and carina.

Poecilasma gigas Annandale, 1916b: 299, pl. IV, fig. 4, pl. V, figs. 10-14, pl. VI, figs. 7, 8.

Megalasma (Glyptelasma) gigas.—Calman, 1919: 364.—Nilsson-Cantell, 1928: 20.—Zevina, 1982: 85, fig. 75.

Glyptelasma gigas.—Broch, 1931: 32, fig. 12.

Material examined.—CP132, 22°20.98'N, 120°6.73'E, 690-700 m, 21 Nov 2001: 9 specimens (CL 2.38-13.59 mm, CW 1.38-7.71 mm, PL 0.78-9.45 mm) (NMNS 005087-00078).—CP132, 22°20.98'N, 120°6.73'E, 690-700 m, 21 Nov 2001: 12 specimens (CL 3.22-14.68 mm, CW 1.63-7.87 mm, PL 1.41-13.39 mm) (CEL-BB-50).—CD230, 22°19.32'N, 120°3.3'E, 795-840 m, 30 Aug 2003: 1 specimen (CL 8.4 mm, CW 4.75 mm, PL 2.37 mm) (NMNS 005087-00080).

Diagnosis.—Capitulum large, with 5 plates, plate surfaces smooth, white and opaque, plates separated by thin chitinous linings. Tergum quadrangular, all margins straight; scutum oval, occludent margin convex, basal and tergal margins straight, carinal margin strongly curved, basal and occludent margins forming a right angle; carina bowed, basal region expanded laterally. Peduncle long and yellow, with concentric winkles. Maxilla bilobed, setae on 2 main regions; cutting edge of maxillule strongly notched, 2 large long spines above notch, short spines at notch, 10 spines below notch, region below notch expanded outwards; mandible with 5 teeth excluding inferior angle, 1st tooth separated from remaining teeth, lower margin short, inferior angle bifid; mandibulatory palp narrow, elongated, setae only on superior margin; labrum concave, without a deep notch,

cutting edge with dense fine teeth.

Size.—CL to 20 mm.

Coloration.—Capitulum white, peduncle yellow.

Habitat.—Attaches onto deep-sea cables and hard substrata.

Distribution.—Malaysia, South China Sea, Taiwan.

Remarks.—New record for Taiwan (Chan et al., 2009).

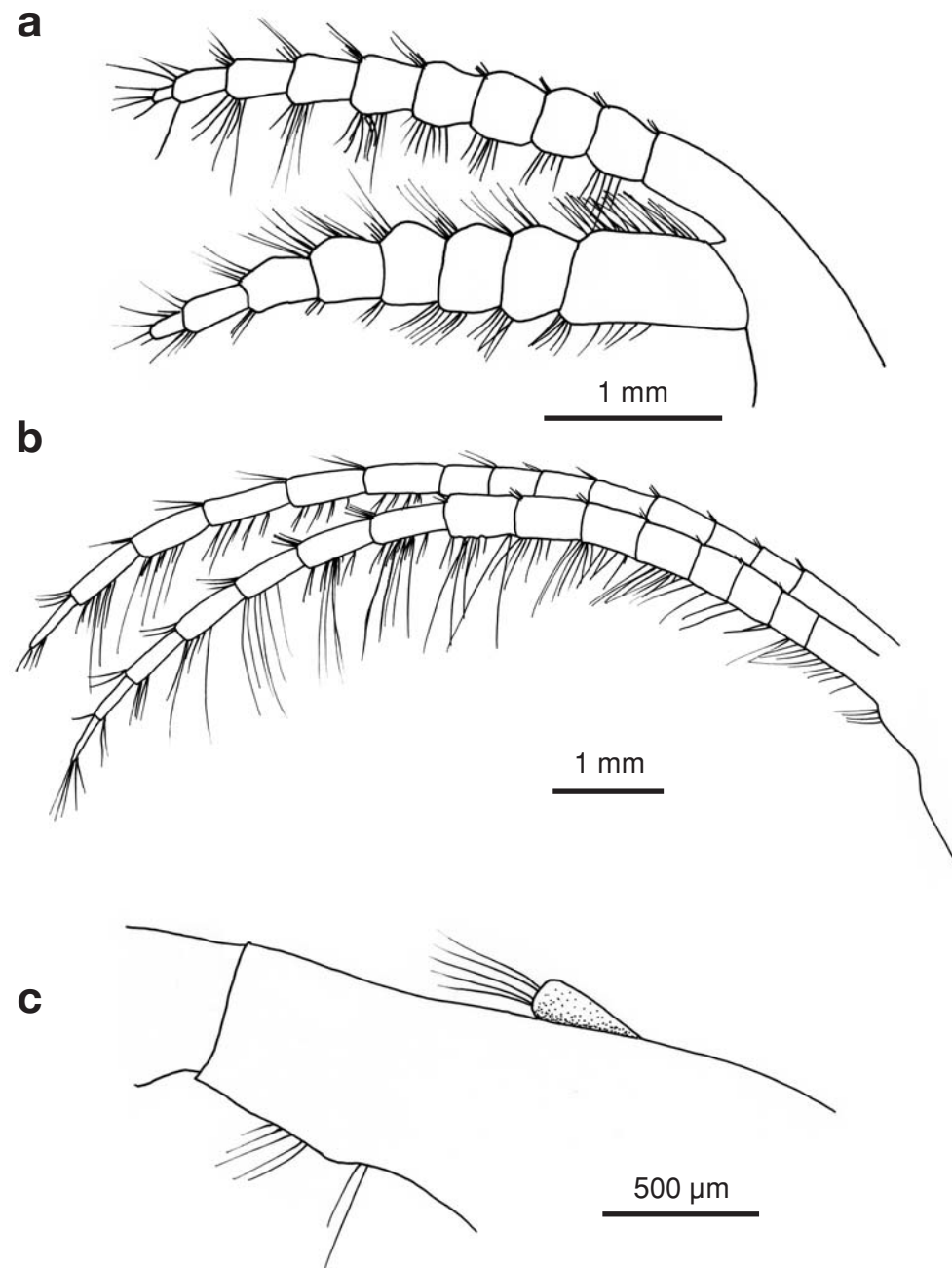


Fig. 32. *Glyptelasma gigas*, CD132, 21 Nov 2001. Line drawings showing a. Cirrus I, b. Cirrus II and c. Caudal appendages.

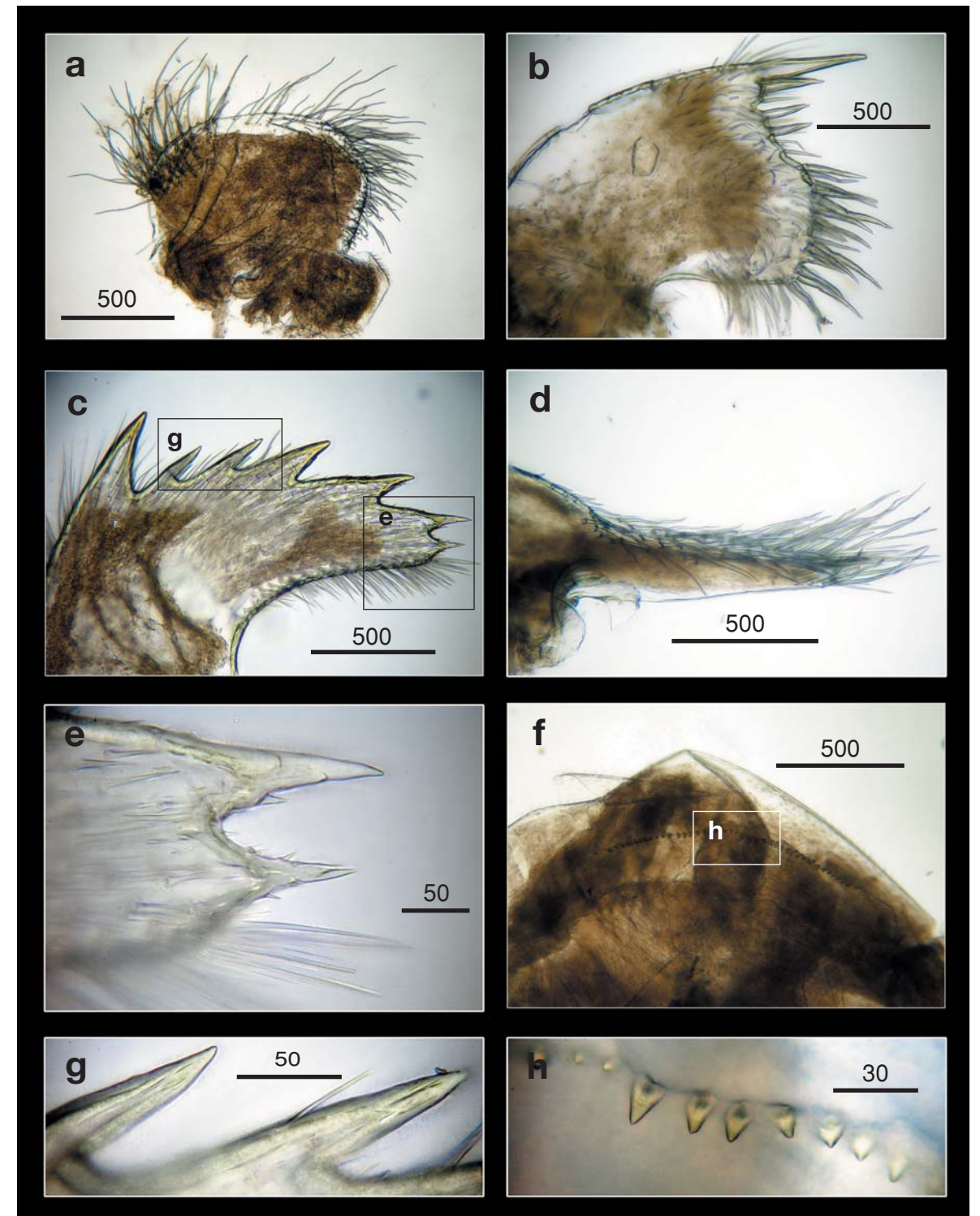


Fig. 33. *Glyptelasma gigas*, CD132, 21 Nov 2001. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Family LEPADIDAE Darwin, 1851
茗荷科

Lepadidae Darwin, 1851: 1.—Gruvel, 1905: 104.—Pilsbry 1907a: 79.—Nilsson-Cantell, 1921: 233.—Withers, 1928: 39, 48.—Withers, 1935: 25.—1953: 317.—Newman et al., 1969: 278.—Newman & Ross, 1971: 29.—Zullo, 1973: 3.—Foster, 1978: 29.—Zevina, 1980: 691.—Liu & Ren, 1985: 217.—Liu & Ren, 2007: 188.

Pentaspidae Gruvel, 1905: 102. Type species *Lepas anatifera* Linnaeus, 1758.

Diagnosis.—Capitulum with 5, 2, or no plates; peduncle naked; caudal appendage highly reduced or absent; hermaphroditic, mandibles with 5 teeth, excluding inferior angle.

Remarks.—Lepadidae includes 6 genera, *Perisinolepas* (a fossil genus), *Lepas*, *Halolepas*, *Conchoderma*, *Alepas* and *Dosima*. In Taiwan, we have recorded *Lepas* and *Conchoderma*.

Key to genera of Lepadidae from Taiwan

- 1. Capitulum fully calcified, with 5 plates *Lepas*
- Capitulum 5 or 2 reduced plates, partially calcified, carina and tergum absent or present *Conchoderma*

Genus *Lepas* Linnaeus, 1758
茗荷屬

Lepas Linnaeus, 1758: 667.—Darwin, 1851: 67.—Gruvel, 1905: 104.—1920: 34.—Hoek, 1907: 1.—Annandale, 1909a: 72.—Jennings, 1918: 57.—Broch, 1922: 266.—Nilsson-Cantell, 1927: 752.—1928: 12.—1938: 26.—Withers, 1928: 39, 48.—1935: 317.—Stubbings, 1936: 2.—Newman et al., 1969: 278.—Newman & Ross, 1971: 29.—Zullo, 1973: 3.—Foster, 1978: 29. Type species *Lepas anatifera* Linnaeus, 1758.

Diagnosis.—Capitulum white, with 5 closely packed plates, carina apex extending to tergum, base of carina forked. Filamentary appendages and caudal appendage present, mandible with 5 teeth excluding inferior angle.

Remarks.—*Lepas* is composed of 8 species and 4 species have been recorded in Taiwan. 2 species are new to Taiwan (see Cai et al., in press).

Key to species of *Lepas* from Taiwan

- 1. Plate surface smooth and with 2 filamentary appendages in the somatic body 2
- Plate surface striated 3
- 2. Umbo of the right scutum has a tooth *Lepas anatifera*
- Umbo of scutum without tooth *Lepas testudinata*
- 3. Scutal margin of terga with notch, occludent margin of scutum slightly convex, carina striated *Lepas pectinata*
- Scutal margin of terga without notch, occludent margin of scutum strongly convex and swollen *Lepas anserifera*

Lepas anserifera Linnaeus, 1767
鵝茗荷

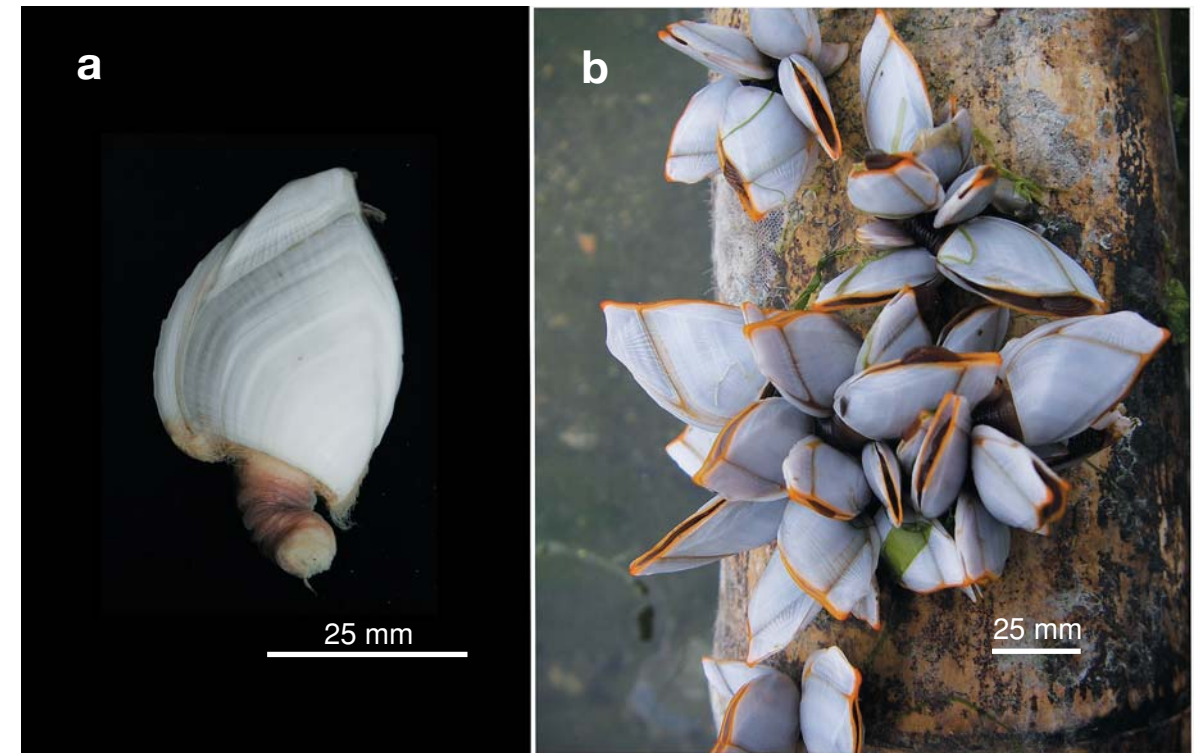


Fig. 34. *Lepas anserifera*, Gueihou, Taipei County, Nov 2005. a. Side view of the capitulum. b. A colony on a floating wood collected at NE coast of Taiwan.

Lepas anserifera Linnaeus, 1767: 1109.—Darwin, 1851: 81, pl. 1, fig. 4.—Hoek, 1883: 39, pl. 1, fig. 4.—Gruvel, 1905: 106, fig. 117.—Pilsbry, 1907a: pl. 80, figs. 1, 3.—Annandale, 1909a: 75, fig. 2.—Nilsson-Cantell, 1921: 234.—1928: 12.—Hiro, 1937a: 57, fig. 48.—1937b: 399, fig. 3b.—1939d: 248.—Utinomi, 1949: 20.—1954: 18.—1958: 287.—Tarasov & Zevina, 1957: 110, fig. 25g.—Zevina & Tarasov, 1963: 77.—Stubbings, 1967: 237.—Gordon, 1970: 32.—Liu & Ren, 1985: 222, fig. 21.

Lepas anserifera anserifera Newman, 1972: 31, fig. 1.

Material examined.—Gueihou, Taipei County, Nov 2005: 56 specimens (CL 4.24-14.91 mm, CW 3.06-11.38 mm, PL 3.49-8.41 mm) (CEL-BB-16).

Diagnosis.—Capitulum with 5 plates, plates thick, white, surfaces striated with radiating lines. Tergum quadrilateral, wider than high; scutum fan-shaped, occludent margin strongly convex, protruding out of level of tergum; carina forked, produced below base of scutum. 1 filamentary process on prosoma, below base of peduncle of cirrus I. Mandible with 5 teeth excluding inferior angle, lower angle pectinate; maxillule not clearly notched, cutting edge with several dense setal aggregations; labrum concave with fine teeth. Caudal appendages short.

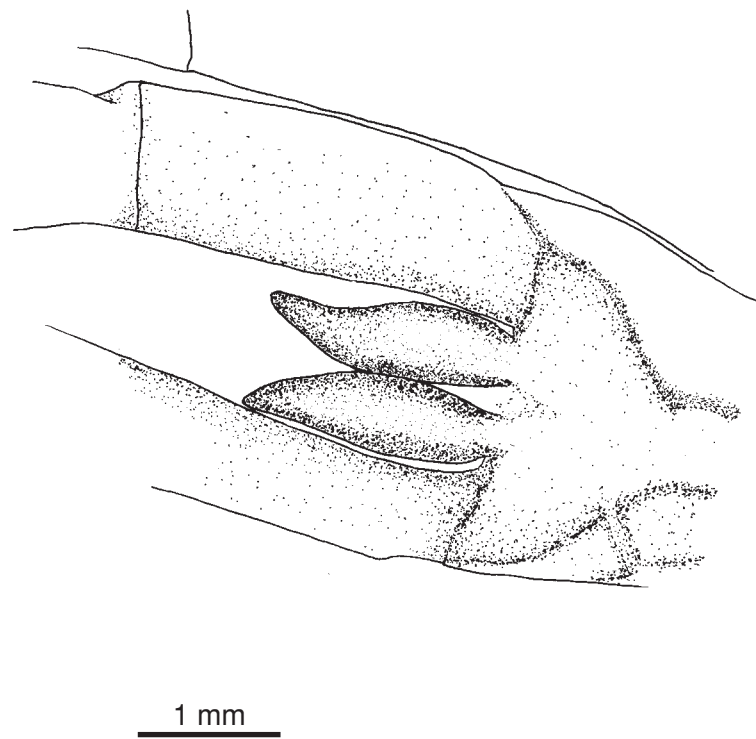


Fig. 35. *Lepas anserifera*, Gueihou, Taipei County, Nov 2005. Line drawing showing the caudal appendage, view from the top.

Size.—CL to 35 mm.

Coloration.—When fresh, capitulum white, tergal scutal flaps yellow, upper portion of pedicle orange. The yellow color of the tergal scutal flaps becomes discolored after preservation in ethanol.

Habitat.—On floating objects.

Distribution.—Cosmopolitan.

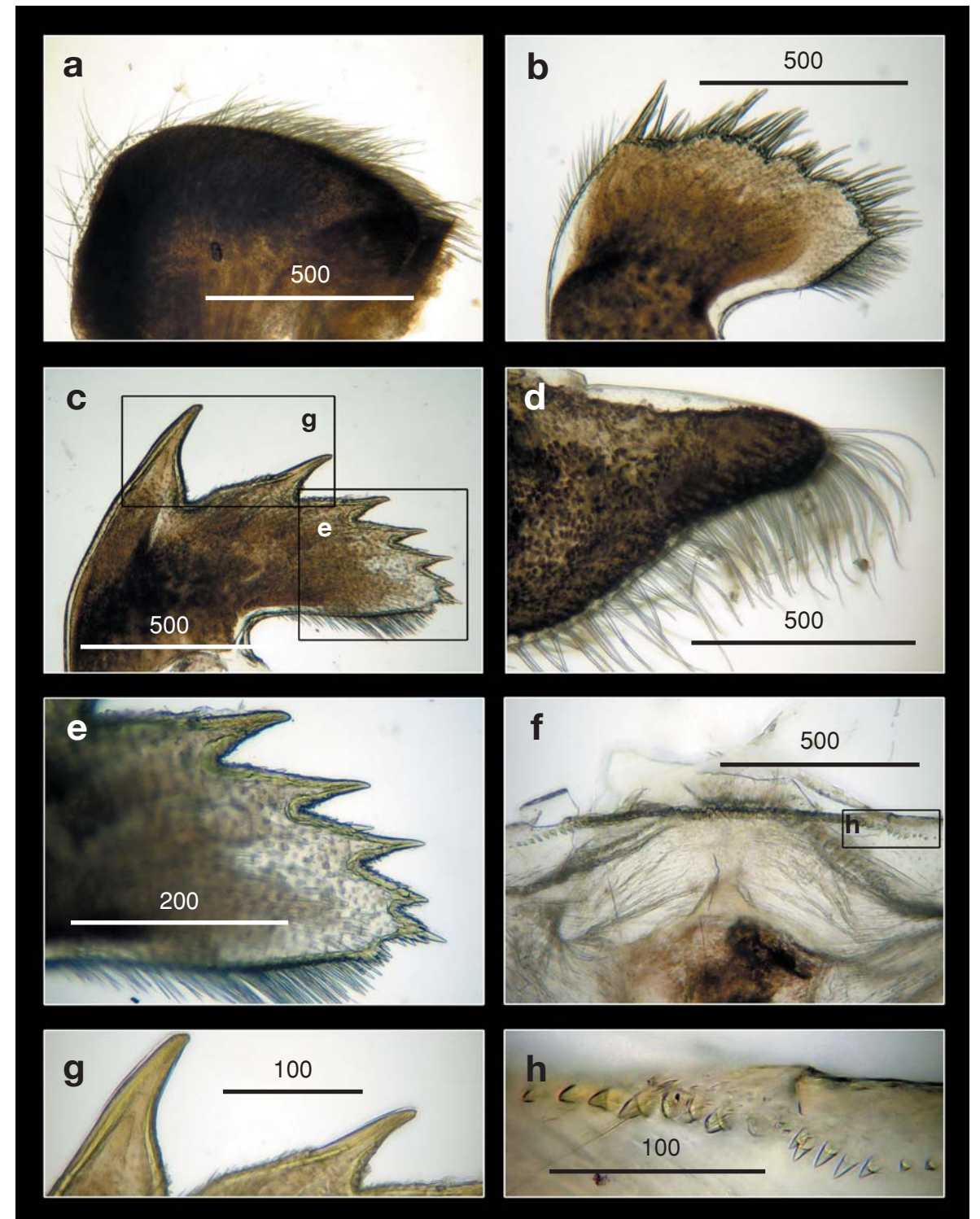


Fig. 36. *Lepas anserifera*, Gueihou, Taipei County, Nov 2005. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Lepas anatifera Linnaeus, 1758

茗荷

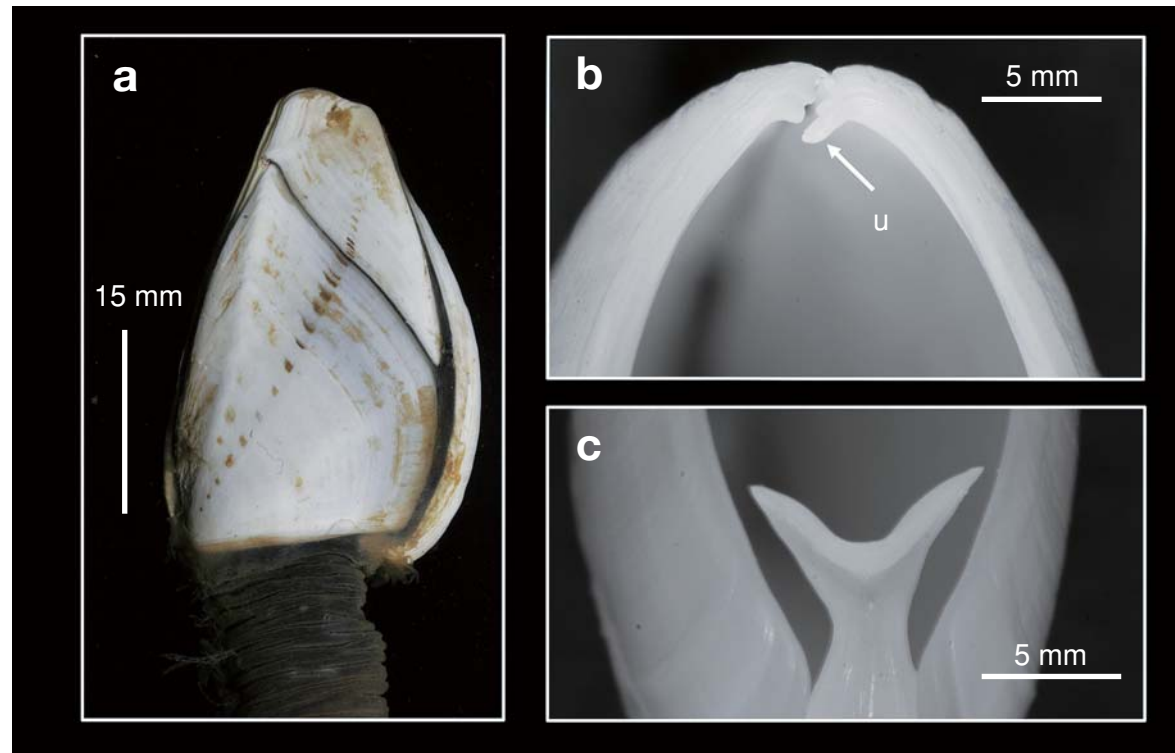


Fig. 37. *Lepas anatifera*, Hemei, Taipei County, 17 Nov 1998. a. Side view of the capitulum. b. The basal view of the paired scutum, showing the umbonal tooth, c. Basal view of the forked carina.

Lepas anatifera Linnaeus, 1758: 668.—Darwin, 1851: 73, pl. 1, fig. 1.—Hoek, 1883: 38, pl. 1, figs. 1, 2.—Pilsbry, 1896: 208.—1907a: 79, figs. 3-5.—Gravel, 1905: 108.—Annandale, 1909a: 73.—Stebbing, 1910: 563.—Nilsson-Cantell, 1921: 236.—Broch, 1924: 46, fig. 15.—Hiro, 1937a: 56, fig. 46.—1937b: 396, figs. 2, 3a.—1939b: 204.—Henry, 1940: 37, pl. 4, fig. 7.—Utinomi, 1949: 20.—1958: 287.—1970: 341.—Tarasov & Zevina, 1957: 104, figs. 14, 24, 26, 28.—Stubbings, 1967: 237.—Zevina, 1968: 35.—Gordon, 1970: 28, fig. 9.—Southward, 2008: 48, fig. 58A.

Lepas anatifera anatifera Newman, 1972: 36.—Liu & Ren, 1985: 218, fig. 19.

Material examined.—Hemei, Taipei County, 17 Nov 1998: 27 specimens (CL 7.98-32.60 mm, CW 5.68-21.49 mm, PL 4.97-13.54 mm) (NMNS 003153-00021).—Chenggong Township, Taitung County, 14 Feb 1996: 4 specimens (CL 23.41-27.37 mm, CW 17.23-20.83 mm, PL 9.36 mm) (NMNS 003000-00209).

Diagnosis.—Capitulum with 5 plates, plates thin and smooth. Right scutum with an internal umbonal tooth; scutum sometimes with dark markings or spots; carina forked below

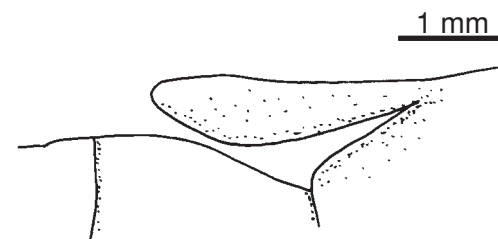


Fig. 38. *Lepas anatifera*, Hemei, Taipei County, 17 Nov 1998. Side view showing the caudal appendage.

umbo. 2 filamentary appendages on each side of base of cirrus I; caudal appendages short, claw-shaped. Maxilla globular; maxillule notched in 4 distinct regions; mandible with 5 teeth excluding inferior angle, inferior angle pectinated; mandibulatory palp triangular with setae on superior margin; labrum strongly concave, with fine setae and teeth on cutting edge.

Size.—CL to 50 mm.

Coloration.—Capitulum white, peduncle brown to dark-brown.

Distribution.—Cosmopolitan on world's oceans.

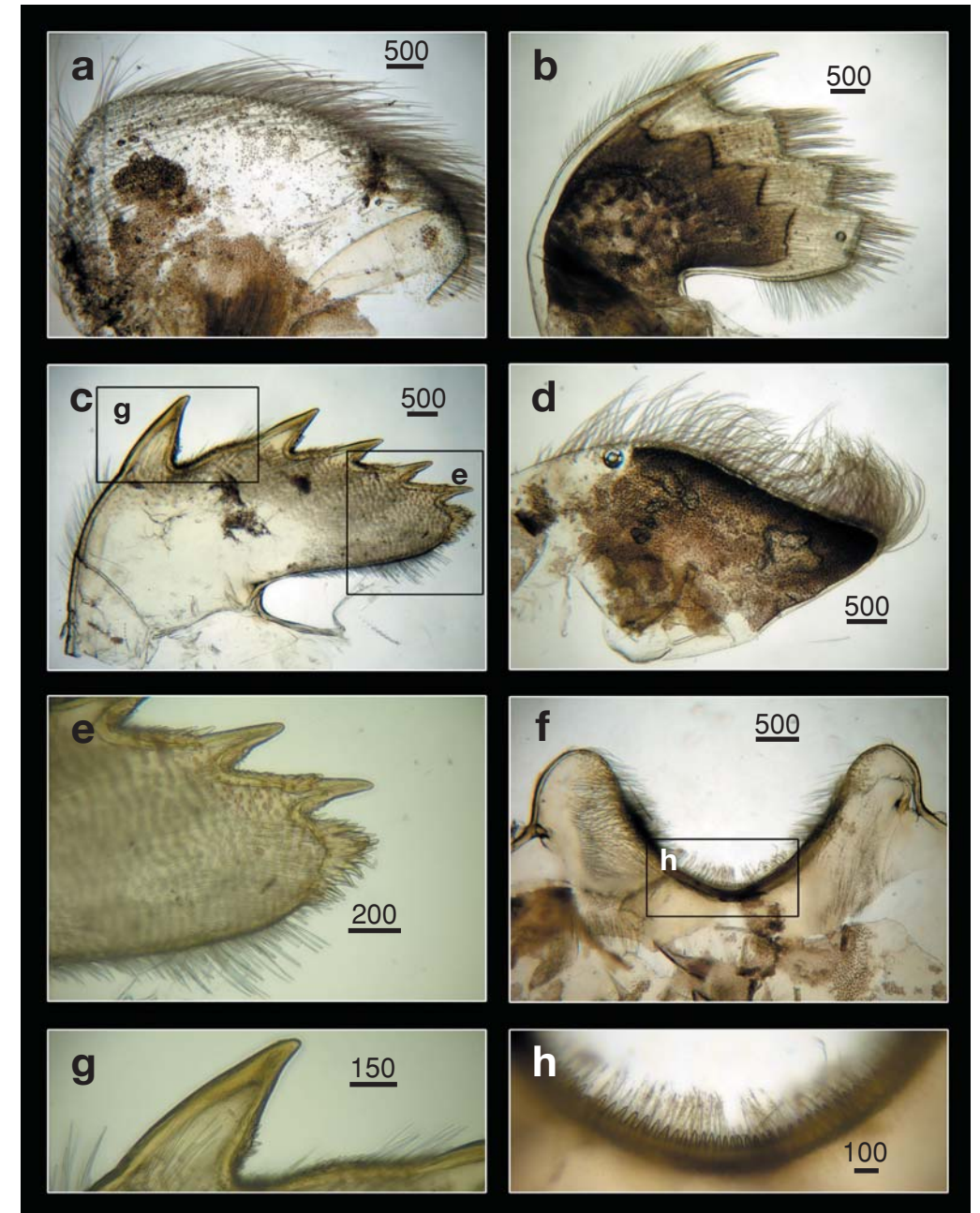


Fig. 39. *Lepas anatifera*, Hemei, Taipei County, 17 Nov 1998. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Lepas pectinata Spengler, 1793
櫛茗荷

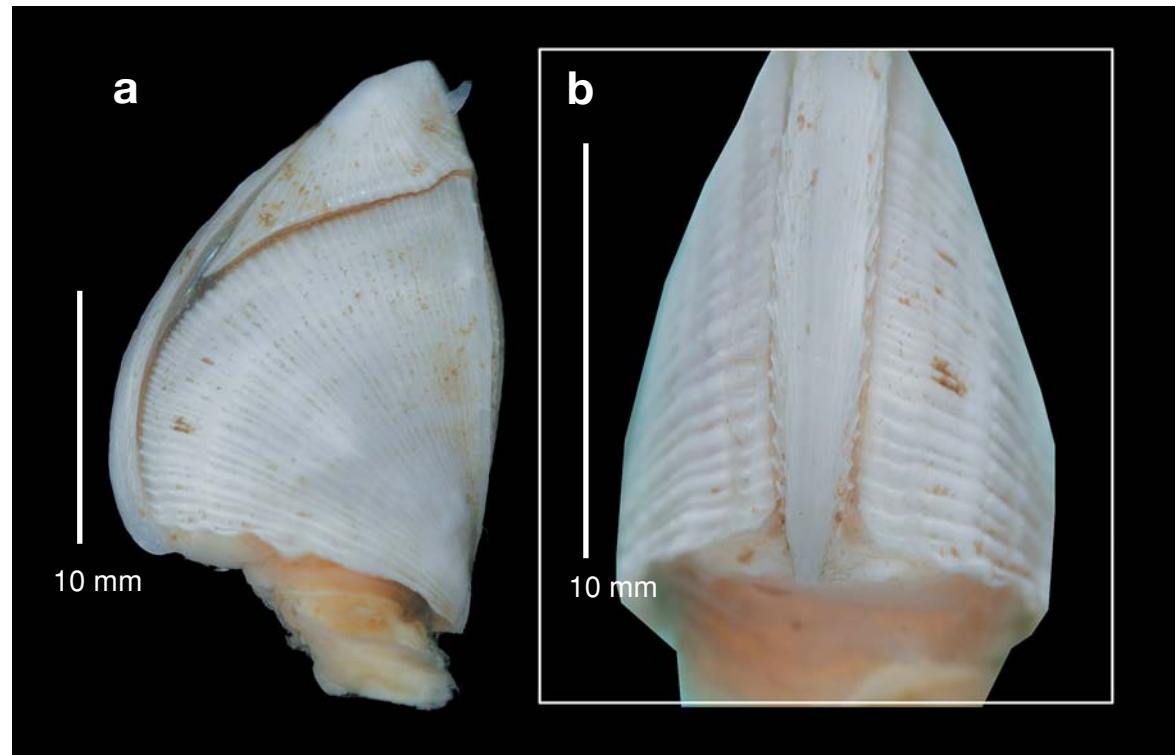


Fig. 40. *Lepas pectinata*, Yeliou, Taipei County, Oct 2006. a. Side view of the capitulum. b. Carinal view, showing the carina.

Lepas pectinata Spengler, 1793. (not seen).—Darwin, 1851: 85, pl. 1, fig. 3.—Gravel, 1905:107, fig. 119.—Pilsbry, 1907a: 81, pl. 8, figs. 4-6, 8.—Borradaile, 1916: 131.—Nilsson-Cantell, 1921: 235, fig. 35d.—Broch, 1922: 266, figs. 26-28.—1924: 50, fig. 17.—Hiro, 1937a: 59, fig. 49.—1937b: 400.—1939b: 204.—Utinomi, 1970: 341.—Foster, 1978: 33, fig. 18.—Zevina, 1982: 15, fig. 6.

Material examined.—Yeliou, Taipei County, attached on floating woods, Oct 2006: 2 specimens (CL 13 mm, CW 9.78 mm).—Gueihou, Taipei County, Nov 2005: 1 specimen (CL 13.68 mm, CW 9.48 mm, PL 3.97 mm) (CEL-BB-92).

Diagnosis.—Plates thick, surfaces striated; carina forked below umbo. Filamentary appendages single-segmented at base of 1st cirrus, anterior and posterior rami of cirrus I-VI counts as I (10, 9), II (10, 11), III (12, 12), IV (12, 13), V (13, 13), VI (13, 13); caudal appendages consisting of elongated triangular projections. Mandible with 3 teeth, lower margin smooth; mandibulatory palps elongated with serrulate setae; labrum with dense large teeth; maxilla spherical with dense setae.

Size.—CL to 40 mm.

Coloration.—Capitular plates white. Peduncle light-brown.

Distribution.—Cosmopolitan species.

Remarks.—New record for Taiwan.

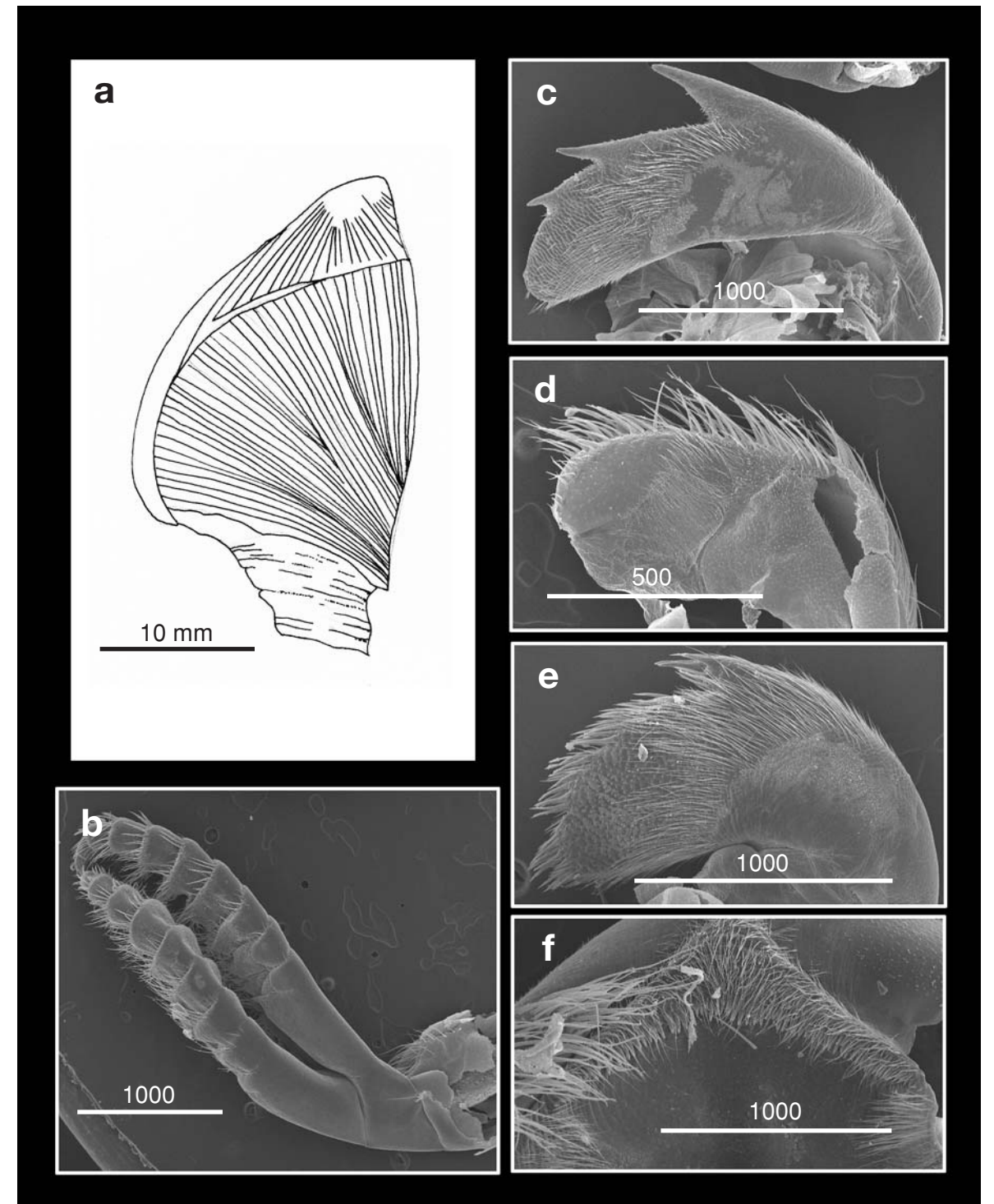


Fig. 41. *Lepas pectinata*, Yeliou, Taipei County, Oct 2006. a. Line drawing of the side view of the capitulum. Scanning Electron Microscopy on b. Cirrus I, c. Mandible, d. Maxilla, e. Maxillule, f. Labrum. Scale bars in µm.

Lepas testudinata Aurivillius, 1892

龜茗荷

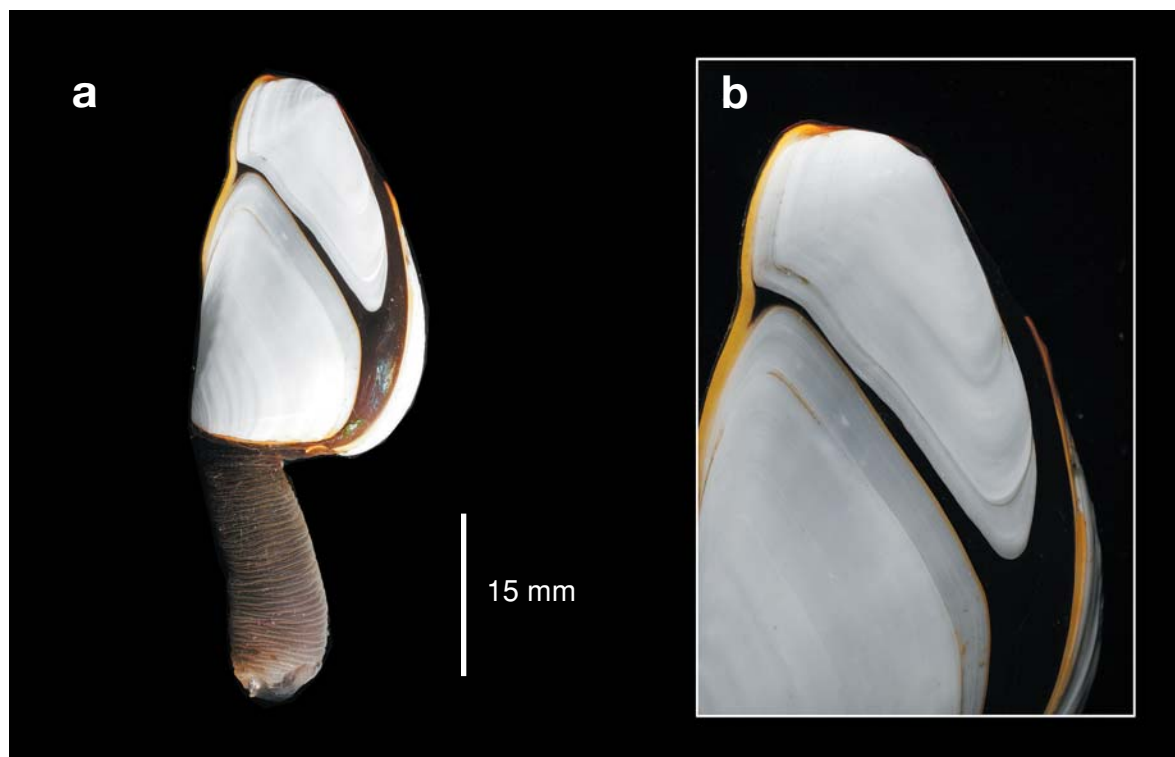


Fig. 42. *Lepas testudinata*, Bitoujiao, Taipei County, Oct 2007. a. Side view of the capitulum. b. Close up view of the tergum and scutum of the capitulum.

Lepas testudinata Aurivillius, 1892: 123.—1894: 7, pl. 1, figs. 1-3, pl. 8, fig. 4.—Borradaile, 1916: 131.—Foster, 1978: 31, fig. 16, pl. 4c.—Liu & Ren, 1985: 220, pl. 5, figs. 11-14.—2007: 193, fig. 78.

Lepas hillii Leach, 1818: 413.

Lepas anatifera var. *testudinata*.—Nilsson-Cantell, 1928: 12.

Material examined.—Bitoujiao, Taipei County, attached on floating woods, Oct 2007: >50 specimens (max individual, CL 32 mm, CW 25 mm).—Bitoujiao, Taipei County, 17 Apr 2007: > 300 specimens (largest individual, CL 32.79 mm, CW 20.41 mm, PL 17.83 mm) (CEL-BB-91).

Diagnosis.—Plates thick, surfaces smooth, separated by conspicuous brown integument. 2 filamentary appendages at base of 1st cirrus, anterior and posterior ramus of cirrus I-VI counts as I (12, 13), II (20, 22), III (25, 27), IV (28, 27), V (27, 27), VI (28, 27). Mandible with 5 teeth, without multi-dentations on large teeth, lower margin short; maxillule notched; mandibulatory palps elongated; maxilla spherical with dense setae. Penis covered with very high density of hairs.

Size.—CL to 35 mm.

Coloration.—Capitulum plates white, peduncle dark-brown.

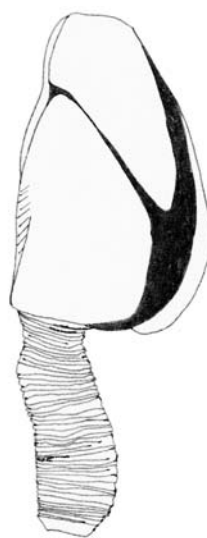


Fig. 43. *Lepas testudinata*, Bitoujiao, Taipei County, Oct 2007. Line drawing of the side view of the capitulum.

Habitat.—On floating objects.

Distribution.—Australia, New Zealand, South Africa, China, Taiwan.

Remarks.—New record for Taiwan.

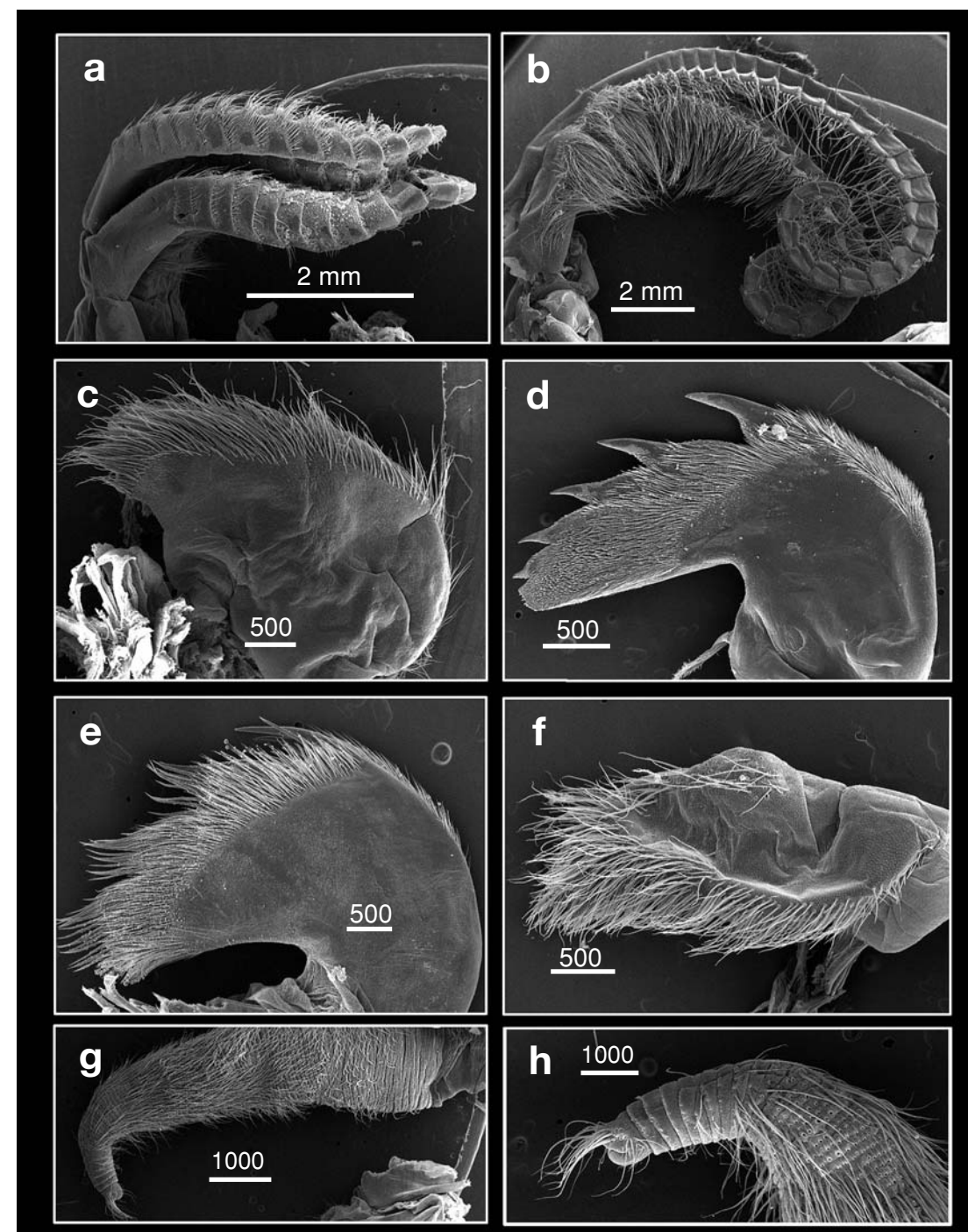


Fig. 44. *Lepas testudinata*, Bitoujiao, Taipei County, Oct 2007. Scanning Electron Microscopy on a. Cirrus I, b. Cirrus II, c. Maxilla, d. Mandible, e. Maxillule, f. Mandibulatory palp. g. Penis, h. Tip of the penis. Scale bars in µm.

Genus *Conchoderma* Olfers, 1814

條茗荷屬

Conchoderma Olfers, 1814: 177 (not seen).—Darwin, 1851: 136.—Hoek, 1883: 55.—Pilsbry, 1907a: 98.—Annandale, 1909a: 79.—Nilsson-Cantell, 1921: 240.—Broch, 1924: 54.—Hiro, 1937a: 61.—Tarasov & Zevina, 1957: 113.—Newman et al., 1969: 279.—Newman & Ross, 1971: 33.—Zevina, 1980: 692.—Liu & Ren, 1985: 225.—Liu & Ren, 2007: 196. Type species *Lepas virgata* Spengler, 1790.

Diagnosis.—Opercular plates reduced, with 2 or 5 plates. Scuta bi- or trilobed, umbo in middle of occludent margin, terga and carina narrow and straight, umbo medial. Somatic body with 6 or 7 filamentary appendages, caudal appendage absent. Mandible with 5 teeth excluding inferior angle.

Remarks.—3 species have been recorded in the world so far and they are all found in Taiwan.

Key to species of *Conchoderma* from Taiwan

- 1. Scutum bilobed *Conchoderma auritum*
- Scutum trilobed 2
- 2. Lobes of scutum broad, upper region of carina projected in a horny shape, capitulum often has dark brown stripes *Conchoderma virgatum*
- Lobes of scutum narrow, carinal latus of capitulum arcuate shaped, often without brown stripes *Conchoderma hunteri*

***Conchoderma virgatum* (Spengler, 1790)**

條茗荷

Lepas virgata Spengler, 1790: 207, tab. VI, fig. 9.
Conchoderma virgata.—Darwin, 1851: 146, pl. 3, fig. 4.—Zevina, 1980: 692.

Conchoderma virgatum.—Hoek, 1883: 55.—Gruvel, 1905: 144, fig. 169.—Gruvel, 1920: 38.—Pilsbry, 1907a: 99, pl. 9, fig. 1.—Annandale, 1909a: 80.—Stebbing, 1910: 566.—Jennings, 1918: 59.—Nilsson-Cantell, 1921: 242.—1928: 16, fig. 7.—1930a: 251, pl. 1, fig. 4.—Barnard, 1924: 61.—Broch, 1924: 58, fig. 20.—Krüger, 1927: 13.—Hiro, 1936b: 623, fig. 2.—1937a: 62, fig. 53.—1937b: 402, fig. 5.—1939b: 205.—1939d: 248.—Utinomi, 1970: 341.—Newman & Ross, 1971: 35, fig. 11, pl. 5E.—Hastings, 1972: 274.—Williams, 1978: 109, pl. 1.—Liu & Ren, 1985: 225, figs. 23, 24, pl. 6: 6-11.—2007: 199, fig. 82.

Material examined.—Kending, Pingtung County, on mouth of a sword fish, Jun 2003: 12 specimens (CL 4.32-9.66 mm, CW 2.31-5.98 mm, PL 1.47-1.57 mm) (CEL-BB-79).



Fig. 45. *Conchoderma virgatum*, Kending, Pingtung County, Jun 2003. Side view of the capitulum.

Diagnosis.—Capitulum rectangular, carinal margin and tergal margin perpendicular, wall thick, pale-white to pale-blue, with brown stripes. Scutum trilobed, T-shaped; tergum narrow and thin, elevated at both apices, an outgrowth formed between terga and carina. Peduncle naked and long. Maxilla globular with setae around margin; maxillule not notched, cutting edge divided into 4 setal clusters; mandible with 5 teeth excluding inferior angle, lower margin very short; mandibulatory palp elongated, with setae on superior margin; labrum cutting edge slightly concave with a row of fine sharp teeth.

Size.—CL to 15 mm.

Coloration.—Capitulum white to pale-blue, with longitudinal brown stripes.

Habitat.—On floating objects and on live marine animals including sea turtles, fish, and whales.

Distribution.—Cosmopolitan, in the world's oceans.

Remarks.—New record for Taiwan.

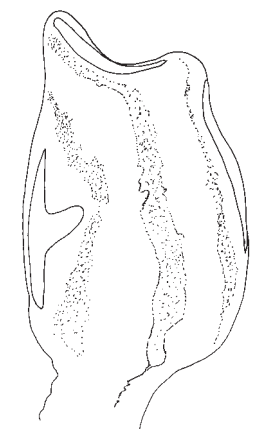


Fig. 46. *Conchoderma virgatum*, Kending, Pingtung County, Jun 2003. Line drawing showing the side view of the capitulum.

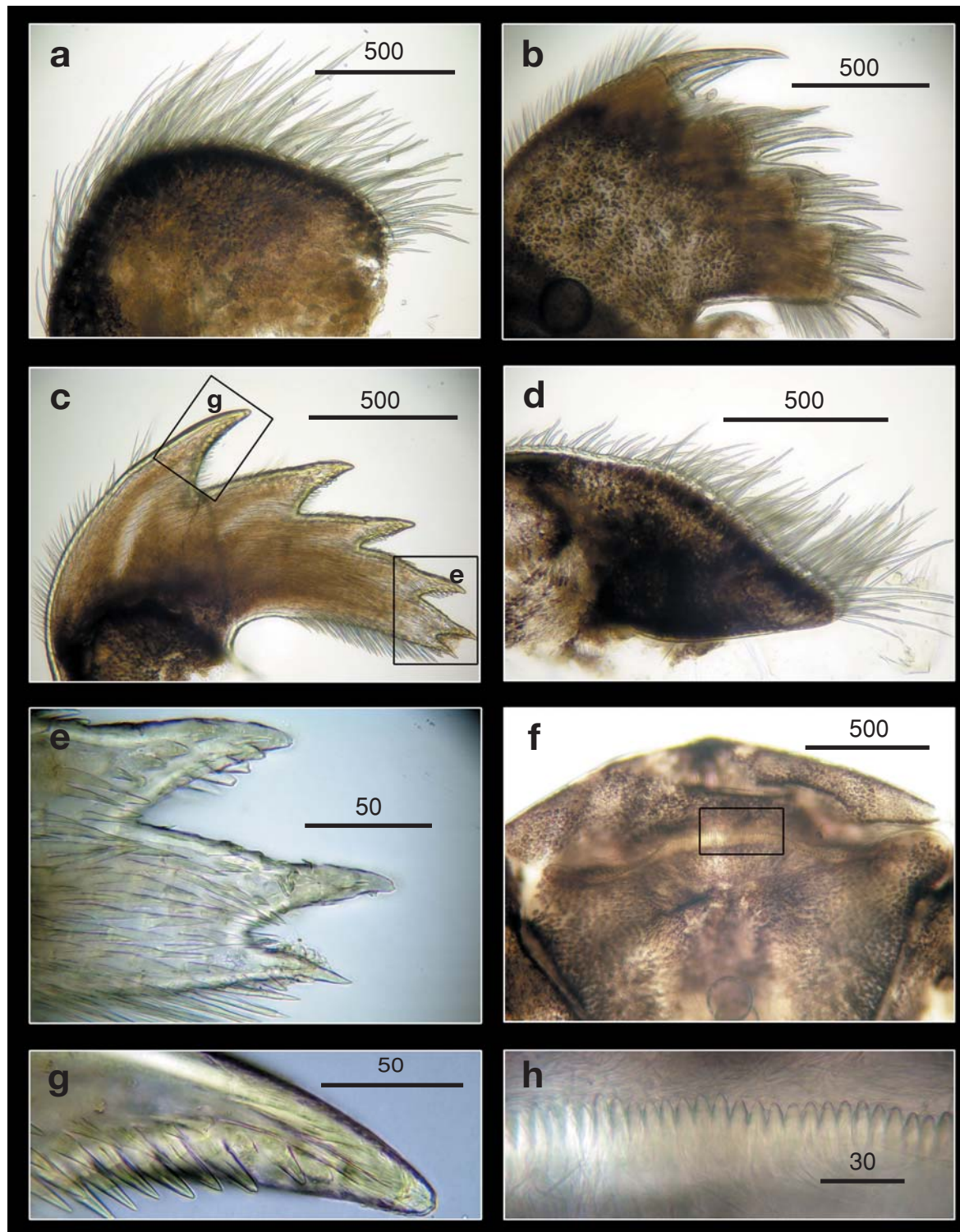


Fig. 47. *Conchoderma virgatum*, Kending, Pingtung County, Jun 2003. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Conchoderma hunteri (Owen, 1830)
細板條茗荷

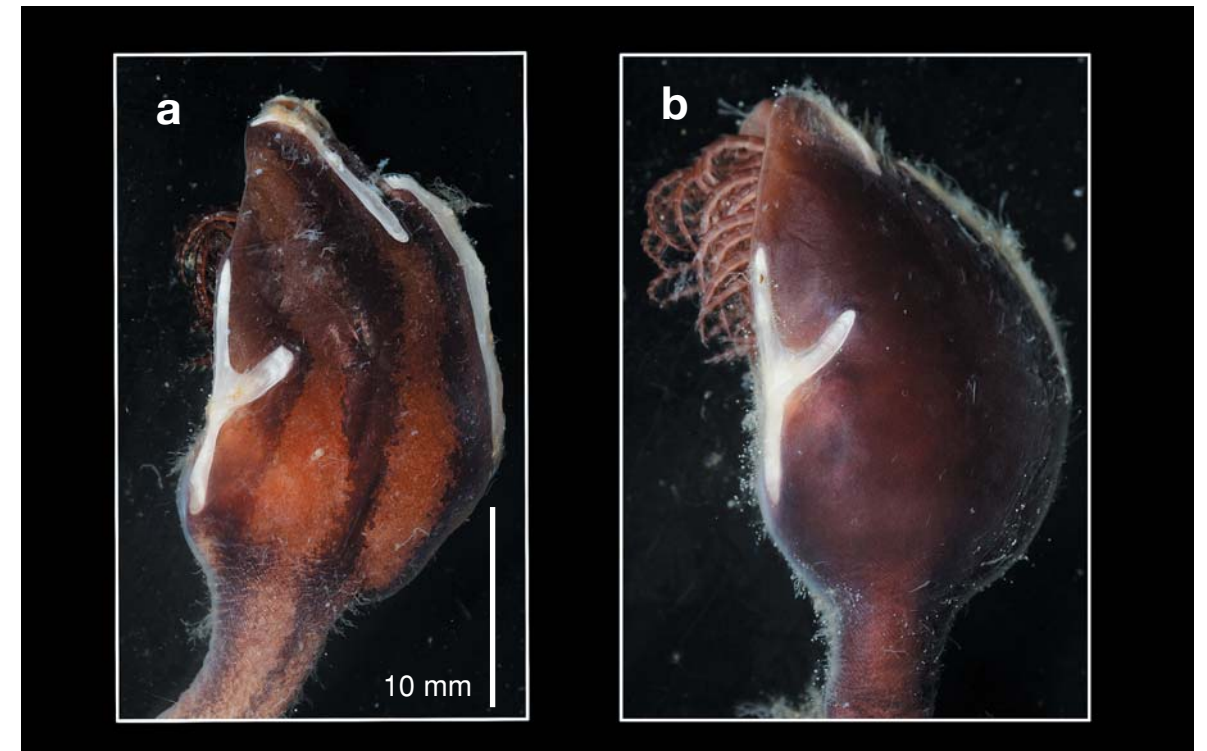


Fig. 48. *Conchoderma hunteri*, Tiaoshin, Taipei County, 2 Feb 2007. Side view of the capitulum showing a. Individuals with bands on capitulum, b. Individuals without bands on capitulum.

Cineras hunteri Owen, 1830 : 71 (not seen).

Conchoderma hunteri.—Darwin, 1851: 153, pl. 3, fig. 3.—Gruvel, 1905: 145, fig. 169.—Barnard, 1955: 247.

Conchoderma virgatum var. *hunteri*.—Annandale, 1909a: 82.—Krüger, 1911: 26, pl. 3, figs. 20-22.

Conchoderma virgatum var. *japonica*.—Krüger, 1911: 27, pl. 3, fig. 23.

Conchoderma virgatum forma *hunteri*.—Broch, 1931: 28.—Nilsson-Cantell, 1938: 27.

Conchoderma virgatum hunteri.—Hiro, 1937a: 63, fig. 53.—1937b: 402, fig. 6.—1939b: 205.—Utinomi, 1968a: 167.—1970: 341; Gordon, 1970: 21, fig. 6.—Dong et al., 1980: 125.—Zevina, 1982: 27, fig. 16.—Liu & Ren, 2007: 201, fig. 83.

Material examined.—Tiaoshih, Taipei County, 2 Feb 2007: 7 specimens (CL 16.11-19.72 mm, CW 10.27-13.14 mm, PL 9.03-10.75mm) (CEL-BB-94).

Diagnosis.—Capitulum deep-purple, with 5 valves, valves narrow and loosely separated. Scutum trilobed and Y-shaped, lateral lobe not wider than lower lobe; terga and carina narrow and bent; base of cirri I-IV with a single filamentary appendage. Peduncle cylindrical and smooth. Maxilla globular with dense setae on cutting margin; maxillule notched, with fine setae on cutting edge, strong setae on top; mandible with 4 major teeth excluding the inferior angle, teeth surface with sharp

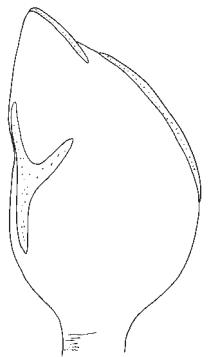


Fig. 49. *Conchoderma hunteri*, Tiaoshin, Taipei County, 2 Feb 2007. Line drawing showing the side view of the capitulum.

setae; mandibulatory palp triangular with setae on anterior margin; labrum slightly concave with numerous fine teeth. Base of cirrus I with 2 filamentary appendages, all other cirri with a single filamentary appendage except cirrus II; cirrus I (anterior ramus 17-segmented; posterior ramus 9-segmented), II (9, 9), III (14, 13), IV (10, 12), V (11, 12), VI (10, 13).

Size.—CL to 20 mm.

Coloration.—Dark-brown, seldom with longitudinal brown stripes.

Habitats.—Shallow-water species. Attaches onto subtidal ropes, sea snakes, and buoys.

Distribution.—Indo-Pacific Ocean.

Remarks.—New record for Taiwan.

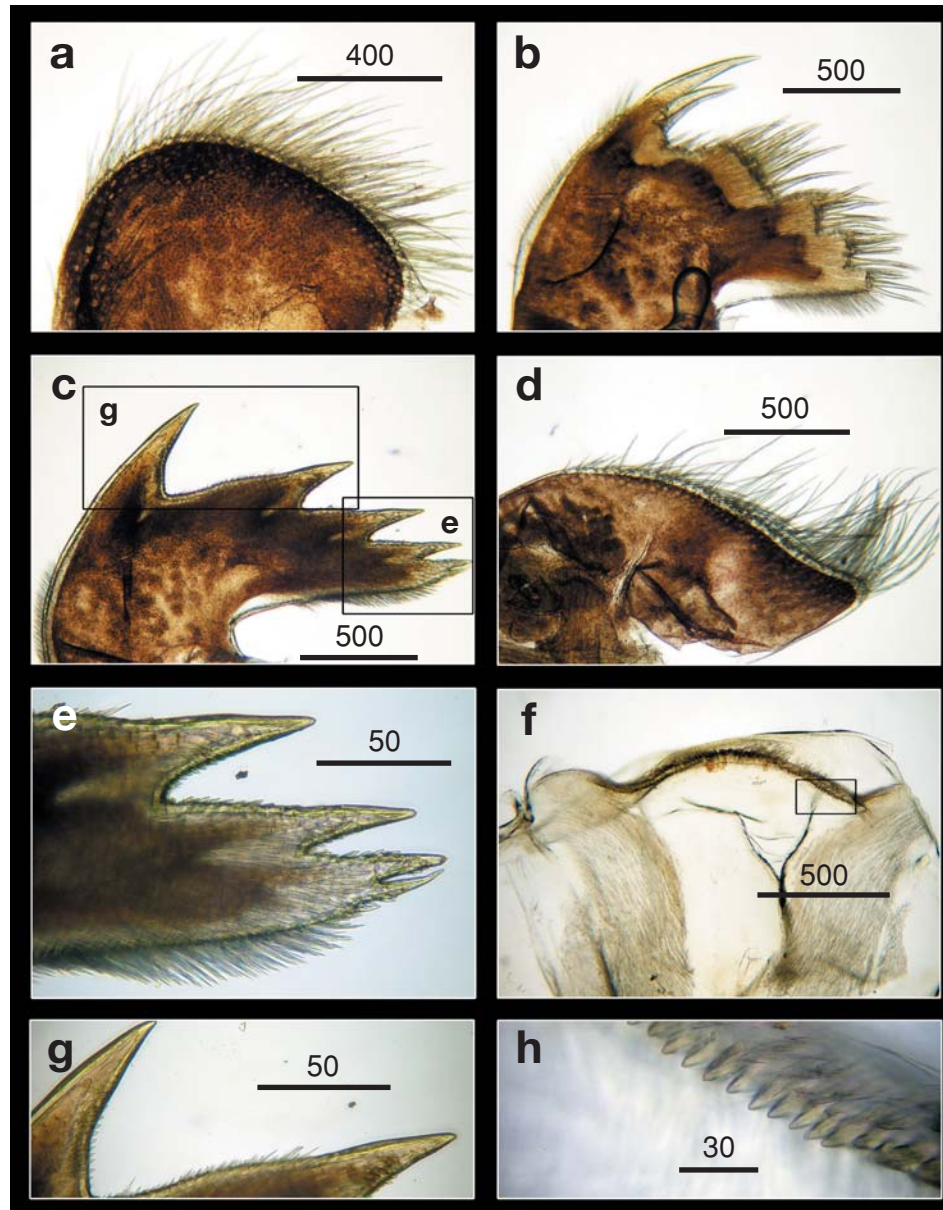


Fig. 50. *Conchoderma hunteri*, Tiaoshin, Taipei County, 2 Feb 2007. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in µm.

***Conchoderma auritum* (Linnaeus, 1767)**

耳條茗荷

Lepas aurita Linnaeus, 1767: 1110.

Conchoderma auritum.—Olfers, 1814: 117.—Hiro, 1939d: 248.

Material examined.—Kending, Pingtung County. Late Sadae Takahashi's collection no. 292, 294 (data from Hiro, 1939d).

Diagnosis.—Capitulum with ear-lobed structure, scutum bilobed.

Size.—CL to 30 mm.

Coloration.—Capitulum white with brown striations.

Distribution.—Cosmopolitan, usually on surfaces of *Coronula*.

Remarks.—At present, we have not yet collected this species. Record in Taiwan is from Hiro (1939d).

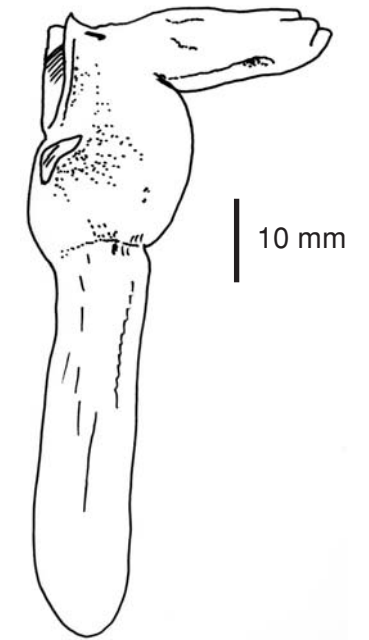


Fig. 51. *Conchoderma auritum*, Mainland China. Redrawn from Liu & Ren (2007).

Suborder HETERALEPADOMORPHA
(Nilsson-Cantell, 1921)
異茗荷亞目

Heteralepadidae Nilsson-Cantell, 1921: 245.

Heteralepadoidea.—Newman, 1987: 5.

Heteralepadomorpha.—Newman, 1987: 8.

Diagnosis.—Capitulum naked, without plates.

Remarks.—The Heteralepadomorpha includes 2 families, the Heteralepadidae and Koleolepadidae. In Taiwan, only the Heteralepadidae has been recorded.

Family HETERALEPADIDAE Nilsson-Cantell, 1921
異茗荷科

Heteralepadidae Nilsson-Cantell, 1921: 245.—Krüger, 1940: 447.—Newman, 1960: 108.—Newman et al., 1969: 278.—Foster, 1978: 15.—Zevina, 1980: 694.—Liu & Ren, 1985: 263.—2007: 121.

Diagnosis.—Capitulum naked, without opercular plates, walls thick; a filamentary appendage present at base of cirrus I, caudal appendage multi-segmented; posterior ramus of cirri V and VI reduced in *Heteralepas*; mandible with 4 major teeth excluding inferior angle.

Key to genera in Heteralepadidae from Taiwan

1. Posterior ramus of cirrus V and VI much reduced and shorter than the anterior ramus *Heteralepas*
Posterior and anterior rami of cirrus V and VI similar in length *Paralepas*

Genus *Heteralepas* Pilsbry, 1907
異茗荷屬

Alepas Rang.—Darwin, 1851: 156.—Aurivillius, 1894: 30.—Gruvel, 1905: 157.—Annandale, 1905: 80.—Hoek, 1907: 33.—Pilsbry, 1907b: 185.

Heteralepas Pilsbry, 1907a: 100.—Annandale, 1909a: 83.—Krüger, 1911: 29.—Nilsson-Cantell, 1921: 246.—Broch, 1922: 279.—Barnard, 1924: 62.—Newman, 1960: 108.—Newman et al., 1969: 278.—Ross, 1975: 17.—Foster, 1978: 15.—Zevina, 1980: 694.—Liu & Ren, 1985: 263.—2007: 123. Type species *Alepas rex* Pilsbry, 1907.

Diagnosis.—Maxillule strongly notched; filamentary appendage present at base of cirrus I, short; posterior ramus of cirri V and VI much reduced in length compared to anterior ramus.

Remarks.—This genus contains 20 species, and only 1 species was recorded in the present study.

Heteralepas japonica (Aurivillius, 1892)
日本異茗荷

Alepas japonica. Aurivillius, 1892: 125.—1894: 28, pl. 2, figs. 14, 15, pl. 8, figs. 3, 7, pl. 9, fig. 3.—Gruvel, 1905: 160, fig. 176.

Heteralepas japonica.—Pilsbry, 1911: 71.—Foster, 1978: 15, fig. 3, pl. 2a, b.—Liu & Ren, 1985: 264, fig. 50, pl. 12, fig. 14.—2007: 122-123, fig. 39.—Chan et al., 2009: 85, figs. 2-5.

Heteralepas (Heteralepas) dubia. Broch, 1922: 288.

Heteralepas (Heteralepas) japonica.—Nilsson-Cantell, 1921: 246, fig. 43, pl. 3, fig. 4.—1927: 755, fig. 6, pl. 1, figs. 2-4.—Broch, 1931: 41.

Material examined.—CD380, 24°38.598'N, 122°10.436'E, 456 m, on the surface of a deep-sea crab, 24 Jul 2007: 12 specimens (CL 1.1-2.4 mm, CW 1.0-1.4 mm).—Dasi fishing port, Yilan County, 17 Nov 1998: 13 specimens (CL 3.96-24.01 mm, CW 2.51-13.71 mm, PL 1.51-15.24 mm) (NMNS 003246-00001).

Diagnosis.—Capitulum white, rounded, with no hard valves; wall of capitulum thick; orifice crenulated. Mandible with 4 large teeth excluding inferior angle, short lower margin, setae blade-shaped; maxillule notched, 2 strong teeth on upper angle, blade-shaped setae on cutting margin; lateral region of mandible and maxillule with dense clump of setae; labrum concave, with 28 small teeth; maxilla bilobed, serrulate setae on each lobe. Cirrus I with unequal rami, anterior ramus shorter, 7-segmented, posterior ramus longer, 13-segmented; base of cirrus I with 1 filamentous appendage; cirri II-IV long and slender; cirrus II (anterior ramus 22-segmented, posterior ramus 25-segmented), cirrus III (48, 49), cirrus IV (62, 58), cirrus V (59, 59), cirrus VI (68, 18); intermediate segment of cirrus VI with 2 large and 2 fine setae. Each segment of cirri II-VI bearing 1 or 2 strong spines on lateral side; caudal appendage present, 6-segmented, 1/4 length of anterior ramus of cirrus VI.

Size.—CL to 40 mm.

Coloration.—Pale-yellow.

Habitat.—Deep-sea cables, gorgonian corals and hard rock substrata.

Distribution.—East China Sea, South China Sea, Japan, Singapore, New Zealand, Malacca Strait, Taiwan.

Remarks.—Nilsson-Cantell (1927) also noted the variability of cirral segments, mouth parts, and caudal appendages. Foster (1978) suggested an intensive revision of this genus should be conducted, due to the high variability of its morphological parts. Also see Chan et al. (2009).

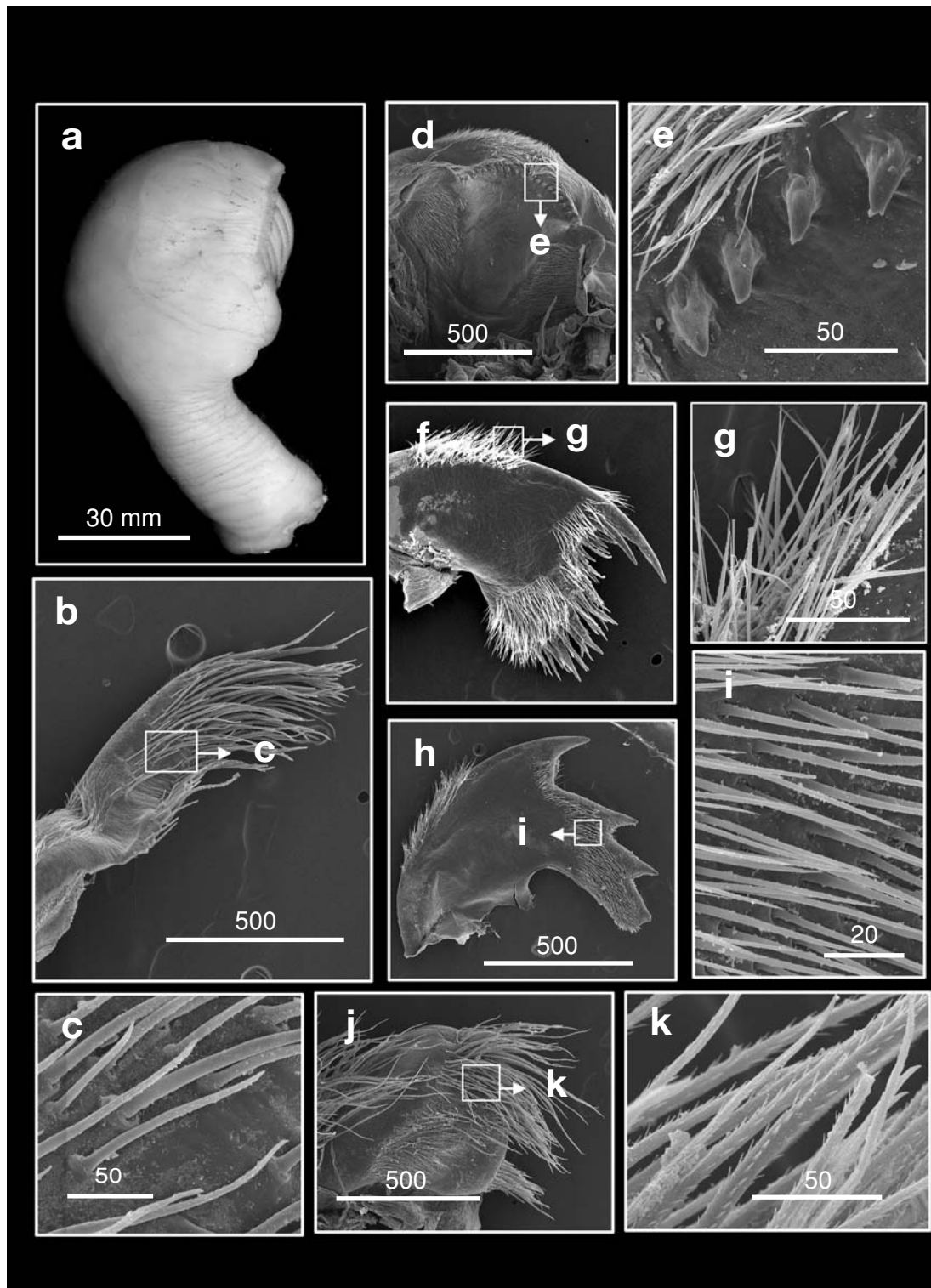


Fig. 52. *Heteralepas japonica*, CD380, 24 July 2007. a. Side view of the capitulum. Scanning Electron Microscopy on mouth parts. b. Mandibulatory palp, c. Setae on palp, d. Labrum, e. Teeth on labrum, f. Maxillule, g. Setae on maxillule, h. Mandible, i. Setae on mandibles, j. Maxilla, k. Setae on maxilla. Scale bars in μm .

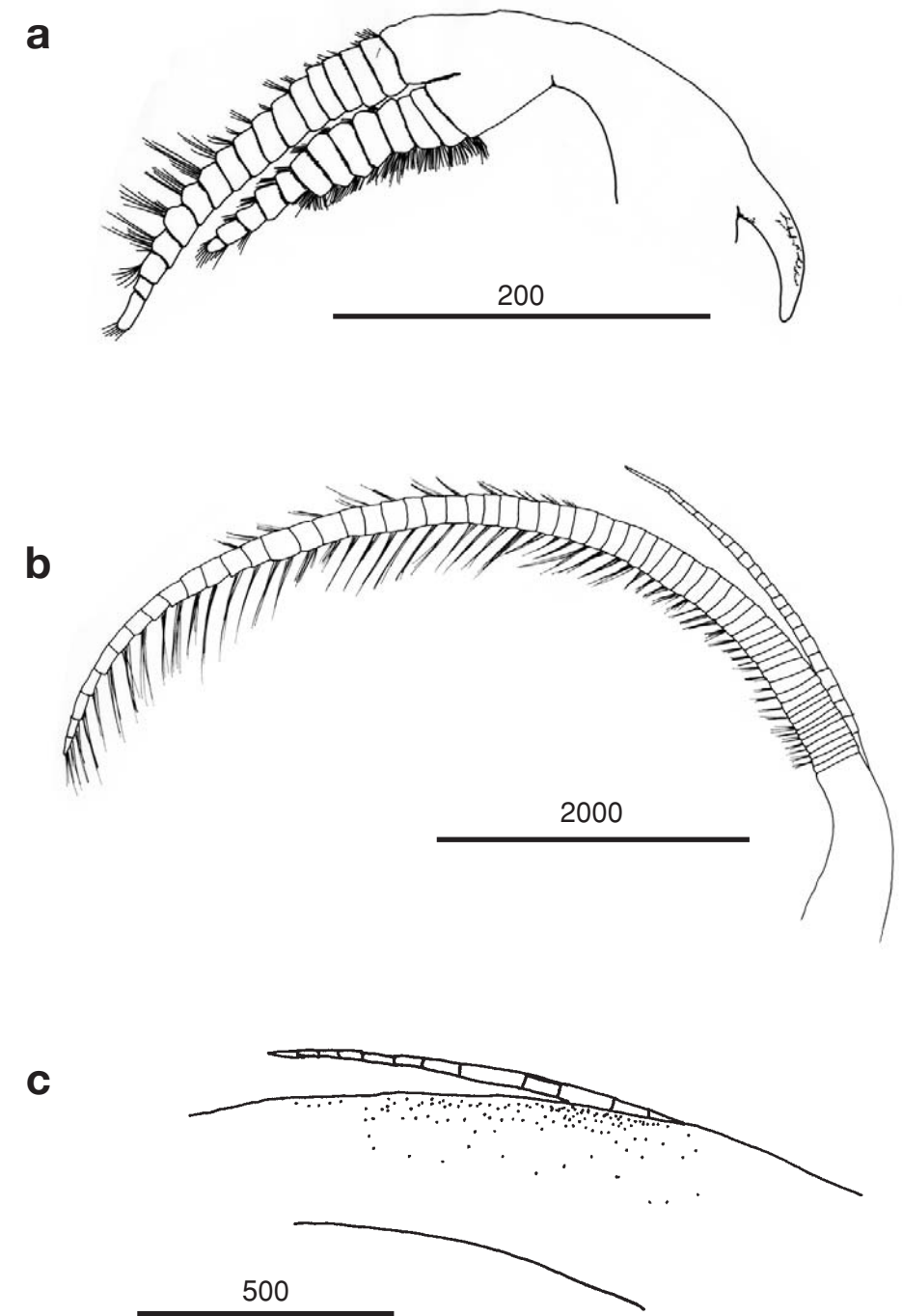


Fig. 53. *Heteralepas japonica*, CD380, 24 Jul 2007. Line drawing showing a. Cirrus I, b. Cirrus VI, c. Caudal appendage. Scale bars in μm .

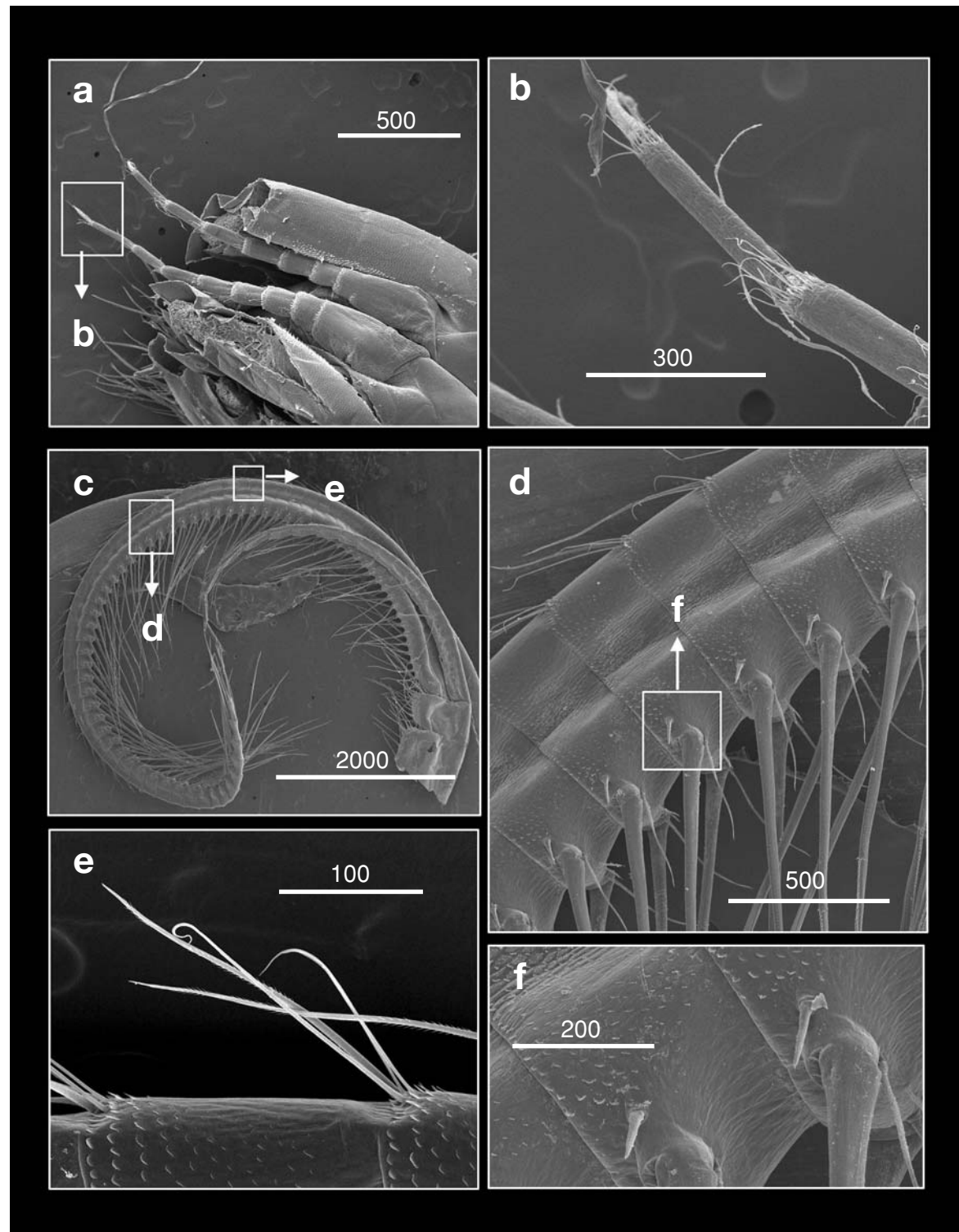


Fig. 54. *Heteralepas japonica*, CD380, 24 Jul 2007. Scanning Electron Microscopy on a. Entire view of caudal appendages, b. Tip of the caudal appendage, c. Cirrus VI, d. Intermediate segment of cirrus VI, e. Setae on the dorsal side of the Cirrus VI, f. Close up of the intermediate segment of cirrus VI. Scale bars in μm .

Genus *Paralepas* Pilsbry, 1907

擬茗荷屬

Alepas Rang.—Hoek, 1883: 56.—1907: 33.—Gruvel, 1905: 157.—Pilsbry, 1907b: 185.

Heteralepas Pilsbry, 1907a: 100.—Annandale, 1909a: 83.—Krüger, 1911: 29.—Nilsson-Cantell, 1921: 246.—Broch, 1922: 279.—Barnard, 1924: 62.

Paralepas Pilsbry, 1907a: 100 (as subgenus).—Newman, 1960: 108.—Newman et al., 1969: 278.—Liu & Ren, 1985: 266.—Liu & Ren, 2007: 125. Type species *Alepas percarinata* Pilsbry, 1907.

Diagnosis.—Maxillule not strongly notched, filamentary appendages well-developed, posterior and anterior rami of cirri V and VI similar in length, segment in cirri V and VI square-shaped.

Remarks.—There are 17 recorded *Paralepas* species, and 2 species have been recorded in Taiwan. *Paralepas minuta* is a new record for Taiwan (see Cai et al., in press).

Key to species of the *Paralepas* from Taiwan

1. Capitulum pale-yellow *Paralepas minuta*
- Capitulum purple *Paralepas quadrata*

Paralepas minuta (Philippi, 1836)
小擬茗荷



Fig. 55. *Paralepas minuta*, Donggang, Pingtung County, 26 Apr 2001. Side views of the capitulum.

Alepas minuta Philippi, 1836: tab. xii, fig. 23.—Darwin, 1851: 160.

Heteralepas (Paralepas) minuta.—Hiro, 1933: 51, text-fig. 15.

Paralepas minuta.—Stubblings, 1967: 240.

Material examined.—Donggang, Pingtung County, 26 Apr 2001: 6 specimens (CL 5.25-6.85 mm, CW 4.58-6.46 mm, PL 1.62-6.46 mm) (NMNS 003636-00050).—Donggang, Pingtung County, 2 Jan 2001: 1 specimen (CL 4.63 mm, CW 4.80 mm, PL 1.07 mm) (NMNS 003736-00004).

Diagnosis.—Small-sized. Capitulum globular, yellow, without valves, surface slightly wrinkled; orifice crenulated. Maxilla globular; maxillule notched, with 2 large and 1 small setae on upper notch; mandibles with 3 major teeth, 2nd and 3rd teeth with large denticles close to margin; mandibulatory palp elongated, with setae on upper side; labrum concave, with small sharp denticles. Anterior ramus of cirrus I flattened, 7-segmented, posterior ramus slender, 8-segmented; cirri II-VI similar in length; segments of anterior and posterior rami ranging 11-13; caudal appendages present, narrow, 1/2 length of cirrus VI, 7-segmented.

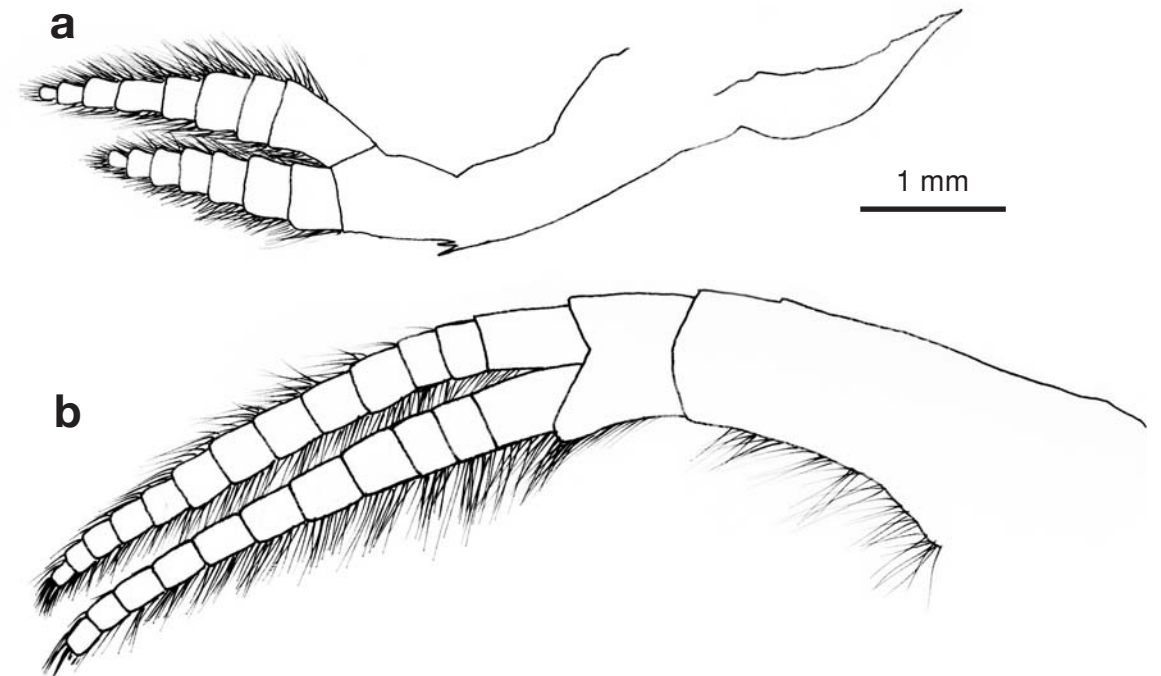


Fig. 56. *Paralepas minuta*, Donggang, Pingtung County, 26 Apr 2001. Line drawings of a. Cirrus I, b. Cirrus IV.

Size.—CL to 10 mm.

Coloration.—Pale-yellow.

Habitat.—This species often found on spines of sea urchins of *Stylocidaris* spp.

Distribution.—Mediterranean Sea, Japan, the Philippines.

Remarks.—*Paralepas minuta* was first identified in the Mediterranean Sea. Hiro (1933) identified this species in Japanese waters. However, neither illustration shows the cirri or mouth part morphology. Further studies should be conducted on the taxonomy of *Paralepas* in Pacific waters. This is a new record for Taiwan.

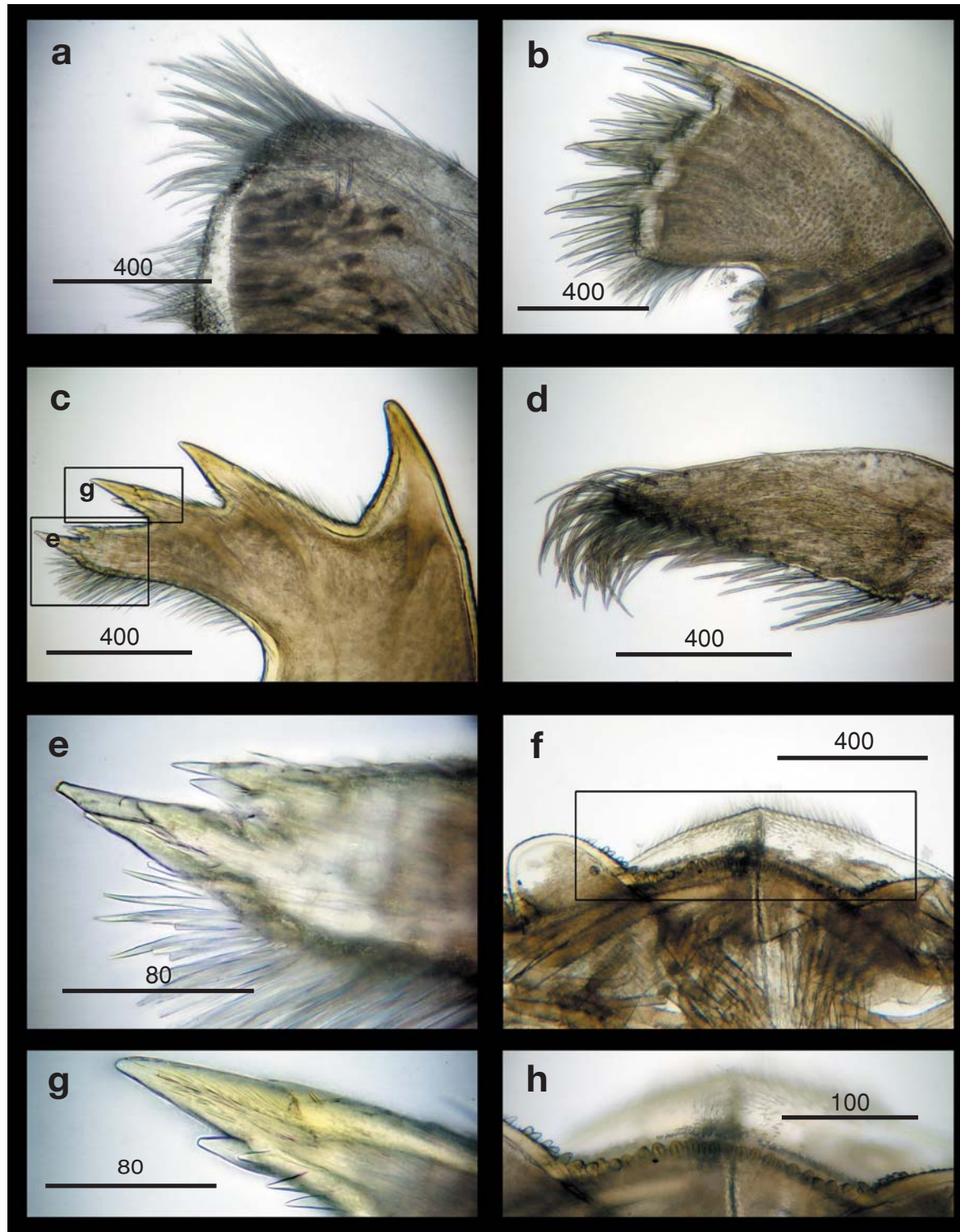


Fig. 57. *Paralepas minuta*, Donggang, Pingtung County, 26 Apr 2001. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Paralepas quadrata (Aurivillius, 1894)
方擬茗荷

Paralepas quadrata Aurivillius, 1894: 30, pl. 2, figs. 16-17, pl. 8, figs. 2, 6, 12.

Heteralepas quadrata.—Krüger, 1911: 30, figs. 50-53.

Heteralepas (Heteralepas) quadrata.—Nilsson-Cantell, 1921: 248.—Hiro, 1939d: 248.

Paralepas quadrata.—Jones et al., 2000: 236.

Materials examined.—Makung, Penghu County, Tamshui, Taipei County, Kaoshiung City (data from Hiro, 1939d).

Diagnosis.—Capitulum square or oval and purple.

Size.—Not available.

Coloration.—Capitulum deep-purple when alive.

Distribution.—Tropical to subtropical oceans.

Remarks.—At present, we have not yet collected this species in Taiwan.

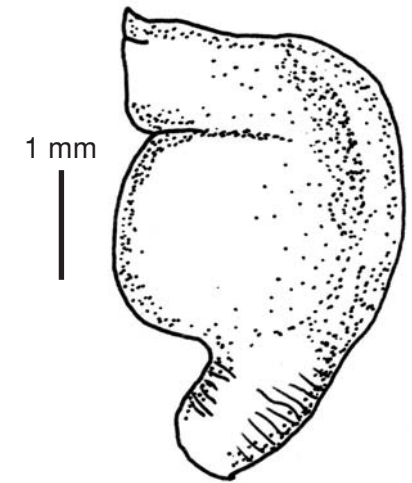


Fig. 58. *Paralepas quadrata*. Redrawn from Aurivillius, 1894.

Order SCALPELLIFORMES Buckeridge & Newman, 2006
鎧茗荷目

Diagnosis.—Capitulum comprising 5 primary plates of the Lepadiformes (carina, paired terga and scuta) and a rostrum. Umboes of these 5 primary plates apical.

Remarks.—Buckeridge & Newman (2006) revised the suborder Scalpellomorpha to an individual order Scalpelliformes. In Taiwan, 4 families were recorded from the Scalpelliformes, namely the Pollicipidae, Lithotryidae, Scalpellidae and Calanticidae.

Key to families of the Scalpelliformes

1. Capitulum 8 platesLithotryidae
Capitulum more than 8 plates2
2. Capitulum and peduncle of dwarf males clearly visibleCalanticidae
Dwarf male without capitulum and peduncle3
3. Capitulum has more than 18 platesPollicipidae
Capitulum has less than 18 platesScalpellidae

Family LITHOTRYIDAE Zevina, 1978
石茗荷科

Lithotryidae Zevina, 1978a: 999.—Liu & Ren, 1985: 182.—Liu & Ren, 2007: 220.

Diagnosis.—Capitulum with 8 plates (carina, paired scutum, tergum and rostral lateral, and rostrum), plates closely packed; carina and rostral lateral minute; plate surfaces strongly sculptured with horizontal lines, peduncle covered by fine scales; hermaphroditic, dwarf male absent.

Remarks.—Only 1 genus is included in the Lithotryidae.

Genus *Lithotrya* Sowerby, 1822
石茗荷屬

Lithotrya Sowerby, 1822 (not seen).—Darwin, 1851: 332.—Borradaile, 1900: 798.—Gruvel, 1905: 96.—Hoek, 1907: 122.—Pilsbry, 1907a: 6.—1953: 23.—Nilsson-Cantell, 1921: 213.—Barnard, 1924: 48.—Sewell, 1926: 269.—Hiro, 1937a: 42.—Newman et al., 1969: 277.—Zevina, 1978a: 999. Type species *Lithotrya dorsalis* (Ellis & Solander, 1786).

Diagnosis.—Capitulum with 8 plates (carina, paired scutum, tergum and rostral lateral, and rostrum), plates closely packed; carina and rostral lateral minute; plate surfaces strongly sculptured with horizontal lines; peduncle covered by fine scales; hermaphroditic, dwarf male absent; mandible with 3 teeth, caudal appendage multisegmented.

Remarks.—3 species have been recorded in *Lithotrya* worldwide, and 1 species is recorded in Taiwan. This is a new record for Taiwan.

Lithotrya nicobarica Reinhardt, 1850
尼科巴石茗荷

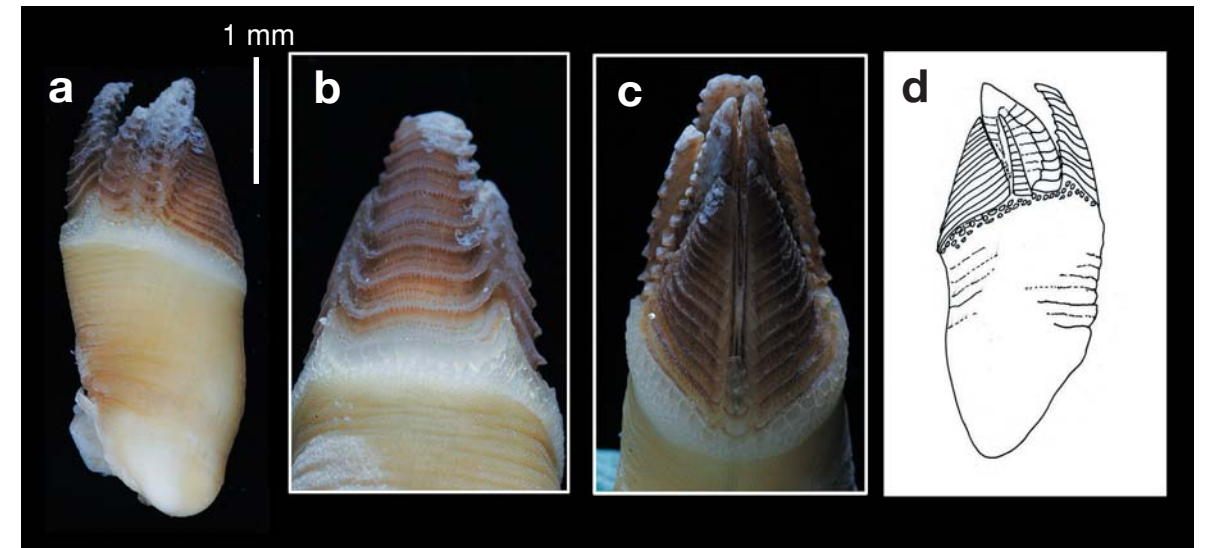


Fig. 59. *Lithotrya nicobarica*, Longkeng Bay, Kending, Pingtung County, 31 May 2007. a. Side view, b. Carinal view, c. Rostral view of the capitulum. d. Line drawing of the side view of the capitulum.

Lithotrya nicobarica Reinhardt, 1850 (not seen).—Darwin, 1851: 359; pl. 8, fig. 2.—Gruvel, 1905: 99, fig. 109.—Hoek, 1907: 122.—Nilsson-Cantell, 1921: 219.—Sewell, 1926: 269, fig. 1018, pl. 15, figs. 1-4.—Hiro, 1937a: 44.—Zevina, 1968: 35.—1978a: 1000.—Rosell, 1972: 150, pl. 3.—Liu & Ren, 1985: 182, fig. 1, pl. 3.

Material examined.—Longkeng Bay, Kending, Pingtung County, intertidal crevices, 31 May 2007: 2 specimens (CL 4.7-6.7 mm, CW 3.81-6.43 mm, PL 6.23-8.63 mm) (NMNS 005583-00001).

Diagnosis.—Capitulum with 8 plates (carina, paired scutum, tergum and rostral lateral, and rostrum), plates closely packed; carina and rostral lateral minute; plate surfaces strongly sculptured with horizontal lines. Peduncle covered by fine scales. Hermaphroditic, dwarf male absent. Mandible with 3 teeth, caudal appendage multisegmented.

Size.—CL to 20 mm.

Coloration.—Plates black, peduncle yellow.

Habitat.—Rock-boring species, inside limestone rocks and coral reefs.

Distribution.—Indo-Pacific waters.

Remarks.—New record for Taiwan.

Family CALANTICIDAE Zevina, 1978
盞茗荷科

Calanticinae Zevina, 1978a: 1000.—Liu & Ren, 1985: 185.

Calanticiidae.—Liu & Ren, 2007: 204.

Diagnosis.—Capitulum with 9-18 plates, closely packed; umbo of carina apex, umbo scutum apical or sub-apical; hermaphroditic with dwarf male, dwarf male body divided into capitular and peduncular parts.

Remarks.—3 genera of Calanticiidae were recorded in Taiwan in the present study.

Key to genera of Calanticiidae from Taiwan

1. Capitulum with 15 plates *Euscalpellum*
- Capitulum with 13 plates 2
2. Plates arranged in 2 distinct whorls *Calantica*
- Plates arranged in more than 3 whorls *Smilium*

Genus *Euscalpellum* Hoek, 1907
真鎧茗荷屬

Eu-Scalpellum Hoek, 1907: 59, 65.

Euscalpellum.—Pilsbry, 1908: 107.—Krüger, 1911: 17.—Hiro, 1933: 18.—Withers, 1953: 170.—Newman et al., 1969: 278.—Newman & Ross, 1971: 40.—Zevina, 1978a: 1001.—Liu & Ren, 1985: 190.—2007: 213. Type species *Scalpellum rostratum* Darwin, 1851.

Diagnosis.—Capitulum with 15 plates, rostrum large and protruding; inframedian latus rhombic; caudal appendage 1- or 2-segmented.

Remarks.—5 species are recorded worldwide, and 1 species was recorded in Taiwan. This is a new record for Taiwan (see Chan et al., 2009).

Euscalpellum rostratum (Darwin, 1851)
吻真鎧茗荷

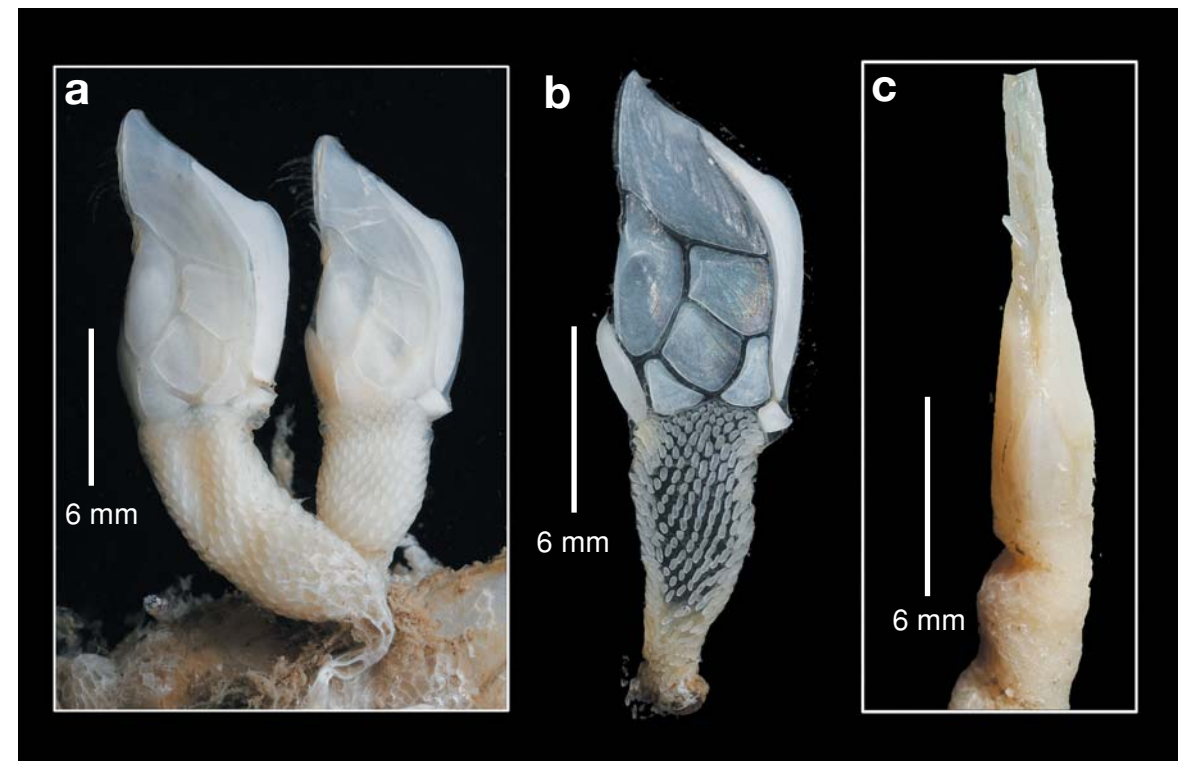


Fig. 60. *Euscalpellum rostratum*, CP164, 25 May 2002. a, b. Side view of the capitulum. c. Rostral view showing the rostrum.

Scalpellum rostratum Darwin, 1851: 259, pl.VI, fig. 7.

Scalpellum (Euscalpellum) rostratum.—Hoek, 1907: 65, pl. 5, fig. 13.—Stubbings, 1936: 19, fig. 7.

Euscalpellum rostratum.—Pilsbry, 1908: 107, figs. 1e-f.—Utinomi, 1968a: 162, fig. 1.—Zevina, 1978a: 1001.—Liu & Ren, 1985: 190, fig. 5, pl. 3, 1-2.—2007: 214, fig. 90.

Scalpellum (Smilium) rostratum.—Annandale, 1914: 274.

Smilium rostratum.—Broch, 1931: 14.—Nilsson-Cantell, 1938: 24, fig. 1.

Material examined.—CP164, 22°15.57'N, 120°35.56'E, 60-90 m, 25 May 2002: 1 specimen (CL 9.76 mm, CW 6.44 mm, PL 7.6 mm) (ASIZCR000225).—CP164, 22°15.57'N, 120°35.56'E, 60-90 m, 25 May 2002: 5 specimens (CL 8.44-13.92 mm, CW 4.46-7.80 mm, PL 4.77-7.96 mm) (CEL-BB-65).

Diagnosis.—Capitulum white, higher than wide, with 15 fully calcified plates. Tergum truncated, quadrangular, wider than high, occludent and basal margins entire, slightly convex, umbo apical; scutum irregularly shaped, occludent margin straight, while tergal, lateral, and basal margins convex, umbo sub-apical; upper latus pentagonal, tergal margin longest, an apex produced over scutal tergal angle, umbo apical; inframedian latus rhombic, diamond-shaped, umbo apical; rostral latus quadrangular, umbo apical; carinal latus quadrangular, umbo apical; rostrum well-developed, large, diamond-shaped; carina strongly bowed, umbo apical, roof wide, laterally convex; sub-carina quadrangular. Peduncle long, with dense fine scales. Maxilla

bilobed, setae distributed into 2 main clusters; maxillule cutting edge with a small notch close to apical region, cutting edge not straight, basal region below notch slightly extending outwards, 2 long setae above notch, 6 setae below notch, and 12 large setae located at extended basal region; mandible with 5 teeth excluding inferior angle, 1st tooth separated from remaining teeth, lower margin absent; mandibulatory palp elongated, with setae in tip region; labrum cutting edge concave, smooth, without teeth. Cirrus I separated from remaining cirri, rami unequal, posterior ramus longer, 13-segmented, anterior ramus shorter, 8-segmented; cirri II-VI rami sub-equal; cirrus II (anterior ramus 16, posterior ramus 13); caudal appendage short with 1 segment, length within basal pedicle segment of cirrus VI.

Size.—CL to 15 mm.

Coloration.—White.

Habitat.—Deep-sea species, attaches onto hydroids.

Distribution.—South China Sea, the Philippines, Malay Archipelago, Arabian Sea.

Remarks.—New record for Taiwan.

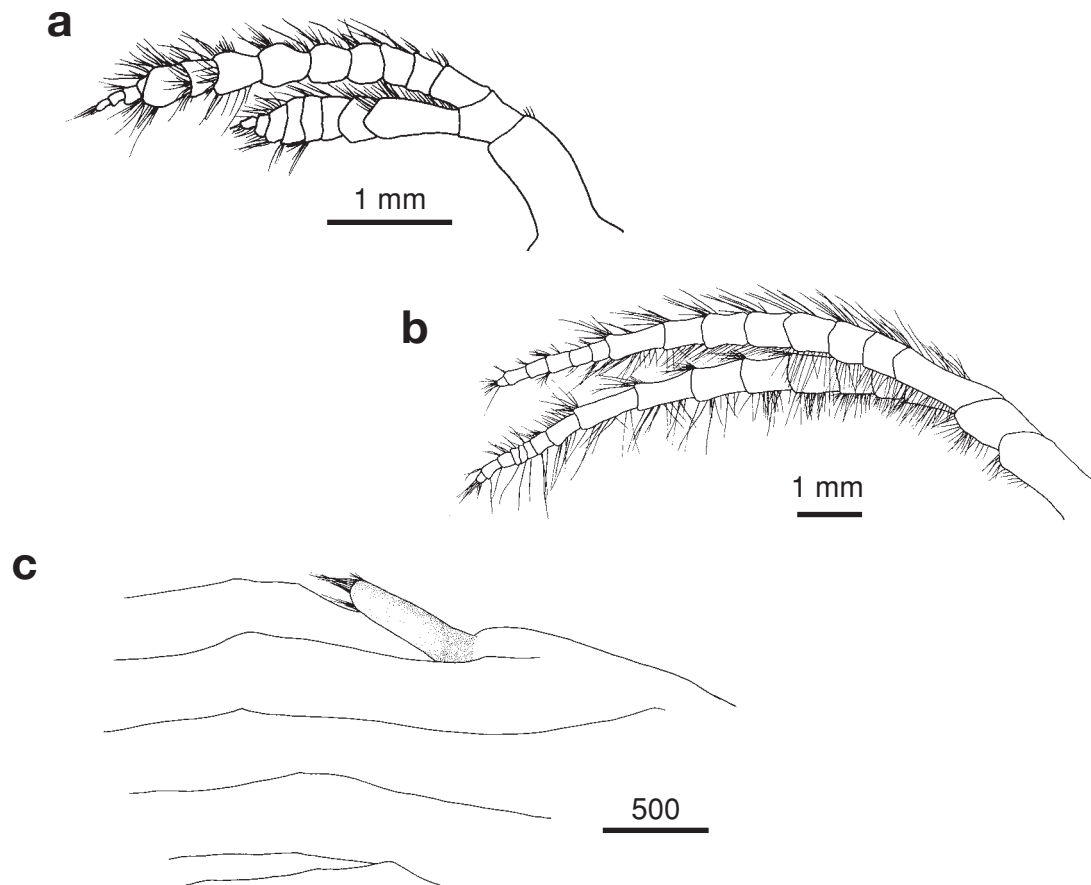


Fig. 61. *Euscalpellum rostratum*, CP164, 25 May 2002. Line drawings showing a. Cirrus I, b. Cirrus IV and c. Caudal appendage. Scale bars in μm

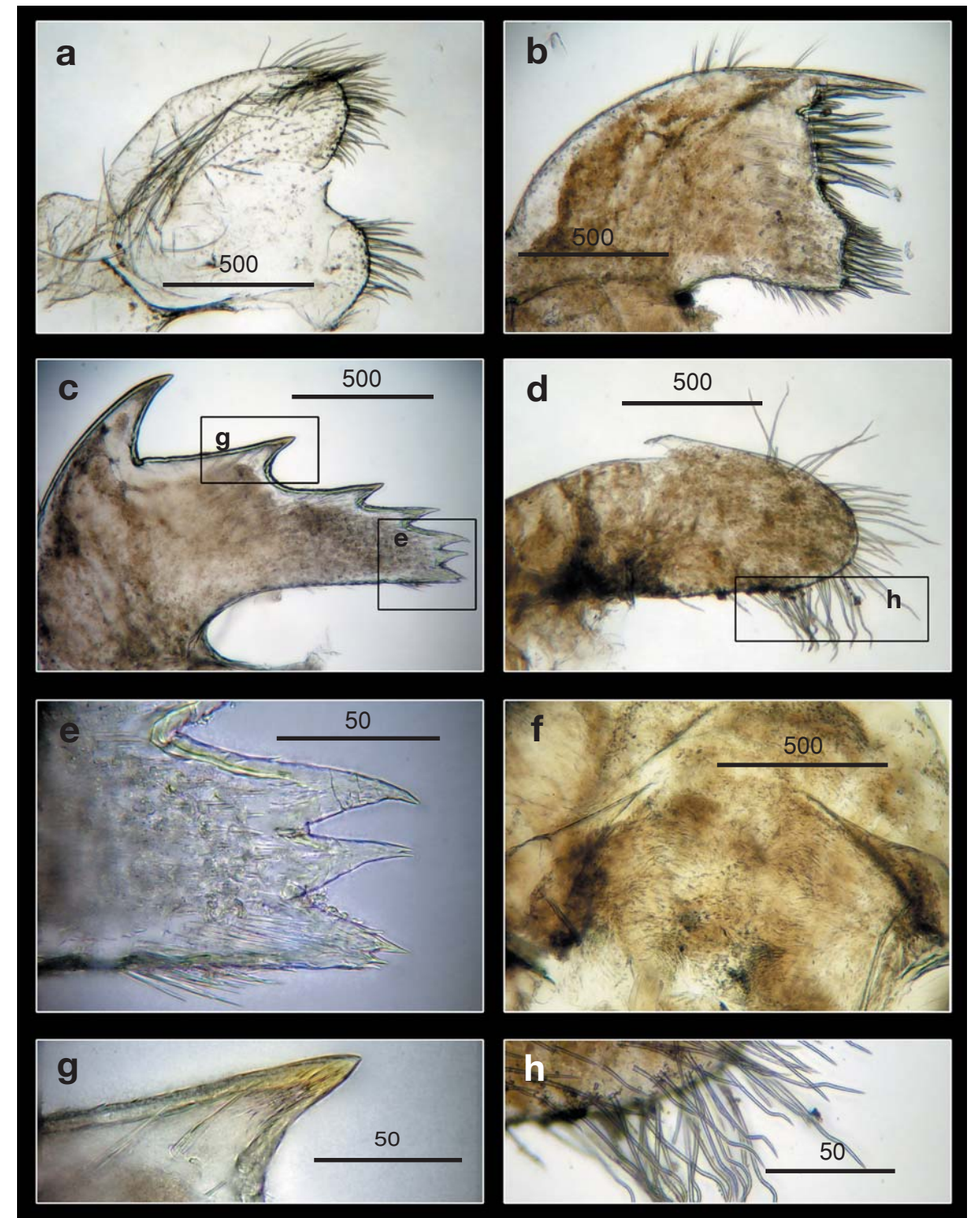


Fig. 62. *Euscalpellum rostratum*, CP164, 25 May 2002. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on setae of mandibulatory palp. Scale bars in μm .

Genus *Calantica* Gray, 1825
 盜茗荷屬

Calantica Gray, 1825: 101.—Zevina, 1978a: 1001.—1981: 51. Type species *Calantica homii* Gray.

Diagnosis.—Capitulum with 13 plates, arranged in 2 distinct rows. Upper rows always containing carina, scutum, and tergum.

Remarks.—1 species was recorded in the present study, which is a new record to Taiwan.

***Calantica quinqelatera* Hiro, 1932**
 側板盜茗荷

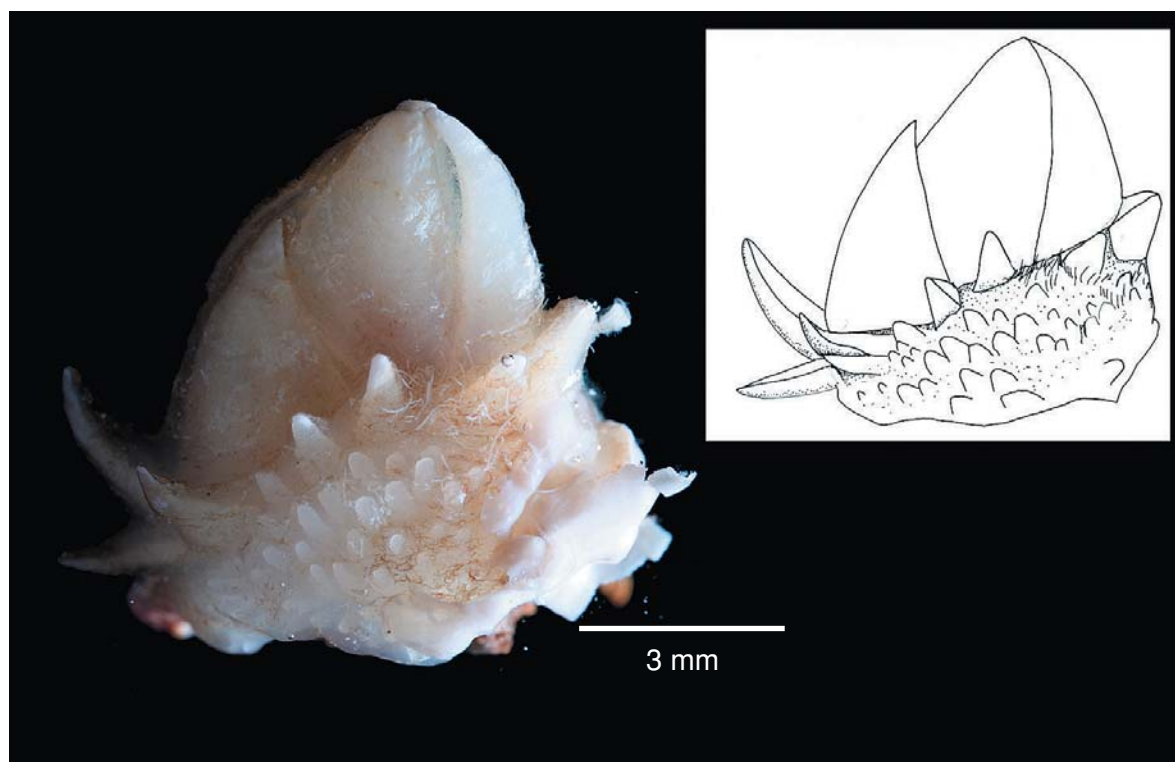


Fig. 63. *Calantica quinqelatera*, Longkeng Bay, Kending, Pingtung County, 31 May 2007. Side view of the capitulum.

Calantica quinqelatera Hiro, 1932a: 469, pl. 30, figs. 1-1b.

Material examined.—Longkeng Bay, Kending, Pingtung County, intertidal crevices, 31 May 2007: 2 specimens (CL 9.36-11.39 mm, CW 5.79-6.62 mm, PL 3.00-4.23mm) (CEL-BB-127).

Diagnosis.—Capitulum with 13 plates, plates divided into 2 whorls; upper whorls containing carina, scutum, and tergum; sub-carina triangular, strongly projecting outwards; rostrum large and horn-shaped, apex projecting strongly out of capitulum; sub-rostrum quadrilateral triangular-shaped; peduncle with large scales.

Size.—CL to 15 mm.

Coloration.—White.

Habitat.—Intertidal rocks.

Distribution.—West Pacific Ocean.

Remarks.—New record for Taiwan.

Genus *Smilium* Leach, 1825
 刀茗荷屬

Smilium Leach, 1825: 209.—Pilsbry, 1907a: 13.—Broch, 1922: 234.—1931: 13.—Barnard, 1924: 11.—Withers, 1928: 36.—1953: 168.—Nilsson-Cantell, 1938: 24.—Newman et al., 1969: 278.—Newman & Ross, 1971: 37.—Zevina, 1978a: 1001.—Liu & Ren, 1985: 185. Type species *Smilium peronii* Gray, 1825.

Diagnosis.—Capitulum with 13 plates, rostral latus absent, sub-carina present.

Remarks.—3 species have been recorded in Taiwan. 2 species are new to Taiwan (see Cai et al., in press).

Key to species of the *Smilium* from Taiwan

1. Capitular plates closely packed *Smilium acutum*
 Capitular plates not closely packed, plates separated by a distance 2
2. Basal verticillate plates of capitulum curved inwards *Smilium sinense*
 Basal verticillate plates of capitulum curved outwards *Smilium scorio*

Smilium sinense (Annandale, 1910)
華刀茗荷

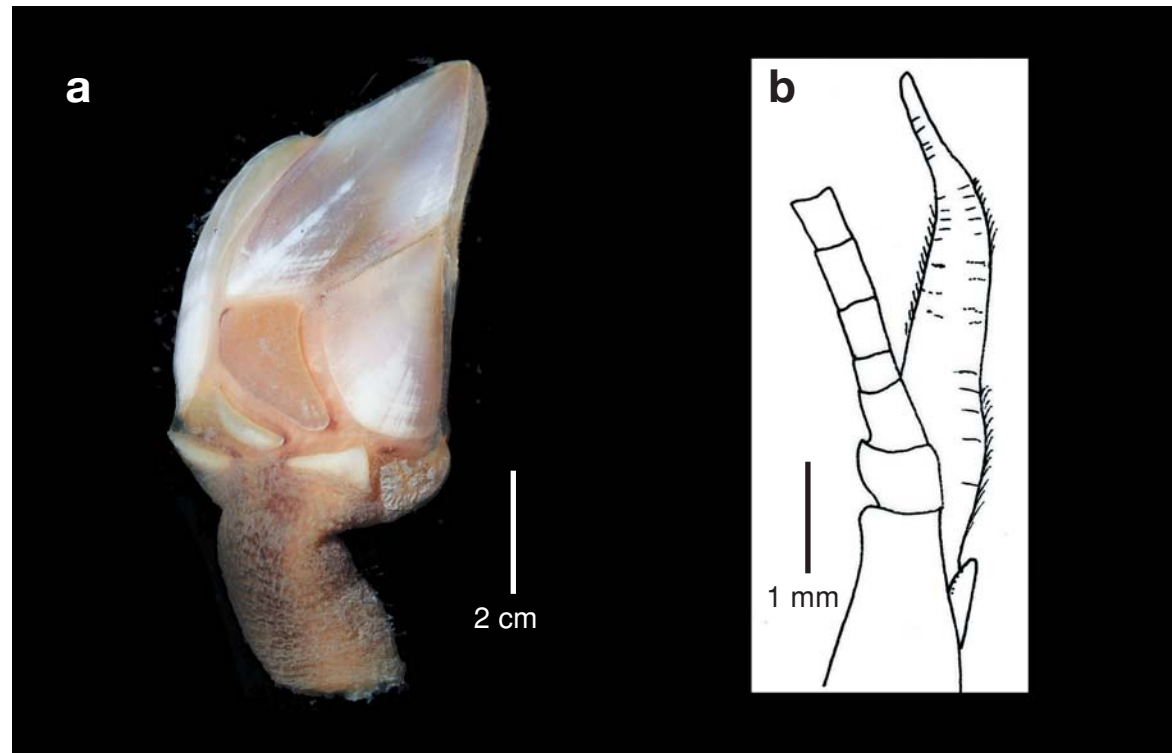


Fig. 64. *Smilium sinense*, Jhongyun, Kaohsiung County, 29 Feb 1996. a. Side view of capitulum. b. Penis. For clarity, the rami of cirrus VI was not complete.

Scalpellum (Smilium) sinense Annandale, 1910: 211, pl. 3, fig. 3.—1914: 274, pls. 33, 34.—Withers, 1953: 170, fig. 71.

Smilium sinense.—Zevina, 1978a: 1001.—Liu & Ren, 1985: 189, fig. 4.—Ren, 1991: 171, fig. 2-2.

Material examined.—Jhongyun, Kaohsiung County, on gorgonium, 29 Feb 1996: 7 specimens (CL11.49-18.61 mm, CW 9.41-11.40 mm, PL 7.24-11.83 mm) (NMNS 003000-00212).

Diagnosis.—Capitulum quadrilateral, with 13 smooth plates. Tergum and upper latus triangular, umbo apical; scutum quadrilateral, umbo apical; carina bowed; sub-carina triangular, carinal latus triangular, wider than high, inframedian latus triangular, wider than high, rostrum quadrilateral, flattened.

Size.—CL to 20 mm.

Coloration.—Opercular plates purple.

Distribution.—China Sea, Andaman Sea.

Remarks.—New record for Taiwan.

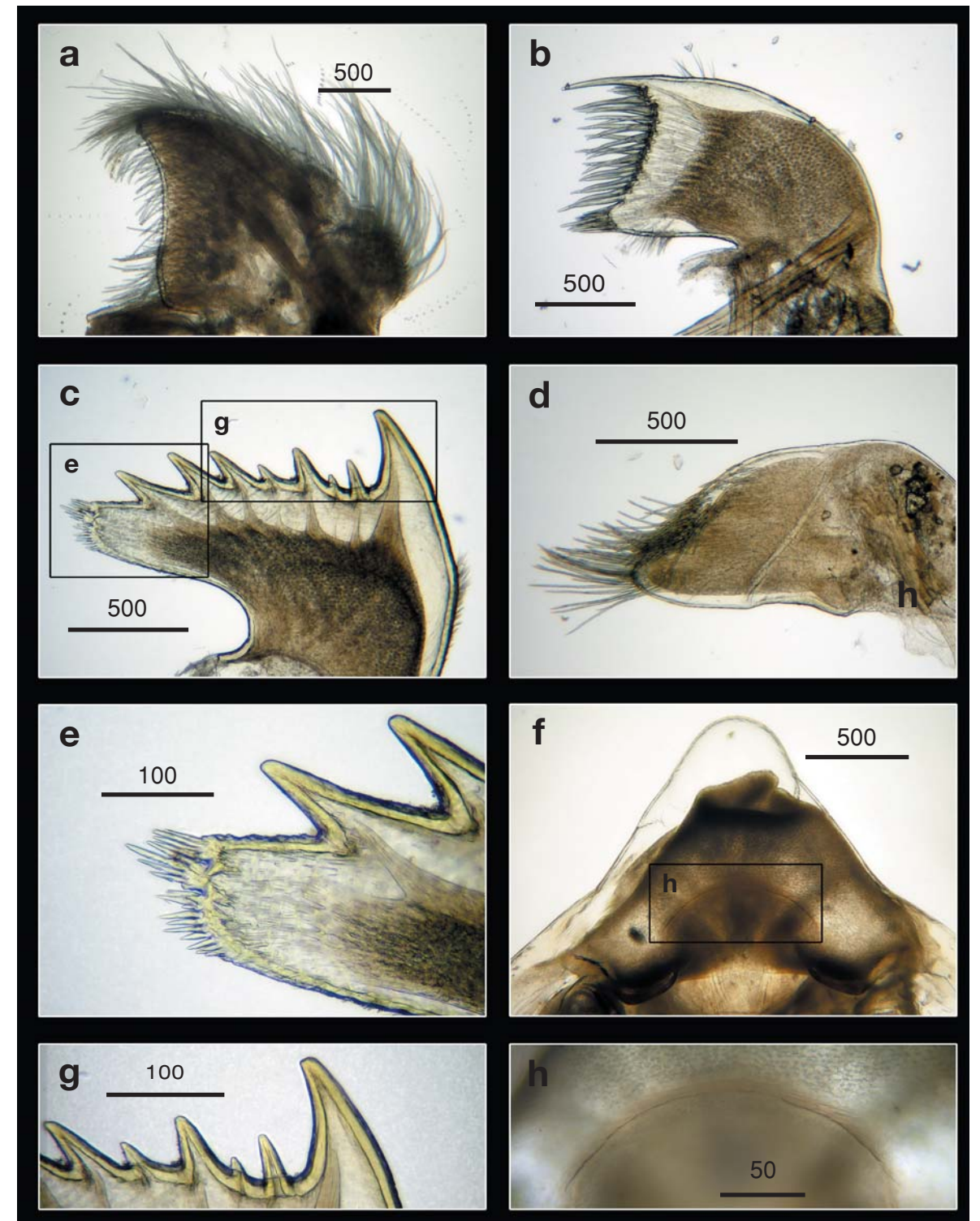


Fig. 65. *Smilium sinense*, Jhongyun, Kaohsiung County, 29 Feb 1996. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum. Scale bars in μm .

Smilium acutum (Hoek, 1883)
尖刀茗荷

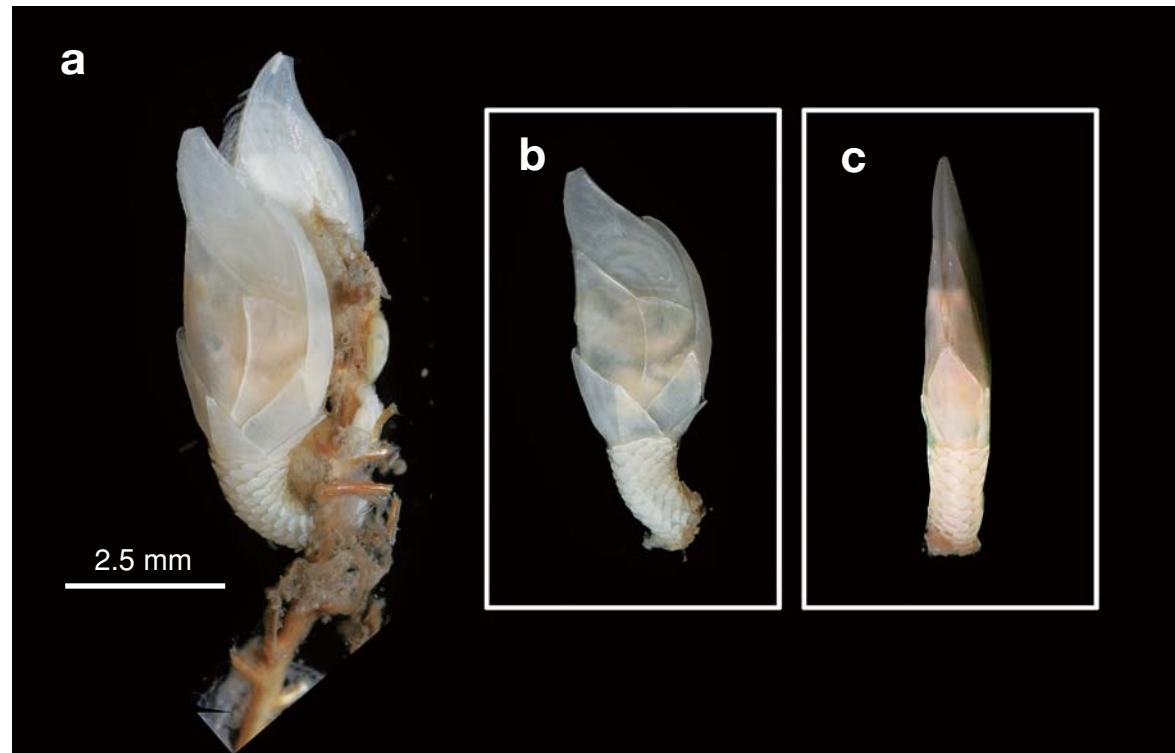


Fig. 66. *Smilium acutum*, CP314, 17 Aug 2005. a, b. Side view and c. Rostral view showing the large rostrum.

Scalpellum acutum Hoek, 1883: 80, pl. 3, fig. 19, pl. 8, fig. 12 [type locality: Near Azores, Atlantic, and near Kermadec Island, Pacific].—1907: 64, pl. 7, fig. 1.—Weltner, 1897: 246.—Gruvel, 1905: 56, fig. 60.—1920: 12, pl. 2, fig. 7.—Nilsson-Cantell, 1921: 170, fig. 23.

Smilium acutum.—Pilsbry, 1908: 107.—Krüger, 1911: 15.—1940: 60.—Broch, 1922: 234, fig. 5.—Hiro, 1933: 17, pl. 1, fig. 3.—1937b: 390.—Stubbings, 1936: 57.—Nilsson-Cantell, 1938: 6.—Withers, 1953: 170, fig. 70.—Utinomi, 1958: 283.—Newman & Ross, 1971: 38.—Zevina, 1978a: 1001.—Liu & Ren, 1985: 185, fig. 2, pl. 1, figs. 6-9.

Material examined.—CP314, 21°40.072'N, 117°43.123'E, 506.2 -509.2 m, 17 Aug 2005: 3 specimens (CL 5.05-6.74 mm, CW 2.47-3.16 mm, PL 2.61-3.39 mm) (NMNS 005087-00085).

Diagnosis.—Capitulum elongated, higher than wide, with 13 plates (sub-carina present). Tergum triangular, basal margin slightly convex, umbo apical; scutum quadrilateral, occludent margin straight; upper latus trapezoidal, carinal latus rhombic, umbo apical; inframedian latus triangular, umbo apical; rostrum wide, pentagonal, sub-carina triangular, narrow; carina short, slightly curved. Maxilla triangular, setae evenly distributed on cutting margin; maxillule notched, 2 large cuspidate setae above notch, 8-10 setae below notch; mandible with 3 teeth, lower margin pectinated; mandibulatory palp elongated, setae on superior margin; labrum cutting edge concave with small fine teeth.

Size.—CL to 7 mm.

Coloration.—Capitular plates and peduncle white.

Distribution.—Worldwide distributed species.

Remarks.—New record for Taiwan.

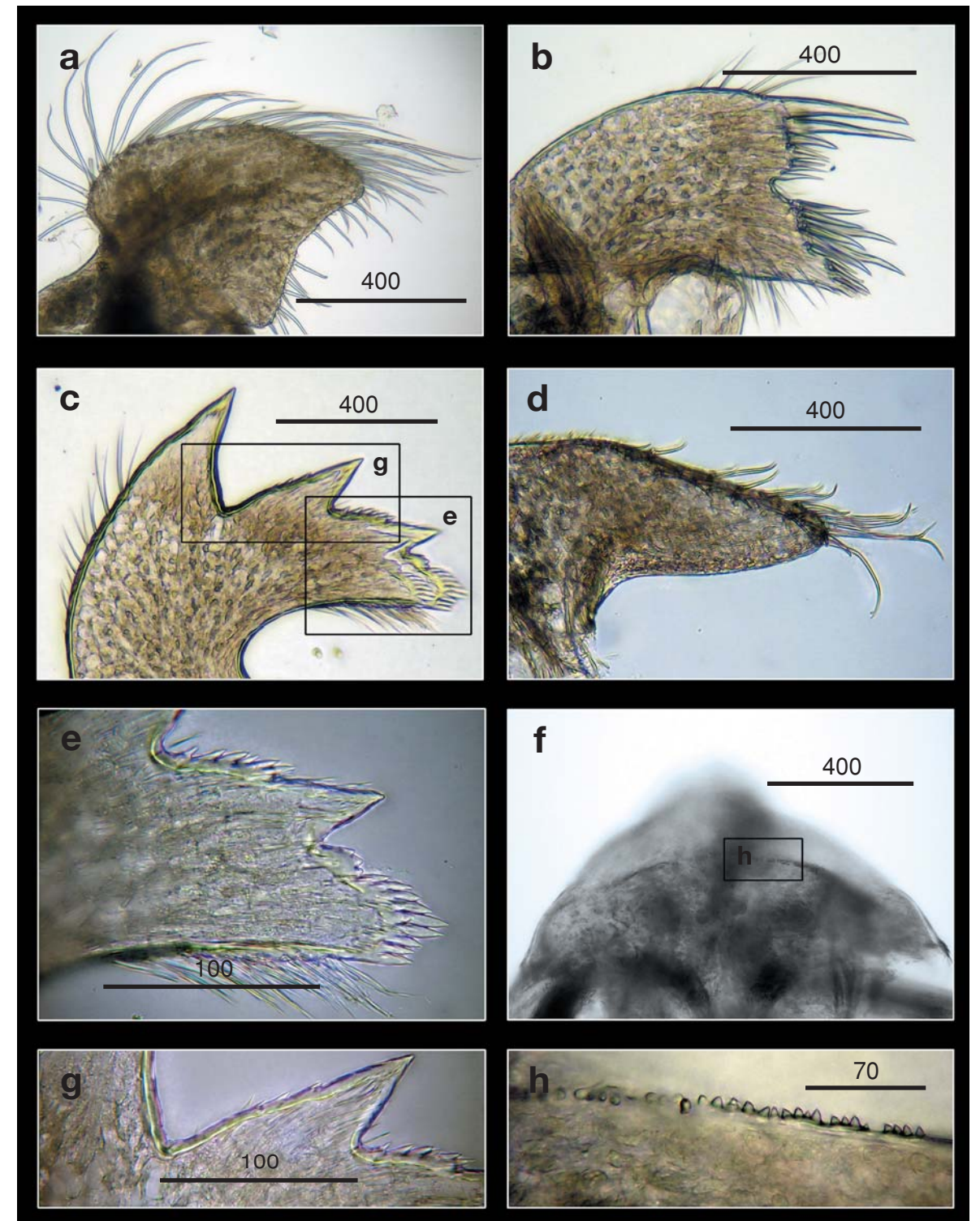


Fig. 67. *Smilium acutum*, CP314, 17 Aug 2005. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

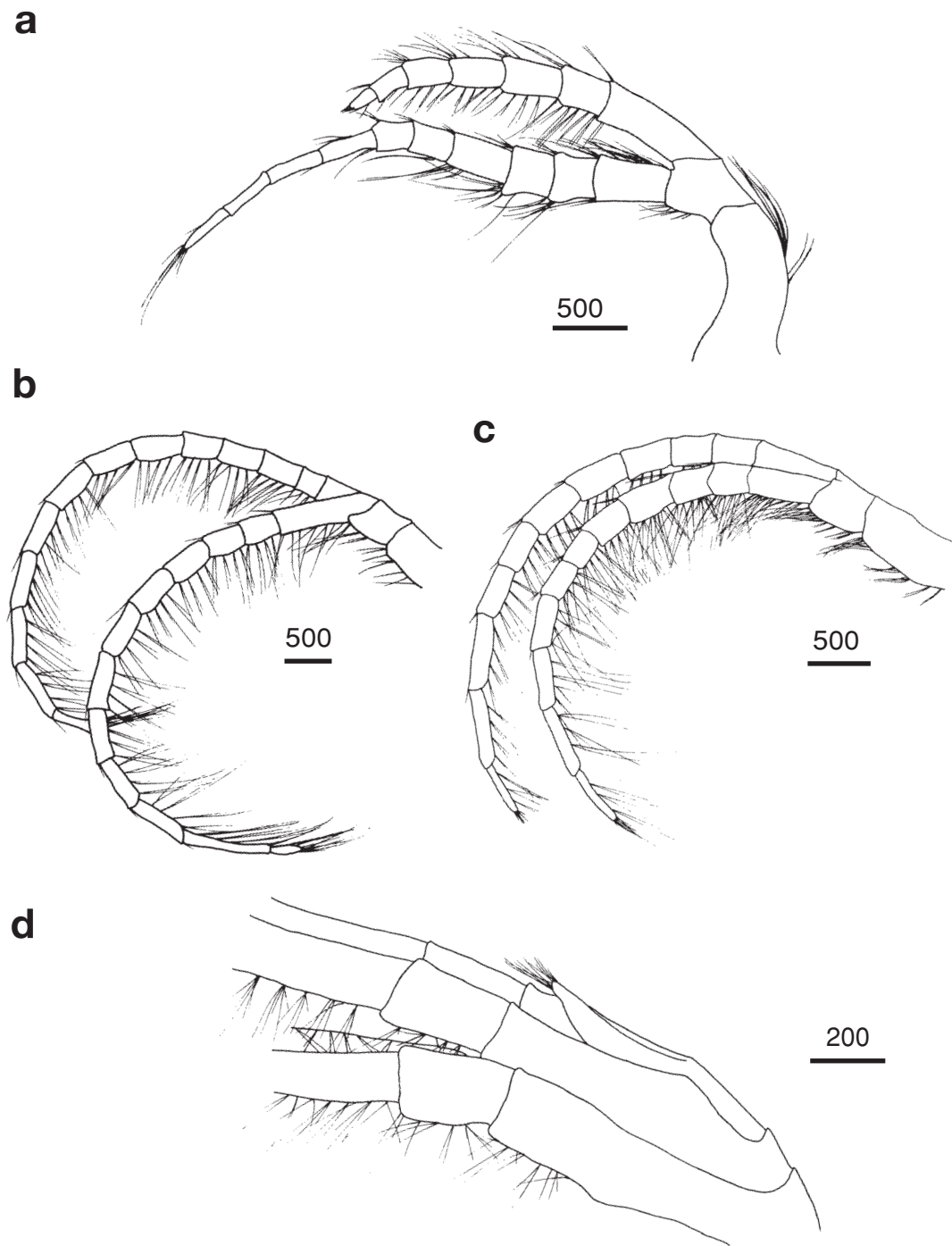


Fig. 68. *Smilium acutum*, CP314, 17 Aug 2005. Line drawing showing a. Cirrus I, b. Cirrus II, c. Cirrus III and d. Caudal appendage. Scale bars in μm .

Smilium scorpio (Aurivillius, 1892)
棘刀茗荷

Scalpellum scorpio Aurivillius, 1892: 126.
Smilium scorpio.—Pilsbry, 1908: 107.—Liu & Ren,
1985: 187, fig. 3.—Liu & Ren, 2007: 210, fig. 88.
Calantica scorpio.—Nilsson-Cantell, 1921: 174.—
Broch, 1931: 6, fig. 2.

Material examined.—Taiwan Strait, depth 70 m
(data from Broch, 1931)

Diagnosis.—Capitulum quadrilateral, with 13
plates. Tergum the largest plate, scutum triangular;
carinal-latus and rostral-latus horn-shaped and bent
downwards.

Size.—CL to 18 mm (data from Liu & Ren, 2007).

Coloration.—Capitulum pale-yellow.

Distribution.—Indo-Pacific waters.



Fig. 69. *Smilium scorpio*, Taiwan Strait. Redrawn
from Broch (1931).

Family POLLICIPIDAE Leach, 1817
指茗荷科

Pollicipidae Leach, 1817 (not seen).

Pollicipinae Gruvel, 1905: 16.—Zevina, 1978a: 1002.

Diagnosis.—More than 18 capitular plates, lateral plates numerous, all plates with an apical umbo; hermaphroditic, dwarf male present or absent, dwarf males with capitular and stalked parts.

Remarks.—The Pollicipidae consists of 2 genera, *Capitulum* and *Pollicipes*. In Taiwan, only *Capitulum* has been recorded.

Genus *Capitulum* Gray, 1825
龜足屬

Capitulum Gray, 1825 (not seen).—Darwin, 1851: 293. Type species *Lepas mitella* Linnaeus, 1758.

Diagnosis.—Capitulum with 8-10 plates; hermaphroditic; dwarf male absent.

Remarks.—Only 1 species has been recorded in Taiwan waters.

Capitulum mitella (Linnaeus, 1758)
龜足

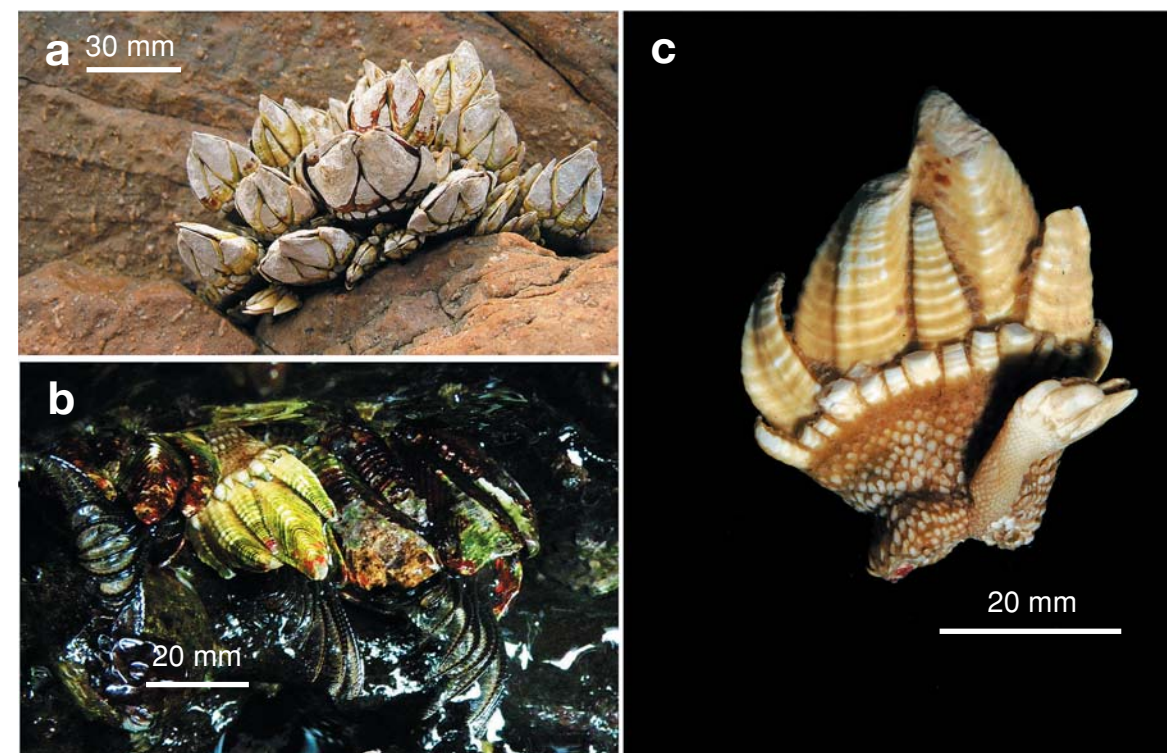


Fig. 70. *Capitulum mitella*, Shihmen, Taipei County, 8 May 1996. a. A colony on rocky shores. b. Individuals extending their cirri during high tides at Hepingdao. c. Side view of the capitulum.

Lepas mitella Linnaeus, 1758: 668.

Pollicipes mitella.—Sowerby, 1833: fig. 2.—Darwin, 1851: 316, pl. 7, fig. 3.—Nilsson-Cantell, 1921: 163, pl. 3, figs. 7-8.—Utinomi, 1970: 340.—Rosell, 1972: 148.—Zevina, 1978a: 1002.—Dong et al., 1980: 124.

Mitella mitella.—Pilsbry, 1907a: 6.—Krüger, 1911: 8, pl. 2, figs. 10, 11.—Annandale, 1916a: 128, pl. 12, fig. 1.—Broch, 1922: 258, fig. 20.—1931: 27.—Hiro, 1932b: 546.—1937a: 23, fig. 16.—1939b: 202.—Withers, 1953: 102.—Dong & Mao, 1956: 287, fig. 2.—Tarasov & Zevina, 1957: 121, fig. 33.—Shen et al., 1962: 59.—Zevina & Tarasov, 1963: 77.—Gordon, 1970: 44, fig. 14.

Capitulum mitella.—Foster, 1980: 209.—Liu & Ren, 2007: 218, fig. 92.

Material examined.—Shihmen, Taipei County, 8 May 1996: 10 specimens (CL 7.31-38.6 mm, CW 7.15-26.5 mm) (NMNS 003000-00200).—HouDaiZih, Penghu County, 15 Jul 1994: 8 specimens (CL 20.2-41.3 mm, CW 19.5-28 mm) (NMNS 003000-00199).

Diagnosis.—Capitulum fan-shaped, with 8 plates, base with 18-25 smaller plates. All plates with an apical umbo, plates yellow. Peduncles covered by numerous fine scales. Maxilla globular; maxillule slightly notched, notch located in anterior portion, 2 large cuspidate setae above notch; mandibles with 5 teeth excluding inferior angle, 4th teeth smallest; mandibulatory palp elongated, with setae on all margins; labrum concave but without teeth on cutting surface.

Size.—CL to 60 mm.

Coloration.—Plates and peduncle yellowish-green, cirri and penis black.

Distribution.—Indo-Pacific region.

Remarks.—*Capitulum mitella* is a common intertidal barnacle in Indo-Pacific waters. It is sold as a commercially important seafood in Japan, China, and outlying islands of Taiwan including Matsu.

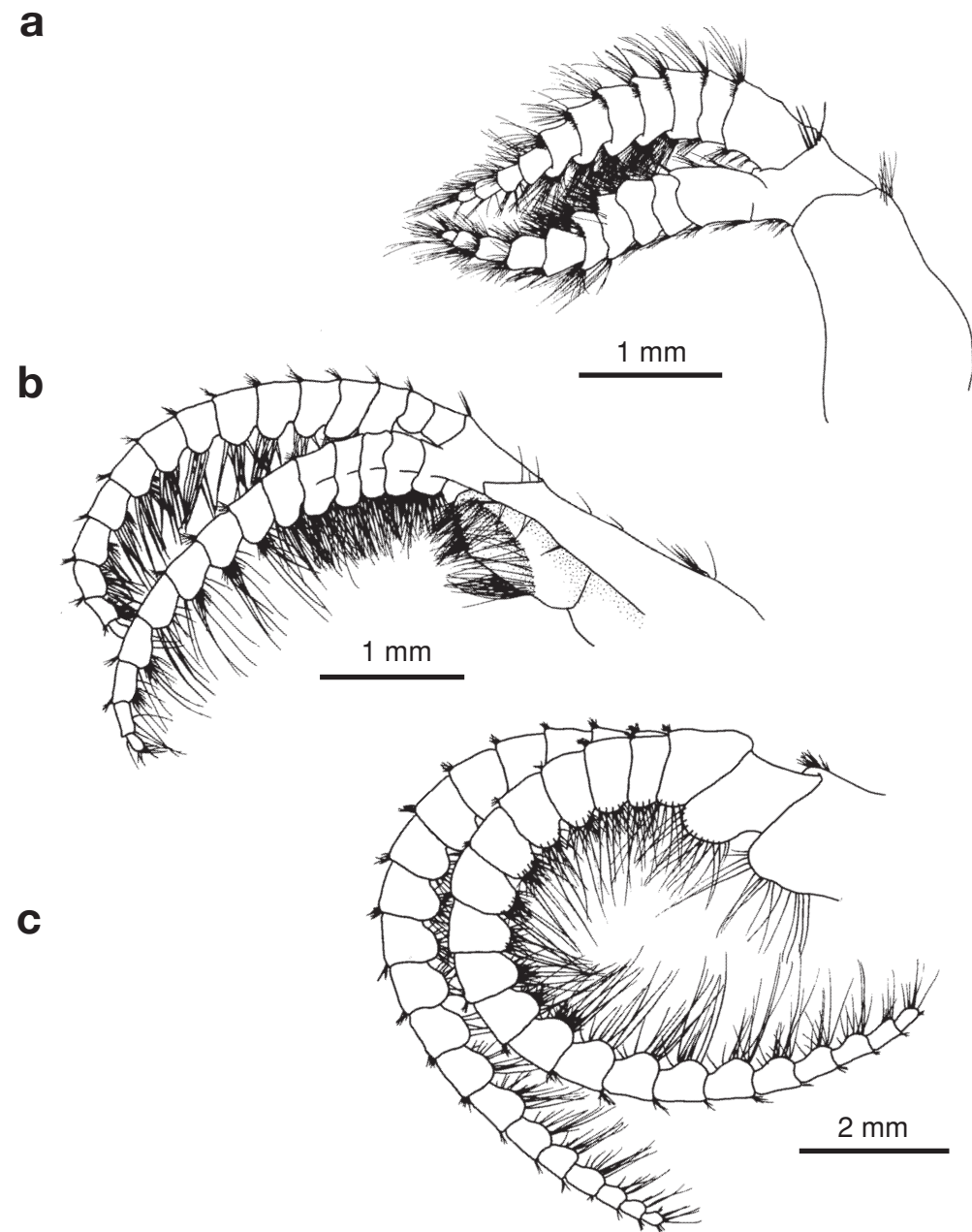


Fig. 71. *Capitulum mitella*, Shihmen, Taipei County, 8 May 1996. Line drawings showing a. Cirrus I, b. Cirrus II and c. Cirrus III.

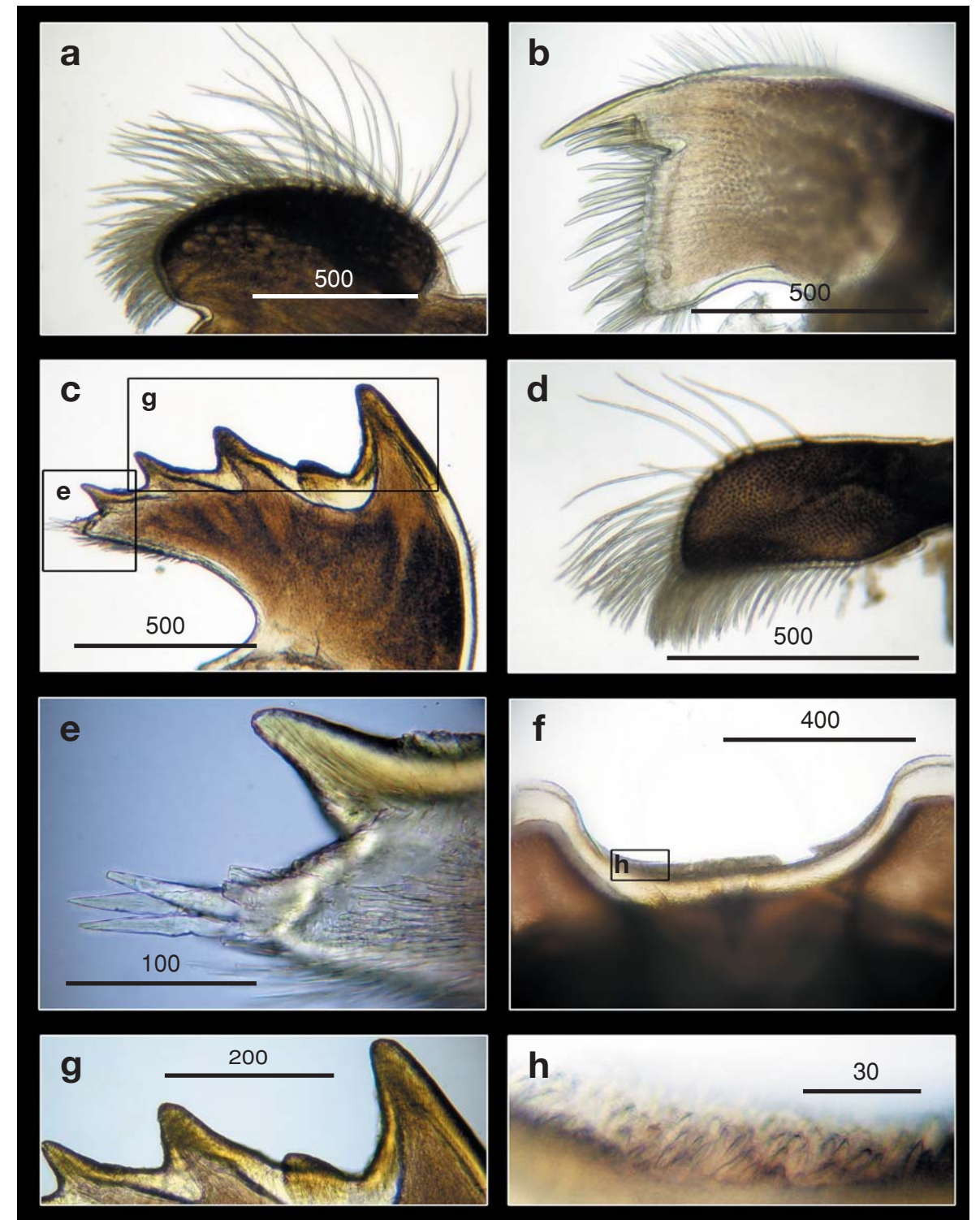


Fig. 72. *Capitulum mitella*, Shihmen, Taipei County, 8 May 1996. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in µm.

Family SCALPELLIDAE Pilsbry, 1907
鎧茗荷科

Lepadidae Darwin, 1851: 8.
Polyaspididae Gruvel, 1905: 8.
Scalpellinae Pilsbry, 1907a: 4.
Pollicipedidae Annandale, 1909a: 63.
Scalpellidae Krüger, 1911: 7.—Pilsbry, 1916: 4.—Nilsson-Cantell, 1921: 162.—1938: 23.—Broch, 1922: 227.—1931: 2.—Barnard, 1924: 10.—Withers, 1928: 65.—1935: 75.—1953: 100.—Newman & Ross, 1971: 37.—Newman et al., 1969: 275.—Weisbord, 1977: 237.—Foster, 1978: 38.—Zevina, 1978a: 999.—1978b: 1343.—1980: 690.

Diagnosis.—Capitulum with more than 5 calcified or partially calcified plates. Peduncles armored by calcareous or phosphorous scales.

Remarks.—The Scalpellidae is divided into 5 subfamilies, the Scalpellinae Pilsbry, 1907, Meroscalpellinae Zevina, 1978; Brochinae Zevina, 1978, Scalpellopsinae Zevina, 1978 and Arcoscalpellinae Zevina, 1978. In Taiwan, only species in the Scalpellinae, Meroscalpellinae and Arcoscalpellinae have been collected.

Key to subfamilies of Scalpellidae from Taiwan

1. Carina strongly bowed, umbo at the bowed point Scalpellinae
Carina curved and umbo apex 2
2. Distance between opercular plates large Meroscalpellinae
3. Capitular plates closely packed Arcoscalpellinae

Subfamily Scalpellinae Pilsbry, 1907
鎧茗荷亞科

Scalpellinae Pilsbry, 1907a: 4.—Zevina, 1978a: 1002.—Zevina, 1981: 93. Type genus *Scalpellum* Leach, 1817.

Diagnosis.—Capitulum with 14 plates, plates completely or partially covering capitulum; carina strongly bowed, umbo at bowed point. Hermaphroditic or with dwarf males.

Remarks.—5 genera are classified in the Scalpellinae: *Scalpellum*, *Pteroscalpellum*, *Barbascalpellum*, *Compressoscalpellum* and *Ornatoscalpellum*. In Taiwan, only *Scalpellum* was recorded.

Genus *Scalpellum* Leach, 1817
鎧茗荷屬

Scalpellum Leach, 1817: 68.—Darwin, 1851: 21.—Hoek, 1883: 59.—Gruvel, 1905: 23.—Pilsbry, 1907b: 181.—Tarasov & Zevina, 1957: 126.—Zevina, 1978a: 1002.—1981: 94. Type species. *Lepas scalpellum* (Linnaeus, 1767).

Diagnosis.—Carina strongly bowed, terga triangular, umbo of scutum at tergo-occludent point; infra-median latus pentagonal, umbo sub-basal, carina lateral horn-shaped, umbo at the basi-carinal angle; angle extending beyond carina.

Remarks.—There are 4 *Scalpellum* species in the world but only 1 species has been recorded in Taiwanese waters.

Scalpellum stearnsii Pilsbry, 1890
司氏鎧茗荷

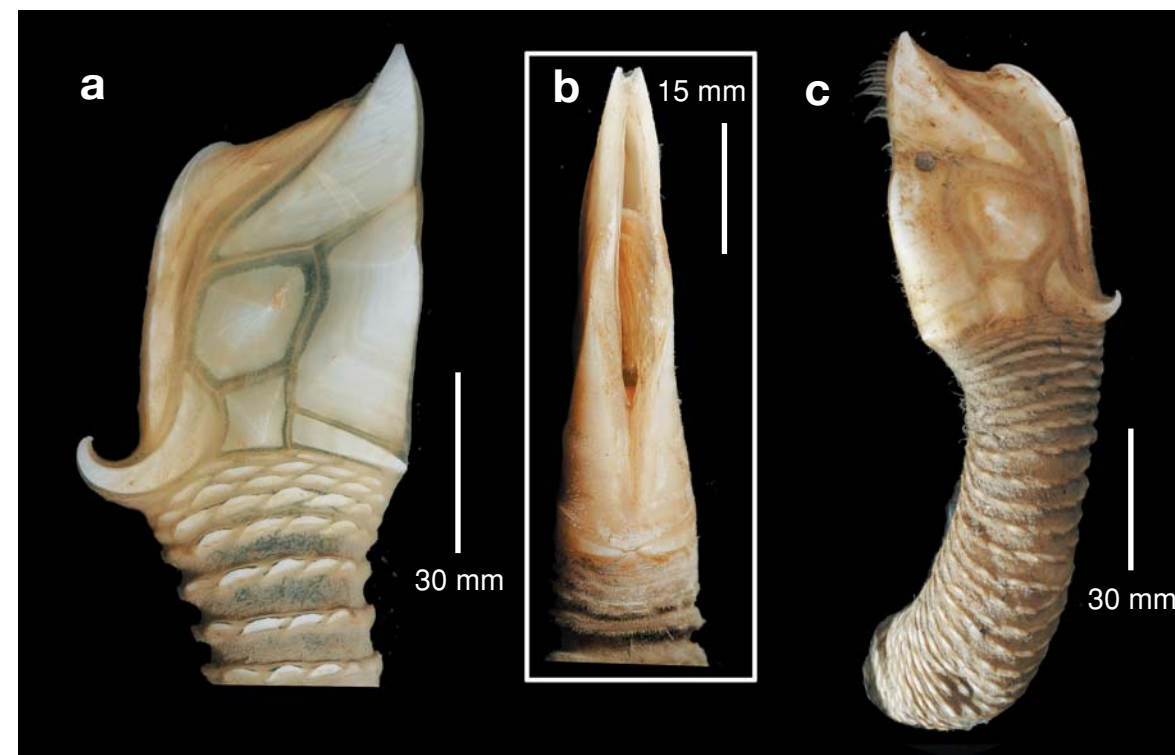


Fig. 73. *Scalpellum stearnsii*, Dasi fishing port, Yilan County, 7 May 2001. a., c. Side view of the capitulum. b. Rostral view, showing the rostrum position.

Scalpellum stearnsii Pilsbry, 1890: 441.—1907a: 14, pl. 4, figs. 1-5.—Hoek, 1907: 69, pl. VI, fig. 1.—Annandale, 1909b: 270.—Krüger, 1911: 18, pl. 2, figs. 18-19.—Nilsson-Cantell, 1921: 175.—1934b: 33.—Broch, 1922: 235, fig. 6.—Hiro, 1933: 22, fig. 4, pl. 1, figs. 5, 5a.—1939a: 237.—Zevina, 1981: 98, fig. 68.—Rosell, 1991: 15.—Liu & Ren, 2007: 226, fig. 95.

Scalpellum stearnsii var. *robusta* Hoek, 1907: 69, pl. VI, figs. 2-3, 8-12.

Material examined.—Dasi fishing port, Yilan County, 7 May 2001: 1 specimen (CL 35.55 mm, CW 22.84 mm, PL 55.11 mm) (NMNS 003603-00010).—Su-ao, Yilan County, 14 May 1998: 4 specimens (CL 14.11-49.10 mm, CW 9.13-35.27 mm, PL 7.47-58.41 mm) (CEL-BB-78).—CP264, 24°28.07'N, 121°53.55'E, 297-330 m, 1 Sep 2004: 1 specimen (CL 29.23 mm, CW 18.04 mm, PL 34.26 mm) (CEL-BB-51).—Nanfeng-ao, Yilan County, 27 May 2004: 1 specimen (CL 34.60 mm, CW 22.84 mm, PL 26.27 mm) (CEL-BB-56).

Diagnosis.—Capitulum almost square-shaped, with 14 valves, perfectly calcified, covered by a yellow membrane. Tergum triangular, umbo apical, tergal margin slightly convex; scutum quadrilateral, lateral margin concave; upper latus pentagonal; inframedian latus pentagonal and smaller than upper latus, umbo sub-medial; carinal latus strongly curved and horn-shaped, extending beyond carina, umbo apical; rostral latus wider than high, narrow; rostrum small; carina strongly bowed, thick. Peduncle long, cylindrical, covered by calcified scales; peduncle scales arranged in concentric patterns. Maxilla triangular with fine setae; maxillules without a

clear notch, more than 35 strong cuspidate setae on cutting edge; mandible with 5 major teeth excluding inferior angle, lower margin with fine denticles; mandibulatory palps elongated and narrow, with serrulate-type setae on inferior margin; labrum strongly V-shaped with at least 30 fine teeth. Cirrus I with unequal rami, anterior ramus oval (12-segmented), posterior ramus long and slender (14-segmented); cirri II-VI similar in morphology, rami almost equal in length, anterior and posterior rami 25-28-segmented; caudal appendages short, with 5 or 6 segments.

Size.—CL to 70 mm.

Coloration.—Pale-yellow.

Habitats.—Deep-sea species. Attaches onto shell surfaces of gastropods, carapace surfaces of crabs, and boulders.

Distribution.—Indo-Pacific region.

Remarks.—New record for Taiwan.

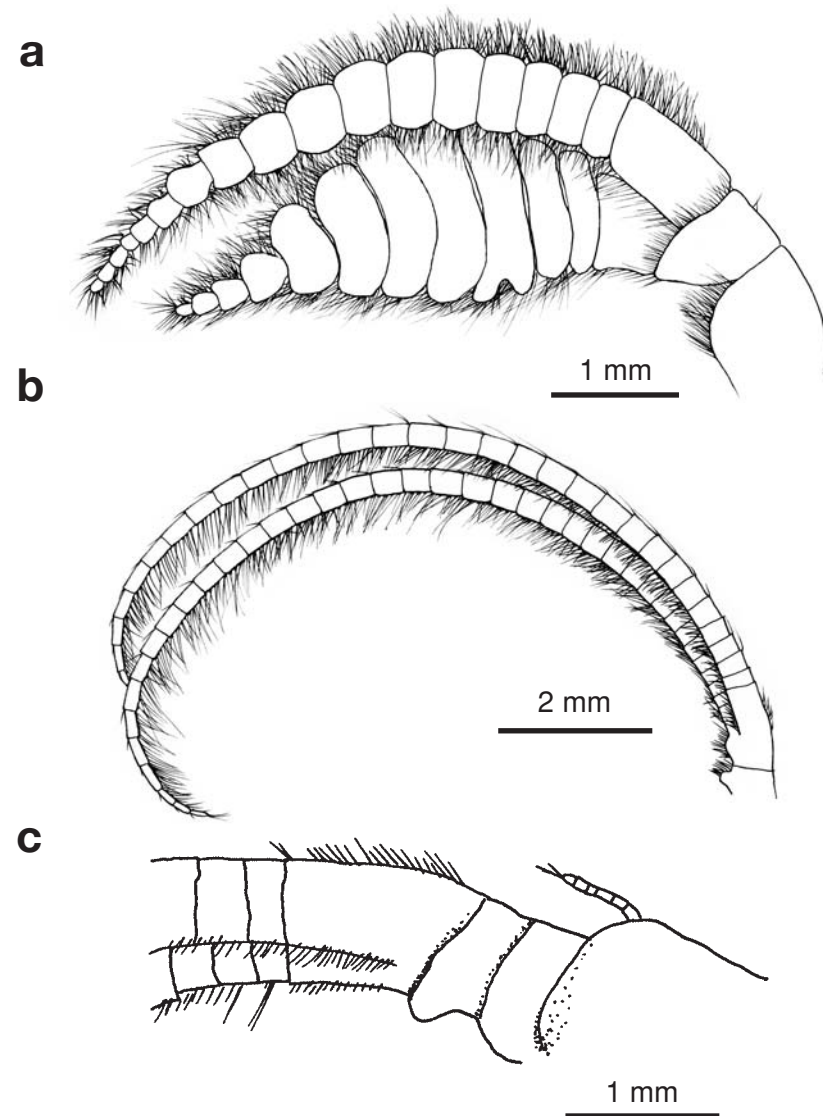


Fig. 74. *Scalpellum stearnsii*, Dasi fishing port, Yilan County, 7 May 2001. Line drawing showing a. Cirrus I, b. Cirrus VI and c. Caudal appendage.

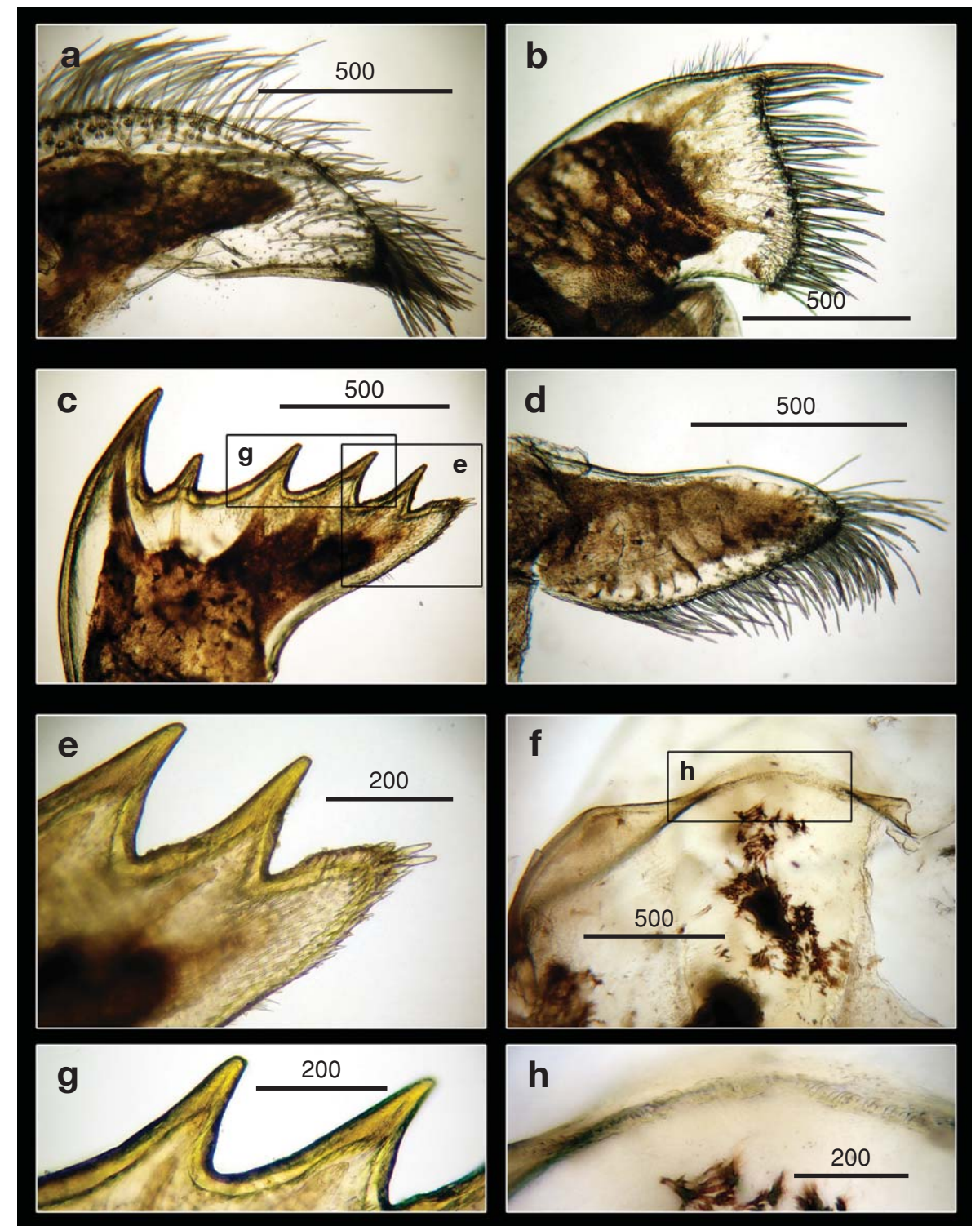


Fig. 75. *Scalpellum stearnsii*, Dasi fishing port, Yilan County, 7 May 2001. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .



Fig. 76. The deep-sea stalked barnacle *Scalpellum stearnsii* lives on various substratum.

Subfamily Meroscalpellinae Zevina, 1978

單鎧茗荷亞科

Meroscalpellum Zevina, 1978b: 1343. Type genus *Meroscalpellum* Zevina, 1978.

Diagnosis.—13 or 14 partially calcified capitular plates. Hermaphroditic or sexes separate, dwarf males sac-like when present.

Remarks.—8 genera are classified in the Meroscalpellinae, and *Litoscalpellum* and *Annandaleum* have been recorded in Taiwan.

Key to genera of the Meroscalpellinae Zevina, 1978 from Taiwan

1. Inframedian latus umbo apex *Litoscalpellum*
- Inframedian latus umbo basal or sub-basal, basal margin of upper latus straight *Annandaleum*

Genus *Litoscalpellum* Newman & Ross, 1971

直鎧茗荷屬

Litoscalpellum Newman & Ross, 1971: 108.—Zevina, 1978b: 1344.—Liu & Ren, 1985: 196.—2007: 228. Type species *Litoscalpellum fissicarinatum* Newman & Ross, 1971.

Diagnosis.—Capitulum plates 14, basal margin of tergum straight; scutum sometimes have apico-lateral arm, basal margin straight and smooth, upper latus triangular or elongated; infra median latus triangular or quadrilateral, umbo apex.

Remarks.—18 species have been recorded worldwide and 1 new species was recently identified in Taiwan in Chan et al. (2009).

Litoscalpellum spinosus Chan, Prabowo & Lee, 2009
背刺直鎧茗荷

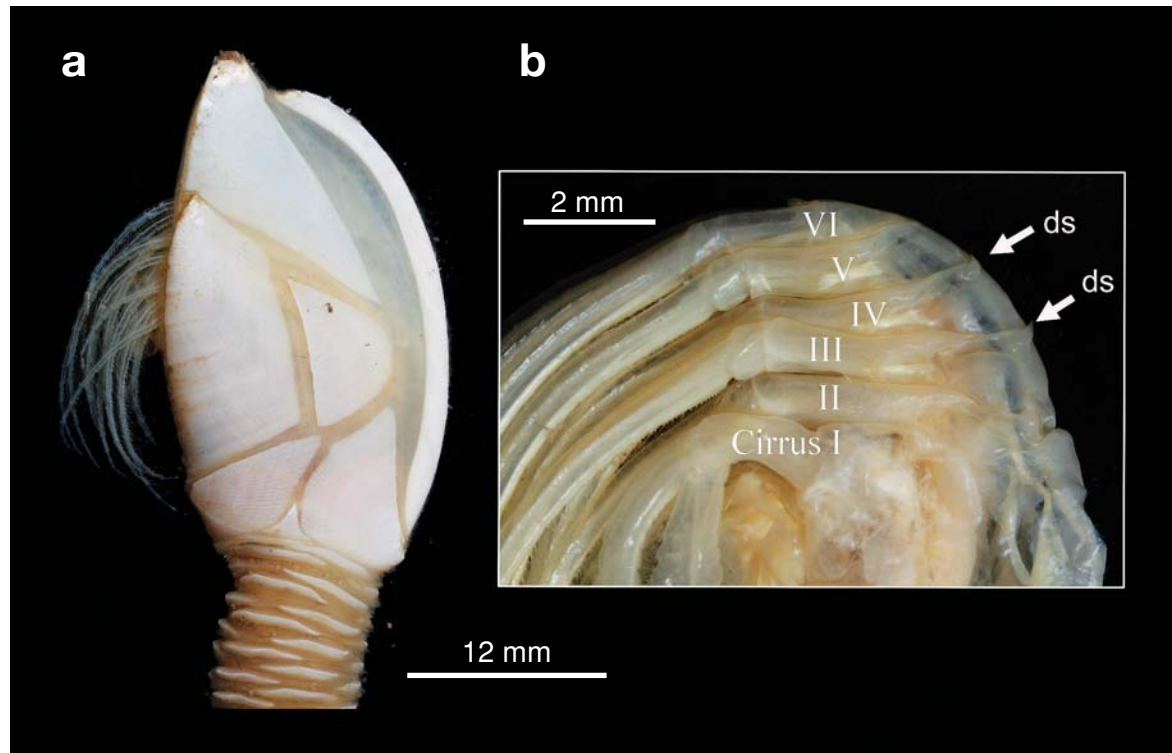


Fig. 77. *Litoscalpellum spinosus*, CD238, 23 Jul 2004. a. Side view of the capitulum. b. Somatic body showing the dorsal thoracica spines (ds).

Litoscalpellum spinosus Chan et al., 2009: in press.

Material examined.—Holotype. CD238, 25°12.28'N, 123°1.85'E, 1650-1689 m, 23 Jul 2004: 1 specimen (CL 24.55 mm, CW 14.04 mm, PL 11.83 mm) (NMNS 6058-001).

Diagnosis.—Capitulum consisting of 14 partially calcified plates, plates white, surfaces covered by dense short hairs, separated by chitinous spaces. Tergum triangular, umbo apical, apex slightly truncated, scutal, occludent, and carinal margins straight; scutum quadrangular, higher than wide, apex produced at tergal margin, slightly overlaying tergum, umbo apical, occludent margin slightly convex, lateral, basal, and tergal margins straight; upper latus quadrangular, carinal margin shortest, tergal and lateral margins convex, scutal margin slightly concave; rostrum very narrow and small; inframedian latus triangular, wider than high, not touching upper latus, umbo apical; rostral latus quadrangular, occludent and scutal margins forming right angle, scutal margin longest; carinal latus triangular, lateral margin convex, umbo at the basi-carinal angle, angle not extending beyond carina; carina bowed with a flat roof, umbo apical; peduncle with white concentric scales. Maxilla quadrangular, setae clustered in 3 main regions, maxillary lobe short, wide without setae; maxillule cutting edge short, notched, 2 large long and 1 short spines above notch, no setae at notch, 5 large spines and 3 short setae below notch; mandible with 3 teeth excluding inferior angle, 1st tooth far separated from 2nd and 3rd teeth, lower margin smooth, inferior angle with 5 setae; mandibulatory palp elongated, narrow, setae on tip and inferior margin, no setae on superior margin; labrum strongly concave, cutting edge with fine, sharp teeth.

Cirrus I separated from cirri II-VI, rami unequal; posterior ramus slender and longer, 12-segmented, anterior ramus broader and shorter, 7-segmented; cirri II-VI, rami sub-equal; cirrus II (anterior 19, posterior 30), III (21, 18), IV (27, 25), V (25, 25), VI (32, 29); caudal appendage very short with 1 segment, length within basal segment of cirrus VI; somatic body with dorsal thoracic spines, located at base of cirri III and IV.

Size.—CL to 30 mm.

Coloration.—White.

Distribution.—At present only recorded in Taiwan.

Remarks.—The capitulum morphology of *Litoscalpellum spinosus* is similar to *L. affricatum* Foster, 1978. The somatic body of *L. affricatum*, however, did not have dorsal thoracic spines on the base of cirrus III and IV. No *Litoscalpellum* species previously reported to have dorsal thoracic spines.

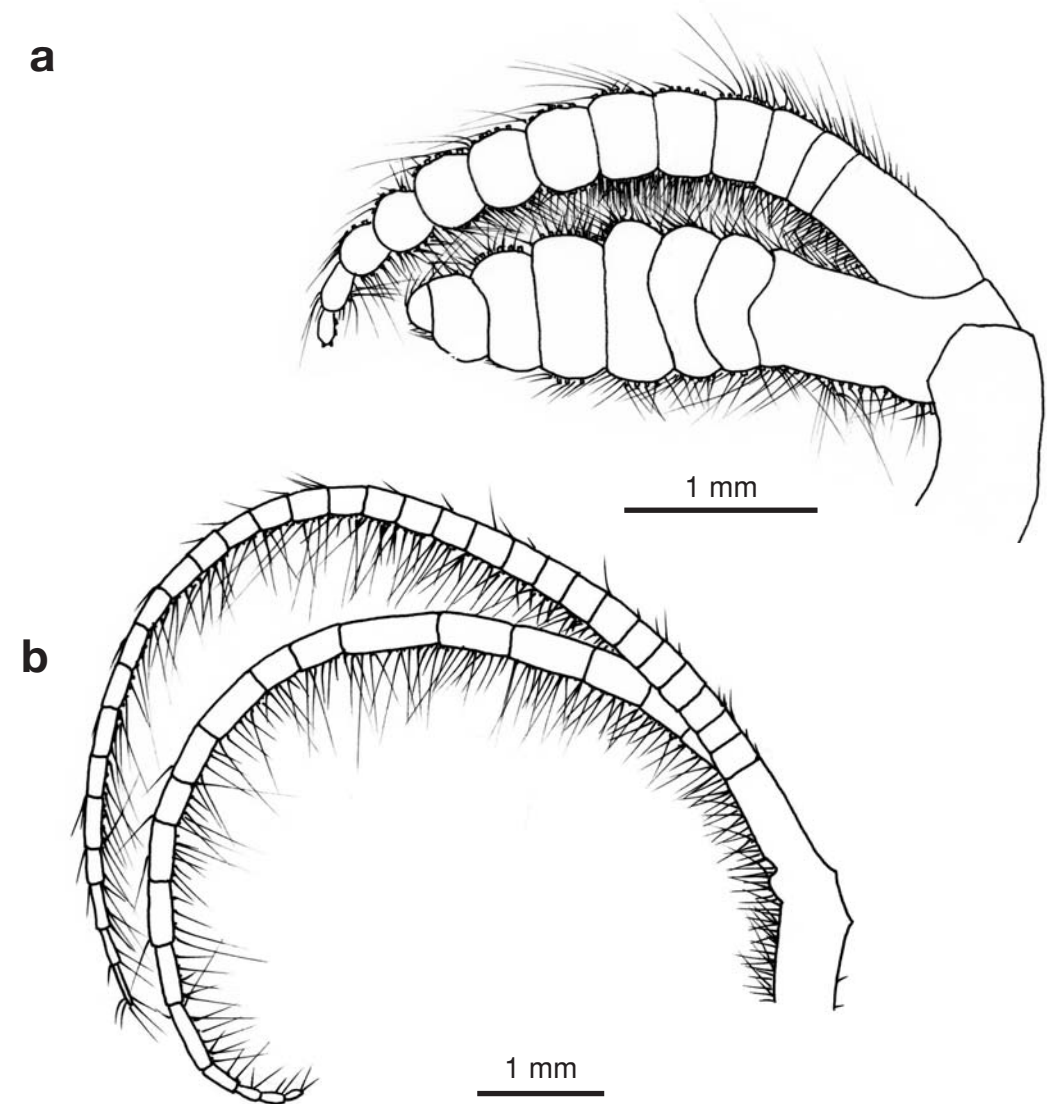


Fig. 78. *Litoscalpellum spinosus*, CD238, 23 Jul 2004. Line drawings showing a. Cirrus I and b. Cirrus II.

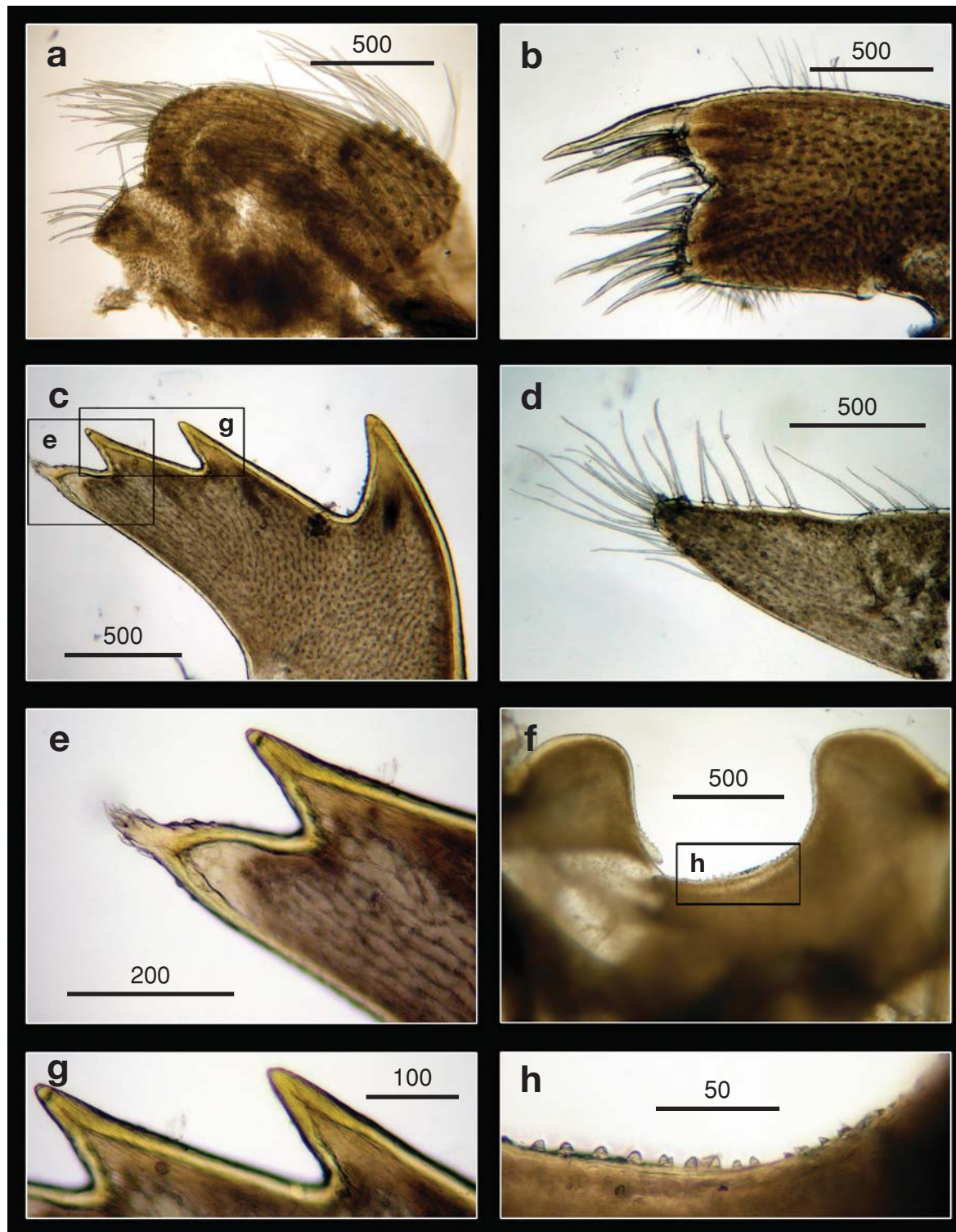


Fig. 79. *Litoscalpellum spinosus*, CD238, 23 Jul 2004. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Genus *Annandaleum* Newman & Ross, 1971

阿南鎧茗荷屬

Annandaleum Newman & Ross, 1971: 122.—Zevina, 1978b: 1346.—1981: 166. Type species *Scalpellum japonicum* Hoek, 1883.

Diagnosis.—Sexes separate, capitulum of female with 14 partially calcified plates; tergum an inverted V-shape; scutum with relatively long apico-lateral arm, about 1/4-1/2 length of tergal margin; upper latus pentagonal to triangular, with or without depending arm; basal margin of scutum entire; carinal latus as high as wide, umbo at the basi-carinal angle; inframedian latus higher than wide, vase-shaped, umbo sub-medial or basal, rostral latus wider than high, caudal appendage long, with 5-11 segments.

Remarks.—5 species have been recorded worldwide (Zevina, 1981), and 2 species are recorded as new to Taiwan (Cai et al., in press).

Key to species of the *Annandaleum* from Taiwan

1. Rostral latus trapezoidal in shape *Annandaleum japonicum biramosum*
- Rostral latus rectangular in shape *Annandaleum laccadivicum*

Annandaleum japonicum biraosum (Pilsbry, 1911)
日本阿南鎧茗荷

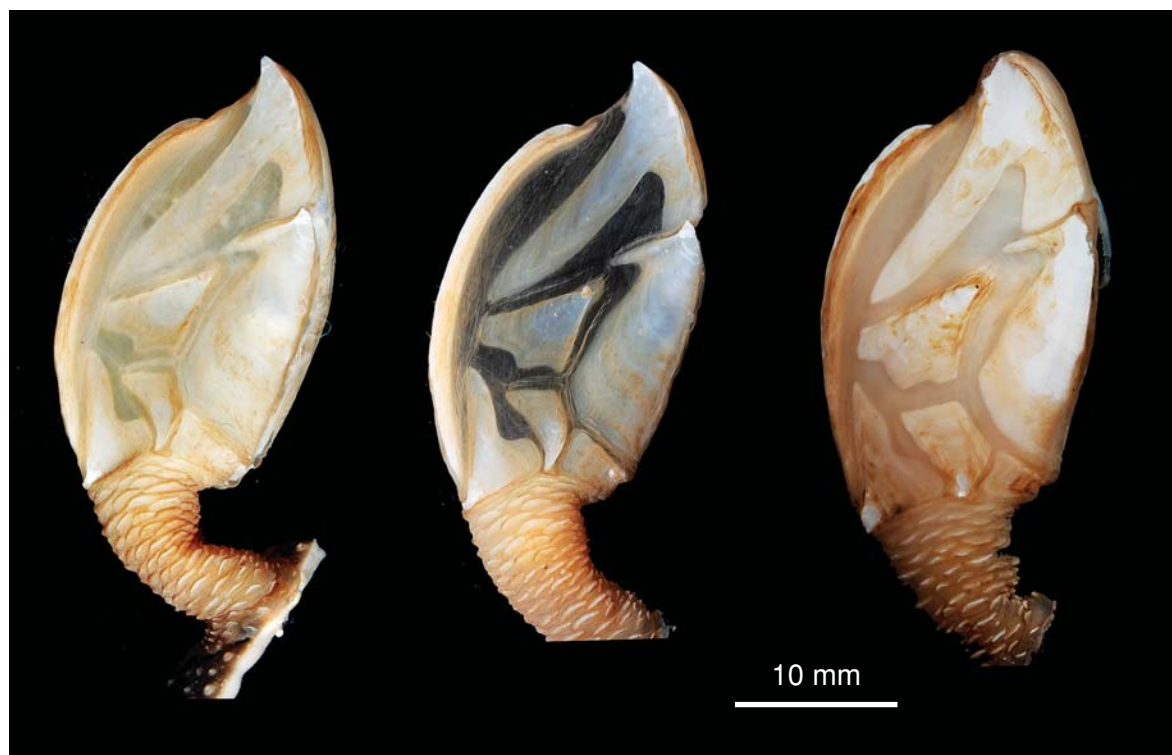


Fig. 80. *Annandaleum japonicum biraosum*, CD130, 22 Aug 2001. Side view showing the capitulum.

Scalpellum japonicum Hoek, 1883: 67, pl. 3, figs. 9, 10.

Scalpellum japonicum biraosum Pilsbry, 1911: 68, pl. XI, figs. 1, 2.

Annandaleum japonicum.—Newman & Ross, 1971: 122.

Material examined.—CD130, 22°18.77'N, 120°6.99'E, 709-728 m, 22 Aug 2001: 1 specimen (CL 19.42 mm, CW 11.57 mm, PL 8.26 mm) (NMNS 003636-00062).—CP196, 24°51.75'N, 122°3.75'E, 636-787 m, 11 Sep 2002: 1 specimen (CL 19.56 mm, CW 11.94 mm, PL 9.94 mm) (CEL-BB-87).

Diagnosis.—Capitulum covered by a semi-transparent pale-yellow membrane, with 14 partially calcified plates, plates separated by broad chitinous spaces. Tergum inverted V-shaped, umbo apical, branch at carinal margin longer than branch at occludent margin; scutum long and narrow, umbo apical, apex touching tergal margin, lateral margin with long apico-lateral arm, about 1/3 length of tergal margin; upper latus irregular, closely resembling triangle, with a lobe extending down scutal margin, lobe bifid on right and simple on left side; rostrum very small and narrow; rostral latus triangular, wider than high; inframedian latus higher and wide, vase-shaped, umbo sub-medial; carinal latus V-shaped, lateral margin bifid; carina bowed, with a flat roof and increasing width towards base. Maxilla roughly triangular, margin covered with dense setae, setae segregated

into 3 main regions; maxillule slightly notched, 3 long and 1 short setae above notch, no setae on notch, 9 setae below notch; mandible with 3 teeth excluding inferior angle, 1st tooth separated from 2nd and 3rd teeth, lower margin very short, without spines; mandibulatory palp triangular, elongated, with setae on tip and superior margin; labrum cutting edge straight, with very fine teeth on cutting edge. Cirrus I separated from cirri II-VI; rami of cirrus I sub-equal, posterior ramus 11-segmented, anterior ramus broader and shorter than posterior ramus, 9-segmented; cirri II-VI, rami sub-equal; cirral counts of cirrus II (anterior ramus 17, posterior ramus 22) and VI (28, 23); caudal appendage about 1/3 length of cirrus VI, 13-segmented.

Size.—CL to 20 mm.

Coloration.—Pale-brown.

Habitat.—Attaches onto rocks, gastropod shells, and gorgonian corals.

Distribution.—Present records cover Pacific waters in Japan and Taiwan.

Remarks.—Pilsbry (1911) identified the subspecies *Annandaleum japonicum biraosum* from *Annandaleum japonicum*. Compared to *A. japonicum*, umbo of the carina of *A. j. biraosum* is closer to the upper end of the plate, the upper latus has a lobe extending down the scutal margin, which is bifid on the right and simple of the left side, and the inframedian latus is less excavated along its upper border (Pilsbry, 1911). Pilsbry (1911), however, doubted that such differences in plate morphology were intraspecific variations. In the present study, the maxillule and mandible of *A. j. biraosum* are similar to the illustration of the maxillule and mandible of *A. japonicum* in Pilsbry (1911). The taxonomic status of *A. japonicum* and *A. j. biraosum* should be evaluated using molecular techniques and with more samples to study the extent of morphological variations in shell plates. This is a new record for Taiwan.

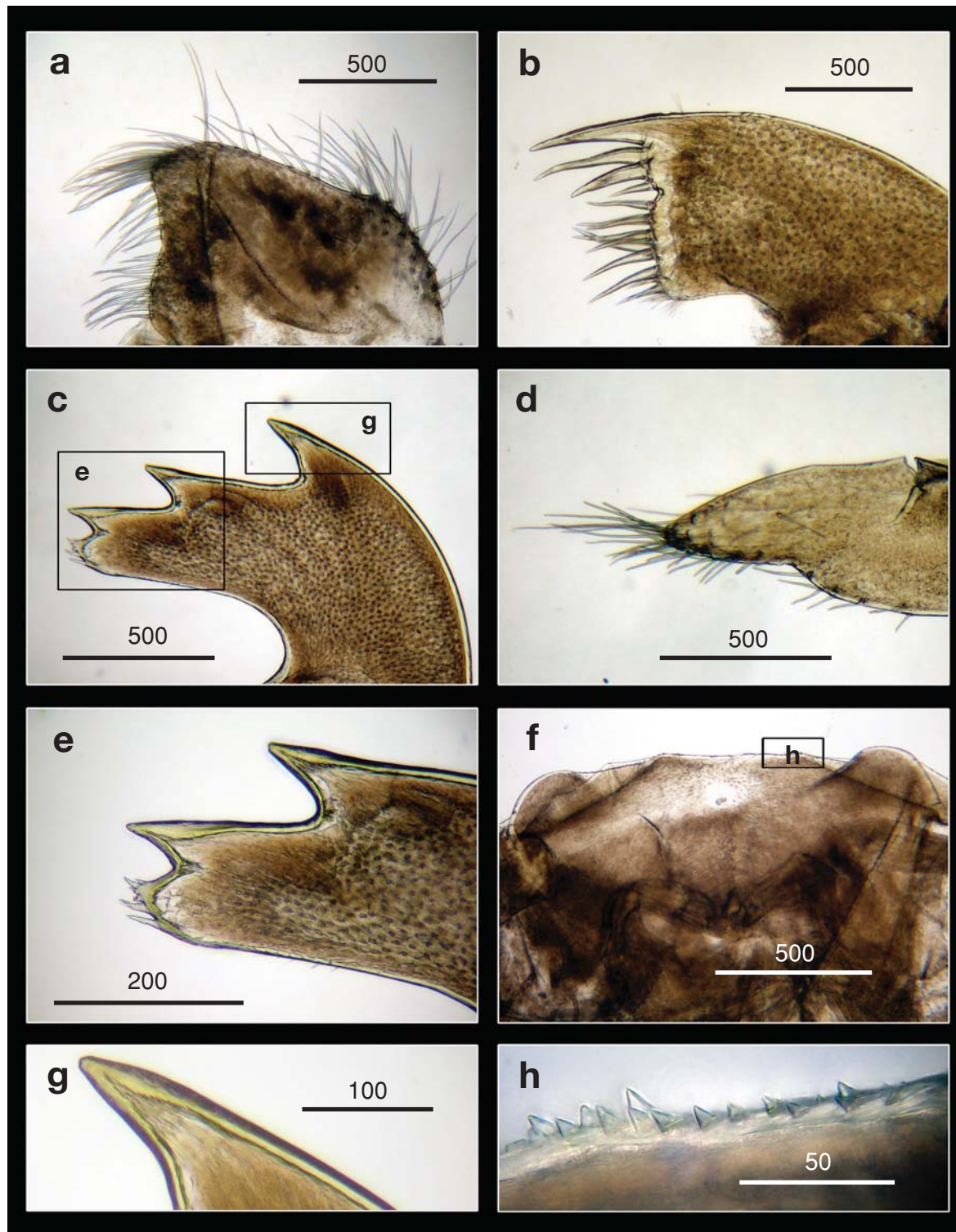


Fig. 81. *Annandaleum japonicum biramosum*, CD130, 22 Aug 2001. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

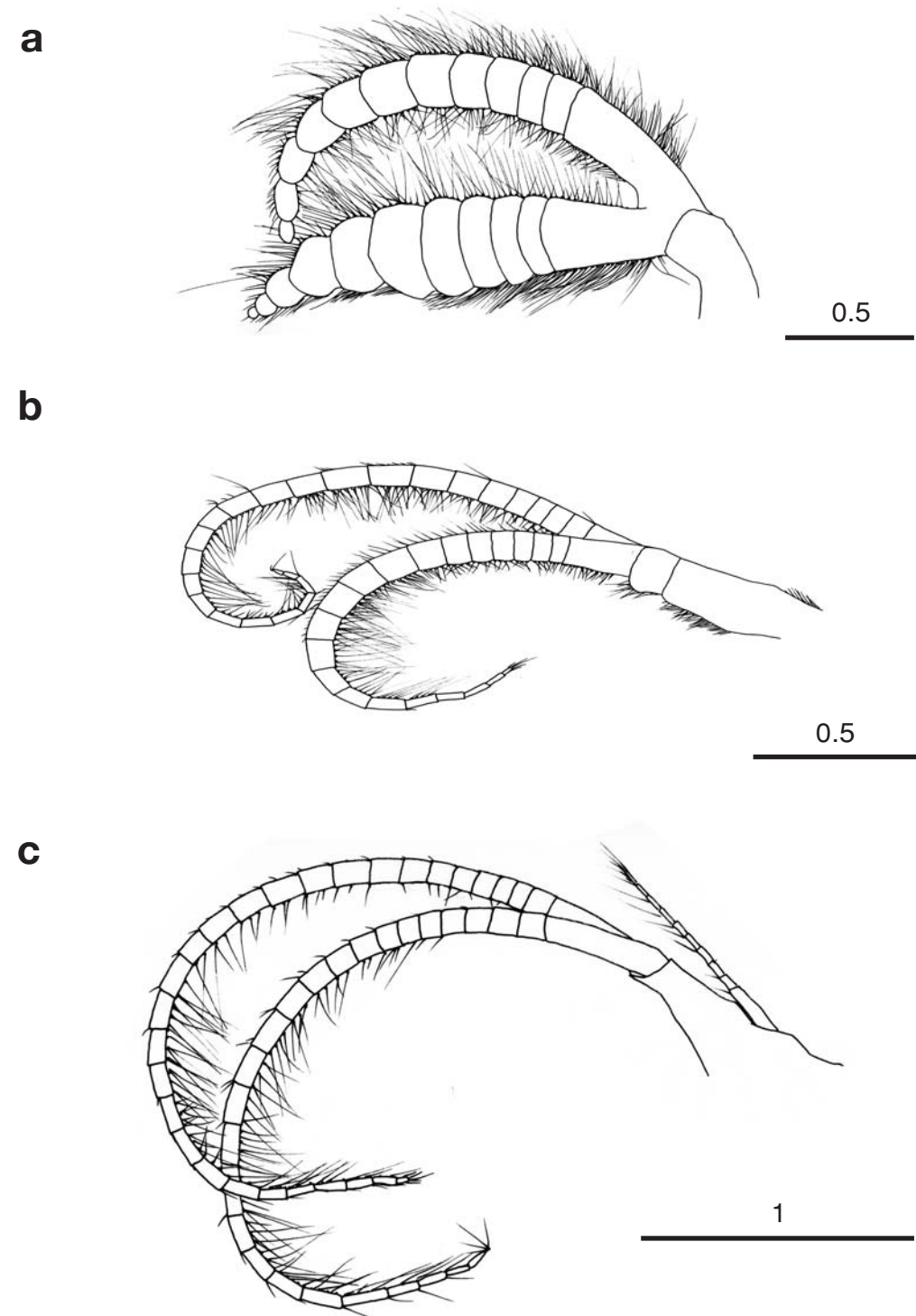


Fig. 82. *Annandaleum japonicum biramosum*, CD130, 22 Aug 2001. Line drawings showing a. Cirrus I, b. Cirrus II and c. Cirrus VI with caudal appendage. Scale bars in mm.

Annandaleum laccadivicum (Annandale, 1906)
繁毛阿南鎧茗荷



Fig. 83. *Annandaleum laccadivicum*, Gueishandao, Yilan County, 9 May 2001. Side view showing the capitulum.

Scalpellum laccadivicum Annandale, 1906b: 393.—1913: 235.

Scalpellum subflavum Annandale, 1906b: 397.—Newman & Ross, 1971: 122.

Scalpellum polymorphum Hoek, 1907: 80, pl. 7, figs. 9-10.

Scalpellum molliculum Pilsbry, 1911: 68, pl. 10, figs. 4, 5.

Material examined.—Gueishandao, Yilan County, 650 m, on *Acila divaricata*, 9 May 2001: 1 specimen (CL 25.6 mm, CW 14 mm, PL 16.9 mm) (NMNS 003566-00036).—CP130, 22°18.77'N, 120°6.99'E, 709-728 m, 22 Aug 2001: 1 specimen, (CL 19.01 mm, CW 11.07 mm, PL 9.47 mm) (NMNS 003636-00062).—CP183, 21°58.22'N, 119°27.99'E, 2519-2556 m, 26 Aug 2002: 1 specimen (CL 10.04 mm, CW 5.00 mm, PL 2.59 mm) (NMNS 005087-00079).

Diagnosis.—Capitulum white, with 14 plates. Tergum quadrilateral, apex produced, umbo apical; scutum quadrilateral with short apico-lateral arm, umbo apical; upper latus quadrilateral, rostral latus rectangular, higher than wide, inframedian latus vase-shaped, umbo basal, rostral latus rectangular, wider than high; carina bowed. Maxilla globular, with sparse setae; maxillule slightly notched;

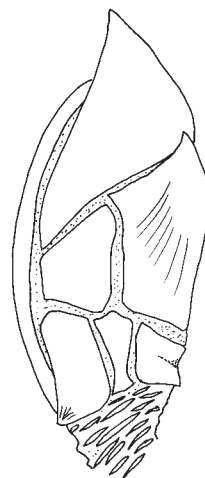


Fig. 84. *Annandaleum laccadivicum*, Gueishandao, Yilan County, 9 May 2001. Line drawing on the side view of the capitulum.

mandible elongated, with 3 teeth excluding inferior angle, lower margin short; mandibulatory palp narrow, setae on superior margin; labrum concave, with sharp teeth.

Size.—CL to 30 mm.

Coloration.—White.

Habitat.—Attaches onto gorgonian corals.

Distribution.—Gulf of Oman, Arabian Sea, Sri Lanka, Indonesia, Japan.

Remarks.—This is a new record for Taiwan.

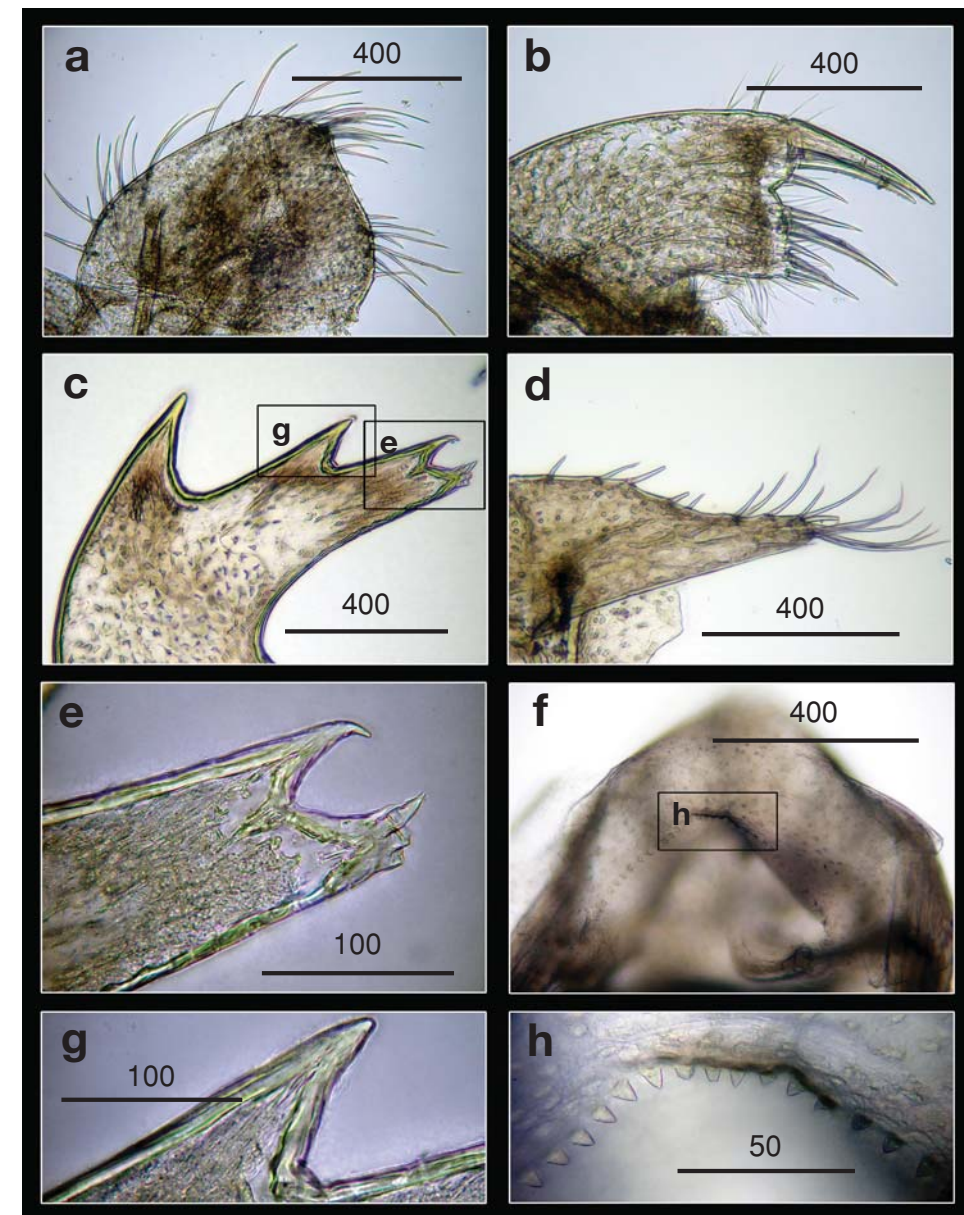


Fig. 85. *Annandaleum laccadivicum*, Gueishandao, Yilan County, 9 May 2001. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Subfamily Arcoscalpellinae Zevina, 1978

小鎧茗荷亞科

Arcoscalpellinae Zevina, 1978b: 1346.—Zevina, 1981: 184.—Liu & Ren, 2007: 238. Type genus *Arcoscalpellum* Hoek, 1907.

Diagnosis.—Capitular plates closely packed with almost no space in-between, carina slightly convex, umbo apical or sub-apical, umbo of scutum and tergum apical.

Remarks.—From revision in Zevina (1978), 13 genera are grouped in the Arcoscalpellinae. In Taiwan, 7 genera were recorded in the present study.

Key to genera of the Arcoscalpellinae from Taiwan

1. Inframedian latus polygonal, with 4-6 sides, carinal latus horny projected *Tarasovium*
Inframedian latus triangular or bacilliform (narrow), carinal latus not horny projected 2
2. Umbo of inframedian latus basal *Verum*
Umbo of inframedian latus sub-medial *Catherinum*
Umbo of inframedian latus apical, sub-apical 3
3. Apex of inframedian latus did not reach the margin of upper latus *Amigdoscalpellum*
4. Apex of inframedian latus reach the upper latus 5
5. Umbo of carinal latus apex *Trianguloscalpellum*
Umbo of carinal latus at basi carinal angle *Teloscalpellum*
Umbo of carinal latus at middle of the carinal margin *Arcoscalpellum*

Genus *Tarasovium* Zevina, 1978

方鎧茗荷屬

Arcoscalpellum Hoek, 1907: 85 (in part).—Newman & Ross, 1971: 42.

Tarasovium Zevina, 1978b: 1347.—Liu & Ren, 1985: 200.—2007: 245. Type species *Scalpellum cornutum* Sars, 1879.

Diagnosis.—Inframedian latus, broad, polygonal, umbo basal or sub-medial, carinal lateral horn-shaped, apex extending beyond carinal margin, caudal appendage short and single-segmented.

Remarks.—8 species have been recorded, and 1 species was recorded and is a new record for Taiwan in the present study (see Chan et al., 2009).

Tarasovium orientale Ren, 1983

東方方鎧茗荷

Tarasovium orientale Ren, 1983: 76, fig. 1 (13-23).—Liu & Ren, 1985: 201, pl. 2 (15-17).—2007: 246-247, fig. 106.

Material examined.—Anping, Tainan City, benthic trawl at south west Taiwan, 15 Aug 2005: 1 specimen (CL 32.93 mm, CW 22.05 mm, PL 17.59 mm) (NMNS 005734-00009)

Diagnosis.—Capitulum pale-yellow, quadrilateral, plates fully calcified, covered by membrane, with sparse hairs. Tergum triangular, umbo apical, occludent and basal margin slightly convex, carinal margin straight; scutum quadrangular, a small apex formed beyond tergal margin, umbo apical, occludent margin convex, basal and upper latus margins concave; upper latus pentagonal, umbo sub-apical; rostral latus narrow triangular, wider than high; inframedian latus broad, rectangular, umbo close to basal region; carinal latus horn-shaped, umbo at the basi carinal angle, angle extending beyond carina; carina curved, umbo apical. Maxilla triangular, with dense setae along entire margin; maxillule not notched, cutting edge with 40 spines; mandible with 6 teeth excluding inferior angle, lower margin straight with dense setae; mandibulatory palp elongated with

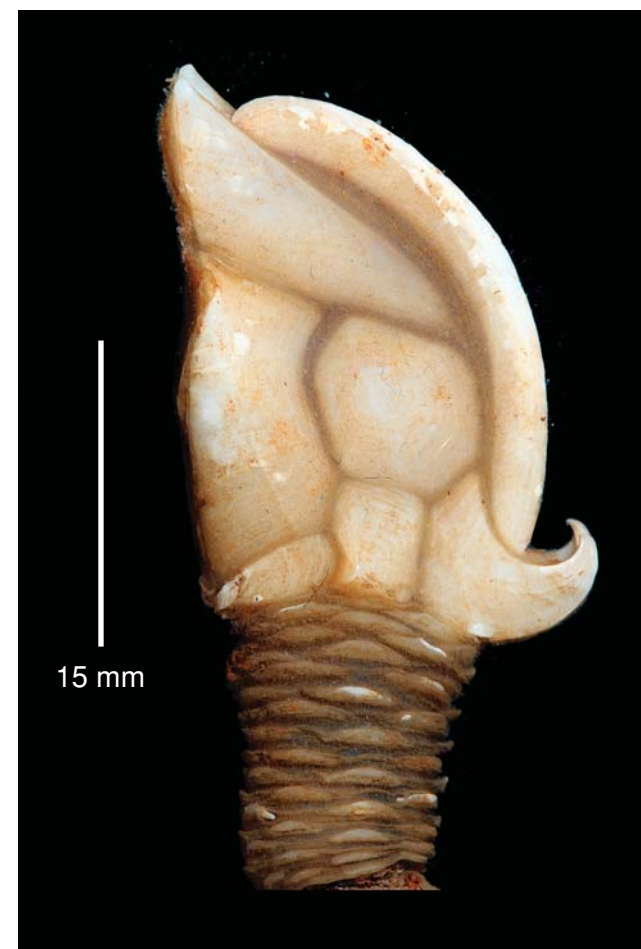


Fig. 86. *Tarasovium orientale*, Anping, Tainan City, 15 Aug 2005. Side view of the capitulum.

dense setae on inferior margin, setae on superior margin absent. Cirrus I rami unequal, separated from cirri II-VI, posterior ramus slender and longer (12-segmented), anterior ramus broader and shorter (8-segmented); cirri II-VI similar in morphology, both anterior and posterior rami similar in length, with 17-19 segments; caudal appendage short, single-segmented, within basal segment of pedicle of cirrus VI.

Size.—CL to 40 mm.

Coloration.—Pale-brown.

Habitat.—Attaches on rocks and gastropod shells.

Distribution.—Taiwanese waters of East China Sea, Pacific.

Remarks.—New record for Taiwan.

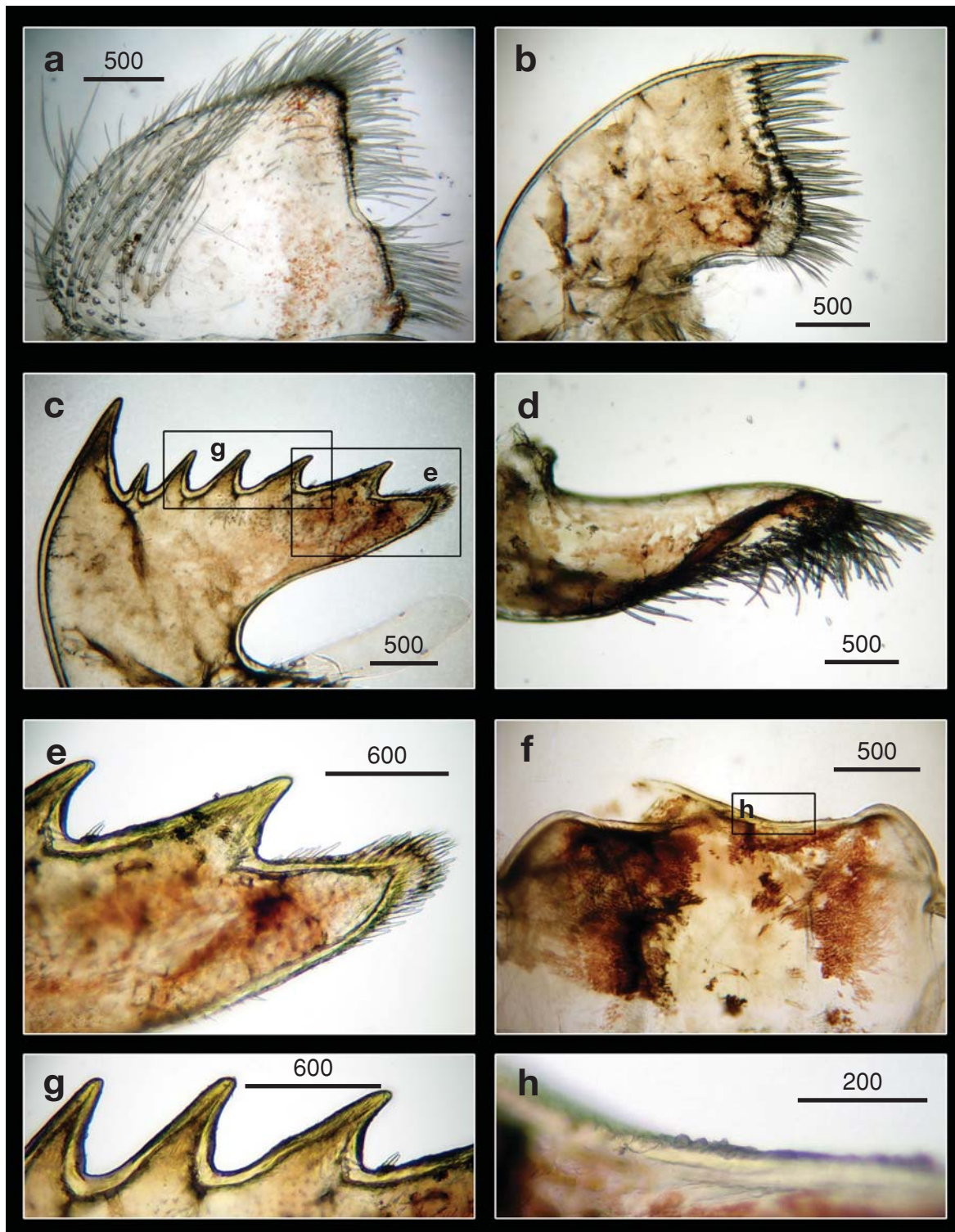


Fig. 87. *Tarasovium orientale*, Anping, Tainan City, 15 Aug 2005. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

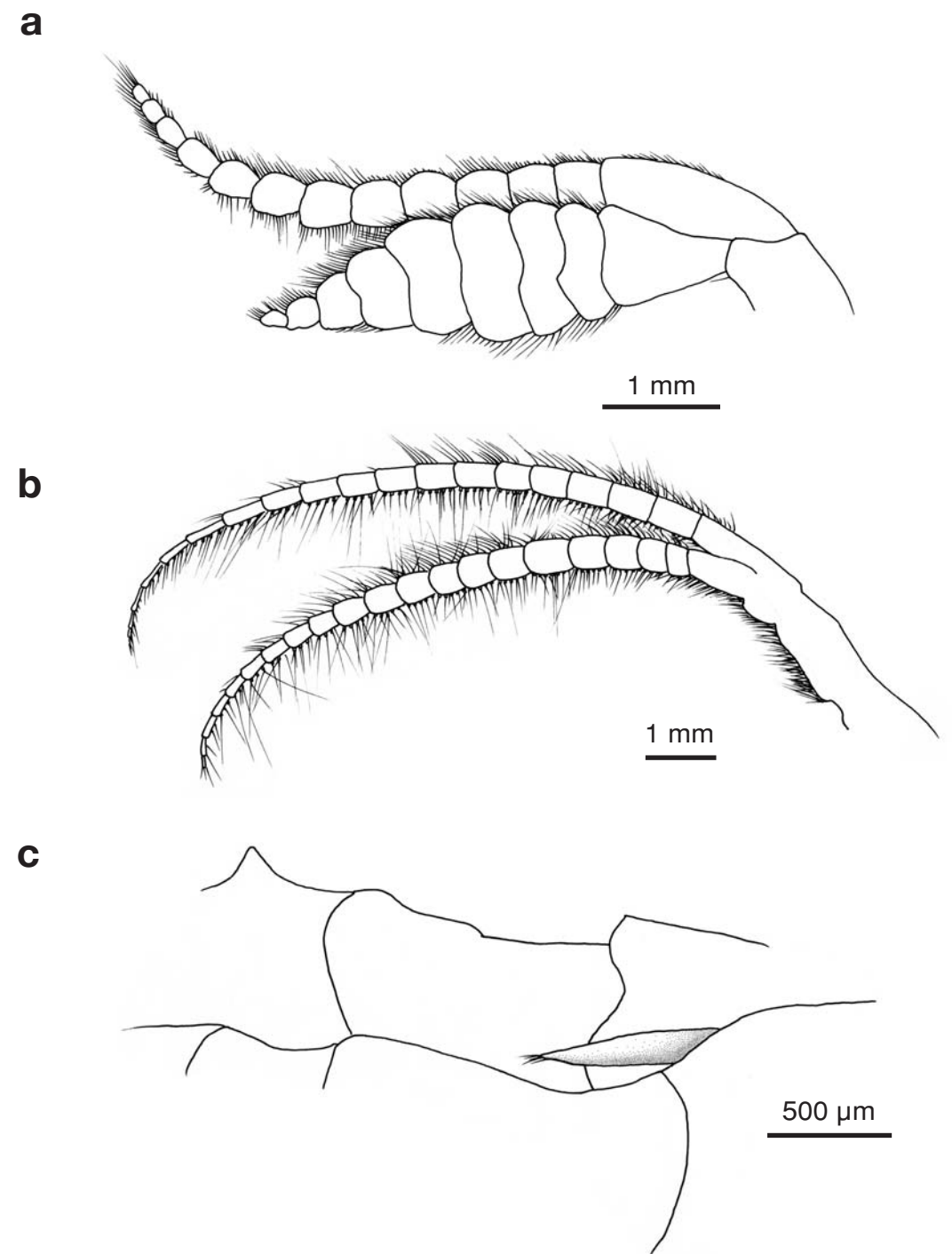


Fig. 88. *Tarasovium orientale*, Anping, Tainan City, 15 Aug 2005. Line drawings showing a. Cirrus I, b. Cirrus VI and c. Caudal appendage.

Genus *Verum* Zevina, 1978
真鎧茗荷屬

Verum Zevina, 1978b: 1348.—1981: 218. Type species *Scalpellum zenkevichi* Zevina.

Diagnosis.—Upper latus umbo apical, inframedian latus triangular with umbo basal or sub-basal, apex of carinal lateral not extending beyond carinal margin.

Remarks.—From the review in Zevina (1981), 23 species have been recorded, 1 species was collected in Taiwanese waters. This is a new record for Taiwan (see Chan et al., 2009).

Verum novaezelandidae (Hoek, 1907)
新真鎧茗荷

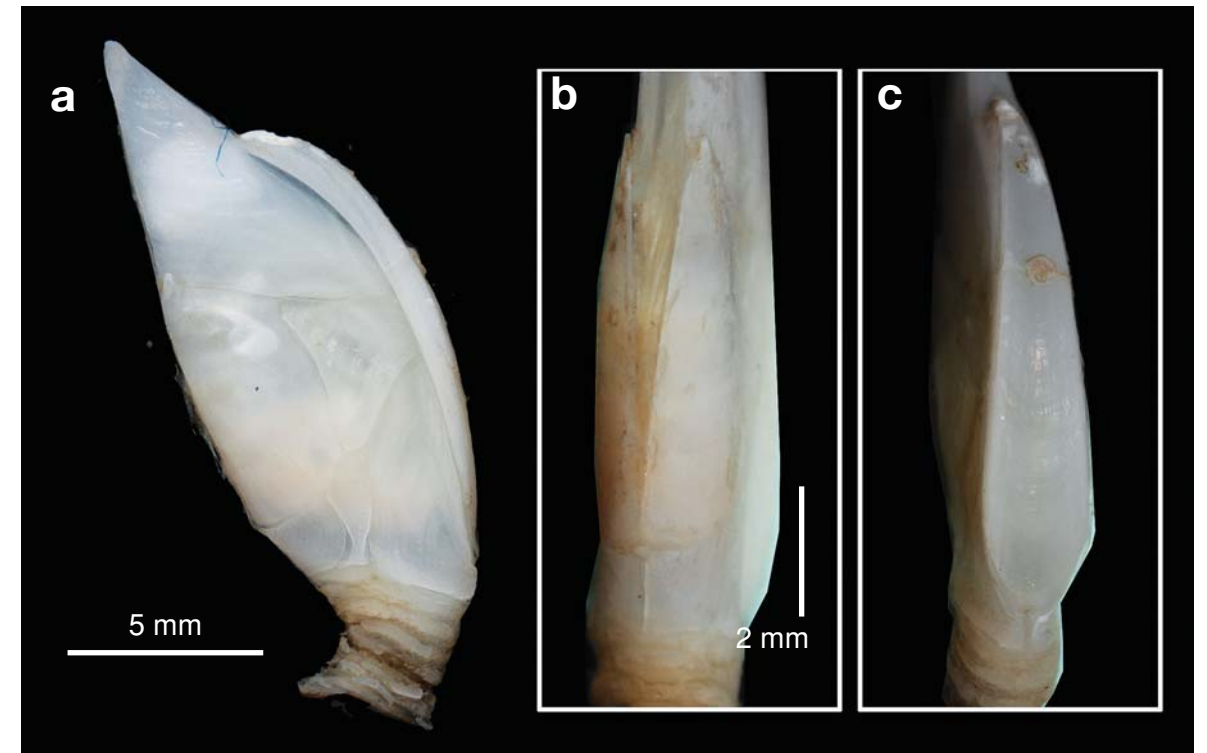


Fig. 89. *Verum novaezelandidae*, CP364, 24 Aug 2006. a. Side view of the capitulum. b. Rostral view and c. Carinal view of the capitulum.

Scalpellum novaezelandidae Hoek, 1907: 100, pl. VIII, figs. 4, 4a.

Verum novaezelandidae.—Zevina, 1981: 288, fig. 165.

Material examined.—CP364, 22°06.335'N, 121°08.224'E, 1260-1275 m, on sunken wood, 24 Aug 2006: 2 specimens (CL 4.40-7.40 mm, CW 1.94-3.09 mm, PL 1.09-1.25 mm) (CEL-BB-76).

Diagnosis.—Capitulum elongated, flattened, white, with 14 fully calcified and closely packed plates, plate surfaces smooth. Tergum right-angled triangular, umbo apical, occludent and scutal margins straight, forming a right angle with each other; scutum quadrangular, apex produced at tergal margin, umbo apical, occludent margin straight, lateral margin slightly convex; upper latus pentagonal, apex produced at tergal-scutal angle, umbo apical; inframedian margin shortest; inframedian latus pentagonal or vase-shaped, umbo sub-medial; rostral latus quadrangular, wider than high; carinal latus higher than wide, umbo at the basi-carinal angle, angle not extending beyond scutum; carina bowed with a flat roof; rostrum small, oval; peduncle covered by dense scales. Maxilla bilobed, setae clumped into 2 clusters; cutting edge of maxillule notched, 4 setae above notch, no setae at notch, 6 setae below notch; mandible with 3 large teeth excluding inferior angle, 1st tooth far separated from 2nd and 3rd teeth; lower margin short with 6 spines; mandibulatory palp triangular, setae present on superior margin and tip but absent from inferior margin; labrum bullate with fine sharp teeth on cutting edge. Cirrus I separated from other cirri, rami sub-equal; posterior ramus slender and longer, 9-segmented, anterior ramus

broader and short, 6-segmented; cirri II-VI rami sub-equal, caudal appendage very short, 1-segmented, length within basal pedicle of cirrus VI.

Size.—CL to 5 mm.

Coloration.—White.

Habitat.—Attaches onto gorgonian corals and sunken woods.

Distribution.—Indo-Pacific waters.

Remarks.—New record for Taiwan.

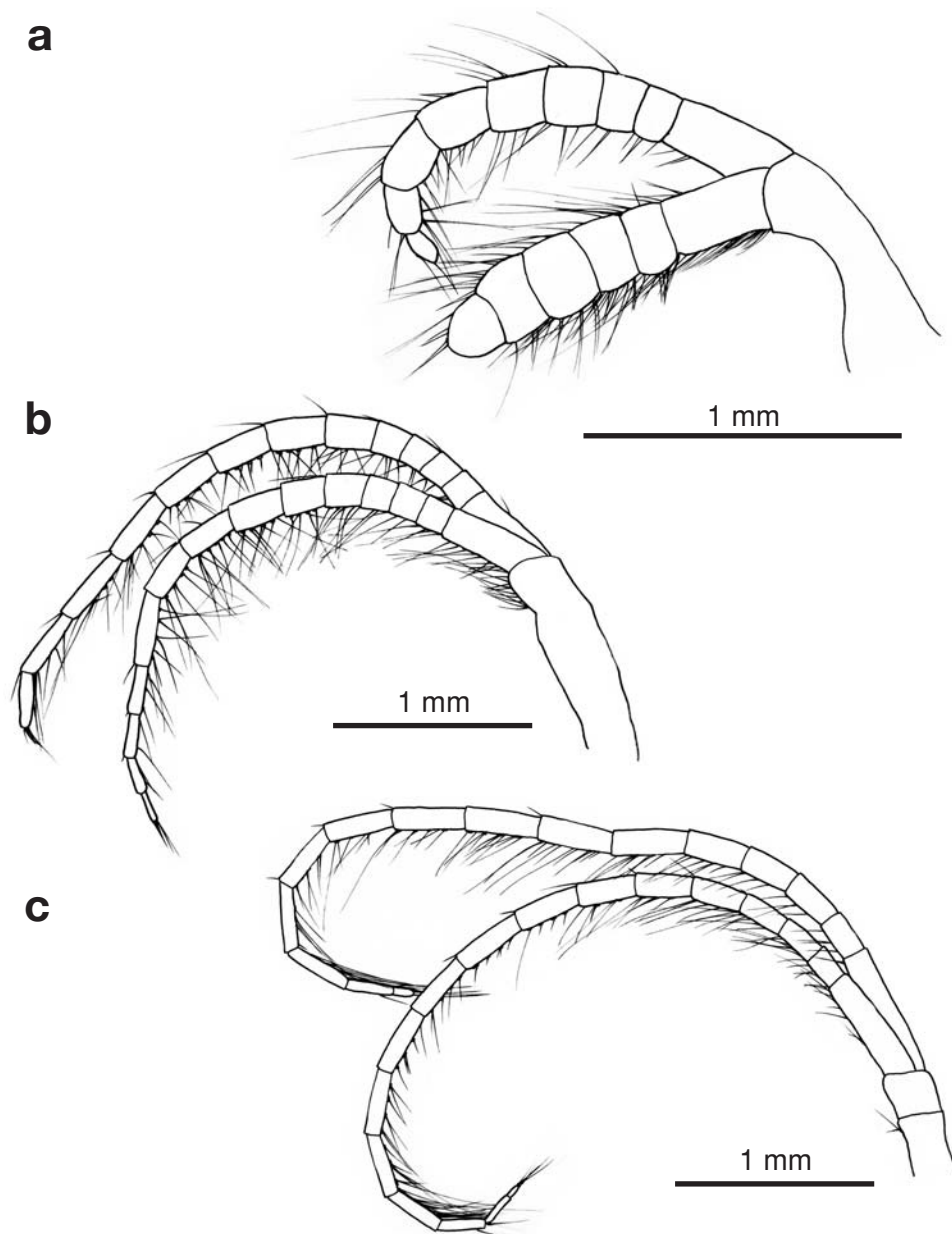


Fig. 90. *Verum novaezelandidae*, CP364, 24 Aug 2006. Line drawings showing a. Cirrus I, b. Cirrus II and c. Cirrus VI.

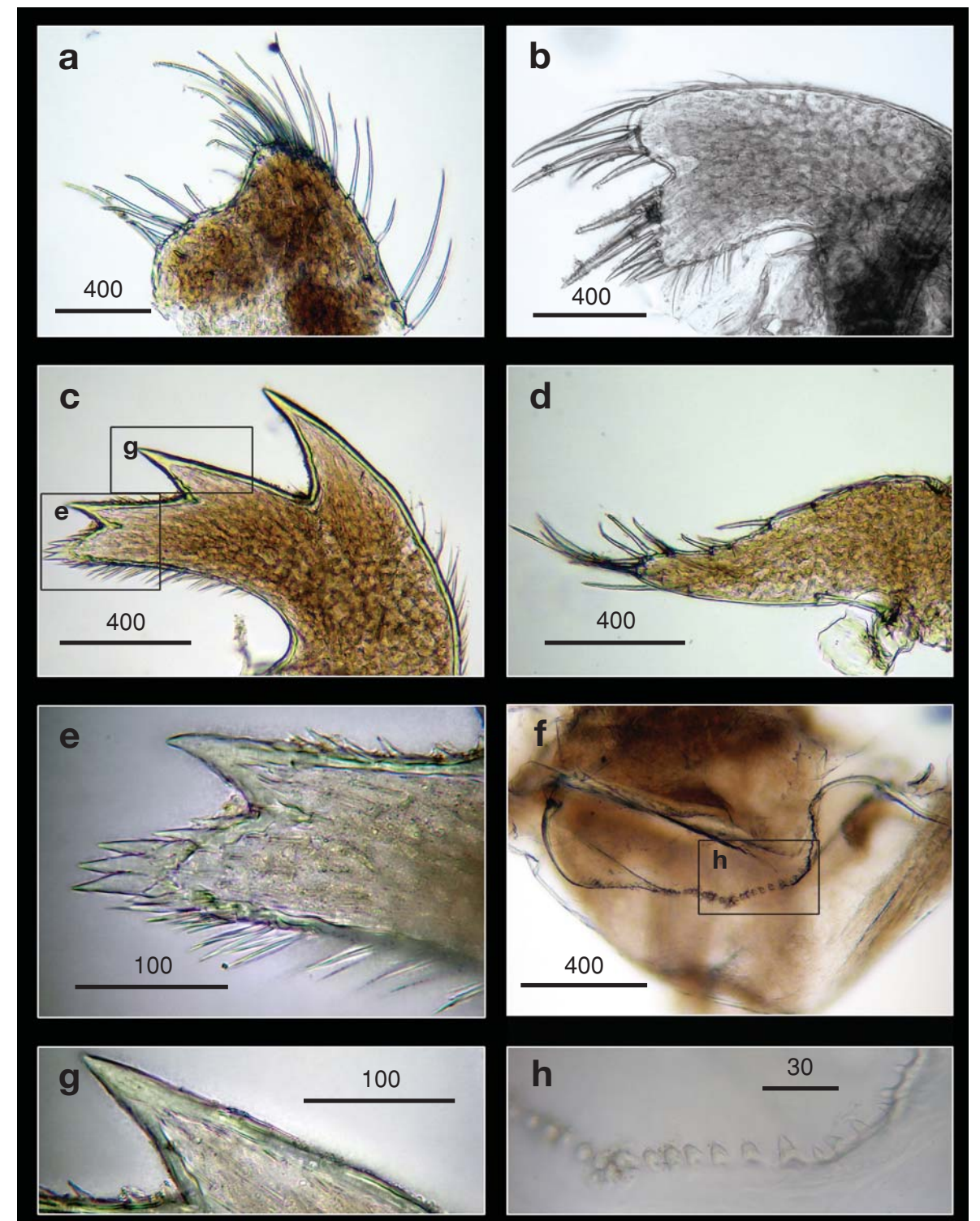


Fig. 91. *Verum novaezelandidae*, CP364, 24 Aug 2006. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Genus *Catherinum* Zevina, 1978
垂鎧茗荷屬

Acroscalpellum Hoek, 1907: 85.—Newman & Ross, 1971: 42 (part).

Catherinum Zevina, 1978b: 1348. Type species *Scalpellum recurvitergum* Gruvel, 1902.

Diagnosis.—Capitulum with 13 or 14 plates, upper latus umbo apical or sub-apical, inframedian latus very narrow, bacilliform, umbo sub-medial, carinal latus not extending beyond carinal margin.

Remarks.—There are 14 *Catherinum* species recorded worldwide, and 1 species has been recorded in Taiwan. This is a new record for Taiwan (see Cai et al., in press).

Catherinum rossi (Lakshmana Rao & Newman, 1972)
羅斯垂鎧茗荷



Fig. 92. *Catherinum rossi*, CD139, 23 Nov 2001. Side view of the capitulum.

Arcoscalpellum rossi Lakshmana Rao & Newman, 1972: 82, fig. 7.

Catherinum rossi.—Zevina, 1978b: 1348.—Liu & Ren, 1985: 203, fig. 12, pl. 2, figs. 11-14.—2007: 250, fig. 108.

Material examined.—CD139, 22°10.73'N, 120°14.1'E, 718-852 m, 23 Nov 2001: 1 specimen (CL 5.91mm, CW 3.52 mm, PL 1.95 mm) (NMNS 005087-00083).

Diagnosis.—Capitulum with 14 plates, inter-space between plates narrow, plates white and smooth. Tergum triangular, umbo apical; scutum higher than wide, rectangular, apex produced at tergo-occludent angle, umbo apical, upper latus pentagonal, apex produced at tergal and scutal margins, umbo apical; rostral latus quadrilateral; inframedian latus very narrow, vase-shaped, umbo sub-medial; carinal latus triangular, umbo at the basi-carinal angle, basi-carinal angle not extending to carinal margin. Peduncle shorter than capitulum, armored with sparse scales. Maxilla triangular, setae evenly spaced on margin; maxillule notched, 2 large cuspidate setae above notch, 5 cuspidate setae below notch; mandibles with 3 teeth excluding inferior angle, teeth simple, lower margin short; cutting edge of labrum straight, with numerous fine teeth. Cirrus I separated from other cirri, anterior ramus shorter and flattened, 5-segmented, posterior ramus slender and longer, 7-

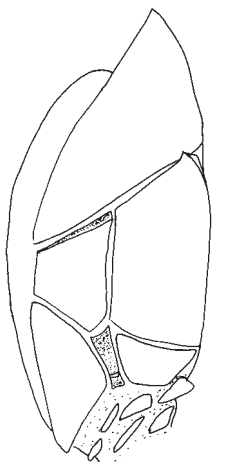


Fig. 93. *Catherinum rossi*, CD139, 23 Nov 2001. Line drawing of the side view of the capitulum.

segmented; cirri II-VI similar in structure, cirrus II with 14 segments for posterior ramus and 12 segment for anterior ramus; caudal appendage short, 4-segmented.

Size.—CL to 6 mm.

Coloration.—Capitulum white.

Habitat.—Attaches onto sponge or gorgonian corals.

Distribution.—East China Sea, Pacific Ocean, Taiwan.

Remarks.—New record for Taiwan.

Genus *Trianguloscalpellum* Zevina, 1978

三角鎧茗荷屬

Arcoscalpellum Hoek, 1907: 85.—Pilsbry, 1907a: 47.—Newman & Ross, 1971: 42.

Trianguloscalpellum Zevina, 1978b: 1349.—Liu & Ren, 1985: 205. Type species *Scalpellum balanoides* Hoek, 1883.

Diagnosis.—Capitulum with 13 or 14 plates, inframedian latus triangular or rectangular, umbo apical; carinal latus triangular, umbo apical.

Remarks.—*Trianguloscalpellum* includes 23 species worldwide, and 5 species are new records for Taiwan (see Cai et al., in press; Chan et al., 2009).

Key to species of the *Trianguloscalpellum* from Taiwan

1. Carinal latus very large, height almost similar to tergum *Trianguloscalpellum balanoides*
Carinal latus small, much shorter than the tergum 2
2. Tergum triangular 3
Tergum quadrilateral *Trianguloscalpellum diota*
3. Capitular with long hairs, tergum sharp *Trianguloscalpellum hirsutum*
Capitular surface without hair 4
4. Tergum narrow and sharp *Trianguloscalpellum weltnerianum*
Tergum broad *Trianguloscalpellum regium*

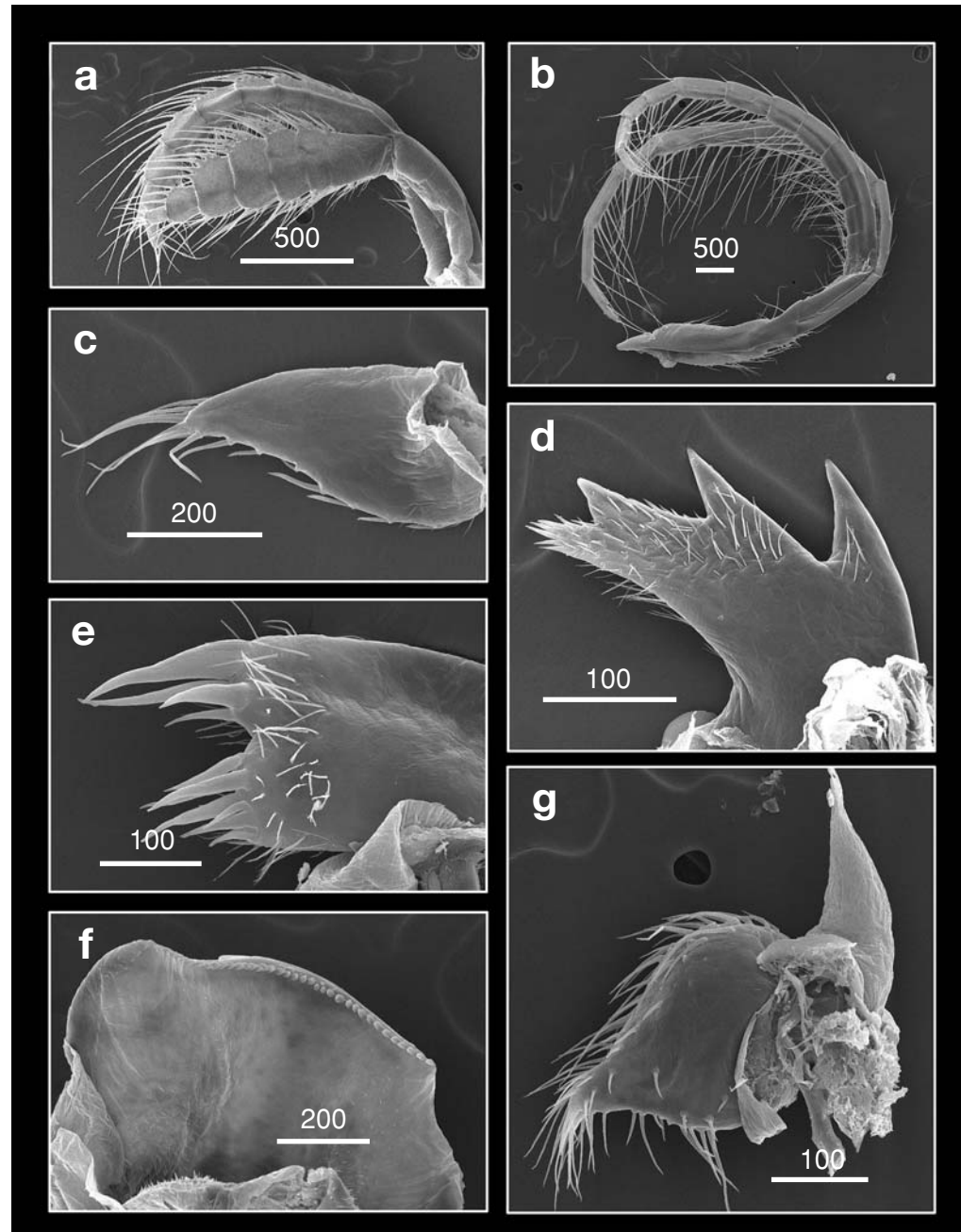


Fig. 94. *Catherinum rossi*, CD139, 23 Nov 2001. Scanning Electron Microscopy on a. Cirrus I, b. Cirrus II, c. Mandibulatory palp, d. Mandible, e. Maxillule, f. Labrum, g. Maxilla. Scale bars in μm.

Trianguloscalpellum balanoides (Hoek, 1883)
藤壺三角鎧茗荷

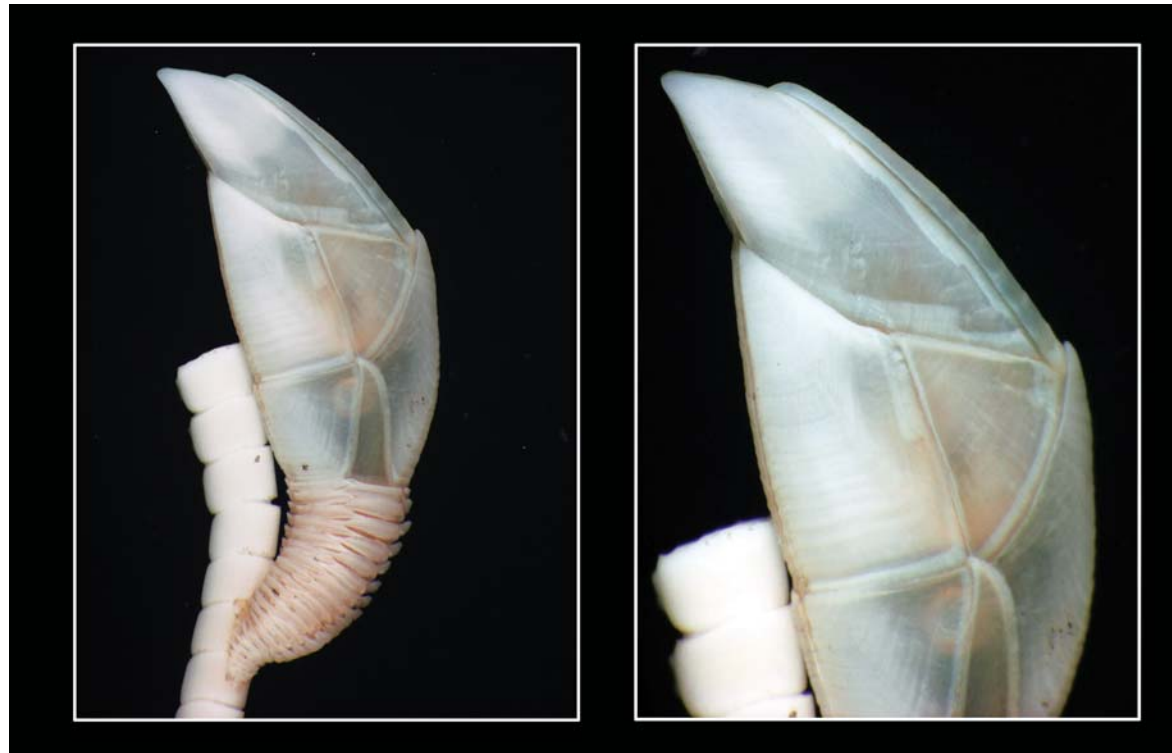


Fig. 95. *Trianguloscalpellum balanoides*, Donggang, Pingtung County, 10 Mar 1997. Side view of the capitulum.

Scalpellum balanoides Hoek, 1883: 129, pl. 5, fig. 15, pl. 10, fig. 11, pl. 11, figs. 1-3.—Broch, 1922: 242, fig. 10.—Hiro, 1937a: 42, fig. 33.

Scalpellum gonionotum Pilsbry, 1911: 65.—Hiro, 1937a: 43.

Trianguloscalpellum balanoides.—Zevina, 1978b: 1349.—1981: 294, fig. 221.—Liu & Ren, 1985: 210, fig. 16, pl. XI, figs. 15-17.

Material examined.—Donggang, Pingtung County, 10 Mar 1997.

Diagnosis.—Capitulum elongated, higher than wide, with 14 smooth white plates; trapezoidal, umbo apical. Scutum quadrilateral, umbo apical, occludent margin straight; upper latus triangular, carinal latus very large, higher than wide, apex produced at level of basal margin of tergum, umbo apical; inframedian latus triangular, higher than wide, rostral latus quadrilateral, carina straight, short.

Size.—CL to 10 mm.

Coloration.—White.

Habitat.—Attaches onto crinoids.

Distribution.—Japan, China, Taiwan, the Philippines, Indonesia.

Remarks.—New record for Taiwan.

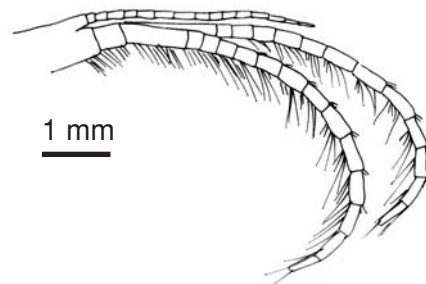


Fig. 96. *Trianguloscalpellum balanoides*, Donggang, Pingtung County, 10 Mar 1997. Cirrus VI and caudal appendage.

Trianguloscalpellum diota (Hoek, 1907)
瓶狀三角鎧茗荷

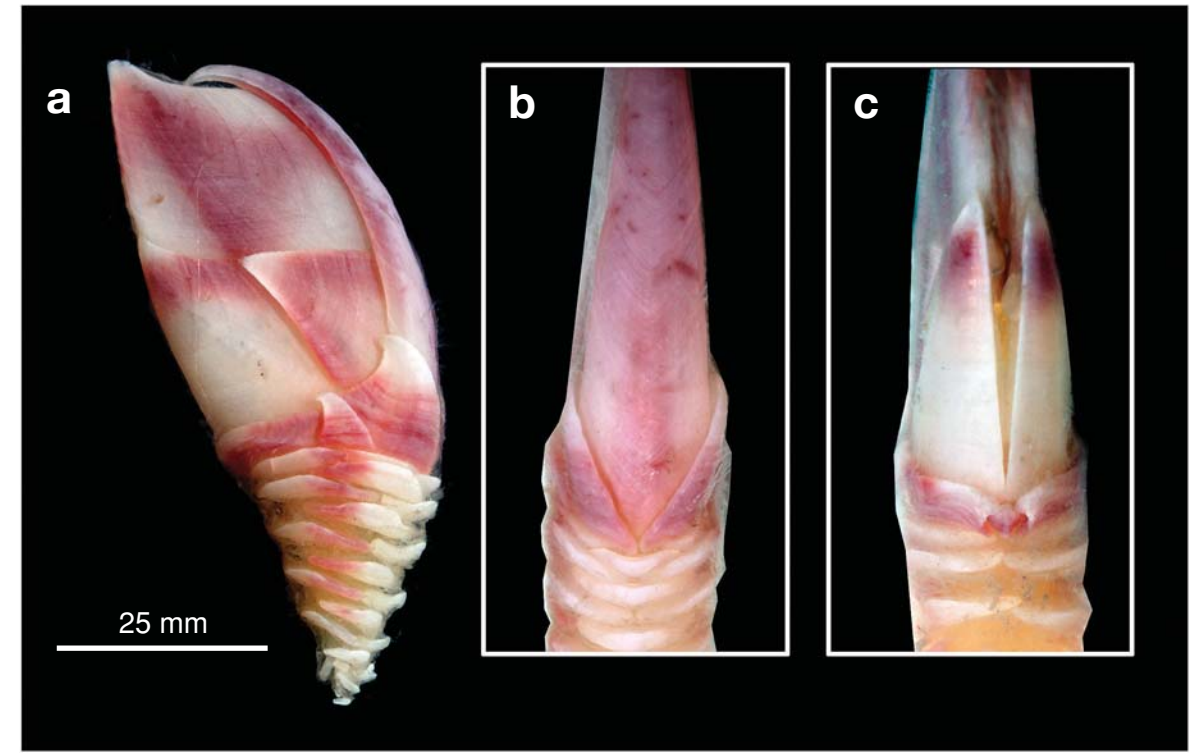


Fig. 97. *Trianguloscalpellum diota*, Donggang, Pingtung County, Apr 2001. a. Side view of the capitulum, b. Carina view and c. Rostral view of the capitulum.

Scalpellum diota Hoek, 1907: 87-88, pl. VII, figs. 15, 15a.—Stubbings, 1936: 22, fig. 9.

Trianguloscalpellum diota.—Zevina, 1981: 315, fig. 239.

Material examined.—Donggang, Pingtung County, benthic trawl at S. Taiwan, on spine of sea urchin *Stylocidaris renei*, April 2001, 1 specimen (CL 5.61 mm, CW 2.79 mm, PL 2.48 mm) (NMNS 003636-00002).

Diagnosis.—Capitulum diffused light-pink, elongated, with 14 valves, covered by hairy membrane. Tergum triangular, occludent margin straight, umbo apical, apex pointed; scutum quadrangular, occludent margin straight, umbo apical, apex slightly overlapping tergum; upper latus quadrilateral; carinal strongly convex and umbo apical; inframedian latus triangular, umbo apical; rostral latus quadrilateral, flattened, wider than high; carinal latus triangular, umbo apical. Maxilla triangular, with setae evenly distributed on cutting edge; cutting edge of maxillule not notched, with 13 spines on edge; mandible with 3 teeth excluding inferior angle, 1st tooth separated from 2nd and 3rd tooth, about 7 spines on lower margin; mandibulatory palp narrow

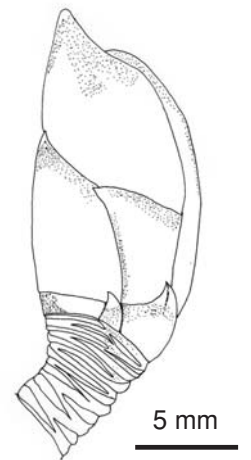


Fig. 98. *Trianguloscalpellum diota*, Line drawing of the side view of capitulum.

and elongated with serrulated setae on superior margin and tip, no setae on inferior margin; labrum straight with small denticles on cutting edge.

Size.—CL to 10 mm.

Coloration.—Plates white with pink diffusions.

Habitat.—Deep-sea species, attaches onto sea urchin spines.

Distribution.—Indonesia, the Philippines, Taiwan.

Remarks.—New record for Taiwan.

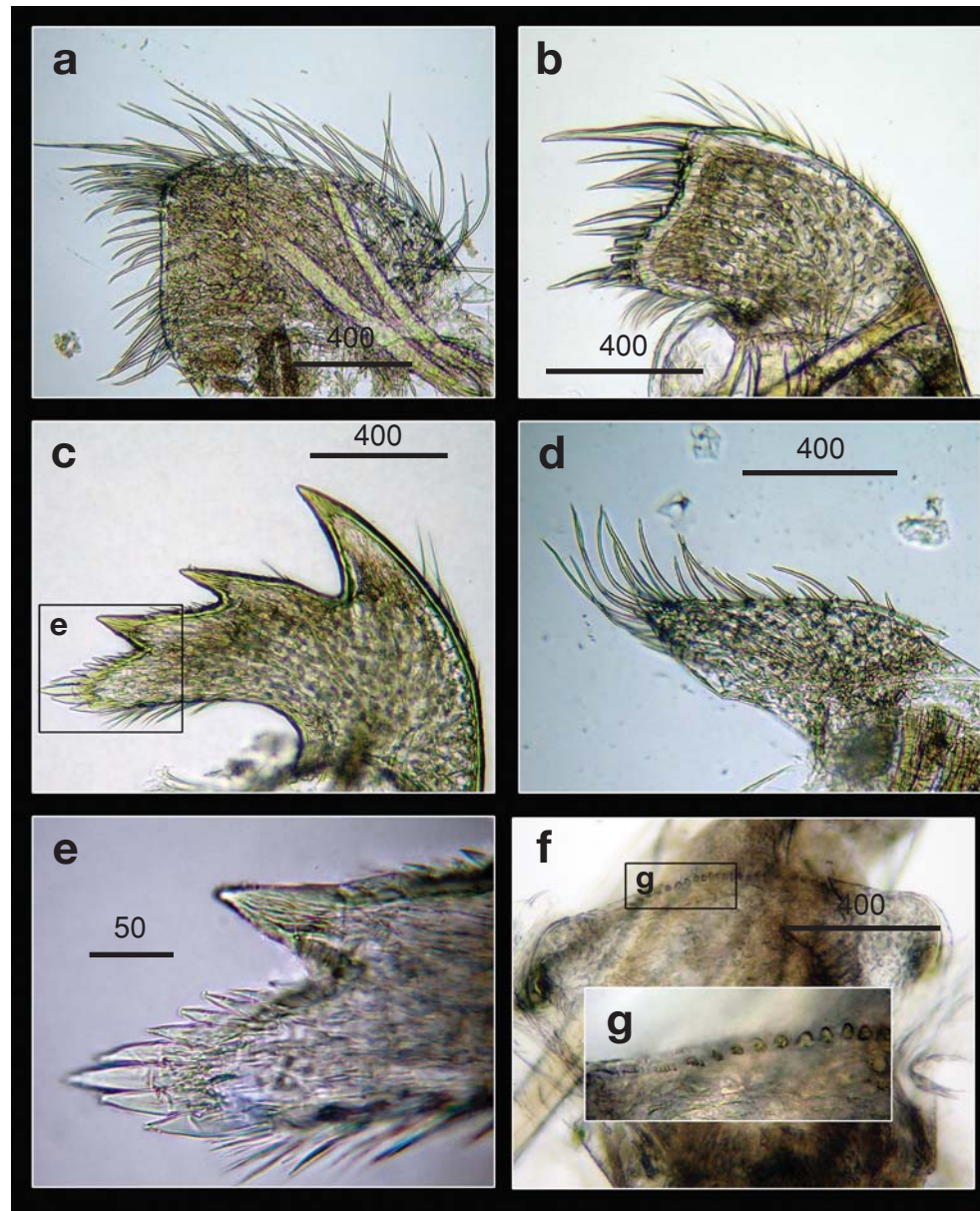


Fig. 99. *Trianguloscalpellum diota*, Donggang, Pingtung County, Apr 2001. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum and g. Close up on the teeth of labrum. Scale bars in μm .

Trianguloscalpellum hirsutum (Hoek, 1883)

多毛三角鎧茗荷



Fig. 100. *Trianguloscalpellum hirsutum*, CP300, 11 Aug 2005. Side view of the capitulum, showing the hairy surfaces.

Scalpellum hirsutum Hoek, 1883: 88, pl. IV, fig. 19.—Newman & Ross, 1971: 63, fig. 28.

Trianguloscalpellum hirsutum.—Zevina, 1981: 309, fig. 233.

Material examined.—CP300, 22°17.156' N, 119°59.963'E, 960-972 m, 11 Aug 2005: 1 specimen (CL 20.88 mm, CW 11.43 mm, PL 9.93 mm) (NMNS 005087-00082).—CP375, 24°16.240'N, 122°11.720'E, 2216-2497 m, 27 Aug 2006: 1 specimen (CL 21.38 mm, CW 19.42 mm, PL 13.78 mm) (CEL-BB-46B).—CP371, 24°28.521'N, 122°12.821'E, 582-613 m, 26 Aug 2006: 1 specimen (CL 20.76 mm, CW 13.22 mm, PL 16.49 mm) (CEL-BB-63).

Diagnosis.—Capitulum with 14 fully calcified plates, plate surfaces covered by long hairs. Tergum large, higher than wide, elongate rhomboidal, apex produced and pointed, umbo apical, occludent margin convex; scutum quadrangular, occludent and tergal margins convex, lateral and basal margins straight, apex produced at tip of occludent margin, umbo apical; upper latus triangular, carinal margin convex; inframedian latus almost an equilateral triangle, umbo apical; rostral latus flattened, twice as wide as high, carinal latus horn-shaped, apex produced, apex touching carina; peduncle short, scales produced in longitudinal rows.

Maxilla bilobed, setae present on 3 main clusters; maxillule cutting edge not notched, with 19 spines on cutting edge; mandible with 3 teeth excluding inferior angle, distances among the 3 teeth equal, lower margin straight; mandibulatory palp elongated, setae on superior margin; labrum concaved, cutting edge smooth with fine setae, without teeth. Cirrus I separated from cirri II-VI, rami unequal, posterior ramus longer and slender, 12-segmented, anterior ramus broad and shorter, 7-segmented; rami of cirrus II sub-equal, posterior ramus 22-segmented, anterior ramus 23-segmented; cirri IV-VI similar in length, longer than cirrus I and II, anterior ramus of cirrus IV 24-segmented and posterior ramus 26-segmented; caudal rami 1-segmented, within first 2 segments of basal pedicle of cirrus VI.

Size.—CL to 30 mm.

Coloration.—Pale-yellow to brown.

Habitat.—On rocks and gastropod shells.

Distribution.—Present records include Borneo, Antarctica, Taiwan.

Remarks.—New record for Taiwan.

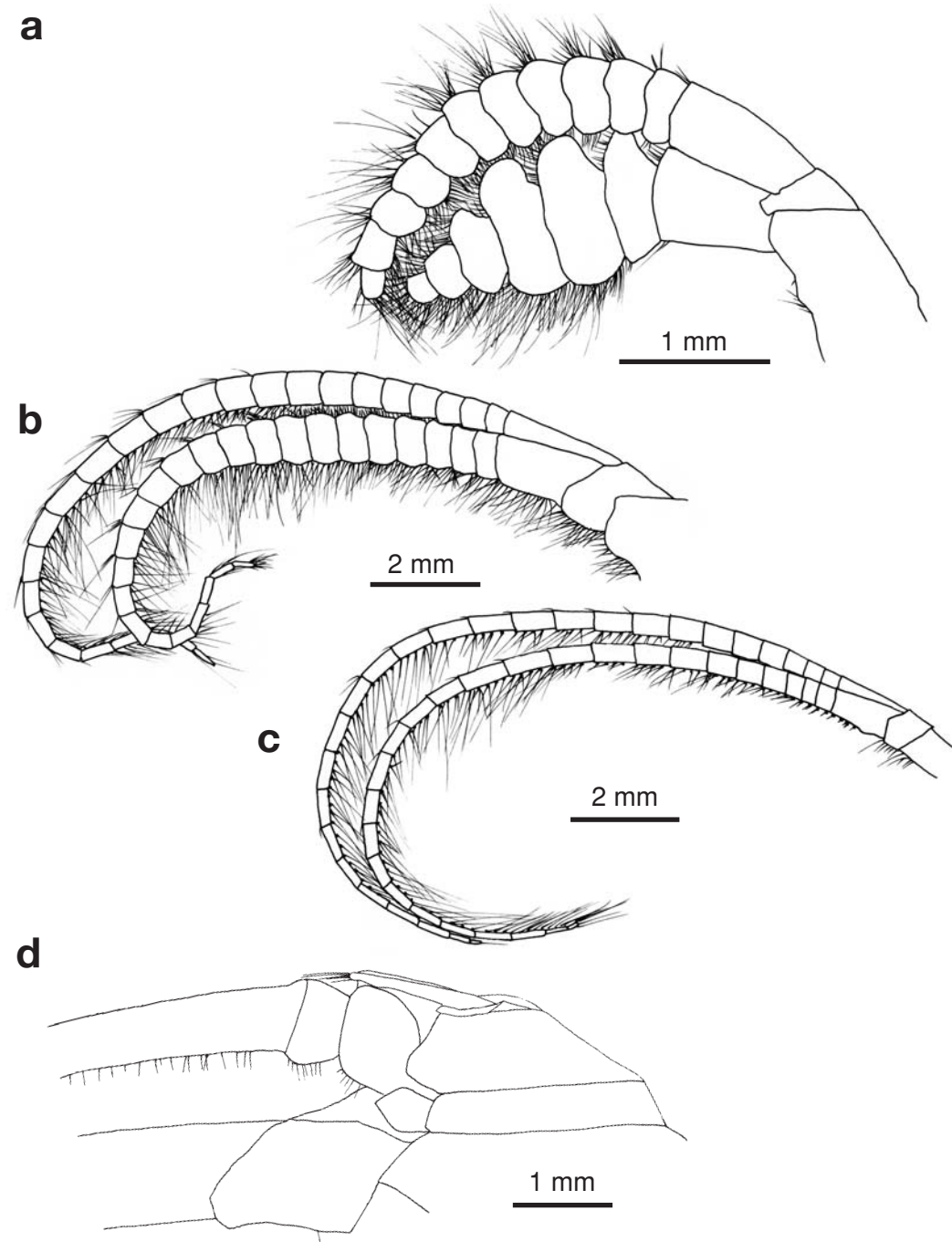


Fig. 101. *Trianguloscalpellum hirsutum*, CP300, 11 Aug 2005. Line drawings of a. Cirrus I, b. Cirrus II, c. Cirrus IV and d. Caudal appendage.

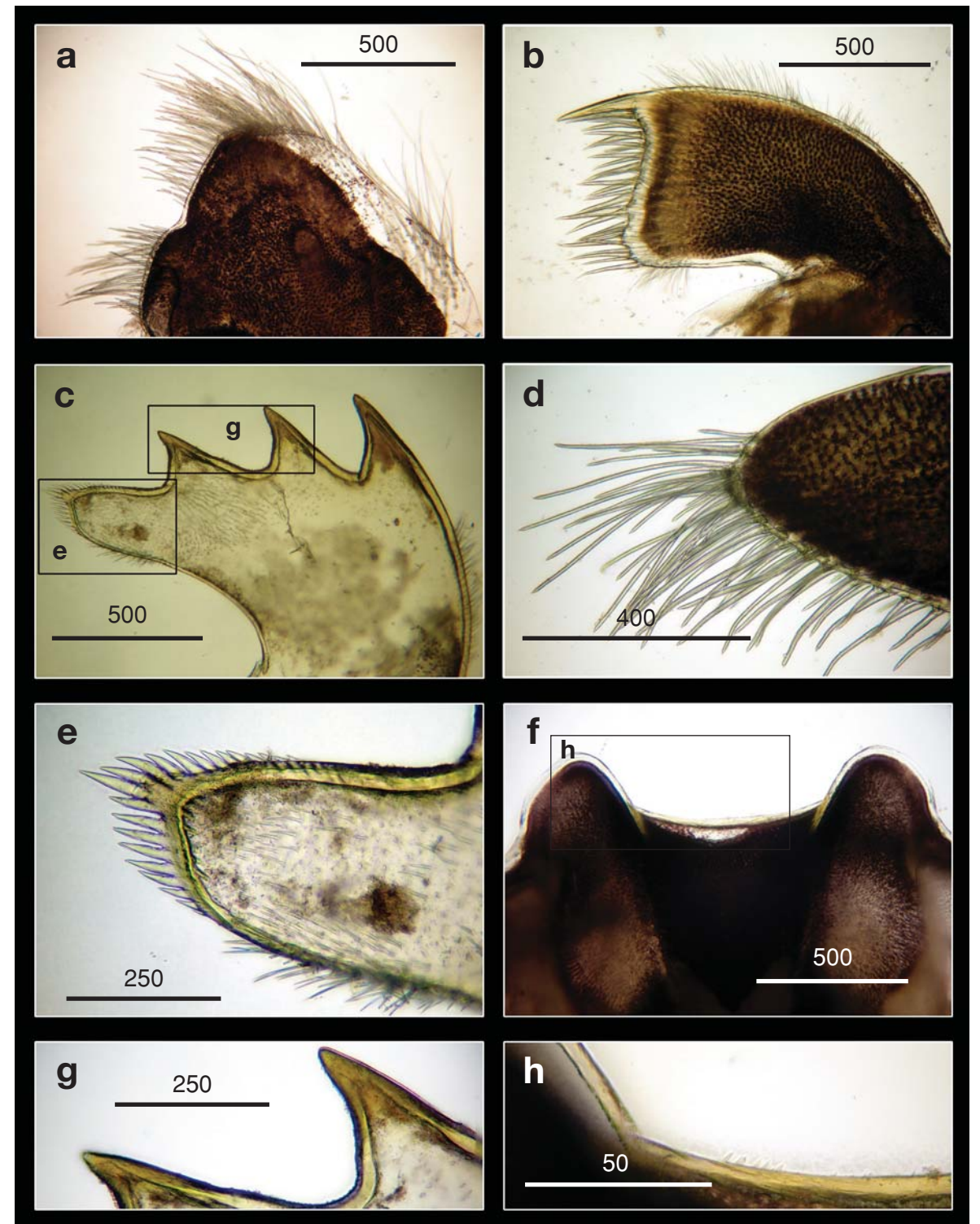


Fig. 102. *Trianguloscalpellum hirsutum*, CP300, 11 Aug 2005. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum. Scale bars in μm .

Trianguloscalpellum weltnerianum (Pilsbry, 1911)
維氏三角鎧茗荷

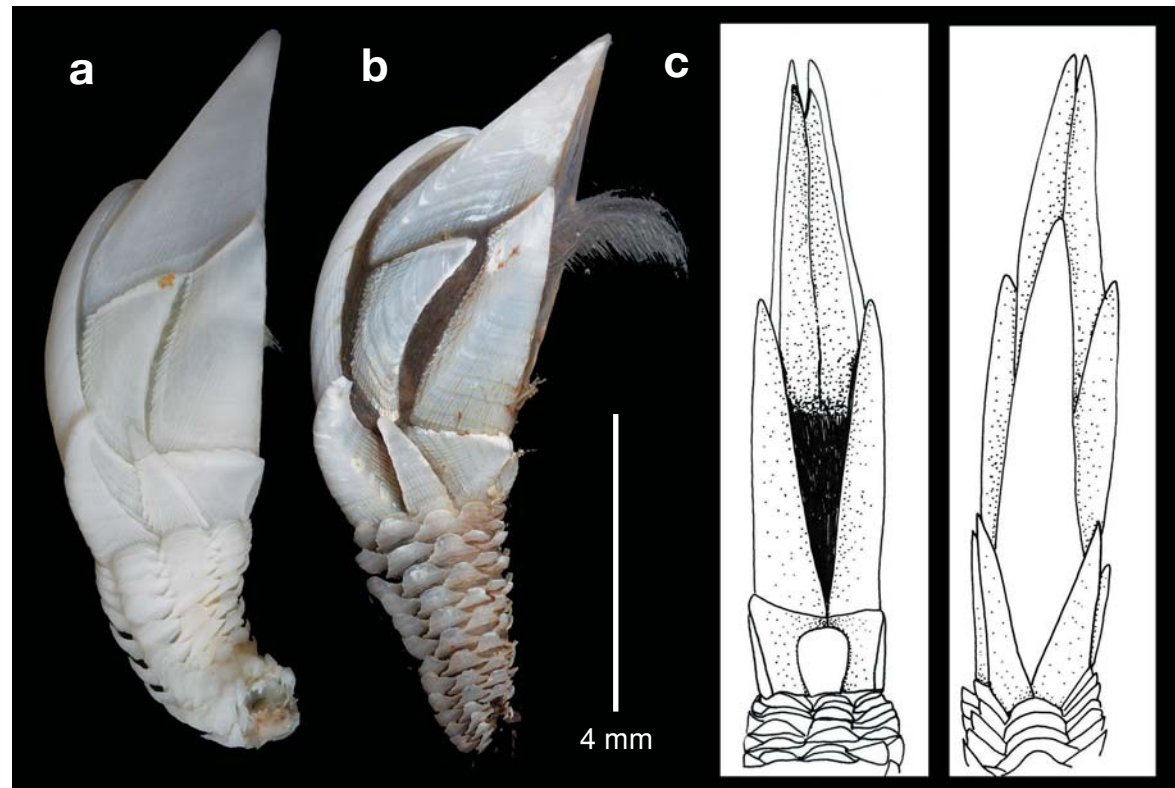


Fig. 103. *Trianguloscalpellum weltnerianum*, CD320, 19 Aug 2005. a. Side view of the capitulum. b. Rostral view and c. Carinal view of the capitulum.

Scalpellum weltnerianum Pilsbry, 1911: 64, pl. IX, figs. 5-7 [type locality S. W. of Kagoshima Bay, Japan].

Trianguloscalpellum weltnerianum.—Zevina, 1981: 306, fig. 230.

Material examined.—CD320, 20°50.090'N, 117°27.170'E, 720-730 m, 19 Aug 2005: 1 specimen (CL 7.40 mm, CW 3.34 mm, PL 3.56 mm) (CEL-BB-88).—PCP342, 22°16.648'N, 119°59.960'E, 988-1010 m, 8 Mar 2006: 1 specimen (CL 11.03 mm, CW 5.20 mm, PL 5.41 mm) (CEL-BB-88B).—near Lyudao, Taitung County, Aug 2006: 1 specimen (CL 11.01 mm, CW 8.23 mm, PL 3.56 mm) (CEL-BB-85).

Diagnosis.—Capitulum elongated, twice as long as wide, with 14 white plates, plate surfaces striated with radial riblets. Tergum higher than wide, triangular; scutum quadrilateral, umbo apical, occludent and basal margins straight, 2 margins intersecting at a right angle; upper latus quadrangular, higher than wide, scutal margin concave, basal margin very narrow; inframedian latus triangular, twice as high as wide, umbo apical; carinal latus curved upwards, umbo apical; rostral latus quadrangular; rostrum relatively large, oval; carina bowed with flat roof. Maxilla bilobed, sub-quadrangular, setae clustered into 3 lobe regions; cutting edge of maxillule notched, edge narrow, 4 spines above notch, no spines in notch, 5 spines below notch; mandible tridentate excluding inferior angle, 1st tooth separated from 2nd and 3rd teeth, lower margin very short with 8 spines; tip and superior margin of mandibulatory palp with setae, no setae on inferior margin. Cirrus I rami unequal, separated from cirri II-VI, posterior ramus longer, slender, 10-segmented, anterior ramus slightly

broader, 6-segmented; cirri II-VI long and slender; cirrus II (anterior ramus 12, posterior ramus 12), III (12, 11), VI (17, 17); caudal appendage very short, 1-segmented, within length of basal pedicle of cirrus VI.

Size.—CL to 15 mm.

Coloration.—White.

Habitat.—At present, this species is only reported to live on crinoids, suggesting an association between crinoids and *T. weltnerianum*.

Distribution.—Japanese and Taiwanese waters.

Remarks.—Pilsbry (1911) pointed out that *T. weltnerianum* was morphologically close to *T. album* (Hoek) collected from the Malay Archipelago. *Trianguloscalpellum weltnerianum* differs from *T. album* by having striated plates on its surface, while plates of *T. album* are smooth as described by Hoek (see Pilsbry, 1911). *Trianguloscalpellum weltnerianum* is a new record for Taiwan.

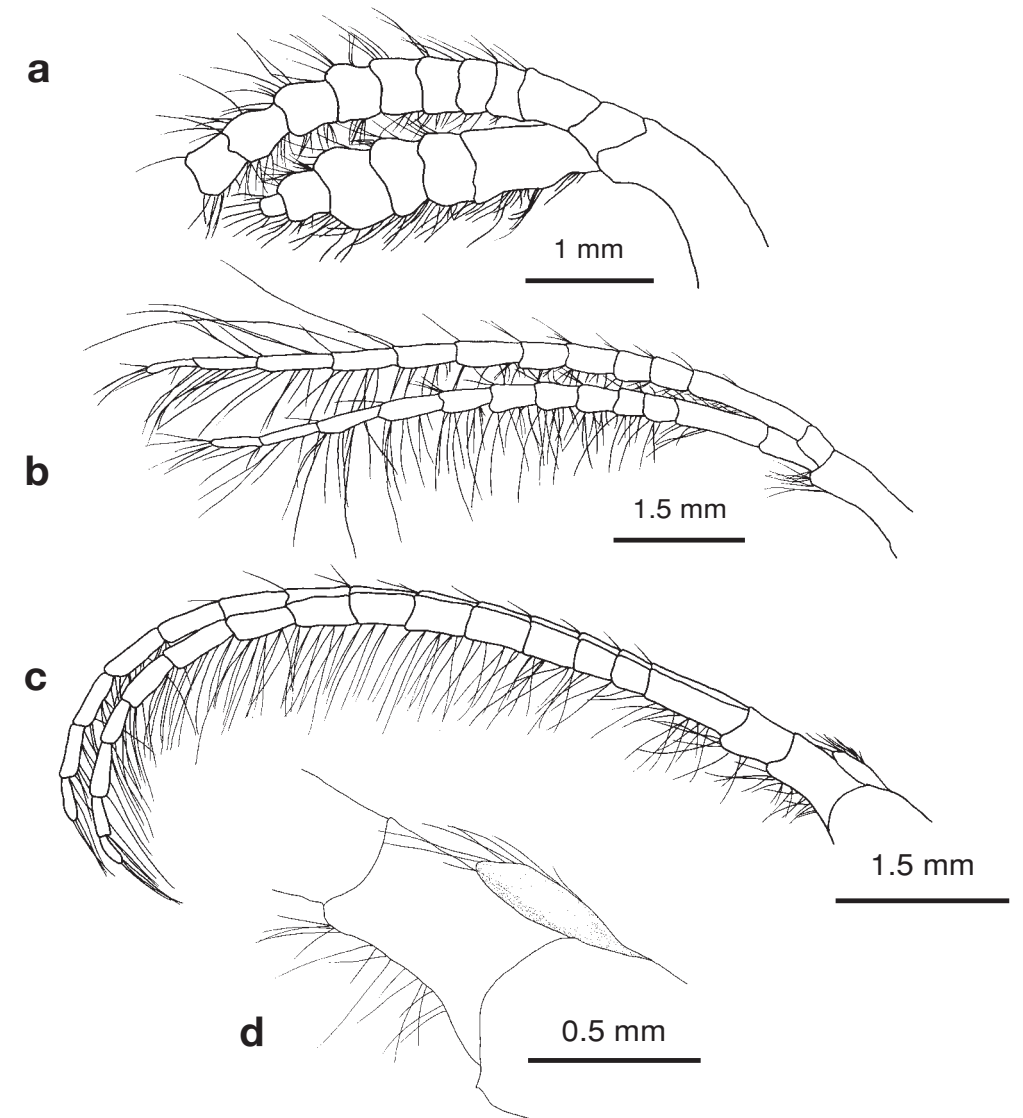


Fig. 104. *Trianguloscalpellum weltnerianum*, CD320, 19 Aug 2005. Line drawings of a. Cirrus I, b. Cirrus II, c. Cirrus VI and d. Caudal appendage.

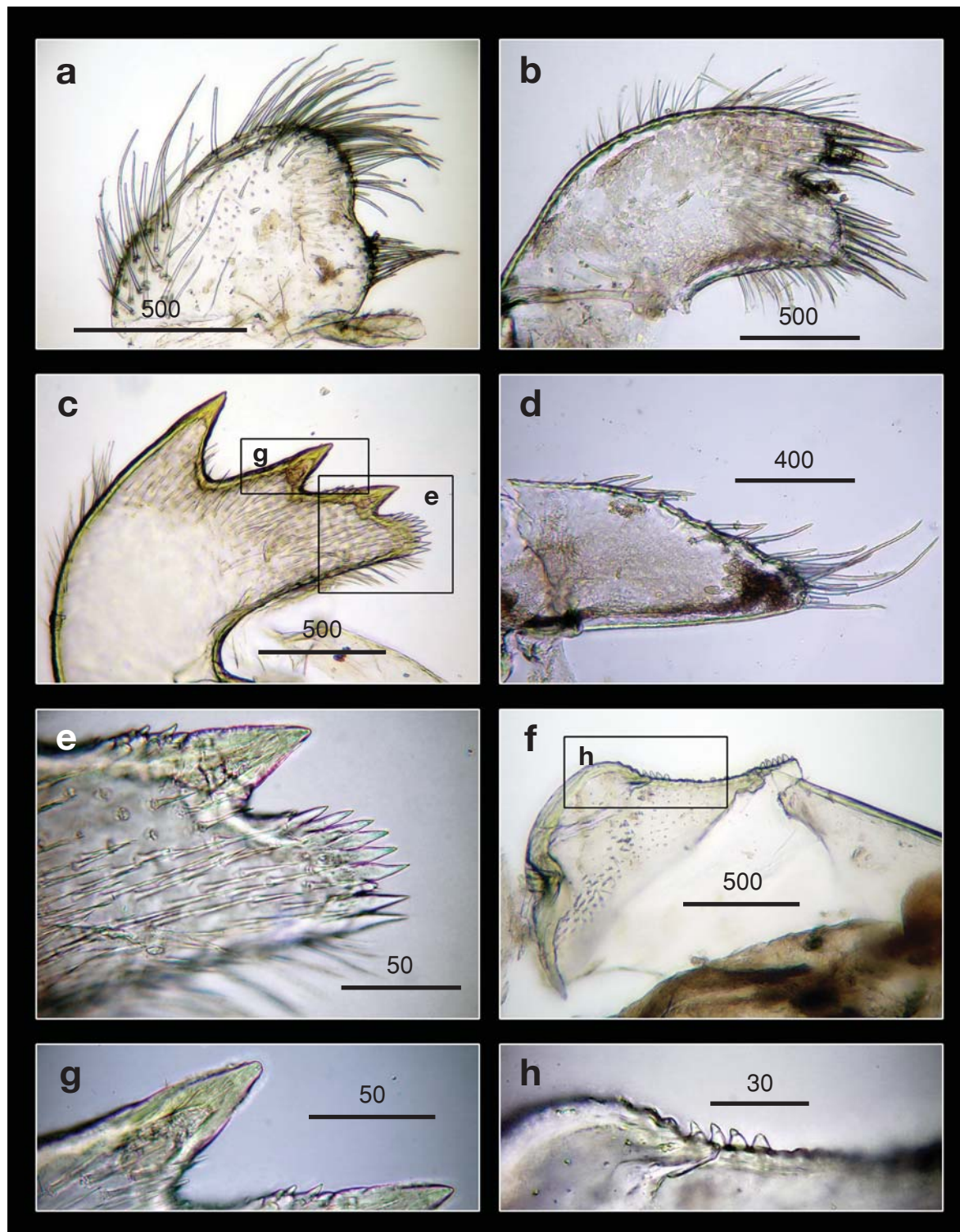


Fig. 105. *Trianguloscalpellum weltnerianum*, CD320, 19 Aug 2005. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Trianguloscalpellum regium (W. Thomson)
欽定三角鎧茗荷



Fig. 106. *Trianguloscalpellum regium*, CP375, 27 Aug 2006. Side view of the capitulum.

Scalpellum regium W. Thompson.—Hoek, 1883: 106, pl. IV, figs. 3-5.—Pilsbry, 1907a: 28, pl. III, figs. 4, 5.—Gruvel, 1920: 30, pl. 1, fig. 7.

Trianguloscalpellum regium regium.—Zevina, 1981: 309-310, fig. 234.

Material examined.—CP375, 24°16.2 40'N, 122°11.720'E, 2216-2497 m, 27 Aug 2006: 1 specimen (CL 37.09 mm, CW 23.09 mm, PL 17.20 mm) (CEL-BB-46C).

Diagnosis.—Capitulum quadrangular, with 14 plates, covered by a membrane. Tergum large, triangular, carinal margin convex, occludent margin straight, umbo apical; scutum quadrangular, higher than wide, apex produced at junction of occludent and tergal margins, umbo apical; upper latus triangular, tergal margin convex, scutal margin concave; inframedian latus an equilateral triangle, umbo apical; rostral latus very narrow, wider than high; carinal latus higher than wide, curved with a produced apex, umbo apical; carina bowed with a flat roof; peduncle with densely packed concentric scales. Maxilla with dense setae evenly spaced along cutting edge; cutting edge of maxillule without a notch, about 22 large spines along cutting edge; mandible with 3 teeth

excluding inferior angle, teeth evenly separated, lower margin long, without setae, inferior angle covered by dense setae; mandibulatory palp narrow, elongated, setae present on superior region but not on inferior region; labrum bullate, cutting edge smooth, without teeth. Cirrus I separated from remaining cirri, rami unequal, posterior ramus long and slender, 10-segmented, anterior ramus broader and shorter, 6-segmented; cirrus II rami of equal length, 22 segments in posterior and anterior rami, cirrus VI rami equal, posterior ramus and anterior ramus 33-segmented; caudal appendage short, 1-segmented, length within basal pedicle segment of cirrus VI.

Size.—CL to 40 mm.

Coloration.—Pale-yellow to brown.

Habitat.—On rocks.

Distribution.—Cosmopolitan. Pacific and Atlantic Ocean.

Remarks.—New record for Taiwan.

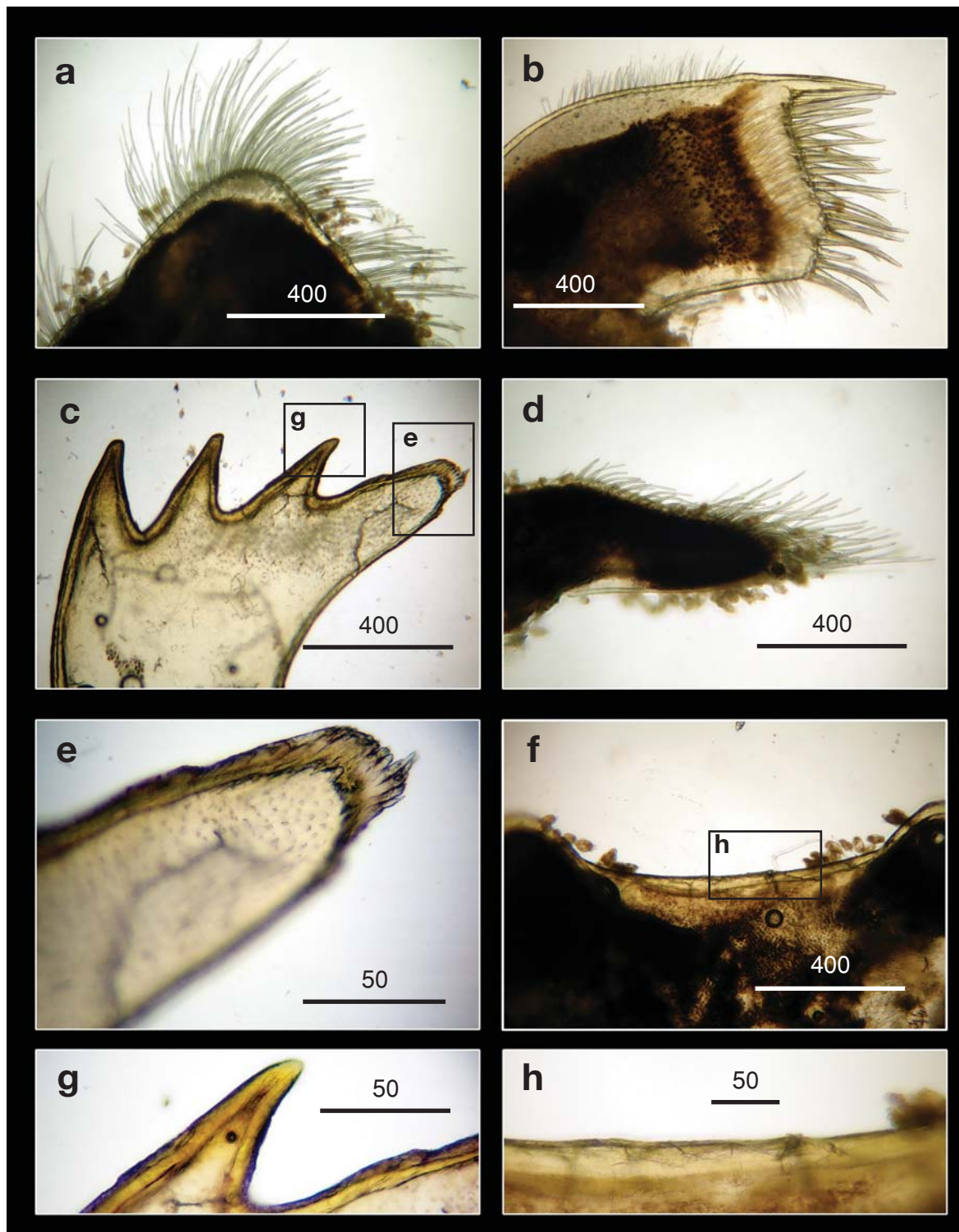


Fig. 107. *Trianguloscalpellum regium*, CP375, 27 Aug 2006. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum. Scale bars in μm .

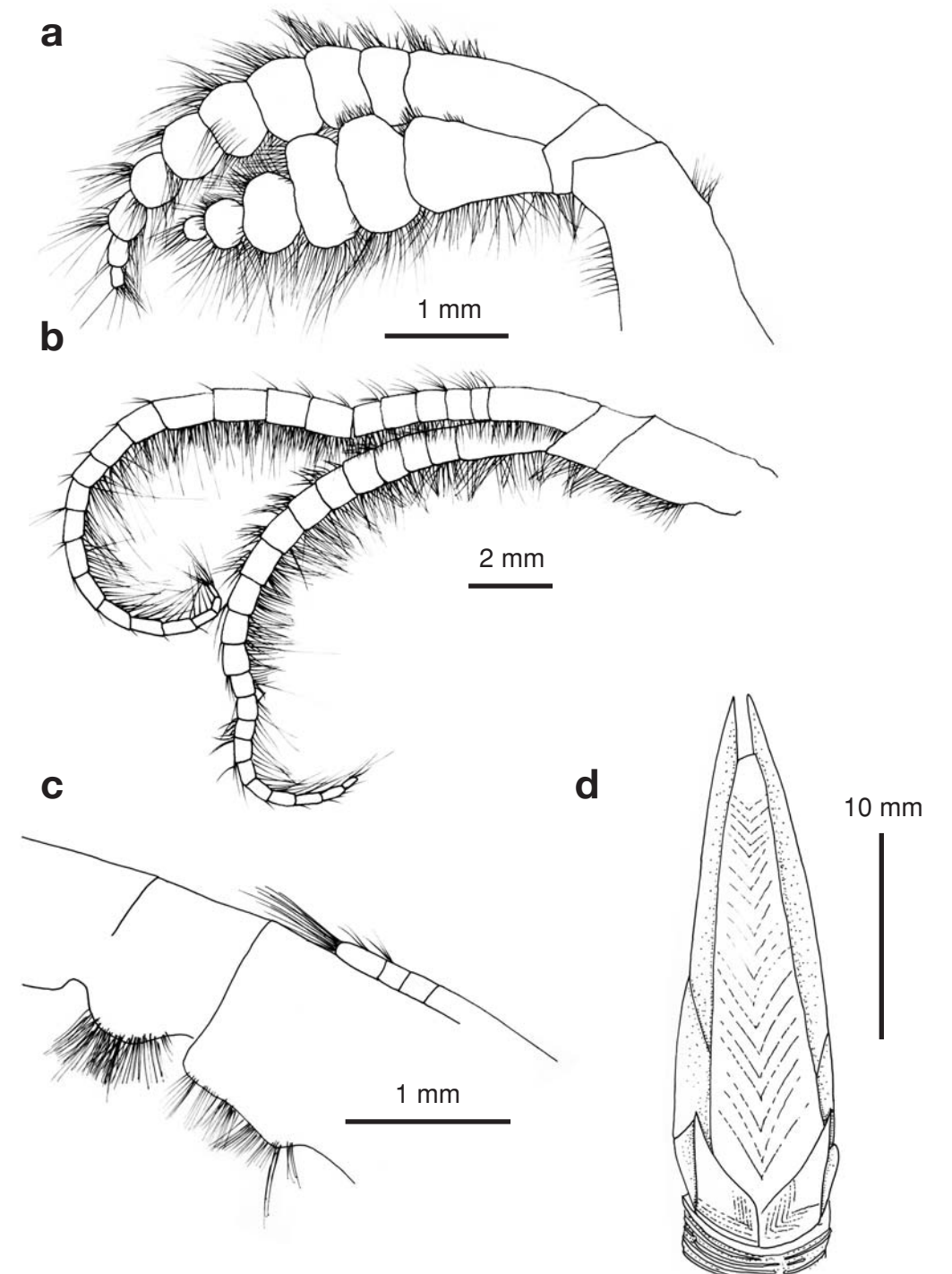


Fig. 108. *Trianguloscalpellum regium*, CP375, 27 Aug 2006. Line drawings of a. Cirrus I, b. Cirrus II and c. Caudal appendage, d. Carinal view of the capitulum.

Genus *Arcoscalpellum* Hoek, 1907

小鎧茗荷屬

Section *Arco-scalpellum* Hoek, 1907: 59.—Pilsbry, 1908: 110 (as subgenus).—Withers, 1953: 96.—Newman & Ross, 1971: 42.—Zevina, 1978b: 1350. Type species *Scalpellum michelottianum* Sequenza, 1876.

Diagnosis.—Capitulum with 14 fully or partially calcified plates; carina with apical or sub-apical umbo; inframedian latus umbo apical, carinal latus umbo in middle region of carinal margin, caudal appendage uni- or multi-articulate.

Remarks.—30 *Arcoscalpellum* species have been recorded so far; and 3 species were recorded in Taiwan in the present study. These are new records for Taiwan (see Cai et al., in press).

Key to species of *Arcoscalpellum* from Taiwan

- 1. Penis present *Arcoscalpellum sociabile*
- Penis absent 2
- 2. Carinal latus wider than high, upper latus triangular, tergum with sharp apex
 *Arcoscalpellum michelottianum*
- Carinal latus higher than wide, upper latus pentagonal, plate surface striated, tergum apex truncated
 *Arcoscalpellum truncatum*

Arcoscalpellum sociabile (Annandale, 1905)

合群小鎧茗荷

Scalpellum sociabile Annandale, 1905: 77, pl. 8, fig. 1, [type locality: Bali Strait.]—Nilsson-Cantell, 1928: 4, fig. 2.—1934a: 45.—Broch, 1931: 19.

Arcoscalpellum sociabile sociabile.—Zevina, 1981: 339, fig. 259.

Material examined.—Donggang fishing port, Pingtung County, 30 Oct 2003: 1 specimen (CL 6.71 mm, CW 3.80 mm, PL 4.47 mm) (NMNS 004212-00002).

Diagnosis.—Capitulum elongated, with 14 plates. Tergum triangular, apex produced, carinal margin curved; scutum quadrilateral, umbo apical; upper latus trapezoidal, umbo apical; carinal latus horn-shaped, umbo in middle region of carinal margin,



Fig. 109. *Arcoscalpellum sociabile*, Donggang fishing port, Pingtung County, 30 Oct 2003. Side view of the capitulum.

inframedian latus triangular, umbo apical; rostral lateral wider than high, rectangular, carina bowed. Maxilla bilobed; maxillule not notched; mandible with 3 teeth excluding inferior angle, inferior angle pectinated, mandibulatory palp elongated, with setae in tip region; labrum with small teeth on cutting edge. Penis with sparse setae on surface.

Size.—CL to 10 mm.

Coloration.—White.

Habitat.—Deep-sea, substratum unknown.

Distribution.—Widely distributed worldwide.

Remarks.—New record for Taiwan.

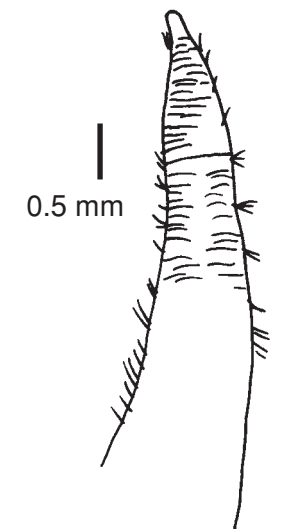


Fig. 110. *Arcoscalpellum sociabile*, Donggang fishing port, Pingtung County, 30 Oct 2003. Line drawing of the penis.

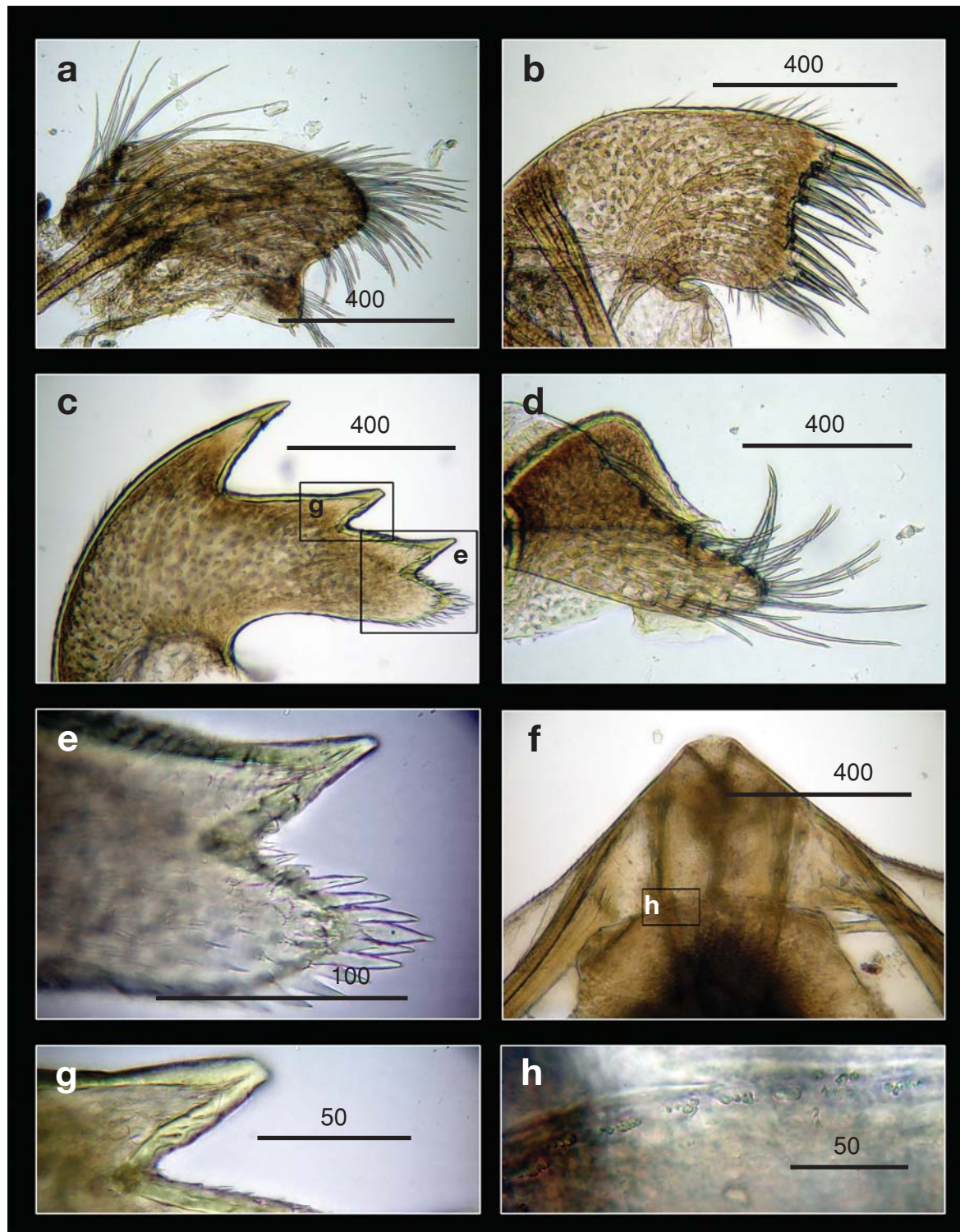


Fig. 111. *Arcoscalpellum sociabile*, Donggang fishing port, Pingtung County, 30 Oct 2003. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Arcoscalpellum michelottianum (Seguenza, 1876)
小甲小鎧茗荷



Fig. 112. *Arcoscalpellum michelottianum*, PCP402, 7 Nov 2007. Side view of the capitulum.

Scalpellum michelottianum Seguenza, 1876: 381, pl. 6, figs. 15-25.—Pilsbry, 1907a: 32.

Scalpellum velutinum Hoek, 1883: 96, pl. 4, figs. 10, 11, pl. 9, figs. 7-9.—Weltner, 1897: 251.—1922: 75.—Gruvel, 1902: 56, pl. 2, figs. 3c, 10a-b, 14, pl. 3, figs. 1, 27-31, pl. 4, figs. 6, 11-22.—1905: 73, fig. 83.—1920: 27, pl. 1, figs. 8-10, pl. 7, fig. 4.—Annandale, 1905: 83.—1911: 588.—1916a: 129, pl. 6, figs. 6, 7.—Pilsbry, 1907a: 26.—Calman, 1918: 108.—Nilsson-Cantell, 1927: 743, fig. 1.—1928: 4.—1938: 8.—Broch, 1931: 18.—Stubbings, 1936: 28, fig. 12.—1967: 234.

Scalpellum eximium Hoek, 1883: 100, pl. 4, figs. 6, 7, pl. 9, fig. 10.—Weltner, 1897: 247.

Scalpellum sordidum Aurivillius, 1898: 190.

Scalpellum alatum Gruvel, 1900: 192.—Gruvel, 1902: 57.

Arcoscalpellum michelottianum.—Withers, 1953: 225.—Newman & Ross, 1971: 71, fig. 34, pl. 9b.—Lakshmana Rao & Newman, 1972: 76, fig. 5.—Zevina, 1978b: 1350.

Arcoscalpellum velutinum Weisbord, 1977: 273, figs. 1, 2.

Trianguloscalpellum michelottianum Liu & Ren, 1985: 207, fig. 14, pl. 4, figs. 10-12.

Material examined.—PCP402, 22°21.157'N, 120°6.088'E, 686-735 m, 7 Nov 2007: 1 specimen (CL 26.37 mm, CW 17.03 mm, PL 25.53 mm) (NMNS 005671-00010).—PCP338, 22°10.435'N, 120°20.826'E, 534-615 m, 7 Mar 2006: 4 specimens (CL 19.19-39.09 mm, CW 12.04-26.25 mm, PL 18.70-49.71 mm) (CEL-BB-103).—Siaoliouciou, Pingtung County, 22 Aug 2001: 1 specimen (CL 35.41 mm, CW 25.47 mm, PL 51.42 mm) (NMNS 003683-00003).

Diagnosis.—Capitulum with 14 smooth white plates. Tergum oval, carinal margin convex, umbo apical; scutum quadrilateral, umbo apical; upper latus triangular, carinal latus horn-shaped, umbo in middle region of carinal margin; inframedian latus triangular, rostral latus highly flattened, carina bowed. Maxilla triangular; maxillule not notched, mandible with 3 sharp teeth excluding inferior angle; mandibulatory palp highly elongated, with setae on superior margin; labrum slightly concave, with fine teeth on cutting edge.

Size.—CL to 40 mm.

Coloration.—White to pale-yellow.

Habitat.—Deep-sea species. Attaches onto gorgonian corals, gastropod shells and rocks.

Distribution.—Distributed worldwide.

Remarks.—New record for Taiwan.

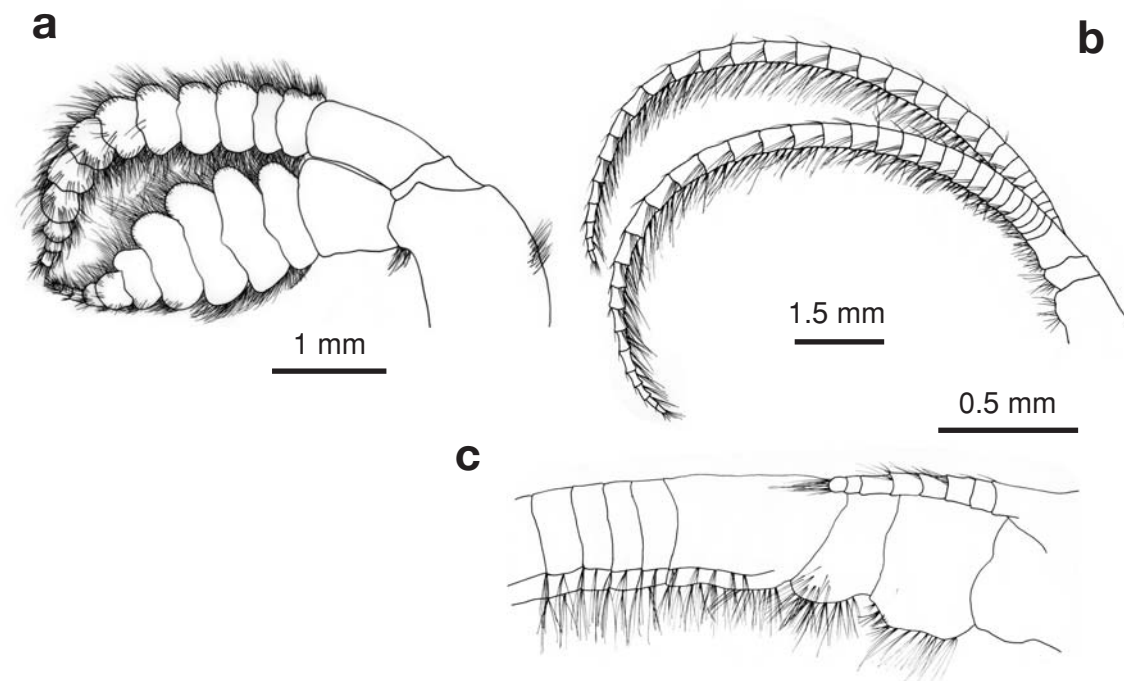


Fig. 113. *Arcoscalpellum michelottianum*, PCP402, 7 Nov 2007. Line drawings showing a. Cirrus I, b. Cirrus II and c. Caudal appendage.

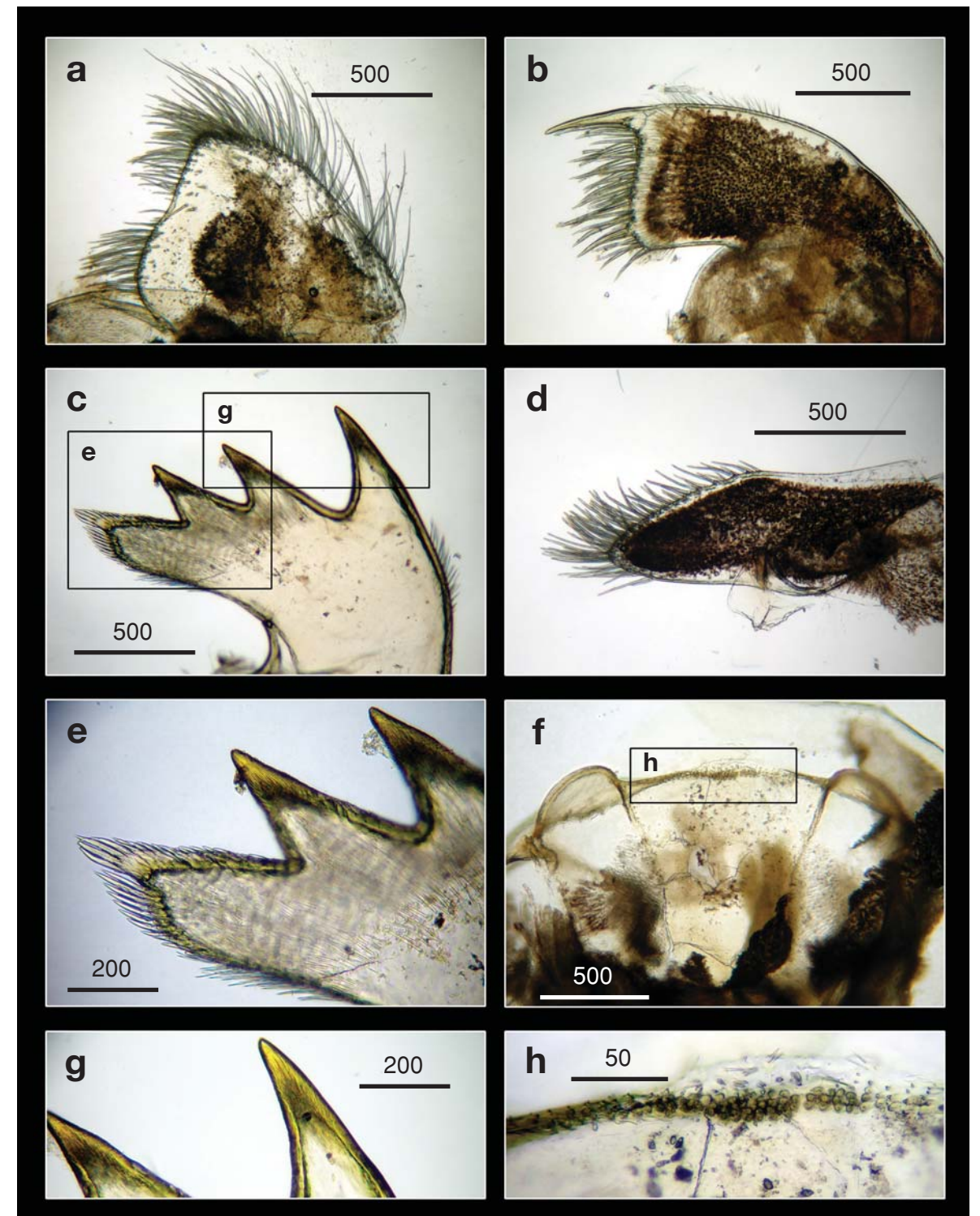


Fig. 114. *Arcoscalpellum michelottianum*, PCP402, 7 Nov 2007. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in µm.

Arcoscalpellum truncatum (Hoek, 1883)

截頂小鎧茗荷

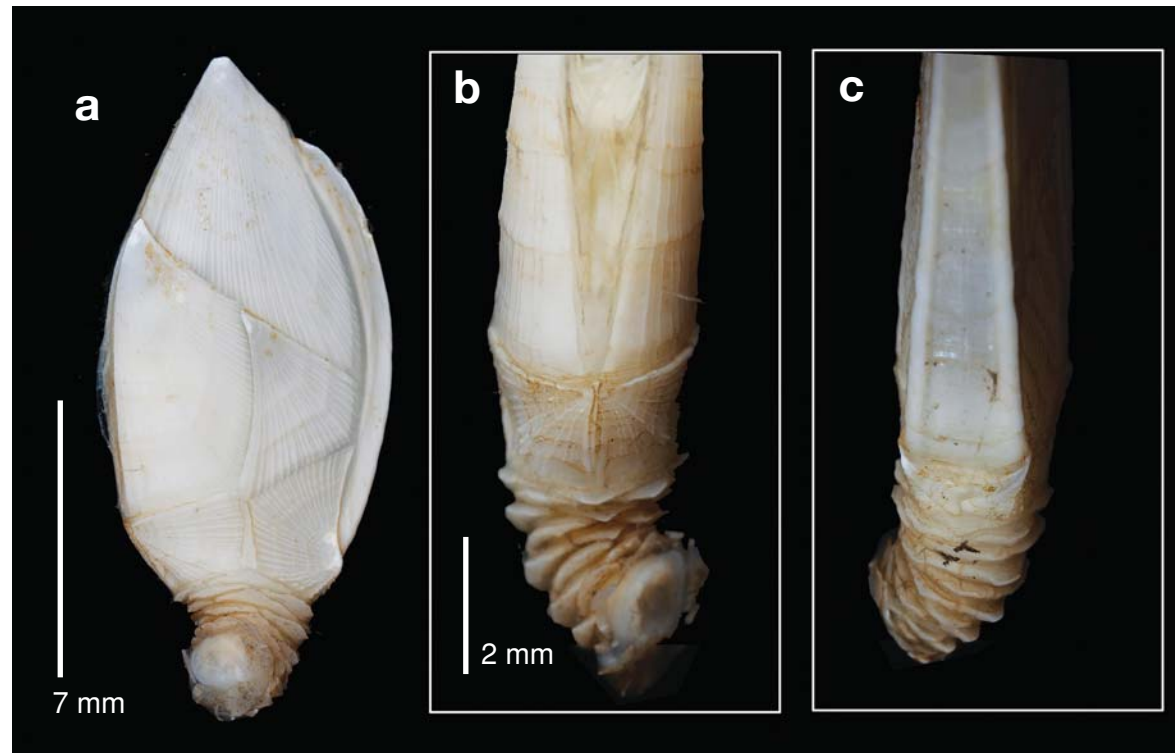


Fig. 115. *Arcoscalpellum truncatum*, CP185, 26 Aug 2002. a. Side view of the capitulum. b. Rostral view and c. Carinal view of the capitulum.

Scalpellum truncatum Hoek, 1883: 92, pl. VI, fig. 13.—Zevina, 1973: 846.

Arcoscalpellum truncatum.—Zevina, 1981: 334, fig. 254.

Material examined.—CP185, 22°0.54'N, 119°27.94'E, 2334-2543 m, 26 Aug 2002: 1 specimen (CL 12.40 mm, CW 6.57 mm, PL 4.50 mm) (NMNS 005087-00073).—CP375, 24°16.240'N, 122°11.720'E, 2216-2497 m, 27 Aug 2006: 1 specimen (CL 17.26 mm, CW 8.98 mm, PL 2.94 mm) (CEL-BB-46D).

Diagnosis.—Capitulum white, with 14 fully calcified plates, plate surfaces with prominent ridges. Tergum pentagonal, bluntly truncated, occludent and basal margins straight, carinal margin slightly curved; scutum umbo apical, apex projecting over tergum, occludent and basal margins straight, tergal margin slightly concave, occludent and basal margins forming a right angle; upper latus trapeziform, carinal margin short and straight; scutal margin long and concave, umbo apical, apex projecting over scutum; rostral latus quadrangular, scutal and basal margins parallel to each other, umbo at occludent margin of scutum; carinal latus irregularly shaped, somewhat resembling quadrangle, carinal margin concave, other margins straight; umbo basi-carinal angle located in middle portion of carinal margin, angle not extending beyond carina; rostrum narrow, very small. Maxilla triangular, with sparse setae; cutting edge of maxillule not notched, with 9 cuspidate setae on cutting edge; mandible tridentate excluding inferior angle, teeth sharply pointed, without multidentations on teeth surface, lower margin smooth and with 2 denticles; mandibulatory palp elongated with sparse setae on superior and inferior margins, dense setae in tip region. Cirrus I rami unequal, separated from cirri II-VI; posterior ramus

longer and slender (10-segmented), anterior ramus flattened with 8 segments; posterior ramus of cirrus II longer (18-segmented) than anterior ramus (13-segmented); cirri III-VI similar in morphology, with both long and slender rami, both with 28-30 segments; caudal appendage short and slender, length within first segment of basal pedicle of cirrus VI, 6-segmented.

Size.—CL to 20 mm.

Coloration.—White.

Habitat.—Deep-sea species, on crinoids and gorgonian corals.

Distribution.—New Zealand, Australia, Taiwan.

Remarks.—New record for Taiwan.

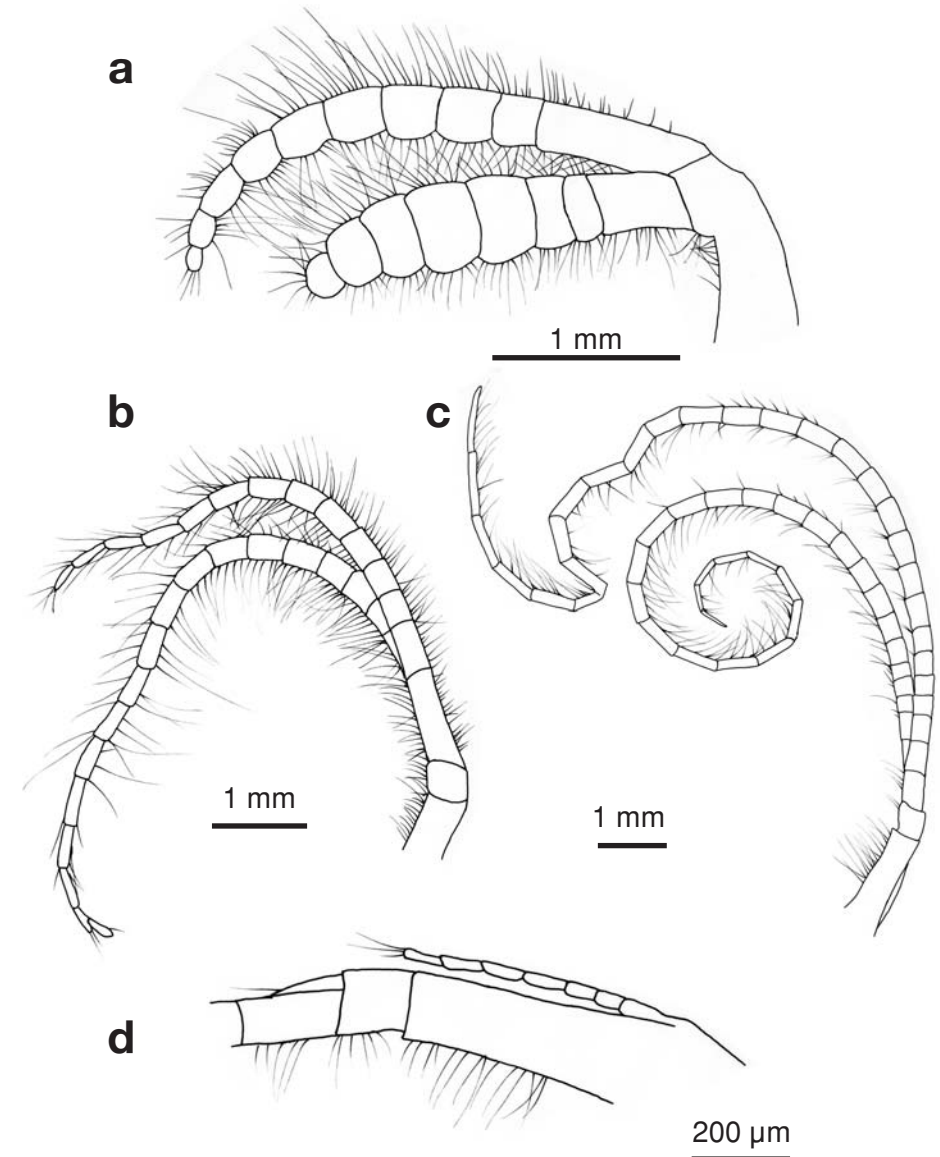


Fig. 116. *Arcoscalpellum truncatum*, CP185, 26 Aug 2002. Line drawings showing a. Cirrus I, b. Cirrus II, c. Cirrus VI and d. Caudal appendage.

Genus *Teloscapellum* Zevina, 1978

遠鎧茗荷屬

Arcoscapellum Hoek, 1907: 85 (in part).—Newman & Ross, 1971: 42.

Teloscapellum Zevina, 1978b: 1350.—Liu & Ren, 1985: 212.—2007: 257. Type species *Scalpellum spicatum* Zevina, 1975

Diagnosis.—Capitulum with 13 or 14 plates, inframedian latus triangular or rod-shaped, umbo apical or sub-apical; carinal lateral umbo at the basi carinal angle, angle not extending beyond carinal margin; caudal appendage multi-segmented.

Remarks.—*Teloscapellum* includes 12 species, and 1 species is a new record for Taiwan.

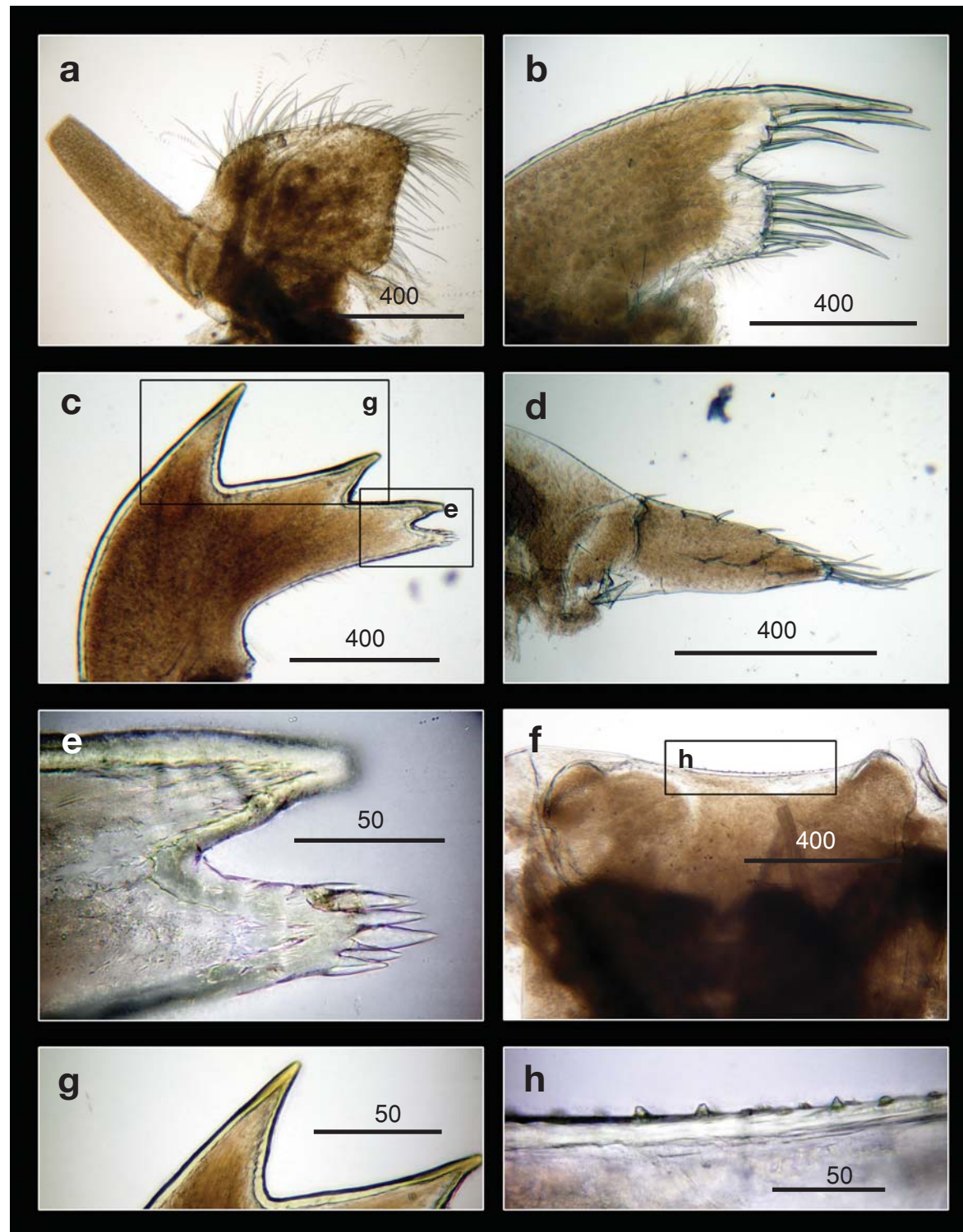


Fig. 117. *Arcoscapellum truncatum*, CP185, 26 Aug 2002. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in µm.

Teloscapellum ventricosum (Hoek, 1907)
大肚遠鎧茗荷

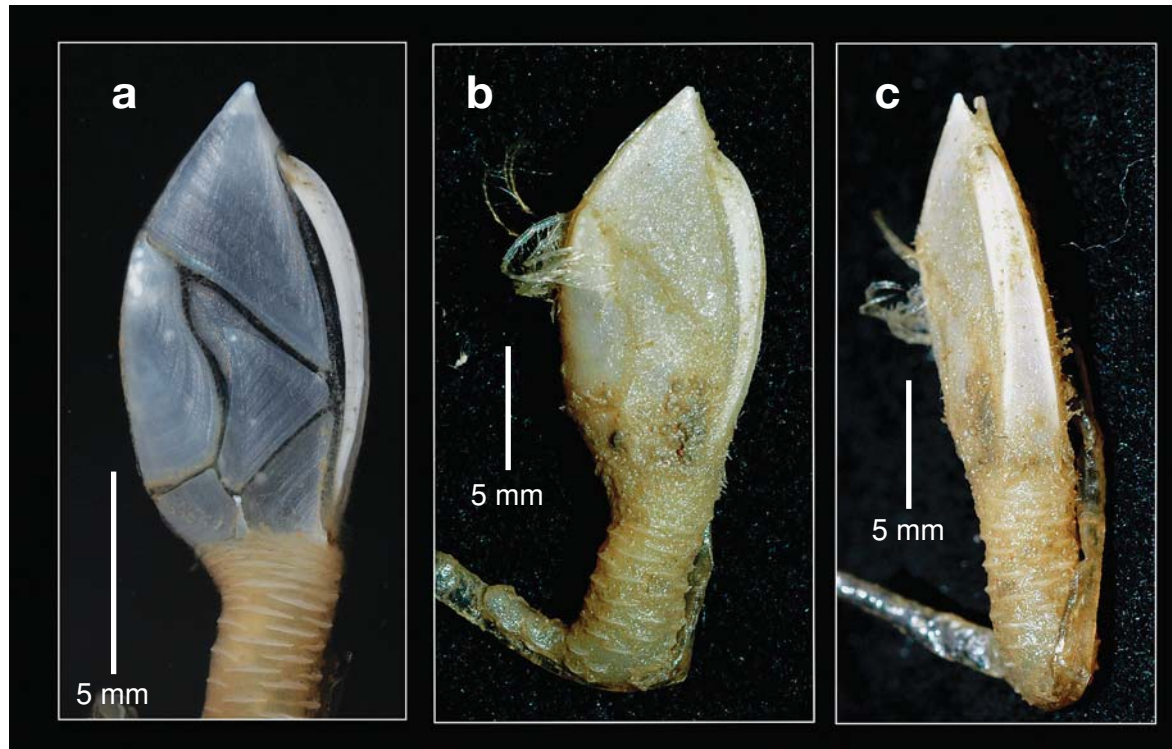


Fig. 118. *Teloscapellum ventricosum*, CD191, 28 Aug 2002. a, b. Side view of the capitulum. c. Carinal view of the capitulum.

Scalpellum ventricosum Hoek, 1907: 275 (replacement name for *Scalpellum arcuatum* Hoek, 1907: 98, figs. 3-3a. (Non *Scalpellum arcuatum* Darwin, 1851: 40)).— Nilsson-Cantell, 1921: 205, fig. 32.

Arcoscalpellum ventricosum.—Newman & Ross, 1971: 86, fig. 43.

Teloscapellum ventricosum.—Zevina, 1978: 1350.

Material examined.—CD191, 21°41.04'N, 118°21.95'E, 1623-1630 m, 28 Aug 2002: 1 specimen (CL 12.47 mm, CW 7.73 mm, PL 7.39 mm) (NMNS 005087-00074).—west off SiaoLiouciou, Pingtung County, 11 Aug 2005: 1 specimen (CL 2.1 mm, CW 1.3 mm, PL 0.9 mm).

Diagnosis.—Capitulum flat, 14-valved, covered by thin membrane; carina separated from other valves by chitinous spaces. Scutum quadrilateral, occludent margin arched, tergal margin short, apex pointed but not produced; tergum large, triangular, occludent margin straight; upper latus large and irregularly shaped, umbo apical; rostrum very small and triangular; rostral latus quadrilateral and narrow, umbo apical; umbo of carinal latus close to base; inframedian latus narrow, umbo apical with greater width in lower portion; rostral latus small and triangular; peduncle short, covered with scales. Mandible with 3 teeth, lower margin smooth; maxilla with sparse setae; maxillule not notched, cutting edge straight; mandibulatory palp with setae on



Fig. 119. *Teloscapellum ventricosum*, CD191, 28 Aug 2002. Line drawing of the side view of capitulum.

the superior margin; posterior ramus of cirrus I with 10 segments, anterior ramus with 7 segments; cirrus II rami sub-equal (anterior ramus 13 segments, posterior ramus with 14 segments).

Size.—CL to 15 mm.

Coloration.—White to pale-yellow.

Habitat.—Deep-sea species, substratum unknown.

Distribution.—Deep-sea species; Indonesia, Taiwan.

Remarks.—New record for Taiwan.

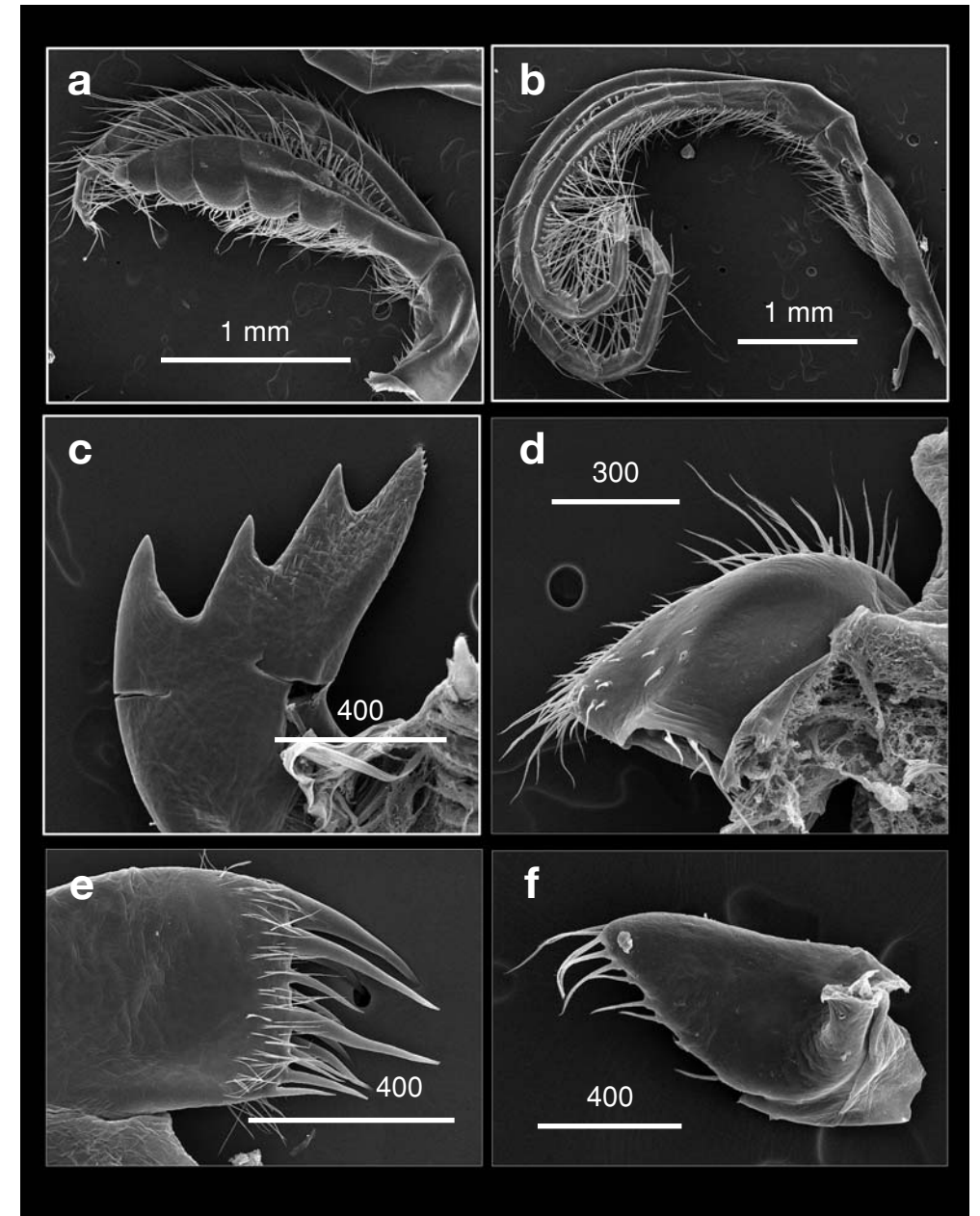


Fig. 120. *Teloscapellum ventricosum*, CD191, 28 Aug 2002. Scanning electron microscopy on a. Cirrus I, b. Cirrus II, c. Mandible, d. Maxilla, e. Maxillule, f. Mandibulatory palp. Scale bars in μm.

Genus *Amigdoscalpellum* Zevina, 1978

友鎧茗荷屬

Arcoscalpellum Hoek, 1907: 85 (in part).

Amigdoscalpellum Zevina, 1978b: 1349.—Liu & Ren, 1985: 206.—2007: 251. Type species *Scalpellum manum* Zevina, 1973.

Diagnosis.—Capitulum with 13 or 14 plates, inframedian latus triangular, narrow, umbo apical, apex not reaching upper latus. Caudal appendage 1-segmented.

Remarks.—*Amigdoscalpellum* includes 18 species, and 1 species was newly recorded in Taiwan in the present study (see Cai et al., in press).

Amigdoscalpellum elegans (Hoek, 1907)

秀麗友鎧茗荷

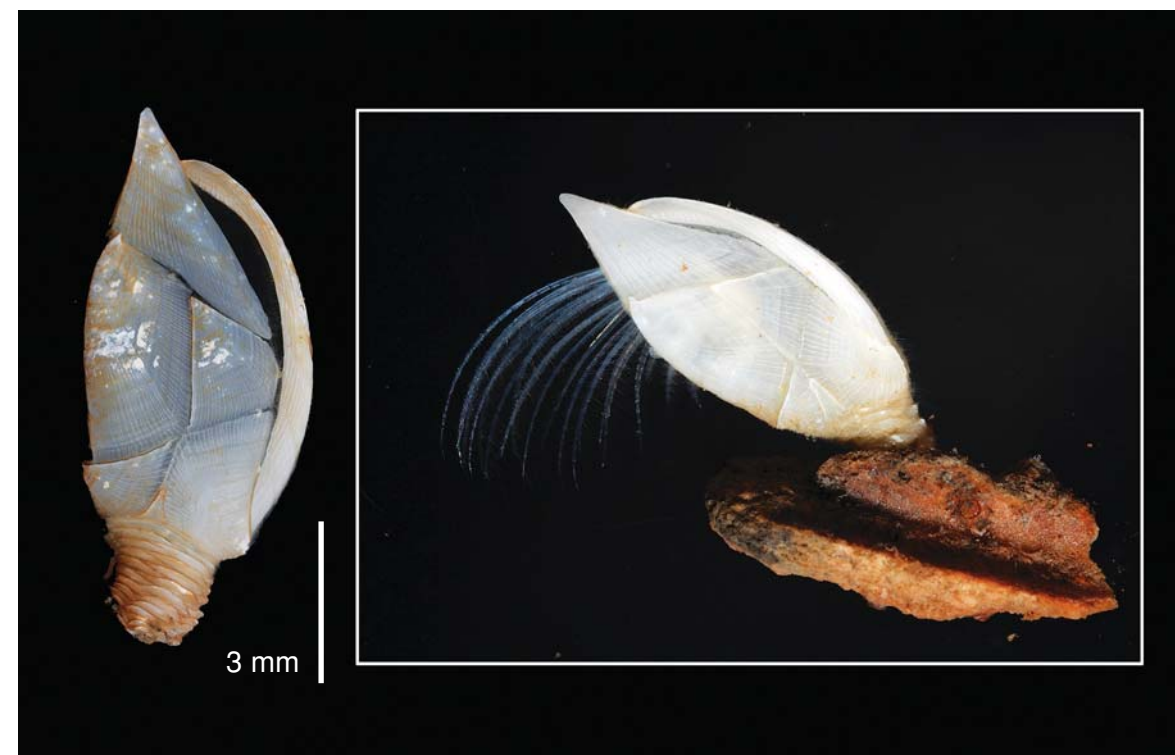


Fig. 121. *Amigdoscalpellum elegans*, CP125, 20 Aug 2001. Side view of the capitulum.

Scalpellum elegans Hoek, 1907: 107, pl. VIII, fig. 14.—Stubbings, 1936: 24.—Zevina, 1981: 268, fig. 201.

Amigdoscalpellum vitreum Rosell, 1991: 20, fig. 2E. (Non *A. vitreum* Hoek, 1883: 115, pl. 5, fig. 14.)

Material examined.—CP125, 22°6.95'N, 120°2.35'E, 1218-1274 m, 20 Aug 2001: 1 specimen (CL 15.62 mm, CW 8.23 mm, PL 3.56 mm) (NMNS 003683-0002).

Diagnosis.—Capitulum white, with 14 fully calcified plates; valve surfaces finely striated. Tergum triangular, umbo apical; scutum quadrilateral, umbo at a small apex at scutal margin, basal margin slightly convex; upper latus trapezoidal; inframedian latus triangular, small, umbo apical and apex not extending to upper latus; rostral latus pentagonal, wider than high; carinal latus higher than wide, umbo at basi-carinal angle, not extending beyond carina; carina narrow and slightly curved; rostrum very small and narrow; peduncle covered by a series of scales. Maxilla globular; mandible with 3 major teeth, no minor teeth on major teeth, lower margin with approximately 12 denticles; mandibulatory palps elongated; cirrus I separated from other cirri. Cirrus I with unequal rami, anterior ramus flattened and short, 8-segmented, posterior ramus slender, 11-segmented; cirri II-IV with equal-length rami, 14-18 segments in anterior and posterior rami; cirri V and VI longest, 18-20 segments in both anterior and posterior rami.

Size.—CL to 20 mm.

Coloration.—White.

Habitat.—Deep-sea species, attaches to rocks.

Distribution.—Cosmopolitan.

Remarks.—This species is morphologically close to *A. vitreum* Hoek, 1883, by having a white capitulum and finely striated valves. *Amigdoscalpellum elegans* differs from *A. vitreum* by a convex basal margin of the scutum, instead of a concave basal margin as in *A. vitreum*. The tergum of *A. elegans* is similar to a right-angled triangle while that of *A. vitreum* is almost an equilateral triangle. The sides of the carina of *A. vitreum* are strongly sculptured (see Hoek, 1883). *Amigdoscalpellum vitreum* illustrated in Rosell (1991) showed a scutum with a convex basal margin and the tergum is right-angled triangular. Thus this record was probably *A. elegans*; *A. elegans* is a new record for Taiwan.

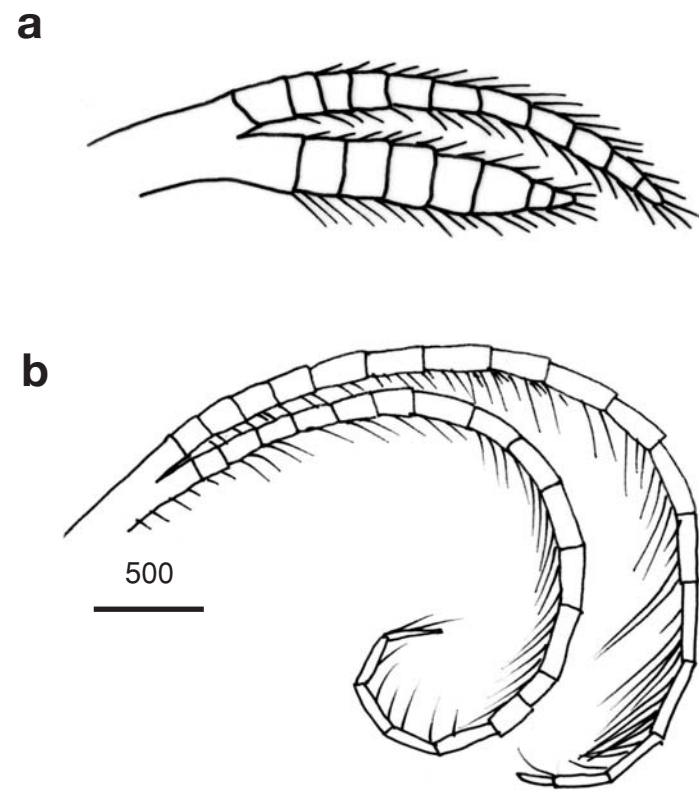


Fig. 122. *Amigdoscalpellum elegans*, CP125, 20 Aug 2001. Line drawings of a. Cirrus I and b. Cirrus VI.

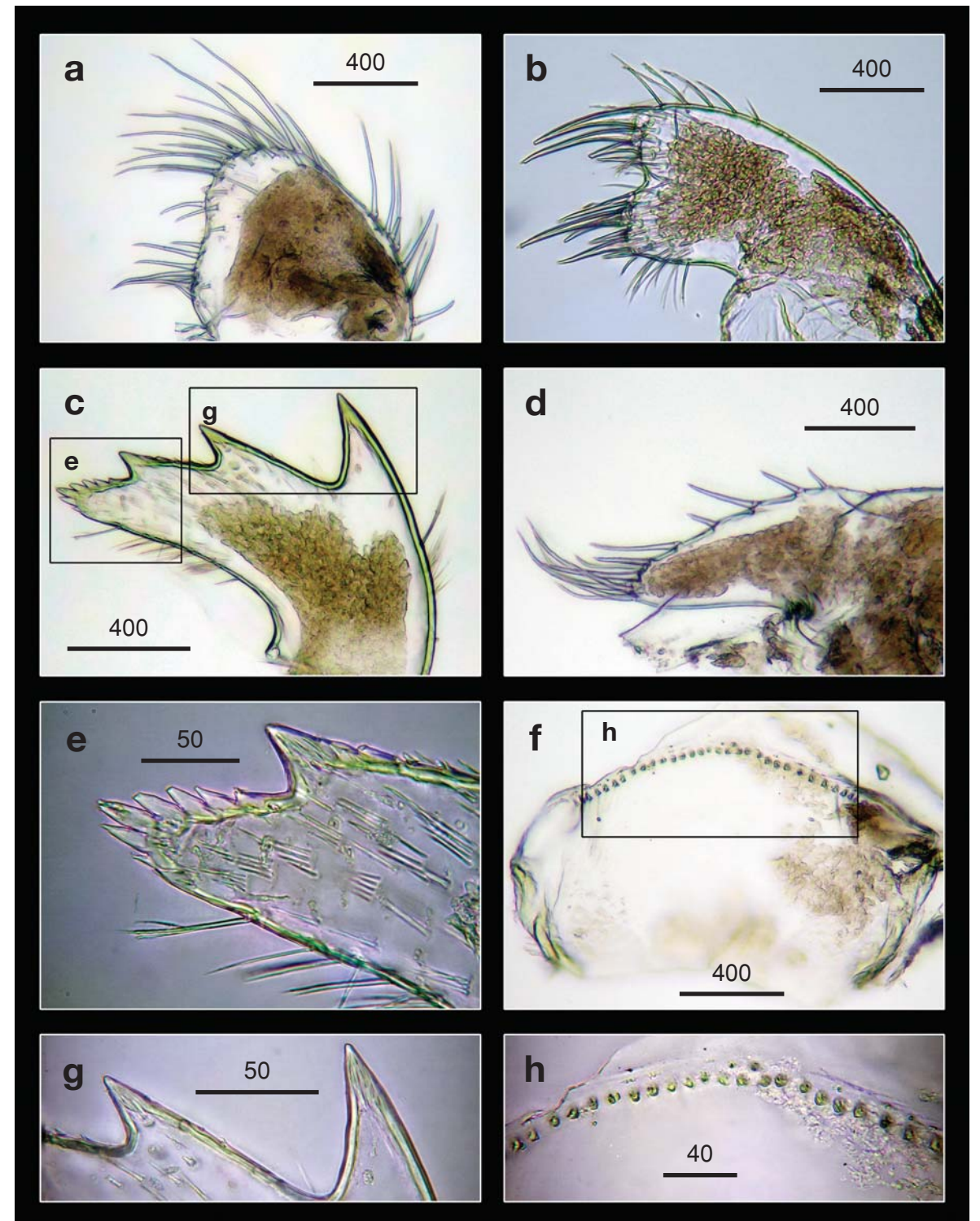


Fig. 123. *Amigdoscalpellum elegans*, CP125, 20 Aug 2001. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in µm.

Order SESSILIA Lamarck, 1818 無柄目

Diagnosis.—Peduncle absent, with calcareous parietes, hermaphroditic.

Remarks.—The Sessilia is further classified into 3 suborders, the Brachylepadomorpha, Verrucomorpha, and Balanomorpha. In Taiwan, only the Verrucomorpha and Balanomorpha were recorded in the present collection.

Key to suborders of SESSILIA from Taiwan

1. Parietes symmetric **Balanomorpha**
Parietes asymmetric **Verrucomorpha**

Suborder BALANOMORPHA Pilsbry, 1916 藤壺亞目

Diagnosis.—Peduncle absent, parietes and opercular plates symmetrical, scutum and tergum separated or fused, hermaphroditic or some species with dwarf males.

Remarks.—Balanomorpha is further divided into 6 superfamilies: the Chinonelasmatiodea, Pachylasmatoidea, Chthamaloidea, Coronuloidea, Tetracitoidea, and Balanoidea. In Taiwan, the Chthamaloidea, Coronuloidea, Tetracitoidea, and Balanoidea were recorded in the present collection.

Key to superfamilies of Balanomorpha from Taiwan

1. Wall of 4 or 6 distinct plates (rostrum, carina and a pair of lateral); parietes tubiferous in single layer or irregularly multilayered tubes; with living tissue or filled with chitin **Tetracitoidea**
Wall of 8, 6 or 4 plates, parietes without living tissues 2
2. Wall of 8, 6 or 4 distinct compartmental plates; parietes solid; inner surface of parietes without longitudinal ribs **Chthamaloidea**
Wall of 8 (tripartite fused rostral plate) or 6 distinct plates; parietes commonly tubiferous, when solid inner surface of parietes with longitudinal ribs 3
3. Sheath extending to base of shell; basis membranous; opercular plates when exist smaller than orifice; mostly attached on marine animals **Coronuloidea**
Radii well developed; basis commonly calcareous; tubiferous parietes commonly exist, uniformly arranged; opercular plates well developed and articulated, filling orifice **Balanoidea**

Superfamily CHTHAMALOIDEA Darwin, 1854 小藤壺總科

Chthamalinae Darwin, 1854: 446.

Chthamalidae Pilsbry, 1916: 290.—Nilsson-Cantell, 1921: 274.—Withers, 1935: 387.—Zullo, 1963: 190.—Pope, 1965: 10.—Utinomi, 1968b: 36.—Newman et al., 1969: 283.—Newman & Ross, 1971: 139.
Chthamaloidea Newman and Ross, 1976: 17, 36, 40.

Diagnosis.—Shell conical, with 8, 6, or 4 plates or completely fused, tergum lacking spurs, base calcareous, non-tubiferous.

Remarks.—The Chthamaloidea includes 2 families; only the Chthamalidae was recorded in Taiwan.

Family CHTHAMALIDAE Pilsbry, 1916 小藤壺科

Chthamalinae Darwin, 1854: 446.

Chthamalidae Pilsbry, 1916: 290.—Newman & Ross, 1976: 36, 40.—Ren, 1984a: 146.—Liu & Ren, 2007: 282.

Diagnosis.—Shell with 8, 6, or 4 plates. Mandibles with 3 or 4 teeth, base without whorls of accessory plates.

Remarks.—3 subfamilies are classified in the Chthamalidae, and 2 subfamilies were recorded in Taiwan.

Key to subfamilies of Chthamalidae from Taiwan

1. Cirrus I or II with multicuspidate setae (Chan et al., 2008a) **Notochthamalinae**
Cirrus I and II without multicuspidate setae **Chthamalinae**

Subfamily Notochthamalinae Foster & Newman, 1987 樂都小藤壺亞科

Notochthamalinae Foster & Newman, 1987: 326.

Diagnosis.—With 6 or 4 parietal shell plates; scutum elongated, tergum narrow and deeply interlocked with scutum; cirri I-III with multicuspidate setae (Chan et al., 2008a). Poltarukha (1996) revised subfamily Notochthamalinae and classified 7 genera, among which, 4 genera were found in Taiwan.

Key to genera of Notochthamalinae from Taiwan

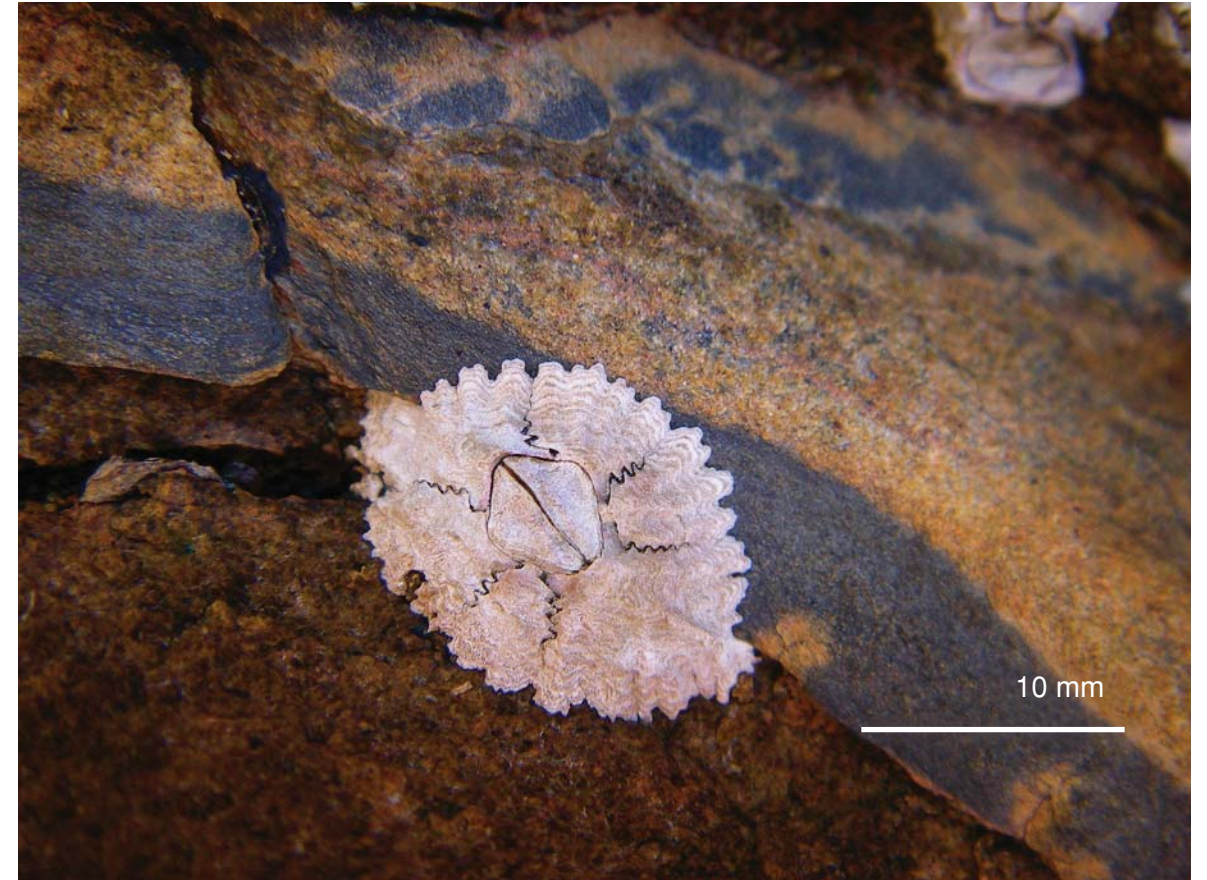
1. Shell with 8 plates 2
Shell with 6 plates 3
2. Scutum and tergum fused **Pseudoctomeris**
Scutum and tergum separated **Octomeris**
3. Scutum and tergum fused **Nesochthamalus**
Scutum and tergum separated **Hexechamaesipho**

Genus *Nesochthamalus* Foster & Newman, 1987

癒合小藤壺屬

Nesochthamalus Foster & Newman, 1987: 326. Type species *Chthamalus intertextus* Darwin, 1854.**Diagnosis.**—Shell with 6 plates, scutum and tergum fused, cirri II and III with multicuspidate-type setae.*Nesochthamalus intertextus* (Darwin, 1854)

中型癒合小藤壺

**Fig. 124.** *Nesochthamalus intertextus*, Okinawa, Jun 2006.*Chthamalus intertextus* Darwin, 1854: 467, pl. 19, figs. 1a, b.—Gruvel, 1905: 206, fig. 229.—Hiro, 1939d: 251, fig. 2.*Euraphia intertextus*.—Newman & Ross, 1976: 41.*Nesochthamalus intertextus*.—Foster & Newman, 1987: 326.**Material examined.**—Kending, Pingtung County (Hiro, 1939d).**Diagnosis.**—Scutum and tergum merged, shell depressed, surface pale-violet to grey. Interior of shell violet.**Size.**—BD to 20 mm (based on samples from Okinawa).**Coloration.**—Dull-grey to pale-violet.**Distribution.**—The Philippines, Hawaii, Okinawa (Japan), Taiwan.**Remarks.**—We have so far not yet collected this species from Taiwanese waters. The previous record from Taiwan was in Hiro (1939d). This species was recorded in high abundance in Okinawan waters (Chan et al., 2008c).

Genus *Hexechamaesipho* Poltarukha, 1996
六板小藤壺屬

Hexechamaesipho Poltarukha, 1996: 989. Type species *Chthamalus pilsbryi* Hiro, 1936.

Diagnosis.—Shell with 6 plates; scutum and tergum deeply interlocking, cirri I and II with multicuspidate-type setae.

Remarks.—At present, only 1 species is classified in *Hexechamaesipho* in the world.

Hexechamaesipho pilsbryi (Hiro, 1936)
皮氏六板小藤壺

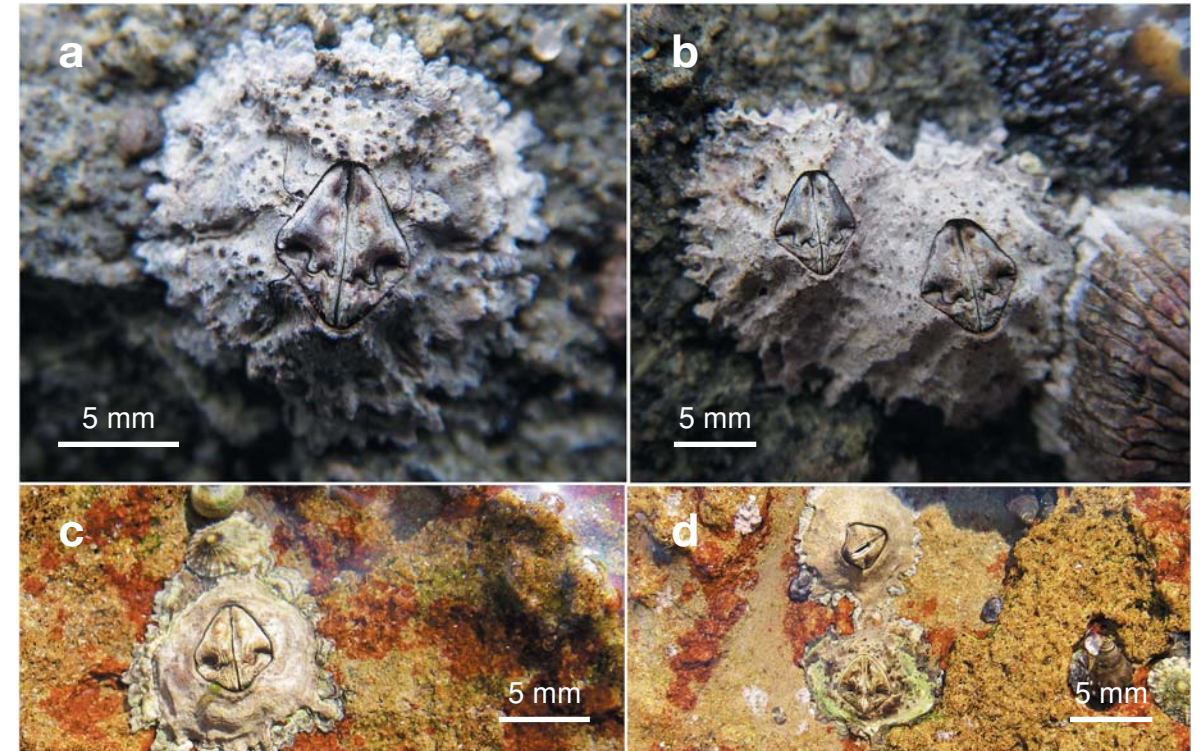


Fig. 125. *Hexechamaesipho pilsbryi*, Dasianglan, Taipei County, 2 Aug 2007. a-d. *In-situ* view on rocky shores.

Chthamalus pilsbryi Hiro, 1936c: 227, fig. 3.—Utinomi, 1949: 21.—1954: 21, fig. 2.

Euraphia pilsbryi.—Newman & Ross, 1976: 41.

Hexechamaesipho pilsbryi.—Poltarukha, 1996: 989.—Chan et al., 2008c: 319, figs. 3-6.

Material examined.—Dasianglan, Taipei County, 2 Aug 2007: 29 specimens (BD 6.90-13.24 mm) (CEL-BB-123).—Badouzhih, Keelung City, 30 Jul 2008: 4 specimens (BD 9.26-10.70 mm) (CEL-BB-124).

Diagnosis.—Shell with 6 plates, base calcareous, shell grey or light-brown parietes, on which black spots may be seen in some individuals; orifice rhomboidal. Scutum and tergum strongly articulated forming a sinuous line; scutum elongated and triangular, tergal margin strongly articulated; tergum narrow, basi scutal angle almost 90°. Mandible with 3 large teeth, inferior angle excluded; pectinated lower angle with 48 small teeth; labrum with a row of 10-12 large teeth on concave edge, covered with smooth setae; mandibulatory palps and maxillules with long, smooth setae. Anterior and posterior rami of cirrus I short, with 4 segments on posterior and 6 segments on anterior ramus, dorsal surface of anterior and posterior rami with conical spines, ventral sides of anterior and posterior rami of cirrus I with serrulate setae; cirrus II with multicuspidate setae; cirri III-VI similar; dorsal side of cirrus III with short, smooth, open-ended setae; ventral side of cirrus with both long and short smooth setae.

Size.—BD to 15 mm.

Coloration.—Shell grey or light-brown parietes, black spots may be seen in some individuals.

Habitat.—On high shores of exposed rocky shores.

Distribution.—Japan (including Okinawa), Taiwan.

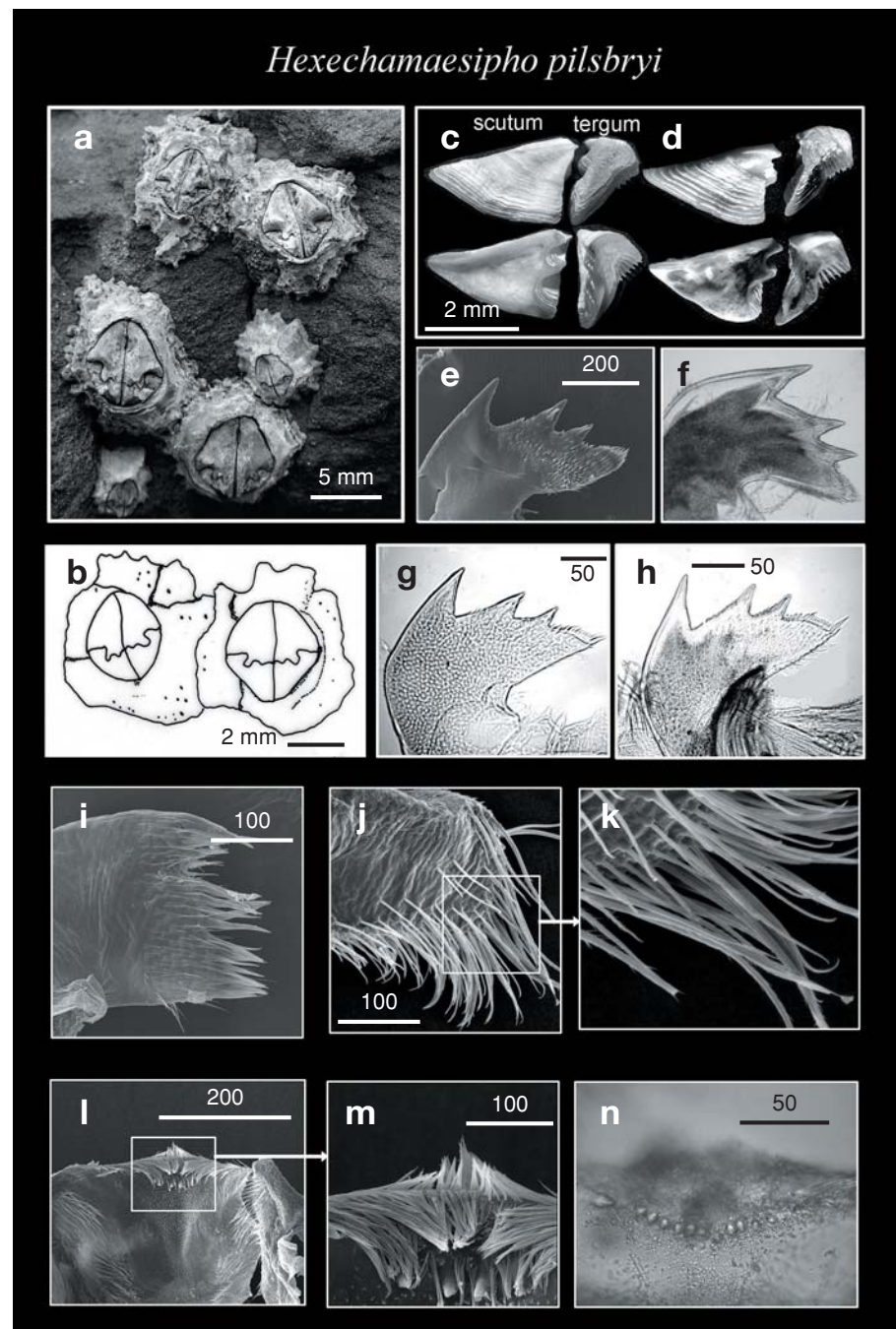


Fig. 126. *Hexechamaesipho pilsbryi*, Dasianglan, Taipei County, 2 Aug 2007. a. *In-situ* view on shores. b. Line drawing of the parietes. c., d. Scutum and tergum. e. SEM on mandibles. f., g., h. Light microscopy on mandibles. i. SEM on maxilla. j. SEM on maxilla. k. Setae on maxilla. l. Labrum. m. Cutting edge of the labrum. n. Light microscopy on cutting edge of labrum, showing teeth. Scale bars in μm .

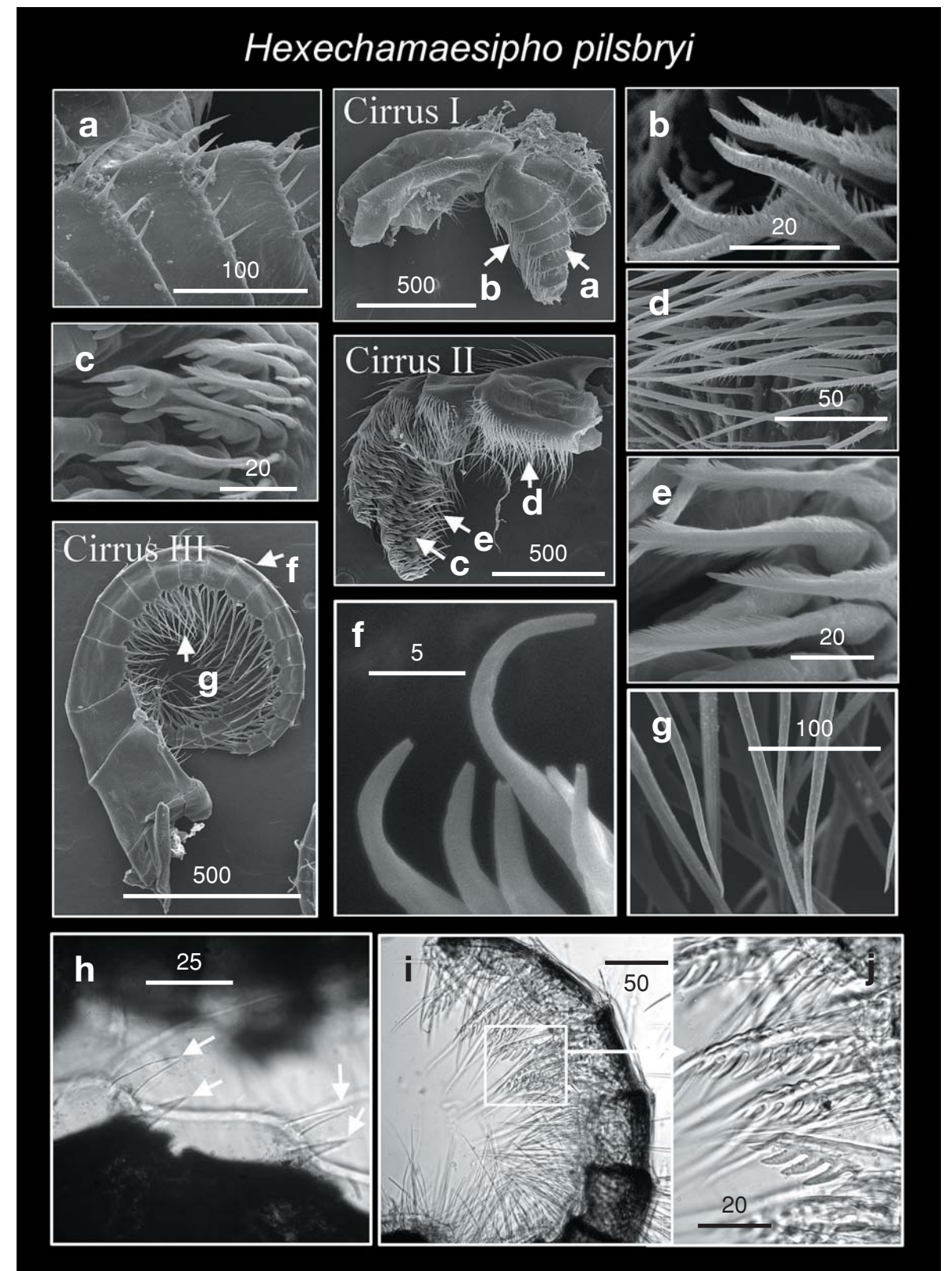


Fig. 127. *Hexechamaesipho pilsbryi*, Dasianglan, Taipei County, 2 Aug 2007. Scanning Electron Microscopy of the cirri I–III. a. Conical spine, b. Pectinate setae on cirrus I, c. Multicuspidate setae on cirrus II, d, e. Pectinate setae on cirrus II, f. Smooth setae with open-ended tip on the dorsal side of cirrus III, g. Long smooth setae on the ventral side of cirrus III. Cirrus V and VI not shown as they are similar to cirrus III, h. Light microscopy on the dorsal side of cirrus I, showing the conical spines (arrows), i. Cirrus II showing the multicuspidate setae (enlarged in j) by light microscopy. Scale bars in μm .

Genus *Octomeris* Sowerby, 1825

肋藤壺屬

Octomeris Sowerby, 1825: 244 (not seen).—Darwin, 1854: 482.—Pilsbry, 1916: 334.—Nilsson-Cantell, 1921: 298.—Pope, 1965: 20.—Newman et al., 1969: 284.—Newman & Ross, 1976: 40. Type species *Octomeris angulosa* Sowerby, 1825.

Diagnosis.—Shell with 8 plates, plate surfaces striated, base membranous, caudal appendage absent, cirrus II with multicuspidate setae.

Remarks.—1 species has been recorded in Taiwan.

Octomeris brunnea Darwin, 1854

多肋藤壺

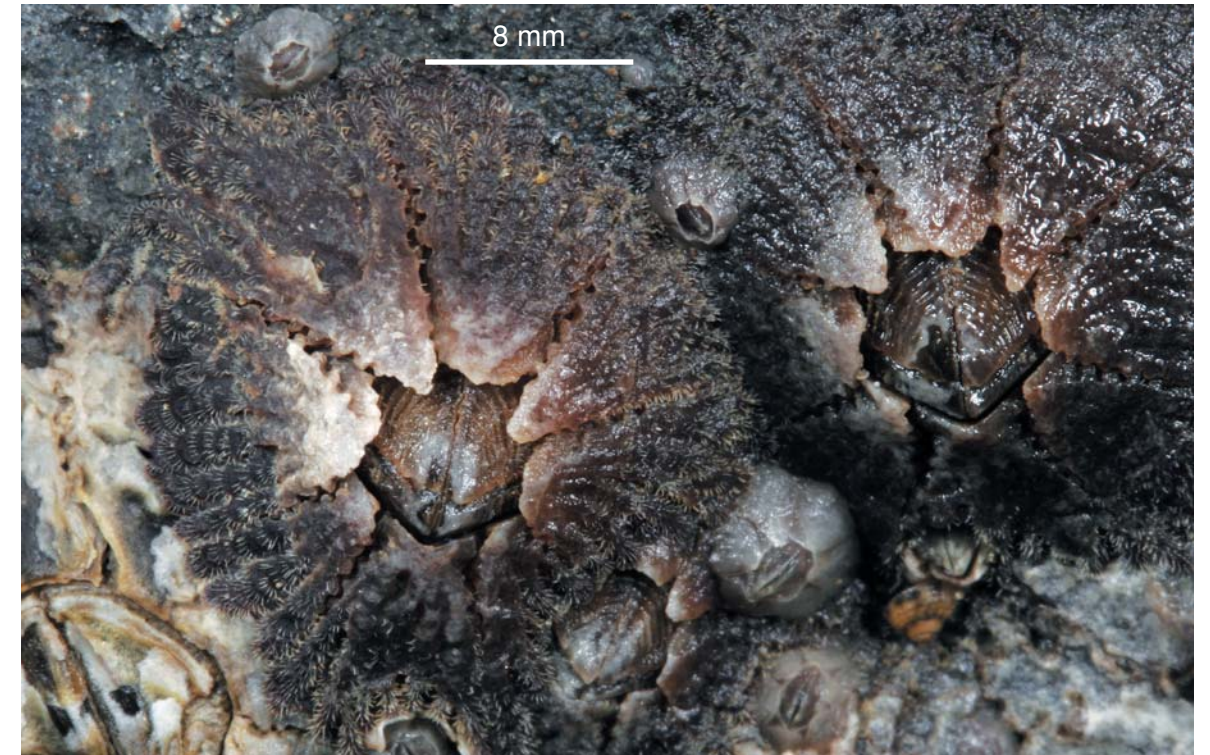


Fig. 128. *Octomeris brunnea*, Haikou, Pingtung County, 4 Dec 2007. *In-situ* view on shores.

Octomeris brunnea Darwin, 1854: 484, pl. 20, figs. 3a-b.—Weltner, 1897: 274.—Gruvel, 1905: 197, fig. 217.—Nilsson-Cantell, 1921: 299, figs. 58-59, pl. 3, fig. 7.—1931: 108.—1932: 14.—Hiro, 1939d: 252, figs. 3-4, 6a-b.—Utinomi, 1949: 25.—1954: 22.—1958: 307.—Newman & Ross, 1976: 40.—Poltarukha, 1996: 992.

Material examined.—Haikou, Pingtung County, 4 Dec 2007: > 30 specimens (largest individual, BD 16.37 mm) (CEL-BB-44).

Diagnosis.—Shell with 8 plates, surfaces strongly sculptured with radiating lines, shell pale-brown, base membranous, shell thin. Dorsal surface of scutum and tergum with strong striations, scutum triangular, occludent margin straight, tergum elongated, scutal margin strongly articulated. Maxilla bilobed, with dense setae on 2 regions and sparse setae on superior margin; maxillule notched; mandible with 3 large teeth, excluding inferior angle, inferior angle pectinated; mandibulatory palp rectangular, with setae on superior margin; labrum concave with fine teeth.

Size.—BD to 20 mm.

Coloration.—Shell light- to dark-brown.

Distribution.—Indo-Pacific region.

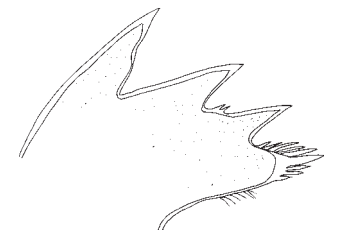


Fig. 129. *Octomeris brunnea*, Haikou, Pingtung County, 4 Dec 2007. Line drawing of mandible.

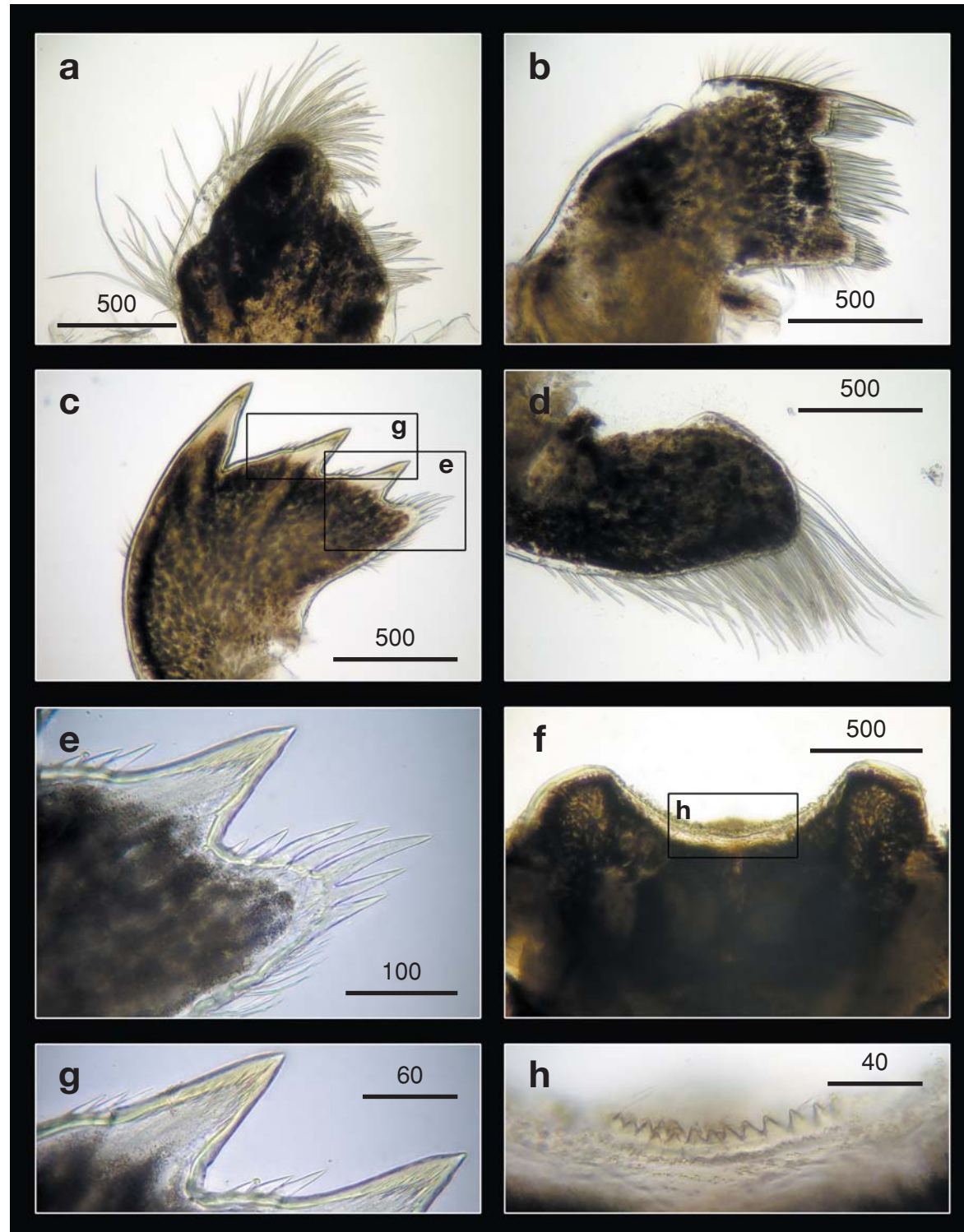


Fig. 130. *Octomeris brunnea*, Haikou, Pingtung County, 4 Dec 2007. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Genus *Pseudoctomeris* Poltarukha, 1996

擬肋藤壺屬

Octomeris Sowerby, 1825: 244 (not seen).—Darwin, 1854: 482.—Nilsson-Cantell, 1932: 8.

Pseudoctomeris.—Poltarukha, 1996: 988.

Diagnosis.—Shell with 8 plates, base membranous, scutum and tergum fused.

Remarks.—1 species was recorded in the world so far.

Pseudoctomeris sulcata (Nilsson-Cantell, 1932)

擬肋藤壺

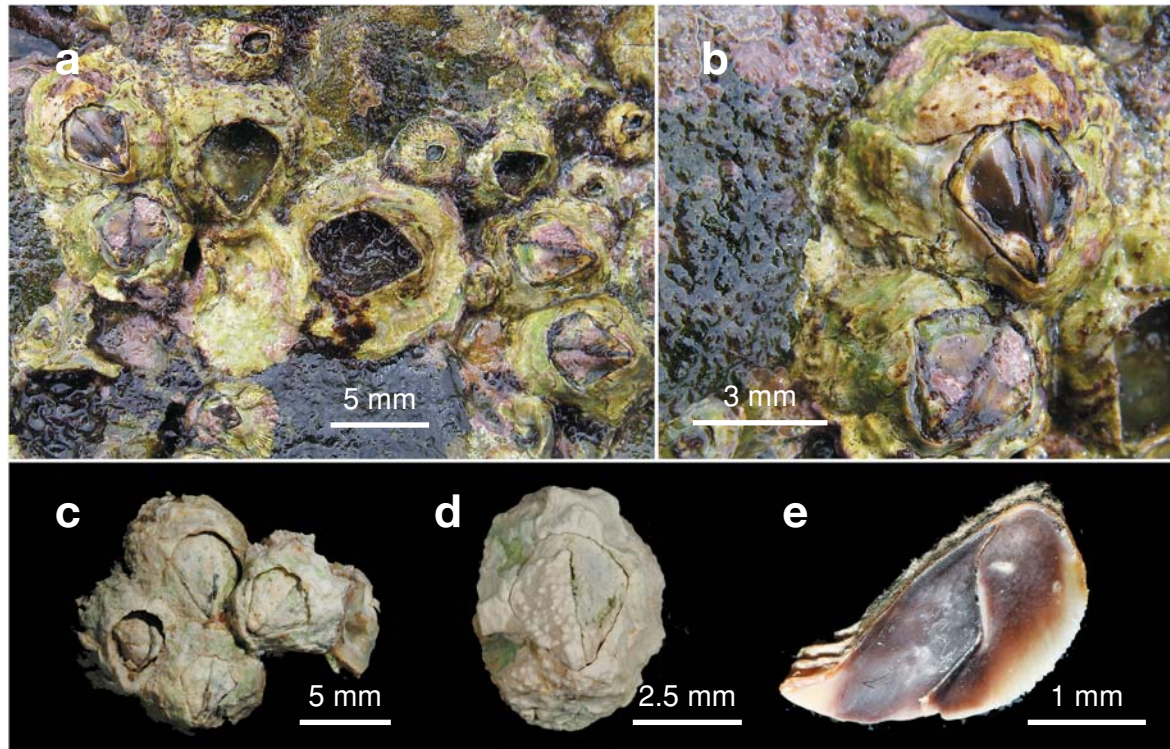


Fig. 131. *Pseudoctomeris sulcata*, Hepingdao, Keelung City, 30 Jul 2008. a., b. *In-situ* view on shores, c, d. Ethanol preserved specimens, showing the bleached encrusting algae on surface. e. Fused scutum and tergum.

Octomeris sulcata Nilsson-Cantell, 1932: 8, figs. 3-4.—Utinomi, 1949: 21.—1970: 345, fig. 3.—Newman & Ross, 1976: 40.

Pseudoctomeris sulcata.—Poltarukha, 1996: 988.

Material examined.—Hepingdao, Keelung City, 30 Jul 2008: 16 specimens (BD 18.42-24.92 mm) (CEL-BB-12).

Diagnosis.—Shell with 8 plates, base membranous; orifice triangular. Scutum and tergum fused. Maxilla triangular; maxillule not notched; mandible with 3 teeth; mandibulatory palp elongated, with setae on inferior margin; labrum concave with blunt teeth.

Size.—BD to 30 mm.

Coloration.—Shell white but shell surface often covered by algae that can mask the color of the shell.

Habitat.—On low shores of exposed intertidal rocky shores.

Distribution.—Japan, Taiwan.

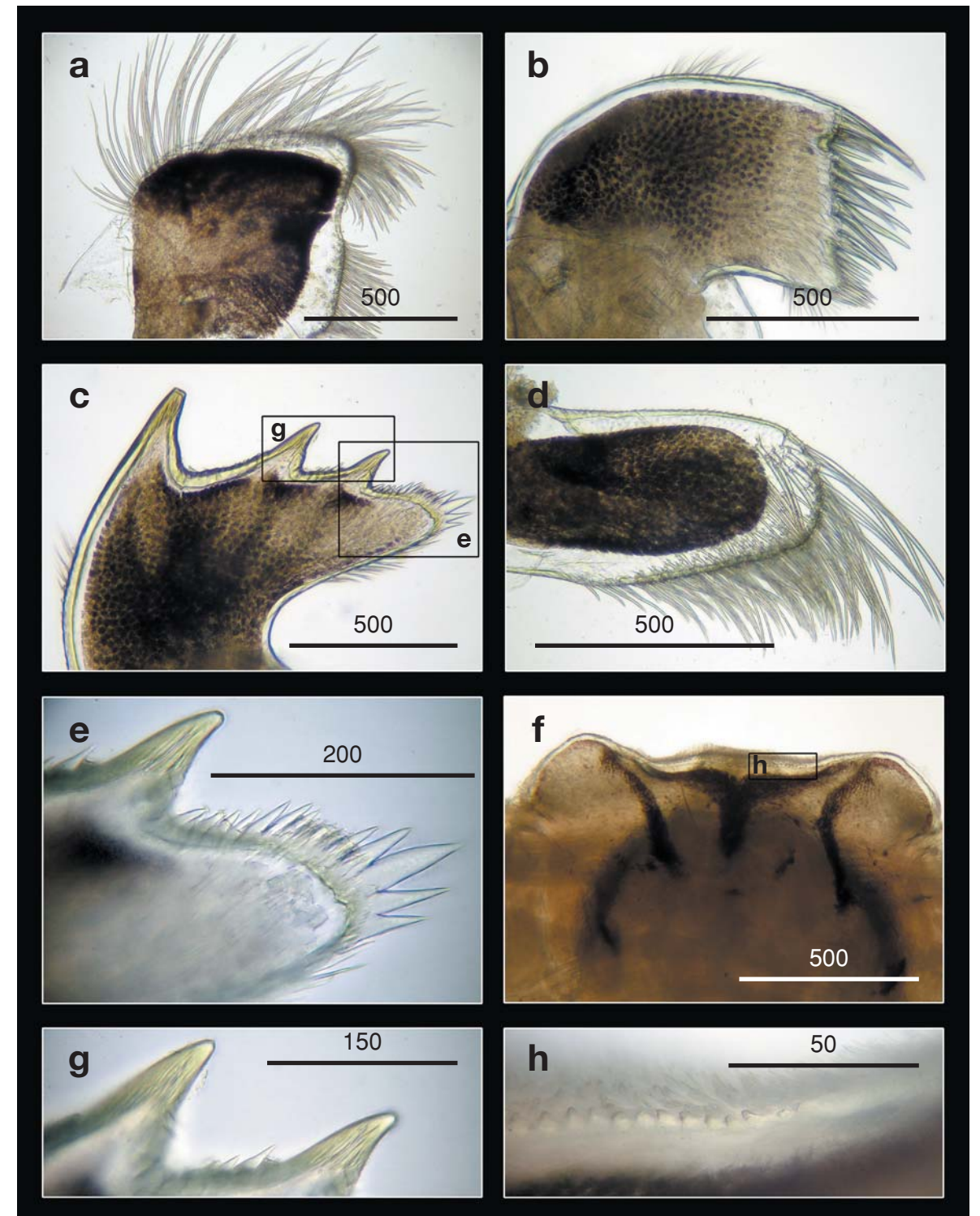


Fig. 132. *Pseudoctomeris sulcata*, Hepingdao, Keelung City, 30 Jul 2008. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in µm.

Subfamily Chthamalinae Darwin, 1854

小藤壺亞科

Chthamalinae Darwin, 1854: 446.—Newman & Ross, 1976: 41.—Ren, 1984a: 149.

Diagnosis.—Shell with 4-6 plates, base membranous, mandible with 4 teeth, caudal appendage absent.

Remarks.—3 genera are present in the Chthamalinae, and only *Chthamalus* was recorded in Taiwan in the present study.

Genus *Chthamalus* Ranzani, 1817

小藤壺屬

Chthamalus Ranzani, 1817: 276 (not seen).—Darwin, 1854: 447.—Pilsbry, 1916: 293.—Nilsson-Cantell, 1921: 274.—Kolosváry, 1941: 67.—Zullo, 1963: 190.—Pope, 1965: 24.—Utinomi, 1968b: 37.—Ross, 1971a: 269.—Newman & Ross, 1976: 41.—Ren, 1984a: 149. Type species *Lepas stellatus* Poli, 1795.

Diagnosis.—Shell with 6 plates, rostrum and carina with radii, rostral lateral lacking radii, carinal lateral lacking, mandible with 4 teeth, base membranous.

Remarks.—26 species have been recorded in *Chthamalus*, and 3 species were recorded in Taiwan.

Key to species of *Chthamalus* from Taiwan

1. Conical spines on cirrus I present; basal guard on apex setae of cirrus II present . . . *Chthamalus malayensis*
 Conical spines on cirrus I absent; basal guard on apex setae of cirrus II absent 2
2. Maxillule with notch; lower margin of mandible moderately long *Chthamalus challengenri*
3. Maxillule with no notch; lower margin of mandible long, shell surface has strongly sculptured radiating lines *Chthamalus moro*

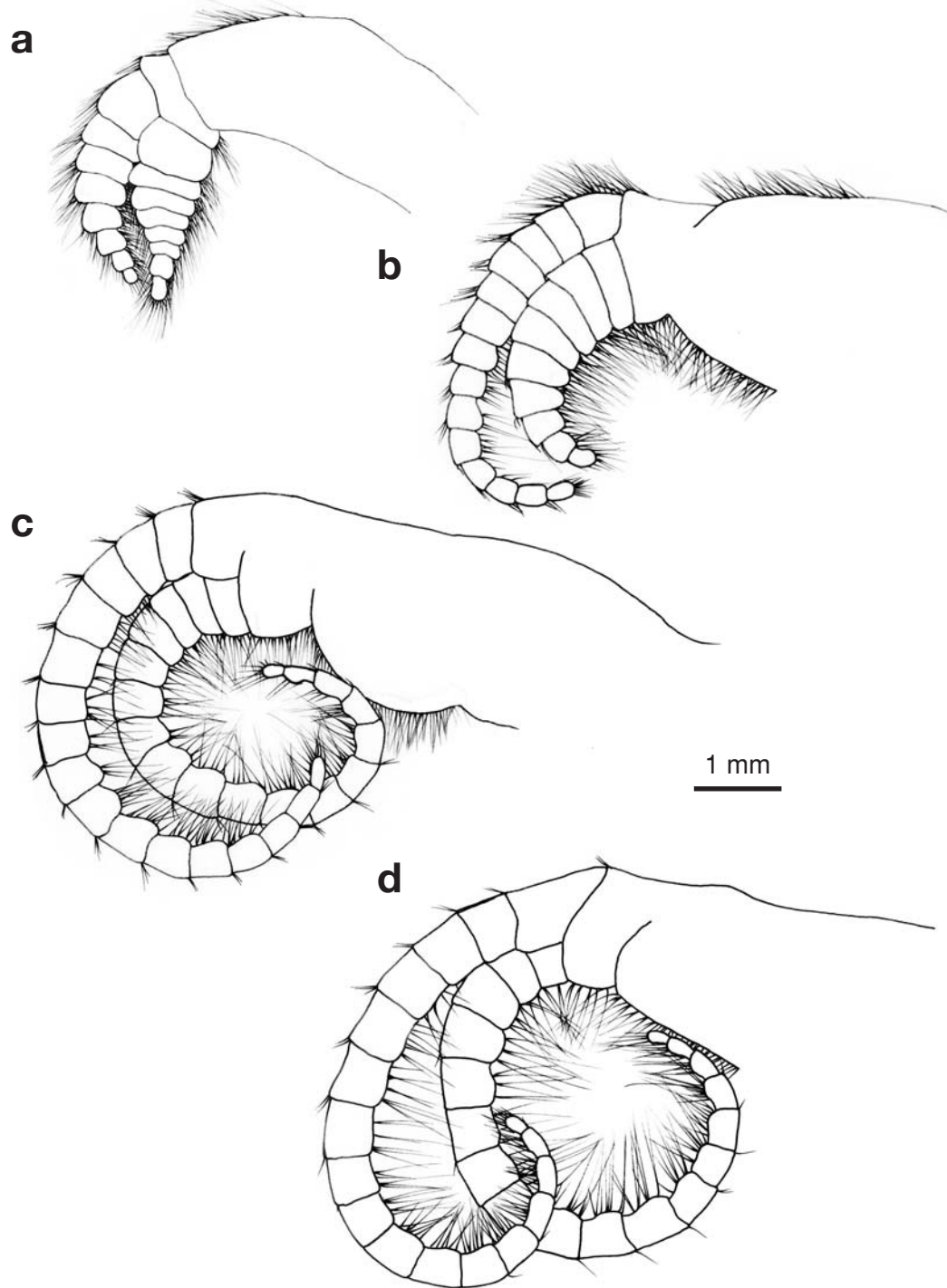


Fig. 133. *Pseudoctomeris sulcata*, Hepingdao, Keelung City, 30 Jul 2008. Line drawings of a. Cirrus I, b. Cirrus II, c. Cirrus III and d. Cirrus IV.

Chthamalus challengenri Hoek, 1883
東方小藤壺

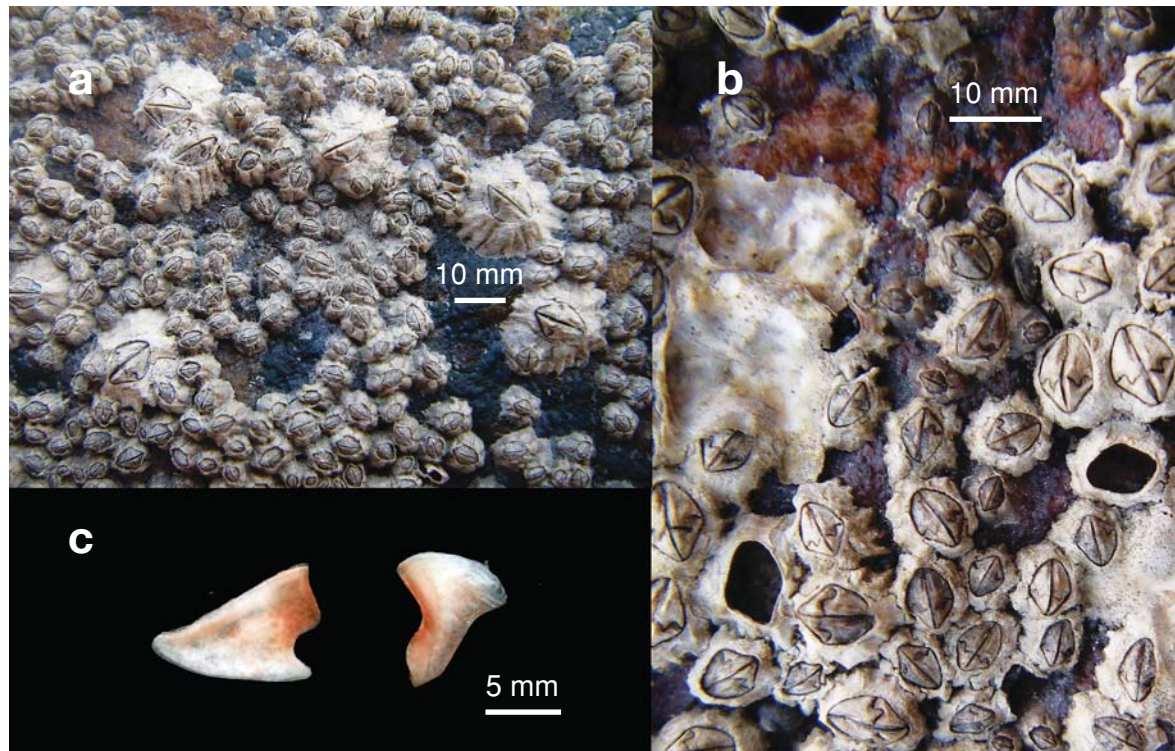


Fig. 134. *Chthamalus challengenri*, Cing Islet, Kinmen, 21 Aug 2006. a, b. *In-situ* view of the shells. c. Scutum and tergum.

Chthamalus challengenri Hoek, 1883: 165, pl. 13, figs. 35-38.—Pilsbry, 1916: 307.—Nilsson-Cantell, 1921: 279, figs. 51c-d.—1927: 781.—1932: 8.—Hiro, 1932b: 546, figs. 1-2.—Tarasov & Zevina, 1957: 256, fig. 103.—Zevina & Tarasov, 1963: 79, fig. 2.—Utinomi, 1970: 345.—Newman & Ross, 1976: 41.—Ren, 1984a: 149, fig. 3, pl. 1, fig. 14, pl. 2, figs. 1-6.—Southward & Newman, 2003: 803, fig. 6.

Material examined.—Cing Islet, Kinmen, 21 Aug 2006: 569 specimens (BD 1.36-5.39 mm) (CEL-BB-13).

Diagnosis.—Shell gray or white, surface smooth with several coarse striations. Suture between scutum and tergum L-shaped, scutum triangular, tergum narrow, higher than wide. Mandible with 4 teeth, lower margin long with many setae; maxillule notched, with 2 large cuspidate setae above notch; maxilla bilobed; mandibulatory palp with dense setae on all margins.

Size.—BD to 8 mm.

Coloration.—Shell white to grey.

Habitat.—High shore of intertidal rocks.

Distribution.—Japan, Korea, N. China, Kinmen and Matsu (2 offshore islands of Taiwan). Absent from the main island of Taiwan.

Remarks.—New record for Taiwan.

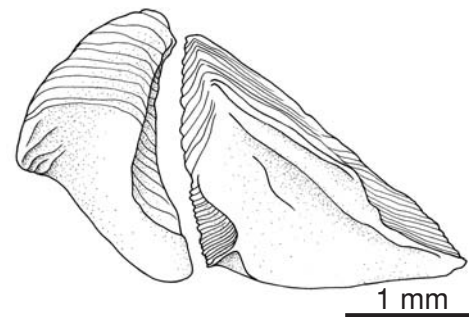


Fig. 135. *Chthamalus challengenri*, Cing Islet, Kinmen, 21 Aug 2006. Line drawings of scutum and tergum.

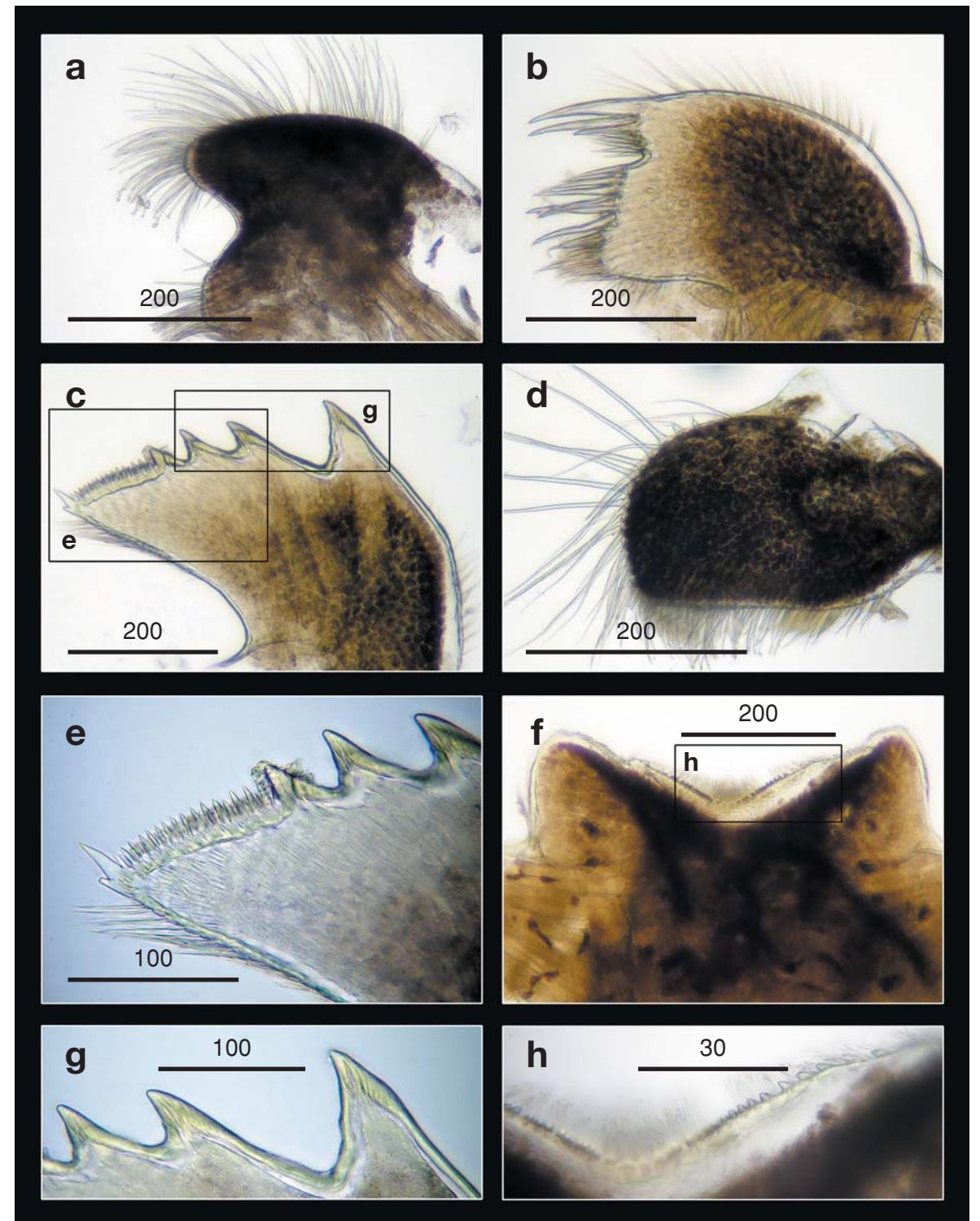


Fig. 136. *Chthamalus challengenri*, Cing Islet, Kinmen, 21 Aug 2006. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the lower margin of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Chthamalus malayensis Pilsbry, 1916
馬來小藤壺

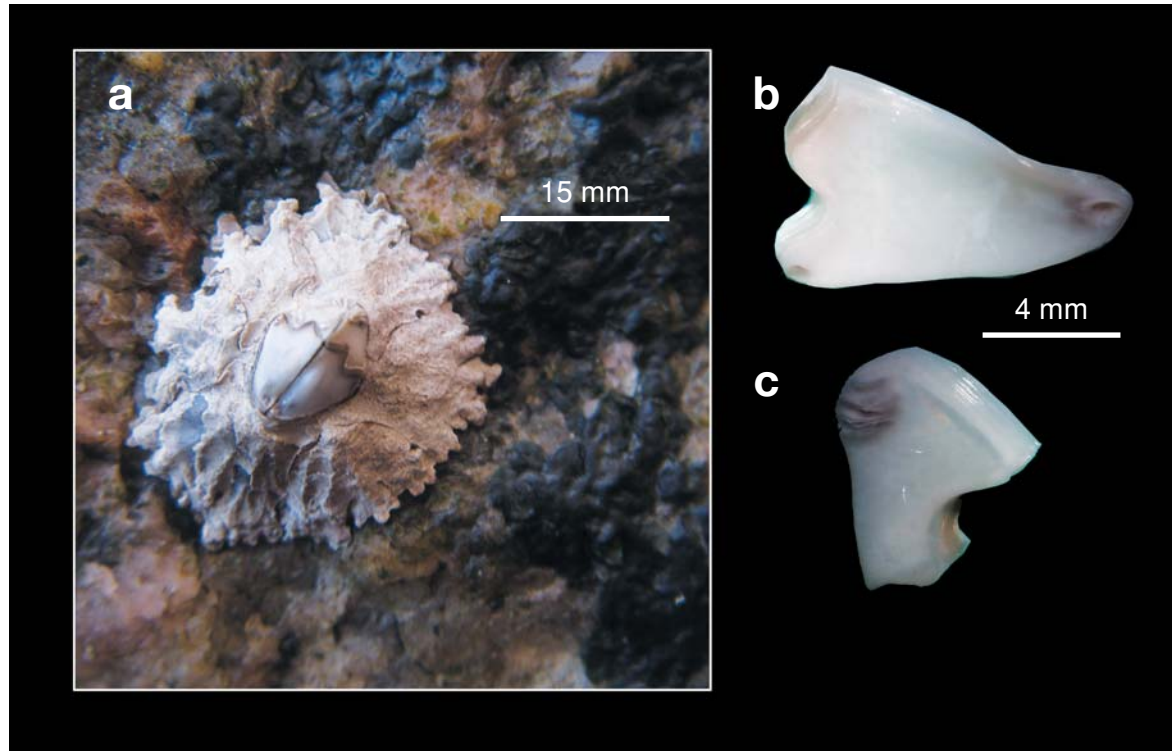


Fig. 137. *Chthamalus malayensis*, Dasianglan, Taipei County, 15 Nov 2006, a. *In situ* view of shores and internal view of b. Scutum and c. Tergum.

Chthamalus malayensis Pilsbry, 1916: 310, pl. 72, figs. 5, 5a.—Broch, 1931: 55.—Nilsson-Cantell, 1938: 31.—Hiro, 1939d: 250.—Kolosváry, 1943: 76.—Utinomi, 1954: 18, fig. 1.—Zevina & Tarasov, 1963: 80, fig. 3.—Pope, 1965: 51.—Newman & Ross, 1976: 42.—Ren, 1984a: 151, fig. 4, pl. 2, figs. 7-16.—Southward & Newman, 2003: 799, figs. 3-5.

Chthamalus antennatus.—Rosell, 1972: 174, pl. 13, figs. 1-7, pl. 14, figs. 1-5 (Non *C. antennatus* Darwin, 1854).

Material examined.—Dasianglan, Taipei County, 15 Nov 2006: 10 specimens (BD 7.46-8.38 mm) (CEL-BB-81).—Dasianglan, Taipei County, 12 Dec 2006: 6 specimens (BD 7.65-9.03 mm) (CEL-BB-82).

Diagnosis.—Shell white, with 6 plates. Scutum elongated, triangular; tergum higher than wide. Mandible with 4 teeth, lower margin pectinated; maxillule notched; maxilla bilobed, with dense setae on 2 distinct regions; mandibulatory palp rectangular with setae on all margins; labrum concave with fine teeth. Cirrus I with conical spine on dorsal side; cirrus II with multi-cuspidate setae

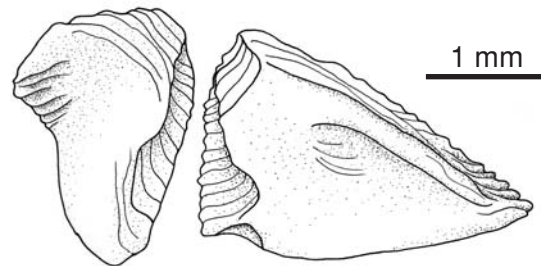


Fig. 138. *Chthamalus malayensis*, Dasianglan, Taipei County, 15 Nov 2006, Line drawing of scutum and tergum.

equipped with basal guard.

Size.—BD to 10 mm.

Coloration.—Shell white to grey.

Habitat.—High shore of intertidal rocks.

Distribution.—Indo-Pacific region.

Remarks.—Tsang et al. (2008b) showed there is a cryptic species complex of *C. malayensis* in the Indo-Pacific region. Yan et al. (2006) and Koh et al. (2004) studied the reproductive cycle of *C. malayensis* in subtropical and tropical regions. *C. malayensis* in the subtropics displays a seasonal reproductive cycle, while the tropical population possess mature gonads year round.

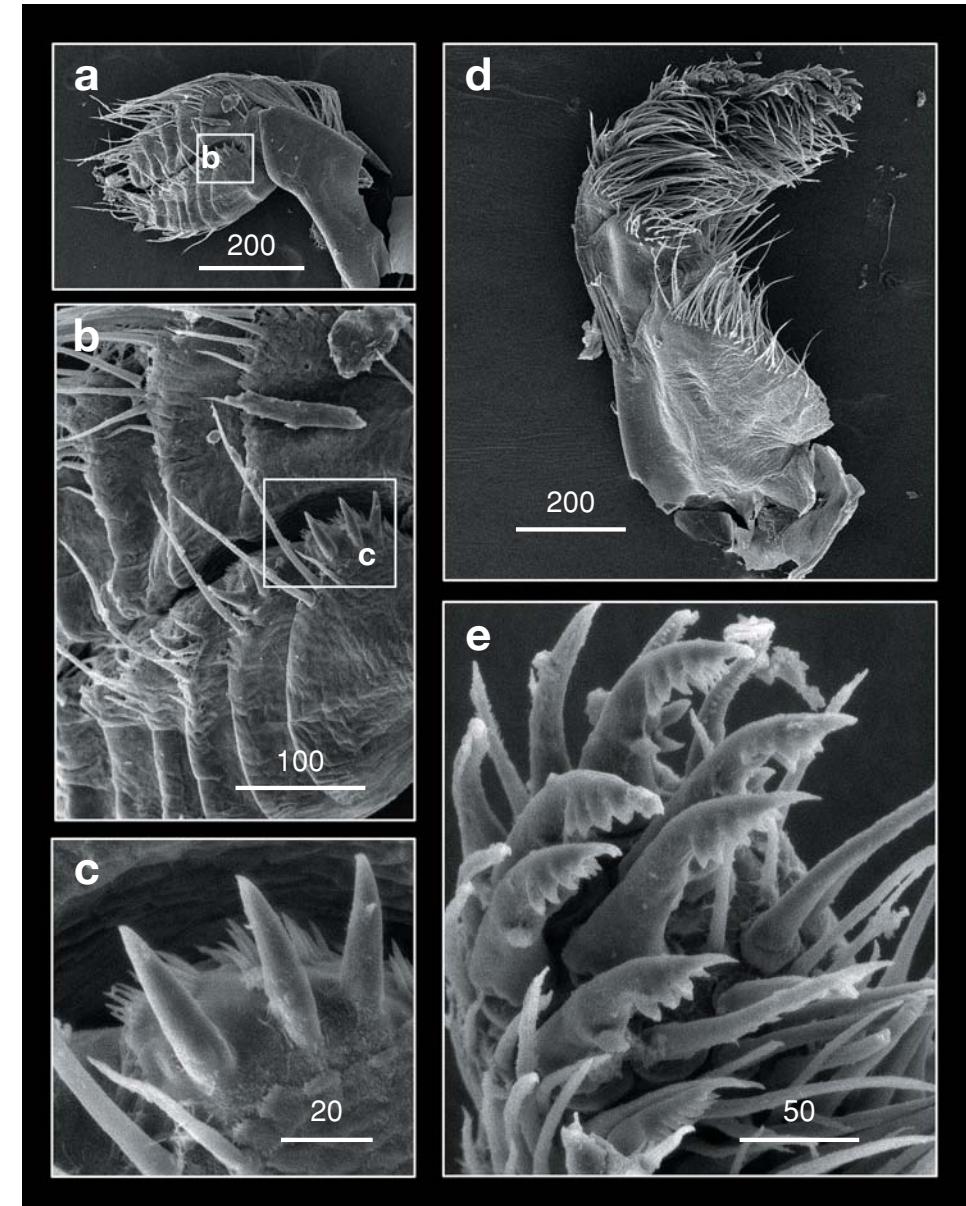


Fig. 139. *Chthamalus malayensis*, Dasianglan, Taipei County, 15 Nov 2006, Scanning Electron Microscopy showing a. Cirrus I, b., c. Conical spines on cirrus I, d. Cirrus II, e. Multicuspidate setae with basal guard on cirrus II.

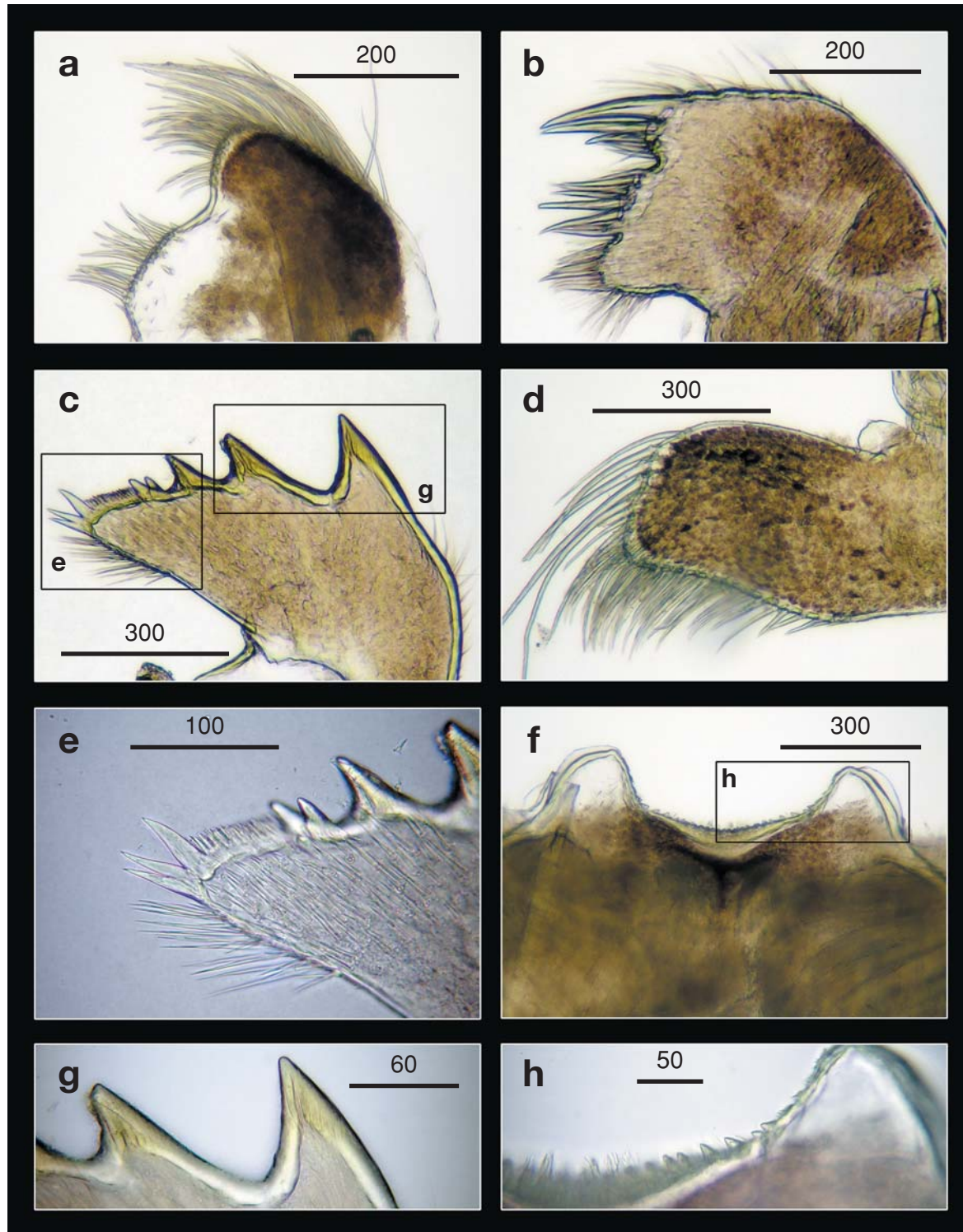


Fig. 140. *Chthamalus malayensis*, Dasianglan, Taipei County, 15 Nov 2006. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Chthamalus moro Pilsbry, 1916
直背小藤壺

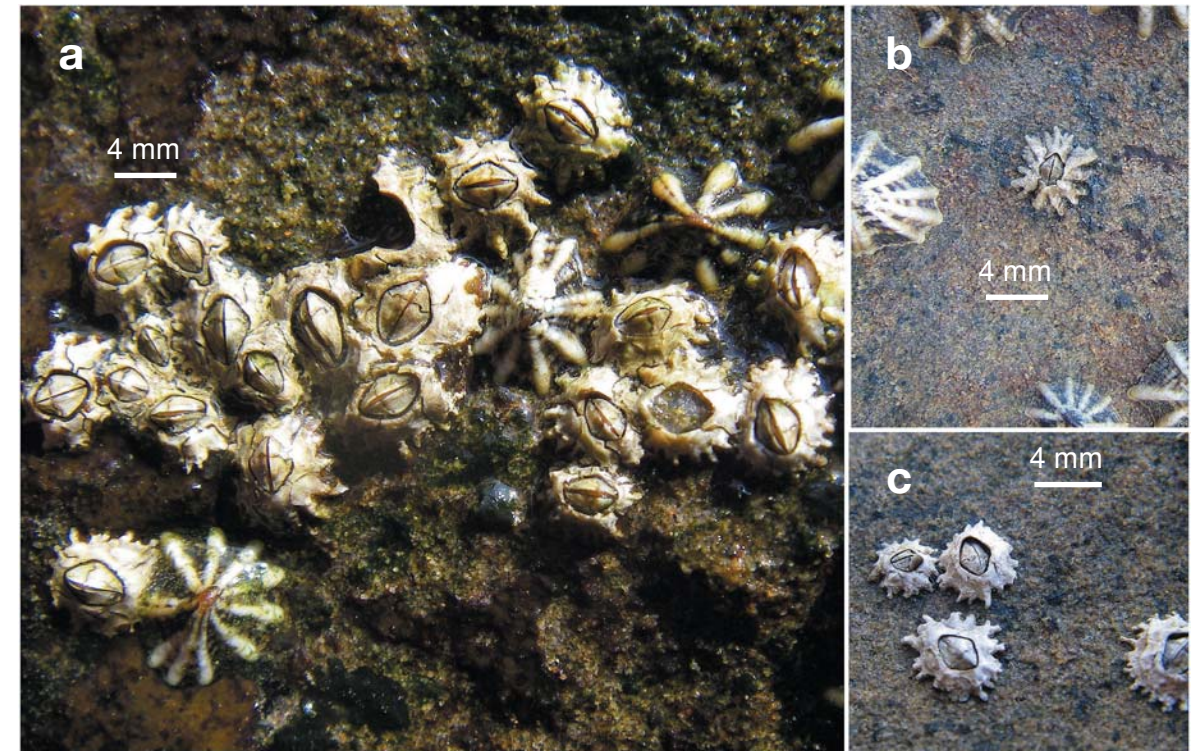


Fig. 141. *Chthamalus moro*, Hongchaikeng, Pingtung County, 28 Apr 2006. a-c. *In-situ* view on shores.

Chthamalus moro Pilsbry, 1916: 311, pl. 72, figs. 6, 6a-b.—Broch, 1922: 307.—1931: 56.—Nilsson-Cantell, 1934b: 50, figs. 9a-f.—Hiro, 1937a: 49, figs. 4a-c.—1939d: 249.—Kolosváry, 1943: 77.—Utinomi, 1949: 25.—Rosell, 1972: 178, pl. 15, figs. 1-10.—Ren, 1984a: 153, fig. 5.

Material examined.—Hongchaikeng, Pingtung County, 28 Apr 2006: > 50 specimens (BD 3.28-4.44 mm) (CEL-BB-125).—Shihtiping, Hualien County, 3 Oct 2008: 28 specimens (BD 2.87-5.58 mm) (CEL-BB-126).

Diagnosis.—Shell white, surface with strong radiating lines. Scutum triangular, tergal margin straight; tergum triangular, scutal margin curved. Mandible with 4 teeth, lower margin long, lower margin with numerous setae; maxillule not notched. Cirrus I without conical spine, and setae on cirrus II without basal guard.

Size.—BD to 6 mm.

Coloration.—Grey to white.

Habitat.—Mid shore of intertidal rocky shores.

Distribution.—Indo-Pacific region.

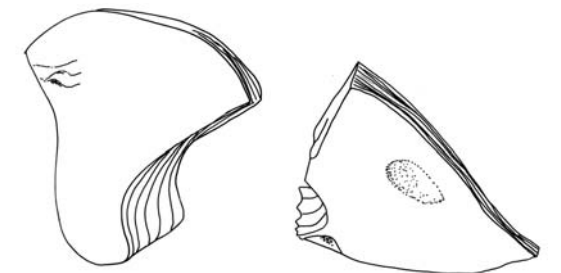


Fig. 142. *Chthamalus moro*, Hongchaikeng, Pingtung County, 28 Apr 2006. Line drawing of scutum and tergum.

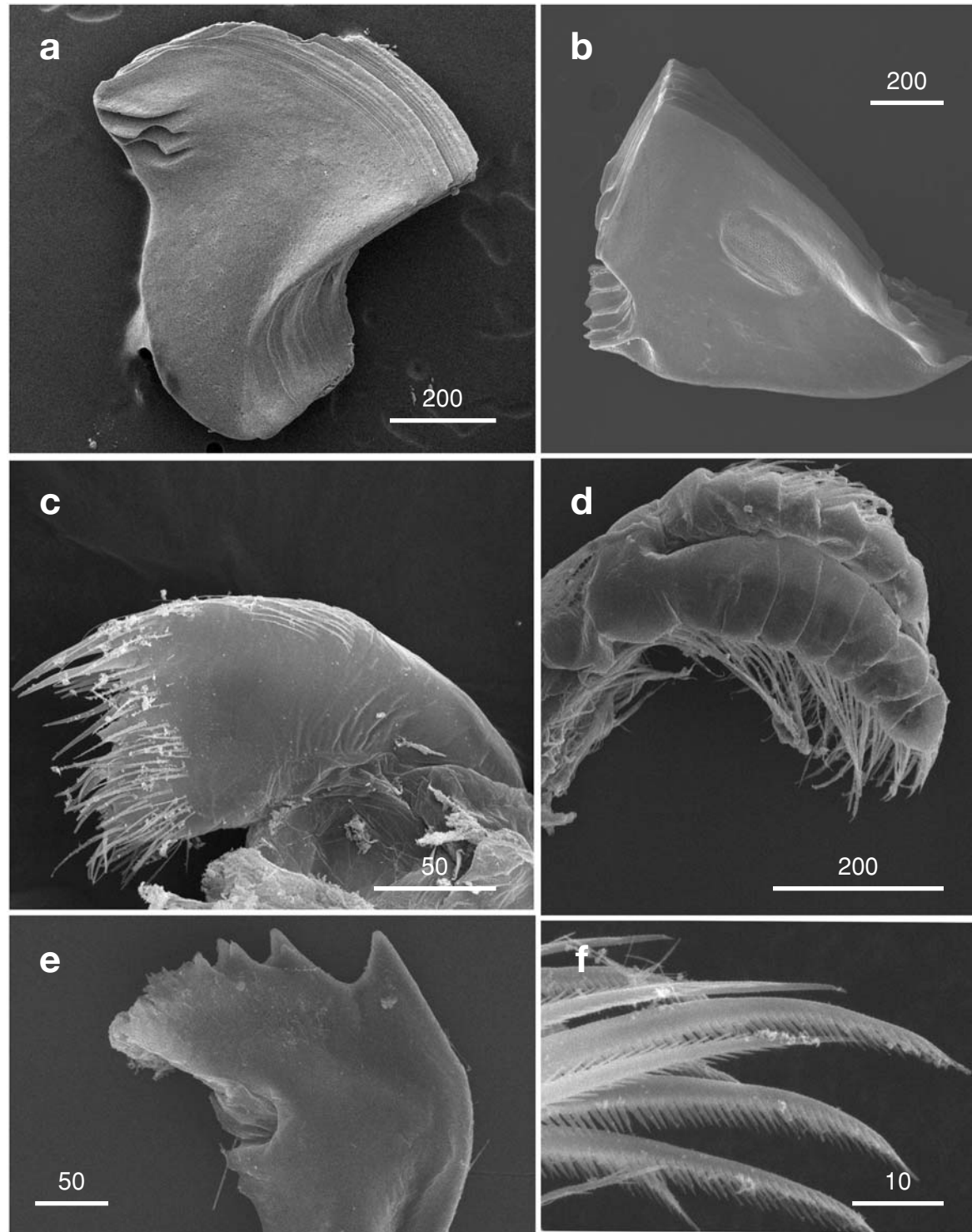


Fig. 143. *Chthamalus moro*, Hongchaikeng, Pingtung County, 28 Apr 2006. Scanning Electron Microscopy on a. Tergum, b. Scutum, c. Maxillule, d. Cirrus I, e. Mandible, f. Serrulate setae on Cirrus II, showing the absences of basal guards.

Superfamily CORONULOIDEA Leach, 1817 鯨藤壺總科

Coronulinae Leach, 1817: 68.

Balanomorpoidea Newman & Ross, 1976: 36, 43.

Coronuloidea.—Newman & Ross, 1977: 102.—Newman, 1993: 408.

Diagnosis.—Parietes with 8 or 6 plates, base membranous, plates tubiferous or non-tubiferous; mandible with 4 teeth; caudal appendage absent.

Remarks.—Coronuloidea is composed of 4 families, among which the Platylepadidae, Coronulidae, and Chelonibiidae were recorded in the present study in Taiwan.

Key to families of Coronuloidea from Taiwan

1. Shell 6 plates, plates with median longitudinal sulcus Platylepadidae
2. Shell 6-8 plates, plates without median longitudinal sulcus Chelonibiidae
3. Shell 6 plates, outerlamina infolded against the sheath, resulting in single row of wall tubes ... Coronulidae

Family CHELONIBIIDAE Pilsbry, 1916 龜藤壺科

Chelonibiinae Pilsbry, 1916: 262.—Nilsson-Cantell, 1921: 368.—Newman et al., 1969: 288.—Newman & Ross, 1976: 37, 43.

Chelonibiidae.—Newman, 1993: 408.

Diagnosis.—Shell composed of 8 or 6 plates, each plate without a median longitudinal sulcus or scales, border of mantle not forming a hood over cirri.

Remarks.—1 genus is included in this family.

Genus *Chelonibia* Leach, 1817

龜藤壺屬

Chelonibia Leach, 1817: 68.—Pilsbry, 1916: 262.—Nilsson-Cantell, 1921: 368.—Newman et al., 1969: 288.—Newman & Ross, 1976: 37, 43.

Chelonobia.—Darwin, 1854: 382.

Diagnosis.—Shell with 8 or 6 plates, each plate without median longitudinal sulcus or scales, border of mantle not forming a hood over cirri.

Key to species of *Chelonibia* from Taiwan

1. Walls thin and light, the outer lamina and septa of the compartments very thin, cavities between septa not filled up with calcareous matter; shell steeply conic, the orifice generally exceeding half the basal diameter; radii broad, smooth, only slightly depressed; usually living on crabs *Chelonibia patula*
2. Walls heavy, the compartments thick and strong; radii narrow; septa very numerous; living on turtles. Radii rather narrow and well sunken; cavities in the parietes between the basal septa rather deep; radii usually notched on the sides, sometimes smooth; parietes not ribbed or longitudinally folded, the peripheral edge not lobed or incised *Chelonibia testudinaria*

Chelonibia testudinaria (Linnaeus, 1758)

龜藤壺

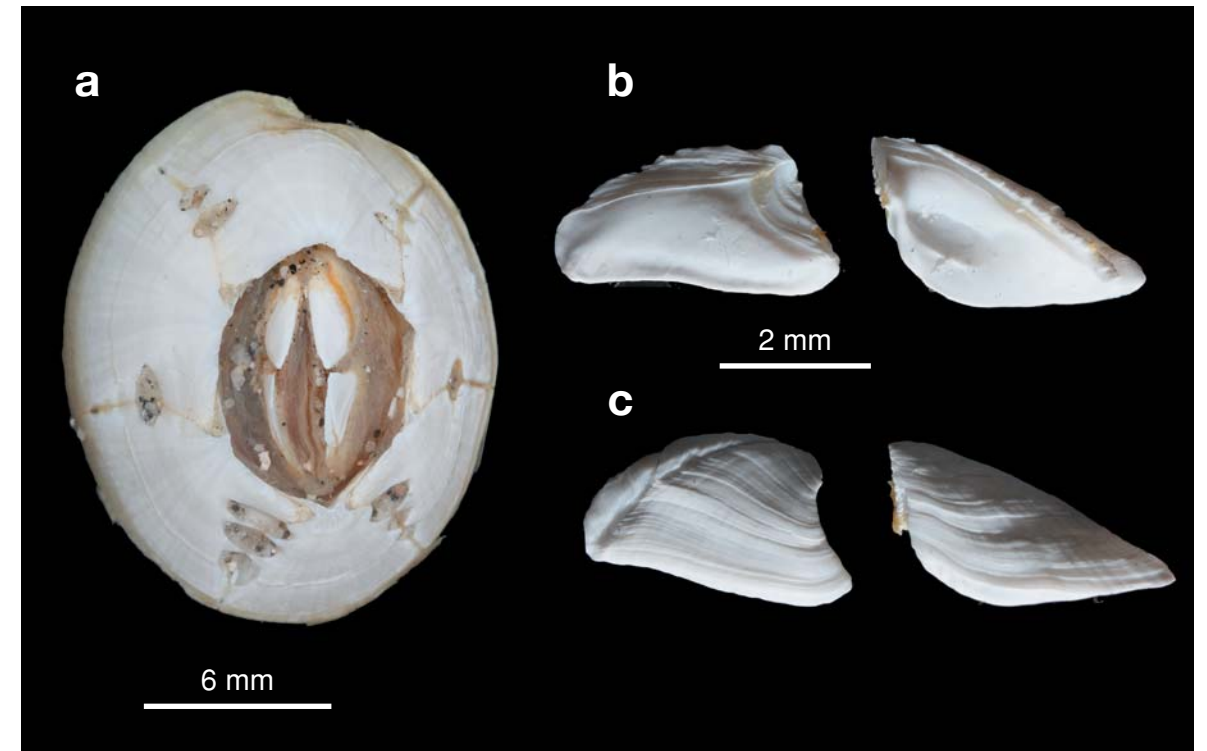


Fig. 144. *Chelonibia testudinaria*, Dong-ao, Yilan County, 17 Jan 2006. a. Whole parietes. b. Scutum and Tergum, internal view, c. Scutum and Tergum, external view.

Lepas testudinaria Linnaeus, 1758: 668.

Chelonobia testudinaria.—Darwin, 1854: 392, pl. 14, figs. 1a-d, 5, pl. 15, fig. 1.—Weltner, 1897: 254.—Lanchester, 1902: 371.—Gruvel, 1905: 267.—Annandale, 1906a: 143.—Krüger, 1911: 57.—Henry, 1954: 444.—1960: 147.—Gordon, 1970: 94, fig. 32.

Chelonibia testudinaria.—Pilsbry, 1916: 264, pl. 62, figs. 1-4.—1928: 316.—Nilsson-Cantell, 1921: 369, fig. 85.—1931: 116.—1938: 77.—Barnard, 1924: 92.—Broch, 1931: 122.—Hiro, 1937a: 69.—1937b: 470.—1939b: 214.—Henry, 1941: 105.—Utinomi, 1949: 24.—1969: 92.—1970: 360.—Stubbings, 1967: 296.—Ross & Newman, 1967: 18.—Newman et al., 1969: 289.—Newman & Ross, 1976: 44.—Ren, 1980: 187, fig. 1, pl. 1, figs. 1-5.—Liu & Ren, 2007: 307, fig. 135.

Material examined.—Dong-ao, Yilan County, 17 Jan 2006: 5 specimens (BD 28.71-42.76 mm) (CEL-BB-45).

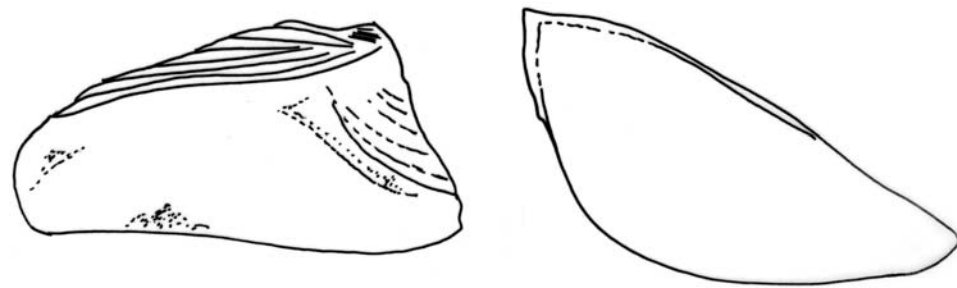


Fig. 145. *Chelonibia testudinaria*, Dong-ao, Yilan County, 17 Jan 2006. Line drawings of scutum and tergum.

Diagnosis.—Shell flattened, oval, white, and smooth, each side of plates denticulated. Scutum white and smooth, triangular; tergum flattened, rectangular. Maxilla globular; maxillule not notched, cutting edge straight; mandible with 5 teeth, lower margin short; mandibulatory palp rectangular; labrum clefted with numerous sharp teeth. Cirrus I rami sub-equal, with serrulate setae, intermediate segment of cirrus VI with 3 long serrulate setae.

Size.—BD to 45 mm.

Coloration.—White.

Habitat.—Epibiotic on turtle surfaces.

Distribution.—Indo-Pacific region.

Remarks.—New record for Taiwan.

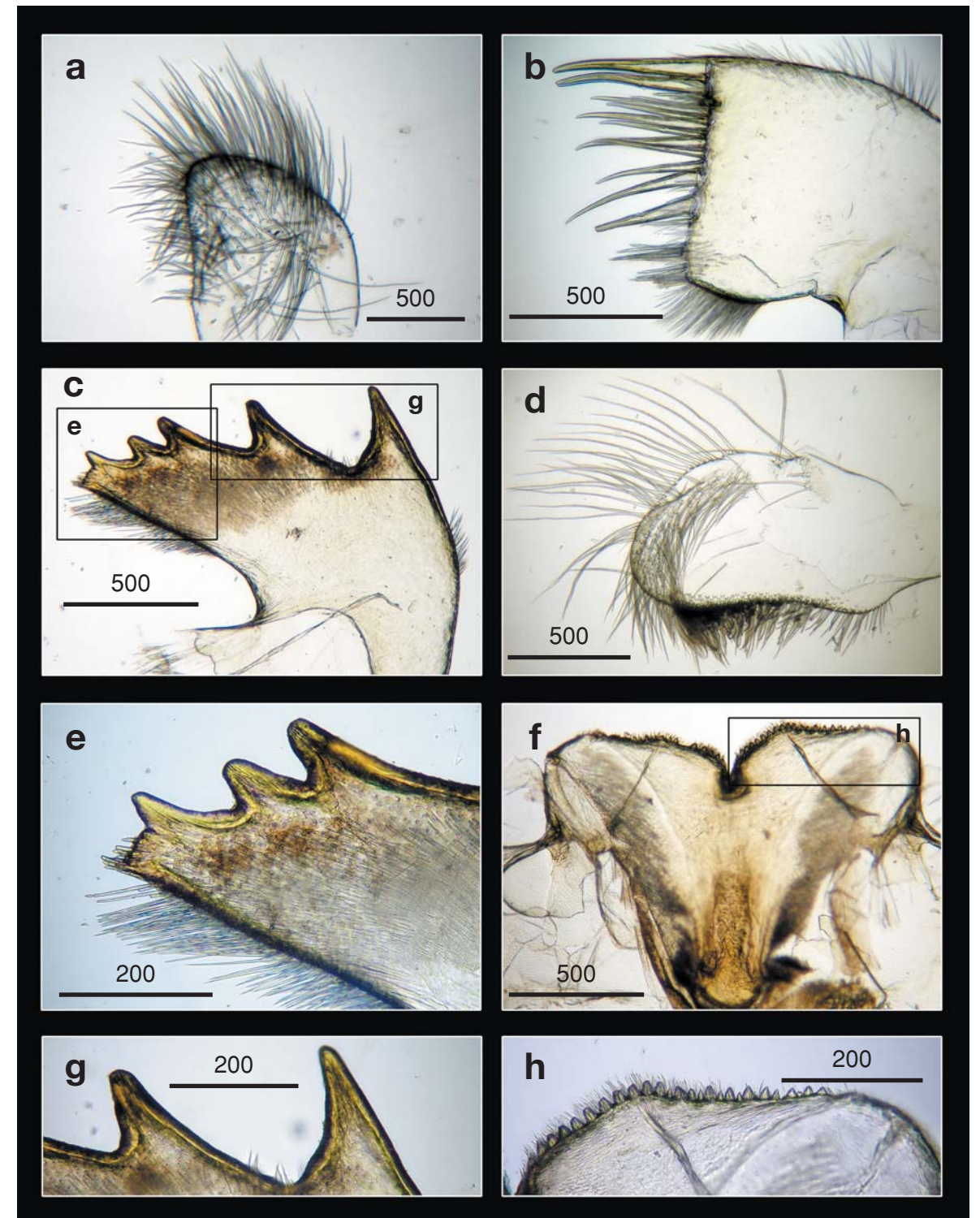


Fig. 146. *Chelonibia testudinaria*, Dong-ao, Yilan County, 17 Jan 2006. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

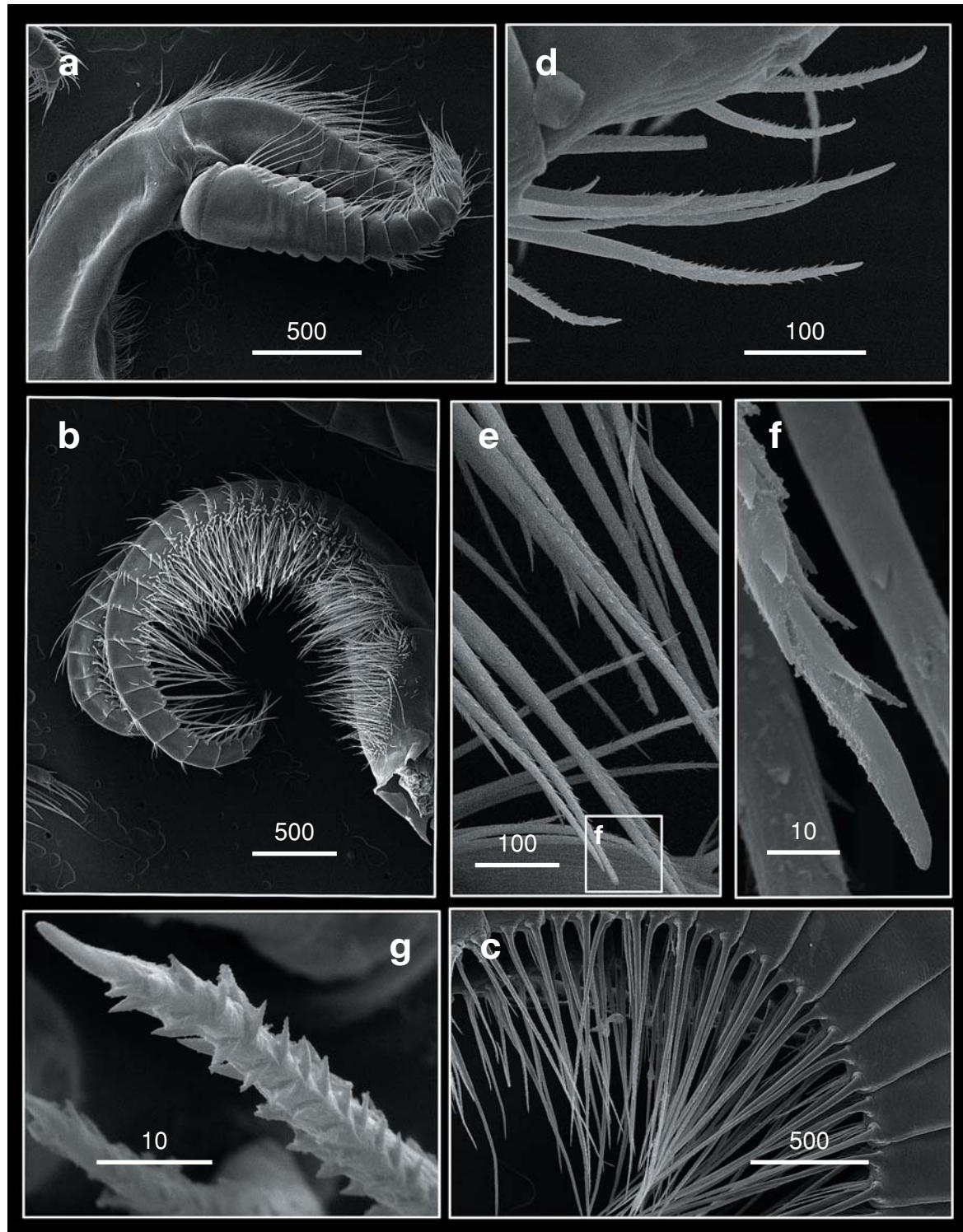


Fig. 147. *Chelonibia testudinaria*, Dong-ao, Yilan County, 17 Jan 2006. Scanning Electron Microscopy on a. Cirrus I, b. Cirrus II, c. Intermediate segment of cirrus VI, d. Serrulate setae on cirrus I, e., f. Serrulate setae on cirrus VI. g. Serrulate setae on cirrus VI. Scale bars in μm .

Chelonibia patula (Ranzani, 1818)
薄殼龜藤壺

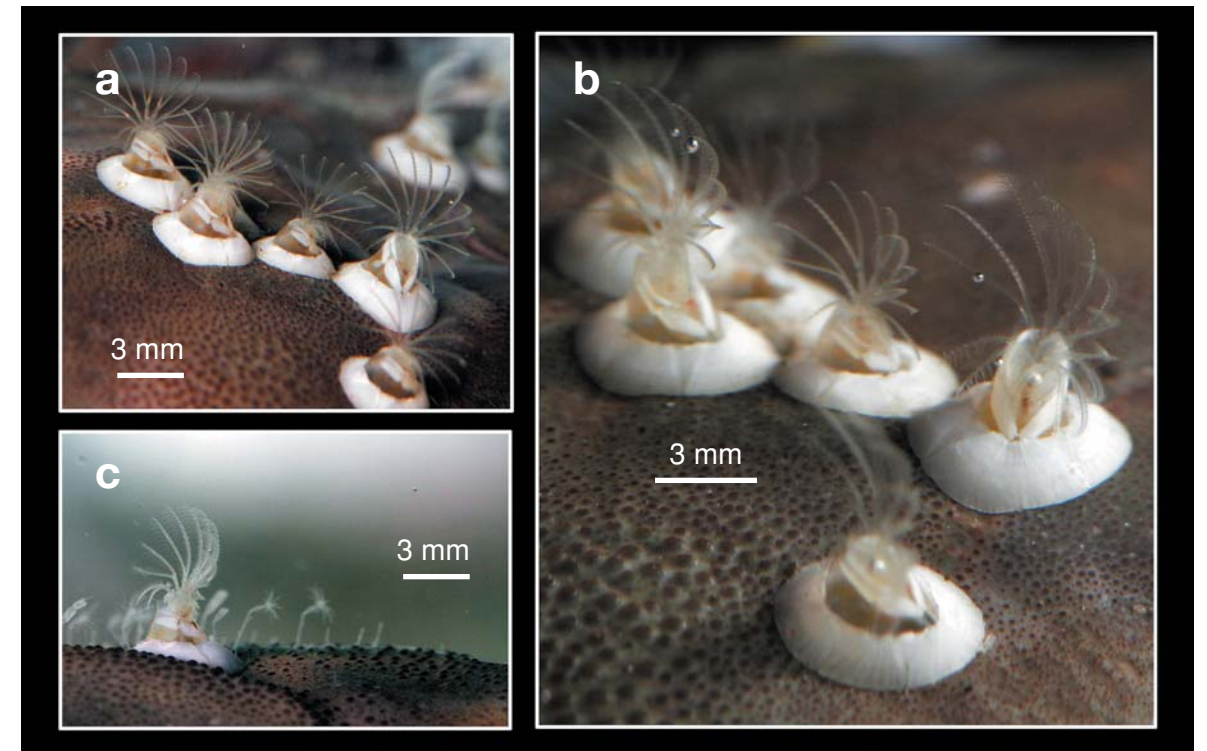


Fig. 148. *Chelonibia patula*, Hepingdao, Keelung City, Sep 2008. a.-c. *In-situ* view on carapace of crab *Podophthalmus vigil*.

Coronula patula Ranzani, 1818: 86.

Chelonibia patula.—Darwin, 1854: 396, pl. 14, figs. 3a-b, 4.—Weltner, 1897: 254.—Gruvel, 1905: 268, fig. 297c.—Krüger, 1911: 4.

Chelonibia patula.—Pilsbry, 1916: 268, pl. 63, figs. 4, 4a.—1928: 316.—1953: 27.—Broch, 1927: 136.—1935: 3.—Henry, 1954: 444.—Utinomi, 1958: 309.—Stubbings, 1967: 297, figs. 23-24.—Southward & Crisp, 1963: 26, fig. 10.—Ross & Newman, 1967: 18.—Gordon, 1970: 90, fig. 31.—Newman & Ross, 1976: 43.—Ren, 1987: 180, fig. 5.—Liu & Ren, 2007: 309, fig. 136.

Material examined.—Hepingdao, Keelung City, on crab, Sep 2008: 6 specimens (BD 2.52-3.32 mm) (CEL-BB-64).

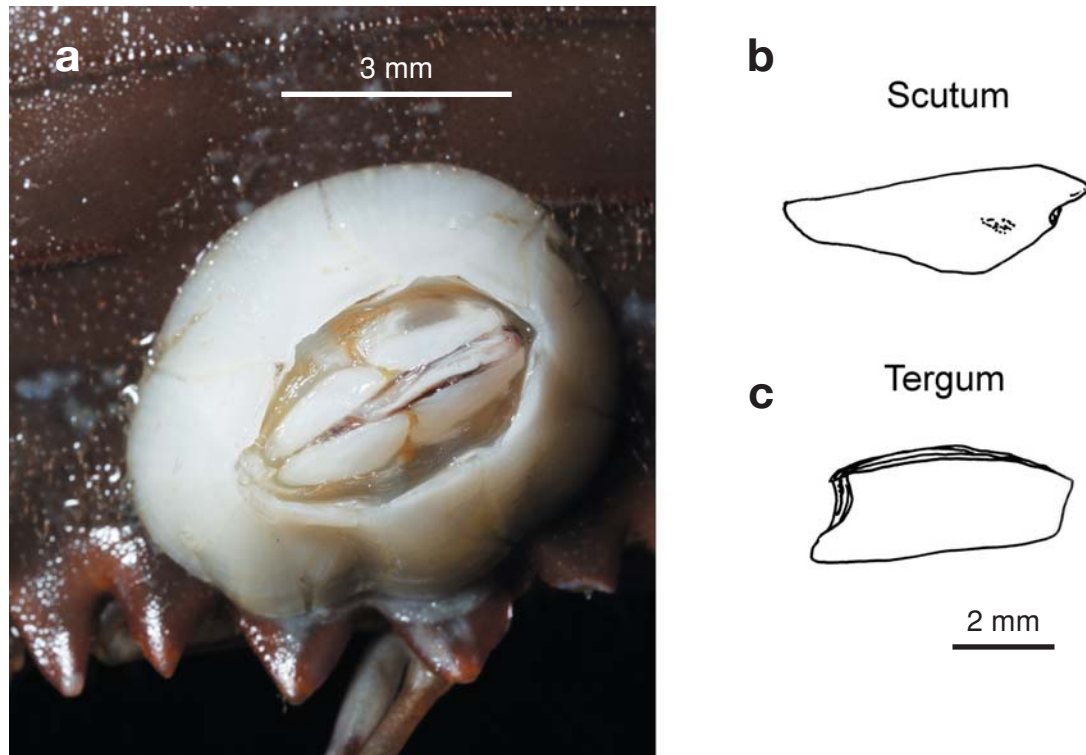


Fig. 149. *Cheloniba patula*, Hepingdao, Keelung City, Sep 2008. a. *In-situ* view on crab carapace and line drawings of b. Scutum and c. Tergum.

Diagnosis.—Shell flattened, oval, white, and smooth. Scutum white and smooth; triangular, tergum flattened, rectangular. Maxilla bilobed; maxillule not notched, cutting edge straight; mandible with 5 teeth, 2nd and 3rd tooth tridentated; lower margin short; mandibulatory palp elongated; labrum clefted with numerous sharp teeth.

Size.—To 15 mm.

Coloration.—White.

Habitat.—On crab surface.

Distribution.—Indo-Pacific waters.

Remarks.—New record for Taiwan.

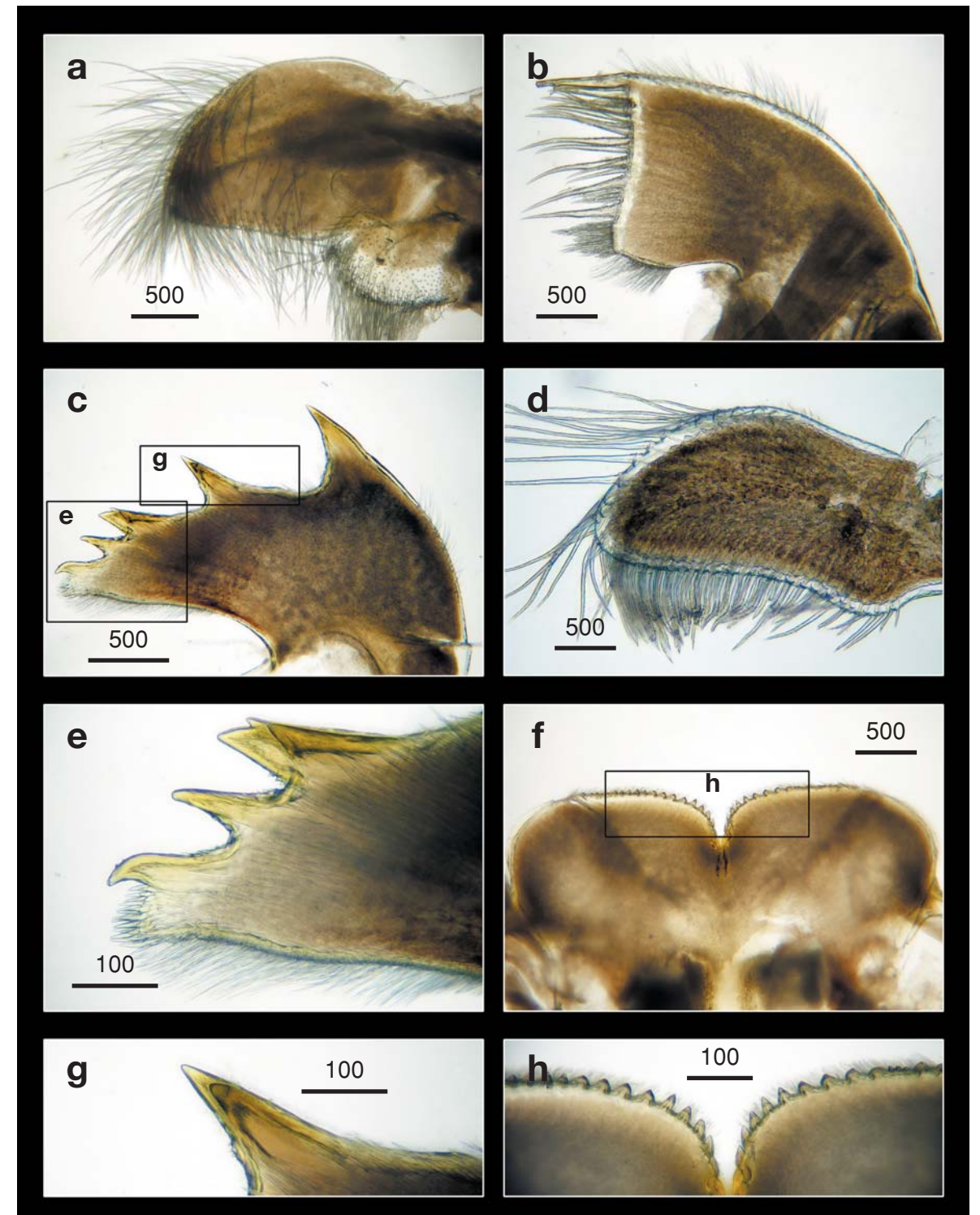


Fig. 150. *Cheloniba patula*, Hepingdao, Keelung City, Sep 2008. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Family PLATYLEPADIDAE Newman & Ross, 1976
扁藤壺科

Platylepadinae Newman & Ross, 1976: 44.—Ren, 1980: 188.

Platylepadidae Newman, 1993: 408.

Diagnosis.—Shell with 6 plates, plate underneath with median longitudinal sulcus.

Remarks.—4 genera have been recorded in Platylepadidae, and 1 genus were recorded in Taiwan.

Genus *Platylepas* Gray, 1825
扁藤壺屬

Platylepas Gray, 1825: 105 (not seen).—Darwin, 1854: 424.—Pilsbry, 1916: 284.—Newman et al., 1969: 289. Type species *Lepas hexastylus* Fabricius, 1798.

Diagnosis.—Shell flattened, surface with strong striations of growth lines, plate underneath with median longitudinal sulcus, sheath short, basis membranous supported by median longitudinal sulcus embedded into skin of turtles, opercular valves occupying entire orifice.

Remarks.—8 species have been recorded worldwide, and 1 species was recorded in the present study. This represents a new record for Taiwan.

Platylepas hexastylus (Fabricius, 1798)
六柱扁藤壺

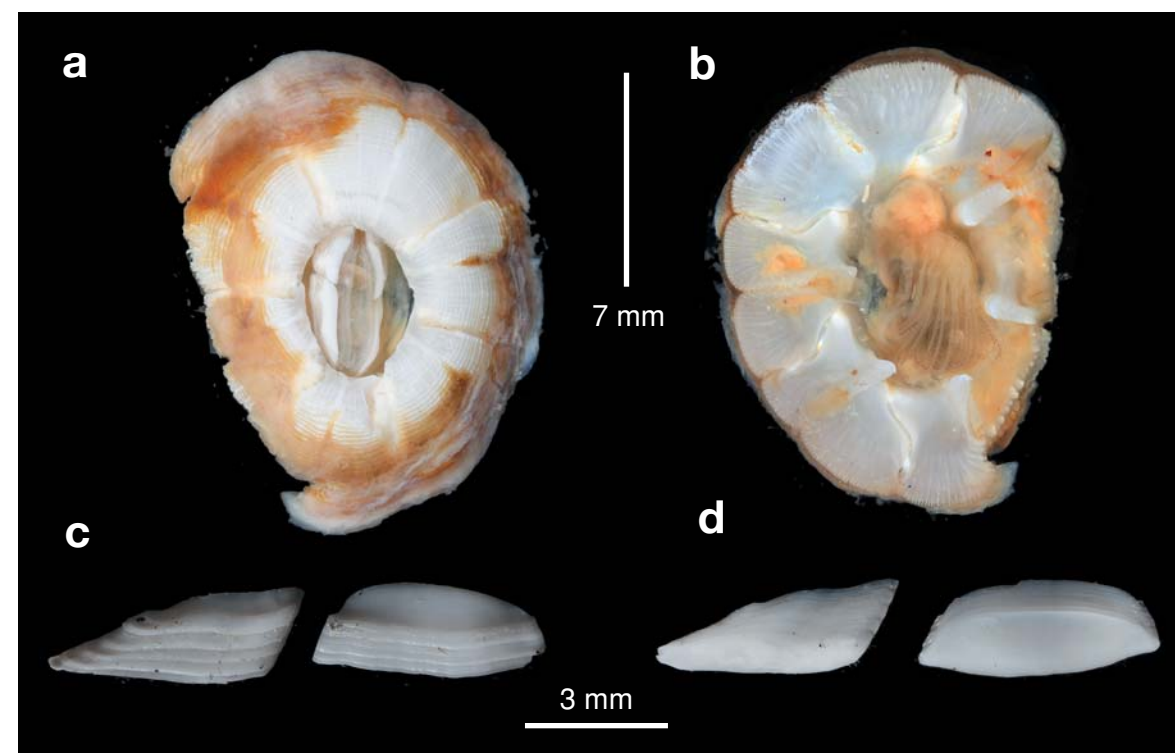


Fig. 151. *Platylepas hexastylus*, Dong-ao, Yilan County, 17 Oct 2006. a. Dorsal and b. Ventral view of the parietes. c. External and d. Internal view of scutum and tergum.

Lepas hexastylus Fabricius, 1798: 35.

Platylepas bissexlobata (De Blaiville).—Darwin, 1854: 428, pl. 17, figs. 1a-d.—Weltner, 1897: 253.—Gravel, 1905: 276, fig. 300.

Platylepas hexastylus.—Pilsbry, 1916: 285, pl. 67, figs. 1-1c.—Broch, 1924: 18, fig. 6.—Hiro, 1936d: 319.—1937b: 472, fig. 43.—Kolosváry, 1943: 101.—Henry, 1954: 444.—Stubbings, 1967: 300.—Utinomi, 1959: 384.—1970: 360.—Newman & Ross, 1976: 44.—Ren, 1980: 188, fig. 2, pl. 1.—Liu & Ren, 2007: 312, fig. 138.

Material examined.—Dong-ao, Yilan County, 17 Oct 2006: 2 specimens (BD 14.87-15.22 mm) (CEL-BB-60).

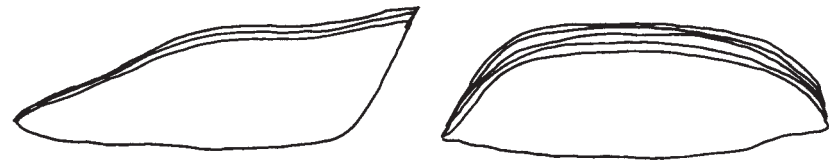


Fig. 152. *Platylepas hexastylus*, Dong-ao, Yilan County, 17 Oct 2006. Line drawings of scutum and tergum.

Diagnosis.—Shell flattened, surface with strong striations of growth lines, plate underneath with median longitudinal sulcus, base embedded into skin of turtles. Scutum and tergum narrow, wider than high. Maxilla bilobed; maxillule notched; mandible with 3 teeth, 2nd and 3rd teeth bidentated, lower margin short, mandibulatory palp rectangular with dense setae on inferior margin; labrum clefted with 3 strong sharp teeth on each side of cutting edge.

Size.—BD to 20 mm.

Coloration.—White to pale-yellow.

Habitat.—On sea turtle skin.

Distribution.—Indo-Pacific waters.

Remarks.—New record for Taiwan.

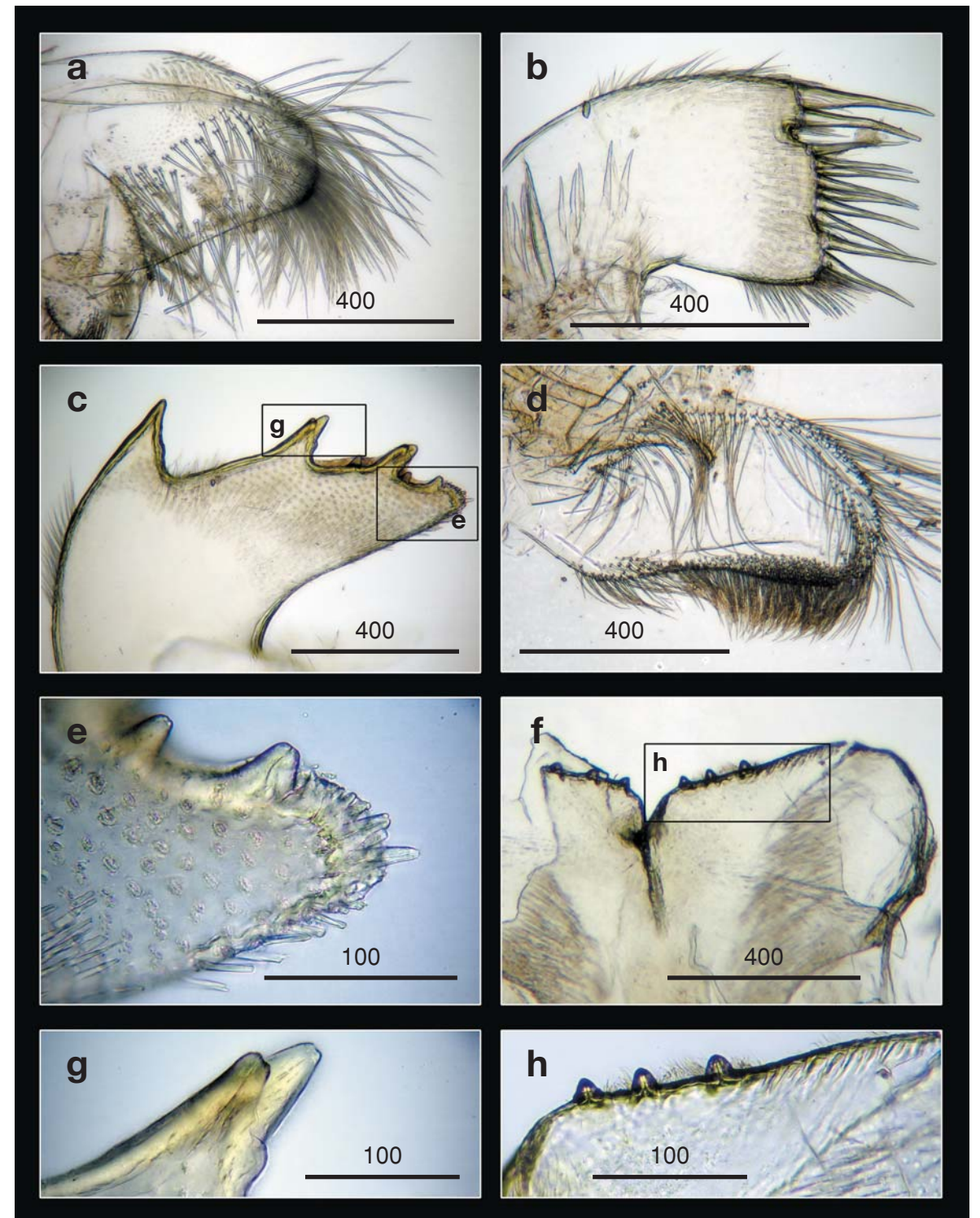


Fig. 153. *Platylepas hexastylus*, Dong-ao, Yilan County, 17 Oct 2006. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Family CORONULIDAE Leach, 1817
鯨藤壺科

Coronulinae Leach, 1817: 68.—Newman & Ross, 1976: 37, 43.—Foster, 1978: 115.
Coronulindae.—Newman, 1993: 408.

Diagnosis.—Shell with 6 plates, outer lamina infolded against the sheath, resulting in a single row of wall tubes.

Genus *Coronula* Lamarck, 1802
鯨藤壺屬

Coronula Lamarck, 1802 (not seen).—Darwin, 1854: 397.—Newman & Ross, 1976: 44.

Diagnosis.—Shell with 6 plates, outer lamina infolded against the sheath, resulting in a single row of wall tubes.

Coronula diadema (Linnaeus, 1767)
桶冠鯨藤壺

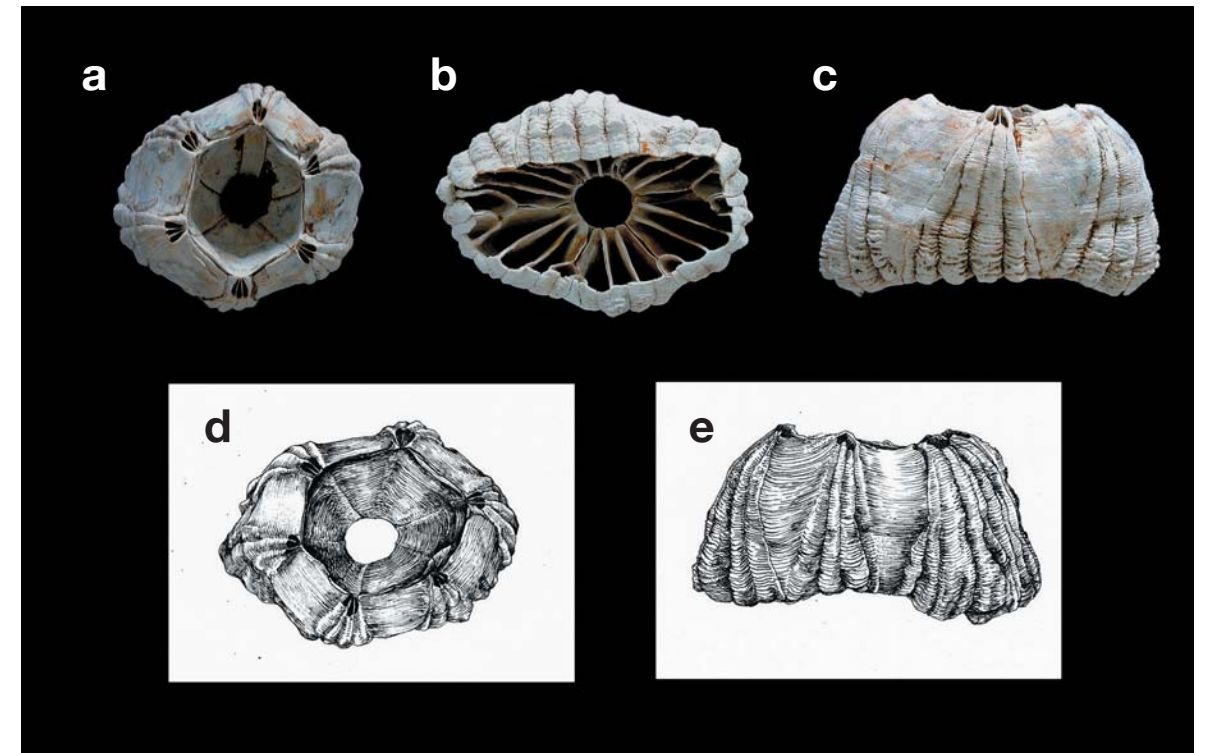


Fig. 154. *Coronula diadema*, Gueishan, Yilan County, CP82, 8 May 2001. a., d. Top view, b. Basal view and c., e. Side view of the parietes.

Lepas diadema Linnaeus, 1767: 1109.

Coronula diadema.—Lamarck, 1818: 387.

Material examined.—GueiShan, Yilan County, CP82, 24°52.12'N, 121°59.17'E, 273 m, Empty shell collected from French beam trawl, 8 May 2001: 1 specimen (BD 71.85 mm, height 38.22 mm) (NMNS-3567-003).

Diagnosis.—Shell with 6 plates, hexagonal, parietes thick and robust. Paries inner surface folded, resulting in 4 tubes at each paries.

Size.—BD to 80 mm.

Coloration.—White, grey.

Habitat.—On whale surfaces.

Distribution.—World Oceans.

Superfamily TETRACLITOIDEA Gruvel, 1903
笠藤壺總科

Tetraclitoidea Gruvel, 1903: 160.—Newman, 1993: 408.

Diagnosis.—Parietes non-, uni-, or multi-tubiferous, tubes with living tissues or filled with chitin, radii well-developed or obsolete, basis membranous.

Remarks.—Tetraclitoidea is divided into 2 families, the Bathylasmatidae and Tetraclitidae. Both families are recorded from Taiwan.

Key to families of Tetraclitoidea from Taiwan

1. Radii not well developed, all cirrus with simple or serrulate setae Bathylasmatidae
2. Radii well developed, cirrus II or III with bidentate or multicuspidate setae Tetraclitidae

Family BATHYLASMATIDAE Newman & Ross, 1971
深板藤壺科

Bathylasmatidae Newman & Ross, 1971: 140.—1976: 45.

Diagnosis.—Parietes with 4-6 plates, without radii, basis membranous or calcareous, if calcareous base without tubes. Cirri II and III morphologically similar.

Remarks.—2 subfamilies are classified in the Bathylasmatidae, and only the Hexelasmae has been recorded in Taiwan.

Subfamily Hexelasmae Newman & Ross, 1976
六壁藤壺亞科

Hexelasmae Newman & Ross, 1976: 46.

Diagnosis.—Parietes with 6 plates, solid or with a single row of tube, shell conical, tergum with short spur, base membranous.

Remarks.—*Hexelasma* and *Mesolasma* are included in the Hexelasmae, and only *Hexelasma* was newly recorded from Taiwan. (see Chan et al., 2009).

Genus *Hexelasma* Hoek, 1913
六壁藤壺屬

Hexelasma Hoek, 1913: 244 (in part).—Newman & Ross, 1971: 155.—1976: 46. Type species *Hexelasma velutinum* Hoek, 1913.

Diagnosis.—Shell 6 plates, carina, carinal latus and latera with alae, carina perfectly jointed with carinal latus, plates non tubiferous, base membranous. Labrum concaved and non-clefted.

Remarks.—In the present study, only *Hexelasma velutinum* was collected, which is a new record for Taiwan (also see Chan et al., 2009).

Hexelasma velutinum Hoek, 1913
絨六壁藤壺

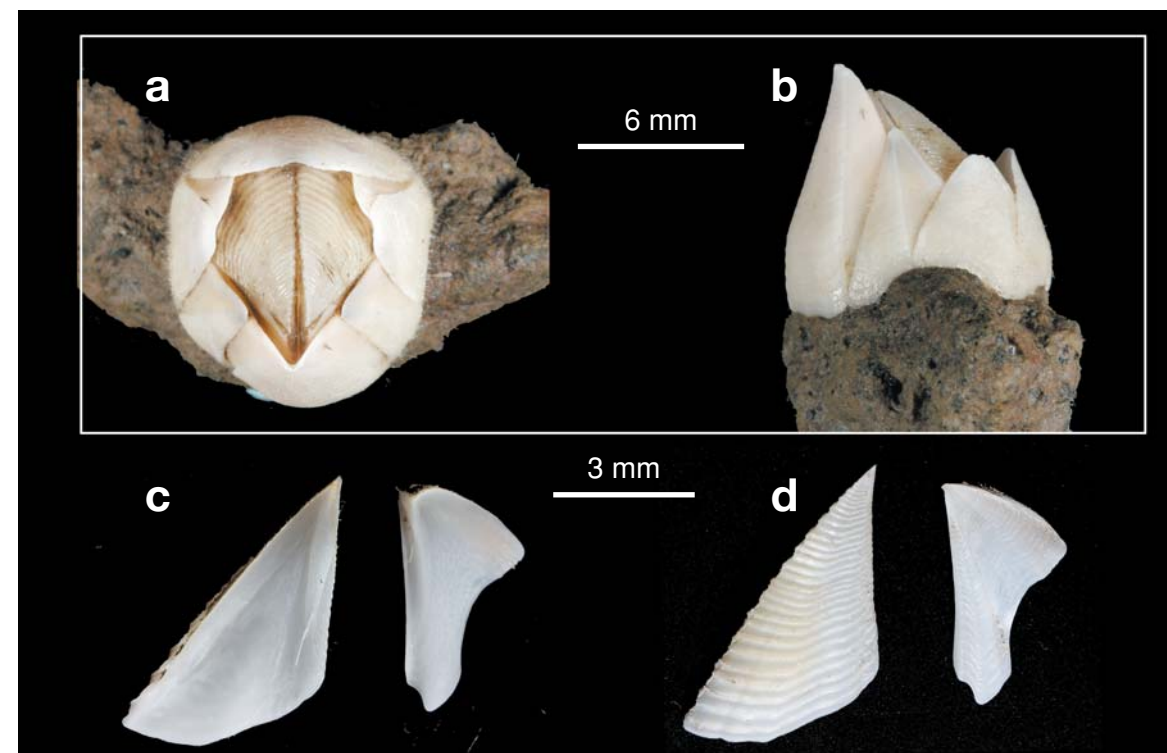


Fig. 155. *Hexelasma velutinum*, CP371, 26 Aug 2006. a. Top view, b. Side view of the parietes, c. Internal view of the scutum and tergum, d. External view of the scutum and tergum.

Hexelasma velutinum Hoek, 1913: 246, pl. 26, figs. 1-6.—Broch, 1931: 53.—Hiro, 1933: 70, pl. 3, fig. 2.—Utinomi, 1968b: 30.—Newman & Ross, 1971: 155.—1976: 46.—Liu & Ren, 2007: 328, fig. 146.

Material examined.—CP371, 24°28.521'N, 122°12.821'E, 582-613 m, 26 Aug 2006: 1 specimen (BD 13.88 mm) (CEL-BB-102).

Diagnosis.—Shell white, conical or cylindrical, operculum large; shell surface with parallel growth lines, entire surface covered by membrane with fine short setae; shell compartment with 6 plates, carina, carinal latus, and lateral plates with alae but without radii; rostrum radii and alae lacking; parietes solid and without longitudinal ribs on inner surface; base membranous. Scutum triangular, occludent margin straight, tergal margin straight; tergum narrow, scutal margin long and straight, basi scutal angle oblique, spur pronounced. Maxilla triangular, setae covering both inferior and superior margins; maxillule cutting edge notched, 2 long spines above notch, 3 fine short setae at notch, and 12 fine setae below notch; mandible with 4 teeth excluding inferior angle, 1st tooth far separated from other teeth, lower margin smooth, inferior angle sharp; mandibulatory palp

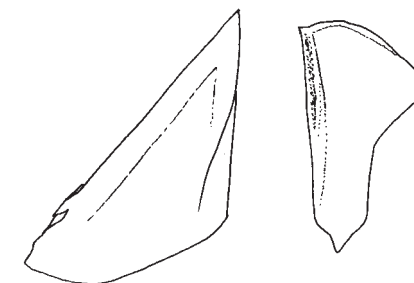


Fig. 156. *Hexelasma velutinum*, CP371, 26 Aug 2006. Line drawings of scutum and tergum.

elongated, blunt and with dense setae on superior margin; labrum concave without a deep notch, cutting edge with fine tridentate teeth, teeth bidentate and tridentate. Intermediate segment of cirri IV-VI with 2 pairs of setae.

Size.—BD to 15 mm.

Coloration.—Pale-yellow.

Habitat.—On gastropod shell or rocks.

Distribution.—South China Sea, Japan, Taiwan, the Philippines.

Remarks.—New record for Taiwan.

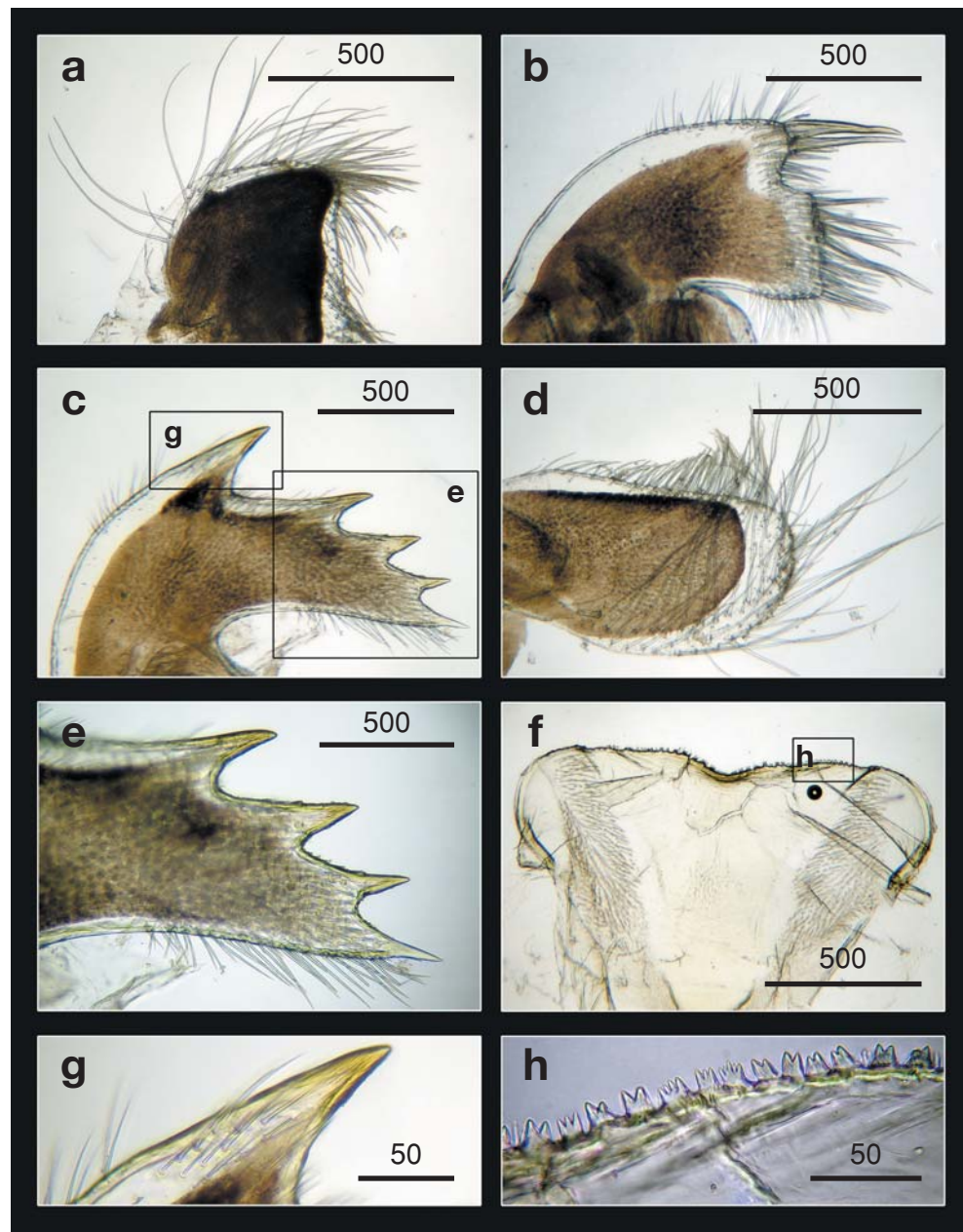


Fig. 157. *Hexelasma velutinum*, CP371, 26 Aug 2006. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Family TETRACLITIDAE Gruvel, 1903 笠藤壺科

Tetraclitines Gruvel, 1903: 160.

Tetraclitines (*Tetraclitinae*) Gruvel, 1905: 284.

Tetraclitinae Nilsson-Cantell, 1921: 357.—Newman et al., 1969: 287.

Tetraclitidae Ross, 1969: 238.—Newman & Ross, 1976: 38.—Ren & Liu, 1979: 338.

Diagnosis.—Parietes with 4 or 6 plates, plates tubiferous (single or multiple), radii well-developed or reduced; basis membranous or calcareous; cirri II and III with bidentate or multicuspidate setae; caudal appendage absent.

Remarks.—Ross & Perreault (1999) revised the *Tetraclitinae* and proposed a new subfamily *Newmanellinae* in the *Tetraclitidae*.

Key to subfamilies of *Tetraclitidae* from Taiwan

1. Radii solid *Tetraclitinae*
Radii tubiferous 2
2. Radii summit oblique, tergum commonly overlying apical portion of scutum *Newmanellinae*
Radii summit horizontal, tergum not overlying scutum *Tetraclitellinae*

Subfamily *Tetraclitinae* Newman & Ross, 1976 笠藤壺亞科

Tetraclitinae Newman & Ross, 1976: 38, 46.—Ren & Liu, 1979: 346.

Diagnosis.—Parietes tubiferous, tubes not completely filled with calcium or chitin, radii well-developed and solid.

Remarks.—*Tetraclitinae* is further divided into *Tetraclita*, *Tesseropora* and *Astroclita*. Only *Tetraclita* was recorded in Taiwan in the present study.

Genus *Tetraclita* Schumacher, 1817 笠藤壺屬

Tetraclita Schumacher, 1817: 91.—Nilsson-Cantell, 1921: 358.—Hiro, 1939d: 270.—Ross, 1968: 8.—Newman & Ross, 1976: 47.—Ren & Liu, 1979: 339.—Chan et al., 2007a: 88.—Chan et al., 2007b: 52.—Liu & Ren, 2007: 346.

Diagnosis.—Parietes conical, with 4 plates, tubiferous, radii solid; mandible with 4 teeth; intertidal species.

Remarks.—In total, 20 species have been recorded, and 4 species are present in Taiwan.

Key to species of *Tetraclita* from Taiwan

1. Parietes green 2
Parietes pink, purplish black or greyish black 3
2. tergum narrow, concaved, apex beaked *Tetraclita squamosa*
tergum broad, apex not beaked *Tetraclita kuroshioensis*
3. Parietes and opercular plates pink, cirrus III with multicuspidate setae *Tetraclita japonica formosana*
Parietes and opercular plates purplish black or greyish black, cirrus III with multicuspidate setae *Tetraclita japonica japonica*

Tetraclita japonica formosana (Hiro, 1939)

美麗笠藤壺

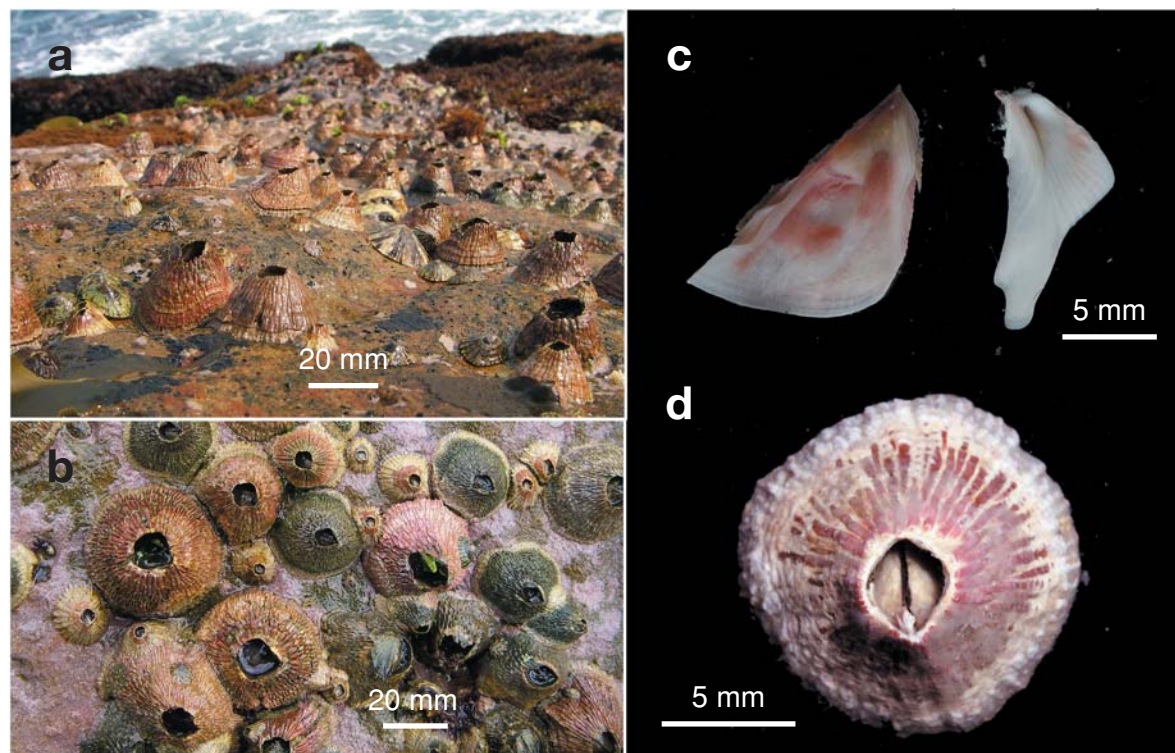


Fig. 158. *Tetraclita japonica formosana*, a, b. In-situ view on shores at Keelung. c. Scutum and tergum, d. Top view of the parietes. Sansiiantai, Taitung County, 17 Aug 1998.

Tetraclita squamosa formosana Hiro, 1939d: 271; fig. 13.—Utinomi, 1949: 23.—1954: 23.

Tetraclita formosana.—Yamaguchi, 1987: 344.

Tetraclita japonica.—Ren & Liu, 1979: 340.—Chan et al., 2007c: 110.—Liu & Ren, 2007: 349, fig. 157.

Tetraclita japonica formosana.—Chan et al., 2007c: 110.

Material examined.—Sansiiantai, Taitung County, 17 Aug 1998: 7 specimens (BD 20.15-28.86 mm) (CEL-BB-120).

Diagnosis.—Parietes and operculum pink, with 4 plates, plates tubiferous, base membranous. Scutum triangular, occludent margin with strong teeth, adductor muscle scar deep; tergum higher than wide, basi scutal angle protruding, spur sharp. Serrulate setae present on cirri I and II; cirrus III with multicuspitate setae. Labrum cutting edge smooth, with sparse small teeth; mandible with 4 teeth, 2nd and 3rd teeth containing double teeth on edge; lower angle of mandible consisting of 10-12 spines; maxillule notched, 2 large setae on upper region and 10-13 setae on lower region; mandibulatory palps and maxilla clothed with fine serrulate setae.

Size.—BD to 40 mm.

Coloration.—Parietes pink.

Habitat.—Mid shore of exposed intertidal rocky shores.

Distribution.—Japan (including Okinawa), Taiwan.

Remarks.—Based on morphological and molecular DNA sequence analyses, Chan et al. (2007c) and Tsang et al. (2007) proved the hitherto *T. japonica* and *T. formosana* were the same species. *T. formosana* is very abundant in Taiwan. *T. japonica* is abundant on the Japanese and Chinese coasts but almost completely absent from Taiwan. Based on differences in geographical distributions, Chan et al. (2007c) re-classified them as 2 subspecies under *T. japonica* which are *T. j. formosana* and *T. j. japonica*. Tsang et al. (2008a) showed that the Japanese and southern Chinese populations of *T. japonica* exhibited distinct genetic divergence at the population level, suggesting limited gene flow between the Japanese and Chinese populations in the Northwest Pacific region.

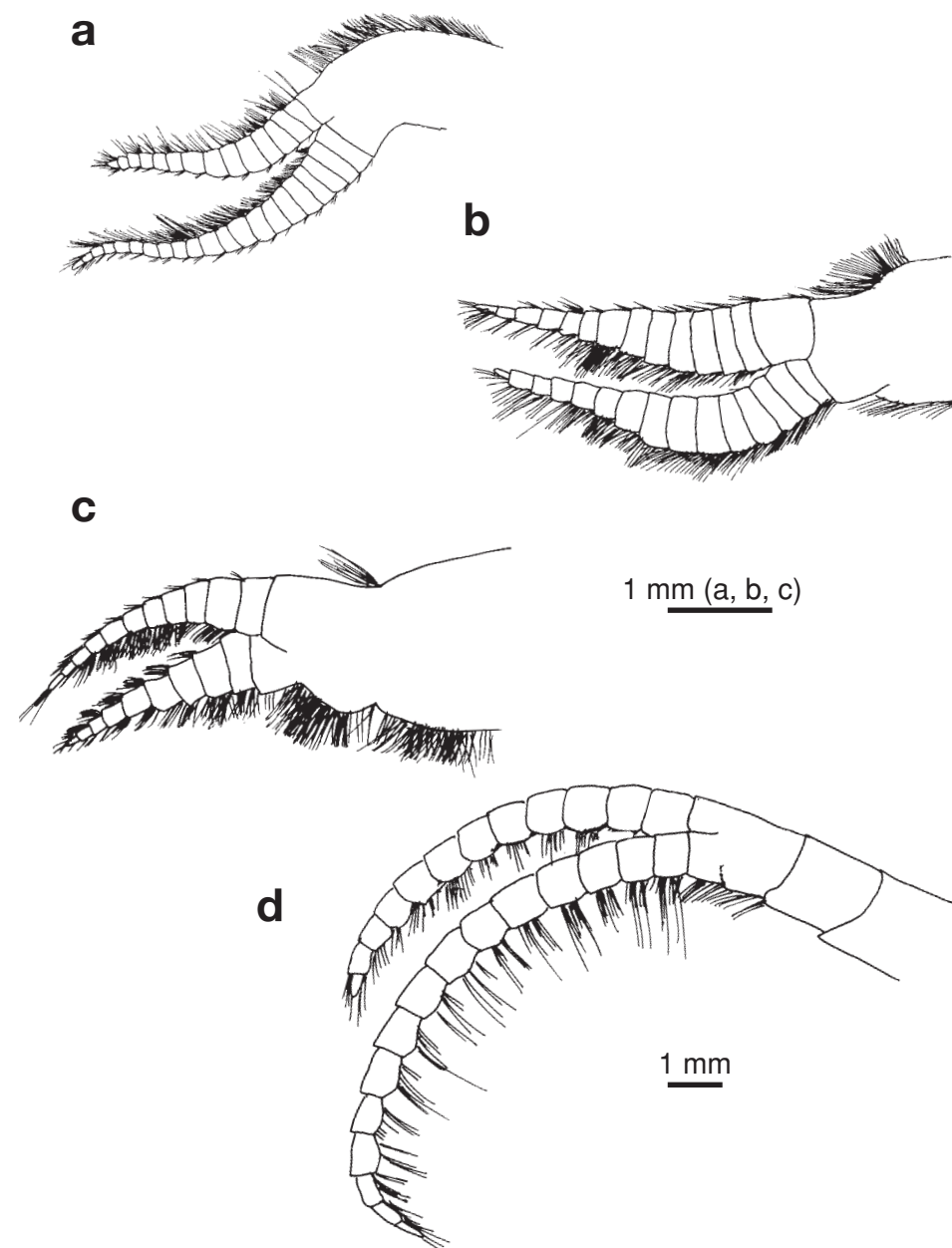


Fig. 159. *Tetraclita japonica formosana*, Sansiiantai, Taitung County, 17 Aug 1998. Line drawings showing a. Cirrus I, b. Cirrus II, c. Cirrus III and d. Cirrus IV.

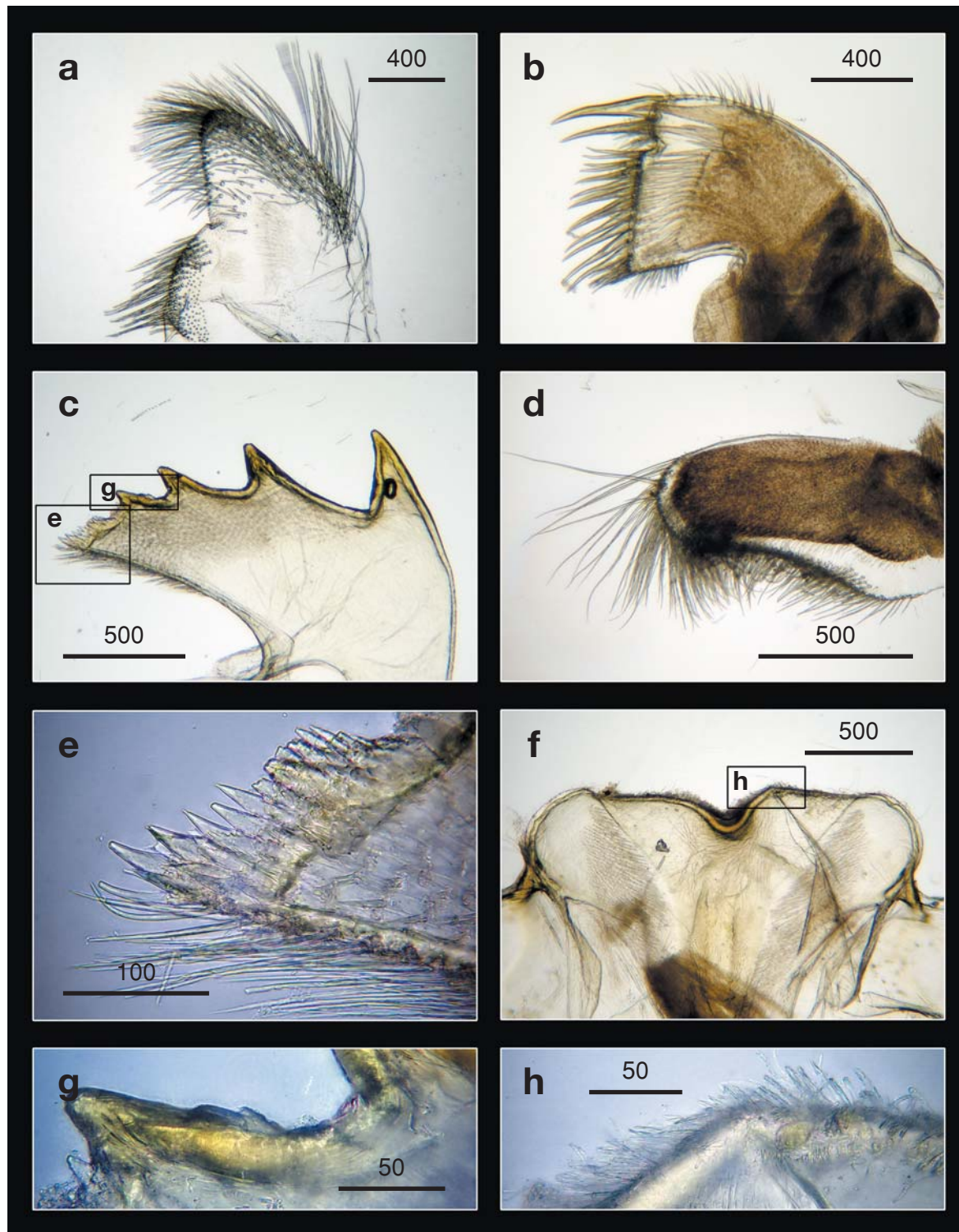


Fig. 160. *Tetracilita japonica formosana*, Sansiiantai, Taitung County, 17 Aug 1998. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Tetracilita japonica japonica (Pilsbry, 1916)
日本笠藤壺

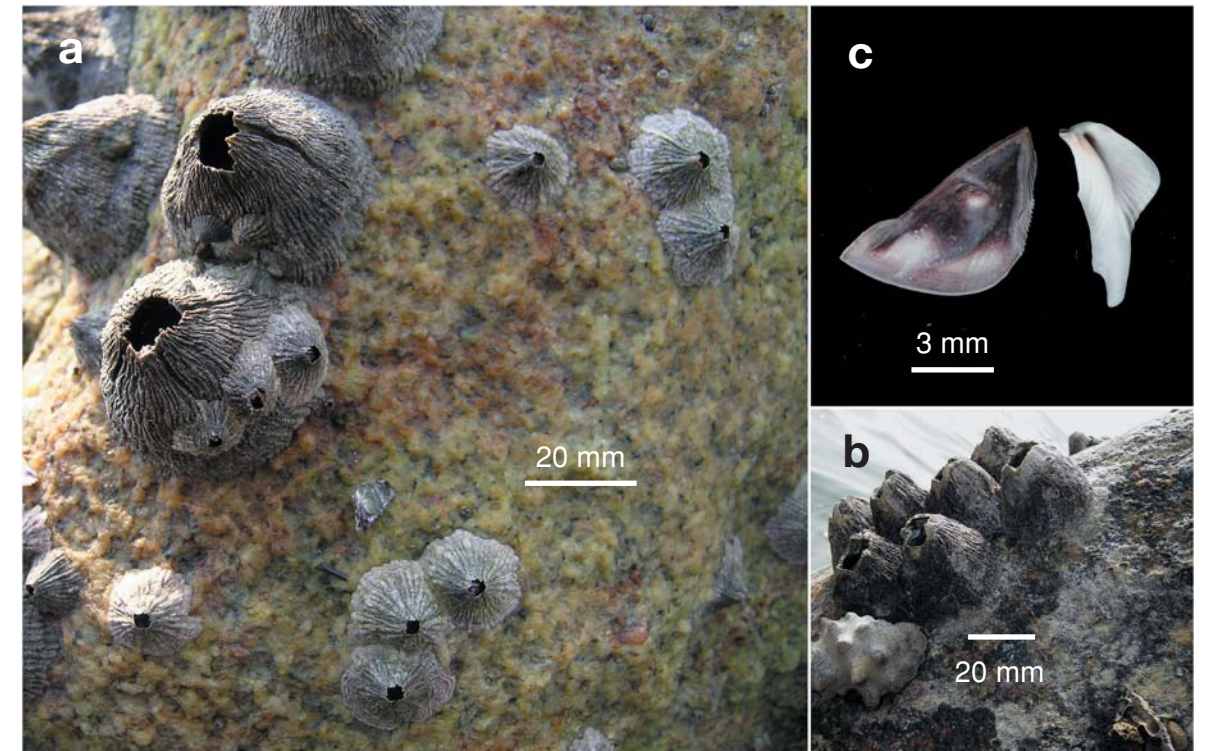


Fig. 161. *Tetracilita japonica japonica*, Kinmen, 22 Aug 2006. a, b. *In-situ* view, c. Scutum and tergum.

Tetracilita porosa var. *nigrescens* Darwin.—Krüger, 1911: 61, fig. 41c.

Tetracilita squamosa japonica.—Pilsbry, 1916: 252, pl. 58, figs.1-3a.—Hiro, 1932b: 551.—1937b: 469.—1939b: 214.—Krüger, 1940: 472.—Kolosváry, 1943: 96.—Utinomi, 1949: 23.—1958: 304.—1970: 347.—Tarasov & Zevina, 1957: 236, fig. 94.—Zevina & Tarasov, 1963: 95.—Newman & Ross, 1976: 48.

Tetracilita porosa japonica.—Nilsson-Cantell, 1927: 786.—1931: 115.—1932: 27, fig. 11.

Tetracilita squamosa japonica.—Utinomi, 1949: 23.—1954: 23.

Tetracilita japonica.—Yamaguchi, 1987: 344.—Ren & Liu, 1979: 340, pl. 1, figs. 12-20.—Chan, 2001: 625, fig. 8.—2003: 525 (larval morphology).

Tetracilita japonica japonica.—Chan et al., 2007c: 110.

Material examined.—Kinmen, 22 Aug 2006: 125 specimens (BD 15.74-35.94 mm) (CEL-BB-118).

Diagnosis.—Parietes and operculum grey, purple, or brown, with 4 plates, plates tubiferous, base membranous. Scutum triangular, occludent margin with strong teeth, adductor muscle scar deep; tergum higher than wide, basi scutal angle protruding, spur sharp. Serrulate setae present on cirri I and II; cirrus III with multicuspidate setae. Labrum cutting edge smooth, with sparse small teeth; mandible with 4 teeth, 2nd and 3rd teeth containing double teeth on edge, lower margin of mandible consisting of 10-12 spines; maxillule notched, 3 large setae on upper region and 10-13 setae on lower region; mandibulatory palps and maxilla clothed with fine serrulate setae.

Size.—BD to 40 mm.

Coloration.—Parietes purple, grey, or brown.

Habitats.—Mid-shore of exposed intertidal rocky shores.

Distribution.—Japan, mainland China, Kinmen and Matsu (Taiwan).

Remarks.—Chan et al. (2001) showed that the distribution of *T. japonica* in Hong Kong waters was related to high-salinity waters. Settlement and recruitment of *T. japonica* in Hong Kong occur in summer, with heat and desiccation stress being major factors controlling the mortality of settlers and recruits (Chan & Williams, 2003, 2004; Chan et al., 2006). (also see remarks in *T. japonica formosana*).

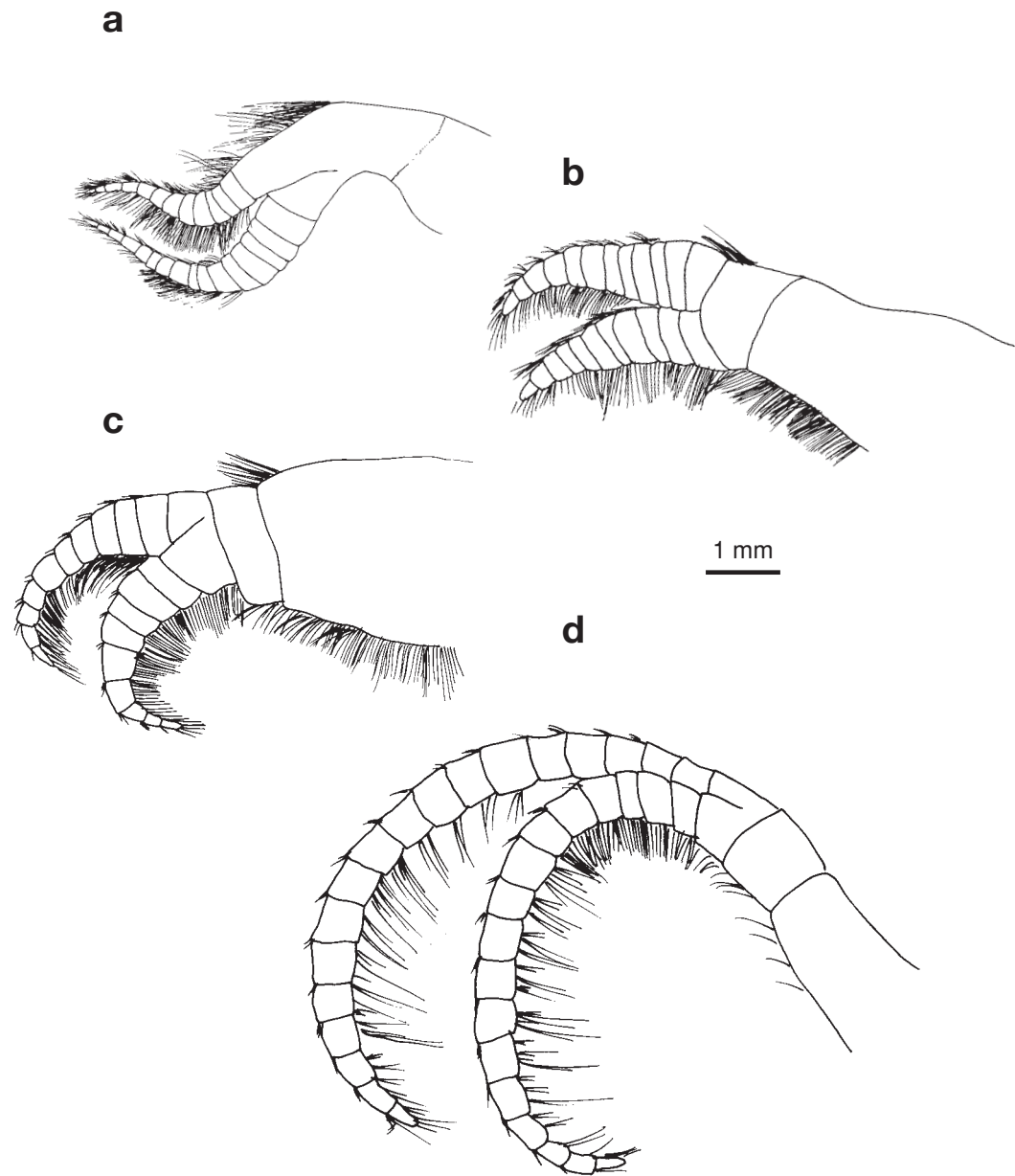


Fig. 162. *Tetracitita japonica japonica*, Kinmen, 22 Aug 2006. Line drawings showing a. Cirrus I, b. Cirrus II, c. Cirrus III and d. Cirrus IV.

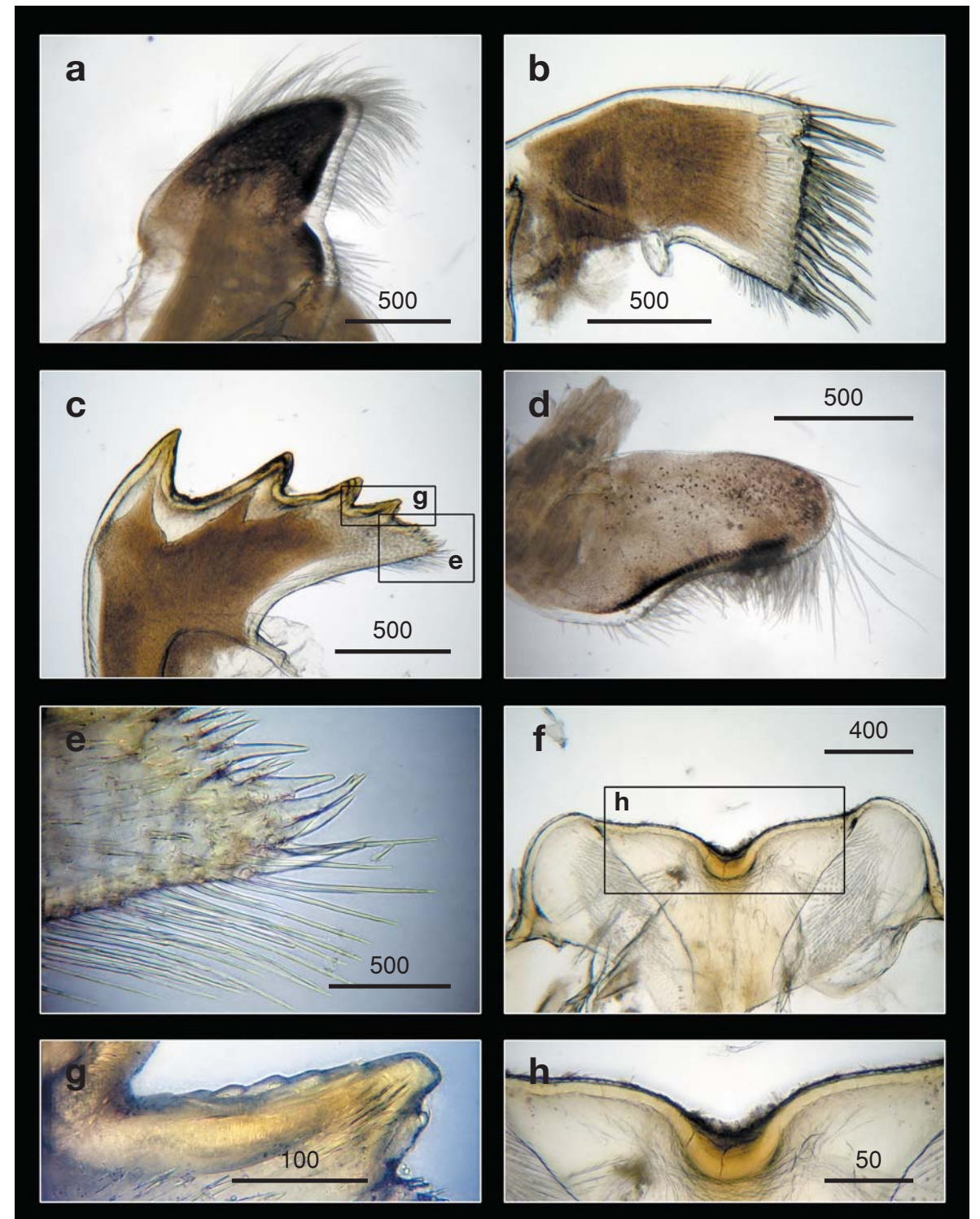


Fig. 163. *Tetracitita japonica japonica*, Kinmen, 22 Aug 2006. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Tetraclita kuroshioensis Chan, Tsang & Chu, 2007
黑潮笠藤壺

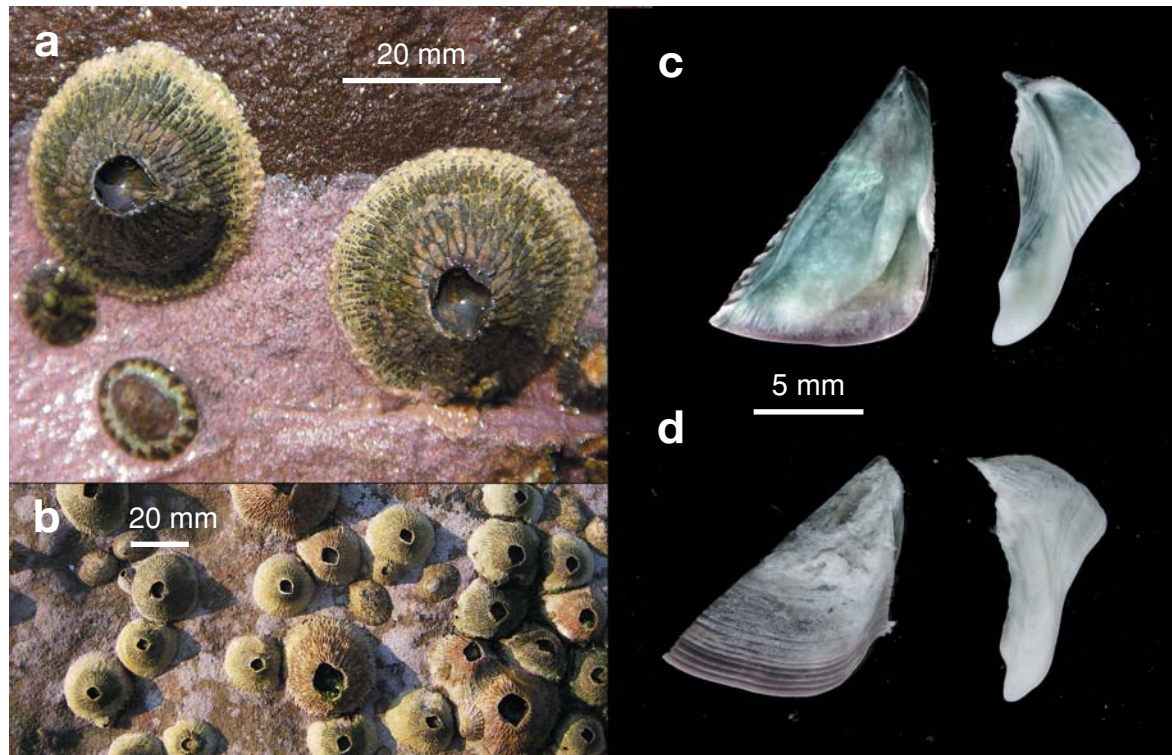


Fig. 164. *Tetraclita kuroshioensis*, Hepingdao, Keelung City, 26 Aug 2008. a., b. *In-situ* view, c. Internal view of the scutum and tergum, d. External view of the scutum and tergum.

Tetraclita squamosa viridis.—Hiro, 1936b: 635.—1937b: 469.—1939d: 271.

Tetraclita squamosa squamosa.—Utinomi, 1968a: 178.

Tetraclita pacifica Chan et al., 2007a: 88.

Tetraclita kuroshioensis Chan et al., 2007b: 56.

Material examined.—Hepingdao, Keelung City, 26 Aug 2008: 76 specimens (BD 7.82-32.71 mm) (CEL-BB-119).

Diagnosis.—Parietes green, with 4 plates, plates tubiferous, base membranous, radii solid. Scutum triangular, occludent margin with fine teeth; tergum broad, higher than wide, apex not produced as a beak, spur sharp, basi scutal angle smaller compared to that of *T. squamosa*.

Size.—BD to 40 mm.

Coloration.—Parietes deep-green to green.

Distribution.—Japan (including Okinawa), Taiwan (Chan et al., 2008b), Palau.

Remarks.—Due to the similar external morphology with *T. squamosa*, the green-shell *Tetraclita* from Japan was considered to be *T. squamosa* in many previous studies. From a molecular DNA sequence analysis, *Tetraclita* from Japan and Taiwan was proven to be a separate species from *T. squamosa*, as *T. kuroshioensis*. The major difference between *T. squamosa* and *T. kuroshioensis* is in the shape of the tergum. The tergum of *T. squamosa* is narrower and with a beak produced at the apex, while that of *T. kuroshioensis* is broader and the apex is more blunt compared to *T. squamosa*.

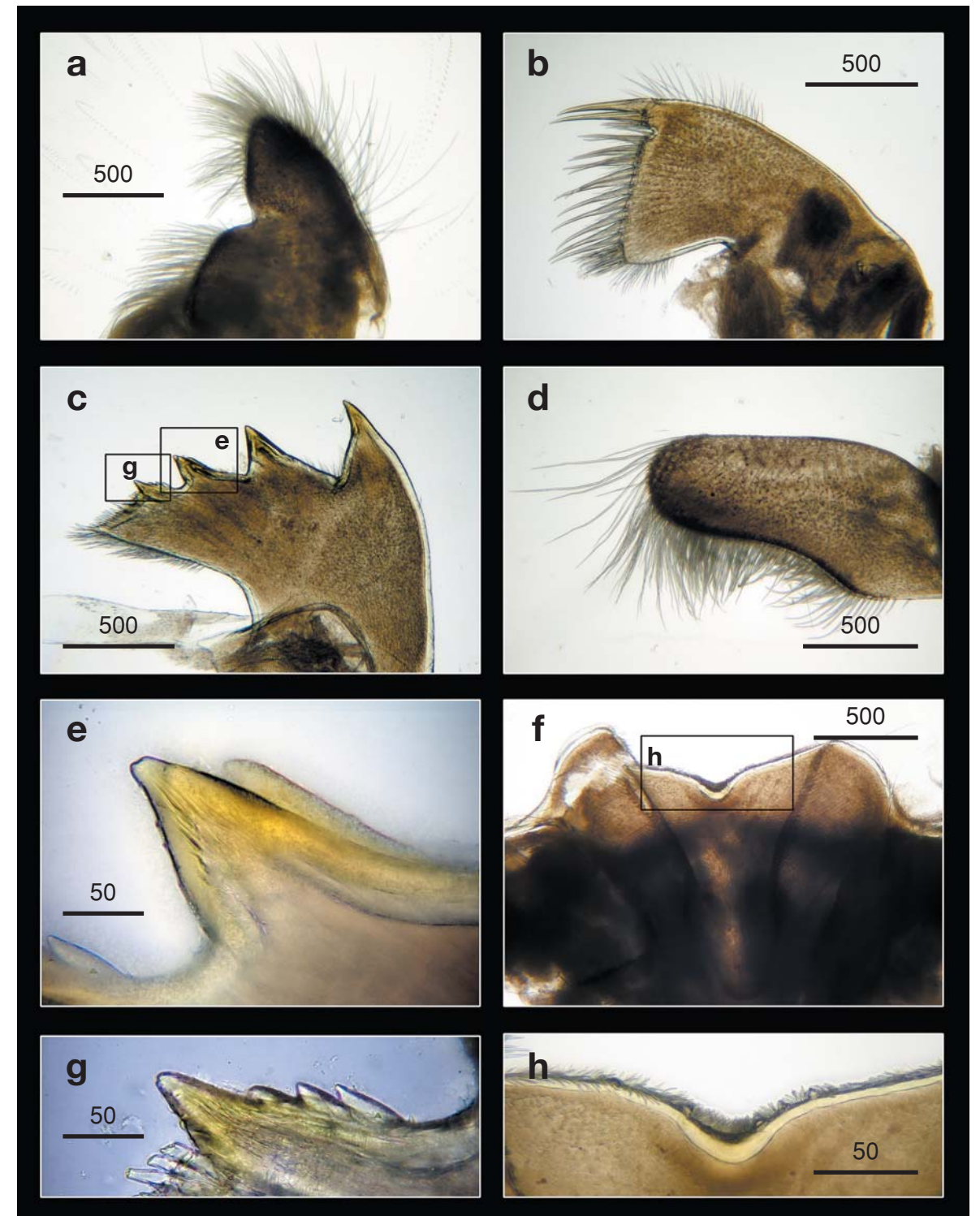


Fig. 165. *Tetraclita kuroshioensis*, Hepingdao, Keelung City, 26 Aug 2008. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

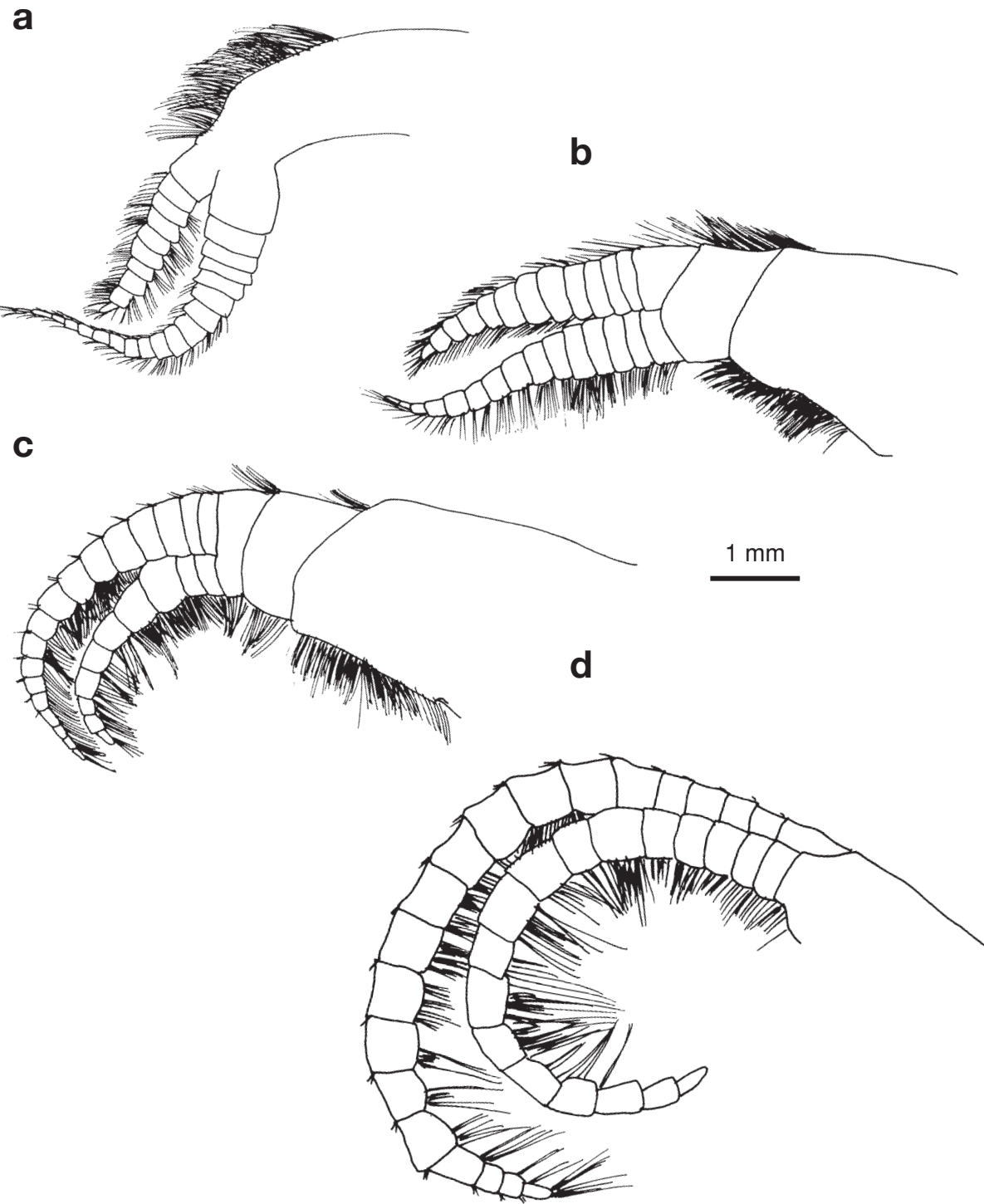


Fig. 166. *Tetracrita kuroshioensis*, Hepingdao, Keelung City, 26 Aug 2008. Line drawings showing a. Cirrus I, b. Cirrus II, c. Cirrus III and d. Cirrus IV.

Tetracrita squamosa (Bruguière, 1789)
鳞笠藤壶

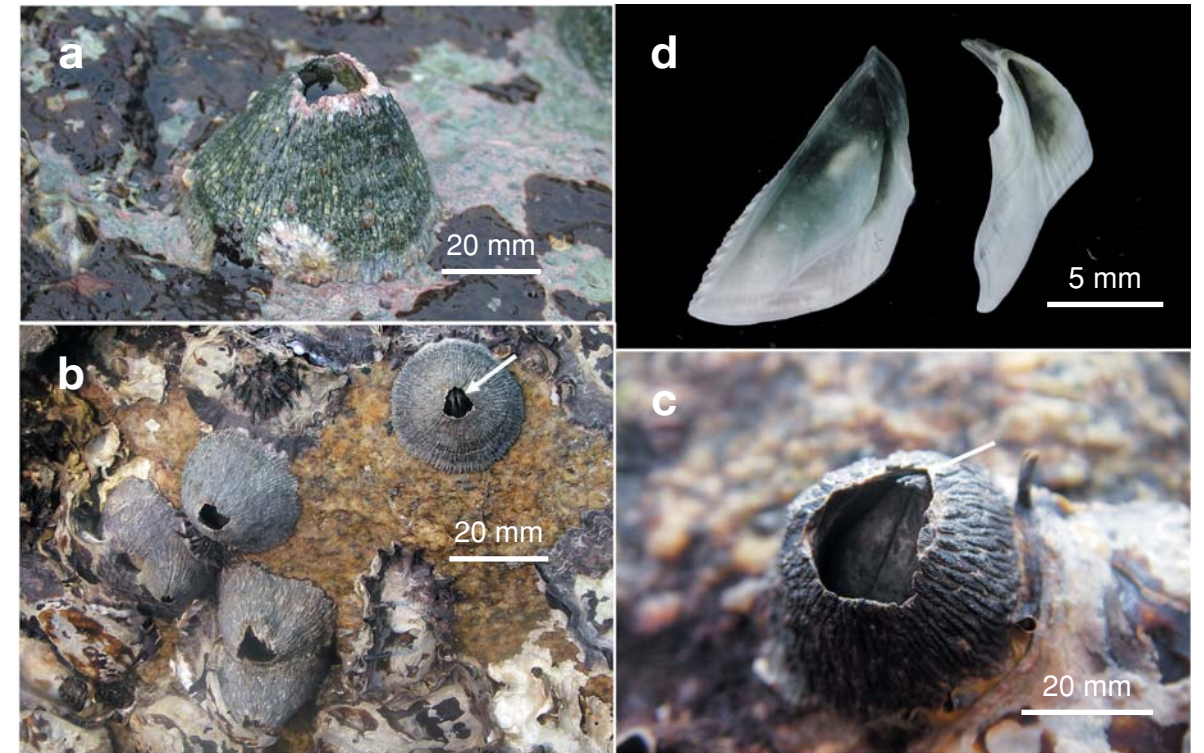


Fig. 167. *Tetracrita squamosa*, Kinmen, 22 Aug 2006. a.-c. In-situ view, note the appearance of the beaked tergum from the operculum (indicated by arrows). d. Scutum and tergum.

Balanus squamosa Bruguière, 1789: 170.

Lepas porosa Gmelin, 1791: 3212.

Tetracrita porosa var. *viridis*.—Darwin, 1854: 329.—Borradaile, 1900: 799.—Gruevel, 1905: 228.—Hoek, 1913: 254.—Krüger, 1911: 61, pl. 4, fig. 41b.

Tetracrita squamosa.—Stebbing, 1910: 570.—Barnard, 1924: 90.—Oliveira, 1941: 6.

Tetracrita squamosa squamosa.—Pilsbry, 1916: 251.—Kolosváry, 1943: 96.—Henry, 1957: 33.—Stubbings, 1967: 294.—Newman & Ross, 1976: 48.—Ren & Liu, 1979: 339, pl. 1, figs. 1-11.

Tetracrita squamosa forma *viridis*.—Broch, 1922: 337.—1931: 116.

Tetracrita porosa perfecta Nilsson-Cantell, 1921: 364.

Tetracrita squamosa.—Yamaguchi, 1987: 344.—Chan, 2001: 625, fig. 8.—Chan et al., 2007a: 82, fig. 4.

Material examined.—Kinmen, 22 Aug 2006: 72 specimens (BD 18.67-40.98 mm) (CEL-BB-117).

Diagnosis.—Parietes green, with 4 plates, plates tubiferous, base membranous, radii solid. Scutum triangular, occludent margin with fine teeth; tergum narrow, higher than wide, apex produced as a beak, spur sharp, basi scutal angle large.

Size.—BD to 45 mm.

Coloration.—Parietes deep-green to green.

Distribution.—South China coast (Chan et al., 2008b), Kinmen and Matsu (Taiwan). Absent from the main island of Taiwan.

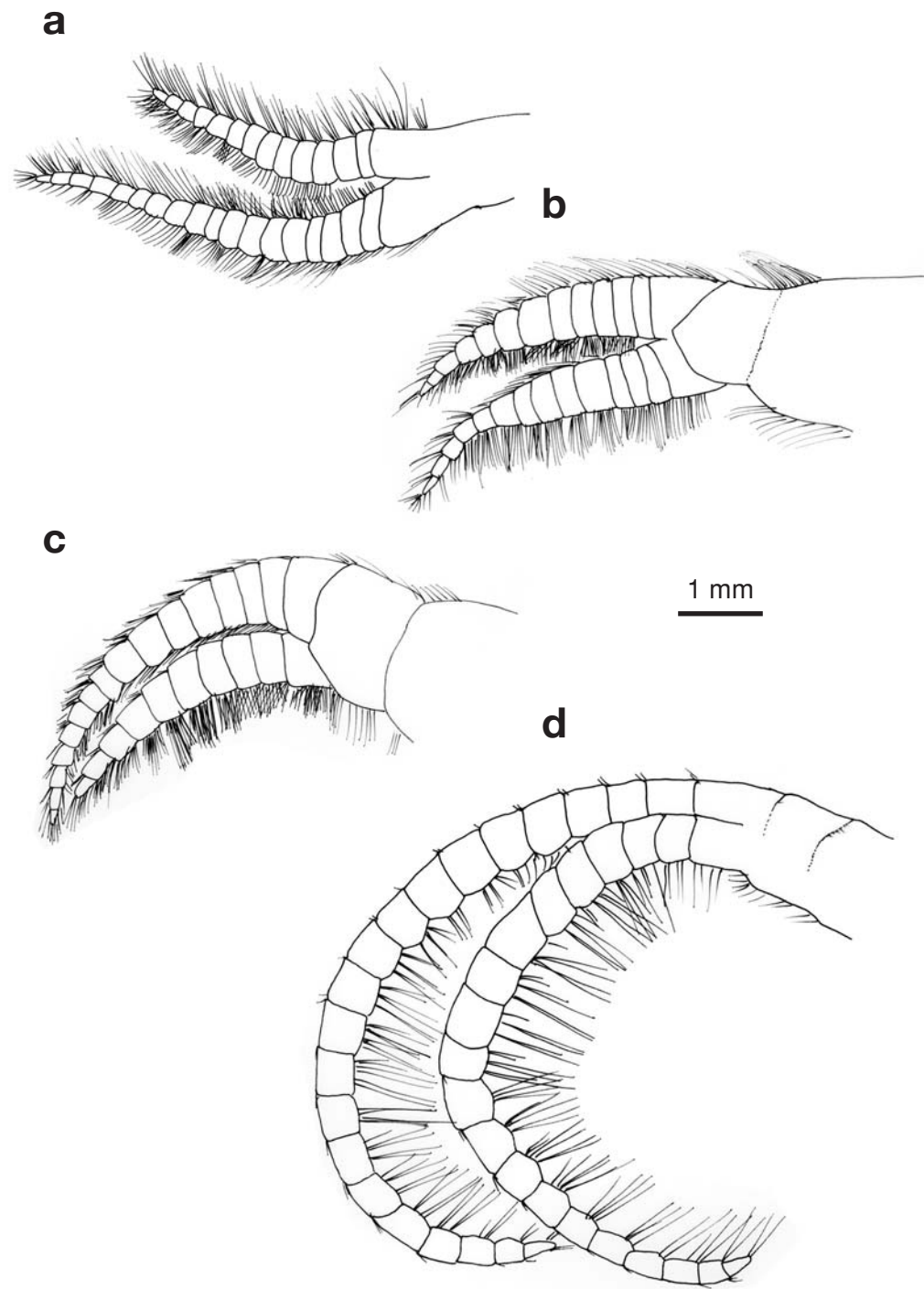


Fig. 168. *Tetracilita squamosa*, Kinmen, 22 Aug 2006. Line drawings showing a. Cirrus I, b. Cirrus II, c. Cirrus III and d. Cirrus IV.

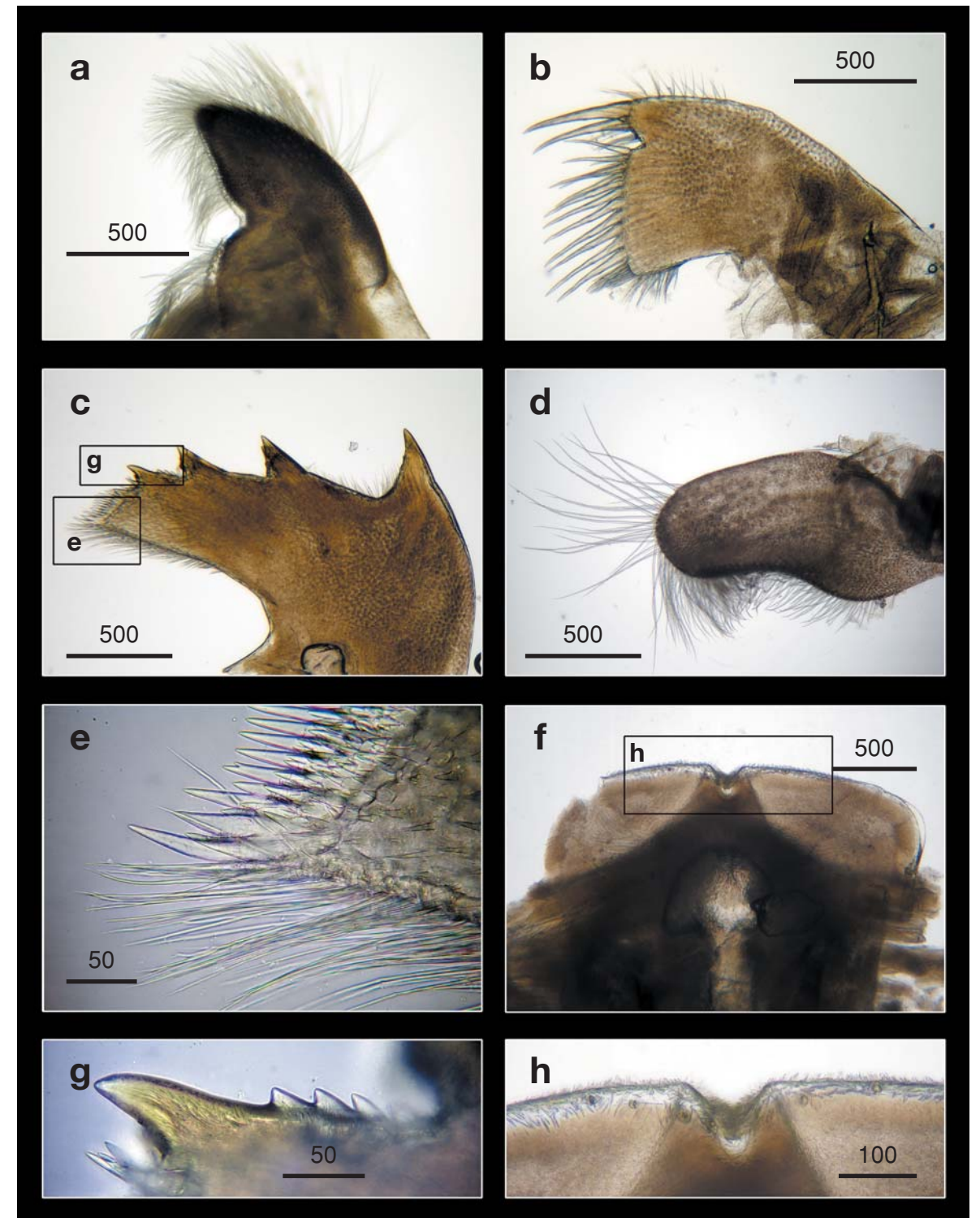


Fig. 169. *Tetracilita squamosa*, Kinmen, 22 Aug 2006. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Subfamily Newmanellinae Ross & Perreault, 1999

紐曼笠藤壺亞科

Nemanellinae Ross & Perreault, 1999: 2. Type genus *Newmanella*, Ross, 1969.

Diagnosis.—Parietes with 4 plates, base calcareous, low conical to cyclindroconic, parietes discrete, wall with 1-3 rows of tubes, junction between scutum and tergum strongly articulated, summit of radii oblique.

Remarks.—*Newmanella* and *Yamaguchiella* are classified in the Newmanellinae. Both genera were recorded in the present study.

Key to genera of Newmanellinae from Taiwan

1. Orifice occluded in part by scutum and apical part of tergum, intromittant organ of penis without basi dorsal point*Newmanella*
2. Orifice occluded wholly by scutum, intromittant organ of penis with basi-dorsal point*Yamaguchiella*

Genus *Newmanella* Ross, 1969

紐曼笠藤壺屬

Newmanella Ross, 1969: 242.—Newman & Ross, 1976: 47.—Ross & Perreault, 1999: 2. Type species *Balanus radiata* Bruguière, 1789.

Diagnosis.—Parietes with 4 plates, base calcareous, low conical parietes discrete, wall with 1-3 rows of tubes, junction between scutum and tergum strongly articulated, summit of radii oblique. Orifice occluded in part by scutum and apical part of tergum, intromittant organ of penis without basi dorsal point.

Remarks.—3 species have been recorded so far, and 1 species was newly recorded in Taiwan.

***Newmanella radiata* (Bruguière, 1789)**

輻紋紐曼笠藤壺

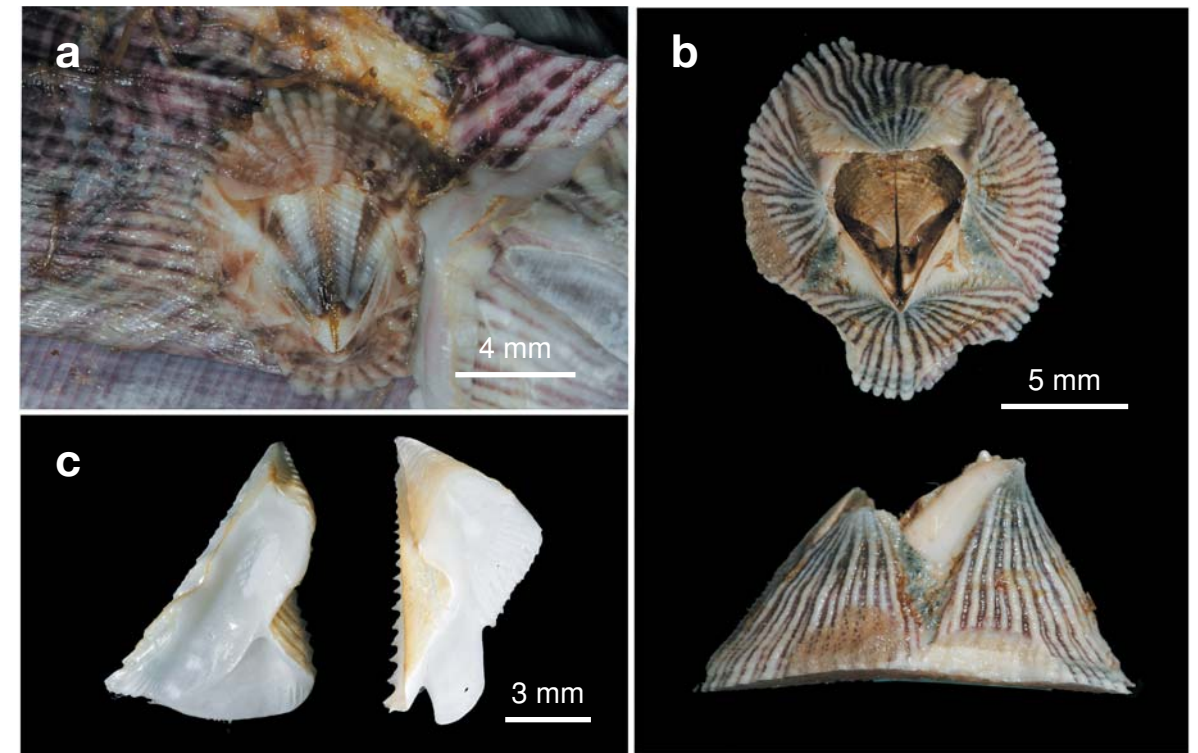


Fig. 170. *Newmanella radiata*, Chenggong, Taitung County, 12 Mar 2009. a. Complete parietes on the shell of *Megabalanus*. b. Top view and side view of the parietes. c. Scutum and tergum.

Balanus radiata Bruguière, 1789: 168.

Tetraclita radiata.—Darwin, 1854: 343.—Pilsbry, 1916: 259.

Tetraclitella radiata.—Ross, 1968: 18.

Newmanella radiata.—Ross, 1969: 242.

Material examined.—Chenggong, Taitung County, 12 Mar 2009: 6 specimens (BD 18.19-21.46 mm) (CEL-BB-20).—Shihtiping, Hualien County, 23 Mar 2007: 1 specimen (BD 14.4 mm) (CEL-BB-42).

Diagnosis.—Parietes green, with 4 plates with blue radiating lines, parietes discrete, base calcareous, low conical to cyclindroconic, wall with 1-3 rows of tubes. Junction between scutum and tergum strongly articulated, summit of radii oblique. Orifice occluded in part by scutum and apical part of tergum. Intromittant organ of penis without basi dorsal point. Maxilla bilobed, with dense setae on 2 lobe regions; maxillule notched, 2 cuspidate setae above notch and numerous setae below notch; mandible with 4 teeth, 3rd tooth bidentated, lower margin with 1 small sharp tooth; mandibulatory palp rectangular with dense setae on superior margin; labrum notched with 3 large teeth on each side of cutting edge.

Size.—BD to 30 mm.

Coloration.—Green with blue radiating lines.

Habitat.—On floating pontoons and rocky shores.

Distribution.—Pacific Ocean.

Remarks.—New record for Taiwan.

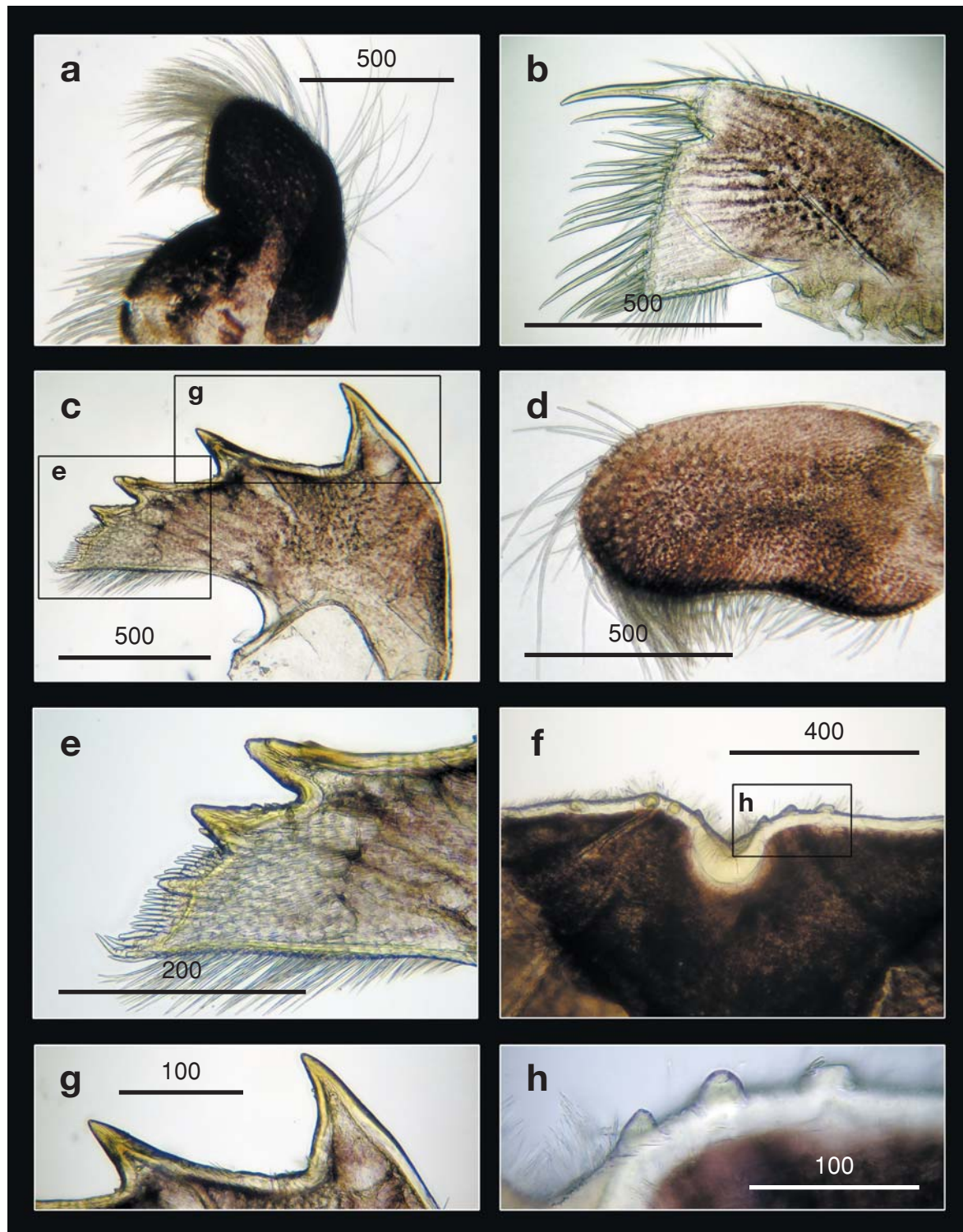


Fig. 171. *Newmanella radiata*, Chenggong, Taitung County, 12 Mar 2009. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

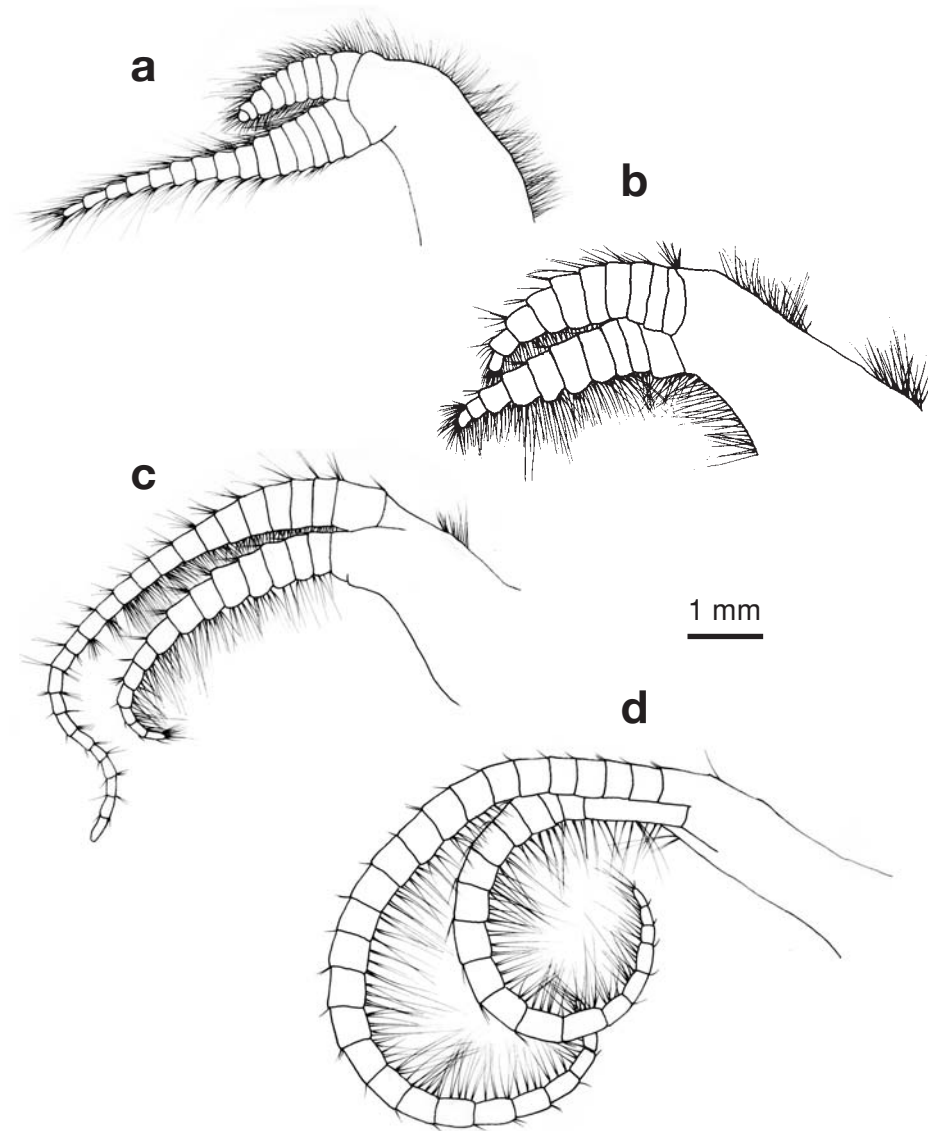


Fig. 172. *Newmanella radiata*, Chenggong, Taitung County, 12 Mar 2009. Line drawings showing a. Cirrus I, b. Cirrus II, c. Cirrus III and d. Cirrus IV.

Genus *Yamaguchiella* Ross & Perreault, 1999
山口笠藤壺屬

Yamaguchiella Ross & Perreault, 1999: 5.

Diagnosis.—Shell conical and tall, parietal tubes in 2 or more rows, small and regular in shape. Type species *Lepas coerulescens* Spengler, 1790.

Remarks.—*Yamaguchiella* is further divided into 2 subgenera, *Yamaguchiella* and *Rosella*. In the present study, only *Yamaguchiella (Yamaguchiella) coerulescens* was collected, which is a new record for Taiwan.

Yamaguchiella (Yamaguchiella) coerulescens (Spengler, 1790)
藍山口笠藤壺

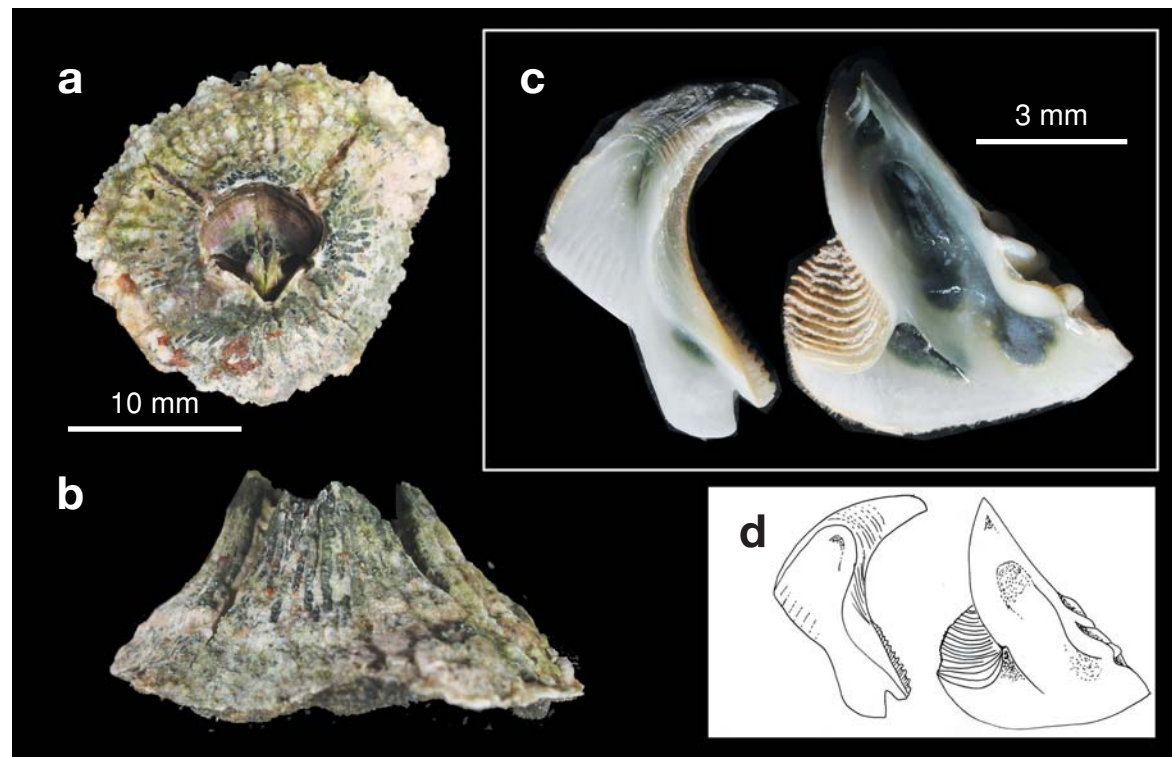


Fig. 173. *Yamaguchiella (Yamaguchiella) coerulescens*, Shihtiping, Hualien County, 31 Mar 2009. a. Top view and b. Side view of the parietes. c. Scutum and tergum, d. Line drawing of scutum and tergum.

Lepas coerulescens Spengler, 1790: 191.

Tetraclita coerulescens.—Darwin, 1854: 342, pl. 11, figs. 4a-d.—Hoek, 1883: 161, pl. 13, fig. 34.—1913: 257.—Weltner, 1897: 257.—Gruvel, 1905: 291, fig. 315.—Pilsbry, 1916: 259.—Hiro, 1936b: 635.—Nilsson-Cantell, 1938: 77.—Rosell, 1972: 211, pl. 30, figs. 1-9.—Newman & Ross, 1976: 47.—Ren & Liu, 1979: 341, fig. 2.

Yamaguchiella (Yamaguchiella) coerulescens.—Ross & Perreault, 1999: 5.

Material examined.—Shihtiping, Hualien County, 31 Mar 2009: 2 specimens (BD 21.35-28.61 mm) (CEL-BB-109).

Diagnosis.—Parietes green, with 4 plates with blue radiating lines, parietes discrete, radii wide, base calcareous, low conical to cylindroconic orifice wholly occluded in scutum, junction between scutum and tergum strongly articulated, summit of radii oblique. Intromittant organ of penis with basi dorsal point. Maxilla bilobed, with dense setae on 2 lobe regions; maxillule notched, 2 cuspidate setae above notch and numerous setae below notch; mandible with 4 teeth, 3rd tooth tridentated, lower margin with 1 small sharp tooth; mandibulatory palp rectangular with dense setae on superior margin; labrum notched, with 3 large teeth on each side of cutting edge.

Size.—BD to 30 mm.

Coloration.—Green.

Habitat.—Low shores of exposed rocky shores.

Distribution.—Pacific Ocean.

Remarks.—New record for Taiwan.

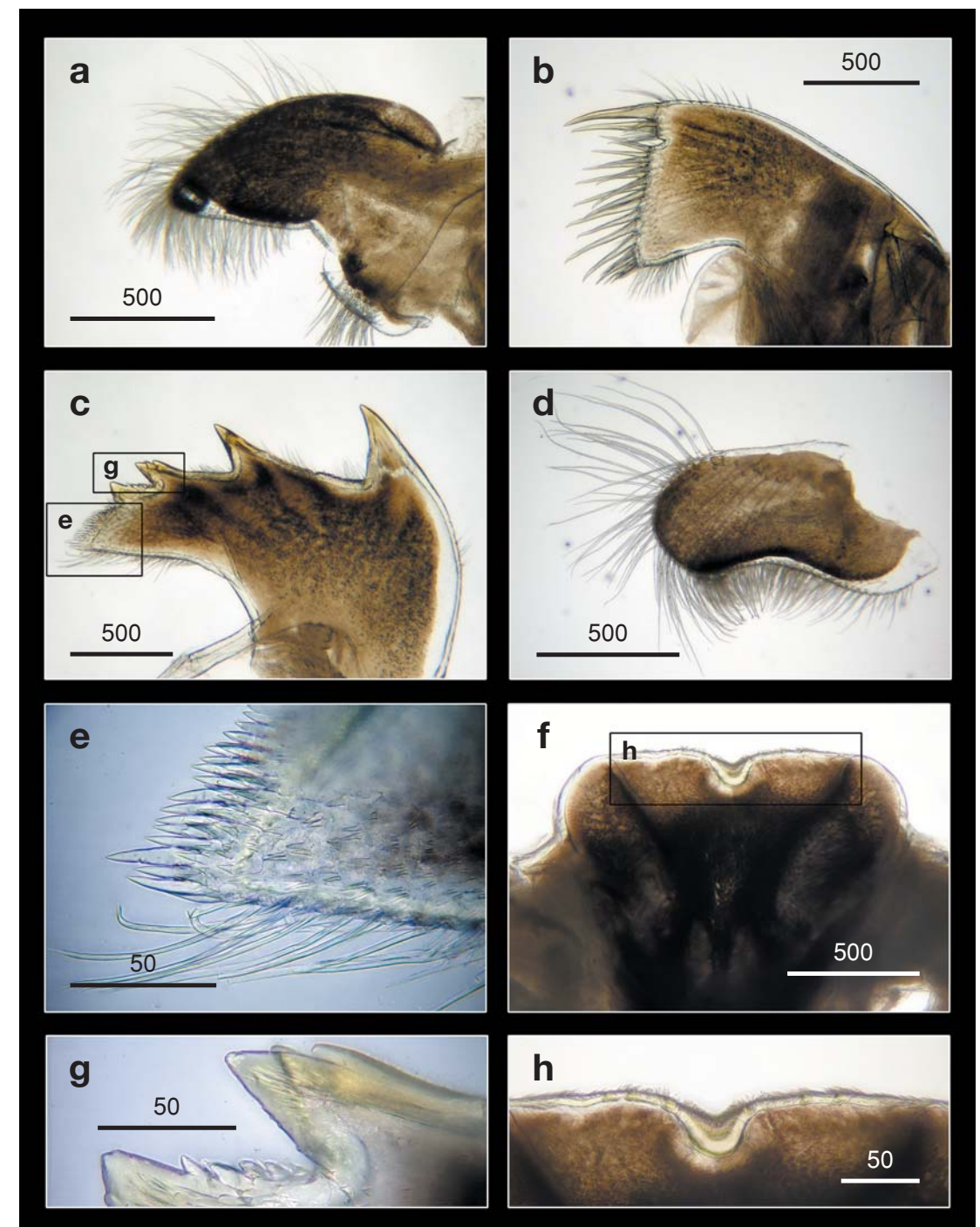


Fig. 174. *Yamaguchiella coerulescens*, Shihtiping, Hualien County, 31 Mar 2009. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in µm.

Subfamily Tetracitellinae Newman & Ross, 1976

小笠藤壺亞科

Tetracitellinae Newman & Ross, 1976: 38, 46.—Ren & Liu, 1979: 346. Type genus *Tetracitella*.

Diagnosis.—Parietes with 4 plates, plates tubiferous, radii tubiferous, summit of radii horizontal.

Remarks.—At present, 1 genus *Tetracitella* is classified in the Tetracitellinae. Within *Tetracitella*, 2 subgenera are assigned, *Tetracitella* and *Eotetracitella* (see Ross & Perreault, 1999). In Taiwan, only species in the subgenus *Tetracitella* have been recorded.

Genus *Tetracitella* Hiro, 1939

小笠藤壺屬

Tetracitella Hiro, 1939d: 273.—Ross, 1961: 209.—1971b: 215.—Newman & Ross, 1976: 46.—Ren & Liu, 1979: 346.—Liu & Ren, 2007: 329. Type species *Lepas purpurascens* Wood.

Diagnosis.—Parietes white or dull-purple, parietes not strongly articulated, plates tubiferous, radii tubiferous, summit of radii horizontal.

Remarks.—5 species are classified in this genus, and 4 species have been recorded in Taiwan.

Key to species of *Tetracitella* from Taiwan

- 1. Scutum dimension wider than high2
- Scutum dimension subequal3
- 2. Tergal spur well separated from scutal margin*Tetracitella divisa*
- Tergal spur not clearly separated from scutal margin*Tetracitella multicostata*
- 3. Radii elevated above the surface of the parietes; parietes with longitudinal ribs, not pierced with hollows*Tetracitella karandei*
- Radii not elevated above the surface of the parietes; parietes smooth, pierced with hollows*Tetracitella chinensis*

***Tetracitella chinensis* (Nilsson-Cantell, 1921)**

中華小笠藤壺

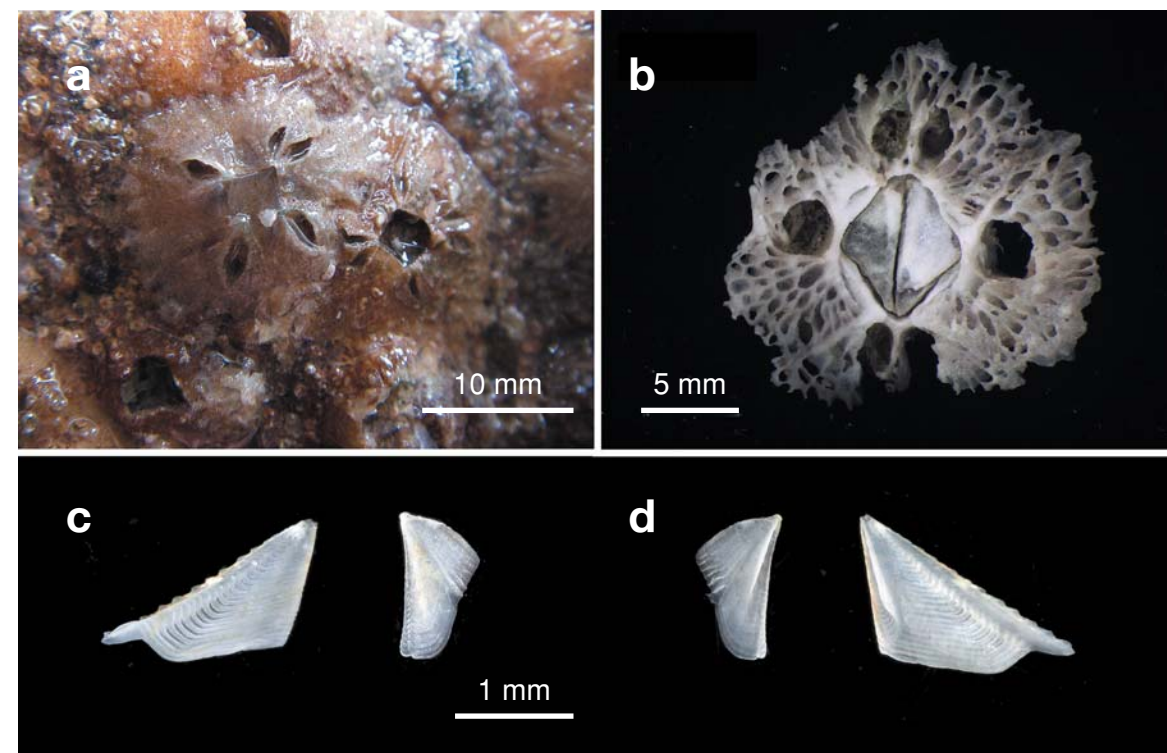


Fig. 175. *Tetracitella chinensis*, Jialeshuei, Pingtung County, 13 Jul 2007. a. *In-situ* view of parietes. b. Complete parietes. c. External and d. Internal view of scutum and tergum.

Tetracitella purpurascens chinensis Nilsson-Cantell, 1921: 359, fig. 81, pl. 3, fig. 12.—Hiro, 1939d: 273, fig. 14.
Tetracitella purpurascens nipponensis Hiro, 1931: 155, fig. 10, pl. 14, figs. 3-3d.—1937b: 469.
Tetracitella (Tetracitella) chinensis.—Utinomi, 1949: 36.—1954: 23.—1962: 231.
Tetracitella chinensis.—Utinomi, 1970: 347.—Ross, 1971b: 217.—Rosell, 1975: 96.—Newman & Ross, 1976: 46.—Ren & Liu, 1979: 347, pl. 3, figs. 5-9.

Material examined.—Jialeshuei, Pingtung County, 13 Jul 2007: 51 specimens (6.10-11.67mm) (CEL-BB-6B).

Diagnosis.—Shell flattened, with 4 plates, carina and rostrum with 2 holes, laterals with a single hole, base membranous, plates tubiferous. Scutum triangular, notch at basal margin; tergum elongated, higher than wide, scutal margin straight. Maxilla bilobed; mandible with 4 teeth, 2nd and 3rd teeth bidentated; maxillule notched; mandibulatory palp rectangular with setae on superior margin; labrum notched.

Size.—BD to 15 mm.

Coloration.—Grey to purplish grey.

Habitat.—On low shore of intertidal rocks and shaded rocks.

Distribution.—Indo-Pacific waters.

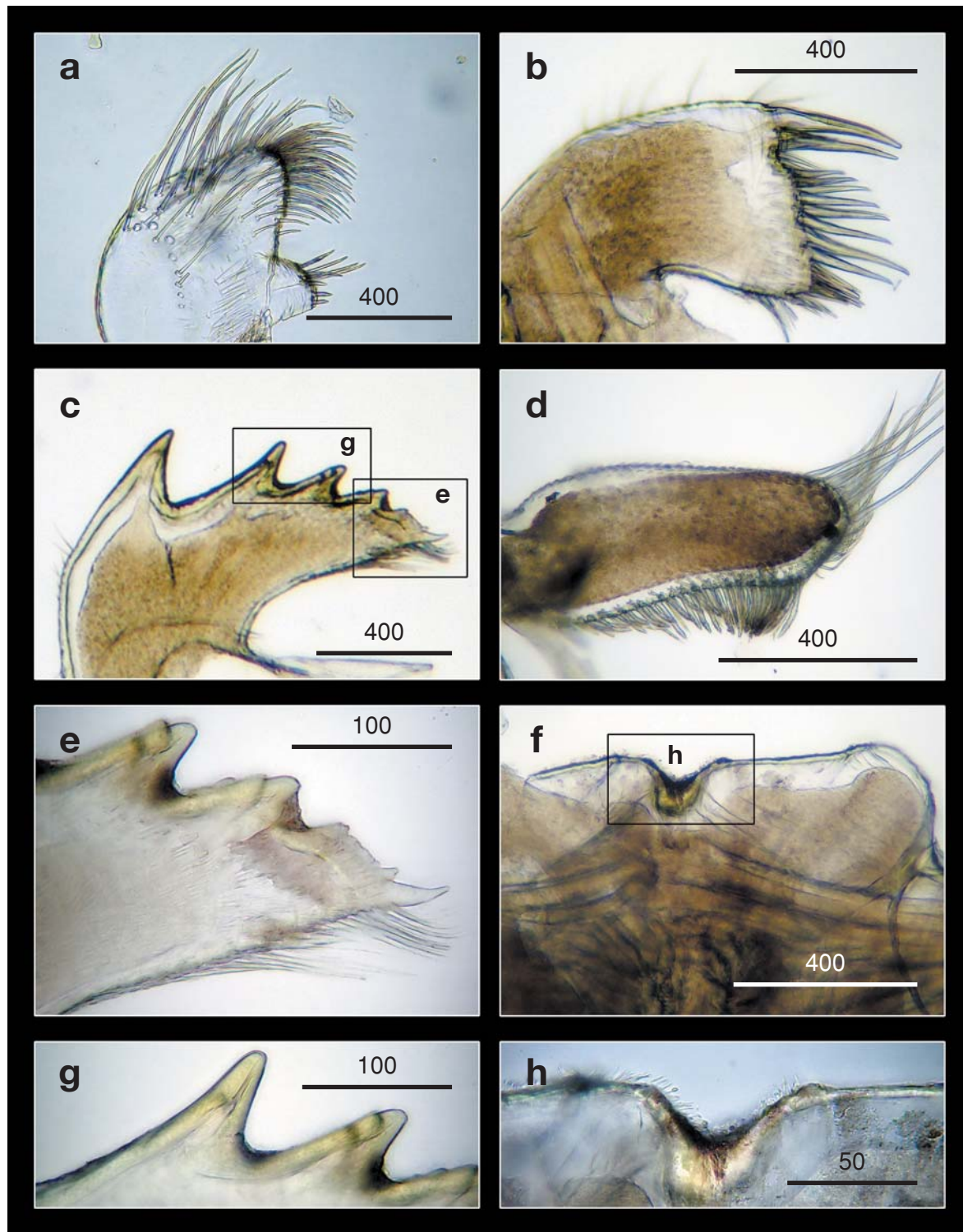


Fig. 176. *Tetracitella chinensis*, Jialeshuei, Pingtung County, 13 Jul 2007. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum. Scale bars in μm .

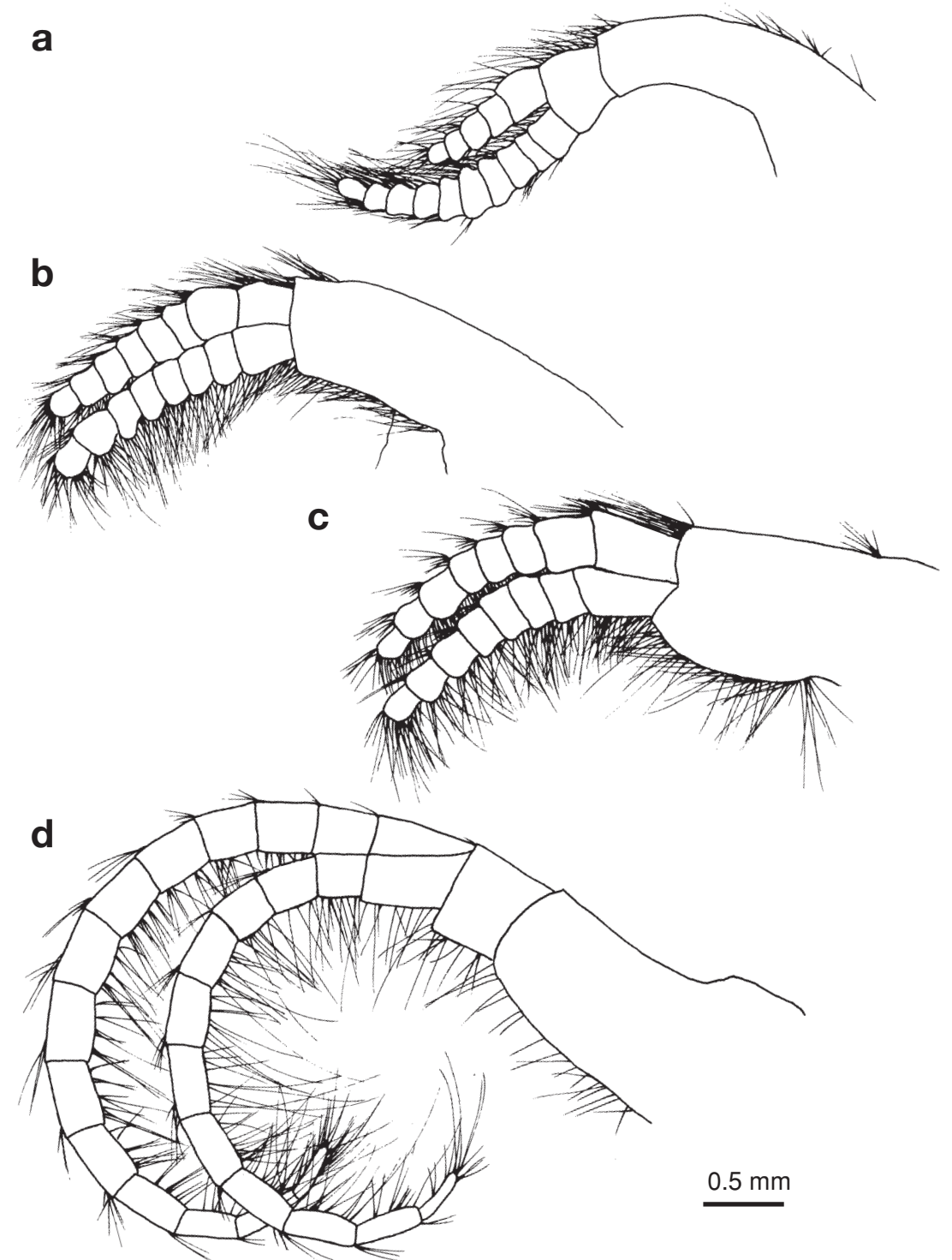


Fig. 177. *Tetracitella chinensis*, Jialeshuei, Pingtung County, 13 Jul 2007. Line drawing showing a. Cirrus I, b. Cirrus II, c. Cirrus III and d. Cirrus IV.

Tetraclitella divisa (Nilsson-Cantell, 1921)
間隔小笠藤壺



Fig. 178. *Tetraclitella divisa*, Jialeshuei, Pingtung County, 13 Jul 2007. Complete parietes.

Tetraclita divisa Nilsson-Cantell, 1921: 362, fig. 83, pl. 3, fig. 11.—Hiro, 1939d: 275, fig. 15.—Utinomi, 1949: 25.—Zevina & Tarasov, 1963: 96, fig. 13.—Stubbings, 1967: 291, fig. 21.—Ross, 1968: 13.

Tetraclitella divisa.—Ross, 1971b: 217.—1972: 307.—Ren & Liu, 1979: 347, pl. 3, figs. 10-15.

Material examined.—Jialeshuei, Pingtung County, 13 Jul 2007: 98 specimens (BD 12.19-15.08 mm) (CEL-BB-6A).

Diagnosis.—Shell flattened, radii wide, surface smooth but with faint ribs. Scutum triangular, tergal margin straight; tergum higher than wide, scutal margin straight, spur short. Maxilla globular; maxillule not notched; mandible with 4 teeth, 2nd and 3rd teeth bidentated; mandibulatory palp elongated, with setae on superior margin; labrum slightly bullate, cutting edge smooth.

Size.—BD to 20 mm.

Coloration.—Grey to dull-yellow.

Habitat.—On shaded intertidal rocks.

Distribution.—South China Sea, Taiwan, Japan.

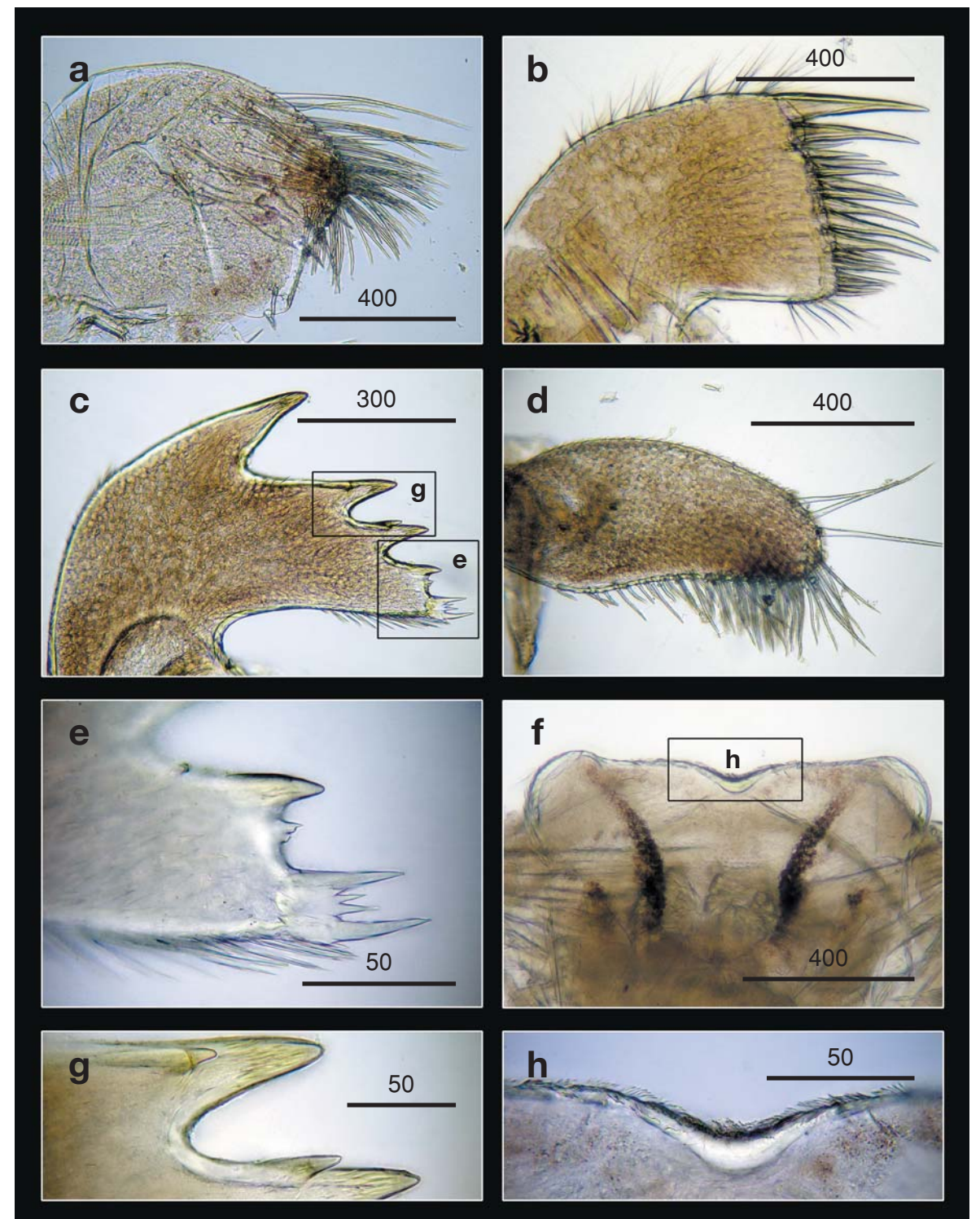


Fig. 179. *Tetraclitella divisa*, Jialeshuei, Pingtung County, 13 Jul 2007. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum. Scale bars in μm .

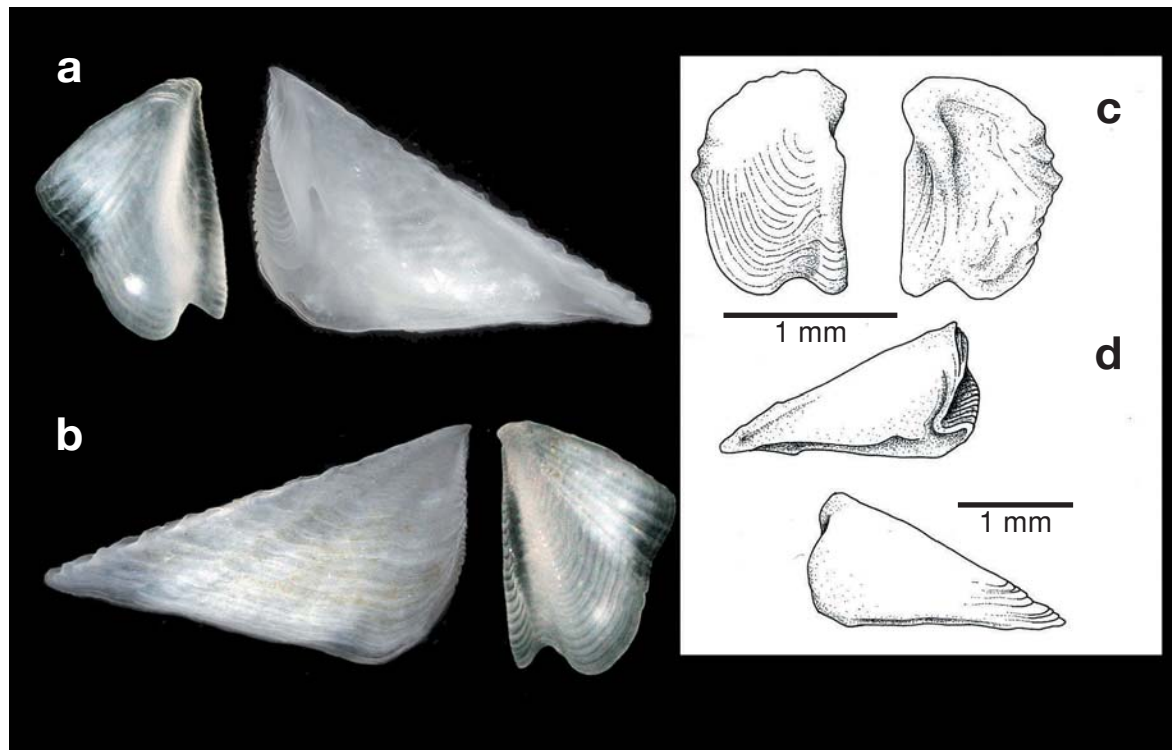


Fig. 180. *Tetracitella divisa*, Jialeshuei, Pingtung County, 13 Jul 2007. Scutum and tergum. a. Internal and b. External view, c. Line drawing of tergum d. Line drawing of scutum.

Tetracitella multicostata (Nilsson-Cantell, 1930)
多肋小笠藤壺

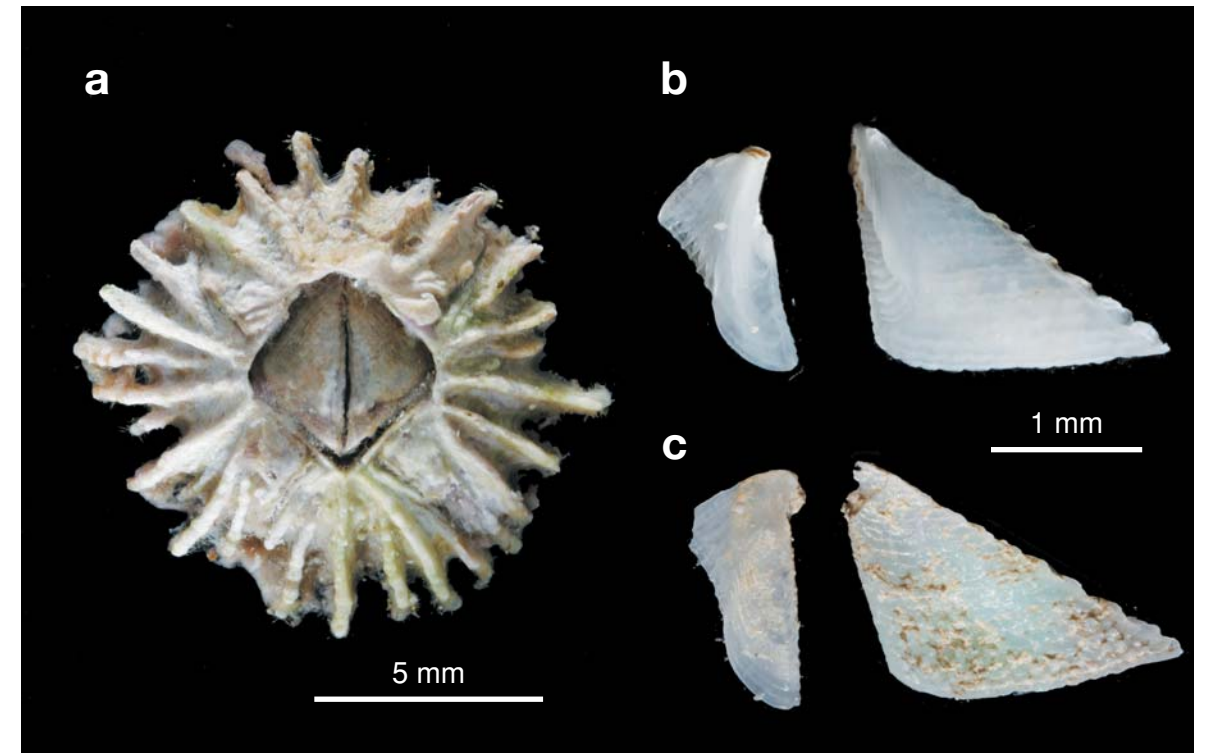


Fig. 181. *Tetracitella multicostata*, Jialeshuei, Pingtung County, 13 Jul 2007. a. Complete parietes. b. Internal and c. External view of scutum and tergum.

Tetracitella purpurascens var. *multicostata* Nilsson-Cantell, 1930b: 2.

Tetracitella multicostata.—Utinomi, 1962: 231, figs. 9-10.

Tetracitella chinensis.—Zevina & Tarasov, 1963: 97, fig. 14.

Tetracitella multicostata.—Ross, 1971b: 217.—Rosell, 1975: 96.—Newman & Ross, 1976: 47.—Ren & Liu, 1979: 347, pl. 4, figs. 3-9.—Liu & Ren, 2007: 335, fig. 150.

Material examined.—Jialeshuei, Pingtung County, 13 Jul 2007: 9 specimens (BD 7.16-11.28 mm) (CEL-BB-6C).

Diagnosis.—Parietes with 4 plates, with multiple longitudinal ribs on surface, ribs supported by numerous accessory ribs. Scutum triangular, basal margin entire, tergal margin straight, tergum higher than wide, spur not protruding. Maxilla bilobed; maxillule notched; mandible 4 teeth, 1st-3rd teeth bidentated; labrum slightly notched, with very fine teeth on cutting edge.

Size.—BD to 15 mm.

Coloration.—Grey to yellow.

Habitat.—On shaded intertidal rocks.

Distribution.—Indo-Pacific region.

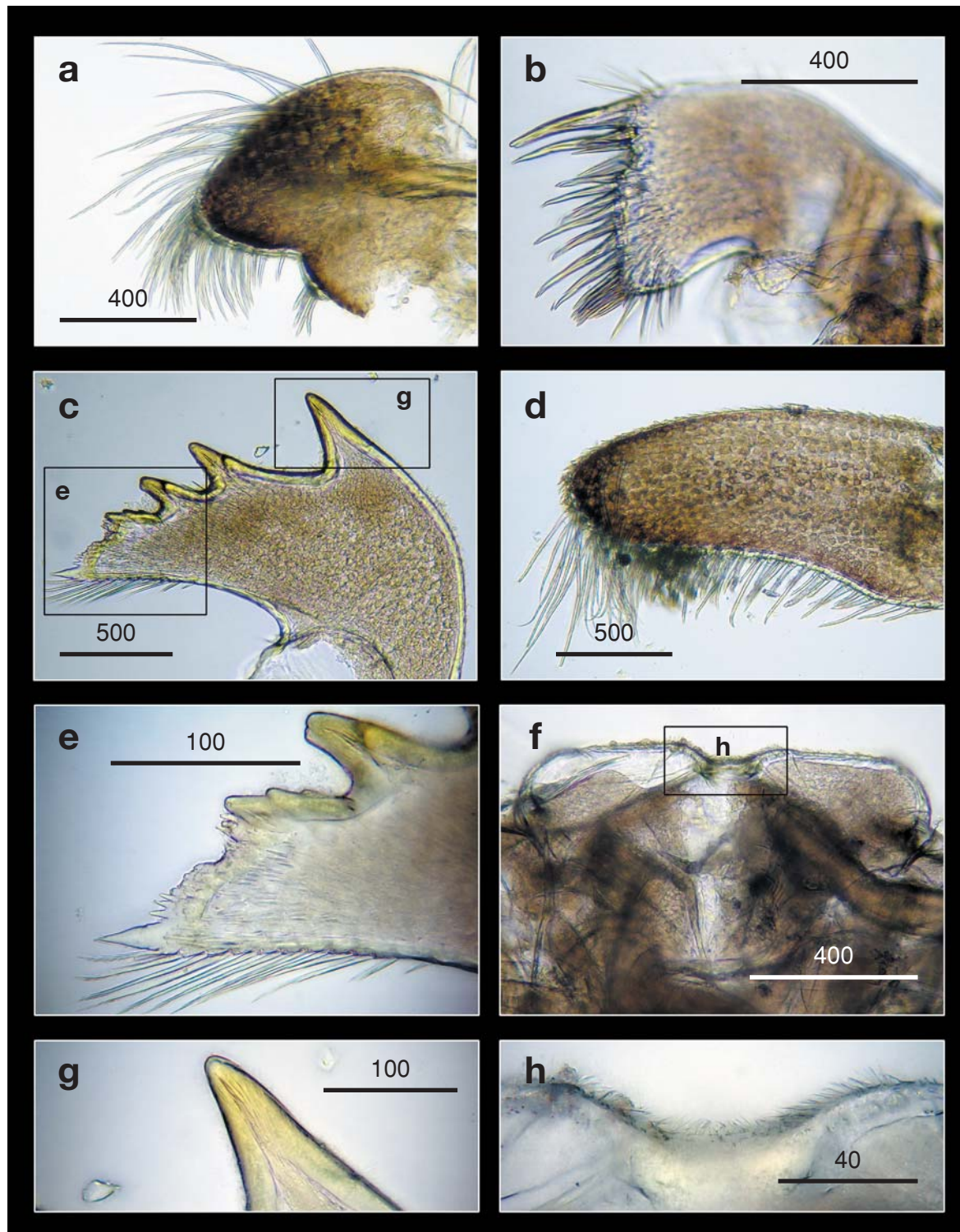


Fig. 182. *Tetracitella multicostata*, Jialeshuei, Pingtung County, 13 Jul 2007. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

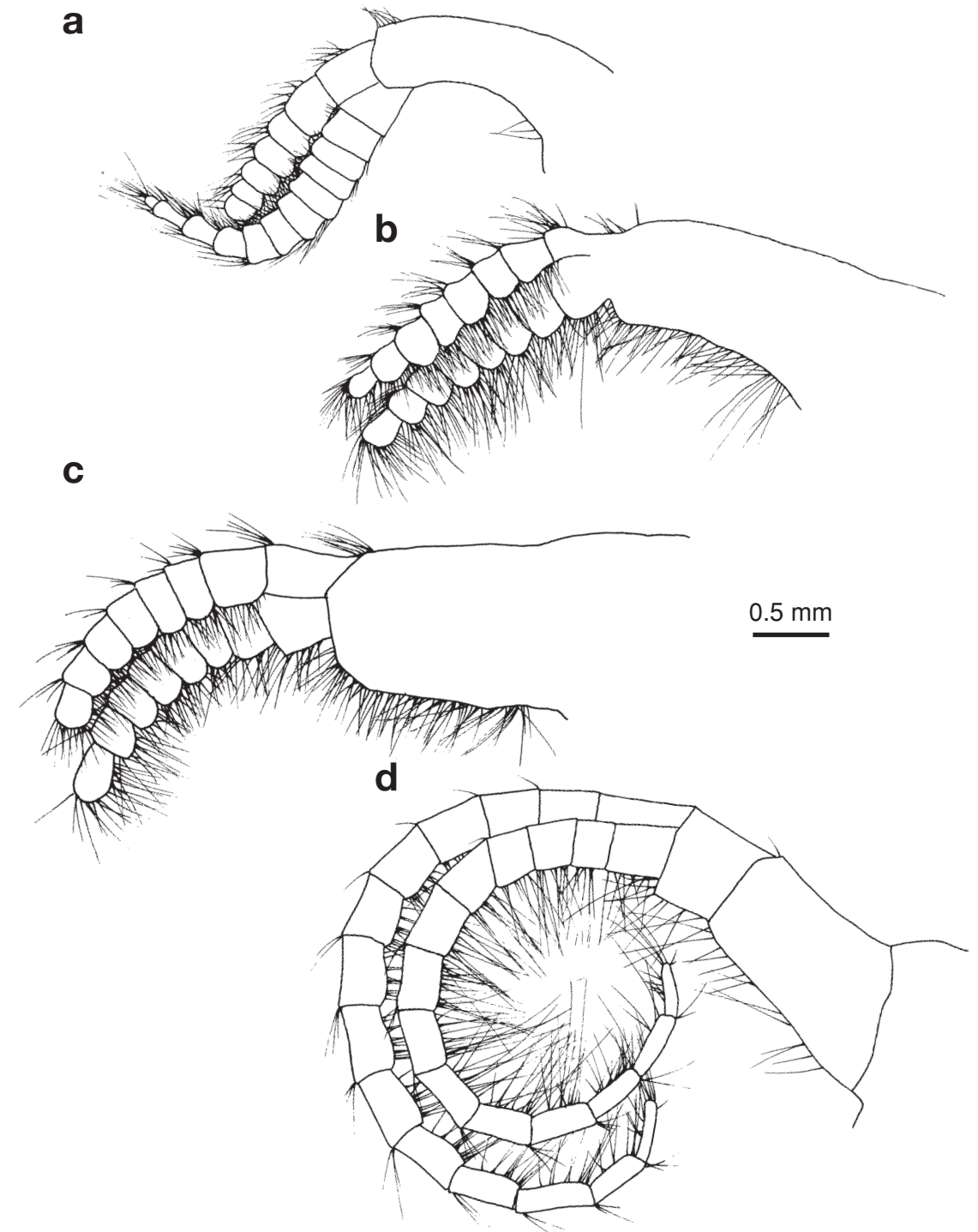


Fig. 183. *Tetracitella multicostata*, Jialeshuei, Pingtung County, 13 Jul 2007. Line drawings showing a. Cirrus I, b. Cirrus II, c. Cirrus III and d. Cirrus IV.

Tetraclitella karandei Ross, 1971
卡氏小笠藤壺

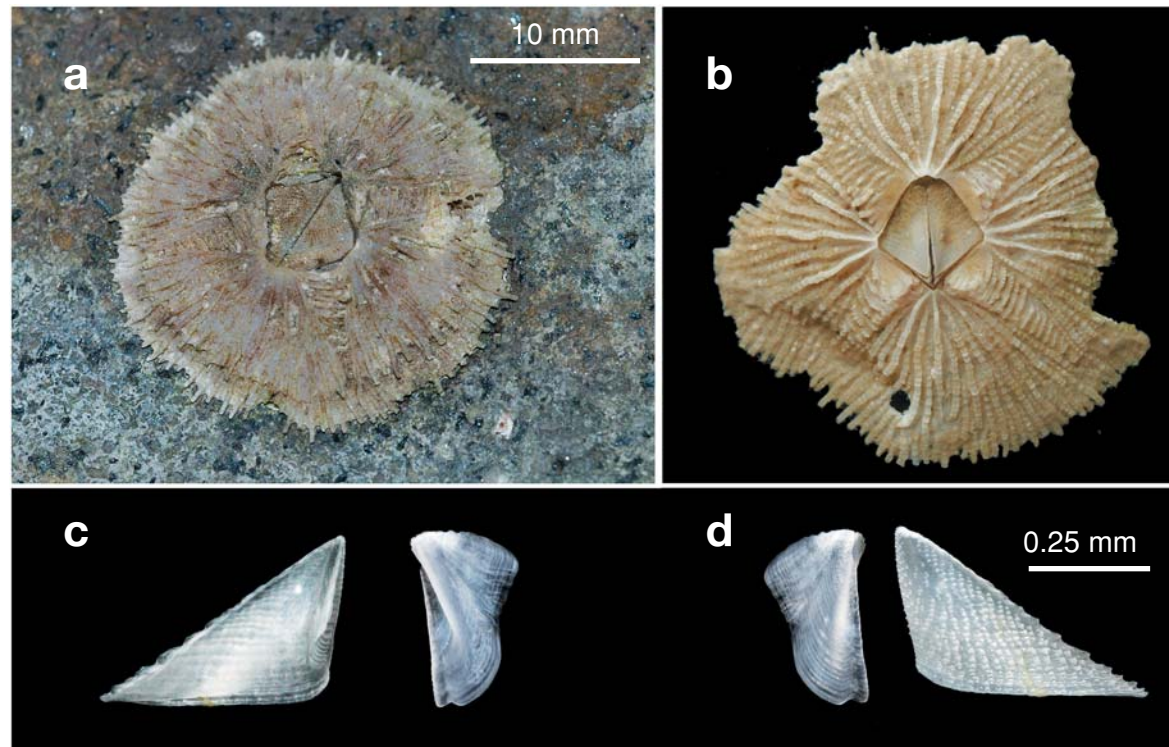


Fig. 184. *Tetraclitella karandei*, Hepingdao, keelung City. a. *In-situ* view on shores, b. Complete parietes. c. Internal and d. External view of scutum and tergum.

Tetraclitella karandei Ross, 1971b: 217, figs. 2-3, 4A-J.—1972: 307.

Material examined.—Siaogang, Taitung County, 22 Feb 2008: 15 specimens (BD 4.16-17.74 mm) (CEL-BB-9).—Hepingdao, Keelung City, 1 specimen (BD 20.45 mm) (CEL-BB-104).—Hepingdao, Keelung City: 4 specimens (BD 11.06-22.05 mm) (CEL-BB-19).

Diagnosis.—Parietes with 4 plates, radii protruding with horizontal striations, surface of parietes with fine hairs and chitin coating. Scuta triangular, occludent and basal margins almost perpendicular, tergal margin straight; tergum higher than wide, scutal margin straight, spur small. Maxilla bilobed; maxillule notched, with 2 cuspidate setae above notch; mandible with 4 teeth, 3rd and 4th teeth tridentated; labrum slightly notched, with 2 small teeth on each cutting edge.

Size.—BD to 30 mm.

Coloration.—Grey to yellow.

Habitat.—On shaded intertidal rocks.

Distribution.—India, Taiwan, the Philippines.

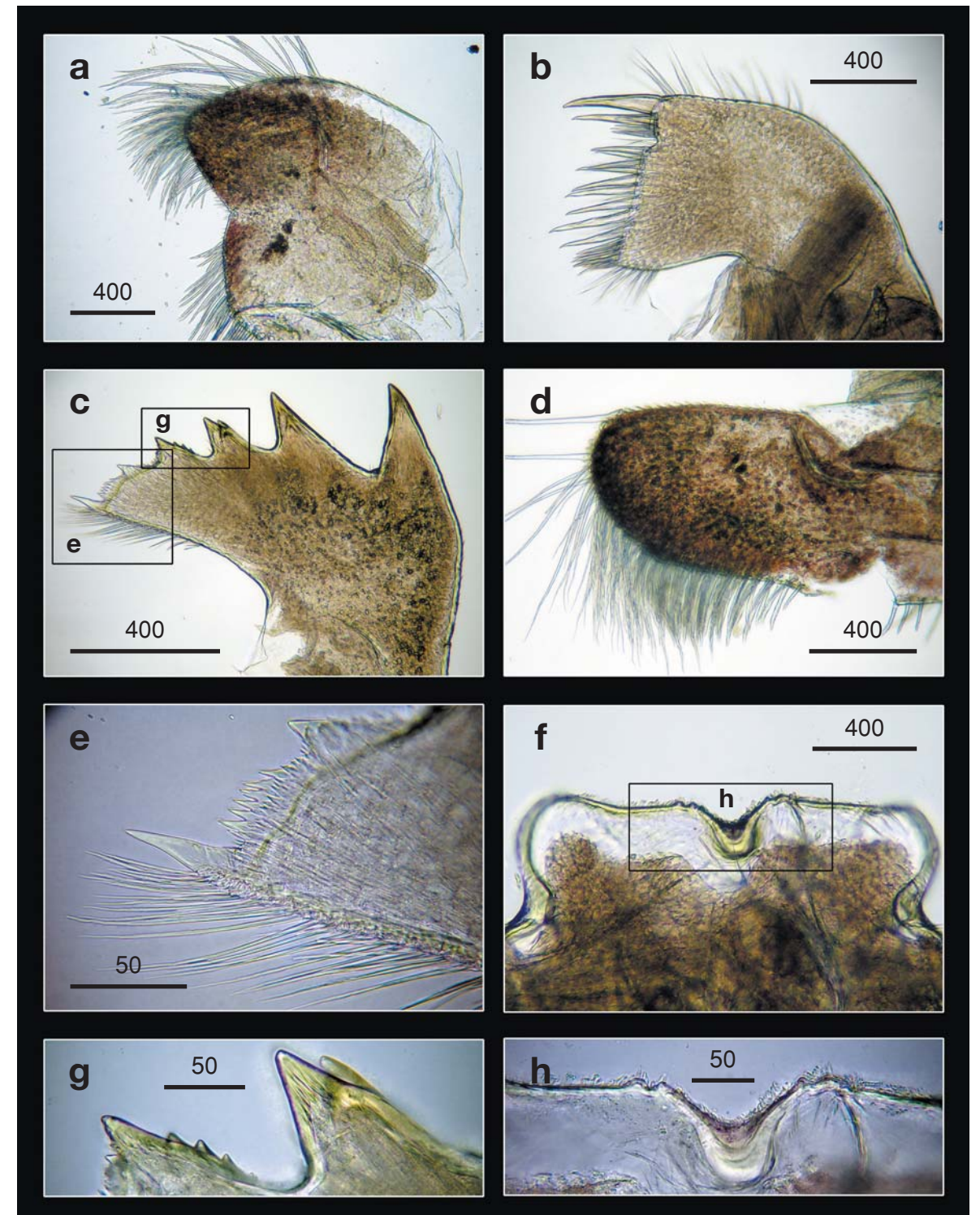


Fig. 185. *Tetraclitella karandei*, Hepingdao, Keelung City. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum. Scale bars in μm .

Superfamily BALANOIDEA Leach, 1817

藤壺總科

Balanidae Leach, 1817 (not seen).—Pilsbry, 1916: 48.—Newman et al., 1969: 284.—Newman & Ross, 1976: 38, 49.—Newman, 1993: 408.

Balaninae Darwin, 1854: 175.

Balanoidea Leach.—Newman, 1996: 502.

Diagnosis.—Wall with 6 plates, consisting of rostrum, carina, and 1 or 2 pairs of lateral compartments; parietes solid or tubiferous; if tubiferous rarely secondarily filled by chitinous or calcareous materials; radii solid or tubiferous; basis often calcareous, solid or permeated by tubes, rarely membranous; if basis calcareous, internal surfaces of parietes often with uniform ribs. Penis with basi-dorsal point. Mandibles with 4 or 5 teeth, with exception of the 1st tooth, remaining teeth often with secondary dentations, inferior angle often molariform. Cirri IV-VI often long and slender; cirrus III similar to cirrus II; rami of cirri II and III never antenniform, caudal appendage absent.

Remarks.—The Balanoidea is divided into 3 families, the Archaeobalanidae, Balanidae, and Pyrgomatidae. Collections of the Pyrgomatidae are not included in the present volume.

Key characters comparison of families of the Superfamily BALANOIDEA from Taiwan

Character	ARCHAEOBALANIDAE	BALANIDAE
Wall	4 or 6 plates	4 or 6 plates
Basis	calcareous, membranous	calcareous
Calcareous basis	solid	commonly tubiferous
Parietes	solid, rarely tubiferous	tubiferous
Parietal tubes	single row, uniform or irregular	single row uniform
Subsidiary tubes of parietes	absent	absent or present
Interlamine figures	simple, linear	complex, arborescent
Radii	solid	solid, tubiferous

Family ARCHAEOBALANIDAE Newman & Ross, 1976

古藤壺科

Archaeobalaninae Newman & Ross, 1976: 38, 49.

Diagnosis.—Parietes solid, rarely tubiferous, base calcareous.

Remarks.—The Archaeobalanidae is further classified into 5 subfamilies. In Taiwan, only the Archaeobalaninae and Acastinae were recorded in the present study.

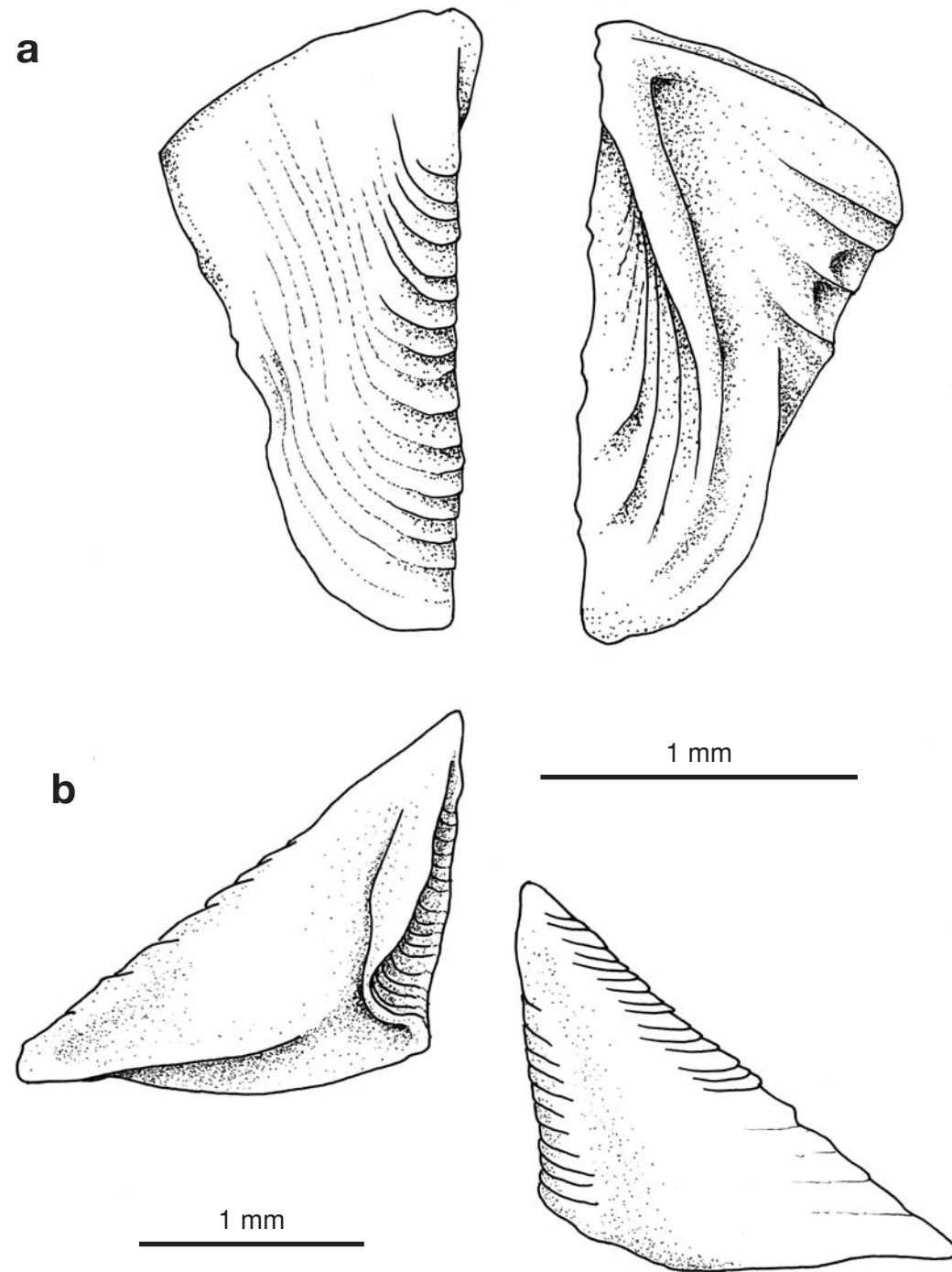


Fig. 186. *Tetracitella karandei*, Hepingdao, Keelung City. Line drawings of a. Tergum and b. Scutum.

Key to subfamilies of Archaeobalanidae from Taiwan

1. Live in sponges Acastinae
 Not living in sponges Archaeobalaninae

Subfamily Archaeobalaninae Newman & Ross, 1976

古藤壺亞科

Archaeobalaninae Newman & Ross, 1976: 38, 49.

Diagnosis.—Wall with 4 or 6 plates; parietes solid, rarely tubiferous; tubes uniformly or irregularly arranged and formed between inner and outer laminae; if parietes regularly-arranged, interlaminar fingers simple, linear; radii solid; basis often calcareous, rarely tubiferous.

Remarks.—There are 17 genera, including 5 fossil genera. In Taiwan, only *Striatobalanus* and *Conopea* were found in the present collection.

Key to genera of Archaeobalaninae from Taiwan

1. Shell base flat *Striatobalanus*
 Shell base conical, shell containing of 2 cones joining at their base *Conopea*

Genus *Striatobalanus* Hoek, 1913

條藤壺屬

Striatobalanus Hoek, 1913: 159, 179.—Pilsbry, 1916: 204.—Newman & Ross, 1976: 50 (as subgenus). Type species *Balanus amaryllis* Darwin, 1854.

Diagnosis.—Parietes solid, non-tubiferous, not strongly arched; radii narrow, sutural edge smooth, scutum with adductor muscle ridge; tergum furrow deep; inner and outer rami of cirrus I strongly unequal in length.

Remarks.—*Striatobalanus* includes 9 species and 4 species have been recorded in the present Taiwan collection. 2 are new records for Taiwan.

Key to species of *Striatobalanus* from Taiwan

1. Tergum with medial furrow 2
 Tergum without medial furrow 3
 2. Parietes with red-purple longitudinal stripes, medial furrow of tergum deep, tergum spur narrow
 *Striatobalanus amaryllis*
 Parietes white, medial furrow of tergum shallow, tergum spur wide and short *Striatobalanus tenuis*
 3. Radii narrow, labrum have numerous teeth *Striatobalanus krugeri*
 Radii wide, labrum have 3 teeth on each side *Striatobalanus taiwanensis*

Striatobalanus tenuis (Hoek, 1883)

薄殼條藤壺

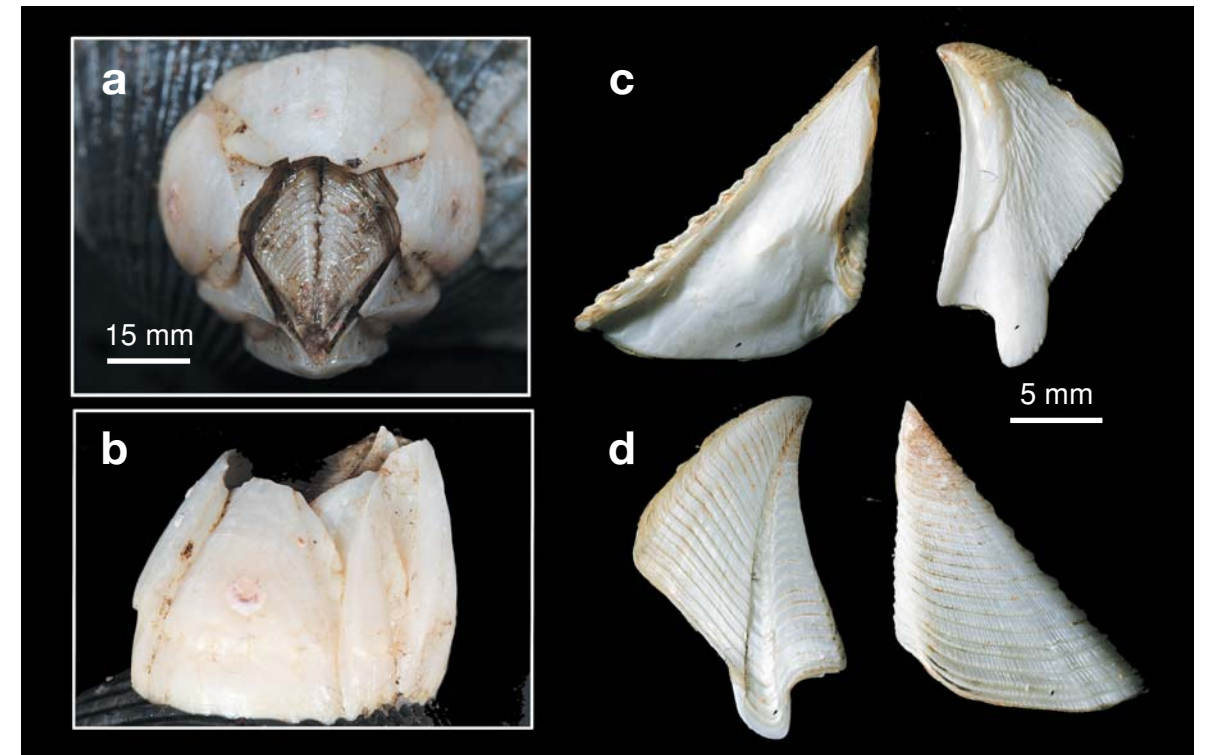


Fig. 187. *Striatobalanus tenuis*, Donggang fishing port, Pingtung County, 23 Mar 2000. a. Top view and b. Side view of the parietes. c. Internal and d. External view of the scutum and tergum.

Balanus tenuis Hoek, 1883: 154, pl. 13, figs. 29-33.—1913: 190, pl. 17, figs. 14-19, pl. 18, fig. 1.—Gruvel, 1905: 247, fig. 275.—Pilsbry, 1916: 216.—Barnard, 1924: 74.—Nilsson-Cantell, 1925: 34, fig. 13, pl. 1, figs. 5-6.—1927: 785.—1938: 46.—Broch, 1931: 70.—Hiro, 1937b: 439, fig. 24.—Utinomi, 1962: 216.—1968a: 174.—1969: 88, fig. 6.—Utinomi & Kikuchi, 1966: 6.—Ren & Liu, 1978: 161, fig. 22, pl. 7, figs. 6-10.

Balanus albus Hoek, 1913: 185, pl. 16, figs. 12-13, pl. 17, figs. 1-6.—Stubbings, 1936: 41, fig. 18.

Chirona tenuis.—Newman & Ross, 1976: 50.

Striatobalanus tenuis.—Liu & Ren, 2007: 363, fig. 161.

Material examined.—Donggang fishing port, Pingtung County, Mar 2005: 1 specimen (shell broken) (CEL-BB-10).—Donggang fishing port, Pingtung County, 23 Mar 2000: 5 specimens (BD 3.02-11.25 mm) (CEL-BB-49).—Dasi fishing port, Yilan County, 21 Dec 2005: 1 specimen (BD 11.21 mm) (CEL-BB-75).—Donggang fishing port, Pingtung County, 360 m, 29 May 2000: 1 specimen (BD 22.18 mm) (CEL-BB-80).—Donggang fishing port, Pingtung County, 300 m, 17 Dec 1998: 1 specimen (BD 22.06 mm) (NMNS 00432-00011).

Diagnosis.—Parietes with 6 plates, conical, white, radii wide. Scutum triangular, strongly sculptured on dorsal surface; tergum triangular, spur short and wide, scutal margin concave, medial furrow present on dorsal side of tergum. Maxilla triangular with dense setae; maxillule slightly notched; mandible with 5 teeth excluding

inferior angle, inferior angle blunt; mandibulatory palp rounded with setae at tip and superior margin; labrum bullate, with 2 or 3 large teeth on each side of cutting edge.

Size.—BD to 40 mm.

Coloration.—Parietes white.

Habitat.—Deep-sea species on rocks, gastropod shells and crab surface.

Distribution.—East China Sea, South China Sea, Japan, the Philippines, Indonesia, Indian Ocean, South Africa.

Remarks.—New record for Taiwan.

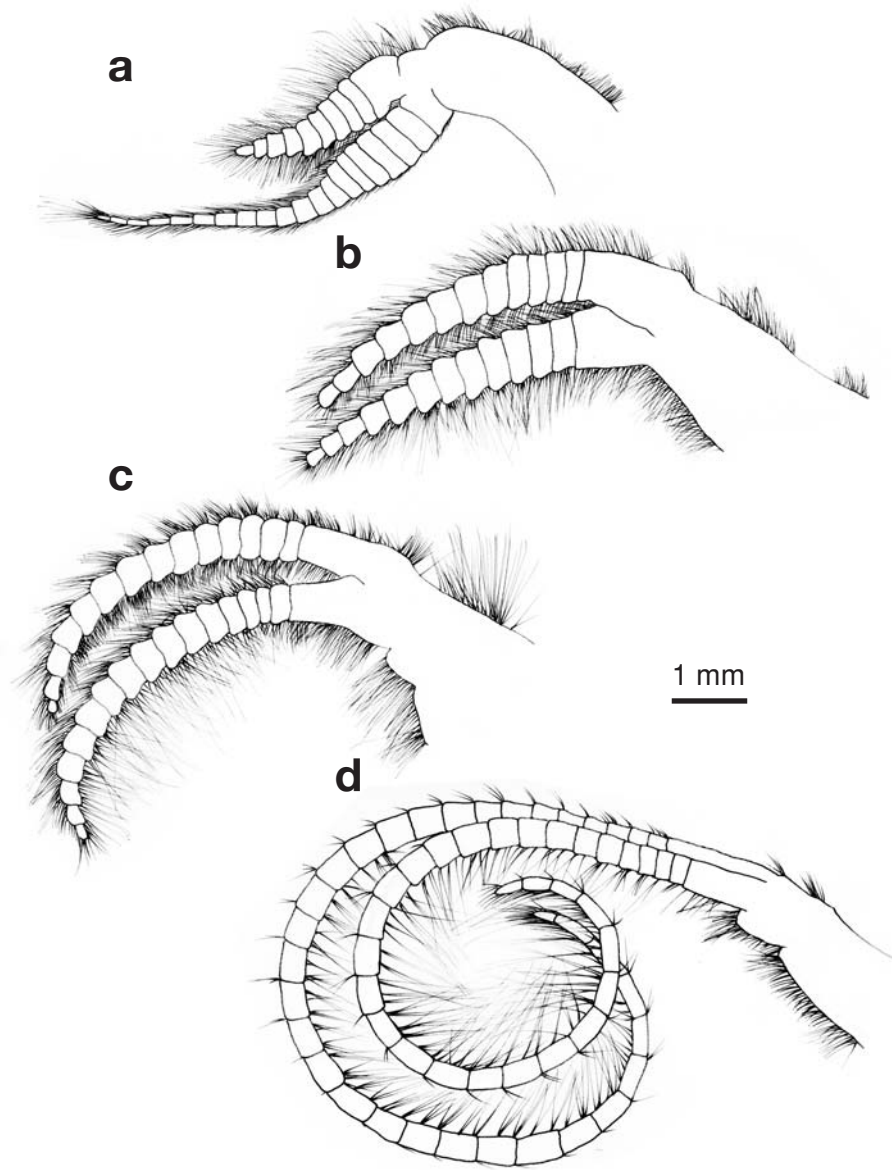


Fig. 188. *Striatobalanus tenuis*, Donggang fishing port, Pingtung County, 23 Mar 2000. Line drawings showing a. Cirrus I, b. Cirrus II, c. Cirrus III and d. Cirrus IV.

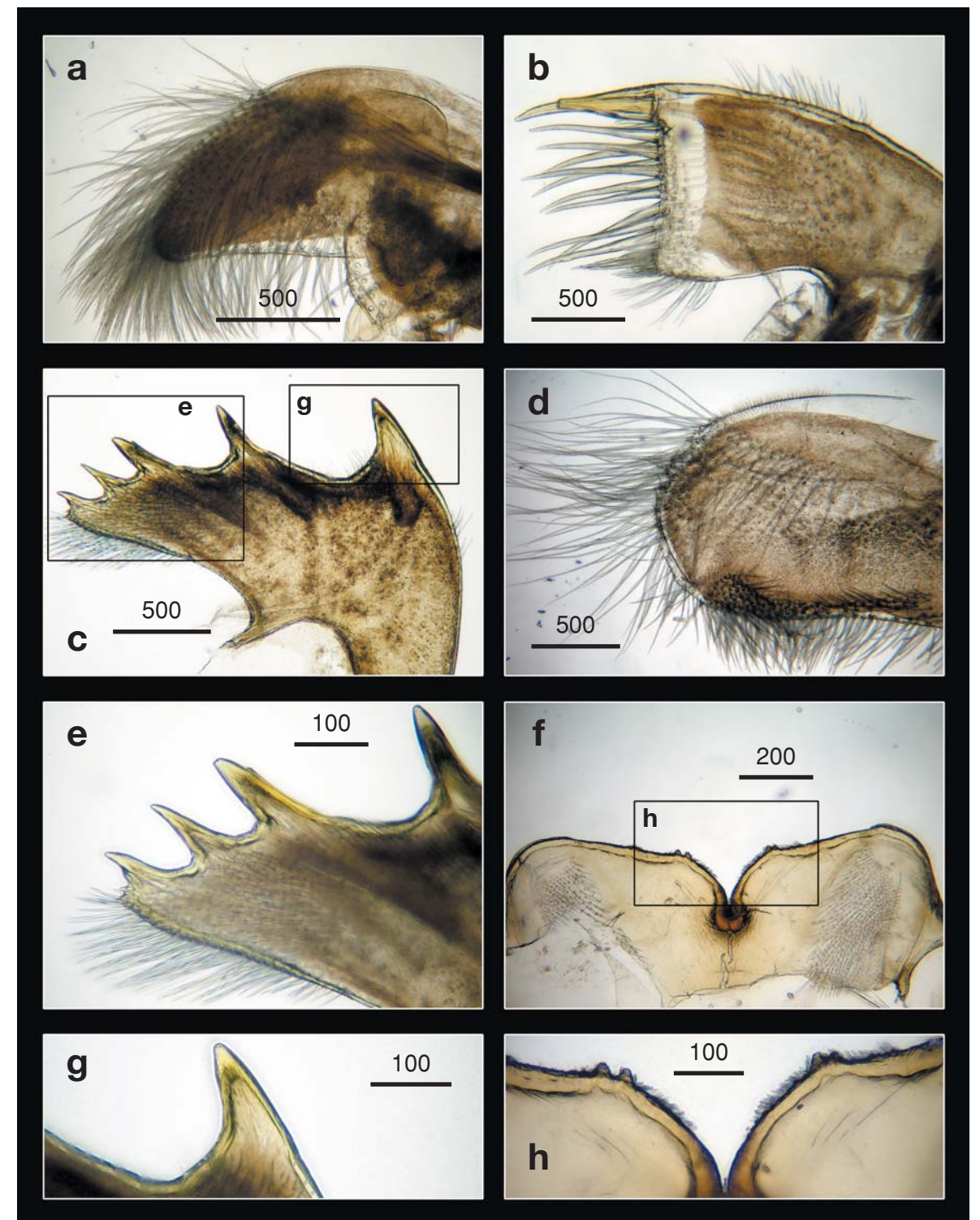


Fig. 189. *Striatobalanus tenuis*, Donggang fishing port, Pingtung County, 23 Mar 2000. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Striatobalanus amaryllis (Darwin, 1854)
高峰條藤壺

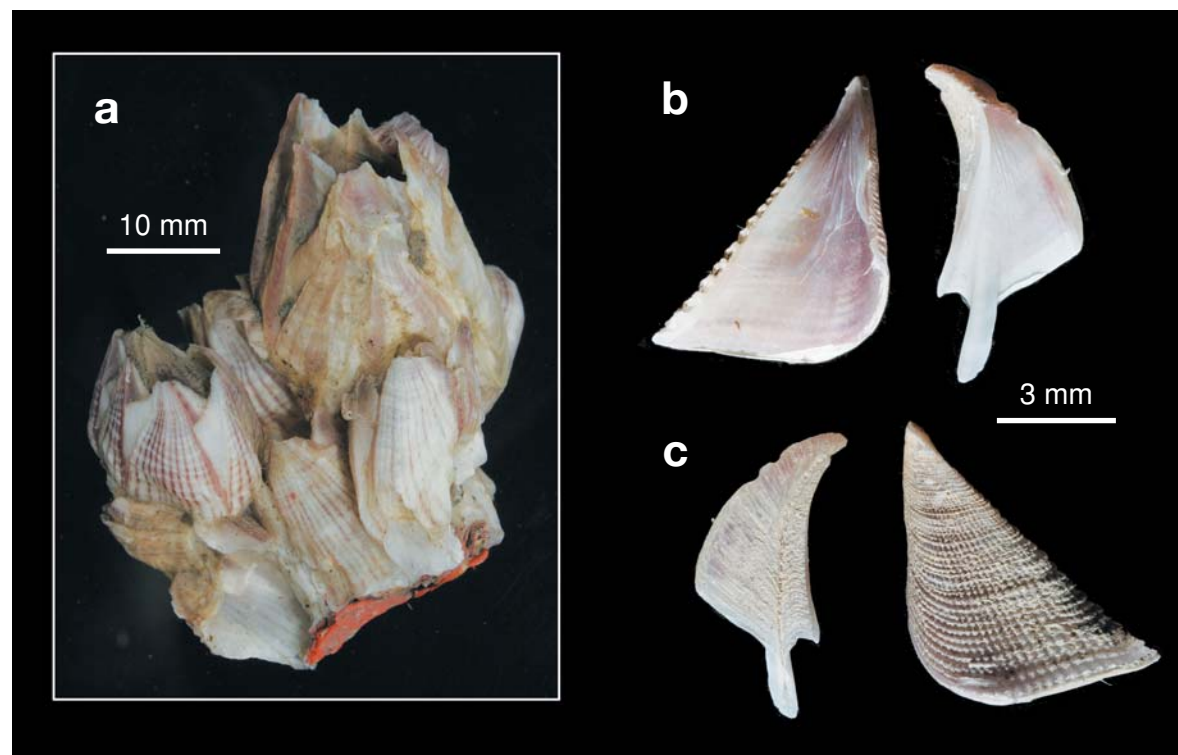


Fig. 190. *Striatobalanus amaryllis*, Mashagou, Tainan County, 10 Nov 1994. a. A colony of *S. amaryllis*. b. Internal and c. External view of the scutum and tergum.

Balanus amaryllis Darwin, 1854: 279, pl. 7, figs. 6a-e.—Hoek, 1883: 153, pl. 7, figs. 4-5.—1913: 179, pl. 15, figs. 17-21, pl. 16, figs. 1-4.—Gruvel, 1905: 250.—Pilsbry, 1916: 217.—Nilsson-Cantell, 1921: 329, pl. 3, fig. 9.—Hiro, 1936b: 624.—Shen et al., 1962: 66.—Zevina & Tarasov, 1963: 94.—Ren & Liu, 1978: 159, fig. 21, pl. 7, figs. 1-5.

Chirona amaryllis.—Newman & Ross, 1976: 50.

Material examined.—Mashagou, Tainan County, 10 Nov 1994: 3 specimens (BD 9.89 mm, others broken) (NMNS 003246-00003).

Diagnosis.—Parietes conical, surface with pink radiating patterns, radii wide. Scutum triangular, surface strongly striated, tergum narrow, beak produced apically, dorsal medial furrows very deep, spur long, narrow and blunt. Maxilla bilobed, elongated with dense setae on inferior margin; maxillule slightly notched; mandible with 4 teeth, distance between 3rd and 4th teeth very large, 1st tooth very small; labrum V-shaped with 3 sharp teeth on each cutting margin.

Size.—BD to 50 mm.

Coloration.—Parietes white with pink radiations.

Habitat.—Low intertidal to subtidal, on rocks or gastropod shell surfaces.

Distribution.—China, Taiwan, the Philippines, Southern Japan, Malaysian waters, Australia and Indian Ocean.

Remarks.—New record for Taiwan.

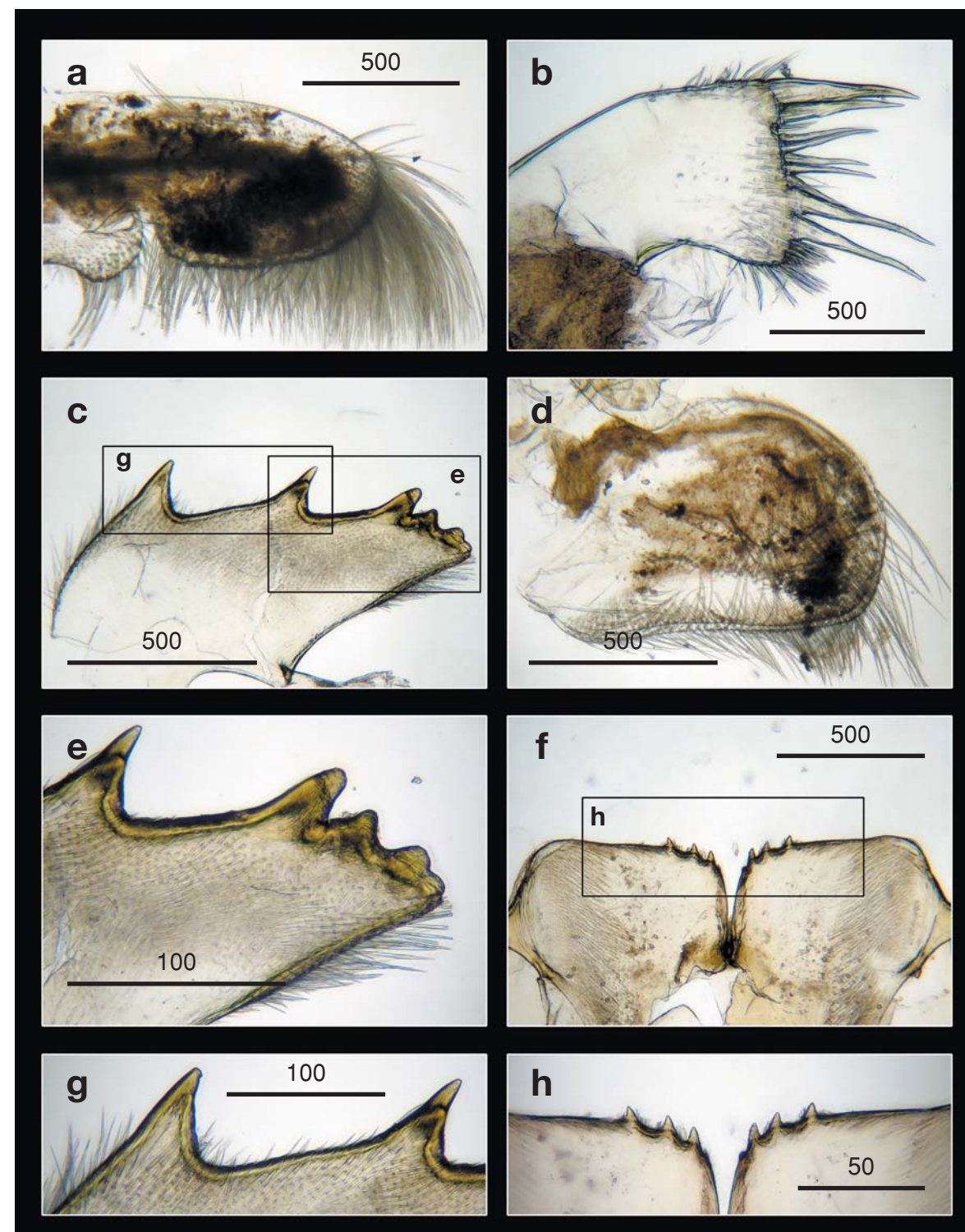


Fig. 191. *Striatobalanus amaryllis*, Mashagou, Tainan County, 10 Nov 1994. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in µm.

Striatobalanus krugeri (Pilsbry, 1916)

窄翼條藤壺

Balanus krugeri Pilsbry, 1916: 214, fig. 69, pl. 52, figs. 1-1f, pl. 51.

Balanus amphitrite niveus Krüger, 1911: 51.

Balanus amphitrite krugeri.—Hiro, 1939d: 263.

Striatobalanus krugeri.—Liu & Ren, 2007: 369, fig. 164.

Materials examined.—Kaoshiung City.

Diagnosis.—Shell white, plates thin with pale-purple striations. Tergum without median furrow.

Size.—BD to 7.4 mm (Liu & Ren, 2007).

Coloration.—Shell white.

Distribution.—South China Sea, Japan, Malay Archipelago. Often attached on sea urchin spines.

Remarks.—The record of *S. krugeri* in Taiwan was in Krüger, 1911. We have not yet collected this species in Taiwan.



Fig. 193. *Striatobalanus krugeri*, Mainland China. Redrawn from Liu & Ren 2007

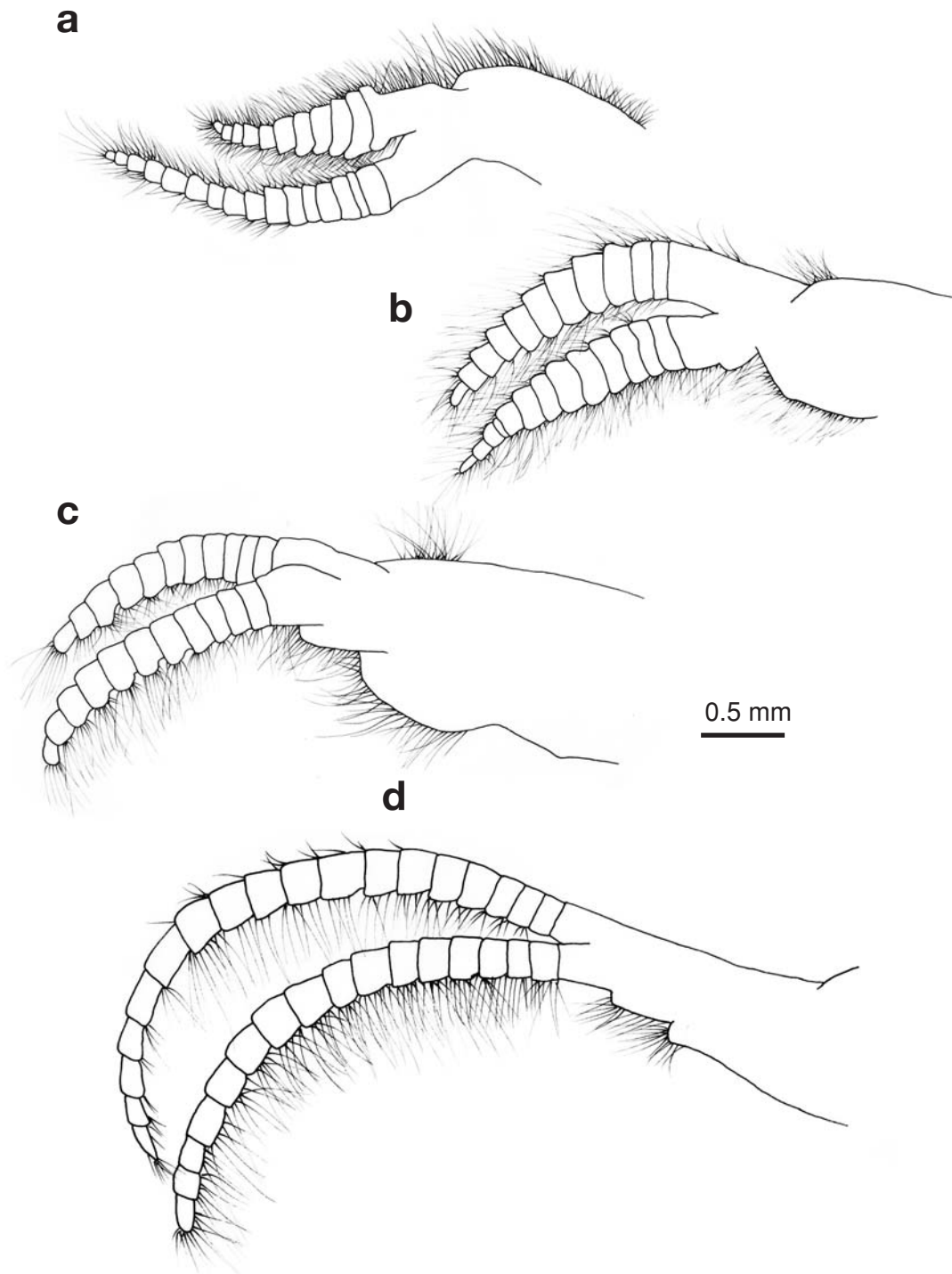


Fig. 192. *Striatobalanus amaryllis*, Mashagou, Tainan County, 10 Nov 1994. Line drawings showing a. Cirrus I, b. Cirrus II, c. Cirrus III and d. Cirrus IV.

Striatobalanus taiwanensis (Hiro, 1939)
台灣條藤壺

Balanus taiwanensis Hiro, 1939d: 264, fig. 9.

Striatobalanus taiwanensis Liu & Ren, 2007: 371, fig. 165

Material examined.—Su-ao, Yilan County, 30 May 1938 (data from Hiro, 1939d).

Diagnosis.—Littoral species. Shell white, smooth with yellow epidermis. Tergum without median furrow.

Size.—BD to 13 mm (Hiro, 1939d).

Coloration.—White.

Distribution.—Taiwan.

Remarks.—After Hiro identified *S. taiwanensis* in 1939 in Taiwan, no further records were made. We still have not recorded this species in Taiwan.

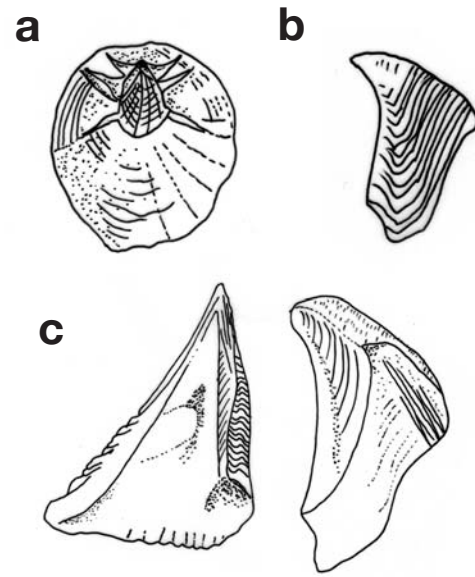


Fig. 194. *Striatobalanus taiwanensis*, Su-ao, Taiwan. a. External shell. b. External view of scutum. c. Internal view of scutum and tergum. Redrawn from Hiro (1939d).

Genus *Conopea* Say, 1822
舟藤壺屬

Conopea Say, 1822: 323.

Balanus Section B Darwin, 1854: 216.

Patella-Balanus Hoek, 1913: 160. Type species *Conopea elongata* Say, 1822.

Diagnosis.—Shell with 2 cones joined at their bases. Base conical or keel-shaped, often attached on gorgonian corals.

Conopea granulatus (Hiro, 1937)
顆粒舟藤壺

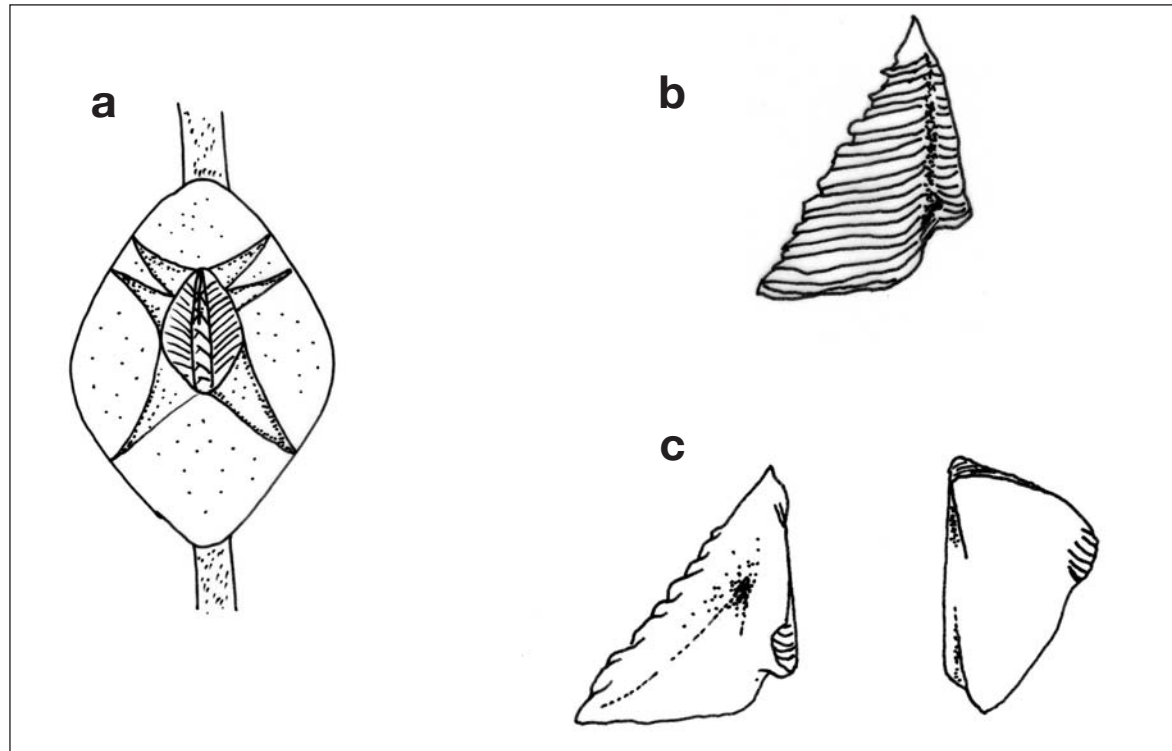


Fig. 195. *Conopea granulatus*. a. External view. b. External view of scutum. c. Internal view of scutum and tergum. Japan. Redrawn from Hiro (1937).

Balanus granulatus Hiro, 1937b: 444, figs. 29-30.—1939d: 266.

Conopea granulata.—Newman & Ross, 1976: 55.—Liu & Ren, 2007: 391, fig. 174.

Materials examined.—Taiwan Strait (data from Hiro, 1939d).

Diagnosis.—Base conical, cup shaped. Shell surface covered by corals.

Size.—Not available.

Coloration.—Shell white when corals detached.

Distribution.—Taiwan, southern Japan.

Remarks.—Currently, we have not yet collected this species in Taiwan.

Family **BALANIDAE** Leach, 1817
藤壺科

Balanidae.—Newman & Ross, 1976: 39, 59.—Newman, 1996: 503.—Pitombo, 2004: 265.

Diagnosis.—Wall with 4 or 6 plates; parietes tubiferous, tubes arranged in a single uniform row which form between inner and outer laminate; supplementary tubes sometimes formed basally; radii solid or tubiferous; basis calcareous or tubiferous.

Key to subfamily of Balanidae from Taiwan

1. Radii well developed, tubiferous **Megabalaninae**
Radii solid 2
2. Wall single or multi-tubiferous. Tergum spur with obvious change in the direction of the growth lines. Scutum with obvious adductor ridge **Amphibalaninae**
3. Wall with single row of tubes. Tergum spur without obvious change in the direction of growth lines. Scutum with inconspicuous adductor ridge **Balaninae**

Subfamily Balaninae Leach, 1817
藤壺亞科

Balaninae.—Newman, 1979: 279.—1993: 408.—1996: 503.—Buckeridge, 1983: 103.—Pitombo, 2004: 263.

Diagnosis.—Wall with 6 plates, surface smooth or ribbed, tubiferous with a single row of major tubes; young individuals with transverse septa in tubes; radii solid, sutural edges smooth or with denticles on lower side; basis calcareous, solid with irregular or uniform tubes; spur and furrow margin of tergum coincident, basi-carinal angle with well-developed depressor muscle crests. Tergum spur without obvious change in direction of growth lines. Scutum with inconspicuous adductor ridge.

Genus *Balanus* Da Costa, 1778, type genus
藤壺屬

Balanus Da Costa, 1778: 249 (not seen).

Balanus Section C, D.—Darwin, 1854: 223.

Balanus Da Costa.—Pilsbry, 1916: 77.

Diagnosis.—Wall tubiferous, radii solid, base calcareous with radiating lines and tubes, ventral side of segments of cirrus III with spines.

Balanus trigonus Darwin, 1854
三角藤壺

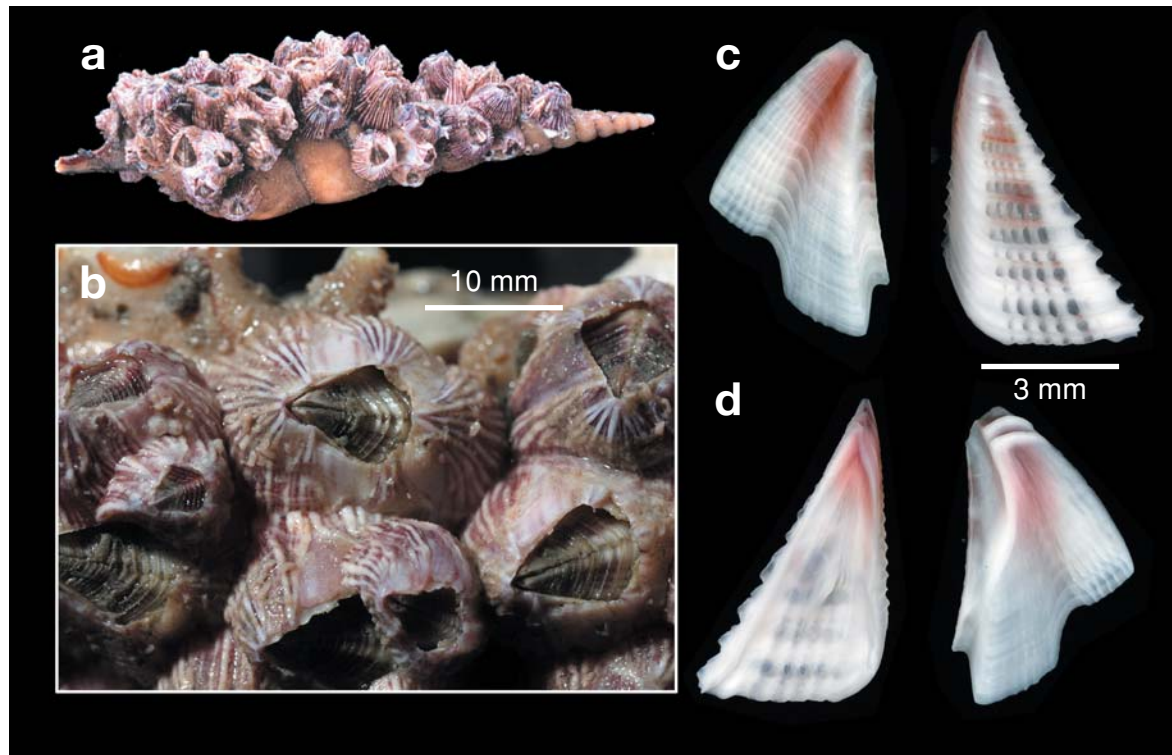


Fig. 196. *Balanus trigonus*, Jhongyun, Kaohsiung County, 27 Apr 2000. a. A colony on a gastropod shell. b. Close up view of the complete parietes. c. External and d. Internal view of the scutum and tergum.

Balanus trigonus Darwin, 1854: 223, pl. 3, fig. 7a.—Hoek, 1883: 149, pl. 12, fig. 20.—Krüger, 1911: 49.
Balanus armatus Muller, 1868: 393.

Material examined.—Jhongyun, Kaohsiung County, 27 Apr 2000: 44 specimens (BD 5.41-14.48 mm) (NMNS 003358-00010).

Diagnosis.—Parietes conical, pink or white, paries surface with white ribs, radii wide, summits inclined; operculum triangular. External surface of scutum with holes arranged in longitudinal patterns; tergum wide, triangular, spur wide. Maxilla with setae on all margins; maxillule slightly notched, with 2 large setae above notch and at least 10 setae below notch; mandibles with 3 teeth excluding inferior angle, lower margin with dense small teeth; labrum with deep notch, each side of cutting edge with 2 large teeth. Cirrus I rami unequal, anterior ramus longer, 18-segmented, posterior ramus shorter, 9-segmented; cirrus II rami sub-equal, anterior ramus 17-segmented and posterior ramus 18-segmented; cirrus III, anterior ramus 36-segmented, posterior ramus 28-segmented.

Size.—BD to 50 mm.

Coloration.—Shell with purple and pink striations.

Distribution.—Indo-Pacific waters including Japan, Australia, and New Zealand, Red Sea, west coast of

the Americas from Peru to southern California, Atlantic Ocean including the West Indies to southern Brazil, Madeira, and the Azores to South Africa.

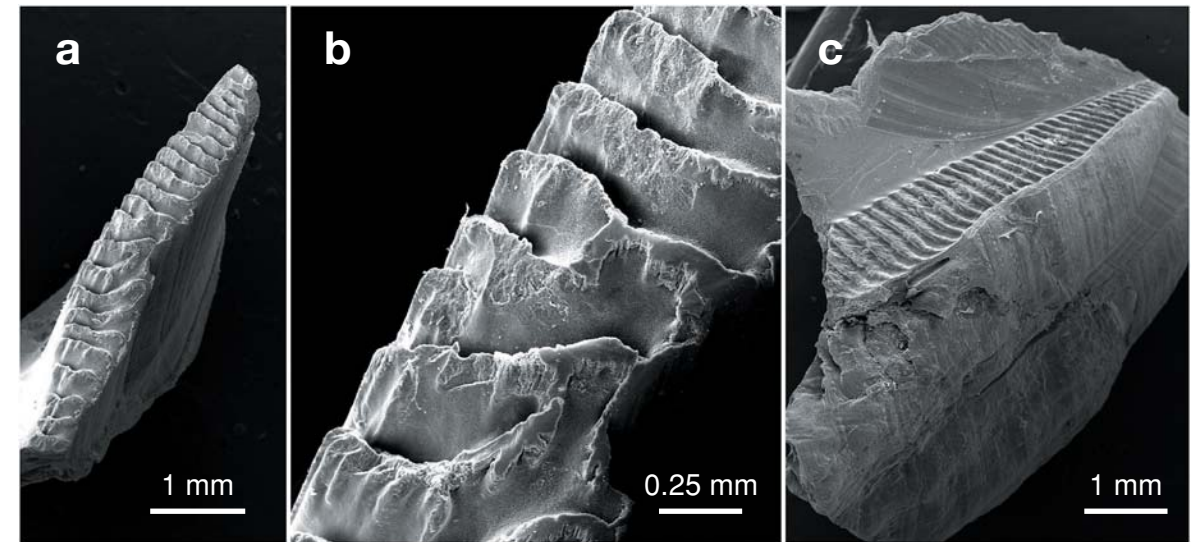


Fig. 197. *Balanus trigonus*, Jhongyun, Kaohsiung County, 27 Apr 2000. Scanning Electron microscopy showing a, b. View of radial sutural edges of radius and c. External view of carinal latus showing alae and denticles of radial joint.

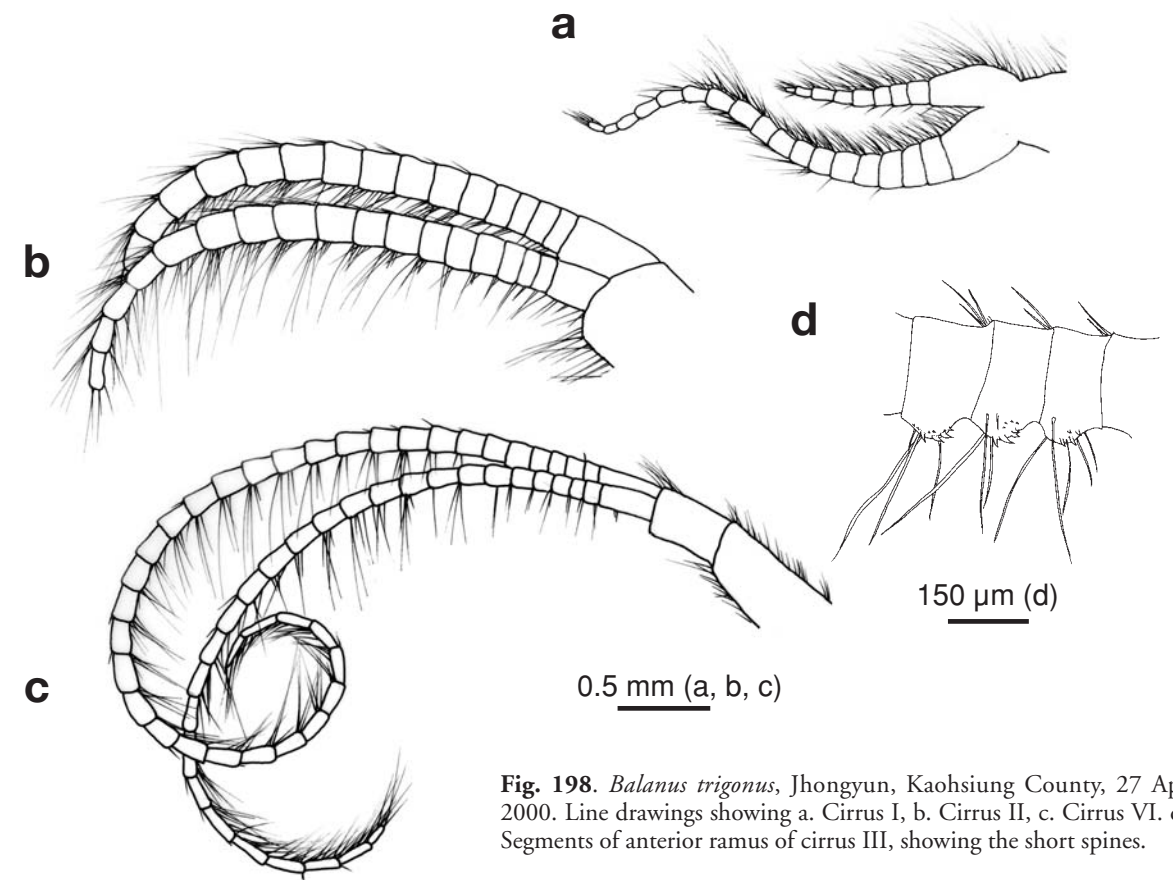


Fig. 198. *Balanus trigonus*, Jhongyun, Kaohsiung County, 27 Apr 2000. Line drawings showing a. Cirrus I, b. Cirrus II, c. Cirrus VI. d. Segments of anterior ramus of cirrus III, showing the short spines.

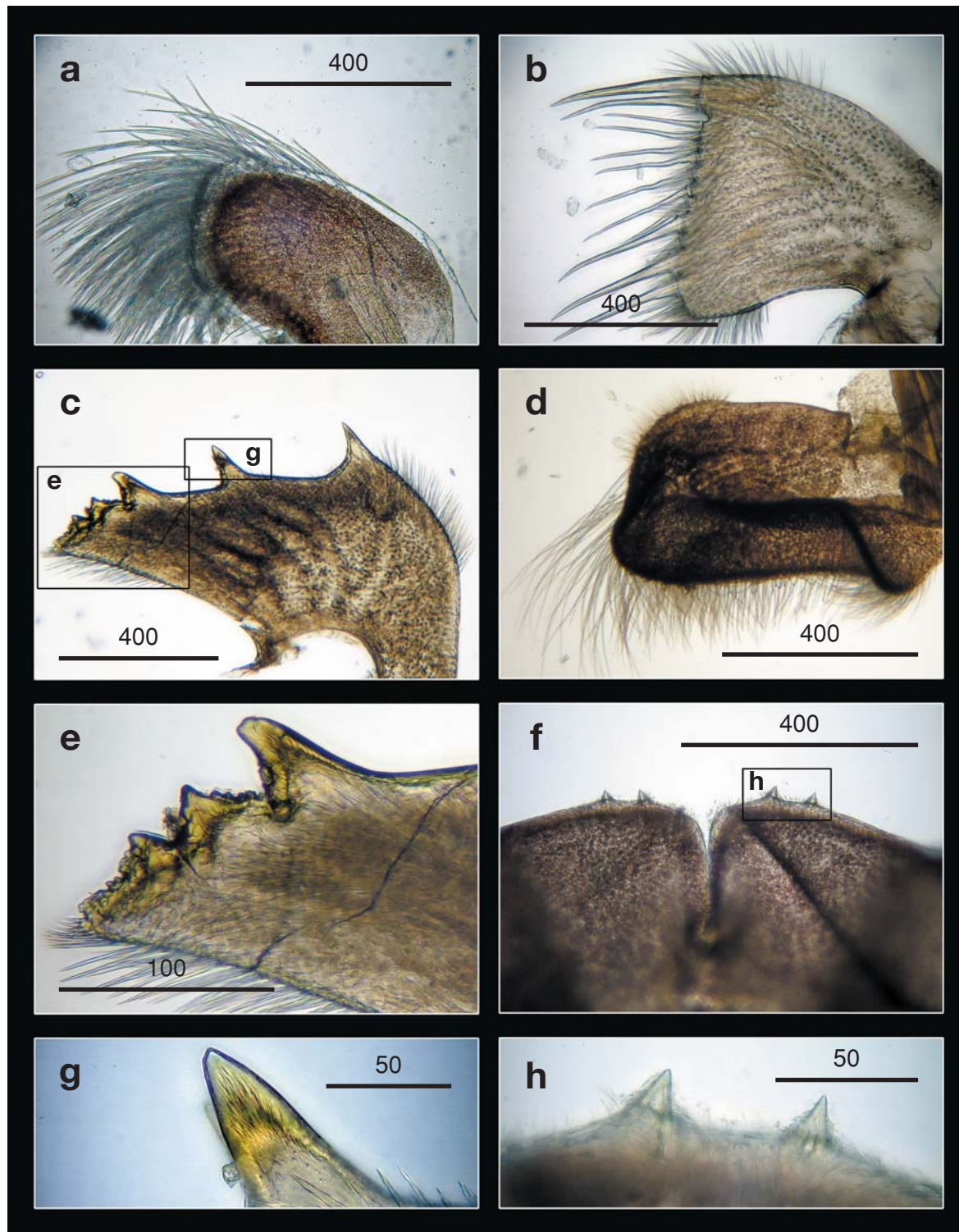


Fig. 199. *Balanus trigonus*, Jhongyun, Kaohsiung County, 27 Apr 2000. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Subfamily Amphibalaninae Pitombo, 2004

紋藤壺亞科

Amphibalaninae Pitombo, 2004: 263. Type genus *Amphibalanus* Pitombo, 2004.

Diagnosis.—Wall with 4 or 6 plates, surface smooth or ribbed, with 1 or more rows of parietal tubes, these with transverse septa; radii solid, transverse teeth on sutural edge with denticles on lower region; alae not cleft; basis calcareous and uni-tubiferous, inner surface of scutum with conspicuous adductor ridge; growth lines in tergum spur exhibiting obvious change in direction, basal margin of tergum with well-developed depressor muscle crests; anterior margin of distal lobe of maxilla with smooth, acuminate setae with enlarged, modified tips.

Remarks.—3 genera are assigned to the Amphibalaninae; 2 of the genera have been recorded in Taiwan.

Key to species of *Amphibalanus* from Taiwan

1. Parietal tubes composed in single primary layer *Amphibalanus*
 Parietal tubes composed in single primary layer with subsidiary tubes irregularly arranged between primaries and outer laminae; in single or more rows *Fistulobalanus*

Genus *Amphibalanus* Pitombo, 2004, type genus

紋藤壺屬

Amphibalanus Pitombo, 2004: 263.

Diagnosis.—Wall surface smooth with 6 plates; parietes with a single row of tubes, with or without transverse septa; radii solid, transverse teeth on sutural edge with denticles on lower region; basis calcareous and uni-tubiferous; inner surface of scutum with conspicuous adductor ridge. Growth lines in tergum spur exhibiting obvious change in direction.

Key to species of *Amphibalanus* from Taiwan

1. Primary parietal tubes with transverse septa; exterior of shell with longitudinal purple striations *Amphibalanus amphitrite*
 Primary parietal tubes with transverse septa, exterior of shell with longitudinal and horizontal striations 2
 Primary parietal tubes without transverse septa; external surface of scutum with single row of pits extending down middle of valve without longitudinal striations *Amphibalanus zhujiangensis*
2. Cirri IV-VI with erect hooks below posterior angles of distal articles of rami *Amphibalanus reticulatus*
 Cirri IV-VI without erect hooks below posterior angles of distal articles of rami *Amphibalanus poecilotheca*

Amphibalanus reticulatus (Utinomi, 1967)
網紋紋藤壺

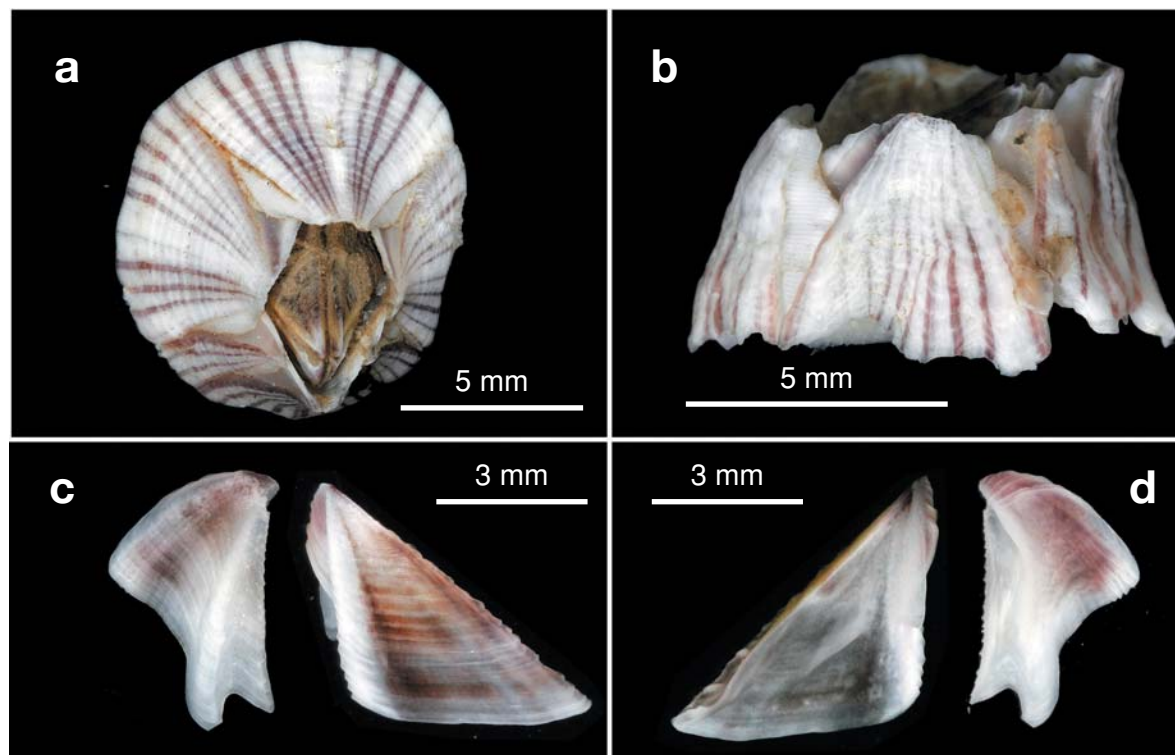


Fig. 200. *Amphibalanus reticulatus*, Dongsha, 3 Aug 2008. a. Top view and b. Side view of a complete parietes. c. External view and d. Internal view of scutum and tergum.

Balanus amphitrite var. *communis* Darwin, 1854: 240, pl. 5, figs. 2e, h, l [type locality: Tachtigatani, Tanabe Bay, Japan].—Broch, 1922: 314.

Balanus amphitrite communis.—Hiro, 1938: 301, figs. 1a, b.—Utinomi, 1956: 52, pl. 26, fig. 11.—1960: 44, figs. 1c, d, 2c, d.

Balanus reticulatus.—Utinomi, 1967: 216, figs. 9a, b, 10a, b, 11a-e, pl. 6, figs. 7-8.—Henry & McLaughlin, 1975: 88, text-figs. 11, 18, pl. 7, fig. d, pl. 8, pl. 9, figs. a, d, e.—Newman & Ross, 1976: 64.

Material examined.—Hepingdao, Keelung City, 26 Aug 2008: 12 specimens (BD 3.81-12.35 mm) (CEL-BB-59).—Dongsha, 3 Aug 2008: 10 specimens (BD 7.67-15.30 mm) (CEL-BB-67).

Diagnosis.—Shell conical, surface smooth with purple, pink, and white longitudinal stripes intersecting with transverse striations; radii narrow, summits inclined; parietes with a single row of tubes. Scutum triangular, inner surface with conspicuous adductor ridge, tergal and occludent margins straight; tergum with a short spur, basi-scutal angle acute, scutal margin straight. Maxilla bilobed with dense setae on margin; maxillule not notched; mandible with 4 teeth excluding inferior angle, 2nd-4th teeth bidentated, inferior angle blunt;

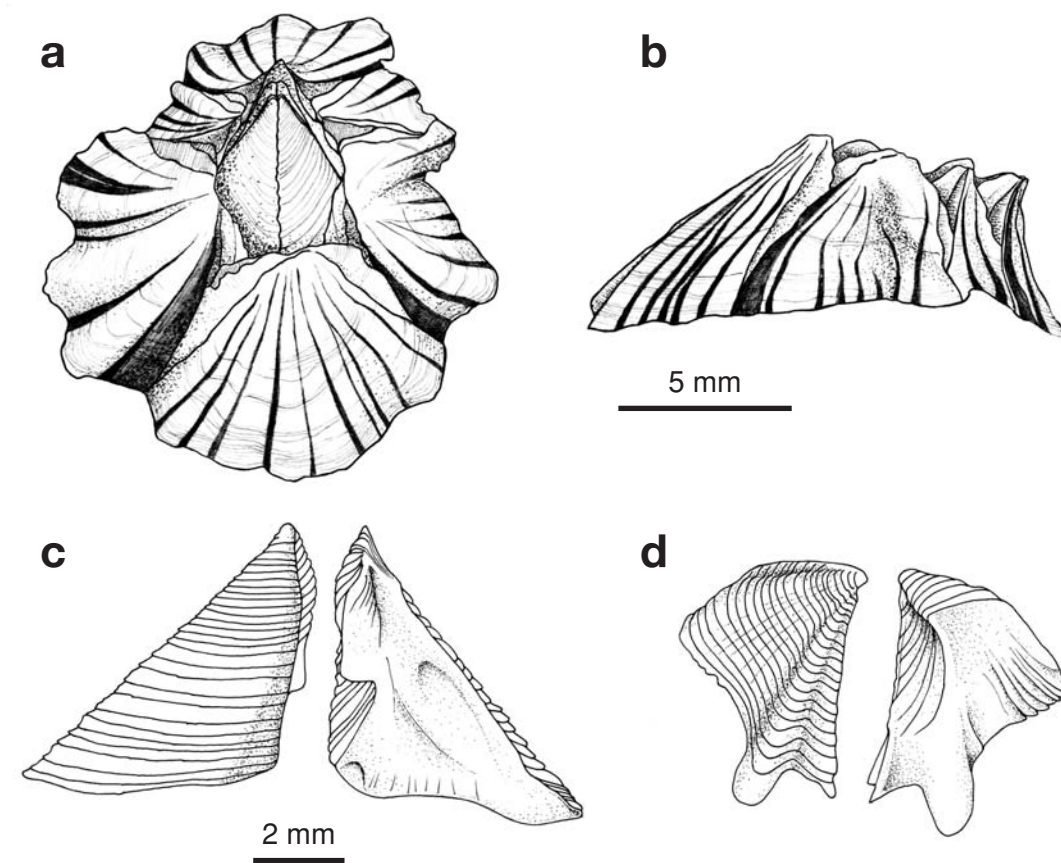


Fig. 201. *Amphibalanus reticulatus*, Dongsha, 3 Aug 2008. a. Top view and b. Side view of the parietes. c. Scutum and d. Tergum.

mandibulatory palp with setae on superior margin only; labrum with a deep cleft and 4 teeth on each side of cutting edge.

Size.—BD to 20 mm.

Coloration.—Shell surface with purple, pink, and white longitudinal stripes intersect transverse striations.

Habitat.—On rocks in sheltered bays and as fouling species on ship bottoms and artificial submerged objects.

Distribution.—Oceans of the world.

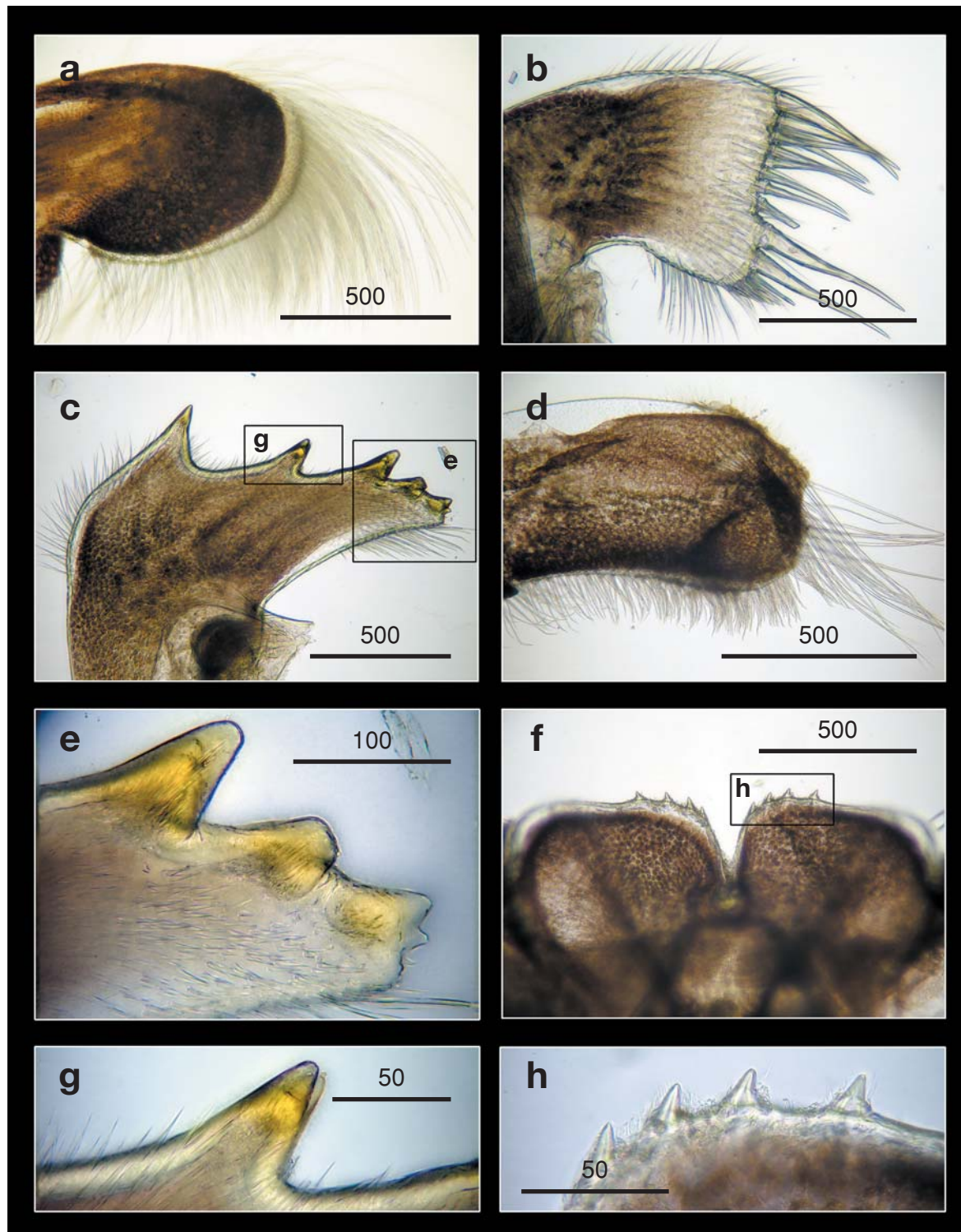


Fig. 202. *Amphibalanus reticulatus*, Dongsha, 3 Aug 2008. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

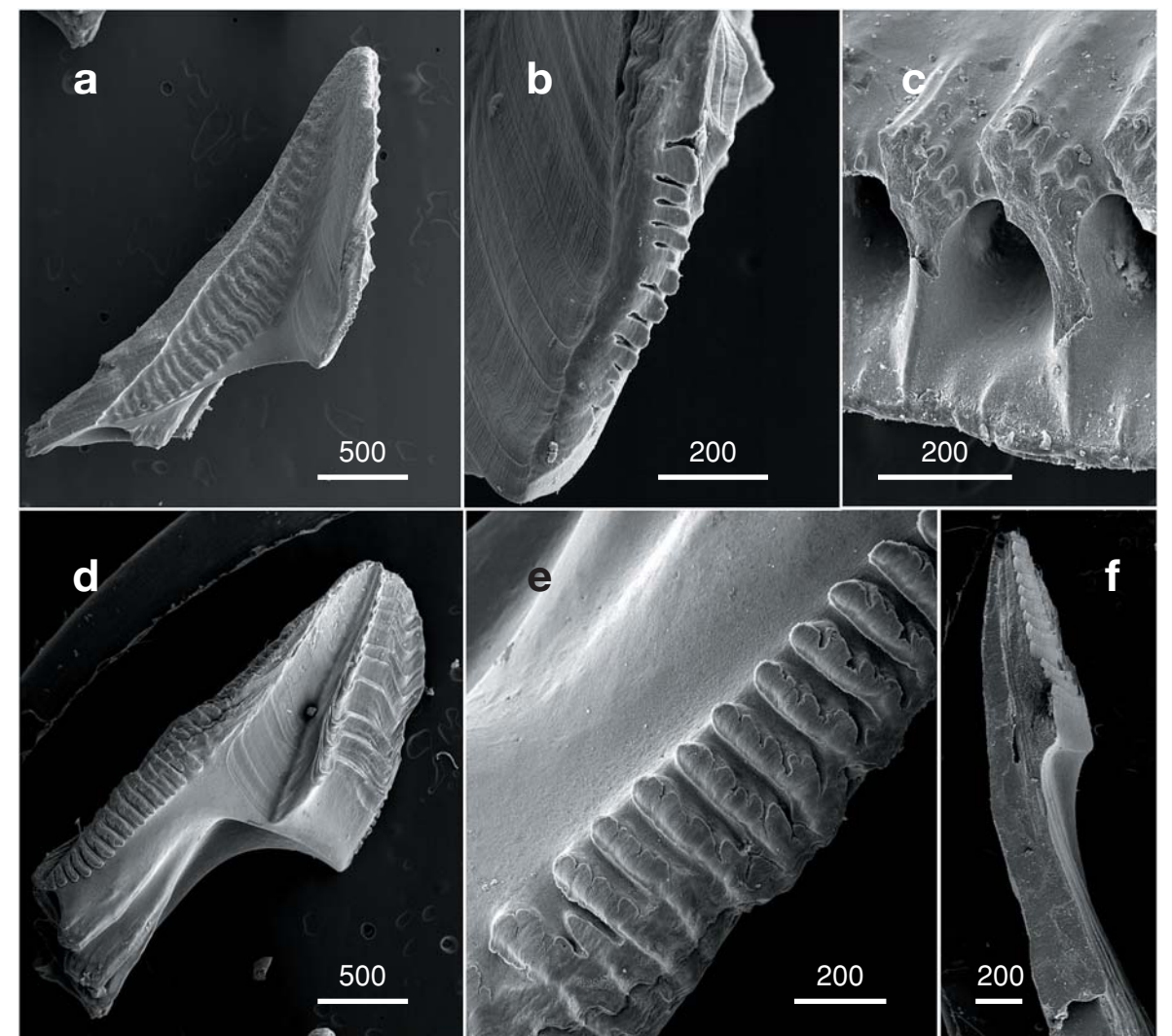


Fig. 203. *Amphibalanus reticulatus*, Dongsha, 3 Aug 2008. Scanning Electron Microscopy of the radii and alae. a, b. View of alar sutural edges of alae (superior alar margin). c. Basal view of shell showing the primary tubes, d., e. View of radial sutural edges of radius. f. Cross section of the shell showing solid sheath and transverse septa of primary tubes.

Amphibalanus zhujiangensis Ren, 1989
珠江紋藤壺

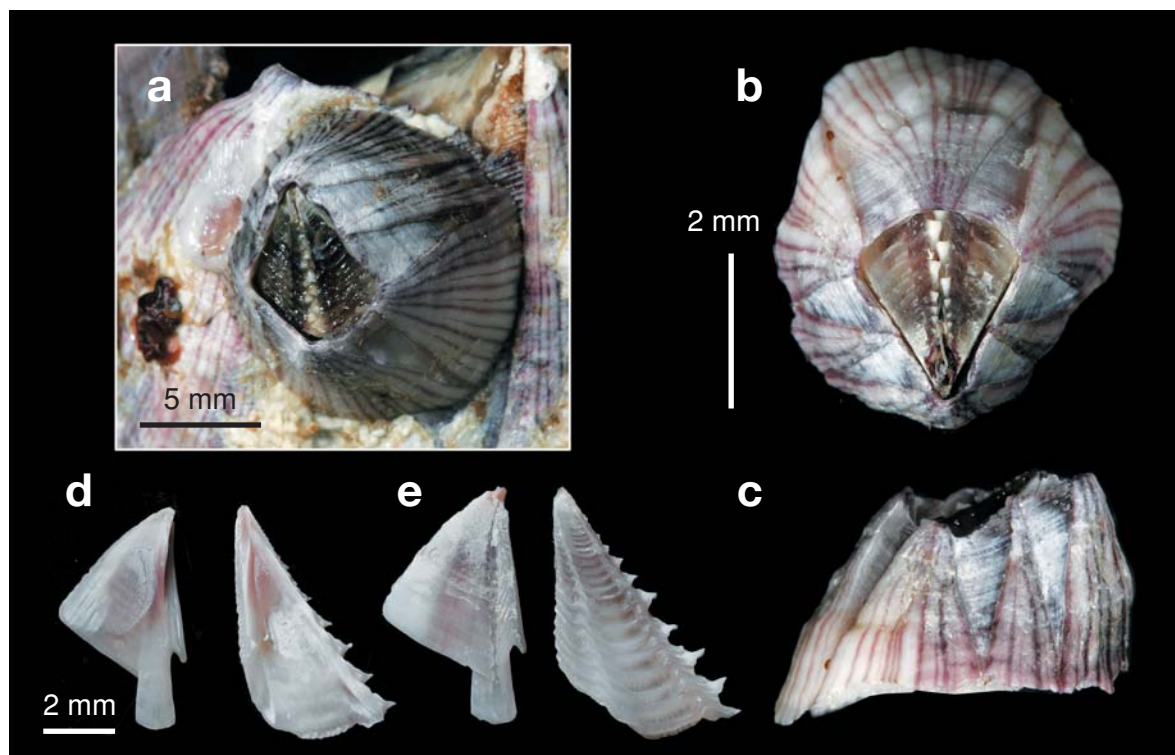


Fig. 204. *Amphibalanus zhujiangensis*, Chenggong, Taitung County, 12 Mar 2009. a, b. Top view and c. Side view of a complete parietes. d. Internal and e. External view of the scutum and tergum.

Balanus zhujiangensis Ren, 1989: 471, fig. 2, (1-13) [type locality: Zhujiang River estuary, South China Sea].
Amphibalanus zhujiangensis.—Liu & Ren, 2007: 502, fig. 227.

Material examined.—Chenggong, Taitung County, 12 Mar 2009: 1 specimen (BD 16.1 mm) (CEL-BB-106).

Diagnosis.—Shell conical, surface of parietes smooth with white or dull-purple longitudinal stripes; orifice rhomboidal, radii wide. Scutum narrow, triangular, external surface with strong horizontal depressions, occludent margin with numerous strong teeth; tergum triangular, spur wide, basi-scutal angle strongly acute. Maxilla with setae on all margins; maxillule not notched, cutting edge straight; mandible with 5 teeth excluding inferior angle, inferior angle blunt; mandibulatory palp with setae on superior margin; labrum with a deep cleft, 3 teeth on each side of cutting edge. Cirrus I rami unequal, anterior ramus 15-segmented, posterior ramus 13-segmented; cirrus II rami sub-equal, anterior ramus 12-segmented, posterior ramus 11-segmented; cirrus III rami sub-equal, anterior ramus 13-segmented, posterior ramus 15-segmented; cirrus IV, anterior ramus 34-segmented, posterior ramus 28-segmented.

Size.—BD to 30 mm.

Coloration.—The shell is white or dull-purple with lilac longitudinal stripes.

Habitat.—Attaches onto floating balls in open waters or on shell surface of *Megabalanus* spp.

Distribution.—South China Sea, Taiwan.

Remarks.—*Amphibalanus zhujiangensis* is a new record to Taiwan.

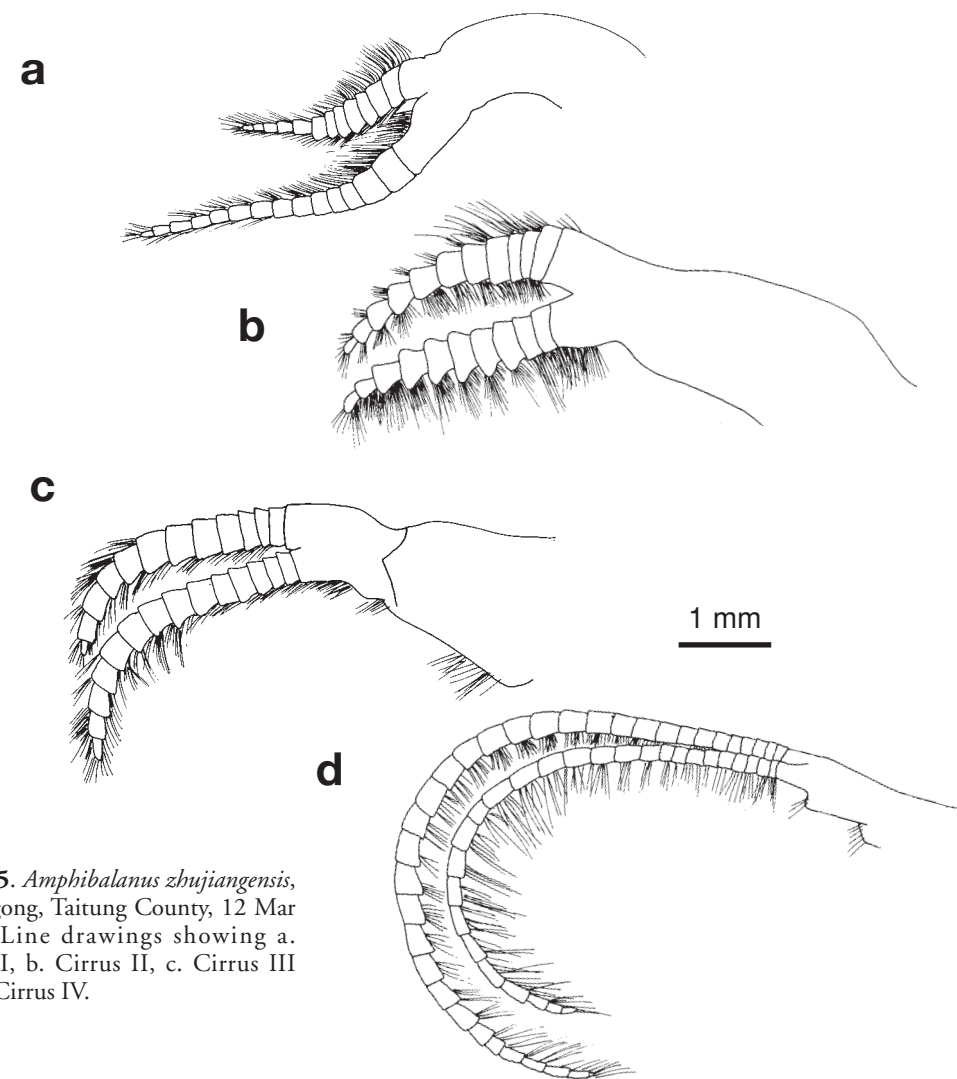


Fig. 205. *Amphibalanus zhujiangensis*, Chenggong, Taitung County, 12 Mar 2009. Line drawings showing a. Cirrus I, b. Cirrus II, c. Cirrus III and d. Cirrus IV.

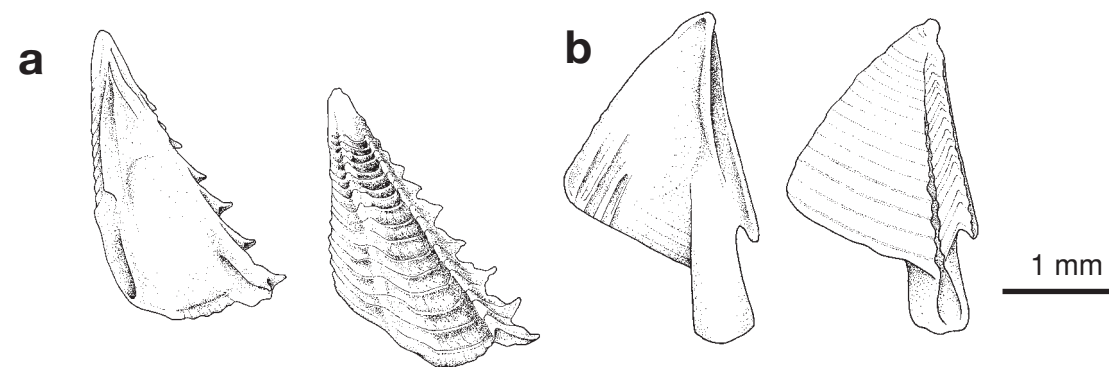


Fig. 206. *Amphibalanus zhujiangensis*, Chenggong, Taitung County, 12 Mar 2009. a. Scutum and b. Tergum.

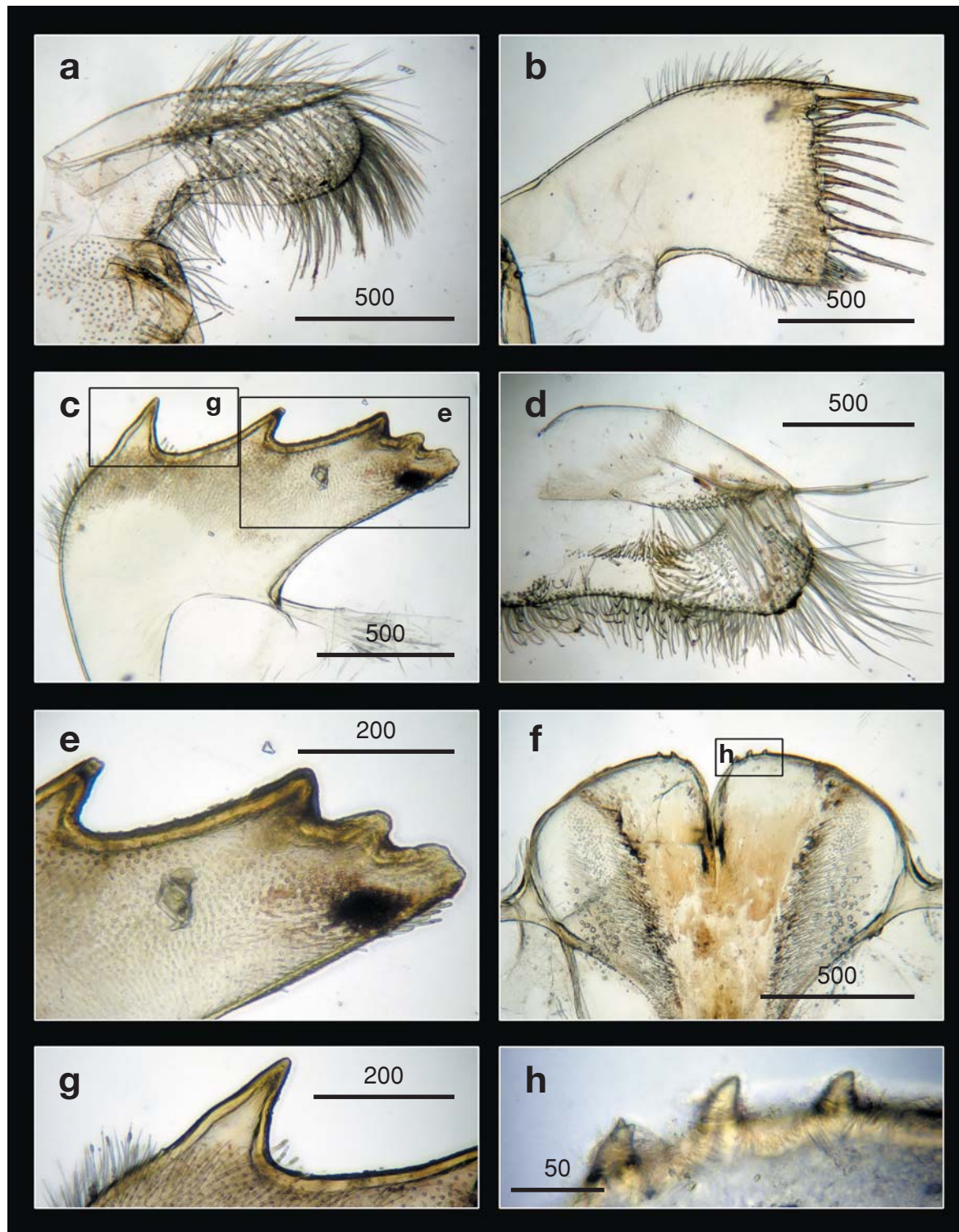


Fig. 207. *Amphibalanus zhujiangensis*, Chenggong, Taitung County, 12 Mar 2009. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in µm.

Amphibalanus amphitrite (Darwin, 1854)
紋藤壺



Fig. 208. *Amphibalanus amphitrite*. Kinmen Island, Jul 2007.

Balanus amphitrite var. (1) *communis* Darwin, 1854: 240 (in part).
Balanus amphitrite Weltner, 1897: 264.—Pilsbry, 1907b: 190.—1928: 312.
Balanus amphitrite communis.—Hiro, 1939d: 263.
Balanus amphitrite hawaiiensis.—Hiro, 1939d: 260.
Amphibalanus amphitrite.—Pitombo, 2004: 263.

Material examined.—Kinmen Island, Jul 2007.

Diagnosis.—Shell conical, surface smooth, with longitudinal deep-purple striations. No horizontal striations on shell surface. Tergum with short, wide spur.

Coloration.—Shell white with longitudinal purple striations.

Size.—BD to 20 mm.

Distribution.—Distributed worldwide.

Remarks.—*Amphibalanus amphitrite* is one of the common fouling species on ship bottoms and distributed throughout the world oceans due to transit by long-distance vessels. There are numerous reports on the existence of *A. amphitrite* and the present synonyms and records focused on the key references and previous records in Taiwan (Weltner, 1897).

Amphibalanus poecilotheca (Krüger, 1911)
缺斑紋藤壺

Balanus poecilotheca Krüger, 1911: 48, figs. 95-97, pl. 1, figs. 2c-e, pl. 3, fig. 32.

Balanus amphitrite poecilotheca.—Hiro, 1939d: 263.

Material examined.—Makung, Penghu County (data from Krüger, 1911).

Diagnosis.—Shell conical, shell plates very thick, with irregular red and purple stripes. Rostrum pale, carina dark. Tergum spur short and wide.

Size.—BD to 16 mm (Data from Liu & Ren, 2007).

Coloration.—Shell white with red and purple stripes.

Distribution.—Indo-Pacific waters.

Remarks.—We have not yet collected this species from Taiwan.

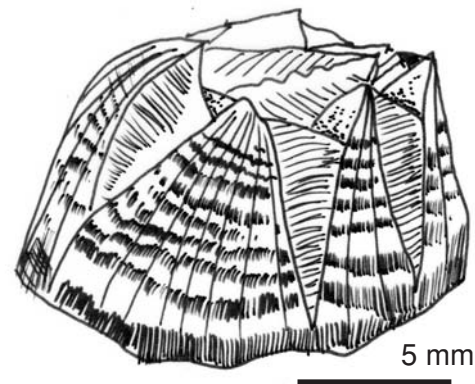


Fig. 209. *Amphibalanus poecilotheca*, Mainland China. Redrawn from Liu & Ren (2007).

Genus *Fistulobalanus* Zullo, 1984
管藤壺屬

Balanus Da Costa.—Pilsbry, 1930: 431.

Fistulobalanus Zullo, 1984: 1330.—Pitombo, 2004: 274.—Liu & Ren, 2007: 503.

Diagnosis.—Shell wall with 6 plates, radii solid, base calcareous and porous. Wall with 2 rows of parietal tubes, including a single row of primary tubes and small irregularly arranged subsidiary tubes between primary tubes and outer laminae.

Key to species of *Fistulobalanus* from Taiwan

1. Outer surface of shells smooth; tergum with deeply clefted basal margin *Fistulobalanus kondakovi*
- Outer surface of shells ribbed; tergum with concave basal margin *Fistulobalanus albicostatus*

Fistulobalanus albicostatus Pilsbry, 1916

白脊管藤壺

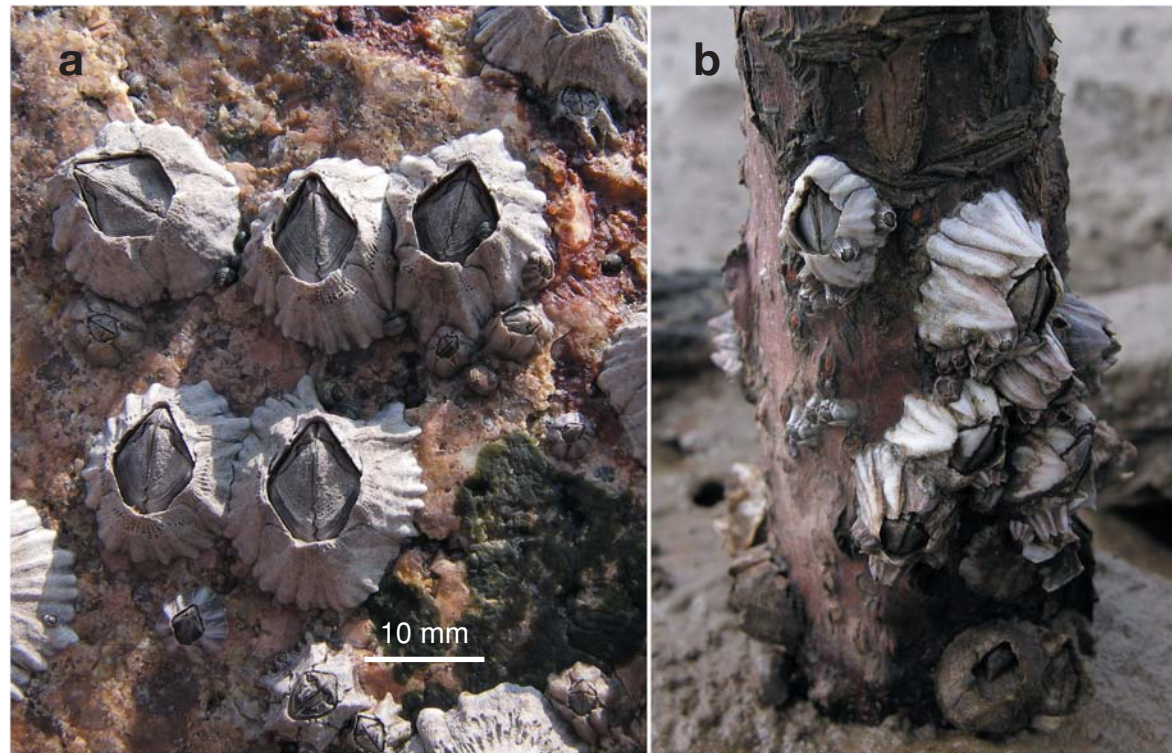


Fig. 210. *Fistulobalanus albicostatus*, Kinmen, 21 Aug 2006. In-situ view on shores.

Balanus amphitrite albicostatus Pilsbry, 1916: 90, figs. 18a, b, pl. 20, figs. 1-4.—Nilsson-Cantell, 1921: 314.—Hiro, 1938: 303, figs. 3a-d.—1956: 52, pl. 26, fig. 19.—Utinomi, 1964: 52, pl. 26, fig. 10.

Balanus amphitrite forma *formosanus* Hiro, 1938: 306, figs. 6a-h, 7a-c.

Balanus albiostatus albicostatus.—Utinomi, 1967: 209, figs. 4a-c, 5a-g, pl. 6, fig. 2.—Newman & Ross, 1976: 62.

Balanus albicostatus formosanus.—Utinomi, 1967: 212, figs. 6a-c, 7a-d, pl. 6, fig. 3.

Balanus albicostatus.—Henry & McLaughlin, 1975: 108, text-figs. 20, 22a, pl. 10, figs. h-k, pl. 11, figs. m, n.

Fistulobalanus albicostatus.—Pitombo, 2004: 275.—Liu & Ren, 2007: 503, fig. 228.

Material examined.—Kinmen, 21 Aug 2006: 83 specimens (BD 3.92-9.79 mm) (CEL-BB-4).—Guanyin, Taoyuan County, 14 Sep 2006: 313 specimens (BD 3.35-10.40 mm) (CEL-BB-8).

Diagnosis.—Shell conical and surface ribbed with white striations; radii solid, base calcareous and porous; wall with 2 rows of parietal tubes, including a single row of primary tubes and small irregularly arranged subsidiary tubes between primary tubes and outer laminae. Scutum triangular, occludent margin straight; tergum narrow, basal margin concave, basi-scutal angle acute. Maxilla bilobed with setae on inferior margin; maxillule not notched, cutting margin straight; mandible with 4 teeth excluding inferior angle, lower margin with small blunt teeth; mandibulatory palp with setae on superior margin; labrum with deep cleft, 3 teeth on each side of cutting edge.

Size.—BD to 20 mm.

Coloration.—Shell reddish-grey or deep-pink with pronounced white longitudinal ribs.

Habitat.—On intertidal rocks of estuarine areas and mangrove trunks.

Distribution.—Indo-Pacific waters.

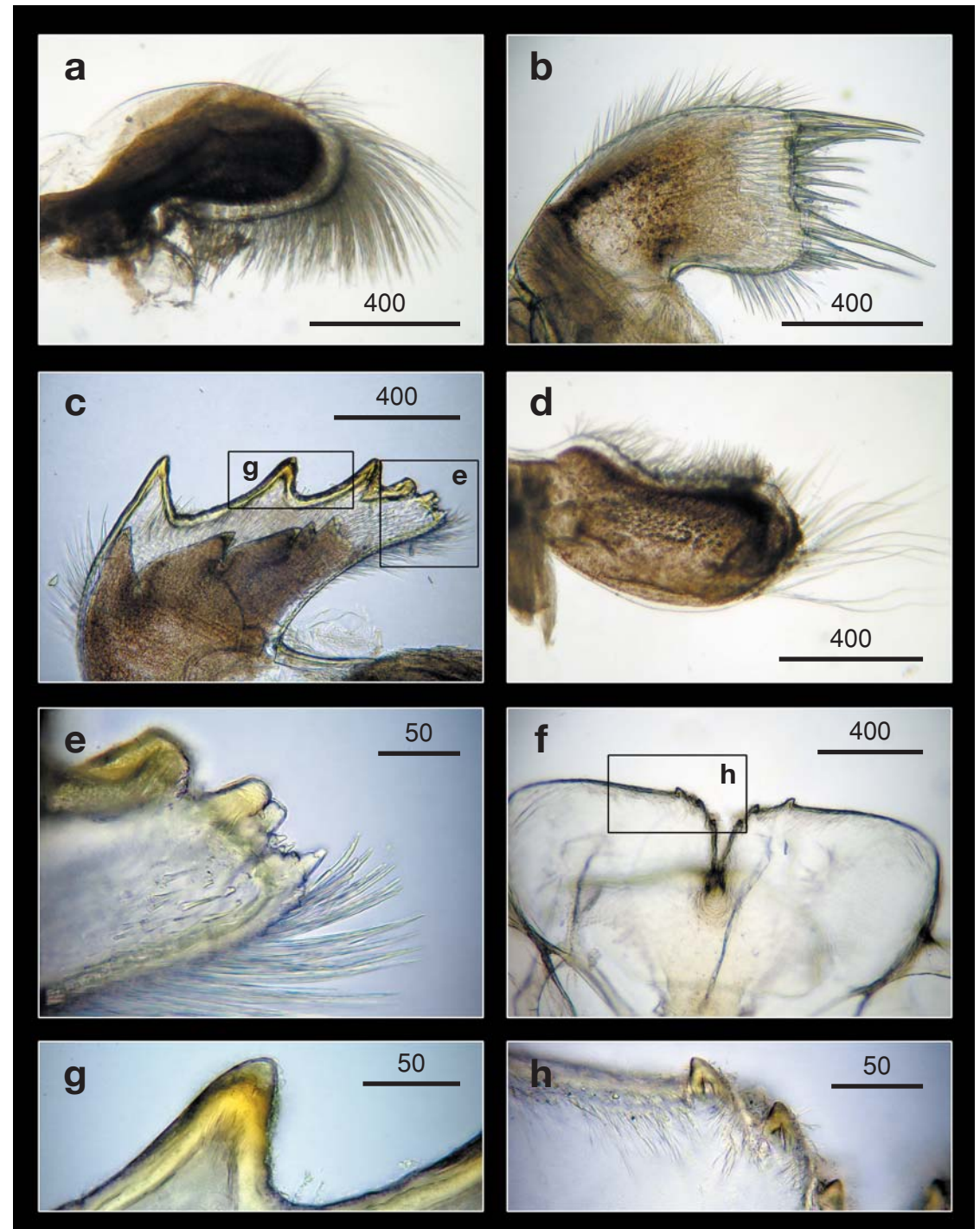


Fig. 211. *Fistulobalanus albicostatus*, Kinmen, 21 Aug 2006. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

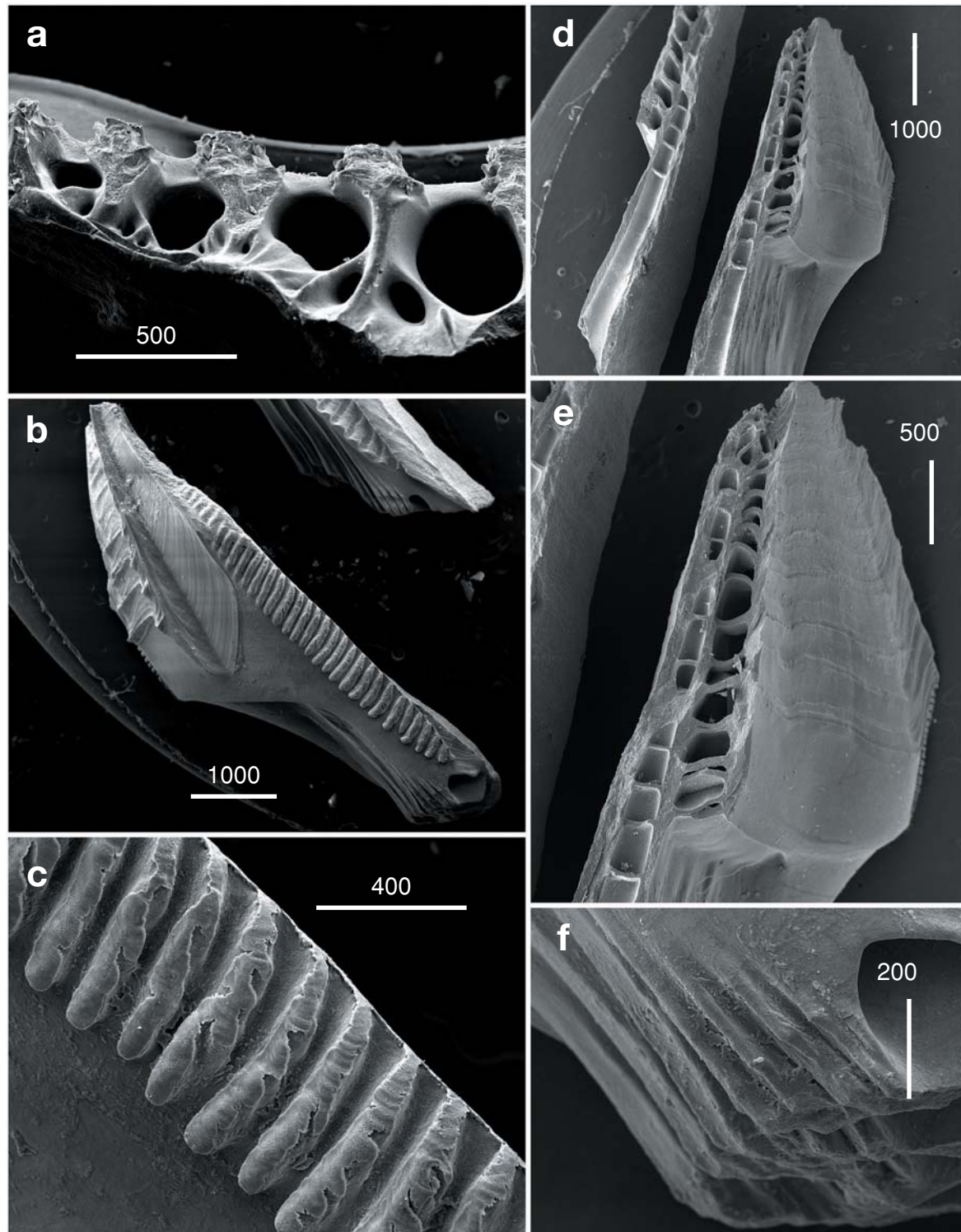


Fig. 212. *Fistulobalanus albicostatus*, Kinmen, 21 Aug 2006. SEM on radii and alae. a. Basal view of shell showing interlaminar primary tubes with secondary (subsidiary) tubes. b, c. View of radial sutural edges of radius. d, e. Cross section of the shell showing vesicular sheath and transverse septa of primary tubes. f. Lateral denticles on longitudinal septa of parietes.

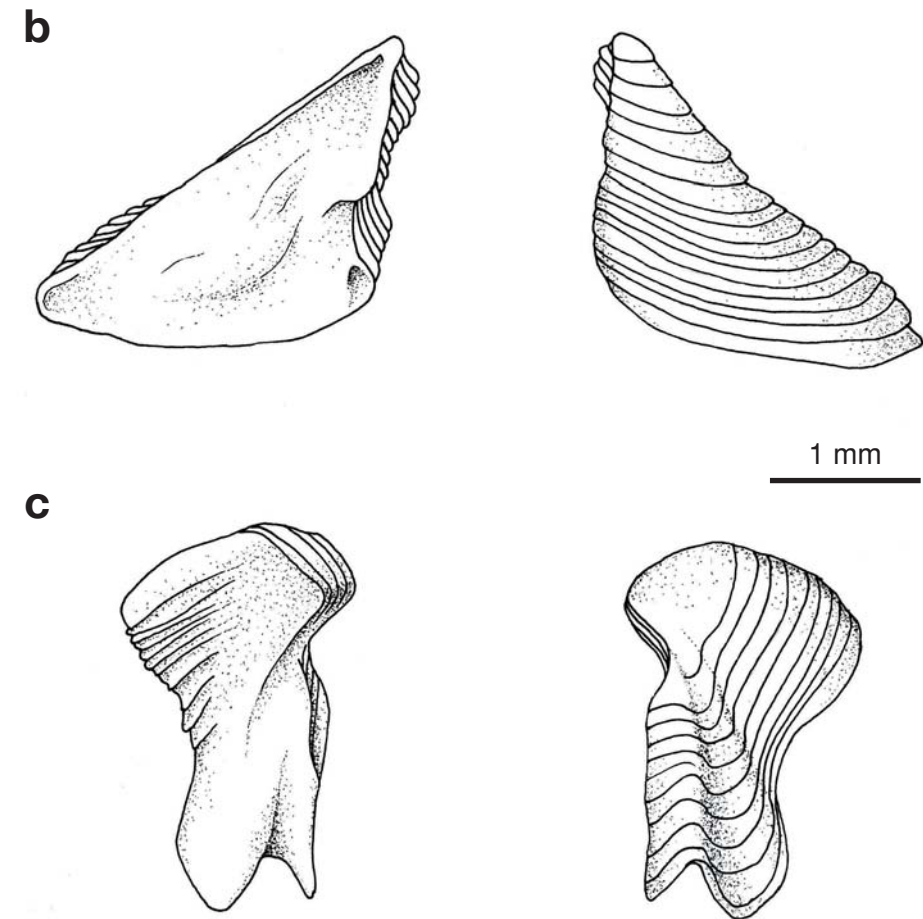
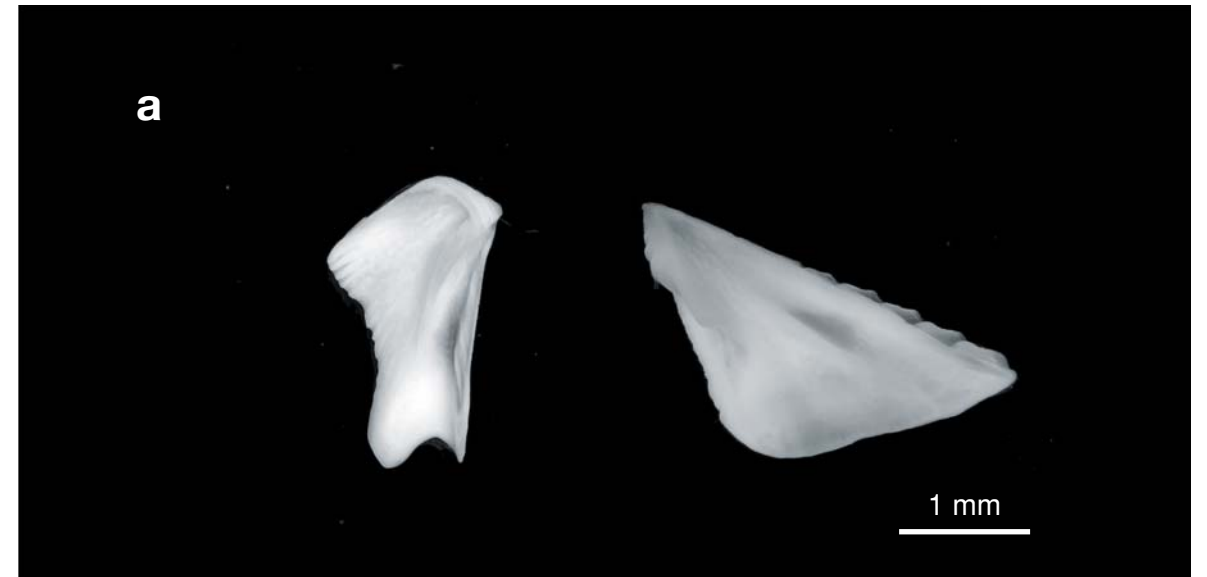


Fig. 213. *Fistulobalanus albicostatus*, Kinmen, 21 Aug 2006. a. Internal view of scutum and tergum. Line drawing of b. Scutum and c. Tergum.

Fistulobalanus kondakovi (Tarasov & Zevina, 1957)
泥管藤壺

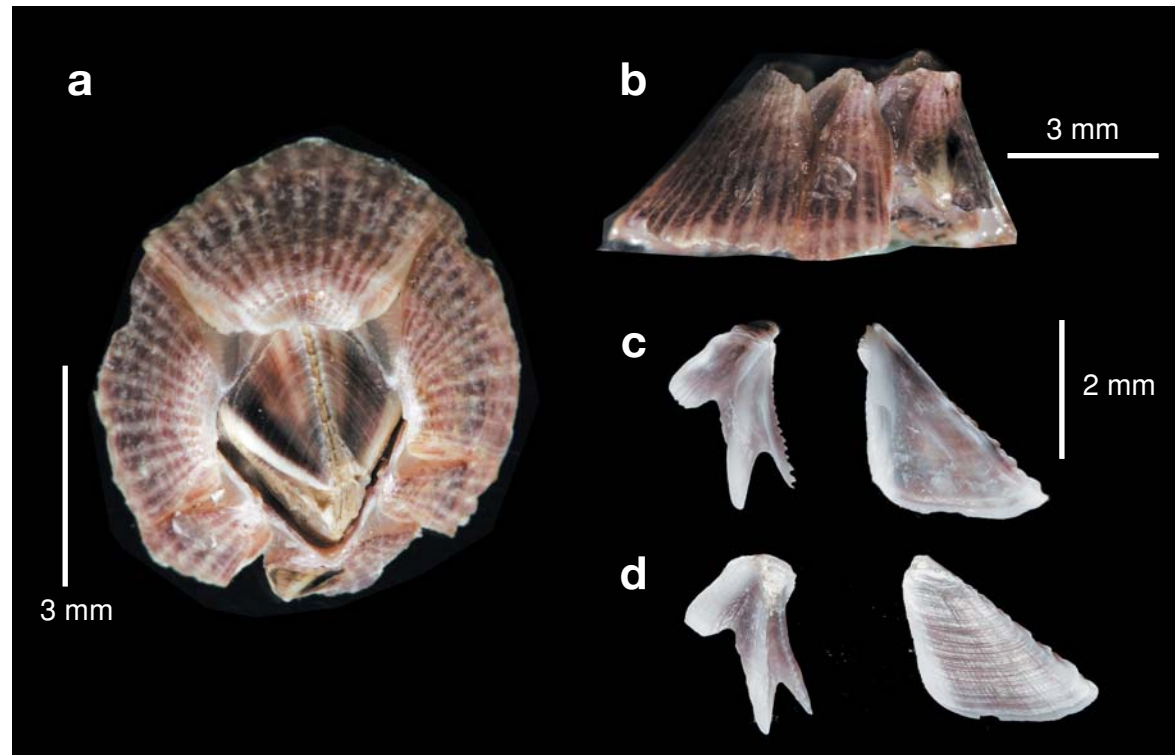


Fig. 214. *Fistulobalanus kondakovi*, Wazihwei, Taipei County, 8 Dec 2005. a. Top view and b. Side view of a complete parietes. c. Internal and d. External view of scutum and tergum.

Balanus amphitrite var. *niveus* Darwin, 1854: 240.—Krüger, 1911: 51, pl. 4, fig. 35.

Balanus amphitrite var. *kondakovi* Tarasov & Zevina, 1957: 179, 191, fig. 76.

Balanus amphitrite kondakovi.—Newman & Ross, 1976: 63.

Balanus uliginosus Utinomi, 1967: 202, figs. 12, pl. 6, figs. 4-6.—1970: 356.—Newman & Ross, 1976: 64.—Ren & Liu, 1978: 143; fig. 13, pl. 3, figs. 10-16.

Balanus kondakovi.—Henry & McLaughlin, 1975: 114, figs. 21, 22b, c, 22f, pl. II, figs. a-m.

Fistulobalanus kondakovi.—Zullo, 1984: 1330.—Pitombo, 2004: 275.—Liu & Ren, 2007: 506, fig. 229.

Material examined.—Wazihwei, Taipei County, 8 Dec 2005: 18 specimens (BD 3.41-7.23 mm) (CEL-BB-95).

Diagnosis.—Shell with 6 plates, plate surfaces smooth, background dull-red with purple stripes. Scutum triangular, dorsal surface with horizontal striations; tergum arrow-shaped, scutal margin straight, basi-scutal angle very acute, spur long and narrow. Maxilla globular; maxillule not notched; mandible with 4 teeth excluding inferior angle; mandibulatory palp elongated, with long setae on tip; labrum clefted, with 3 large sharp teeth on each side of cutting edge.

Size.—BD to 20 mm.

Coloration.—Shell dull-red with purple stripes.

Habitat.—On rocks in estuarine coastal areas.

Distribution.—Indo-Pacific region.

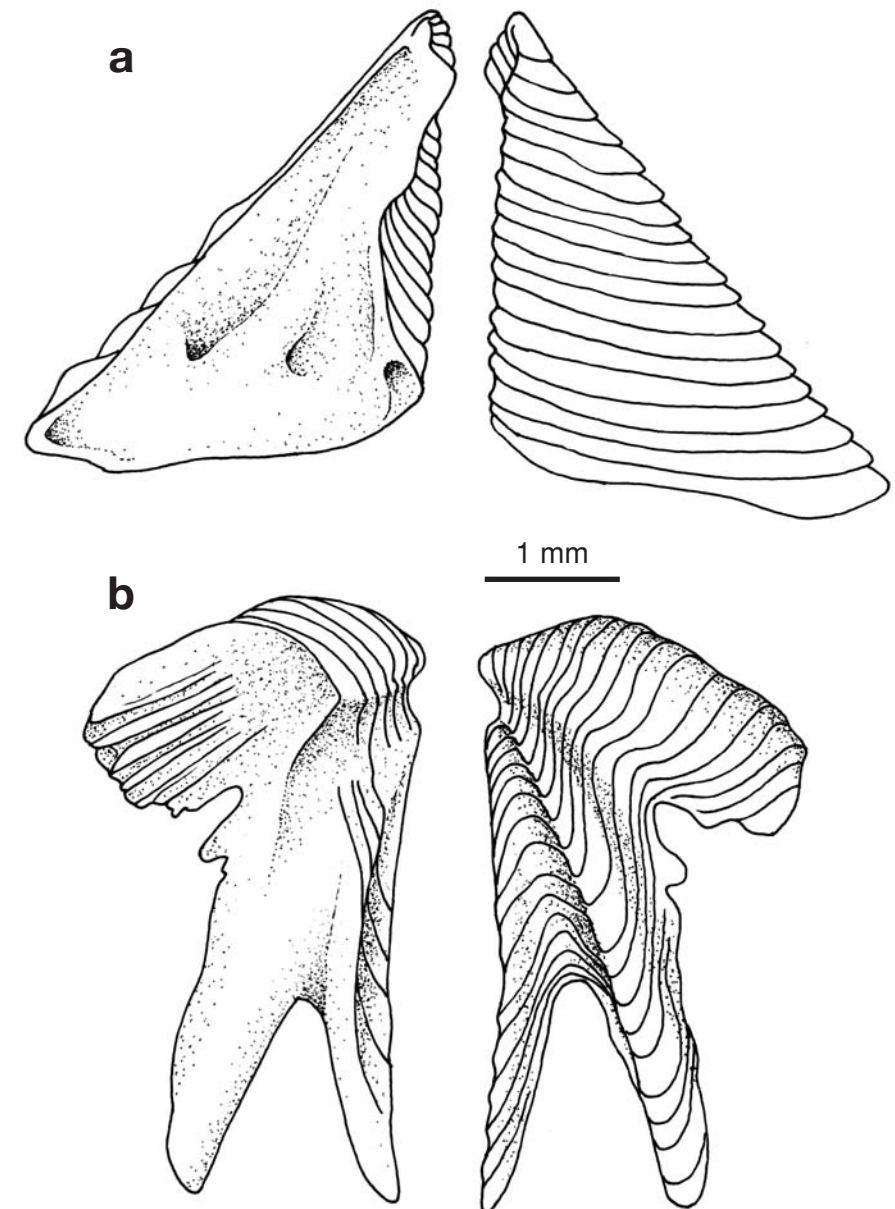


Fig. 215. *Fistulobalanus kondakovi*, Wazihwei, Taipei County, 8 Dec 2005. Line drawings of a. Scutum and b. Tergum.

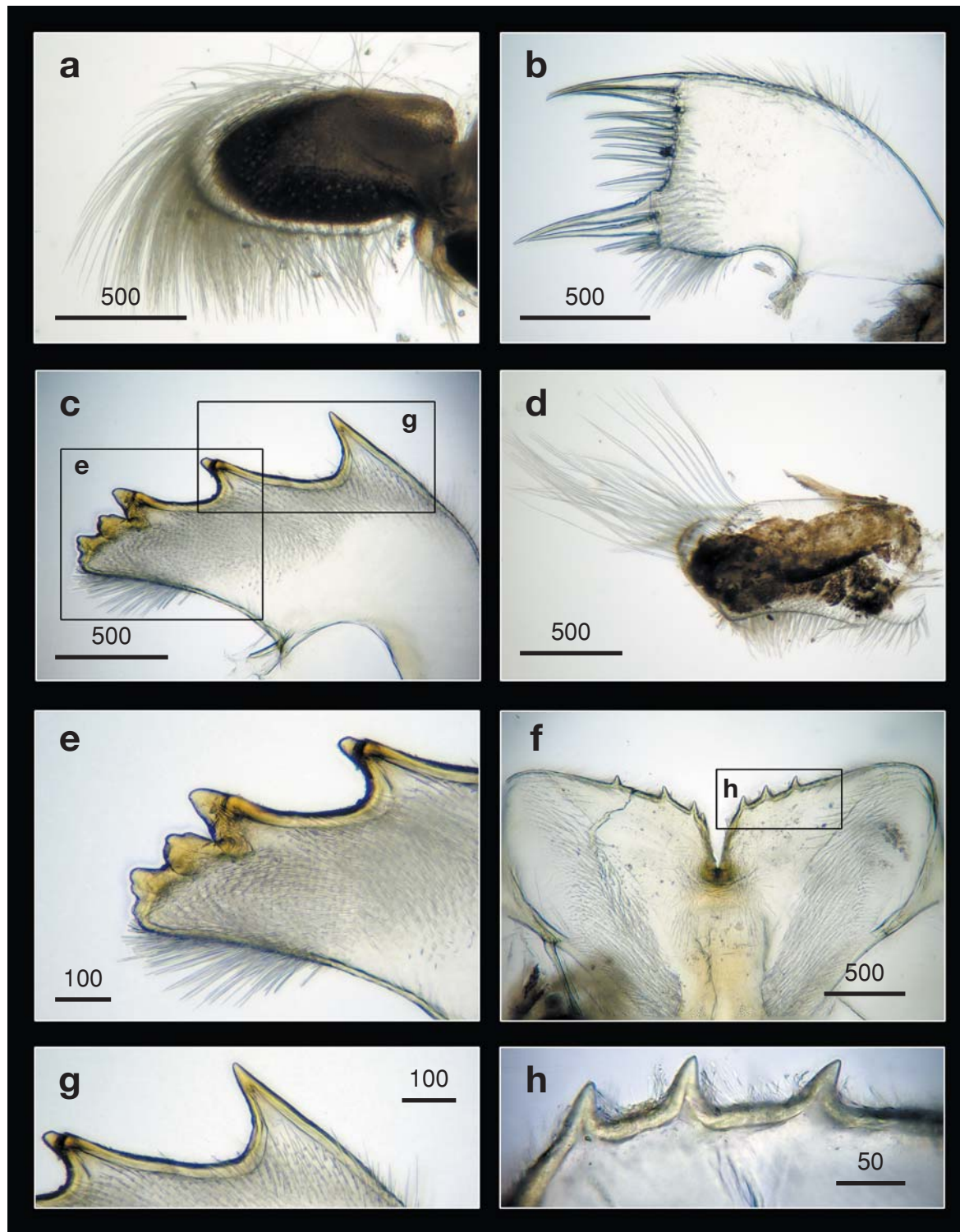


Fig. 216. *Fistulobalanus kondakovi*, Wazihwei, Taipei County, 8 Dec 2005. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

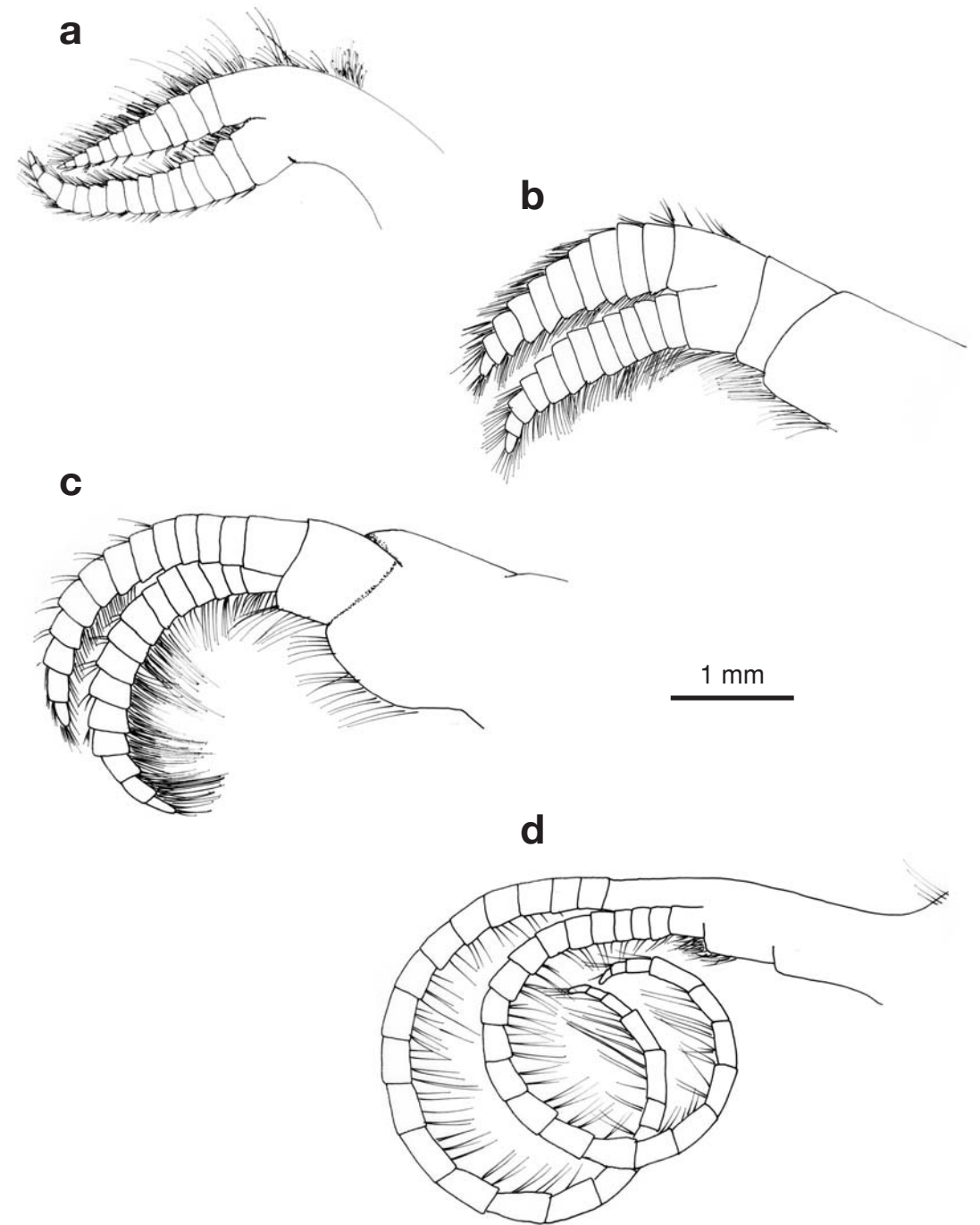


Fig. 217. *Fistulobalanus kondakovi*, Wazihwei, Taipei County, 8 Dec 2005. Line drawings showing a. Cirrus I, b. Cirrus II, c. Cirrus III and d. Cirrus IV.

Subfamily Megabalaninae Newman, 1979

巨藤壺亞科

Megabalaninae Newman, 1979: 279.—Buckeridge, 1983: 103.—Newman, 1996: 503.—Pitombo, 2004: 265.

Diagnosis.—Parietes tubiferous; radii tubiferous, base calcareous.

Remarks.—4 genera were recently classified into the Megabalaninae; 1 genus was recorded in Taiwan.

Genus *Megabalanus* Hoek, 1913

巨藤壺屬

Balanus Section A Darwin, 1854: 194.

Megabalanus Hoek, 1913: 158.—Pilsbry, 1916: 51.—Newman et al., 1969: 258.—Newman & Ross, 1976: 67.—Ren & Liu, 1978: 121.—Pitombo, 2004: 275.

Diagnosis.—Parietes with 6 plates, paries, radii, and base tubiferous.

Key to species of *Megabalanus* from Taiwan

1. Epibiotic on fire corals *Megabalanus ajax*
Live on abiotic surfaces 2
2. Parietes surface with wide, sculptured longitudinal ribs or striations 3
Parietes surface without wide, sculptured longitudinal ribs or striations 4
3. Ribs or striations white *Megabalanus zebra*
Ribs or striations coloured *Megabalanus validus*
4. Parietes surface with spines, external surface of scutum with longitudinal striations 5
Parietes surface without spines, external surface of scutum without longitudinal striations 6
5. Spur furrow of tergum closed, spur width less than the basi scutal length *Megabalanus volcano*
Spur furrow of tergum open, spur width equal or greater than the basi scutal length *Megabalanus occator*
6. Parietes rose red, surface smooth, spur wide and short *Megabalanus rosa*
Parietes purple, surface smooth with dark purple stripes, spur narrow and long *Megabalanus tintinnabulum*

Megabalanus ajax (Darwin, 1854)

亞傑巨藤壺

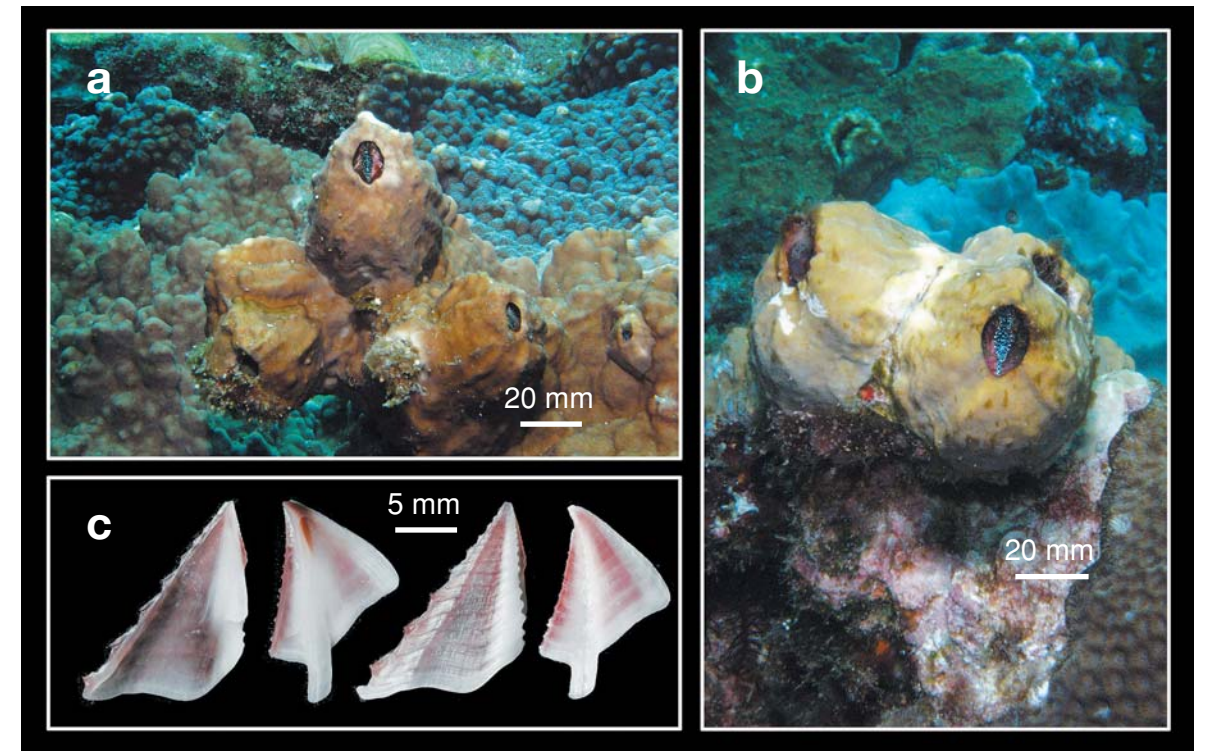


Fig. 218. *Megabalanus ajax*, Lyudao, Taitung County, 17 Jun 2008. a, b. *In-situ* view on shores. c. Internal and external view of the scutum and tergum.

Balanus ajax Darwin, 1854: 214, pl. 3, figs. 1a-d (in part).—Pilsbry, 1916: 74.—Nilsson-Cantell, 1938: 34, fig. 6.

Megabalanus ajax.—Newman & Ross, 1976: 67.—Ross, 1999: 275, fig. 1.

Megabalanus stultus.—Soong & Changlai, 1992: 24, figs. 1, 2 (Non *M. stultus* Darwin, 1854).

Material examined.—Lyudao, Taitung County, 17 June 2008: 1 specimen (BD 41.84 mm) (CEL-BB-112).

Diagnosis.—Shell massive and conical, surface smooth and often overgrown with fire coral *Millepora* spp., tergal scutal flaps with bright-blue coloration. Scutum and tergum with purple striations, scutum triangular, higher than wide, occludent margin straight with teeth, external surface with strong horizontal lines and faint longitudinal striations; tergum triangular with short spur, tergal margin straight. Maxilla bilobed with setae on 2 lobes; maxillule not notched; mandible with 5 teeth excluding inferior angle, 1st-4th teeth bidentated, inferior angle blunt; mandibulatory palp elongated with setae on superior margin; labrum with deep cleft and with 1 small fine tooth on each side of cutting edge. Cirrus I rami sub-equal, anterior ramus 16-segmented, posterior ramus 15-segmented; cirrus II rami sub-equal, anterior ramus 19-segmented, posterior ramus 15-segmented; cirrus III anterior ramus 17-segmented, posterior ramus 14-segmented; cirrus IV rami sub-equal, anterior ramus

41-segmented, posterior ramus 40-segmented.

Size.—BD to 50 mm.

Coloration.—Parietes pale-brown, covered by *Millepora* corals. Scutum pinkish; tergum white.

Habitat.—Epibiotic on fire coral *Millepora* species.

Distribution.—Indo-Pacific region.

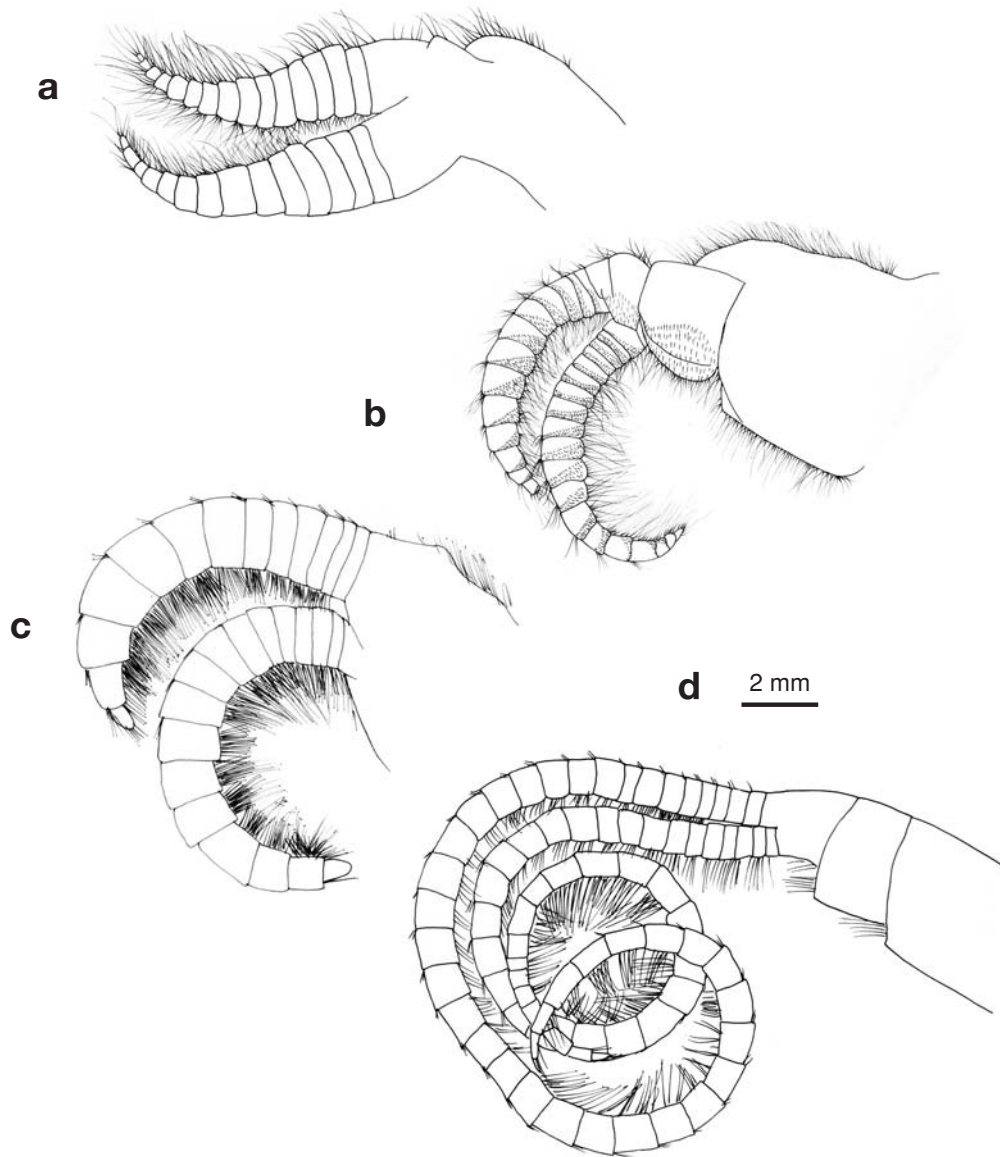


Fig. 219. *Megabalanus ajax*, Lyudao, Taitung County, 17 Jun 2008. Line drawings showing a. Cirrus I, b. Cirrus II, c. Cirrus III and d. Cirrus IV.

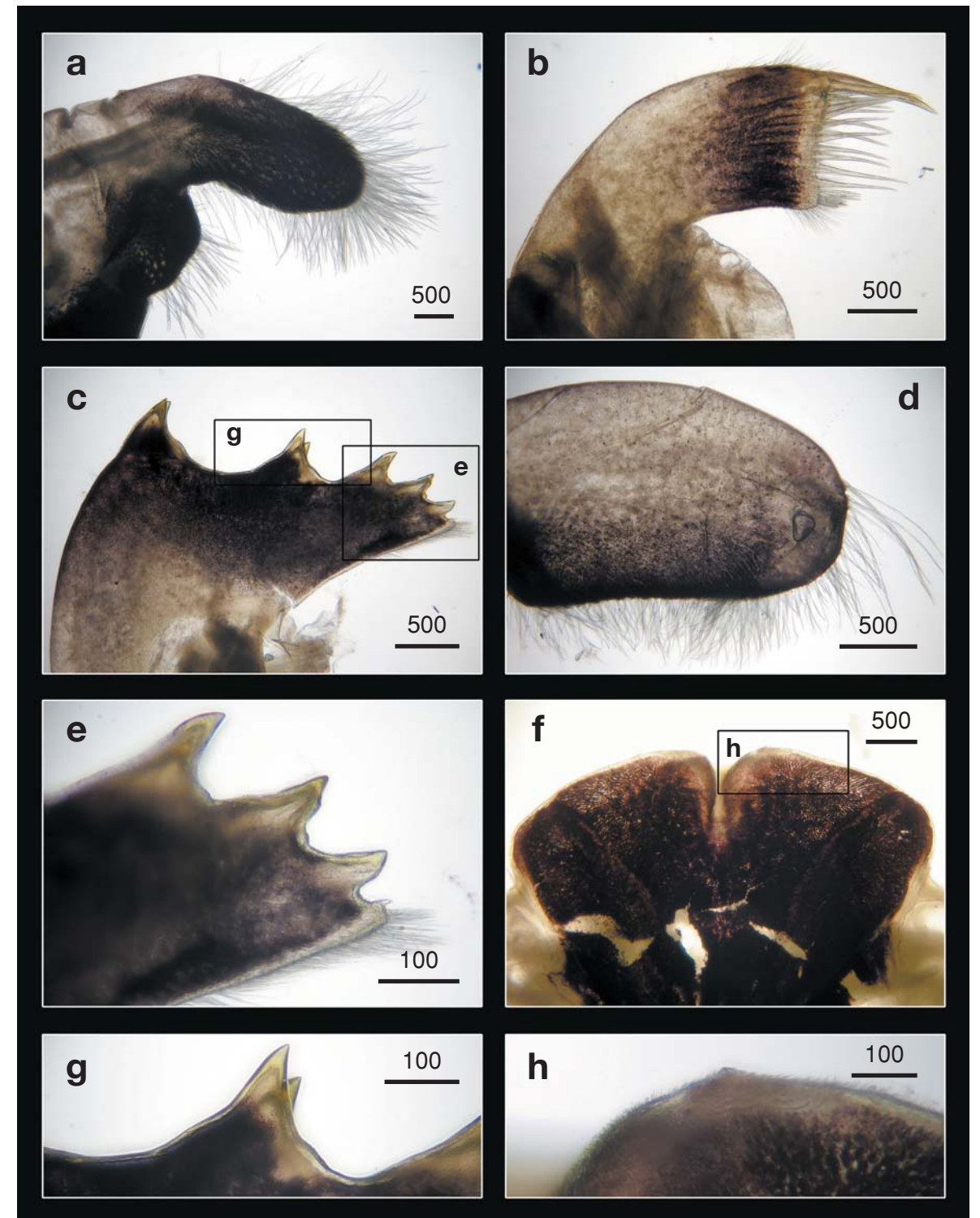


Fig. 220. *Megabalanus ajax*, Lyudao, Taitung County, 17 Jun 2008. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum. Scale bars in µm.

Megabalanus rosa Pilsbry, 1916
紅巨藤壺

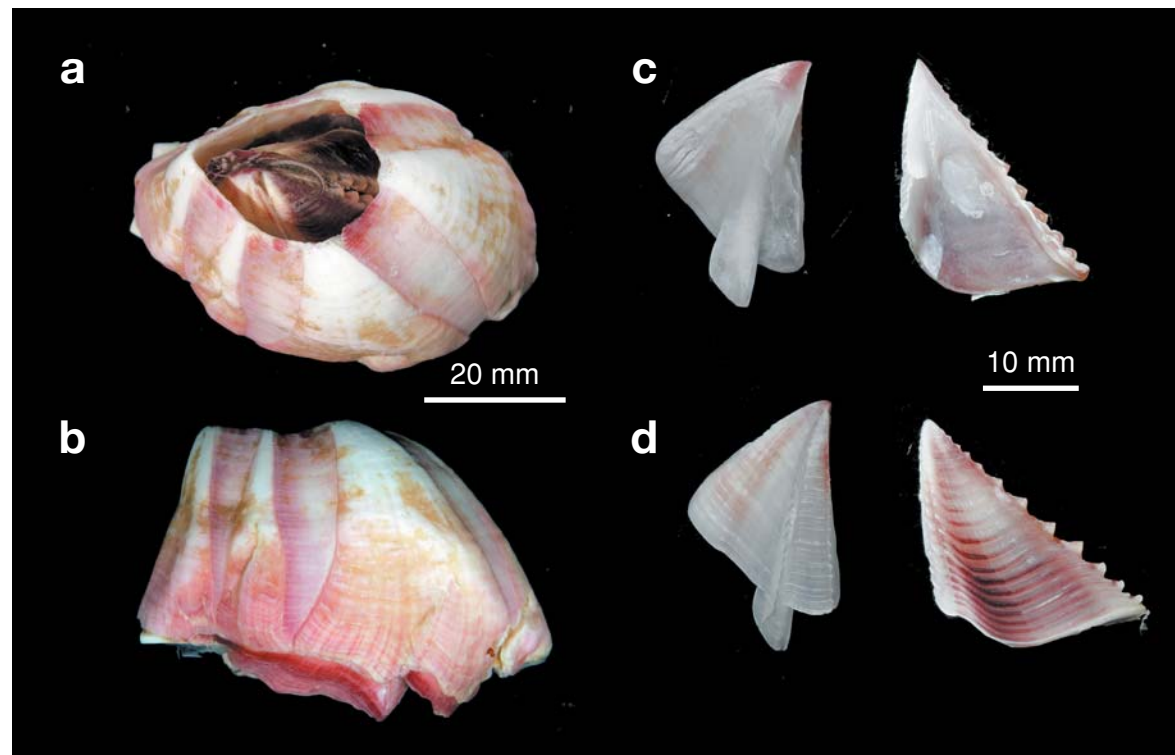


Fig. 221. *Megabalanus rosa*, Shihtiping, Hualien County, 22 Mar 2007. a. Top view, b. Side view of a complete parietes. c. Internal view and d. External view of scutum and tergum.

Balanus tintinnabulum rosa Pilsbry, 1916: 61 [type locality: Azabu, Japan].—Hiro, 1932b: 549, figs. 3a, b.—1937b: 431, fig. 19b.—Nilsson-Cantell, 1932: 16, text-fig. 6, pl. 1, fig. 3.

Balanus (Megabalanus) tintinnabulum rosa.—Tarasov & Zevina, 1957: 164, figs. 55, 56.—Utinomi, 1970: 349, pl. 18, fig. 7.

Balanus (Megabalanus) rosa.—Yamaguchi, 1973: 130, fig. 10, pl. 6, figs. 1a-j, 3, 6, 7, pl. 7, figs. 3a, 4b, pl. 8, figs. 1, 2b.—Ren & Liu, 1978: 127, text-fig. 4, pl. 1, figs. 17-21.

Megabalanus rosa Newman & Ross, 1976: 68.

Material examined.—Dasi fishing port, Yilan County, 2 specimens (BD 22.27 mm, other one broken) (CEL-BB-2).—Shihtiping, Hualien County, 22 Mar 2007: 1 specimen (BD 14.08 mm) (CEL-BB-41).

Diagnosis.—Surface of parietes smooth, pink or white; radii wide, summits horizontal. Scutum triangular, external surface with strong horizontal striations; tergum triangular, spur short and wide. Maxilla elongated, with setae on all margins; maxillule slightly notched; mandible with 5 teeth excluding inferior angle; labrum with a deep cleft, with 3 sharp teeth on each side of cutting edge. Cirrus I rami unequal, anterior ramus longer, 22-segmented, posterior ramus 14-segmented; cirrus II rami sub-equal, anterior ramus 14-segmented, posterior ramus 12-segmented; anterior ramus of cirrus III, 15-segmented; posterior ramus 17-segmented; cirri IV-VI similar in morphology; cirrus IV rami sub-equal, anterior ramus 34-segmented; posterior ramus 25-segmented.

Size.—BD to 30 mm.

Coloration.—Parietes pink to reddish-purple, some individuals entirely white; radii slightly darker than parietes.

Habitat.—On low rocky shores or on floating pontoons.

Distribution.—Japan, China, Taiwan.

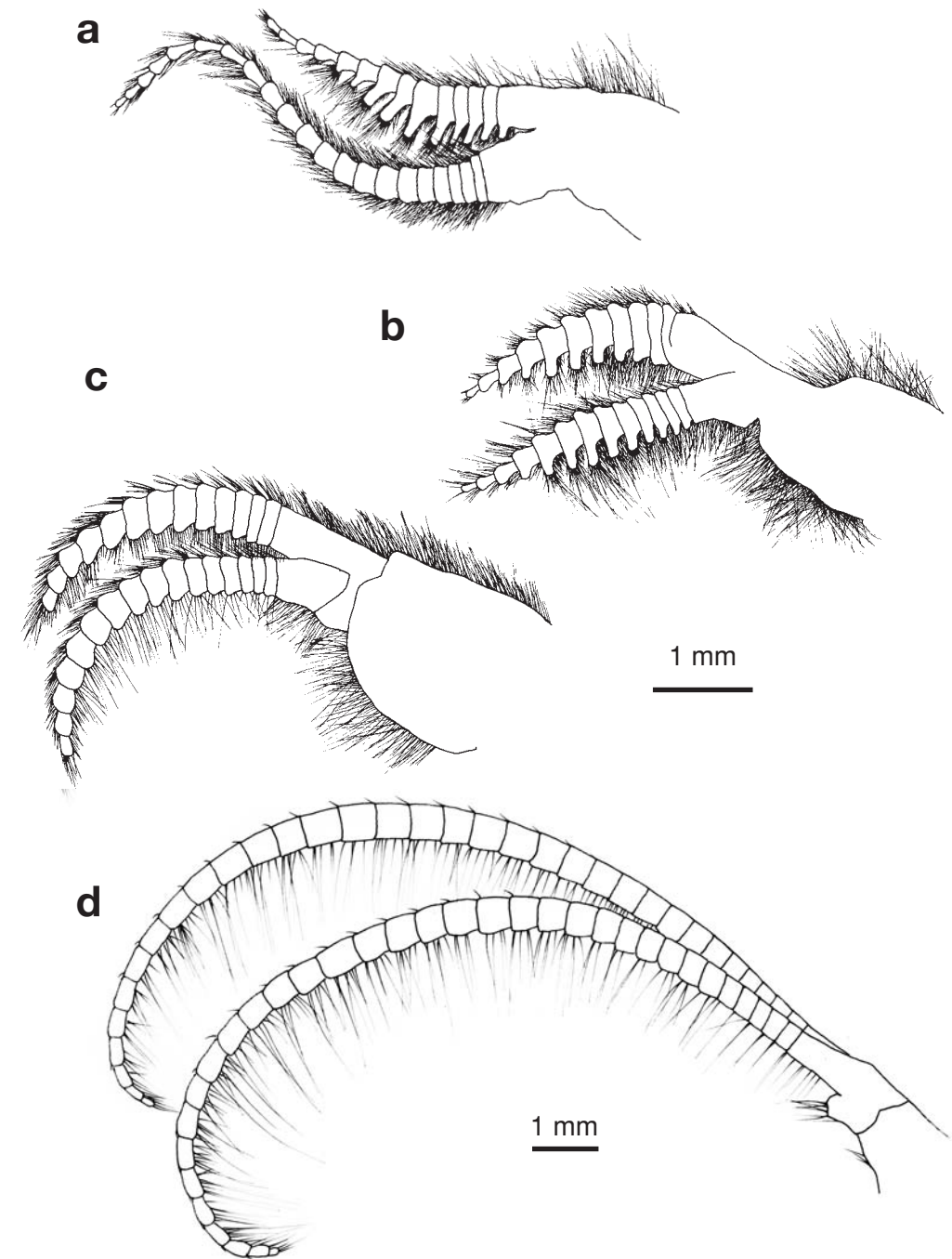


Fig. 222. *Megabalanus rosa*, Shihtiping, Hualien County, 22 Mar 2007. Line drawings showing a. Cirrus I, b. Cirrus II, c. Cirrus III and d. Cirrus IV.

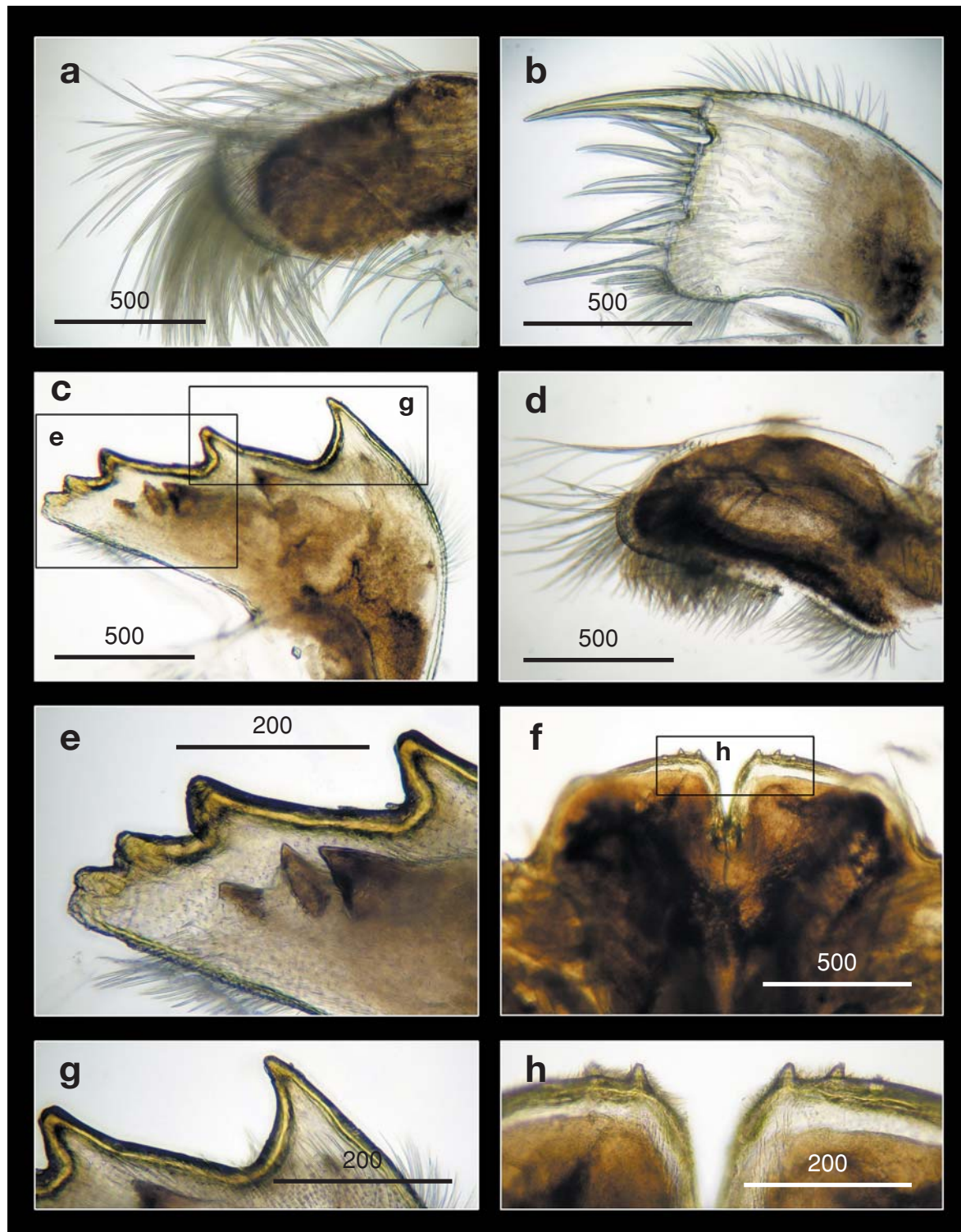


Fig. 223. *Megabalanus rosa*, Hualien County, 22 Mar 2007. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Megabalanus tintinnabulum Linnaeus, 1758
鐘巨藤壺

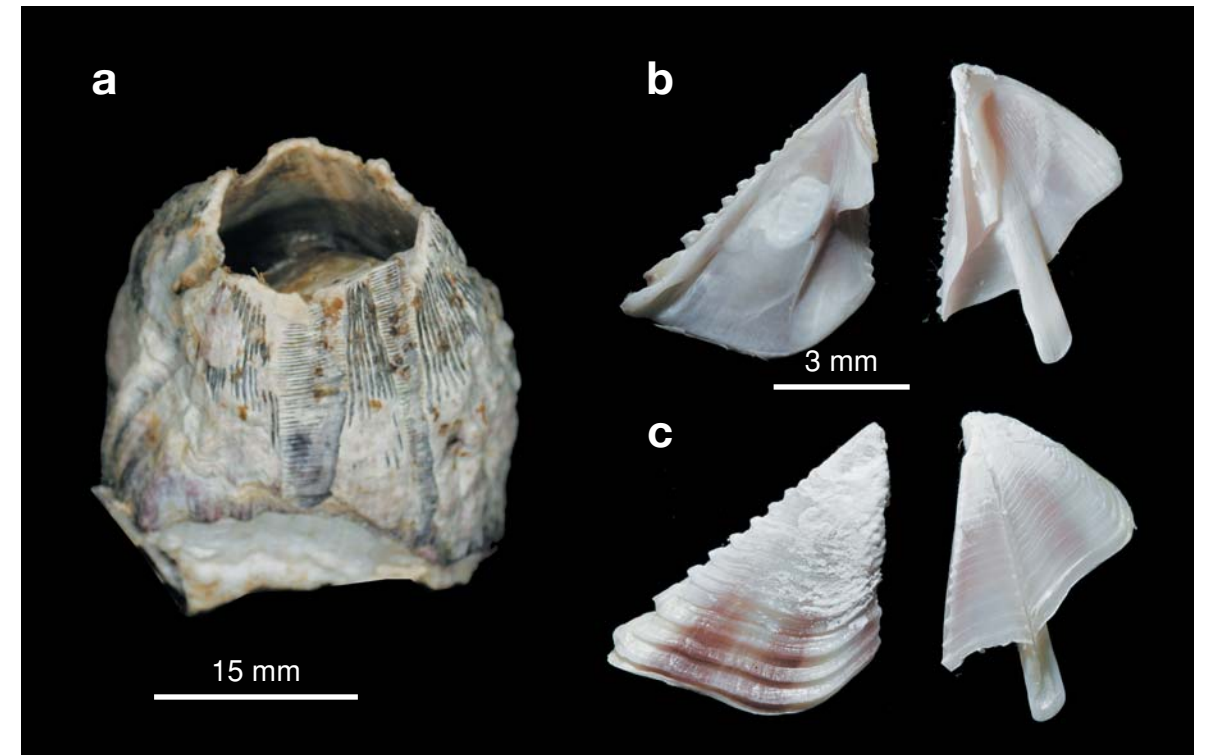


Fig. 224. *Megabalanus tintinnabulum*, Hepingdao, Keelung City, 30 Jun 2008. a. Parietes. b. Internal and c. External view of scutum and tergum.

Lepas tintinnabulum Linnaeus, 1758: 668.—Chemnitz, 1785: pl. 97, figs. 830, 831 (in part).
Balanus tintinnabulum.—Bruguère, 1789: 165 (in part).—Holthuis & Heerebout, 1972: 24, pl. 1.
Lepas tintinnabulum Wood, 1815: 38, pl. 6, figs. 1, 2.
Balanus tintinnabulum tintinnabulum.—Pilsbry, 1916: 55, pl. 10, fig. 1-1e.—Hiro, 1939d: 258, figs. 7a-b.—Daniel, 1956: 17, pl. 4, figs. 1-6.—Davadie, 1963: 26, pl. 2, fig. 4, pl. 6, figs. 1a, 2b.—Zevina & Tarasov, 1963: 87, fig. 8.—Stubbings, 1964b: 335, fig. 3.—1967: 263.
Balanus tintinnabulum var. *tintinnabulum*.—Oliveira, 1941: 11, text-fig. 1, pl. 2, figs. 1, 2, pl. 4, fig. 1, pl. 5, fig. 3, pl. 8, fig. 6.
Megabalanus tintinnabulum.—Newman & Ross, 1976: 68.—Lacombe & Rangel, 1978: 3, fig. 4.

Material examined.—Dasi fishing port, Yilan County, 2 specimens (BD 7.59 mm, another one shell broken) (CEL-BB-1).—Hepingdao, Keelung City, 30 June 2008: 25 specimens (BD 18.48-40.89 mm) (CEL-BB-11).

Diagnosis.—Parietes cylindrical to conical, depending on density of barnacles attached to substratum; surface without spines, smooth or with

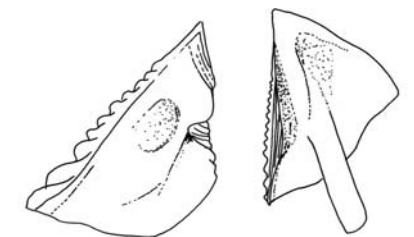


Fig. 225. *Megabalanus tintinnabulum*, Hepingdao, Keelung City, 30 Jun 2008. Line drawing showing the internal view of scutum and tergum.

longitudinal stripes; pale-purple to purple; radii wide. Scutum triangular, external surface with horizontal striations, inner surface with conspicuous articular ridge; tergum triangular, spur long and narrow; external surface with median furrow. Maxilla bilobed with setae on all margins; maxillule not notched, cutting edge straight; mandible with 5 teeth excluding inferior angle, inferior angle blunt; mandibulatory palp rectangular with setae on superior margin; labrum with deep cleft, 3 sharp teeth on each side of cutting edge.

Size.—BD to 50 mm.

Coloration.—Parietes pale-purple to purple.

Habitat.—Attaches onto low exposed rocky shores, ship bottoms, and floating pontoons.

Distribution.—Distributed worldwide.

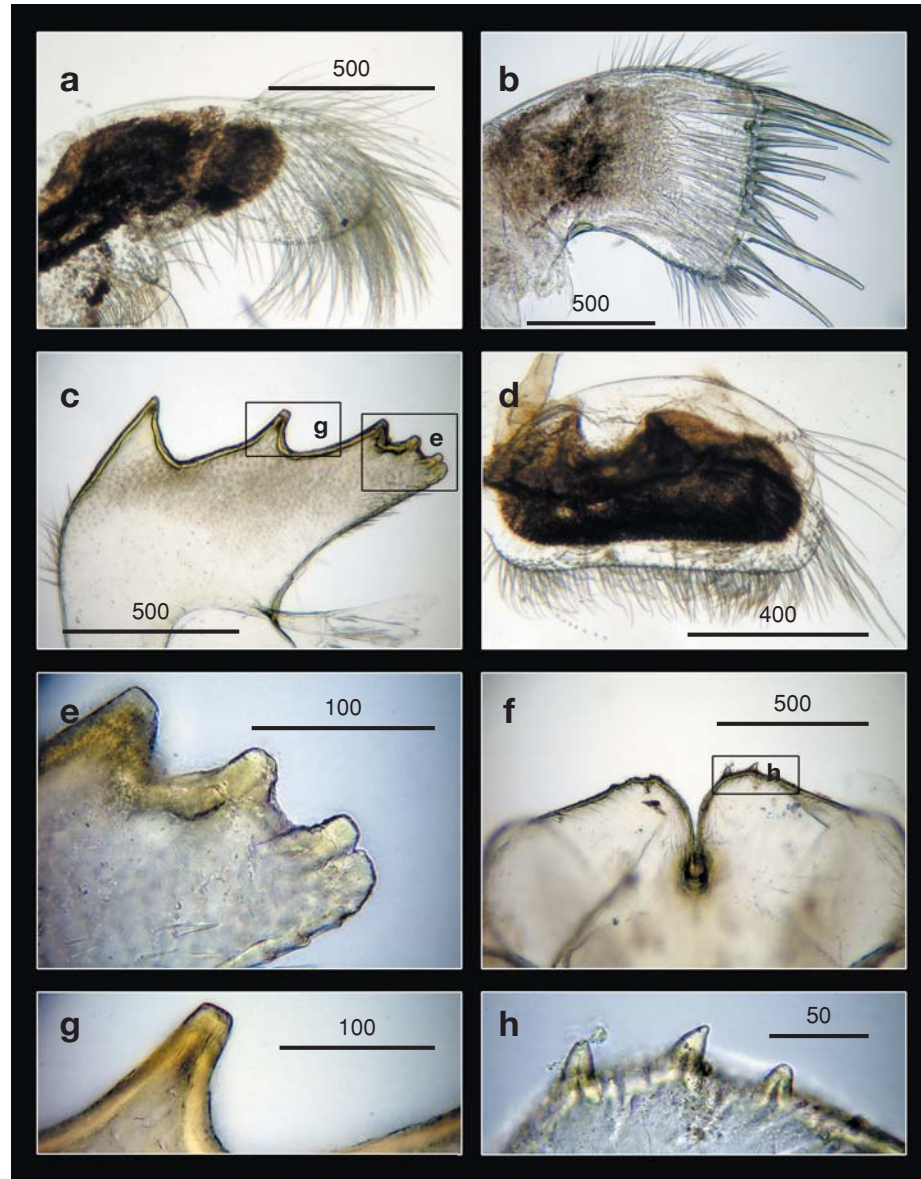


Fig. 226. *Megabalanus tintinnabulum*, Hepingdao, Keelung City, 30 Jun 2008. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Megabalanus validus Darwin, 1854

壯肋巨藤壺



Fig. 227. *Megabalanus validus*, Haikou, Pingtung County, 27 Apr 2006. *In-situ* view on shores.

Balanus tintinnabulum var. *validus* Darwin, 1854: 195, pl. 1, figs. c, f.—Hoek, 1913: 164, pl. 13, figs. 16-18, pl. 14, figs. 1-4.

Megabalanus validus.—Newman & Ross, 1976: 69.

Material examined.—Haikou, Pingtung County, 27 Apr 2006: 1 specimen.

Diagnosis.—Shell conical, surface with colored, sculptured longitudinal striations, radii wide.

Size.—BD to 40 mm.

Coloration.—Parietes purple with colored striations.

Habitat.—On low intertidal rocks and ship bottoms.

Distribution.—Malay Archipelago, Taiwan.

Megabalanus volcano Pilsbry, 1916
刺巨藤壺

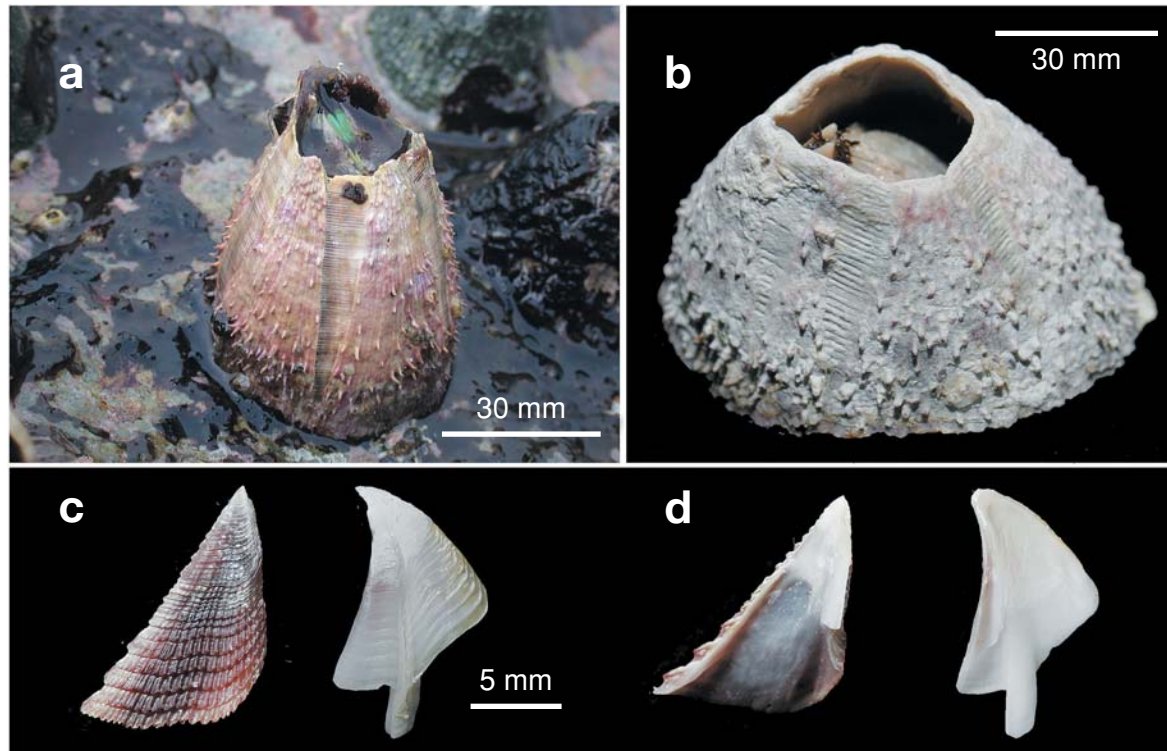


Fig. 228. *Megabalanus volcano*, Hepingdao, Keelung City. 12 Jun 2006. a. *In-situ* view on shores. b. Ethanol preserved parietes. c. External and d. Internal view of scutum and tergum.

Balanus tintinnabulum var. *volcano* Pilsbry, 1916: 60, pl. 11, figs. 2-2c.—Nilsson-Cantell, 1932: 19, figs. 7a-e.—Hiro, 1937b: 430, fig. 19a.

Balanus tintinnabulum peninsularis Nilsson-Cantell, 1927: 783, figs. 18a, b (Non *Balanus tintinnabulum peninsularis* Pilsbry, 1916).

Balanus (Megabalanus) tintinnabulum volcano.—Tarasov & Zevina, 1957: 165.—Utinomi, 1970: 350, pl. 18, fig. 6.

Megabalanus volcano.—Newman & Ross, 1976: 69.

Balanus (Megabalanus) volcano.—Ren & Liu, 1978: 125, text-fig. 3, pl. 1, figs. 6-16.

Material examined.—Hepingdao, Keelung City, 12 June 2006: 15 specimens (BD 17.65-32.36 mm) (CEL-BB-7).—Shihtiping, Hualien County, 22 Mar 2007: 1 specimen (BD 11.93 mm) (CEL-BB-39).—Shihtiping, Hualien County, 22 Mar 2007: 1 specimen (BD 40.56 mm) (CEL-BB-43).

Diagnosis.—Parietes conical, purple or pale-purple, surface with small dense spines; radii wide, summit horizontal. Scutum triangular, higher than wide, external

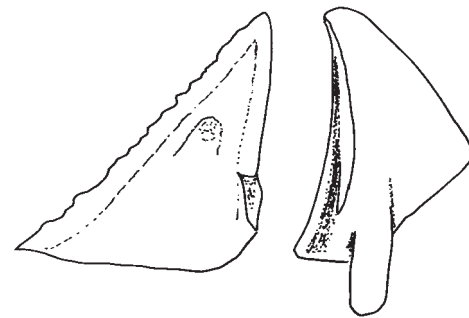


Fig. 229. *Megabalanus volcano*, Hepingdao, Keelung City. 12 Jun 2006. Line drawings of scutum and tergum.

surface with longitudinal and horizontal striations intersecting each other; tergum with a curved scutal margin, curved apex produced, spur short and wide, external surface with medial furrow. Maxilla bilobed with setae on 2 lobe regions, maxillule slightly notched with 2 large setae above notch; mandible with 5 teeth excluding inferior angle, 2nd-5th teeth bidentated; mandibulatory palp rectangular with setae on superior margin; labrum with deep cleft, 3 sharp teeth on each side of cutting edge.

Size.—BD to 50 mm.

Coloration.—Parietes purple with spines on surface.

Habitat.—On low shores of intertidal rocky shores, floating pontoons and ship bottoms.

Distribution.—Japan, China, Indian Ocean.

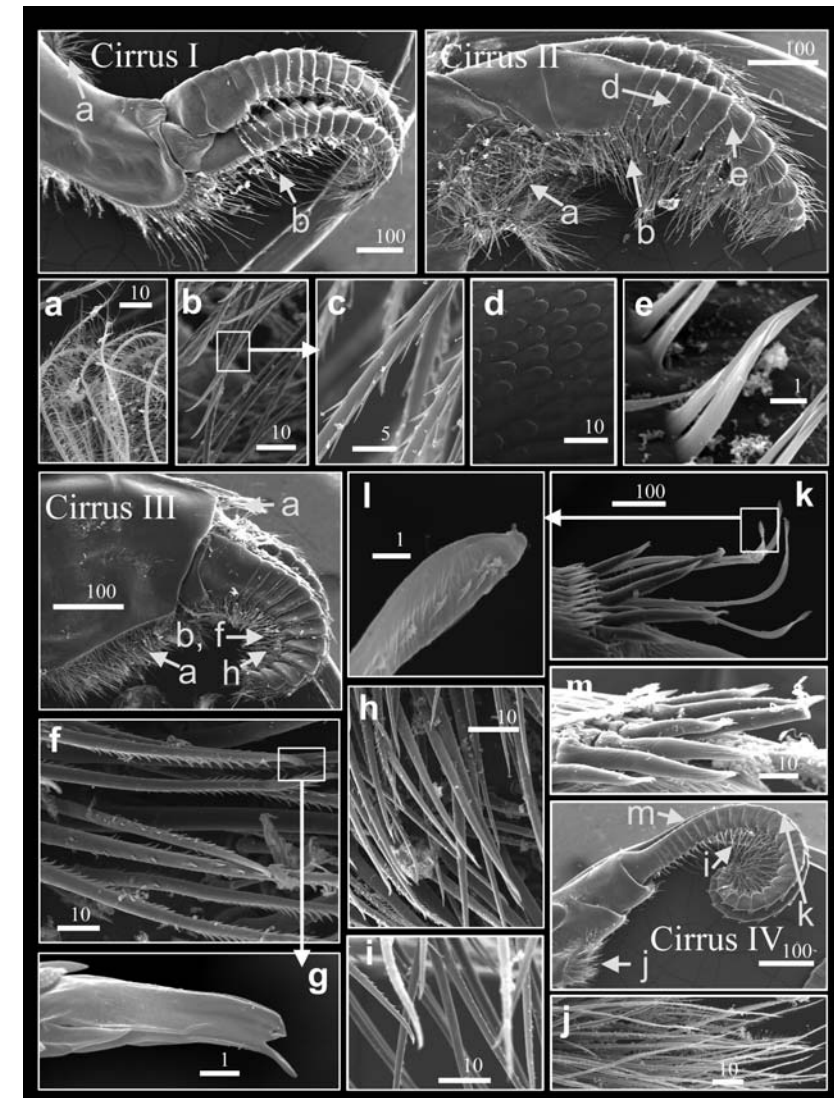


Fig. 230. *Megabalanus volcano*. Scanning electron microscopy on the cirri. a. Feathery plumose setae on basipod of cirrus I, II and III. b, c. Serrulate setae on exopod and endopod of cirrus I, II and III. d. Fan-shaped denticles on the surface of exopod and endopod on cirrus I-III. e. Short setules on the segment junctions of the exopod and endopod of cirrus I-III. f. Serrulate setae on cirrus III and have terminal pores g, h. Serrulate setae on cirrus III. i. Serrulate setae on cirrus IV. j. plumose setae on cirrus IV. k, l. Short flattened setae on the segment junction of cirrus IV. m. Cuspidate setae on cirrus IV. Scale bars in μm .

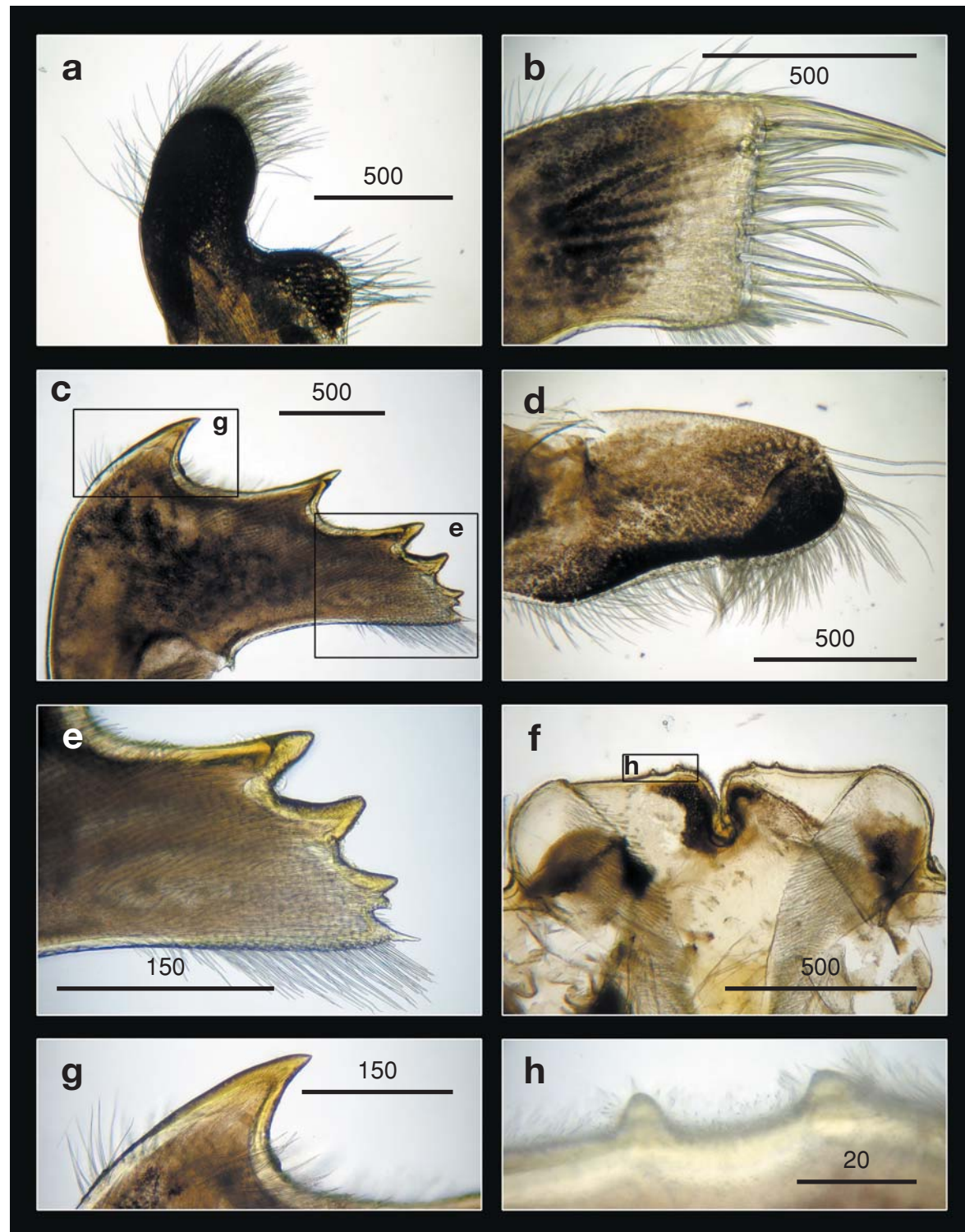


Fig. 231. *Megabalanus volcano*, Hepingdao, Keelung City, 12 Jun 2006. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Megabalanus zebra Darwin, 1854
縱肋巨藤壺

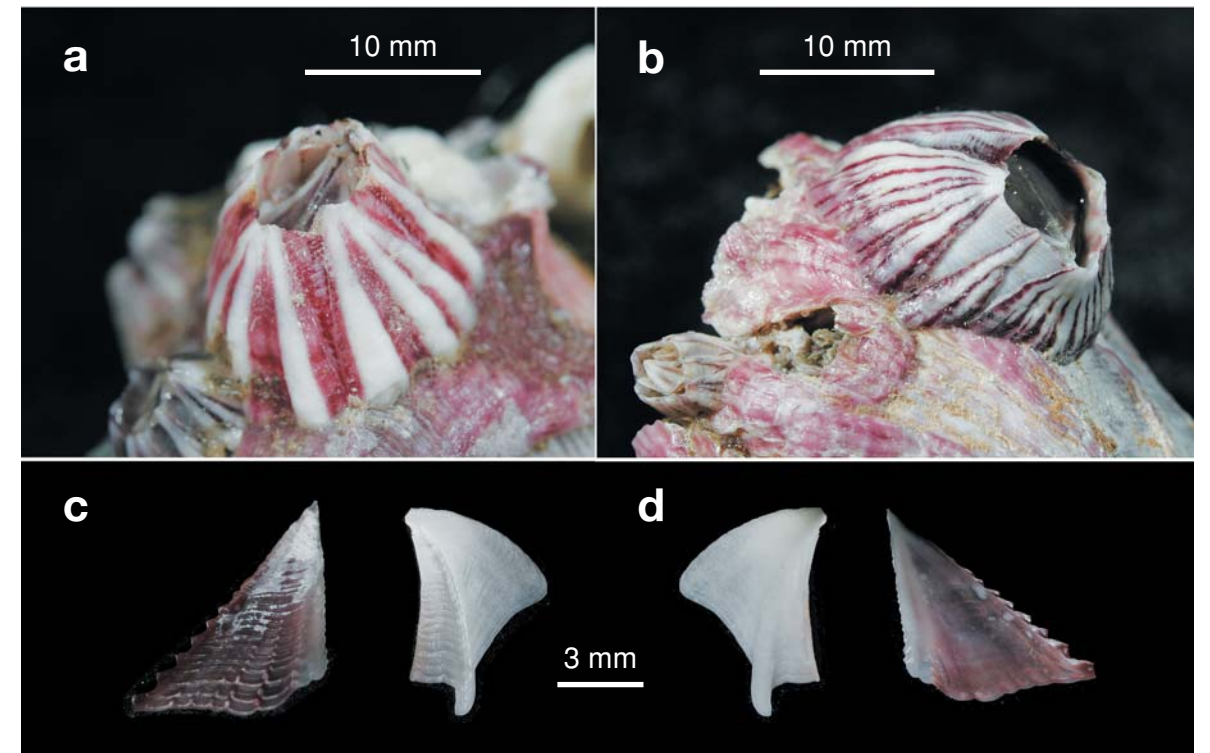


Fig. 232. *Megabalanus zebra*, Shihtiping, Hualien County, 22 Mar 2007. a, b. Parietes. c. External and d. Internal view of scutum and tergum.

Balanus tintinnabulum var. *zebra* Darwin, 1854: 195, pl. 1, fig. G.

Balanus tintinnabulum zebra.—Pilsbry, 1916: 57, pl. 10, figs. 2-3.—Hiro, 1939d: 259.—Davadie, 1963: 26, pl. 2.—Stubbings, 1967: 264.

Megabalanus zebra.—Newman & Ross, 1976: 69.

Material examined.—Shihtiping, Hualien County, 22 Mar 2007: 1 specimen (BD 11.66 mm) (CEL-BB-38).—Shihtiping, Hualien County, 22 Mar 2007: 1 specimen (BD 6.00 mm, shell broken) (CEL-BB-40).

Diagnosis.—Parietes conical, surface smooth, purple with strong white longitudinal striations. Scutum triangular, external surface with horizontal and longitudinal striations, intersecting each other; tergum quadrangular, scutal margin slightly curved, basal margin inclined, spur short. Maxilla bilobed, with setae on each lobe region; maxillule slightly notched, with strong setae above notch; mandible with 4 teeth excluding inferior angle, inferior angle blunt; mandibulatory palp elongated with setae on superior margin; labrum with deep cleft, 3 sharp teeth on each side of cutting edge. Cirrus I rami unequal; anterior ramus 14-segmented, posterior ramus 8-segmented; cirrus II rami sub-equal, anterior ramus 9-segmented, posterior ramus 13-segmented; cirrus III anterior ramus 10-segmented; posterior ramus 11-segmented; cirrus IV anterior ramus 20-segmented; posterior ramus 18-segmented.

Size.—BD to 30 mm.

Coloration.—Purple with strong white longitudinal striations.

Habitat.—On floating pontoons.

Distribution.—West coast of Africa, Indo Pacific region, Taiwan.

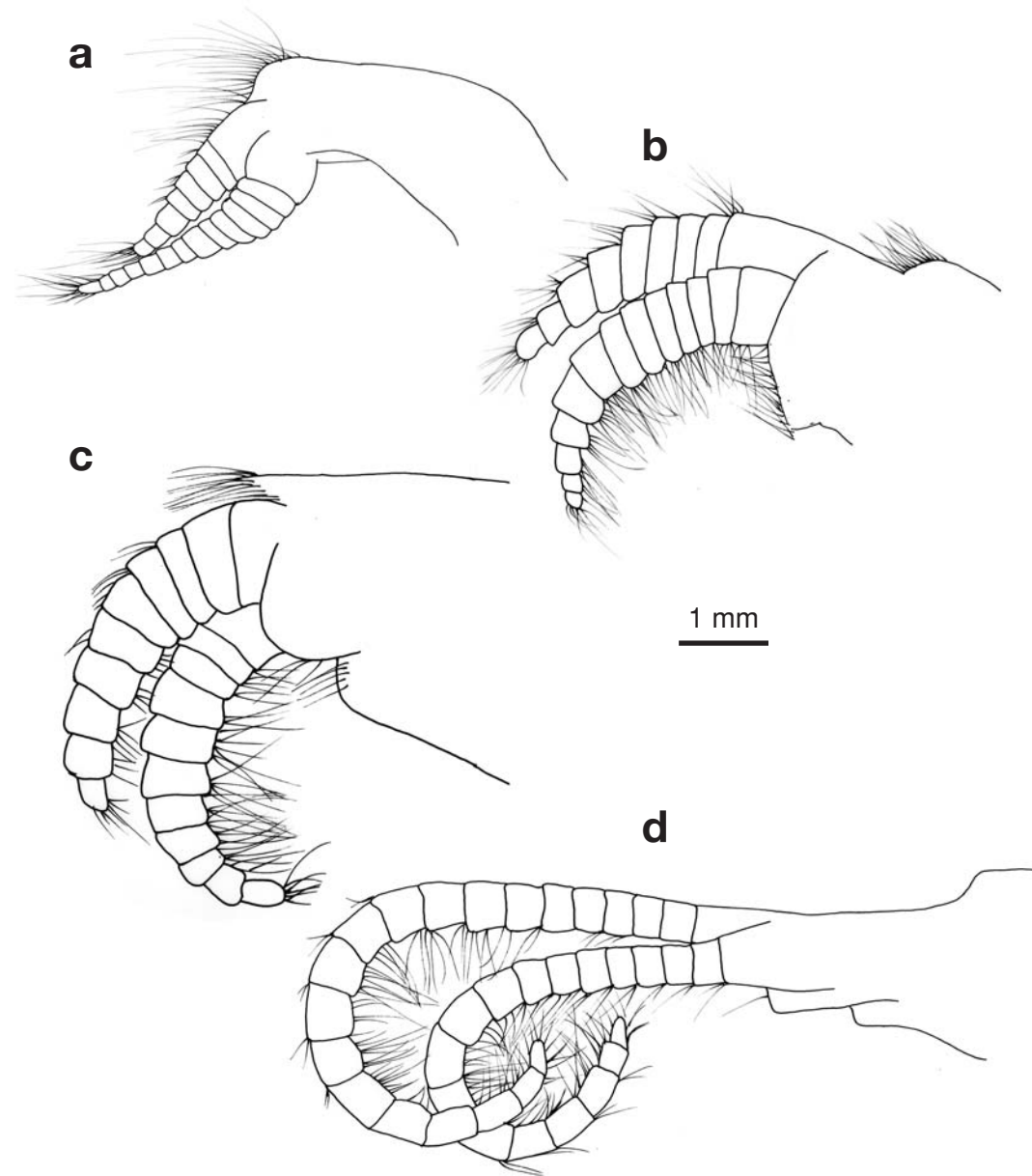


Fig. 233. *Megabalanus zebra*, Shihtiping, Hualien County, 22 Mar 2007. Line drawings showing a. Cirrus I, b. Cirrus II, c. Cirrus III and d. Cirrus IV.

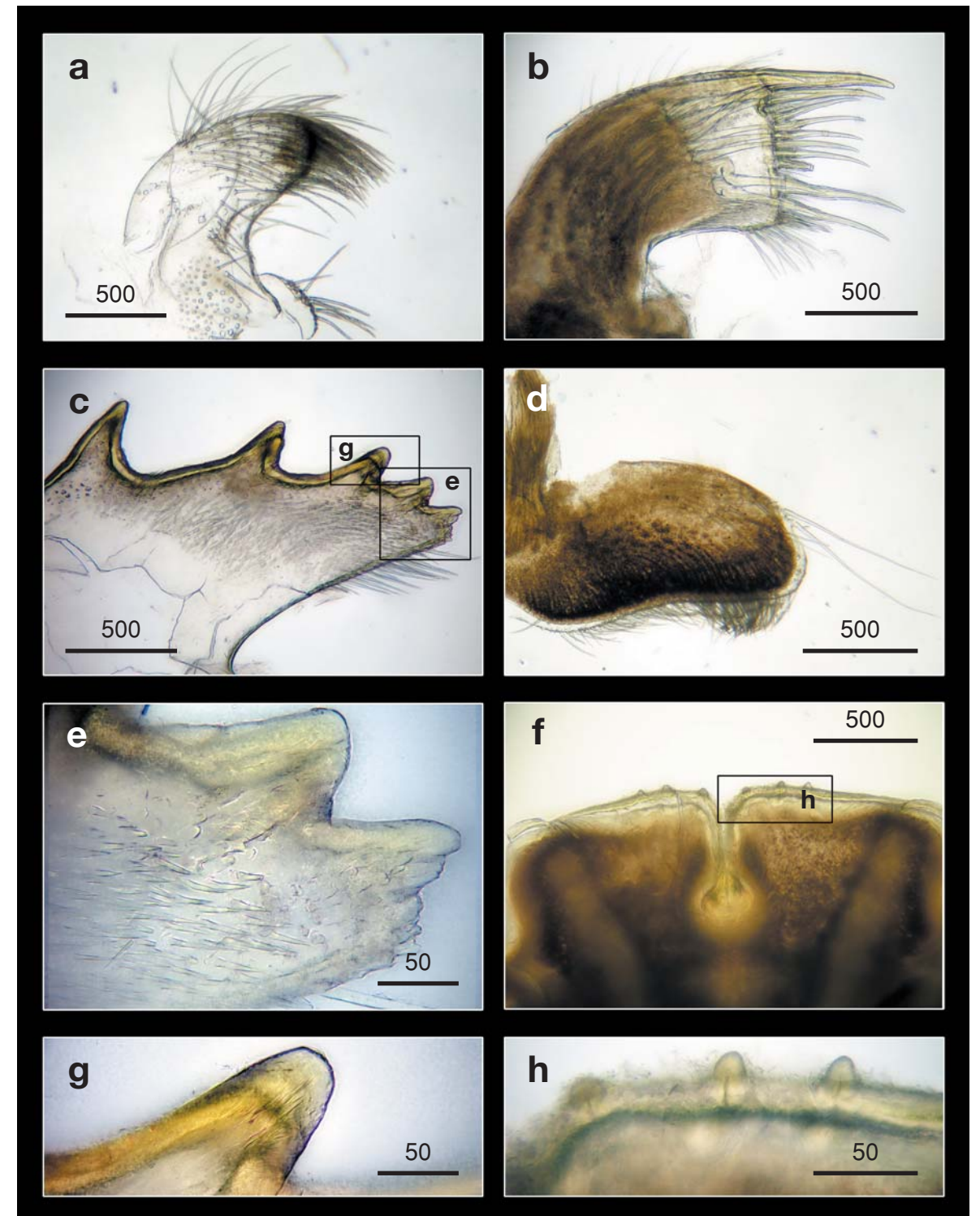


Fig. 234. *Megabalanus zebra*, Shihtiping, Hualien County, 22 Mar 2007. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in µm.

Megabalanus occator (Darwin, 1854)
齒楯巨藤壺

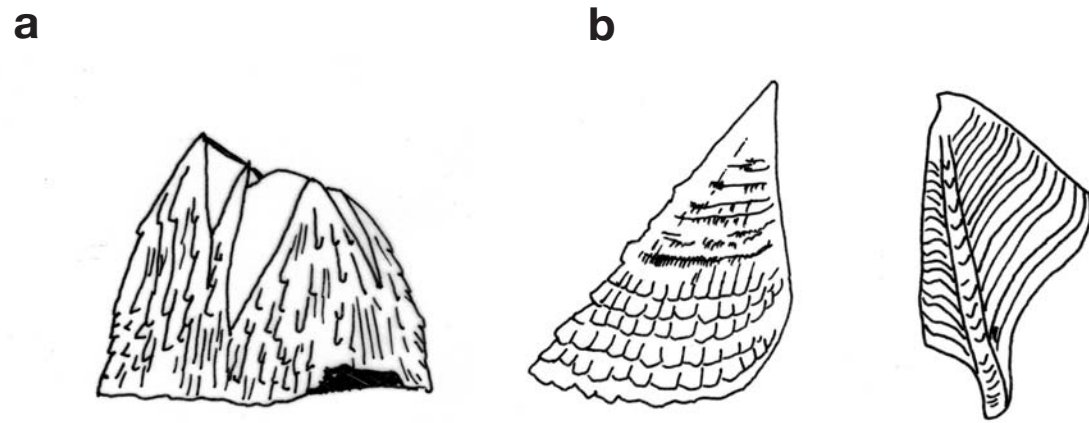


Fig. 235. *Megabalanus occator*, The Philippines. Redrawn from Pilsbry 1916. a. External parietes. b External view of scutum and tergum.

Balanus tintinnabulum var. *occator* Darwin, 1854: 196, pl. 1, fig. K. pl. 2, fig. 1b.

Balanus tintinnabulum occator.—Pilsbry, 1916: 59, pl. 11, figs. 1-1e.—Hiro, 1939d: 260.

Megabalanus occator.—Newman & Ross, 1976: 68.—Pitombo, 2004: 275.

Material examined.—Gueishandao, Yilan County, 29 May 1938 (data from Hiro, 1939d).

Diagnosis.—Surface of parietes with purple striations and with spines at basal margin.

Size.—BD to 32 mm (Hiro, 1939d).

Coloration.—Shell white with purple stripes.

Distribution.—The Philippines, Taiwan, Fiji, Bonin Islands, Indian Ocean.

Remarks.—At present, we have not yet collected specimens of *M. occator*. From intensive studies on the *Megabalanus* species in eastern Taiwan, individuals which have spines all belong to *M. volcano*, which is a very common species in sub-tidal regions of the Taiwanese coasts but Hiro (1939d) did not report this species. It is possible that the previous record of *M. occator* in Taiwan was actually *M. volcano*. The record of *M. occator* in Taiwan should receive further study.

Suborder VERRUCOMORPHA Pilsbry, 1916
花籠亞目

Verrucomorpha Pilsbry, 1916: 14.—Newman et al., 1969, 281.—Newman & Ross, 1971: 135.—Newman, 1987: 8.—1996: 501.—Buckeridge, 1994: 89.—Young, 1998: 74.

Diagnosis.—Shell asymmetrical, box-like. Shell with only 4 plates (carina, rostrum, scutum and tergum), base membranous, caudal appendage present.

Remarks.—3 families are classified in the Verrucomorpha, and only 1 family was recorded in Taiwan.

Family VERRUCIDAE Darwin, 1854
花籠科

Verrucidae Darwin, 1854: 495.—Gruvel, 1905: 169.—Withers, 1935: 323.—Newman et al., 1969: 281.—Newman & Ross, 1971: 135.—Buckeridge, 1994: 89.—Young, 1998: 74.

Diagnosis.—Shell with 4 plates (carina, rostrum, scutum, and tergum), no lateral plates.

Remarks.—There are 8 genera in the Verrucidae. In Taiwan, 4 genera have been recorded.

Key to the genera of Verrucidae from Taiwan

1. Rostrum and carinal apex remain in the opercular margin 2
Rostrum apex remove from the opercular margin *Rostratoverruca*
2. Fixed scutum with a myophore *Metaverruca*
Fixed scutum without myophore 3
3. Operculum parallel to base *Newmaniverruca*
Operculum perpendicular to base *Altiverruca*

Genus *Rostratoverruca* Broch, 1922
吻花籠屬

Rostratoverruca Broch, 1922: 298.—Newman et al., 1969: 283.—Ren, 1984b: 169.—Buckeridge, 1994: 118.—Young, 1998: 80. Type species *Verruca nexa* Darwin, 1854.

Diagnosis.—Movable operculum parallel to base, rostral apex removed from opercular margin. Fixed scutum without myophore.

Remarks.—11 species are placed in the *Rostratoverruca*; 1 species has been recorded in Taiwan in the present collection.

Rostratoverruca koehleri (Gruvel, 1907)
貝雕吻花籠

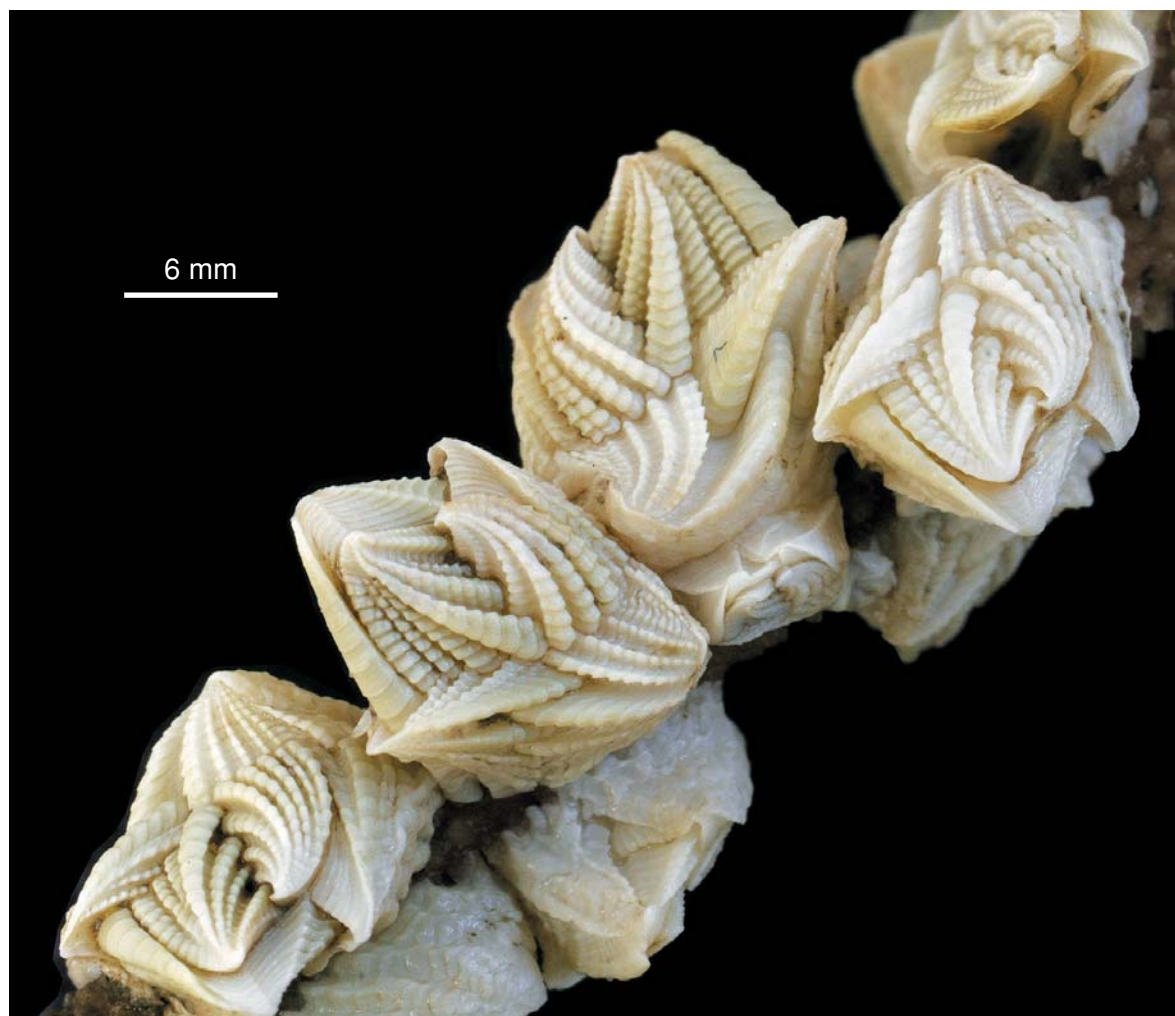


Fig. 236. *Rostratoverruca koehleri*. Donggang fishing port, Pingtung County, 17 Jan 2000. A colony on urchin spine.

Verruca koehleri Gruvel, 1907: 4, pl. 1, figs. 7-8.—Ren, 1984b: 170, fig. 3, pl. 1, figs. 12-14, pl. 2, figs. 1-4.—Liu & Ren, 2007: 273, fig. 119.

Material examined.—Donggang fishing port, Pingtung County, on spine of the sea urchin *Stylocidaris renei*, 17 Jan 2000: 55 specimens (BD 2.25-6.45 mm) (NMNS 0003328-00076).—Donggang fishing port, Pingtung County, on spine of the sea urchin *Stylocidaris renei*, 2 Jan 2002: 120 specimens (BD 1.37-6.62 mm) (NMNS 0003736-00003).—Donggang fishing port, Pingtung County, 200 m, 8 Dec 1999: 115 specimens (BD 1.32-6.32 mm) (NMNS 003275-00031).

Diagnosis.—Shell white, base membranous; rostrum patelliform, apex of rostrum removed from opercular margin; carina apex produced, extending beyond basi-tergal angle of tergum; carina and rostrum interlocked with 3 ribs; movable scutum triangular, with 4 ribs on tergal side; 3 more ribs present in occludent region,

interlocking with rostrum at scutal basal margin; apex produced and incurved. Movable tergum quadrangular; apex produced and incurved towards movable scutum; 3 secondary ribs with movable scutum; 3 more ribs occurring on occludent margin interlocking with carina. Maxilla globular with setae around margin; maxillule notched, 2 large setae above notch, fine setae at notch and at least 7 setae below notch; mandible with 3 teeth excluding inferior angle, lower margin strongly pectinated, with 7 sharp teeth; labrum not strongly concave with fine teeth on cutting edge, some teeth bidentated. Cirrus I rami unequal, posterior ramus 13-segmented, anterior ramus 9-segmented; cirrus II rami sub-equal, anterior ramus 9-segmented, posterior ramus 14-segmented; caudal appendage long, half the length of cirrus VI, 18-segmented.

Size.—BD to 10 mm.

Coloration.—Shell creamy-yellow when clean.

Habitat.—At present, this species often reported on spines of sea urchins, suggesting this species may have a commensal relationship with sea urchins.

Distribution.—East China Sea, South China Sea, Japan, the Philippines, Indonesia, Andaman Island, Madagascar.

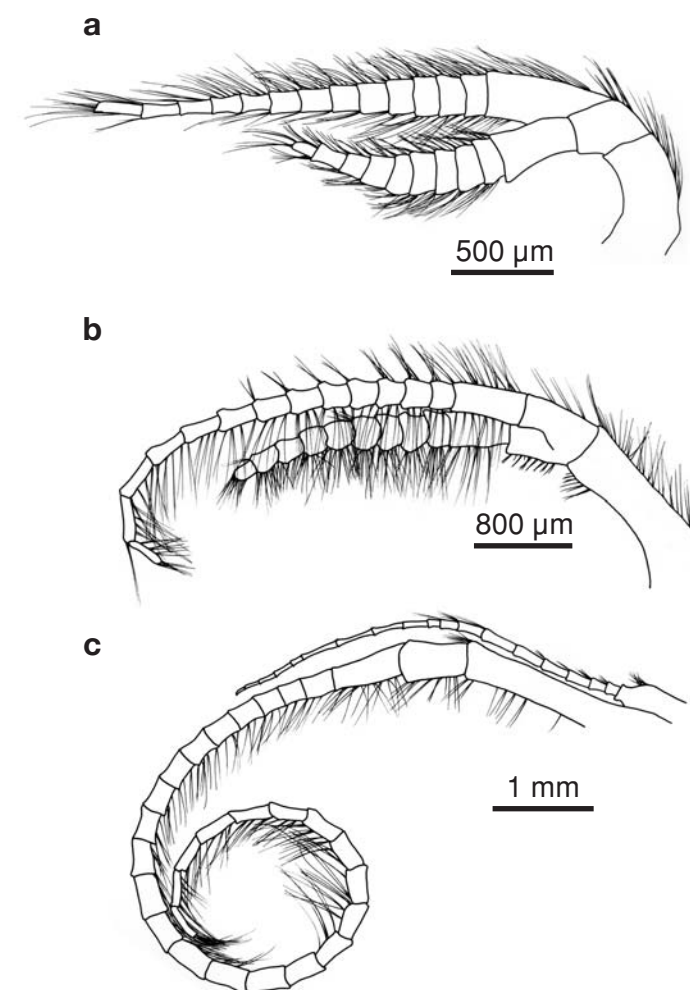


Fig. 237. *Rostratoverruca koehleri*. Donggang fishing port, Pingtung County, 17 Jan 2000. Line drawings showing a. Cirrus I, b. Cirrus II, c. Cirrus VI and caudal appendage.

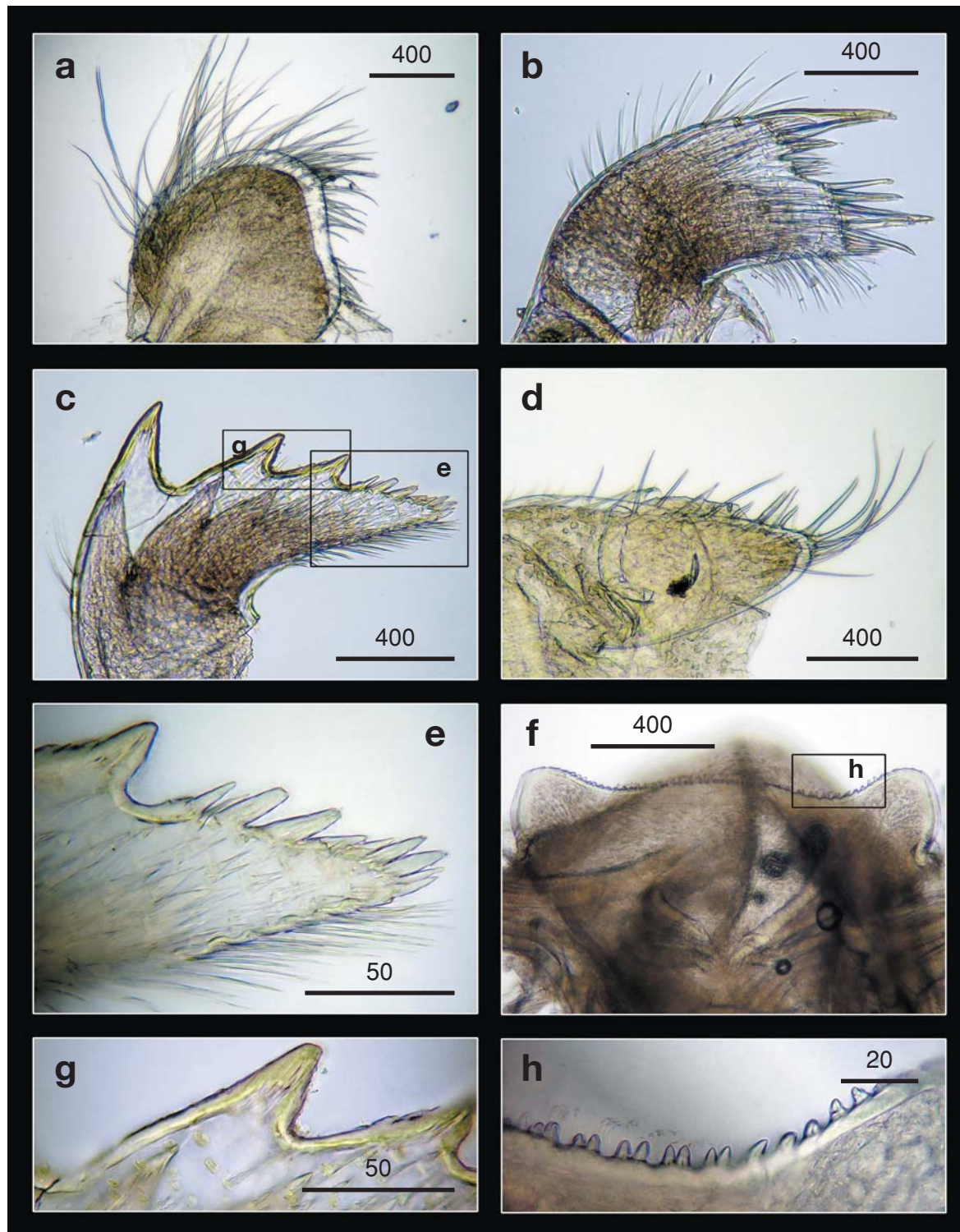


Fig. 238. *Rostratoverruca koehleri*. Donggang fishing port, Pingtung County, 17 Jan 2000. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Genus *Metaverruca* Pilsbry, 1916

擬花籠屬

Metaverruca Pilsbry, 1916: 21.

Verruca (*Metaverruca*) Newman et al., 1969: 283.—Foster, 1978: 68.

Metaverruca Zevina, 1987: 1812.

Diagnosis.—Shell box-like, orifice D-shaped, operculum parallel to base; apices of carina and rostrum marginal; fixed scutum with a myophore.

Remarks.—There are 12 species in *Metaverruca*, and 2 species have been recorded from Taiwan.

Key to species of *Metaverruca* from Taiwan

1. Movable scutum and tergum interlock with 4 articular ribs *Metaverruca defayae*
2. Movable scutum and tergum interlock with 3 articular ribs *Metaverruca recta*

Metaverruca defayae Buckeridge, 1994

狄法葉擬花籠

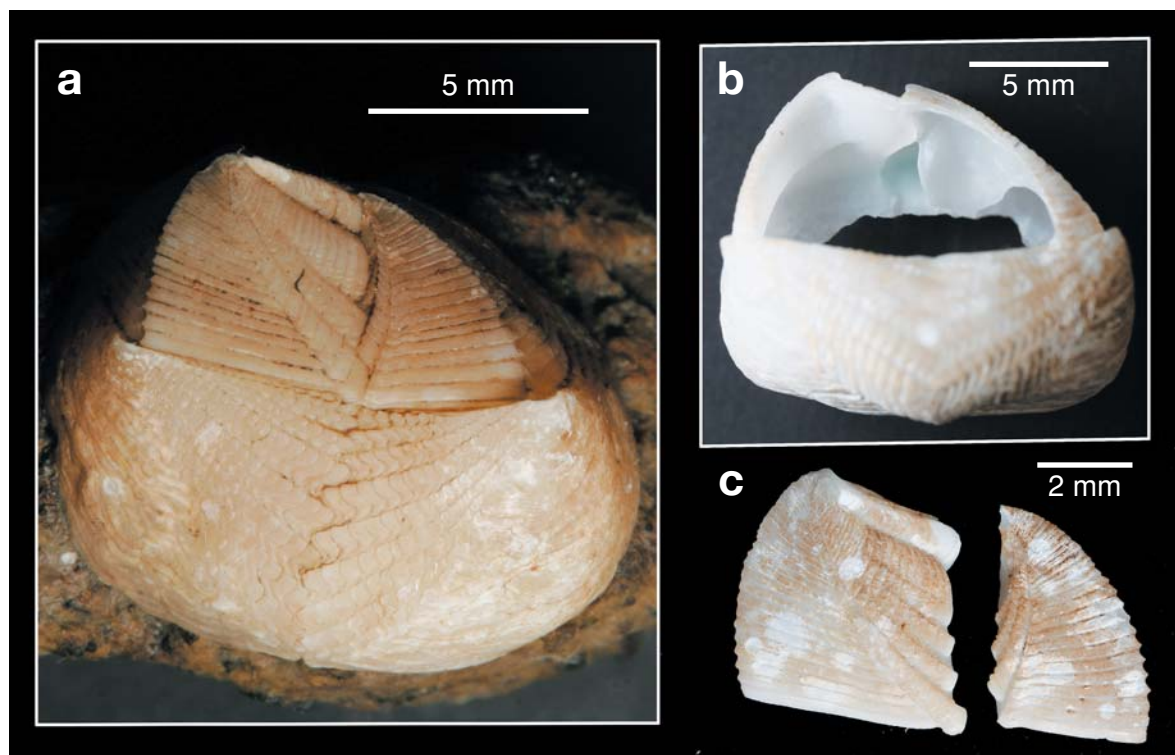


Fig. 239. *Metaverruca defayae*, CP371, 26 Aug 2006. a. Whole parietes, b. Myophores on fixed scutum and tergum. c. Scutum and tergum.

Metaverruca defayae Buckeridge, 1994: 109, figs. 19a-g.—Buckeridge, 1997: 138.

Material examined.—CP371, 24°28.521'N, 122°12.821'E, 582-613 m, 26 Aug 2006: 4 specimens, (BD 10.22-13.10 mm) (CEL-BB-100).

Diagnosis.—Shell white, surface smooth with dense growth lines, low conical, sides steep, base membranous; operculum sub-parallel to base; orifice D-shaped; rostrum and carina articulated together with up to 5 ribs. Fixed scutum with myophore; movable tergum quadrangular, apical basal rib present, interlocking with movable scutum and its 3 ribs; movable scutum triangular, articulated with movable tergum in 3 secondary ribs and 1 apical-basal rib. Maxilla bilobed, with dense serrulate-type setae; maxillule notched, upper notch with 2 large spines, notch with 6 spines, lower notch with 14 spines; mandible with 4 teeth, lower margin hirsute with additional sharp spine and apex ended ending in long setae; mandibulatory palps elongated; labrum concave with small fine teeth. Rami of cirrus I of unequal length, anterior ramus slender and shorter (11-segmented) than posterior ramus (19-segmented); cirrus II with longer posterior ramus (18-segmented) than anterior ramus (13-segmented); cirri IV-VI similar in morphology; cirrus IV (anterior ramus 22, posterior ramus 21), V (27, 27), VI (31, 27); caudal appendage short, 7-segmented, within basal segment of cirrus VI.

Size.—BD to 15 mm.

Coloration.—Shell dull-yellow.

Habitat.—Deep-sea species. On gastropod shells or rocks.

Distribution.—Western Pacific, Taiwan waters.

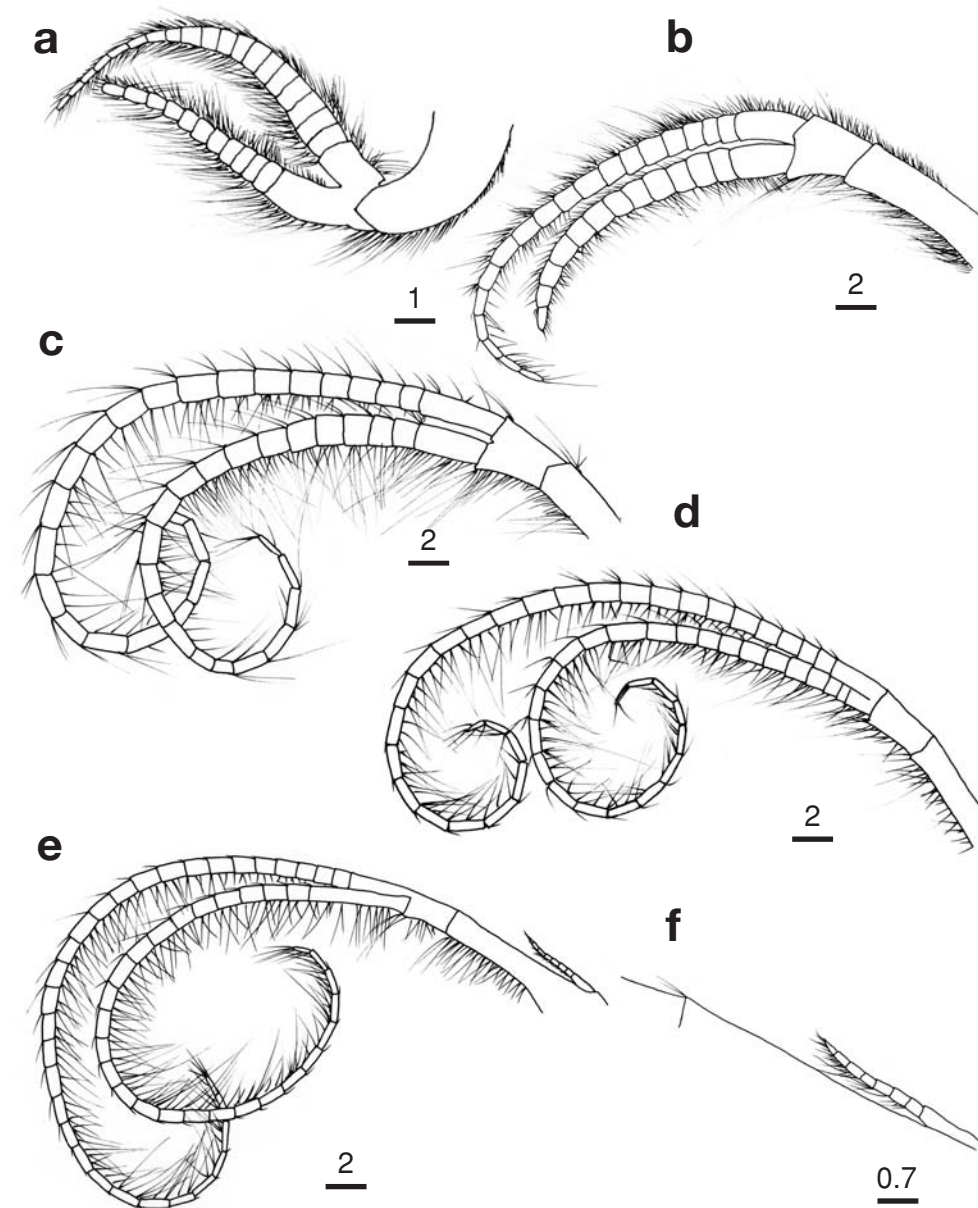


Fig. 240. *Metaverruca defayae*, CP371, 26 Aug 2006. Line drawings showing a. Cirrus I, b. Cirrus II, c. Cirrus III and d. Cirrus IV, e. Cirrus VI and caudal appendage and f. Caudal appendage. Scale bars in mm.

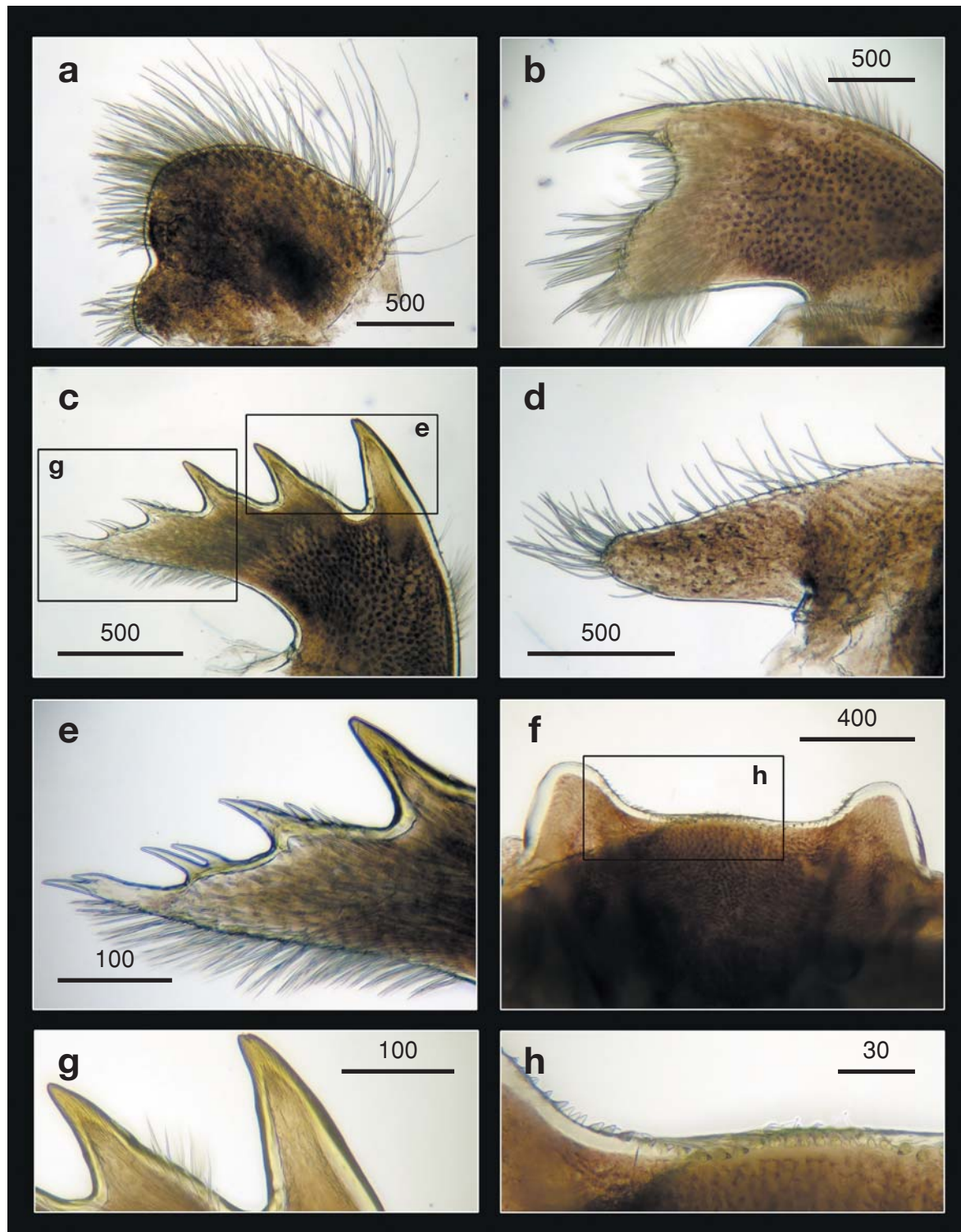


Fig. 241. *Metaverruca defayae*, CP371, 26 Aug 2006. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in µm.

Metaverruca recta (Aurivillius, 1898)
直邊擬花籠



Fig. 242. *Metaverruca recta*, CP278, 14 Jun 2005. Complete parietes.

Verruca recta Aurivillius, 1898: 195.

Verruca sculpta Aurivillius, 1898: 197.

Verruca halothea Pilsbry, 1916: 188, pl. 12, figs. 9-10.

Verruca cookei.—Rosell, 1981: 299, pl. 11, figs. r, s, u, v.—Rosell, 1991: 33 (Non *Verruca cookei* Pilsbry, 1928: 308, figs. 1-2, pl. 25, fig. 9).

Metaverruca recta.—Buckeridge, 1994: 116, fig. 13.—Young, 1998: 52.

Material examined.—CP278, 24°23.63'N, 122°14.13'E, 1222-1239 m, 14 Jun 2005: 1 specimen (BD 6.96 mm) (NMNS).

Diagnosis.—Movable tergum and scutum with 3 articular ribs, external shell smooth with dense growth lines. Maxilla bilobed, with dense setae along margin; maxillule notched, 2 large spines above notch, 7 fine setae at notch, 7 large setae below notch; mandible with 4 teeth, lower margin with several large teeth; labrum cutting edge not concave, with sharp fine teeth.

Coloration.—Shell dull-yellow.

Size.—BD to 15 mm.

Habitat.—Deep-sea species. On gastropod shells and rocks.

Distribution.—Caledonia, the Philippines, Taiwan, Atlantic Ocean.

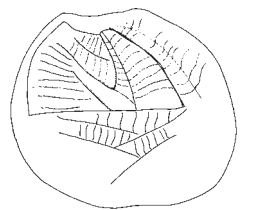


Fig. 243. *Metaverruca recta*, CP278, 14 Jun 2005. Line drawing of parietes.

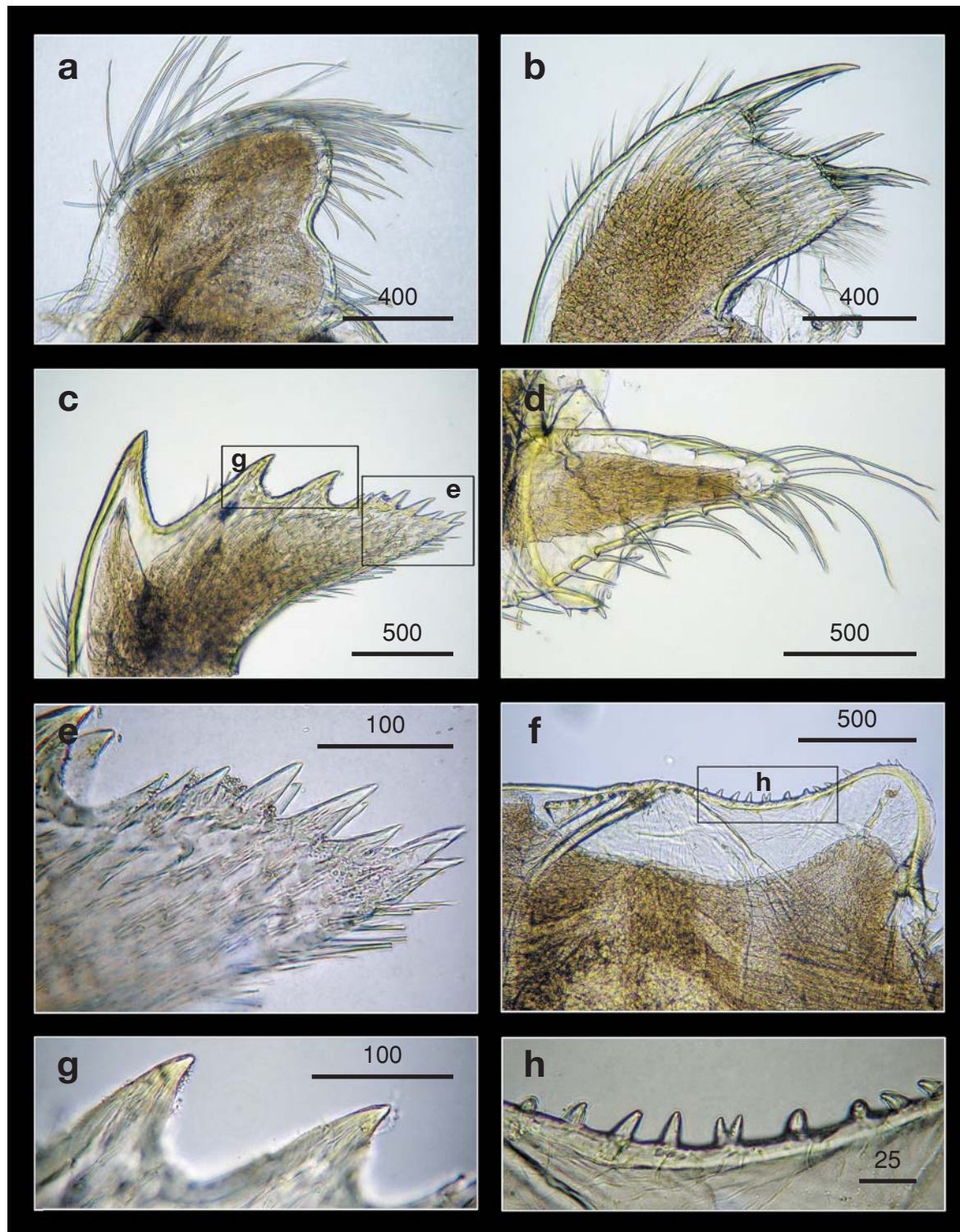


Fig. 244. *Metaverruca recta*, CP278, 14 Jun 2005. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Genus *Altiverruca* Pilsbry, 1916

高花籠屬

Verruca Section D *Altiverruca* Pilsbry, 1916: 40.

Altiverruca Pilsbry.—Newman et al., 1969: 282.—Newman & Ross, 1971: 135.—Ren, 1984b: 172.—

Buckeridge, 1994: 92.—Young, 1998: 77. Type species *Verruca hoeki* Pilsbry, 1907.

Diagnosis.—Operculum perpendicular to base, apex of rostrum and carina marginal.

Remarks.—More than 40 species have been recorded; 2 species were found in Taiwan.

Key to species of *Altiverruca* from Taiwan

1. Lower margin of mandible short *Altiverruca navicula*
2. Lower margin of mandible very long *Altiverruca longimandible*

Altiverruca navicula (Hoek, 1913)
船型高花籠



Fig. 245. *Altiverruca navicula*, CP285, 16 Jun 2005. Dorsal and ventral view of parietes.

Verruca navicula Hoek, 1913: 134, figs. 4-6.—Nilsson-Cantell, 1927: 778, figs. a-f.

Altiverruca navicula.—Buckeridge, 1994: 100, fig. 5.—Chan et al., 2009: in press.

Material examined.—CP285, 24°16.09'N, 122°11.52'E, 2268-2426 m, 16 Jun 2005: 1 specimen. (BD 10.36 mm) (NMNS 005087-00077).

Diagnosis.—Shell white, rostral and carinal apices marginal, carina and rostrum interlocking with 3 ribs. Movable tergum quadrangular, with 5 ribs on scutal margin, apex curved; movable scutum triangular, tergal margin with 4 ribs, apex curved. Maxilla bilobed, with setae distributed all round edges; maxillule strongly and widely notched, horizontally elongated, 2 large spines above notch, numerous dense setae at notch, notch wide, 7 setae below notch; mandible with 3 teeth excluding inferior angle, teeth without multidentations, lower margin long with small spines; mandibulatory palp elongated, wider than high, dense setae on superior margin; labrum slightly concave, with fine teeth on cutting margin, each tooth bidentate to quadridentate in structure. Cirrus I rami unequal, posterior ramus 27-segmented, much longer and elongated, anterior ramus shorter, 15-segmented; cirrus II rami unequal, posterior ramus 27-segmented and anterior ramus 11-segmented; posterior ramus of cirrus III 30-segmented, anterior ramus 27-segmented; cirrus IV (anterior ramus 37, posterior ramus 36); caudal appendage long, with 34 segments.

Size.—BD to 15 mm.

Coloration.—White to pale-yellow.

Habitat.—On deep-sea sponges.

Distribution.—Pacific Ocean.

Remarks.—New record for Taiwan.

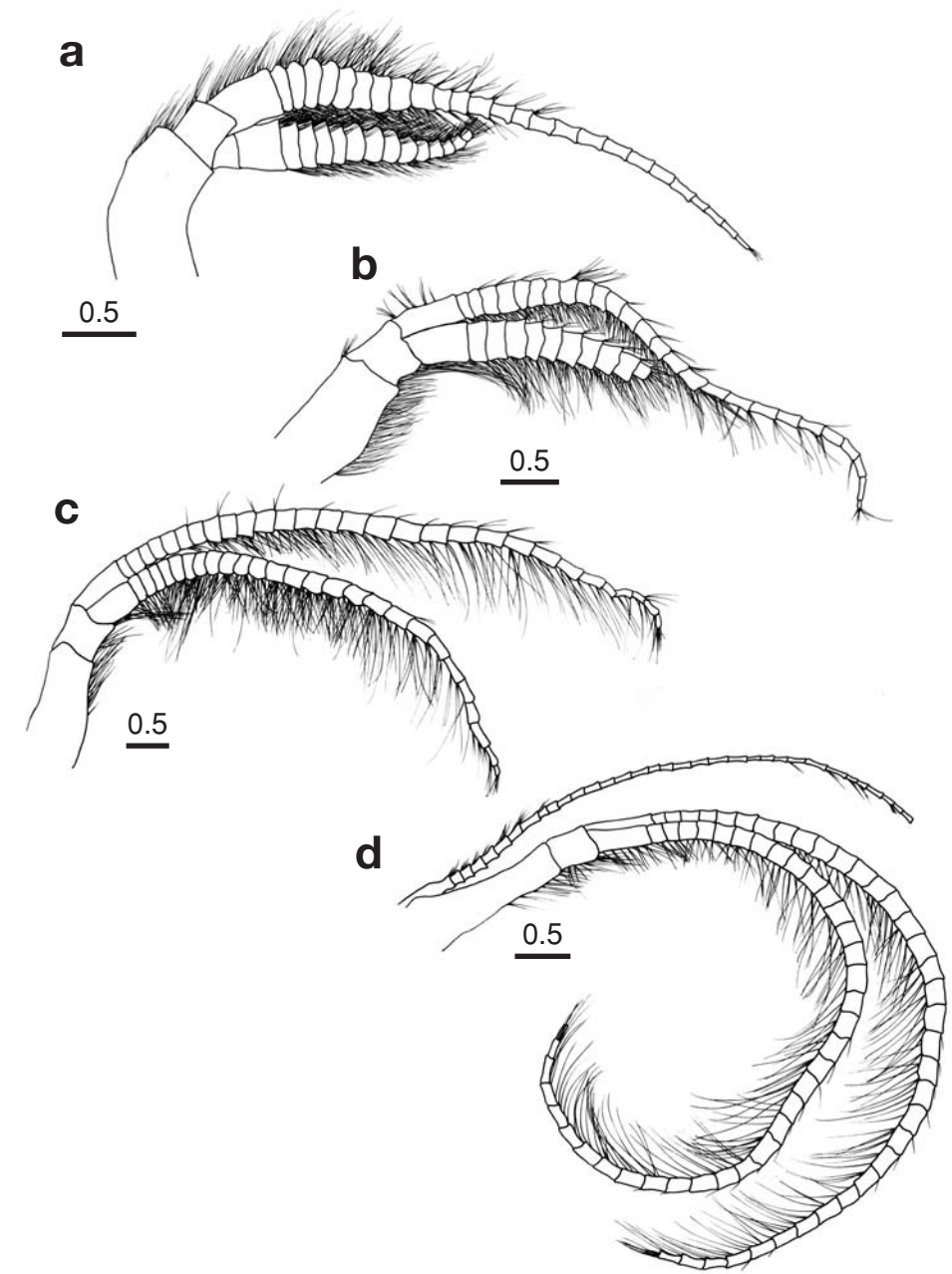


Fig. 246. *Altiverruca navicula*, CP285, 16 Jun 2005. Line drawings showing a. Cirrus I, b. Cirrus II, c. Cirrus III and d. Cirrus IV and caudal appendage. Scale bars in mm.

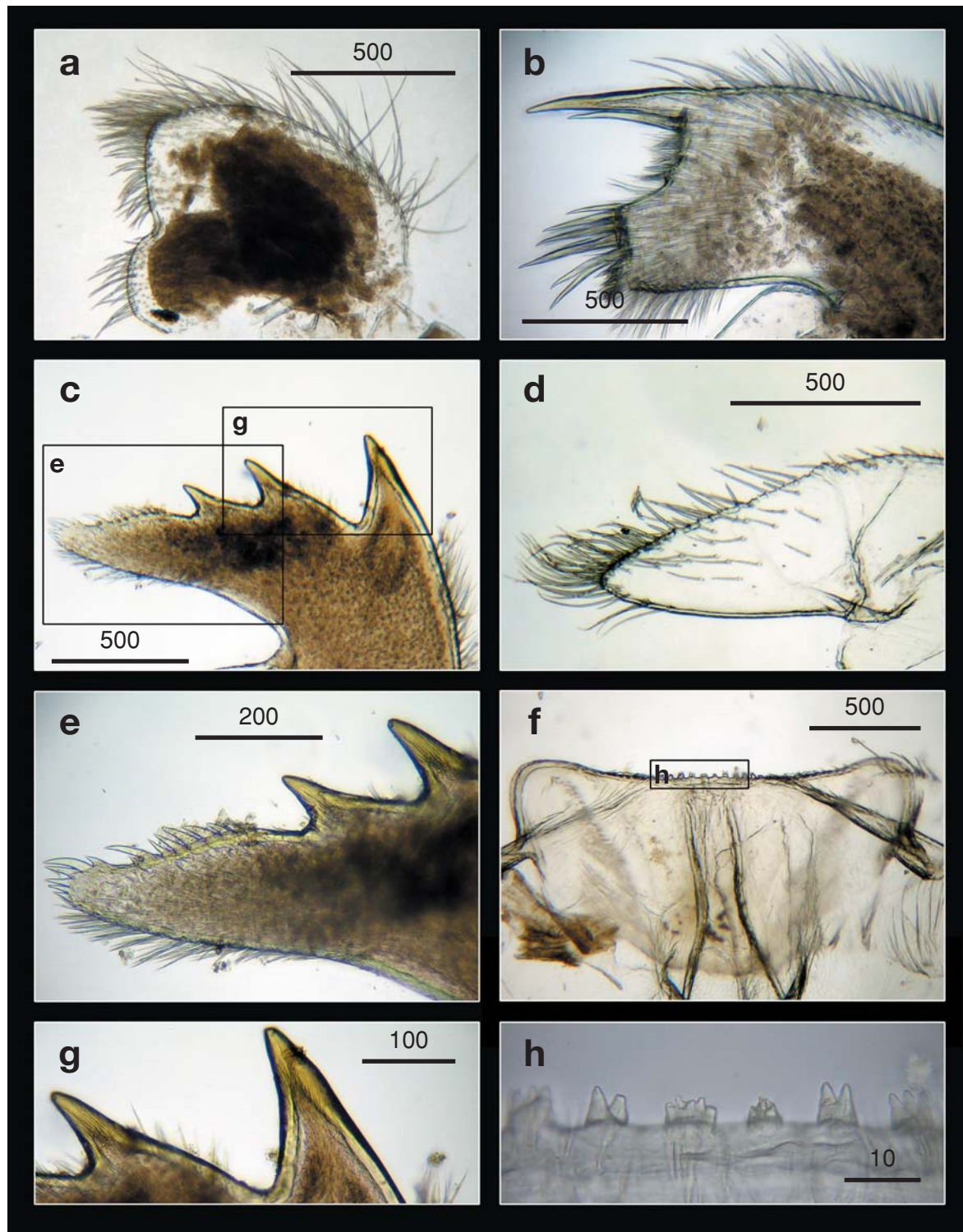


Fig. 247. *Altiverruca navicula*, CP285, 16 Jun 2005. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up on the teeth of mandible, h. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Altiverruca longimandible Chan, Prabowo & Lee, 2009
長顎高花籠

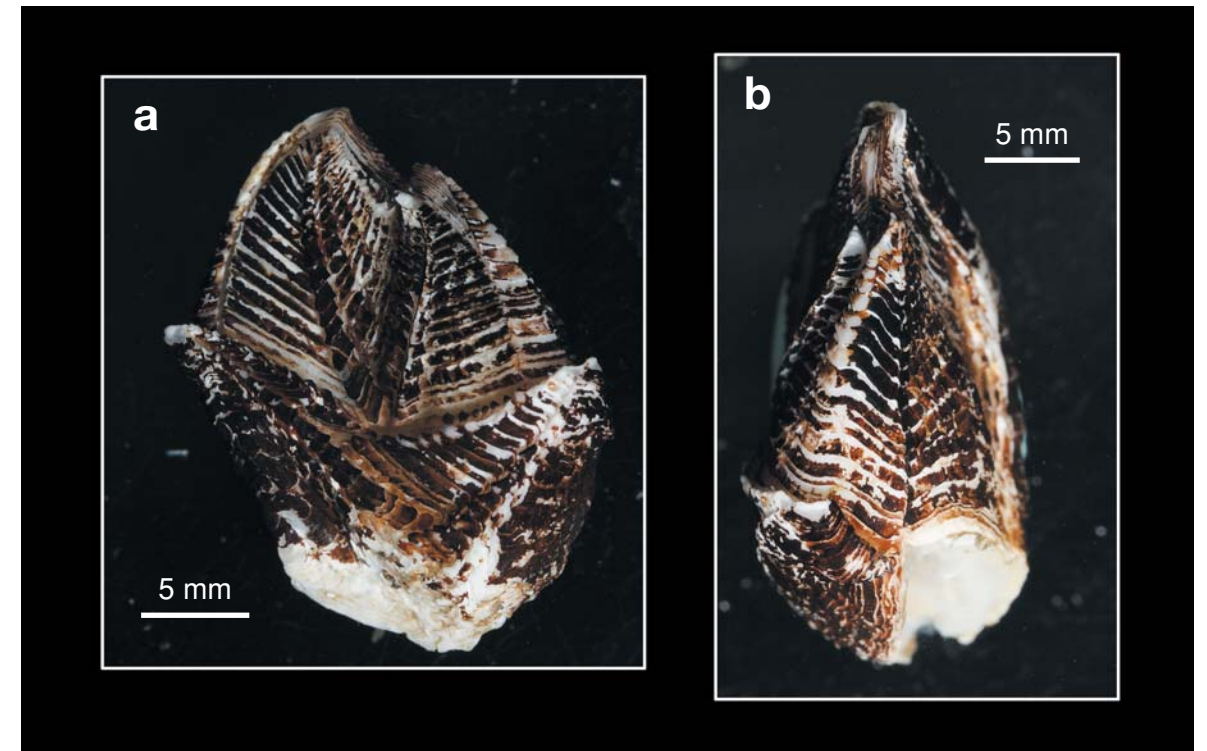


Fig. 248. *Altiverruca longimandible*. Holotype, CP375, 27 Aug 2006. a. Dorsal and b. Side view of the parietes.

Altiverruca longimandible Chan et al., 2009: in press.

Material examined.—Holotype. CP375, 24°16.240'N, 122°11.720'E, 2216-2497 m, 27 Aug 2006: 1 specimen (BD 9.78 mm) (ASIZCR 000224).—Paratype. Locality same as holotype: 2 specimens (BD 8.2-9.8 mm) (NMNS-6006-003).—Locality same as holotype: 4 specimens (BD 8.2-9.8 mm) (CEL-BB-46A).

Diagnosis.—Shell white, some individuals covered by dark-brown coating; apices of rostral and carina produced, curved outwards; rostrum and carina interlocking in major rib; apices of rostrum and carina marginal; rostrum without secondary ridges directed towards tergal base. Movable tergum quadrangular; interlocking with movable scutum in 3 main ribs; movable tergum quadrangular; movable scutum triangular. Maxilla bilobed, with long setae on superior margin and dense shorter setae clustered at 2 lobes; maxillule not notched, basal region of cutting edge expanded outwards, 2 large and robust spines on upper region of cutting edge, about 10 fine spines on mid-region and 8 large spines on lower expanded region; mandible long, with 3 teeth excluding inferior angle, inter-tooth distances equal, lower margin very long and smooth, without setae, inferior angle blunt; mandibulatory palp elongated, setae on inferior margin; labrum not concave, cutting edge straight, with numerous fine teeth. Cirrus I rami unequal, posterior ramus very long and antenniform, 26-segmented, anterior ramus short and normal, 11-segmented; cirrus II rami unequal, posterior ramus antenniform, 21-segmented,

anterior ramus shorter, 10-segmented and with dense setae; cirri III-VI similar in morphology, both rami long and slender, but sub-equal in length; cirrus III (27, 22), IV (34,33), V (27, 30), VI (33, 33); caudal appendage long, half the length of cirrus VI, 33-segmented.

Size.—BD to 10 mm.

Coloration.—Shell white to dirty-yellow.

Habitat.—Deep-sea species, on sponges.

Distribution.—At present only recorded in Taiwanese waters.

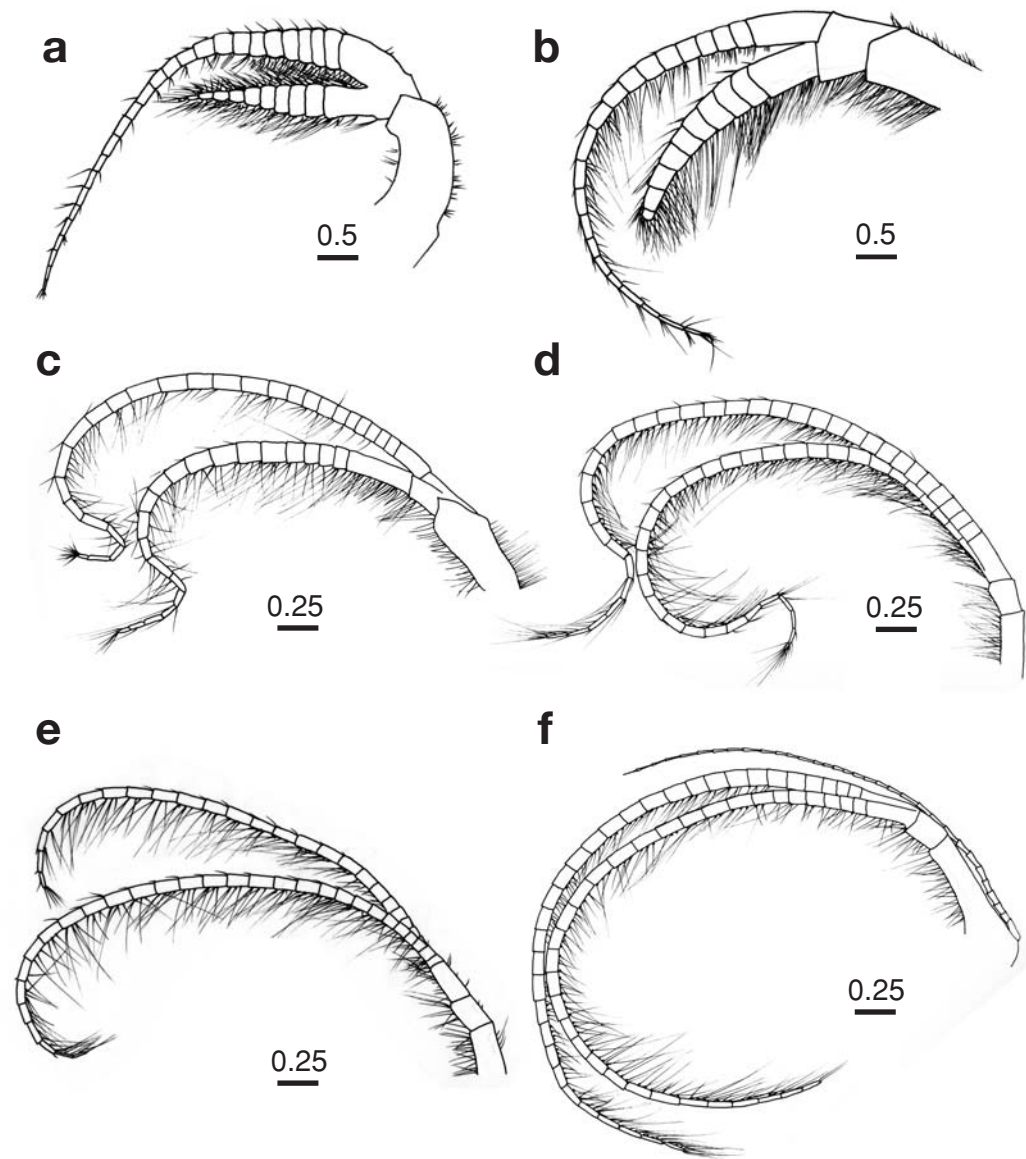


Fig. 249. *Altiverruca longimandible*. Holotype, CP375, 27 Aug 2006. Line drawings showing a. Cirrus I, b. Cirrus II, c. Cirrus III, d. Cirrus IV, e. Cirrus V and f. Cirrus VI and caudal appendage.

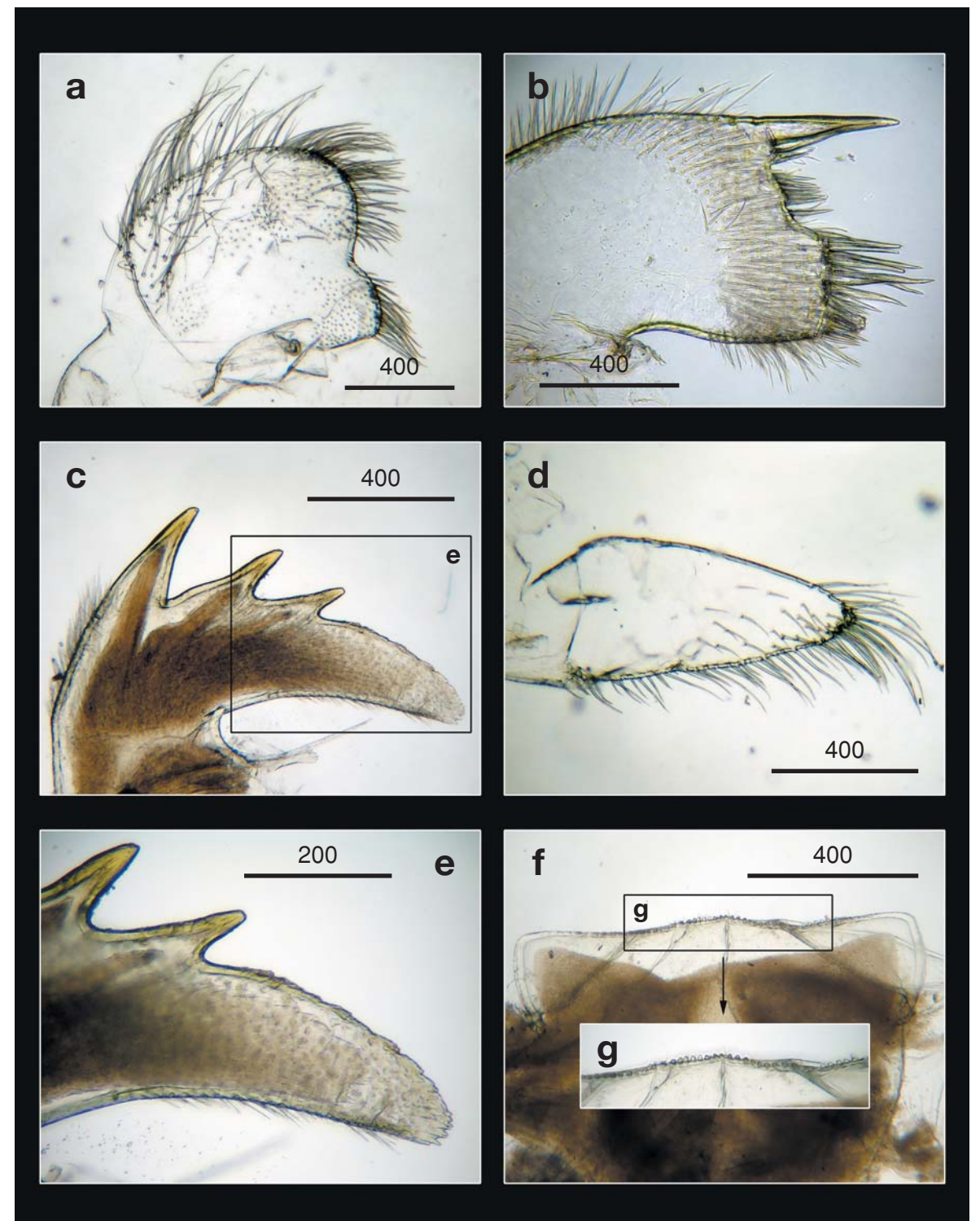


Fig. 250. *Altiverruca longimandible*. Holotype, CP375, 27 Aug 2006. Light microscopy on mouth parts. a. Maxilla, b. Maxillule, c. Mandible, d. Mandibulatory palp, e. Close up on the inferior angle of mandible, f. Labrum, g. Close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

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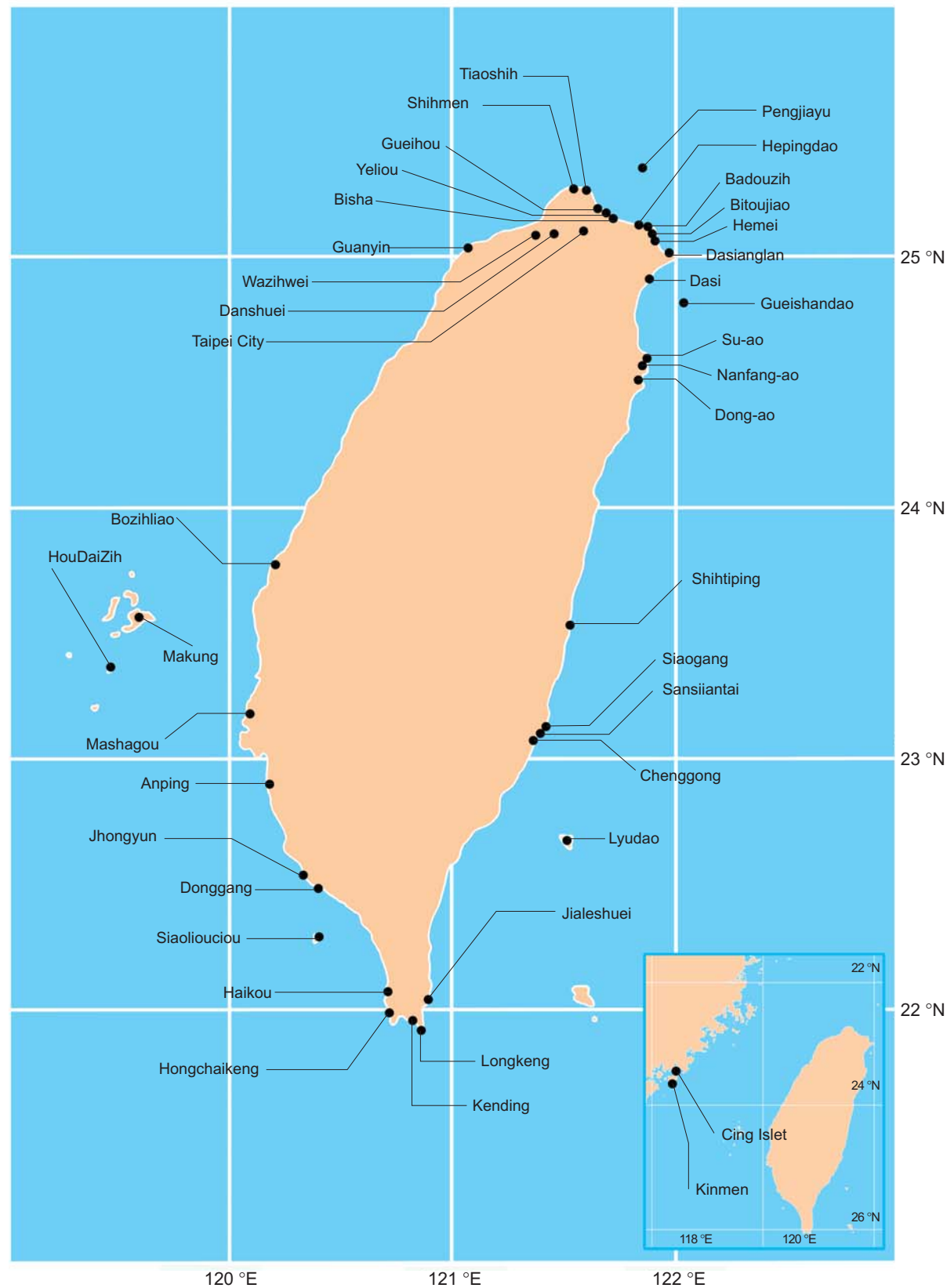
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Map of Taiwan



List of Localities in English and Chinese

Anping, Tainan City	台南市, 安平
Badouzi, Keelung City	基隆市, 八斗子
Bisha, Keelung City	基隆市, 碧砂
Bitoujiao, Taipei County	台北縣, 鼻頭角
Bozihliao, Yunlin County	雲林縣, 箔仔寮
Chenggong, Taitung County	台東縣, 成功
Cing Islet, Kinmen	金門, 青嶼
Danshuei, Taipei County	台北縣, 淡水
Dasi, Yilan County	宜蘭縣, 大溪
Dasianglan, Taipei County	台北縣, 大香蘭
Dong-ao, Yilan County	宜蘭縣, 東澳
Donggang, Pingtung County	屏東縣, 東港
Dongsha (Pratas), South China Sea	東沙群島
Guanyin, Taoyuan County	桃園縣, 觀音
Gueihou, Taipei County	台北縣, 龜吼
Gueishandao, Yilan County	宜蘭縣, 龜山島
Haikou, Pingtung County	屏東縣, 海口
Hemei, Taipei County	台北縣, 和美
Hepingdao, Keelung City	基隆市, 和平島
Hongchaikeng, Pingtung County	屏東縣, 紅柴坑
HouDaiZih, Penghu County	澎湖, 後袋子
Jhongyun, Kaohsiung County	高雄縣, 中芸
Jialeshuei, Pingtung County	屏東縣, 佳樂水
Kending, Pingtung County	屏東縣, 墾丁
Kinmen	金門
Longkeng, Pingtung County	屏東縣, 龍坑
Lyudao, Taitung County	台東縣, 綠島
Mashagou, Tainan County	台南縣, 馬沙溝
Makung, Penghu County	澎湖縣, 馬公
Nanfang-ao, Yilan County	宜蘭縣, 南方澳
Pengjiayu, Keelung City	基隆市, 彭佳嶼
Sansiantai, Taitung County	台東縣, 三仙台
Shihmen, Taipei County	台北縣, 石門
Shihtiping, Hualien County	花蓮縣, 石梯坪
Siaogang, Taitung County	台東縣, 小港
Siaoliouciou, Pingtung County	屏東縣, 小琉球
Su-ao, Yilan County	宜蘭縣, 蘇澳
Taipei City	台北市
Tiaoshih, Taipei County	台北縣, 跳石
Wazihwei, Taipei County	台北縣, 挖子尾
Yeliou, Taipei County	台北縣, 野柳

**CRUSTACEAN FAUNA OF TAIWAN :
BARNACLES, VOLUME I – CIRRIPEDIA: THORACICA
EXCLUDING THE PYRGOMATIDAE AND ACASTINAE**

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