Diversity and Morphological Phylogenetics of Marine Gammarid Amphipods in Thai Waters

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I hereby certify that this work has not been accepted in substance for any other degree, and is not being currently submitted in candidature for any degree.

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ชื่อวิทยานิพนธ์ **ความหลากชนิดและวิวัฒนาการชาติพันธุ์ทางสัณฐานวิทยาของแกมมาริดแอมฟิพอดในน่านน้ำไทย**
ผู้เขียน **นางสาวกรอร วงษ์กำแหง**
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บทคัดย่อ

ศึกษาแกมมาริดแอมฟิพอดทะเลในน่านน้ำไทย พบแกมมาริดแอมฟิพอดทั้งหมด 33 ชนิด จาก 17 วงศ์ โดยแอมฟิพอด 8 ชนิดเป็นชนิดใหม่ของโลกได้แก่ *Grandidierella halophilus, Grandidierella phetraensis, Cheiriphotis trifurcata, Ceradocus andamanensis, Maeropsis paphavasita, Parelasmopus siamensis, Rotomelita longipropoda* และ *Tethygeneia khanomensis* แอมฟิพอด 8 ชนิดเป็นรายงานใหม่ในน่านน้ำไทยได้แก่ *Amphilochus justi, Ampithoe africana, Ampithoe ramondi, Cymadusa pilipes, Paradexamine latifolia, Listriella longipalma, Waldeckia elephas* และ *Melita latiflagella* และอีก 3 ชนิดยังไม่สามารถจำแนกชนิดได้ ได้แก่ *Grandidierella* sp.A, *Chelicorophium* sp.A และ *Tiron* sp.A ทำให้ในปัจจุบันมีรายงานของแอมฟิพอดในน่านน้ำไทย 63 ชนิด ทำการเปรียบเทียบวิวัฒนาการชาติพันธุ์ของการศึกษาก่อนหน้านี้กับการศึกษาครั้งนี้และสร้างแผนภูมิแสดงวิวัฒนาการชาติพันธ์ของแอมฟิพอดในน่านน้ำไทย โดยใช้ลักษณะทั้งหมด 40 ลักษณะ พบว่ามีความสอดคล้องกับการจัดกลุ่มของแอมฟิพอดในปัจจุบันยกเว้นแอมฟิพอดวงศ์ Melitidae, Aoridae, Photidae และ Corophiidae แอมฟิพอดที่พบมีลักษณะทางนิเวศแตกต่างกัน แบ่งได้เป็นกลุ่มที่หากินตามหน้าดินและเหนือพื้นดิน (neritic) กลุ่มที่อยู่ในดิน (nestler) กลุ่มที่สร้างท่อ (dominolous) และกลุ่มที่อาศัยอยู่กับสัตว์ชนิดอื่น (inquilinous) ทำการหาสายสัมพันธ์เชิงวิวัฒนาการของแอมฟิพอดในแต่ละสกุล

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ABSTRACT

The present study of marine gammaridean amphipod revealed 33 species in 17 families. Of these, 8 species were new to science namely *Grandidierella halophilus, Grandidierella phetraensis, Cheiriphotis trifurcata, Ceradocus andamanensis, Maeropsis paphavasita, Parelasmopus siamensis, Rotomelita longipropoda* and *Tethygeneia khanomensis* and 8 species were new record to Thai Waters namely *Amphilochus justi*, *Ampithoe africana*, *Ampithoe ramondi*, *Cymadusa pilipes*, *Paradexamine latifolia, Listriella longipalma, Waldeckia elephas* and *Melita latiflagella* and 3 species are unidentified namely *Grandidierella* sp.A, *Chelicorophium* sp.A and *Tiron* sp.A. Sixty three species are now known from Thai Waters. By considering to both previous phylogenetics and the results in this study, the phylogeny of the marine gammaridean Amphipoda in Thai Waters was created. Forty morphological characters were used in analyses. The phylogenetic tree shows the relationship between amphipod group which mostly follow the recent amphipod classification except the members Family Melitidae, Aoridae, Photidae and Corophiidae. The species occurred as a variety of ecological forms including neritic, nestler, domicolous and inquinous. Cladistic methods were used to examine phylogenetic relationships among the genera of marine gammaridean Amphipoda.

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CHAPTER 1
INTRODUCTION

Gammarid amphipods are the major groups of macrofaunal in benthic communities that encompasses about 9,100 species (Väinölä et al., 2008). They can be found from marine to freshwater habitats, from the depths of the deep-sea to intertidal habitats and also subterranean and semi-terrestrial habitats. Moreover, amphipods can be classified according to habitats as neritic, nestler and domicolous, as well as the inquilinous group that associate with other invertebrates.

The classification and systematics of gammarid amphipod, the phylogenetic relationships have been uncertain. The classification focus on most parts of diagnosis characters but not the apomorphic characters. It makes the classification do not lead to monophyletic taxa and makes some confuse classification. The first systematics of gammarid amphipod was established by Stebbing (1906), using the mysid like group as the most primitive group. After that, Barnard (1969) proposed the phylogeny of selected families of amphipod that radiated from basic gammaridean. Bousfield (1979) proposed the classification of 91 families and 20 superfamilies base on morphology of reproductive male amphipod but Karaman and Barnard (1979) disagreed in some idea and revised the classification. Recently, Kim & Kim (1993) create the phylogenetic tree of selected amphipods from 16 characters and gave some useful result in some families while others are questionable. Since then phylogeny of many families and superfamilies had been studied, such as, Corophiidae, Gammaroidea, Lysianassidae and Stenothoidae (Englisch & Konenemann, 2001, Englisch et al, 2003; Myers & Lowry, 2003 and Krapp-Schickel & Koenemann, 2006)

In Thailand, gammaridean amphipods can be found in hard bottom; coral reefs and soft bottom; seagrass bed and offshore area. They also distribute in estuarine and mangrove forest. The number of 58 species, 17 families have been reported from the Andaman Sea. (Bussarawich et al, 1984; Bussarawich, 1985; Lowry & Barrent, 2002; Lowry & Stoddart, 2002; Lowry & Watson, 2002; Myers, 2002; Peart, 2002; Jansen & Dinesen, 2003 and Lowry & Myers, 2003) and 34 species, 17 family from the Gulf of Thailand (Angsupanich & Kuwabara, 1995; Angsupanich et al, 2005 and

Wongkamhaeng, 2004). They inhabit mangrove forest and soft bottom of Phuket Islands and estuary of Songkhla Lake. However, other ecosystems including coral reef, seagrass bed still have lack of data as same as amphipods seasonal variation that was have been reported only in Uppper Songkhla Lake (Ruensirikul et al., 2007). This study will be useful in understanding the systematic of gammarid amphipod and also provide more insight on amphipod diversity and ecology in coastal habitats in Thailand.

OBJECTIVES

1. To study the species composition and distribution of gammarid amphipods in Thai Waters.
2. To study the morphological phylogenetics of the gammarid amphipods living in Thai Waters.

LITERATURE REVIEW

1.1 General Charateristics of gammarid amphipods

Amphipod characters is the crustacean of class Malacostraca, Superorder Peracarida, including tanaidacean, isopods, cumaceans and mysids. The characters are as the following; lack a carapace, seven definitive thoracic segments (pereonites) are visible, the first thoracic segment fused to the head and modified to maxilliped. Their life cycles are characterized by direct development and female carry their embryos in their brood pouch modified from their gill at pleopods. Amphipod body is laterally compressed, shrimp-like appearance. The amphipod eyes compound sessile eyes.

Seven pair of thoracic appendages are called pereopods, each one compose of seven articles. Male and female can be separated by their morphology. The male is determined by the ventral surface of thoracic segment between pair of pereopod 7 and small pair of penial projection. Amphipods body is range from 0.1-28 cm. Their color are variety and most are translucent, brown and grey in color; some are red, green, or blue-green. (Barnes, 1987)

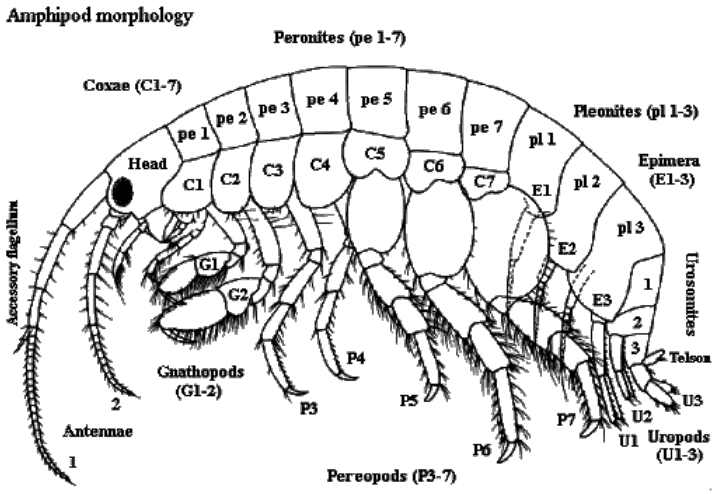


Figure 1 General morphology of amphipods (Lowry et al., 2000)

1.2 Systematics Resume of Order Amphipoda

Superorder Peracarida. Their bodies have marsupium, or brood pouch, under the thorax of female. The organ is formed by large flexible platelike oostegites producing from the thoracic coxae and using for brooding their eggs until some hatch as post larvae. The first and sometime second segments may be fused with

head to form a cephalothorax. The mandible has movable toothed process called lacinia mobilis located between molar and incisor. The compound eyes may be sessile or stalked.

Order Amphipoda. Their bodies are lateral compressed and lack of carapace. The eyes are compound and sessile. The first and second antennae are usually well developed. The first thoracic and in some cases second segments are fused with the head. The first pair of thoracic appendages is modified to form maxillipeds. The second and third thoracic appendages which are enlarged and subchelate for prehension are called gnathopods. The anterior three pairs are pleopods, used in swimming and in ventilation. The posterior three pairs, the uropods are directly backward. (Barnes, 1987)

Suborder Gammaridea : Amphipods in this Suborder have shrimplike bodies. Their eyes are normal size and usually occupying less than half of head. Their maxillipeds usually with palp. They have thoracic legs with coxal plates. Their abdomens are strong. Their three pairs of uropod are well developed with rami. Uropod 1 are biramous. They are primarily benthic or are found to be pelagic species only 20 percent (Fig. 2A).

Suborder Hyperiidea : Amphipods in this Suborder have transparent shrimplike bodies. Their eyes are usually present and large in size, covering most of the head. Their maxilliped are without palp. Their thoracic coxal plates are small and fused with their bodies. Their pleopods are usually strong and biramous. They have three pairs of uropod that sometime rami is absent. They are primarily planktonic or commensal on gelatinous pelagic animals. (Fig. 2B)

Suborder Caprellidea : Skeleton shrimps or marine praying mantis. They were characterized by extremely thin tubular bodies. Their head and first peraeon (second thoracic) segment variously fused. Their coxal plates are lacking or vestigial. Their abdomen segment are less than 5. Their appendages are usually vestigial only gnathopods and pereopods remained. The brood plates and gills locate on thoracic segments 3 and 4. They are primarily adapted to a sedentary life waiting to attack their prey. (Fig. 2C)

Suborder Ingolfiellidea: They often bear cephalic “ocular” scales which allows them forz terrestrial existence. Their thoraxes compose of seven distinct segments. They have thoracic appendages with coxal plates. Their brood plates and coxal gills are on three or more segments. Their abdomens compose of strong six segments with appendages. Their bodies are vermiform. Their pleopods are vestigial. They have two pairs of biramous uropods. Most of them are terrestrial species, living in cave. Some are found in fresh water and marine environment. (Fig. 2D)

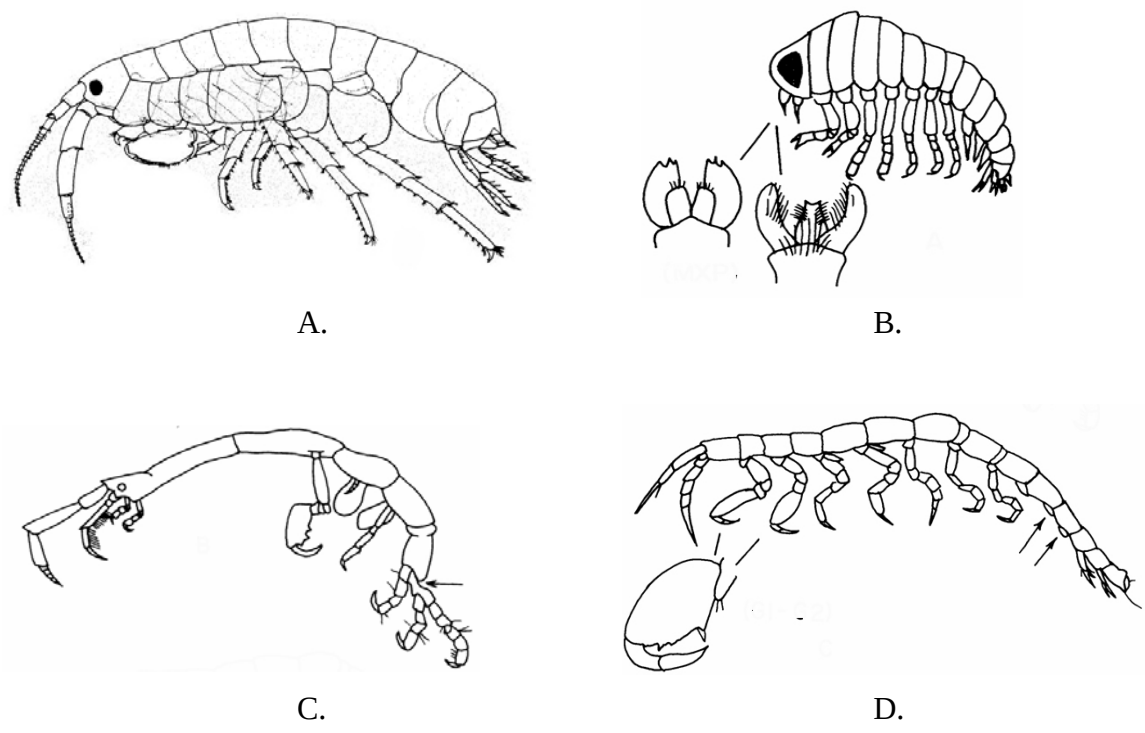


Figure 2 Order Amphipoda (Modified from Bousfield, 1973)

A. Suborder Gammaridea

B. Suborder Hyperiidea

C. Suborder Caprellidea

D. Suborder Ingolfiellidea

1.3 Mophology of gammarid amphipod

Head- The head character in the gammarids is highly variable. Normally the 'basic' gammaridean length from the rostrum to the end is about as long as 1.5

pereonites (Fig. 3). The head length varies from much shorter than the first pereonite to as long as the first three pereonites combined. The families that have elongate head are noticeable in the Ampeliscidae, Phoxocephalidae (including the visor-like rostrum), Synopiidae and Oedicerotidae. Moreover, there are 'massive' head that is not only elongate but very deep. Most members of that group that have very short pereonite 1 to 3, shorter tham head length are considered as massive head.

Antennae – amphipods have two pairs of antennae (Fig. 4). The first three articles of the first pair are called peduncle and the remaining articles are called flagellum. At the end of the peduncle of the first antenna, amphipod some families may have an accessory flagellum that crucial to amphipod systematics. The second antennae of first five articles are call peduncle and the following are flagellum. The both antennae show sexual dimorphism, male antennae often longer than female and might has sensory appendages, including aesthetascs and calceoli.

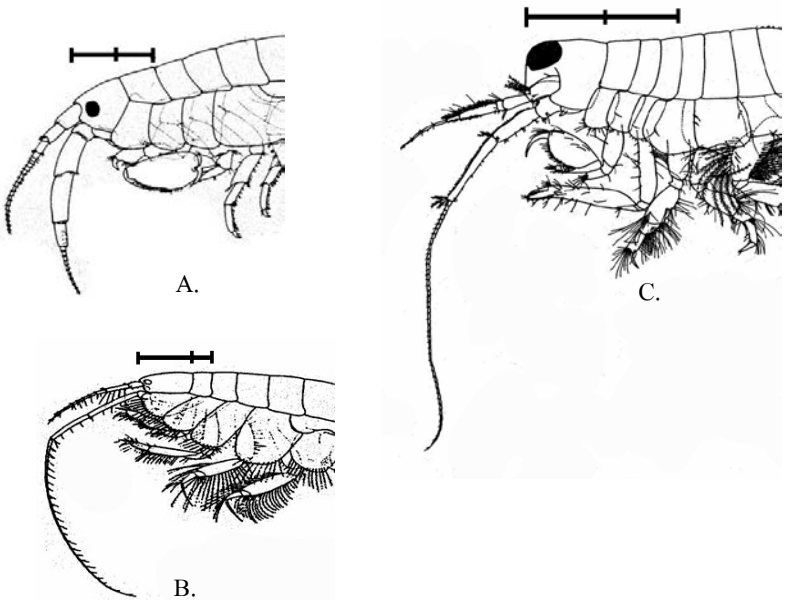


Figure 3 Amphipod head (Modified from Bosfield, 1973)
A. General amphipod head
B. Elongate head of amphipod family Ampeliscidae
C. Massive head of amphipod family Odicerotidae

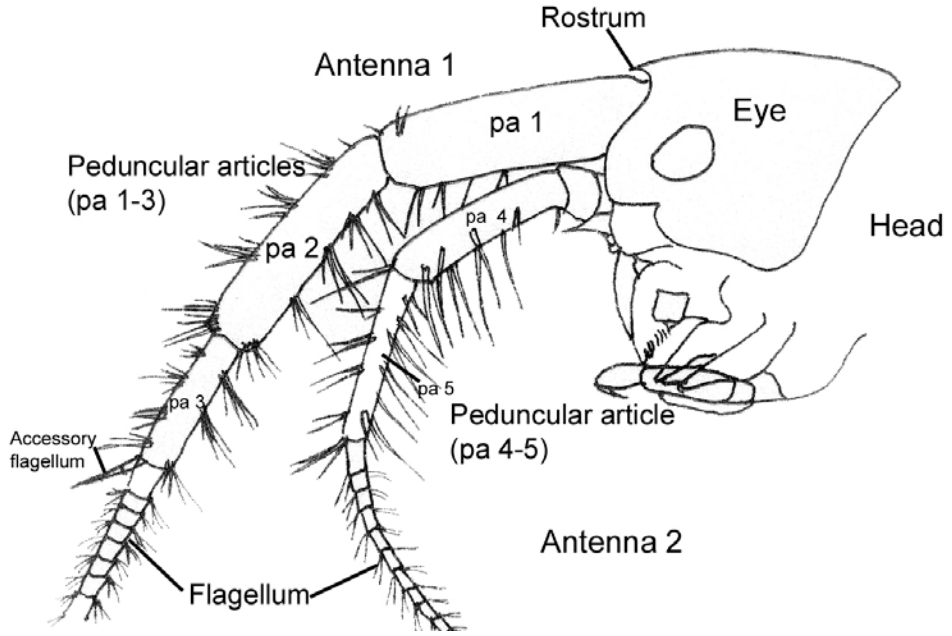
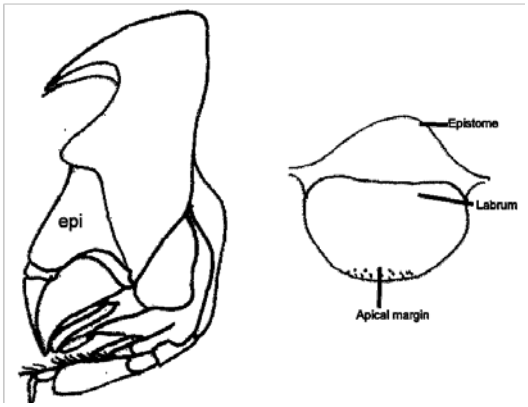


Figure 4 Head structure of amphipods (Lowry et al., 2000)

Amphipod first antenna is an important character which was discussed in amphipod evolution. Platvoet and Pinkster (1992) suggested that the long accessory flagellum is a plesiomorphic form. The oldest marine *Gammarus* and *Echinogammarus* species contain this character with higher ration of accessory flagellum and main flagellum. They also show the clear correlation between first antanna composition and the occurrence in marine or freshwater habits.

Mouthparts- Amphipods with different feeding mode display array of feeding structures, in particular, mouthparts and associate appendages mainly antennae and gnathopods. These mouthparts are modified according to food items. Moreover, they also have other modified appendages to suit their habitats. Myers & Lowry (2003) used this idea to construct the higher-level classification for the suborder Corophiidea Leach, 1814. They divided the Corophiidea into two superfamily (Corophiidea and Caprelloidea). The mouthparts are consisted of the following structures.



A. B.

Figure 5 Upper lip

A Epistome (side view)

B Epistome and Labrum (front view)

(modified from Barnard & Karaman,1991 and Bousfield, 1973)

- Upper lip (Fig. 5A,B) a single lobe or flap anterior to the mouth. In about 10% of known species the anterior cephalic surface above the upper lip (labrum) is produced into a point, keel, or lobe known as the epistome. Its function is unknown. In a few families, especially Lysianassidae, the upper lip has a keel projecting anteriorly and usually separated from the epistomal region by a deep slit or sinus. Oceasionally both epistome and upper lip are produeed together and oceasionally they are fully amalgamated.

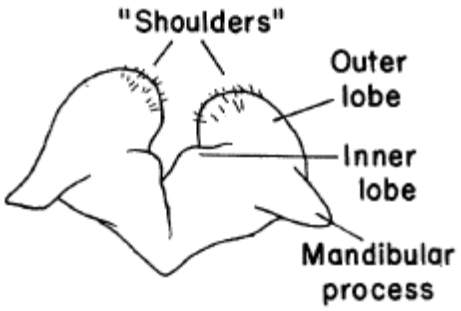


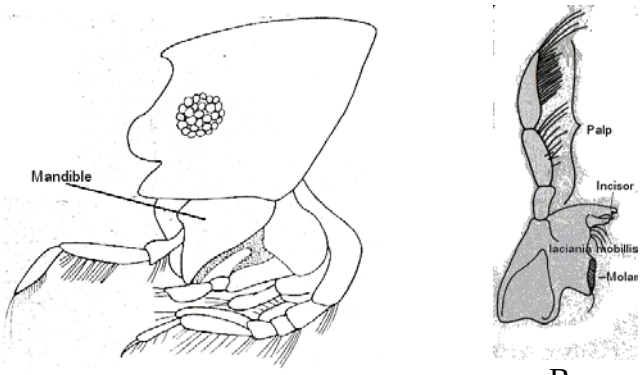
Figure 6 Lower lip

(modified from Bousfield, 1973)

- Lower lip (Fig. 6)- a bilaterally symmetrical complex forming a partition behind the mouth. Also known as a labium, the lower lip is composed of at least a pair of lateral lobes, having their lateral extremities produced, often acutely and often bearing apicomedially a tiny eusp enclosing the meatus of a salivary duct. About half of the known gammarideans has a pair of medial lobes on the lower lip.

Mandibles (Fig.7) - a pair of appendages attached lateral to the mouth; with the upper and lower lips they form a box around the mouth, permitting buccal closure. It is composed of anterodistal ends called incisors that use for biting. The proximal of

incisor called lacinia mobilis (aceessory plate) which may occur on only one or none of the mandibles. A molar is used for grinding have tooth or ridged or smooth surface often occurs on the medioventral surface of the mandible. Most Gammaridea have palp attached to the dorsolateral surface of the mandible. The palp is used to clean the bases of the antennae.



A. B.

Figure 7 A. Mandible position in mouthparts
B. Mandible structure (Barnard & Karaman, 1991)

Walting (1993) suggested that mandible is an important character for amphipod systematic. He compared the modification of mandible, including the reduction of the incisor, loss of the lifting spines, reduction or loss of molar from different groups. The modifications are response to feeding modes. He construct the two different pathways (Fig. 8); the reductions occur on a compact coxa and the group that mandible modified to elonagate and incisor changes for cutting. He concluded that the predatory/scavenging mandible cannont be considered to be plesiomorphous.

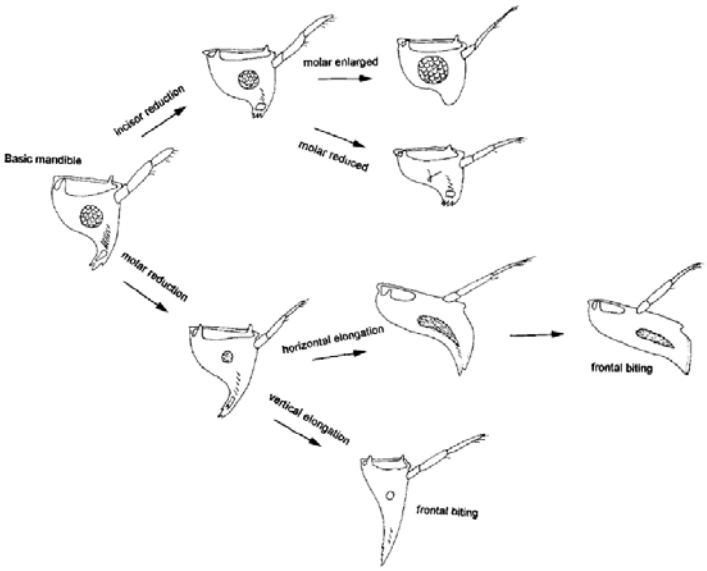


Figure 8 The mandible modification pathways (Walting, 1993)

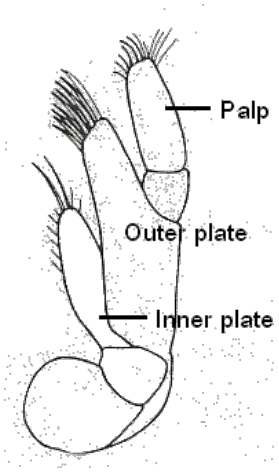


Figure 9 First maxillae (Barnard & Karaman, 1991)

- **First maxillae**: These are situated posteriors to the lower lip. This pair of appendages is small, each bearing a medial free lobe (inner plate), and outer lobe with spines, and attached to the outer lobe, a palp consisted of one or two segments. (Fig. 9) Filter feeding amphipods use fist maxillae for pushing food between the mandibular palp spine rows or molar. This structure is also used for biting particles in amphipods that have small incisor. Herbivorous amphipods both filter feeders and grazers swing first maxilla and use the apical spine teeth for cutting their food (McGrouther, 1983 and Dixon & Moore, 1997).

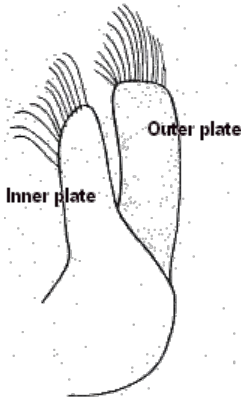


Figure 10 Second maxillae (Barnard & Karaman, 1991)

- **Second maxillae**: Two pairs of lobes, second maxillae are behind the first maxillae. This appendage consisted of simple medial called inner plate and lateral plates called outer plate. (Fig. 10). Detritivorous amphipods such as *Lembos websteri* use outer plate of second maxillae as scissor with outer plate of first maxillae in vertical position to cut detritus particles. *Corophium bonellii*, the filter feeding amphipods also use second maxillae together with first maxillae. (Dixon & Moore, 1997)

Thoracic Appendages

The thorax bears seven pairs of legs. All thoracic appendages have seven articles, the proximal member of which is the coxa or sideplate. Other six appendages called basic, ischium, merus, carpus, propodus and dectylus respectively (Fig. 11). Sometime we can use the number instead the name of each appendages.

- Pereopods: pereopods are divided into two parts. The first two pair, gnathopods or gamopods are the first two pairs of thoracic appendages. They usually are prehensile. Six and seven articles form into chaelate or subchaelate gnathopods. Gnathopod 2 generally show the sexual dimorphism. There are different kind of gnathopods for particular amphipods ecology. (Fig. 12). In some gammaridean groups an enlarged gnathopod 2 is used primarily for grasping the female during copulatory amplexus. The male grasp female until the female molt and male emits spermatophores (sacs of spermatozoa) that pass from the ventral side of his seventh pereon segment into the pouch formed by the female brood lamellae.

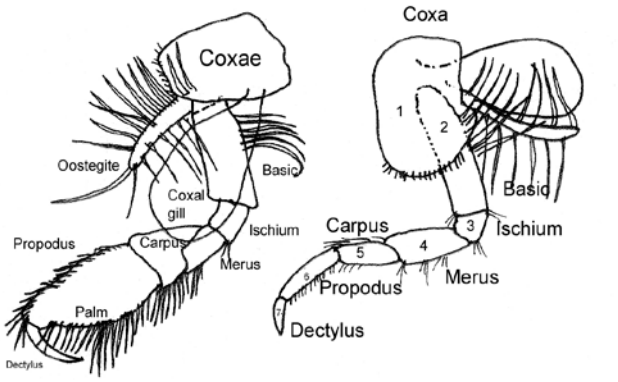


Figure 11 Thoracic appendages of amphipod (Lowry et al., 2000)

Other five pairs of legs posterior from gnathopods are called pereopods. The first two pairs of perepods are useful in cleaning the gnathopods and the other anterior appendages and as a balance when alighting from a swim. The last three pairs appear rather immobile and less adapted for walking. Fossorial pereopods, pereopods with dense setae, are found in burrowing amphipods.

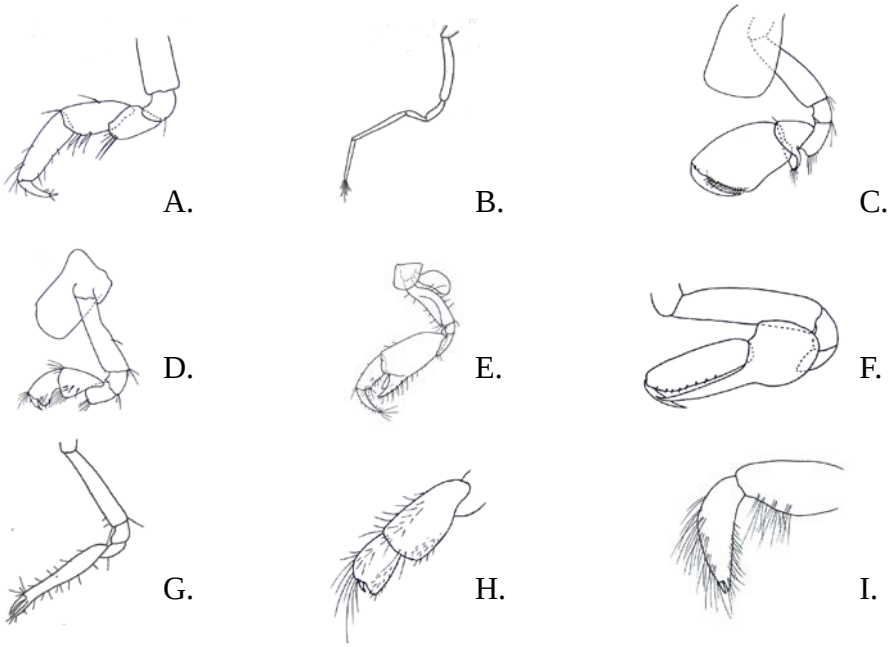


Figure 12 Gnathopod types A. simple B. filliform C. large subchelate D. small subchelate E. complex subchelate F. carpochelate G. chelate H. small chelate I. large chelate (Modified from Bousfield, 1983)

Oostegites (Fig. 11)- in females the medial surfaces of coxae 2 to 5 (or 3 to 4 only) carry brood lamellae (oostegites). Steel (1991) suggested that there are of two main types - broad with relatively short marginal setae and narrow with long marginal setae. The primitive amphipod have broad oostegites and tend to have smaller eggs than those with narrow oostegites. It is concluded that following the evolution of the major amphipod groups, the oostegites were modified as egg sizes have changed as part of the reproductive strategies of the species within these groups.

Pleopods (Fig. 13A,B)- are paired biramous appendages on the first three segments of the pleon, the rami multisegmented and strongly setose. Minute coupling hooks on the medial edges of the peduncles are used to engage the pairs of pleopods for coordinated paddling.

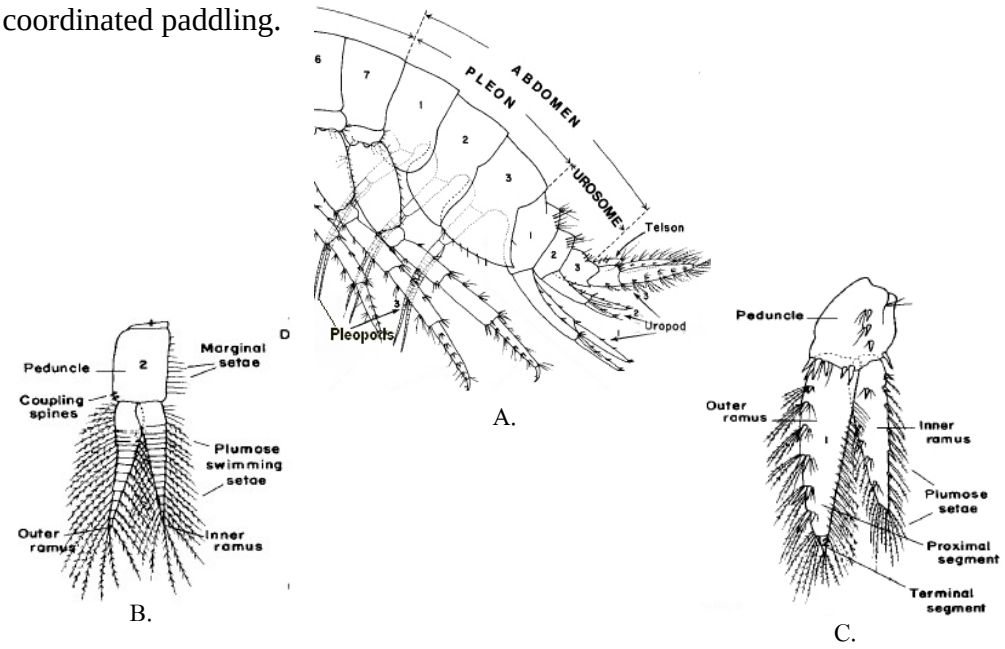


Figure 13 Pleon appendages

A. Amphipods abdomen and appendages

B. Pleopods

C. Uropods (Modified from Bousfield,1983)

Urosome (Fig. 13A) - There is justification in restricting the term pleon to the first three abdominal segments which bearing pleopods, while the term urosome is used for the last three abdominal segments bearing uropods. Uropods in many malacostracans are used for swimming. Amphipods use uropods 1-2 for strengthening the caudal portion of the body to allow jumping or flipping by rapid flexion of the

urosome. The third uropod are often reduced or absent in sedentary species.The telson is a flap attached to the sixth pleonite above the anus. It may be cleft into two lobes, fused into a single, elongate, fleshy or ornate. (Barnard, 1969)

1.4 Status of gammarid amphipods

Barnard & Karaman (1991) concluded around 5,700 species from 1,060 genera of Suborder Gammaridea. The 1,870 species of 235 genera are freshwater and inland water species and the rest are marine. Vader (2004) concluded the 2,793 addition species from 1991 to 2004. After that, he also reported some taxonomic changes such as Acanthonotozomellidae, the genus Spindlerella shown to be base on juvenilws of Paraampithoe, and various Mediterranean *Batheporeia* species, which have been put into synonymy with older species. Most of the latter spcies are from Baikan Lake.

1.5 Evolutionary Pattern of gammarid amphipod

a. Phylogenetic relationship of gammarid amphipod species

Suborder Gammaridea, is the most primitive group but the classifications and phylogenetic relationships among subgroups are still confusing. The classical scheme of classification and phylogeny of the Gammaridea was established by Bate (1862), Sars (1895) and Stebbing (1906). In their systems, the Lysianassidae, Phoxocephalidae, other mysid-like groups and Talitridae were treated as the most primitive groups.

The phylogenetic classification of amphipod group have been based on morphological characters at the beginning. Barnard (1969) was the first who produced the evolutionary tree base on plesiomorphic characters e.g. accessory flagellum, basic mouthparts, large coxae and dominant of gnathopod 2 in males (Fig. 14). The most part of this tree still valid and used as basic idea for amphipod classification. Bousfield (1978) proposed the world gammaroidean amphipods systematics that using cladistic method. He suggested that amphipods in this group have diverse characters that contain both plesiomorphic and apomorphic characters (Fig. 15). He proposed systematic of 19 gammaridean superfamilies (Bousfield, 1983). He used the primitive characters of Mysidacea that represent the primitive conditions in the Peracarida. Moreover, his tree and classification is base on the reproductive

morphology of male and the losses of structure including pleon, mouthparts and accessory flagellum (Fig. 16). However, the phylogenetic tree he proposed still contained the problems that the characters used in defining the existing concept of Gammaridae (sensu. lato.) always together with exceptions that means the tree might not represent the monophyletic taxa.

Barnard & Karaman (1983) added the classification of amphipod base on telson characters and concluded that amphipod Suborder Corophiidea is the ancestor of Gammaridae Caprellidae and Hyperiidae (Fig. 17). By the way, the Suborder Corophiidea of this thee composed of Superfamily Coriphoidea and Caprelloidea which have same character, fleshy telson.

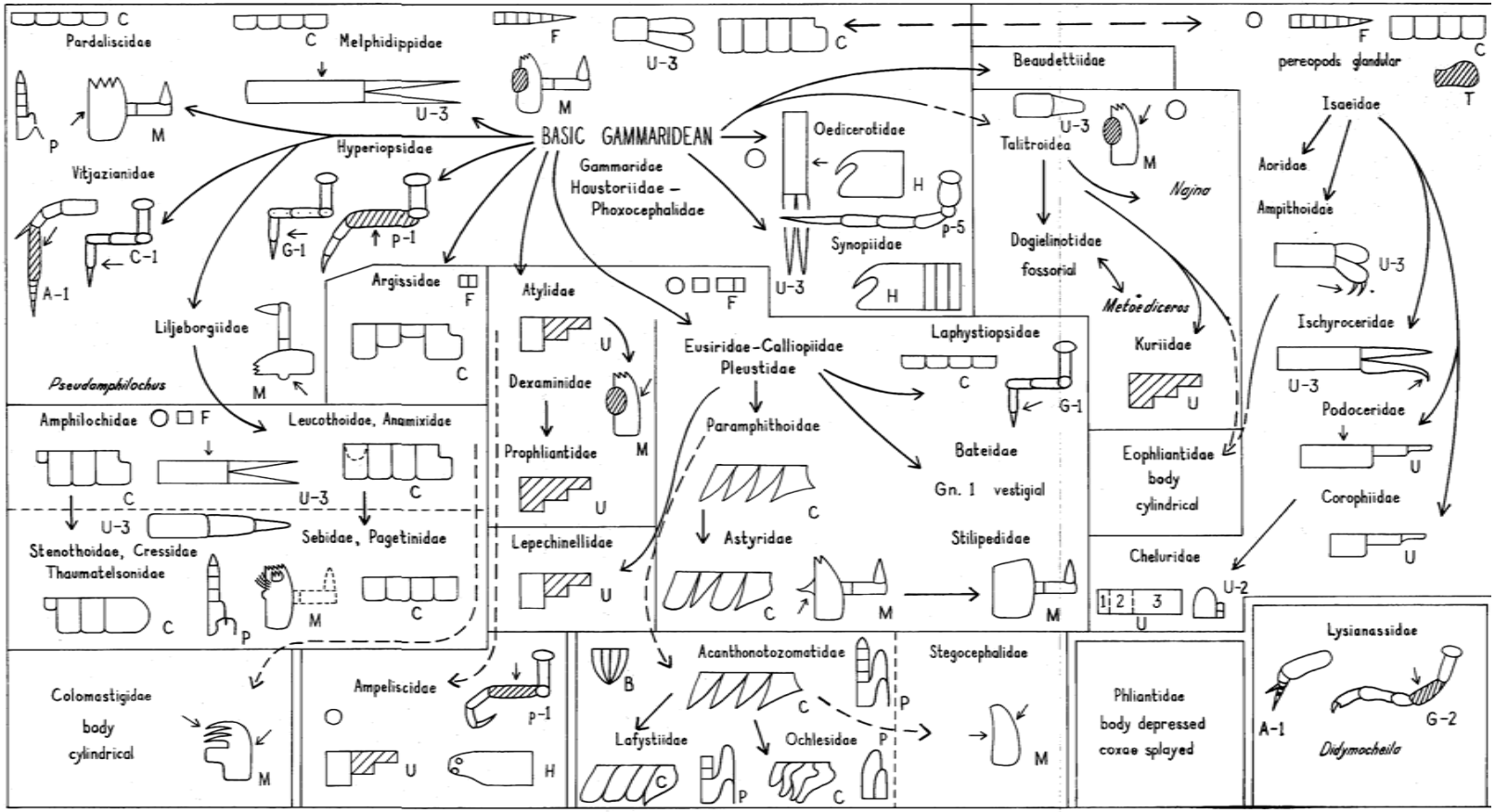


Figure 14 Pattern of evolution in the Gammaridea (Barnard, 1969)

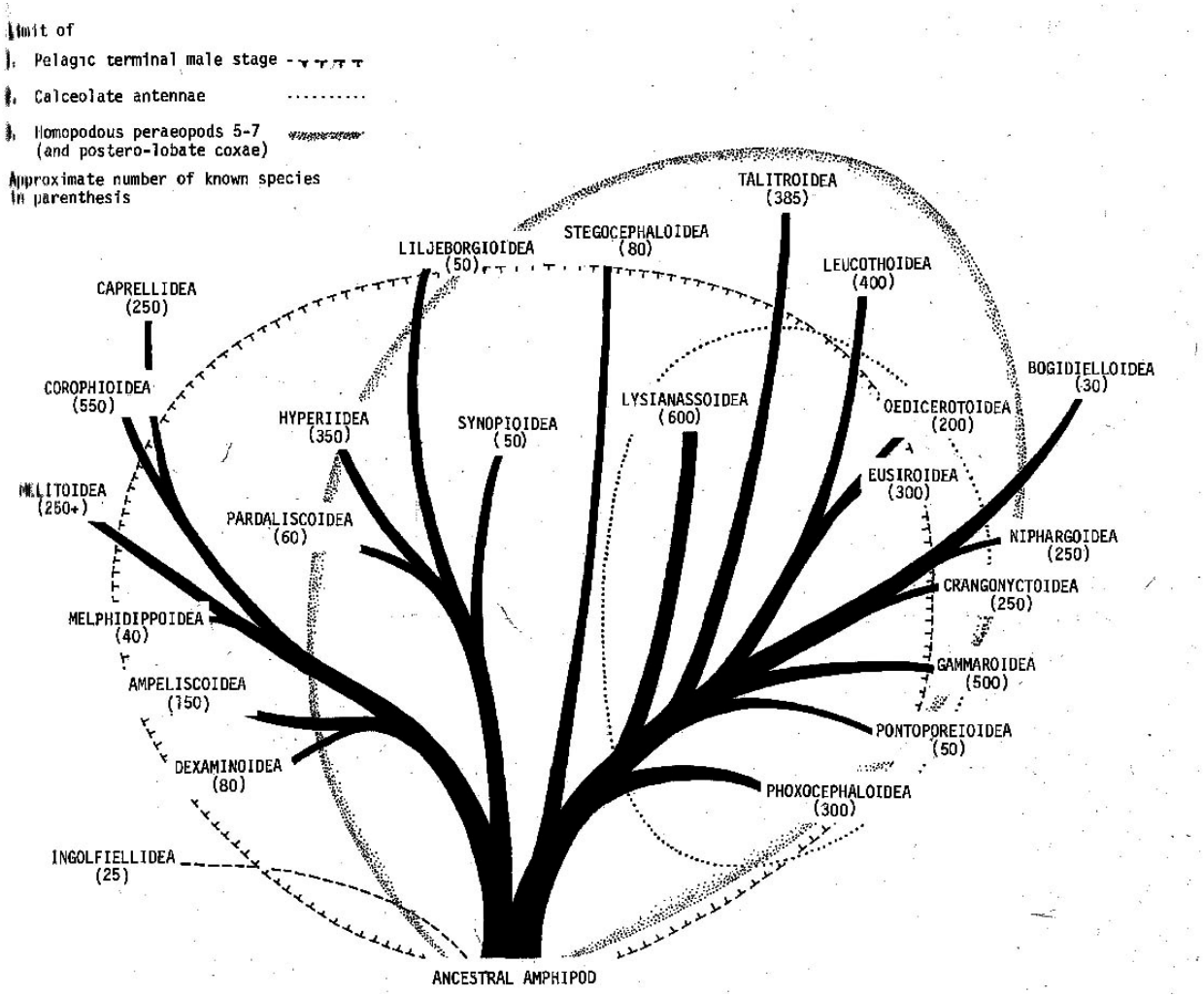


Figure 15 World gammaroidean amphipods systematics (Bousfield 1978)

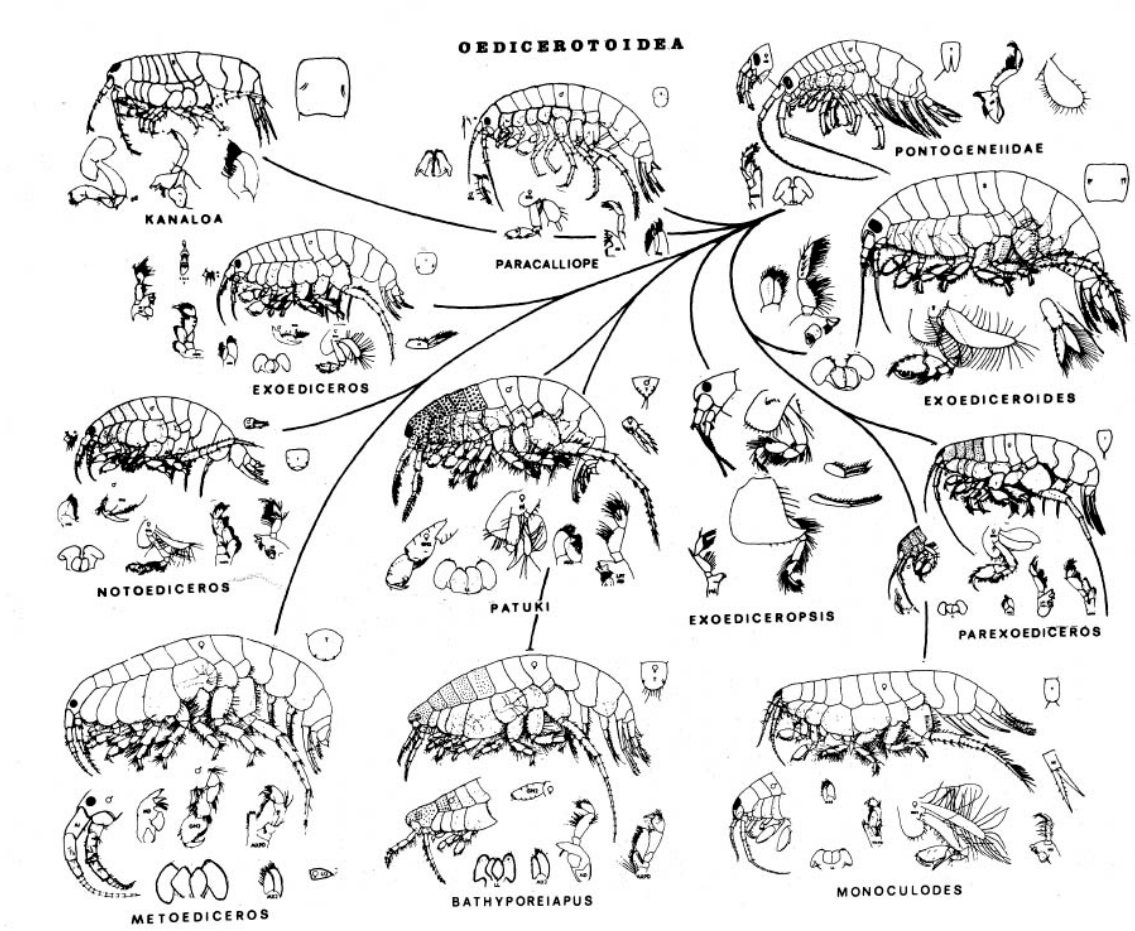


Figure16 Systematic of 19 gammaridean superfamilies (Bousfield, 1983)

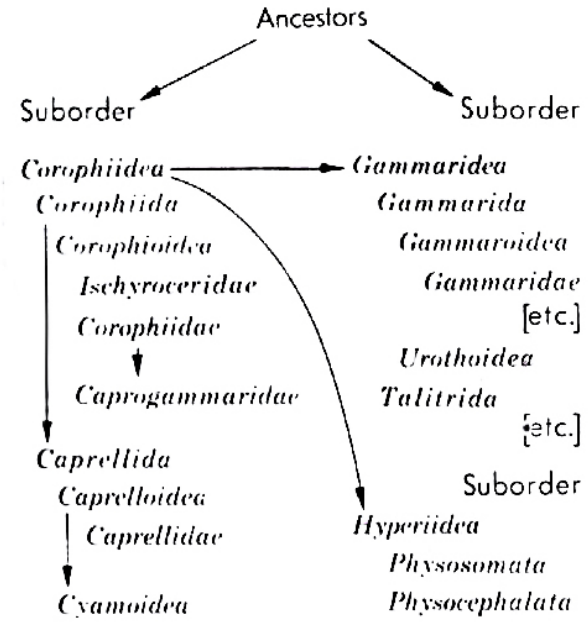


Figure 17 The evolutionary tree of gammarid amphipod (Barnard & Karaman, 1983)

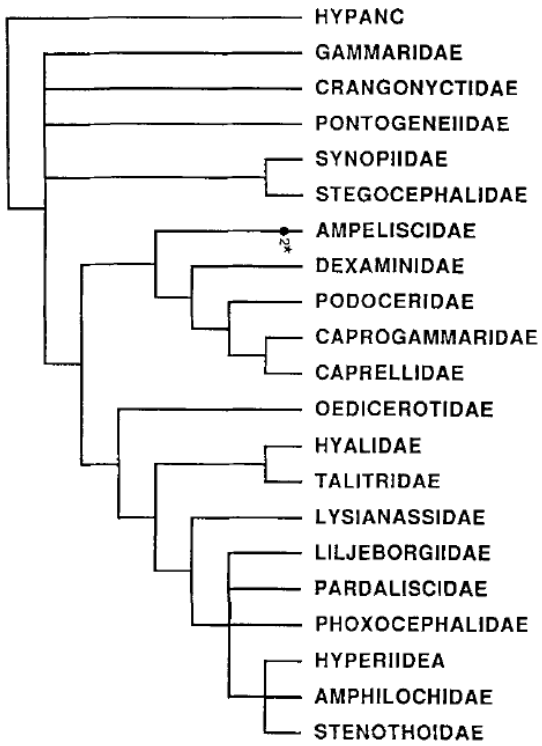


Figure 18 The phylogenetic relationships among gammaridean families (Kim & Kim 1993)

After that, the situation in amphipod phylogeny was characterized by Barnard & Karaman (1991). However, the amphipod evolutionary plan that proceeds from complex ancestral kinds to simplified derived kinds still shows some "missing links". Recent attempts to establish a phylogeny of amphipods based on morphological data were made by Kim & Kim (1993) that created a system of selected families based on sixteen characters (Fig. 18) and created hypothetical ancestor amphipod (HYPANC) as an outgroup. Five independent lineages identified from this analysis were Gammaridae, Crangonyctidae, Pontogeneiidae, Synopiidae plus Stegocephalidae, and one comprising the other groups considered in this study. This result show that the combination of the Corophioidea with Caprellidea would be monophyletic same as Barnard's idea. The results still contain some problems because they selected small number of some families and make the remaining families are justified only by uninformative characters.

In the present time, Myer & Lowry (2003) established suborder Corophiidea and removed it from the Gammaridea based on the characters telson shape. Lowry & Myers (2013) established new suborder Senticaudata which incorporates 95 families formerly in Gammaridea defined by the presence of apical robust setae on the rami of uropod 1—2. It includes almost all freshwater species and some of marine benthic taxa.

b. Primitive and derived characters

The characters used to classify taxonomically and to determine evolutionary relationships are not grossly revolution but involve the reduction of accessory flagellum, the development of fossorial spine, the loss of structure on molars, incisors and palps of mandibles, the elongation of certain pereopods, reduction of coxa 1, reduction of the basal lobes on maxillipeds, loss of ramus on uropod 3, the elongation of the peduncle of uropod 3 and the fusion of two or three urosomite. All of the characters presented in Table 1 are concluded from the previous work of Bousfield (1979, 1983), Kim & Kim (1991) Myers & Lowry(2003) and Lowry & Myers(2013).

Table 1 Comparatives of gammaridaen characters

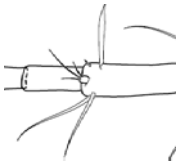
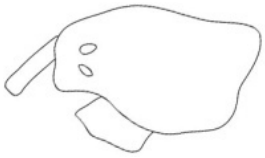
Characters	Primitive Characters	Derive Characters
Accessory flagellum	Fully developed 	Reduced 
Eyes paired	Eyes paired 	Eye corneal lens with two pairs 
Maxilla 1 inner lobe	Large and densely setose marginally 	Absent 
Maxilla 2 inner lobe	Broad, and densely setose marginally and facially 	Narrow or small, sparsely setose marginall and facially 

Table 1 Comparatives of gammaridaen characters

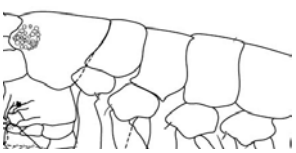
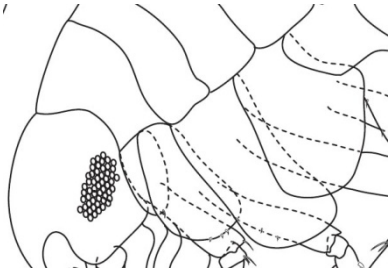
No.	Characters	Primitive Characters	Derive Characters
1.	Molar structure	Trituative 	Weakly developed and smooth or absent 
2.	Mandibular palp	Strongly developed and 3-articulate	absent
3.	Maxilliped, inner plate	Well developed 	Reduced or fused 
4.	Maxilliped palp	4-articulate and unguiform	Article 4 of palp reduced or palp absent
5.	Coxa 1-4	Present, deep large/small shallowed 	Vestigial or absents 

Table 1 Comparatives of gammaridaen characters

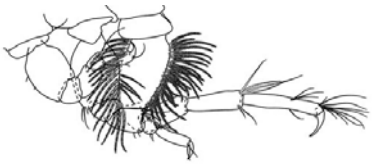
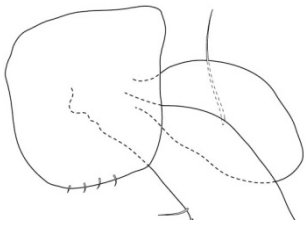
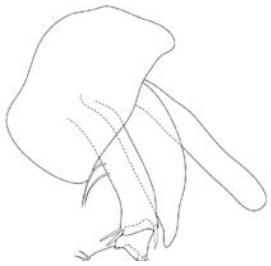
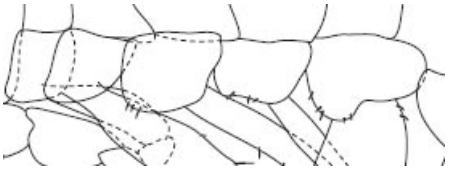
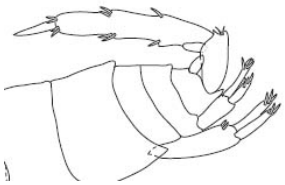
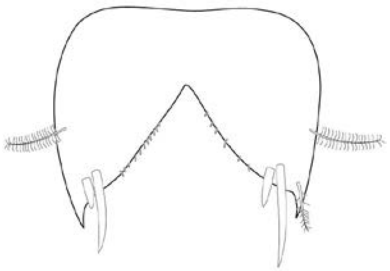
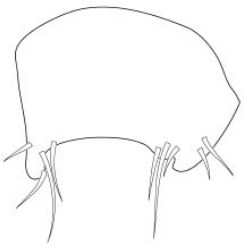
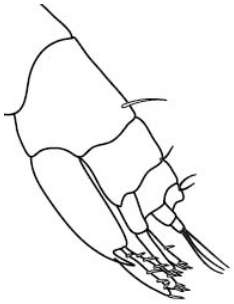
No.	Characters	Primitive Characters	Derive Characters
6.	Sexually diverse gnathopods	Strong: Male gnathopod 2 larger than female	Weak: Equally in male and female
7.	Pereopod 5-7	Subequal in size and form 	Unequal both size and form, fossorial 
8.	Number of gill	Occur on coxae 2-7	Occur on coxa 2-4
9.	Number of oostegites	Occur on coxae 2-5	Occure on coxae 3-4
10.	Oostegite character	Broad with relatively short marginal setae 	Narrow with long marginal setae 
11.	Coxae contiguous	Coxae overlab 	Coxae discontiguous 
12.	pleopod	Well developed	Reduce or absent

Table 1 Comparatives of gammaridaen characters

No.	Characters	Primitive Characters	Derive Characters
13.	Uropod 1 and 2	Biramous	Uniramous or vestigial
14.	Uropod 3	biramous	absent
15.	Size of uropod 3 biramous rami	Equal or subequal 	Unequal 
16.	telson	Cleft and larminar 	Lobe fused entirely 
17.	urosome	Free 	Urosome 1 distincly elongate or urosome absent 

CHAPTER 2
MATERIALS AND METHODS

2.1 Sampling Stations

The sampling stations will be included the Andaman Sea and the Gulf of Thailand (Fig. 19) covering four main habitats, coral reef zone, seagrass bed, estuarine zone as well as other zones with soft bottom and some of fouling communities such as fish cage and port. Two monsoon seasons can be distinguished in these areas. The Andaman Sea and eastern Gulf of Thailand, the rainy southwest monsoon period starts from May to October with strong winds and wave action and the dry northeast monsoon period is from November to February. The lower western Gulf of Thailand, the rainy southwest monsoon period starts from May to October with dry period and northeast monsoon period with strong winds and wave action is from November to February.

The Andaman Sea

The sampling sites in the Andaman Sea are composed of 13 sampling sites along Andaman coast with 6 islands and 7 mainland sites. (Table 2)

Table 2 Study sites in the Andaman Sea

Number	Province	Site	Habitat types	
AS1	Ranong	Phayam Island	Coral reef	09°47'49.3"N 98°22'52.3"E
AS2	Phang Nga	Surin Island	Coral reef	9°26'33"N 97°48'57"E
AS3		Yao Yai Island	Seagrass bed	
AS4	Phuket	Paklok bay	Seagrass bed	08° 01’32’’N 98° 25’45’’E
AS5		Racha Yai Island	Coral reef	07°36.426’ N 98°22.813 E
AS6		Loan Island	Coral reef	7°47'55"N 98°22'15"E

Table 2 Study sites in the Andaman Sea

Number	Province	Site	Habitat types	
AS7		Chalong Bay	soft bottom, Seagrass bed, Coral reef	7°48'6"N 98°21'1"E
AS8	Trang	Yong lam Bay	Seagrass bed	07°22'60"N 99°19'60"E
AS9		Pakmeng Beach	Seagrass bed, Coral reef	07°29'46"N 99°19'18"E
AS10		Libong Island	Seagrass bed	07°14’07’’N 99° 22’09’’E
AS11	Satun	Phetra Island	Coral reef	6°46'42"N 99°46'5"E
AS12		Buloan Island	Coral reef and mangrove forest	6°49'42"N 99°32'4"E

Gulf of Thailand

Upper Gulf of Thailand

The sampling sites in upper eastern Gulf of Thailand are composed of 5 sampling sites along the coast with 2 islands and 3 mainland sites. (Table 3) and 2 sites are located in inner Gulf of Thailand (Table 4).

Table 3 Study sites in easthern Gulf of Thailand

Number	Province	Site	Habitat types	
EGT1	Chonburi	Sichang and Kang Kao Island	Coral reef, Soft bottom	13°7'7"N 100°48'27"E
EGT2		Samaesan Beach	Coral reef	12°33'03"N 100°57'05"E
EGT3	Rayong	Mae Ramphaung Beach	Soft bottom	12°37'3"N 101°22'18"E
EGT4	Chanthaburi	Kungkraben Bay	Seagrass bed	12°35'19"N 101°53'44"E
EGT5	Trat	Kut Island	Coral reef	11°39'42"N 102°33'59"E

Table 4 Study sites in inner Gulf of Thailand

Number	Province	Site	Habitat types	
IGT1	Samut Sakhorn	Naklua	Mangrove Forest	13.51^{0}0768°N, 100.3525478°E
IGT2	Samut Songkhram	Klong Kone	Mangrove Forest	13°19'43"N 99°58'24"E

Lower western Gulf of Thailand

The sampling sites in lower western Gulf of Thailand are composed of 7 sampling site along the coast with 3 islands and 4 mainland sites. (Table 4)

Table 5 Study sites in lower western Gulf of Thailand

Number	Province	Site	Habitat types	
LGT1	Prachuap Khiri Khan	Bang Saphan	soft bottom/with sand dune	11°05'41"N 99°29'22"E
LGT2 LGT3	Surat Thani	Samui Island Phangan Island	Coral reef, Seagrass Bed	9°41'48"N, 100°0'2"E
LGT4	Nakhon Si Thammarat	Rab Island	Algal bed	9°18'42"N 99°57'29"E
LGT5		Talet Bay	Seagrass bed	09˚18'39.5"N 99˚46'46.4"E
LGT6	Songkhla	Songkhla Lake	Soft bottom	09°18'39.5"N, 99°46'46.4"E
LGT7	Pattani	Ban Bang Ta Wa	Coral reef	06^{o}56'04'N 101^{o}08'34"E

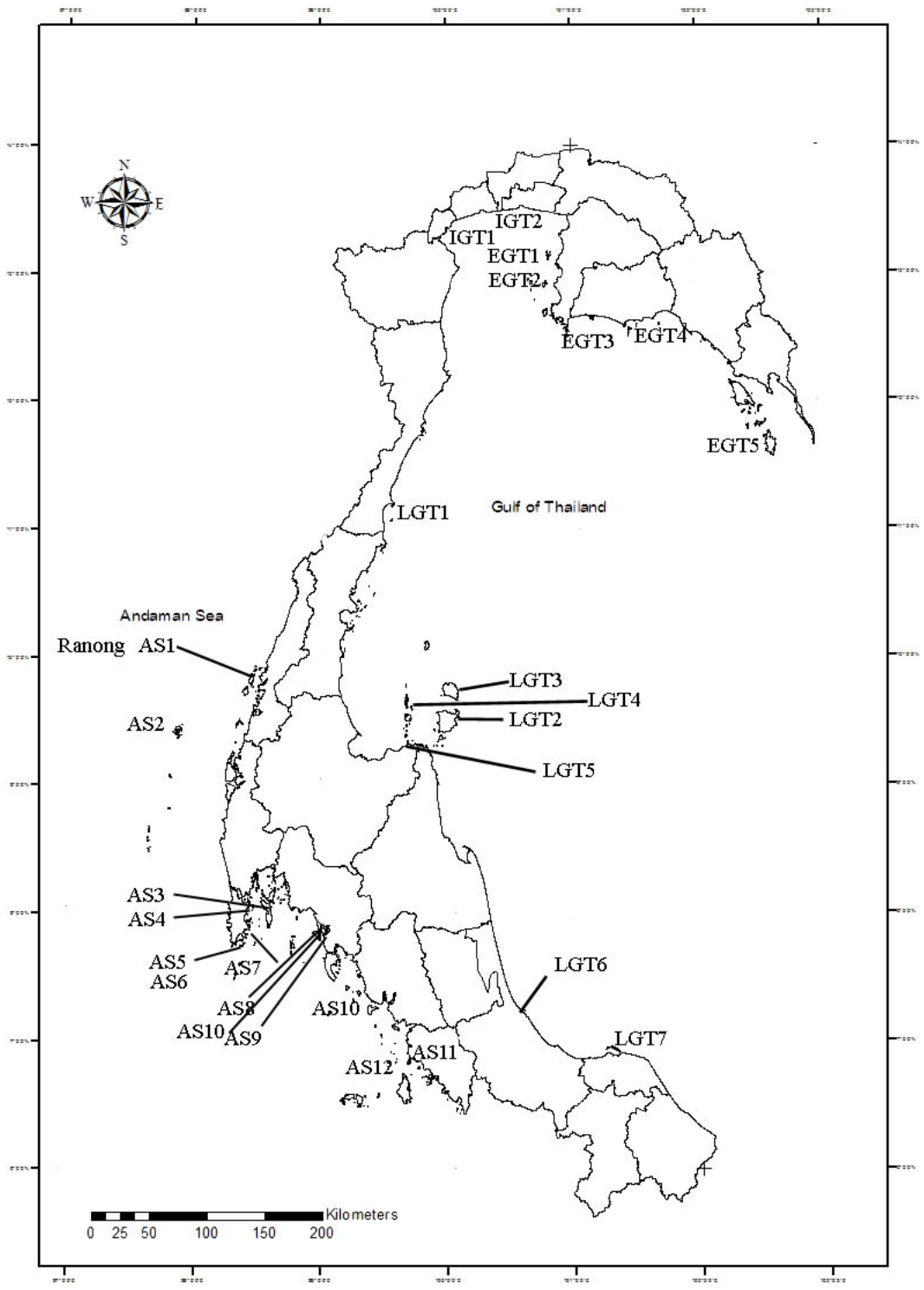


Figure 19 Map of study sites

2.2 Sampling Methods

The field sampling program were carried two times of each station for representing two monsoon periods.

1. coral reef zone

The empty space between coral head were selected and sediment were collected to 10 cm depth in the 50X50 cm quadrats by hand collecting with SCUBA diving. The substrate were consisted of mixture of sand and rubble. A total of 20 quadrates are at each station. The sediment samples were preserved in 70% EtOH and sorted in the laboratory later.

2. seagrass bed zone

Sediment samples were collected using 20 cm diameter core sampler during low tide when the seagrass expose. The 20X20 cm grab sampler were used during high tide. A total of 5 cores and 5 grab are at each station. Seagrass shoots were collected, for further sorting of associated amphipods, and kept in plastic bags. After that, rhizomes and sediment samples were collected down to the depth of 5 cm and kept in separated plastic bags. Samples were preserved in 70% EtOH and sorted in the laboratory later.

3. soft bottom zone and estuarine zone

The sediment quantitative samples were collected using 20x20 cm grab. Amphipoda are most easily collected by washing substrates in a bucket of seawater. A total of 5 grab are at each station. The sediment qualitative sampling were collected with hyperbenthic sledge towing for 20 meter 5 times for each station. Samples were preserved in 70% EtOH and sorted in the laboratory later.

4. Fouling zone

Sample were collected by placing 20X20 cm quadrat on the surface and removing all the founling organism by scraping the surface with a knife. The sample were transfer to a plastic bag and preserved in 70% EtOH and sorted in the laboratory later.

2.3 Specimen Collection

The samples were washed through the sieve of 0.5 mm mesh size. Specimens retaining on the sieves were hand picked and identified to species. Descriptions and drawings were made after the identification using the camera lucida. Characters were recorded in the analytical sheet modified from Barnard (1969).

The following abbreviations are used on the plates: A, antenna; ABD, abdomen; EPIM, epimeron; G, gnathopod; LL, lower lip; MD, mandible; MX, maxilla; MP, maxilliped; P, pereopod; PL, pleopod; PLN, pleonite; T, telson; U, uropod; UR, urosome; UL, upper lip; L, left; R, right; ♂ , male; ♀, female.

2.4 Phylogenetic Study

Phylogenetic become important in classification. This idea base on all the associations involves in classification. The characters are based on the feature derived from a common ancestor. The organisms may have the very complex systems; the kind of change that occurs over generation of evolution must have their own structures and functions and that characters must reflect the evolution. This approach will weight the character into two groups; the plesiomorphic (primitive) character and apomorphic (derived) character. The organisms that share common ancestor should shared-derived characters or synapomorphic character. They infer the state of character by reference with more distantly related outgroups. The appropriated outgroups should be the sister group. The characters that share with the sister groups or outgroups should be the plesiomorphic state. The classification will constructed into the tree with using the least number of character states change to group all ingroup taxa into a phylogeny or parsimonious tree.

2.5. Phylogenetic analysis

The phylogenetic of the amphipod were constructed on basis of morphological data.

Morphological phylogeny

The amphipods morphological characters will be determined and digitally coded, emphasizing on females due to lacking of secondary sexual characters and assuming to be more conservative than males. The analysis for construction of

phylogenetic dendrogram will be processed with PAUP software using heuristic searches and criterion of parsimony.

Character and scoring

Base on Kim & Kim (1993) and Myers & Lowry (2003), combined 51 phylogenetically informative characters. The characters were scored using a multistate system: viz. the ancestral state = 0, the derived state = 1, the further derived state = 2, 3 and 4 respectively. A score of 9 = missing data, indicating that the appendage is absent in that group. The characters were ordered except for the telson. The use of ordered, multistate characters implies a linear transformation series.

1. Head (Fig. 20); free, (0) not coalesced with pereonite; (1). partially or completely coalesced with pereonite 1

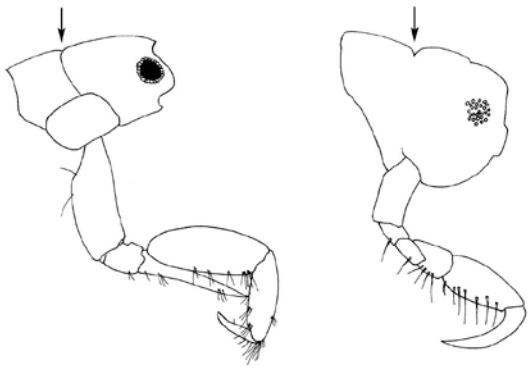


Figure 20 Head characters: free and coalesced (Myers & Lowry, 2003)

2. Head; (0) rectangular, anterodistal margin recessed; (1) rectangular, anterodistal margin truncate (2) triangular; (3) round with a distinct neck region (4) columnar

3. Head lateral cephalic lobe; (0) weakly or not extended, eye, if present, situated proximal to lobe; (1) extended, eye, if present, at least partly enclosed in extended lobe; (2) strongly extended, eye, if present, completely enclosed in extended lobe

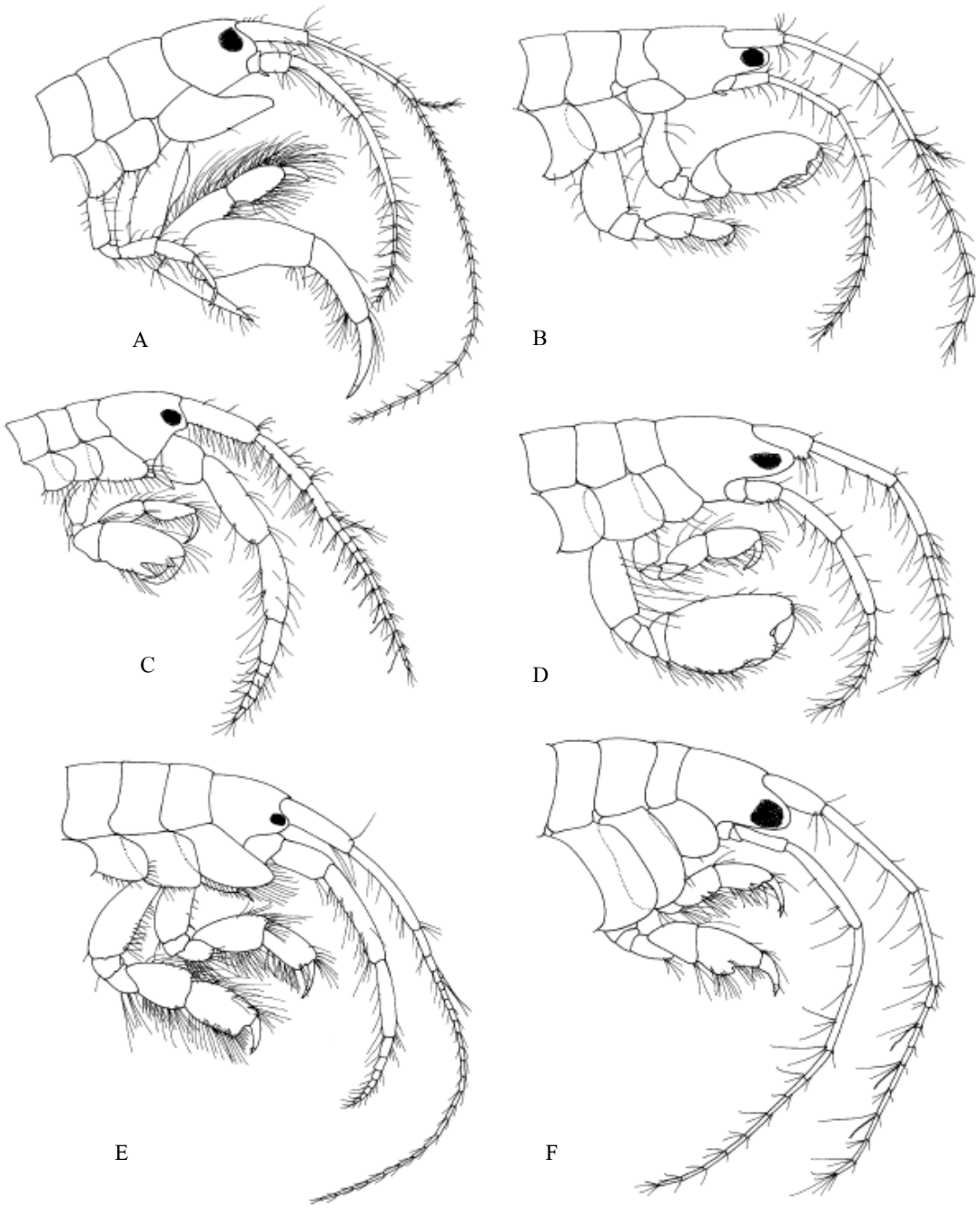


Fig 21 Head lateral cephalic lobe A. weakly or not extended, B. extended, C. anteroventral margin weakly recessed, D. lateral cephalic lobe strongly extended E. and F. anteroventral margin strongly recessed (Myers & Lowry, 2003)

4. Head lateral cephalic lobe; (0) apically rounded; (1) apically acute

5. Head anteroventral margin; (0) poorly to weakly recessed and moderately excavate (except where strongly excavate for reception of large antenna);

(1) moderately to strongly recessed and moderately excavate (except where strongly recessed and strongly excavate for reception for large antennae); (2) obliquely truncate on spheroid head; (3) not recessed, on round head

6. Body; (0) without sternal spines; (1) with sternal spines on some of pereonites 2 to 7 (Fig. 22)

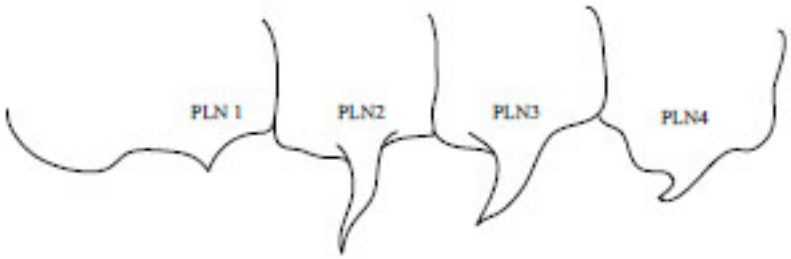
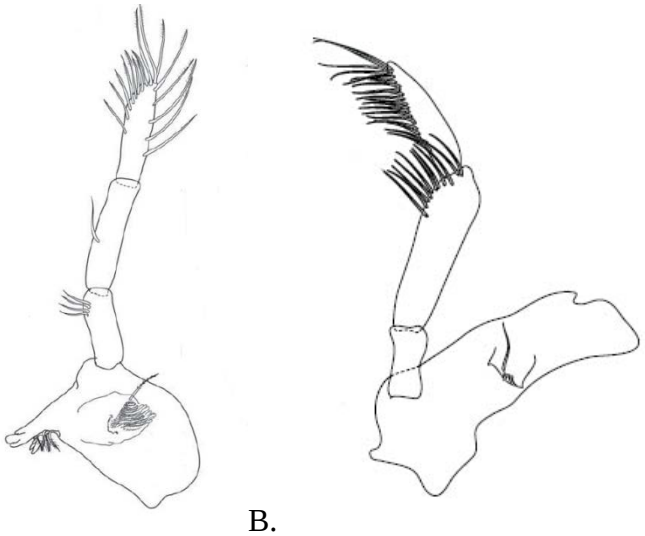


Figure 22 Sternal spines

7. Antenna 1 peduncular article 3; (0) short (half or less the length of article 2) (2) long (more than half, or usually much more than half, the length of article 2)

8. Mandible molar (Fig. 23)

Mandible, molar: (0) Strongly developed and triturative; (1) weakly developed and smooth or molar absent. A strongly developed and triturative (= grinding surface composed of ridges and teeth) molar is found in other peracarids which can (more or less) be regarded as an outgroup.



A. B.

Figure 23 Mandibular molar A. Strongly developed mandibular molar B. weakly developed mandibular molar

9. Mandible palp article 3; (0) anterior and posterior margins symmetrical, distally rounded, setae extending along most of posterodistal margin (1) anterior and posterior margins subsymmetrical, distally flattened, setae mostly distal (2) approximately parallel-sided

10. Mandible, palp (Fig 24): (0) Strongly developed and 3-articulate; (1) weakly developed or article 3 absent; (2) absent. A strongly developed, 3-articulated palp is shown in other peracarids, especially mysidaceans.

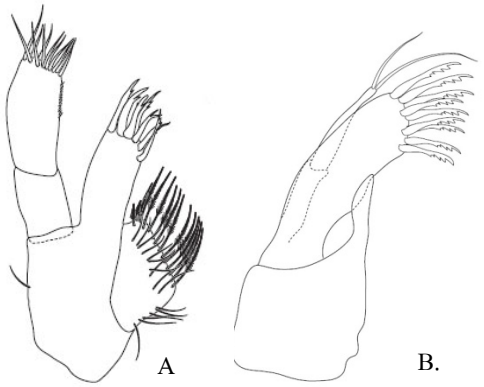


Figure 24 Maxilla 1 inner lobe A. Large, B small

11. Maxilla 1, inner lobe: (0) Large and densely setose marginally; (1) small and sparsely setose marginally; (2) absent.

12. Maxilla 2 (Fig.25), lobes: (0) Broad, and densely setose marginally and facially; (1) narrow or small, and sparsely setose marginally and facially. Barnard (1974) also regarded a well developed maxilla 2 as exemplifying the ancestral state. The ancestral state, has well developed lobes of maxilla 2.

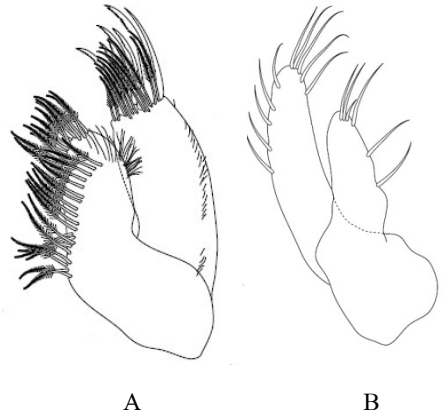


Figure 25 Maxilla 2 inner lobe A. Broad, B small

13. Labium outer lobes (Fig. 26); (0) inner margin evenly convex; (1) inner margin concave (2) inner margin with strongly developed notch

14. Labium outer lobe; (0) without distal slit (1) with distal slit

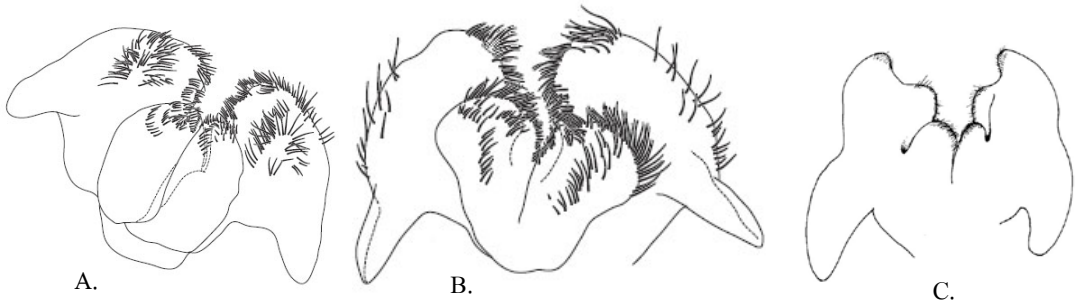


Figure 26 Labium outer lobes; A. inner margin evenly convex, B. inner margin concave C. inner margin with strongly developed notch

15. Maxilliped, inner plate (Fig. 27): (0) Well developed; (1) reduced or fused. In most amphipod groups the ancestral state is exhibited. A derived state, with reduced inner plate.

16. Maxilliped, palp: (0) 4-Articulate and unguiform; (1) article 4 of palp reduced or palp absent.

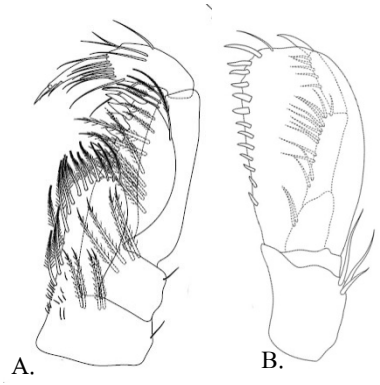


Figure 27 Maxilliped inner plate A. well developed, B. reduced

17. Coxae 1—4: (0) Present, deep and large or small and shallow; (1) vestigial or absent.

18. Pereopods 5—7: (0) Rather subequal in size and form; (1) unequal in size and form, and articles broadly expanded and strongly spinose and/or setose (=

fossorial). Bousfield (1978, 1983) considered fossorial pereopods 5-7 to be apomorphic. In most groups the ancestral state is shown, while in fossorial groups such as Oedicerotidae and Phoxocephalidae the derived state is found.Phylogenetic relationships among amphipod subgroups

19. Number of gills: (0) Occur on coxae 2-7 (or 6); (1) occur on coxae 2-4.

20. Number of oostegites: (0) Occur on coxae 2-5; (1) occur on coxae 3-4. Steele (1991) suggested that the ancestral state is found in the gammaridean families and Hyperiidea. The derived state is retained only in the Caprogammaridae and Caprellidae.

21. Pereonites 6–7 (0) free and orientated ventrally (1) fused and oriented posteriorly

22. Pereonite 7; (0) posterodistal margin weakly rotated or not rotated posteriorly; (1) posterodistal margin rotated posteriorly (pereopod 7 directed posteriorly)

23. Gnathopod 1; (0) not enlarged in either males or females (1) enlarged in males and females or only in males

24. Gnathopod 1 (0) not forming a sieving structure in conjunction with gnathopod 2; (1) forming a sieving structure (dense sieving setae on posterior margin of carpus and merus or ischium) in combination with gnathopod 2

25. Gnathopod 1 (female); (0) coxa small (almost always smaller than coxa 2); (1) coxa large (almost always larger than coxa 2)

26. Gnathopod 1 (male); (0) coxa greatly enlarged (occasionally anteroventrally produced); (1) coxa or not weakly enlarged

27. Gnathopod 2 (male); (0) coxa subequal in size to coxa 3; (1) coxa greatly enlarged and shield-like, almost entirely covering coxa 1

28. Gnathopod 2 merus; (0) not enlarged and fused along anterodistal margin of carpus, or broadened and fused along entire length with posterior margin of carpus; (1) enlarged and free along anterodistal margin of carpus

29. Pereopods 3–4; (0) well developed; (1) reduced or absent

30. Pereopods 3–4 bases; (0) nonglandular; (1) with glands in basis; (2) with glands in merus

31. Pereopod 5 carpus; (0) long, subrectangular; (1) small, lunate or reniform

32. Pereopods 5–7; (0) not subchelate; (1) subchelate

33. Pereopods 5–7; (0) not prehensile; (1) prehensile, dactylus elongated and closing along most of posterior margin of propodus

34. Pereopods 5–7 dactyli; (0) without accessory spines on anterior margin; (1) with accessory spines on anterior margin

35. Pereopod 7; (0) subequal to or not longer than 1.1 3 pereopod 6; (1) elongate, entire propodus extending beyond pereopod 6

36. Pleonite 3; (0) expanded ventrally to form an epimeron; (1) not expanded ventrally to form an epimeron

37. Urosome: (0) Free; (1) at least 2 urosomites fused; (2) urosomite 1 distinctly elongate or urosomites absent. In most amphipod groups the ancestral state is shown.The derived state is exhibited by the inquilinous Dexaminidae and the tube-dwelling Ampeliscidae. A further derived state is found in the sedentary groups (Podoceridae,Capregammaridae and Caprellidae) which have urosomite 1 distinctly elongated or lack urosomites.

38. Urosome 1 or 1 and 2; (0)short to long; (1) extremely long (length at least 33 breadth)

39. Uropods 1–2 peduncle; (0) without distoventral corona of cuticular spines; (1) with distoventral corona of cuticular spines

40. 12. Uropods 1 and 2: (0) Biramous; (1) uniramous or vestigial.

41. Uropods 1–2 rami; (0) lacking a dense array of strong robust setae; (1) long, with a dense array of strong robust setae; (2) short, with a dense array of strong robust setae

42. Uropod 3 peduncle; (0) short (length 23 or less breadth), parallel sided (1) short (length 23 or less breadth), sides expanded or medially lobate; (2) long (length more than 23 breadth), broad proximally and narrow distally; (3) long (length more than 23 breadth), parallel sided; (4) vestigial or absent

43. Uropod 3; (0) with rami; (1) without rami

44. Rami of uropod 3: (0) Biramous; (1) uniramous; (2) absent.

45. Size of rami if biramous: (0) Equal or subequal; (1) unequal.

46. Uropod 3 outer ramus; (0) with uniformly similar marginal and apical slender,flexible setae; (1) with a mixture of robust and slender setae; (2) with 1–2 recurved, robust apical setae; (3) with rudimentary setae or lacking setae

47. Uropod 3; (0) without recurved spines; (1) with recurved spines

48. Telson; (0) laminar; (1) dorsoventrally thickened

49. Telson; (0) without hooks or denticles; (1) with rows of recurved hooks; (2)with patches of small denticles

50. Telson telsonic cusps; (0) absent; (1) present

51. Telson shape; (0) Lobes separated, deeply or narrowly; (1) lobes fused entirely. The entire telson frequently appears in most other peracarids and so Barnard & Barnard (1983) regarded the non-laminar, entire telson of domicolous amphipods such as Corophioidea to be primitive. Barnard & Karaman (1991), however, considered the bilobed and laminar telson of nondomicolous amphipods (e.g. Gammaridae) as the ancestral state. Moreover, the function of the telson in amphipods is not fully understood. Outgroup comparison is uninformative in this case. Therefore, this transformation must be treated as unordered.

A data matrix will prepared from gammarid amphipods characters with caprellid and hyperiids amphipod as outgroup, utilizing 41 morphological characters. If multistates of a character were found in a group, the major state was selected as representative.

The characters of the 'Basic marine gammaridean' were selected (Barnard & Karaman, 1991) and combined these characters with those of 'Primitive amphipod' (Barnard & Barnard, 1983). These combined features were regarded as characteristics of the hypothetical ancestor, and polarity of each character was selected by comparing the state of each character with that shown in this hypothetical ancestor

The data matrix was analysed using the PAUP program. (The options employed were heuristic search, CLOSEST addition, TBR branch-swapping, and MINF optimization.

CHAPTER 3
RESULTS

3.1 Species list

A total of 33 species belonging to 17 gammaridean families have been reported in this study. Of these 8 species (with **) are new to science and 8 species (with *) are records for Thai Waters and 3 species are not identified. A list of the gammaridean Amphipoda in Thai Waters is presented below. (Table 5)

ORDER AMPHIPODA Latreille, 1816

SUBORDER GAMMARIDEA Latreille, 1802

1. FAMILY Ampeliscidae Costa, 1857

GENUS *Ampelisca* Kröyer, 1842

1. *Ampelicsa brevicornis* (Costa, 1853)

2. *Ampelisca cyclops* Walker, 1904

2. FAMILY Amphilochidae Boeck, 1871

GENUS *Amphilochus* Bate, 1862

3. *Amphilochus justi* Azman, 2009*

3. FAMILY Ampithoidae Stebbing, 1899

GENUS *Ampithoe* Leach, 1814

4. *Ampithoe africana* Barnard, 1926*

5. *Ampithoe ramondi* Audouin, 1826*

GENUS *Cymadusa* Savigny, 1816

6. *Cymadusa pilipes* (Ledoyer, 1984)*

4. FAMILY Aoridae Stebbing, 1899

GENUS *Bemlos* Shoemaker, 1925

7. *Bemlos quadrimanus* (Sivaprakasam, 1970)

GENUS *Grandidierella* Coutière, 1904

8. *Grandidierella gilesi* Chilton, 1921

9. *Grandidierella gravipes* Barnard, 1935

10. *Grandidierella halophilus* Wongkamhaeng, Pholpunthin & Azman, 2012**

11. *Grandidierella phetraensis* Wongkamhaeng, Coleman & Pholpunthin, 2013**

12. *Grandidierella* sp. A

5. FAMILY Corophiidae Leach, 1814

SUBFAMILY Corophiinae Leach, 1814 (Myers & Lowry,2003)

TRIBE Corophiini Leach, 1814 (Myers & Lowry, 2003)

GENUS *Chelicorophium* Bousfield & Hoover, 1997

13. *Chelicorophium* sp.A

SUBFAMILY Protomedeiinae Myers & Lowry, 2003

GENUS *Cheiriphotis* Walker, 1904

14.*Cheiriphotis megacheles* (Giles, 1885)

15. *Cheiriphotis trifurcata* Wongkamhaeng, Azman & Puttapreecha, 2012**

6. FAMILY Dexamininae Leach, 1814

GENUS *Paradexamine* Stebbing, 1899

16. *Paradexamine latifolia* Ren, 2006*

7. FAMILY Hyalidae Bulycheva, 1957

SUBFAMILY Hyalinae Rathke, 1837

GENUS *Parahyale*

17. *Parahyale aqulina* Barnard, 1935

8. FAMILY Liljeborgiidae Stebbing, 1899

GENUS *Listriella* J.L. Barnard, 1959

18. *Listriella longipalma* Othman & Morino, 2006*

9. FAMILY Kamakidae

GENUS *Kamaka*

19. *Kamaka songkhlaensis* Ariyama, Angsupanich & Rodcharoen, 2010

10. FAMILY Lysianassidae Dana, 1849

SUBFAMILY Lysianassinae Dana, 1849

GENUS *Waldeckia* Chevreux, 1907

20. *Waldeckia elephas* Hirayama & Kikuchi, 1980*

11. FAMILY Maeridae Krapp-Schickel, 2008

GENUS *Ceradocus* Costa, 1853

21. *Ceradocus andamanensis* Wongkamhaeng, Coleman & Pholpunthin, 2013**

GENUS *Maeropsis* Chevreux, 1919

22. *Maeropsis paphavasita* Wongkamhaeng, Coleman & Pholpunthin, 2013**

12. FAMILY Melitidae Bousfield, 1983

GENUS *Elasmopus* Costa, 1853

23. *Elasmopus puteus* Appadoo & Myers, 2003

GENUS *Melita* Leach, 1814

24. *Melita latiflagella* Ren&Andres, 2012*****

GENUS *Parelasmopus* Stebbing, 1888

25. *Parelasmopus siamensis* Wongkamhaeng, Coleman & Pholpunthin, 2013**

GENUS *Rotomelita* J.L. Barnard, 1977

26. *Rotomelita longipropoda* Wongkamhaeng, Coleman & Pholpunthin, 2013**

13.FAMILY Photidae Boeck, 1871

GENUS *Ampelisciphotis* Pirlot, 1938

27. *Ampelisciphotis tridens* Pirlot, 1938

GENUS *Gammaropsis* Liljeborg, 1855

28. *Gammaropsis atlantica* Stebbing, 1888

GENUS *Photis* Krøyer, 1842

29. *Photis longicaudata* (Bate & Westwood, 1863)

14. FAMILY Podoceridae Leach, 1814

GENUS *Podocerus* Leach, 1814

30. *Podocerus andamaniensis* (Giles, 1890)

15. FAMILY Pontogeneiidae Stebbing, 1906

GENUS *Tethygeneia* J.L. Barnard, 1972

31. *Tethygeneia khanomensis* Wongkamhaeng, Pholpunthin &Darakrai, 2010**

16. FAMILY Synopiidae Dana, 1853

GENUS *Tiron* Liljeborg, 1865

32. *Tiron* sp.A

17. FAMILY Urothoidae Bousfield, 1978

GENUS *Urothoe* Dana, 1852

33. *Urothoe spinidigitus* Walker,1904

Table 5 List of species found in this study

Family	Species	Study sites																								
		AS 1	AS 2	AS 3	AS 4	AS 5	AS 6	AS 7	AS 8	AS 9	AS 10	AS 11	AS 12	EG T1	EG T2	EG T3	EG T4	EG T5	IG T1	IG T2	LG T1	LG T2	LG T3	LG T4	LG T5	LG T6	LG T7
Ampeliscidae	*Ampelicsa brevicornis*	8	-	2	15	-	-	-	4	-	-	-	-	-	54	-	-	12	-	-	-	20	-	22	-	-	-
	Ampelisca cyclops	-	2	-	-	-	-	5	-	-	-	3	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-
Amphilochidae	*Amphilochus justi*	5	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ampithoidae	*Ampithoe africana*	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	15	-	-	-	-	-	-	-	-	-	-
	Ampithoe ramondi	-	-	5	13	-	-	-	-	-	-	-	-	12	-	-	-	-	-	-	-	-	-	19	-	-	-
	Cymadusa pilipes	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	12	-	-	-	-	-	-	-	-	-	-
Aoridae	*Bemlos quadrimanus*	-	-	-	-	-	-	3	-	-	-	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Grandidierella gilesi	12	-	14	20	-	-	-	14	-	-	-	-	-	22	-	-	-	-	-	14	-	-	17	-	-	20
	Grandidierella gravipes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	-
	Grandidierella halophilus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	45	-	-	-	-	-	-	-	-
	Grandidierella phetraensis	-	-	-	-	-	-	-	-	-	-	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Grandidierella sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-	-	-	-	-	-	-	5	-	-
Corophiidae	*Chelicorophium* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-
	Cheiriphotis megacheles	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	-	-
	Cheiriphotis trifurcata	-	-	-	-	-	-	-	-	-	-	13	-	-	-	-	-	-	-	-	-	-	-	-	47	-	-
Dexamininae	*Paradexamine latifolia*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	-	-	-	-	-	4	18	5
Hyalidae	*Parahyale aqulina*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Liljeborgiidae	*Listriella longipalma*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	-	5
Kamakidae	*Kamaka songkhlaensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	31	-
Lysianassidae	*Waldeckia elephas*	35	2	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Maeridae	*Ceradocus andamanensis*	-	-	-	-	-	-	-	-	-	-	-	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Maeropsis paphavasita	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	24	-	-	-	-
Melitidae	*Elasmopus puteus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18	-	-

Table 5 List of species found in this study

Family	Species	Study sites																									
		AS 1	AS 2	AS 3	AS 4	AS 5	AS 6	AS 7	AS 8	AS 9	AS 10	AS 11	AS 12	EG T1	EG T2	EG T3	EG T4	EG T5	IG T1	IG T2	LG T1	LG T2	LG T3	LG T4	LG T5	LG T6	LG T7
Melitidae	*Melita latiflagella*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	58	-
	Parelasmopus siamensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	-	-	-	-	-	-	-
	Rotomelita longipropoda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	24	-	-	-	-
Photidae	*Ampelisciphotis tridens*	-	-	3	-	-	-	5	12	15	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Gammaropsis atlantica	-	-	-	-	-	-	25	14	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Photis longicaudata	-	-	-	-	-	-	12	34	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Podoceridae	*Podocerus andamaniensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	18	-	-
Pontogeneiidae	*Tethygeneia khanomensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18	-	-
Synopiidae	*Tiron* sp. A	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Urothoidae	*Urothoe spinidigitus*	-	-	-	-	-	-	15	-	-	-	-	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	60	4	28	54	3	2	65	78	50	12	68	40	38	76	7	27	12	57	25	14	50	48	70	161	131	30

3.2 Systematic account

The present study described the newly collected fauna in Thai Waters. Figures of generalized gammaridean amphipod including the morphological terms used in descriptive accounts are included to facilitate the understanding of the taxonomical description and the use of the key to species (Figs.1—13). The systematic text is presented in alphabetical order of families, genera within each family, and then of species within each genus. Generic diagnoses are presented. The description is provided only the new record and unidentified species. Synonymies and distributional records of known species are given based on the latest information from the literature, preference being given to those incorporating good figures or pertaining specifically to the neighbouring waters of this region. Each end of individual unidentified species the remark is given which detailed comparison with congeners is included.

i. Descriptions of Species

Family Ampeliscidae Costa, 1857

Diagnosis: Urosomites 2-3 coalesced. Pereopods 56 alike but pereopod 7 of distinct structure, article 2 with distinct, usually broad posteroventral lobe, article 2 of pereopods 5-6 rhomboid or diamond shaped and poorly lobed. Eyes when present composed of internal pigment masses served by 2-4 external cuticular lenses. Accessory flagellum absent. Article 4 of pereopods 3-4 elongate, article 6 much shorter than 4 and article 5 much shorter than 6, these pereopods glandular. Head very large. Gnathopods feeble. Uropod 3 biramous. Telson laminar.

Genus *Ampelisca* Kröyer, 1842

Diagnosis: Flagellaof antennae 1-2 with 5 or more articles. Article 3ofmaxilliped palp unproduced. Article 2of pereopod 7 with posterior margin oblique and article expanding ventrally, rarely parallel to anterior margin, anterior margin of posteroventral lobe near junction with article 2 not setose. Telson much longer than broad, cleft much more than half its length.

Ampelisca brevicornis (Costa, 1853)

Araneops brevicornis Costa, 1853, p. 171

Ampelisca laevigata Liljeborg, 1856: Sars, 1895: 169—170, pl. 59.

Ampelisca brevicornis (Costa, 1853): Chevreux & Fage, 1925: 77—79; Schellenberg, 1925: 130—133; Pirlot, 1936: 277—278; Schellenberg, 1942: 146—147; Reid, 1951: 204—210; Nagata, 1959: 265—266; Nagata, 1965: 150—151; Imbach, 1967: 55—57, pl. 3;Kaim-Malka, 1969: 928—932, 934, 953—958; Karaman, 1975: 7—12; Rabindranath,1975: 257—261; Lincoln, 1979: 112—113; Ledoyer, 1982: 56, 58—59; Hirayama, 1991:86; Bussarawich, 1985:4.

Ampelisca sp. cf *brevicornis* (Costa, 1853) Dahl, 1945; 9-12.

Material examined: 8 ♀,Phayam Island, 09°47'49.3"N 98°22'52.3"E, 4 m. coral reef, Wongkamhaeng, K. 15-02-2010. 3 ♂,12 ♀,Paklok bay, 08° 01’32’’N 98° 25’45’’E, 1 m. seagrass bed, Wongkamhaeng, K. 12-07-2009. 4 ♀,07°22'60"N 99°19'60"E , 1.5 m. seagrass bed, Vongpanich, V. 17-07-2008. 24♂,30♀,Samaesan Beach, 12°33'03"N 100°57'05"E,2 m. coral reef, Damrongrojwattana, P. 30-09-2011. 3♂,17♀,Bang Saphan,11°05'41"N 99°29'22"E, 3 m. coral reef, Wongkamhaeng, K. 20-08-2010. 4♂18♀, Rab Island, 9°18'42"N 99°57'29"E , algal bed, Darakrai, A. 15-03-2008. 8♂10♀, Ban Bang Ta Wa, 06°56'04'N 101°08'34"E, 2 m. coral reef, Puttapreecha, R. 15-07-2010.

Local Distribution: Chonburi, Prachuap Khiri Khan, Nakorn Si Thammmarat, Pattani, Ranong, Phuket, Krabi, Trang.

Geographical distribution: Cosmopolitan.

Remarks: *Ampelisca brevicornis* is a cosmopolitan species which has been collected from both hard substrata like coral reef and soft substrata like seagrass and algal bed (Rabindranath, 1975; Lincoln, 1979) and from water column (Hirayama, 1983). *A. brevicornis* collected from this study are similar to those of Imbach (1967) from south China Sea. The specimens show minor different from Imbach’s on basis of pereopod 6 anteriorly excavated and posterior margin of pereopod 7 with marginal setae.

Ampelisca cyclops Walker, 1904

Ampelisca cyclops Walker, 1904, p. 253, pl. 2, fig. 14; Stebbing 1906, p. 722 ; Pirlot, 1936, p. 280; Barnard, 1937, p. 149; Nagata, 1965, p. 151; Barnard & Karaman, 1991, p. 87.

Ampelisca iyoensis Nagata,1959: 79—80, fig. 9—11 .

Ampelisca cyclops iyoensis Imbach, 1967: 59, pl. 5A-C.

Material examined: 2 ♀, Surin Island, 09° 26’33’’N 97° 48’45’’E, 44 m. coral reef, Wongkamhaeng, K. 07-03-2008. 2 ♂,3 ♀, Chalong Bay, 7°48'6"N 98°21'1"E, 5 m. seagrass bed, Wongkamhaeng, K. 08-10-2006. 2 ♂,9 ♀, Petra, 08° 01’32’’N 98° 25’45’’E, 3 m. coral reef, Rodcharoen, E.. 27-11-2011. 3 ♂,5 ♀, Kang Kao Island, 13°7'7"N 100°48'27"E, 4 m. coral reef, Wongkamhaeng, K. 12-04-2001.

Local distribution: Ranong, Phuket, Trang and Chonburi.

Geographical distribution: Indian Ocean, South China Sea and Sea of Japan.

Remarks: Imbach (1967) have reported three subspecies namely *Ampelisca cyclops iyoensis, Ampelisca cyclops cyclops.* The present specimens are fit in *A. c. iyonensis* as following, 1) Article 6 of pereopod 5 is slender, 2) the third pleonal epimeron poorly sinuate posteriorly with a very small tooth at the posterodistal corner and the rami of uropod 2 very densely spinose. It shows different antenna 1 of present specimen is longer than peduncle of antenna 2 while those of Imbach is shorter than peduncle of antenna 2.

FAMILY Amphilochidae Boeck, 1871

Diagnosis: Coxa 4 immensely broadened, coxae with contiguous margins overlapping, not rabbeted, coxa 2 not hidden; coxa 1 very small and hidden by coxa 2. Peduncle of uropod 3 elongate. Telson entire, elongate.

GENUS *Amphilochus* Bate, 1862

Diagnosis. Mandibular molar small, columnar, conical or weakly bulbous, poorly or not triturative. Palp of maxilla 1 2-articulate. Maxilla 2 ordinary, or outer plate as long as inner but inner much wider, well setose. Outer plate of maxilliped not excavate, palp article 1 subequal to or longer than (type) article 2. Gnathopods 1-2 large to small, diverse or not, subchelate, palm straight or weakly convex,

subtransverse, dactyl lacking nodiform process. Urosomite 3 poorly alate. Lower lip ordinary.Gnathopods more ot less carpochelate.

Amphilochus justi Azman, 2009

(Figs 28)

Amphilochus justi Azman, 2009 144-147, pl. 1-2

Material examined: 5♀,Phayam Island, 09°47'49.3"N 98°22'52.3"E, 4 m. coral reef, Wongkamhaeng, K. 15-02-2010. . 3 ♂,3 ♀,Paklok bay, 08° 01’32”N 98° 25’45’’E, 1 m. seagrass bed, Wongkamhaeng, K. 12-07-2009.

Description

Body laterally compressed, smooth. Head cuboidal, rostrum long, cephalic blunt. Eye raniform, brown colour in alcohol. Both antennae subequal; antenna 1 shorter than 2, accessory flagellum absent, peduncular article 3 of antenna 1 shorter than 1, article 2 and 3 progressively longer. Labrum slightly excavated. Mandibular molar weak, conical, incisor toothed. Labium outer lobes excavated, inner lobes reduced, mandibular lobe long narrow. Maxilla 1 inner plate reduced, outer plate with 7 robust setae, palp 2-articulate. Inner plates of maxilla 2 broader than outer. Inner plate of maxilliped short, serrated, palp with 4 articles.

Coxa 1 short, subtriangular, patially hiden by coxa 2. Coxa 1-3 progressive larger, broader than long. Coxa 4 excavate posteriorly. Coxae 6-7 subequal. Gnathopods 1-2 weakly diverse, gnathopod 2 slightly larger than 1, article 2 of both gnathopod 1 and 2 straight. Gnathopod 1 subchelate, carpus produced along posterior margin and reach 70% of propodus, propodus short, palm oblique with 2 defining robust setae. article 5 triangular, shorter than 6, poorly lobed, propodus expanded, palm oblique, dactylus curved. Gnathopod 2 subchelate, carpus produced along posterior margin reach 60% of propodus, propodus 1.5 as long as broad, palm transverse, defined by a 2 robust setae, dactyl curve.

Coxal gills present on segment 2-6. Pleopod normal. Epimeron 3 produced posteriorly. Uropod 1-3 biramous Uropod 1 rami subequal in length with several short robust setae along margin; peduncle 1.5x longer than rami, with 2 rows of robust setae. Uropod 2 biramous, inner ramus longer than outer ramus; peduncle subequal in

length to inner ramus. Uropod 3 biramous, rami subequal; peduncle longer than rami. Telson entire, longer than wide, rounded distally.

Local distribution: Phuket and Satun**.**

Geographical distribution: Australia and Andaman Sea (current study).

Remarks: Our specimens are similar to those of Azman (2009) from Lizard Island except the uropod 1-3 are wider and carpus of gnathopod 2 is shorter.

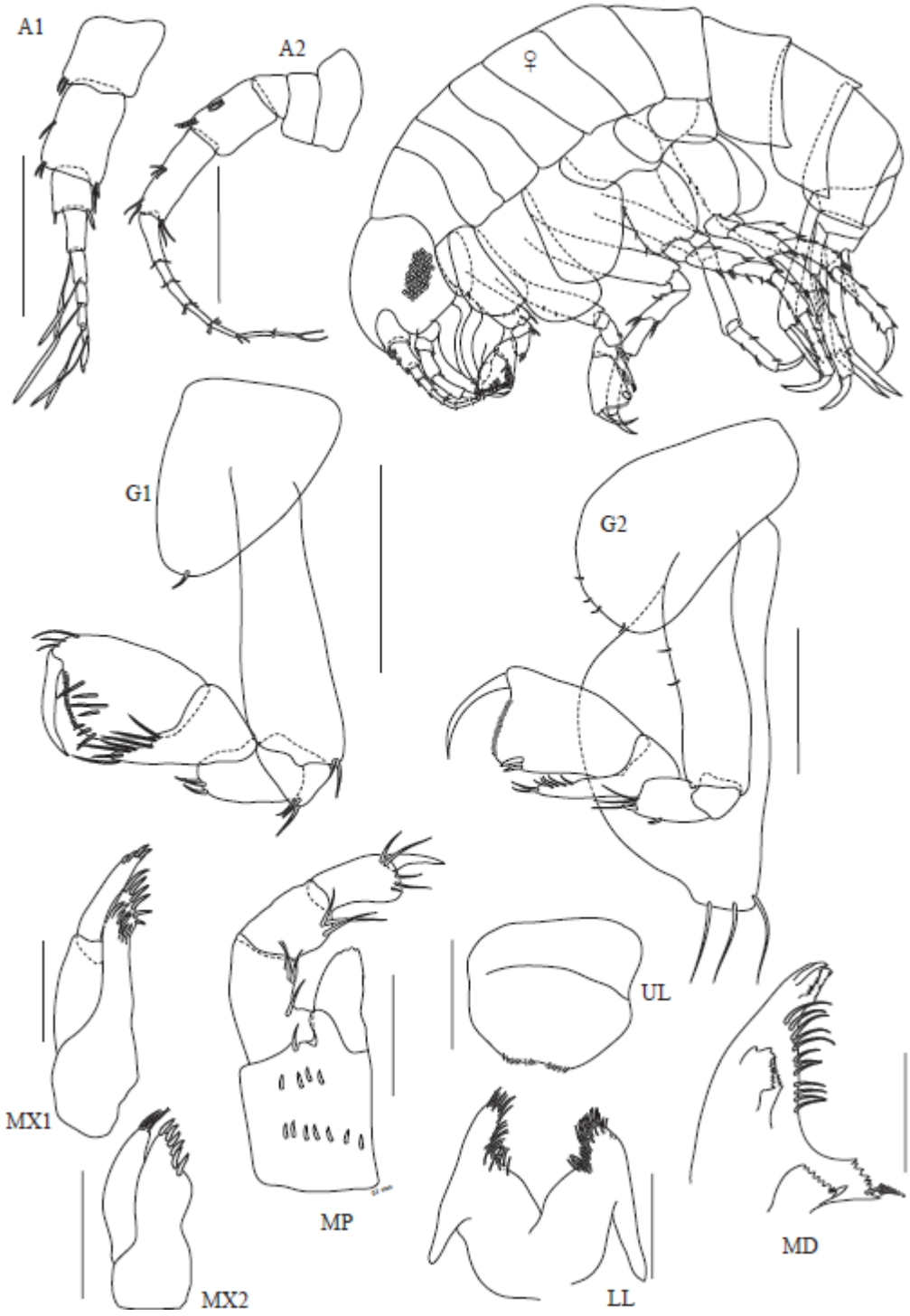


Figure 28 *Amphilochus justi* Azman, 2009 ♀ (6.3 mm); all scale represent 0.5 mm

Family Ampithoidae Stebbing, 1899

Diagnosis: Corophioid either with outer lobes of lower lip notched (except Amphitholina, Pleonexes and Pseudopleonexes in Ampithoidae and see contrary positive occurrence in Arctolembos of Corophioidea)· or with inner ramus of uropod 3as short as (shortened) outer ramus and broad, pad-like and apically setose,or outer ramus of·uropod 3 with 1-2 large articulate apical spines divergent from axis of ramus.

Genus Ampithoe Leach, 1984

Diagnosis: Antenna 1 lacking accessory flagellum ; mandible with palp ; gnathopods large, subchelate, gnathopod 2 equal to or larger than 1 ; article 6 of pereopods 3-5 scarcely widened apically, rarely prehensile; outer ramus of uropod 3 with two hooks; apical cornified processes of telson, if present, obsolescent.

Ampithoe ramondi Audouin, 1826

(Figure 29)

Amphithoe ramondi Audouin, 1826 . p. 93. pl . 11. fig. 6 ; Krapp-Schiekel, 1978. pp. 1—4. figs . 1—2 , 1982. pp. 98, 101. figs. 66—67: Myers, 1985, P. 27. fig. 17; Barnard, 1965, pp. 25—27. fig .15, 1970, P. 50, figs. 18, 19: Rabindranath, 1972, pp. 162—164, figs. 1—2 : Nagata, 1965, p. 315. fig . 380: Kim & Kim, 1988 , p . 121, fig. 9.

Ampithoe vaillanti Chevreux and Fage, 1925, pp. 333, 334, figs . 341. 342.

Amphithoe intermedia Walker. 1904, pp. 290, 291, pl. 7, fig. 46.

Ampithoe divisura Shoemaker, 1933, pp. 255, 256, fig . 8.

Material examined: 6♂,7 ♀,Paklok bay, 08^{o} 01’32’’N 98^{o} 25’45’’E, 1 m. seagrass bed, Wongkamhaeng, K. 3 ♂,9 ♀, Kang Kao Island, 13°7'7"N 100°48'27"E, 4 m. coral reef, Wongkamhaeng, K. 12-04-2001. 6♂13♀, Rab Island, 9°18'42"N 99°57'29"E , algal bed, Darakrai, A. 15-03-2008.

Description

Body laterally compressed, smooth. Head cuboidal, rostrum short, ocular lobe short, blunt, antennal sinus weak. Eye round, brown colour in alcohol. Both antennae subequal; antenna 1 shorter than 2, 0.5 body length, accessory flagellum absent,

peduncular article 3 of antenna 1 shorter than 1, article 2 and 3 progressively longer. Antenna 2 0.6 body length. Epistome unproduced anteriorly, Labrum subrounded, entire. Mandibular molar trituative, incisor toothed, composed of 9 spines, palp strong, article 3 rectolinear, article 3 shorter than 2. Labium with notched outer lobes and well developed inner lobes, mandibular lobe long and blunt. Maxilla 1 inner plate triangular with 2 apical setae, outer plate with 7 spines, palp 2-articulate. Outer plates of maxilla 2 broader than inner. Inner plate of maxilliped with distal spines on medial margin, palp with 4 articles, article 2 short, article 3 unlobed, article 4 short, with medium nail and setae.

Coxae relatively long, overlapping, coxa 1-4 subquadrate, coxa 1 produced forward, coxa 2 smaller than 1, coxa 4 longer than coxa 1, unlobed, coxa 4 as long as 4, coxa 4 not excavate, coxae 6-7 much smaller than anterior coxae.

Gnathopods 1-2 weakly diverse, gnathopod 2 slightly larger than 1, article 2 of both gnathopod 1 and 2 apically lobed, gnathopod 1 subchelate, article 5 triangular, shorter than 6, poorly lobed, propodus expanded, palm oblique, anterodistally without spine. Gnathopod 2 enlarged, subchelate, palm deeply excavate, defined by a large single spine, article 4 extended distally along posterior margin of article 5, article 5 shorter than 6, dactyl ordinary.

Sternal process of thorax absent. Coxal gills present on segment 2-6. Pleopod normal. Epimeron 3 smooth. Uropod 1-2 biramous, normal, rami slightly unequal, peduncle of uropod 1-2 without ventrodistal process. Uropod 3 stout and short, biramous, both rami very short, peduncle longer than rami, outer ramus recurved apically, with 2 distal hook-spines, inner ramus longer than outer ramus, broad, pad-like and apically setose. Telson entire, as broad as long, ovate with hooked apical cusps.

Local Distribution: Phuket, Chonburi, Nakorn Si Thammmarat

Geographical distribution: Cosmopolitan in tropical and subtropical seas.

Remarks: Our specimens are congruent with those reported by Nagata (1965) from Japan Sea and Barnard (1970) from Hawaii except the propodus of gnathopod 2 in the specimens from Thailand. The excavate of gnathopod 2 is shallower than those of Indian and African specimens.

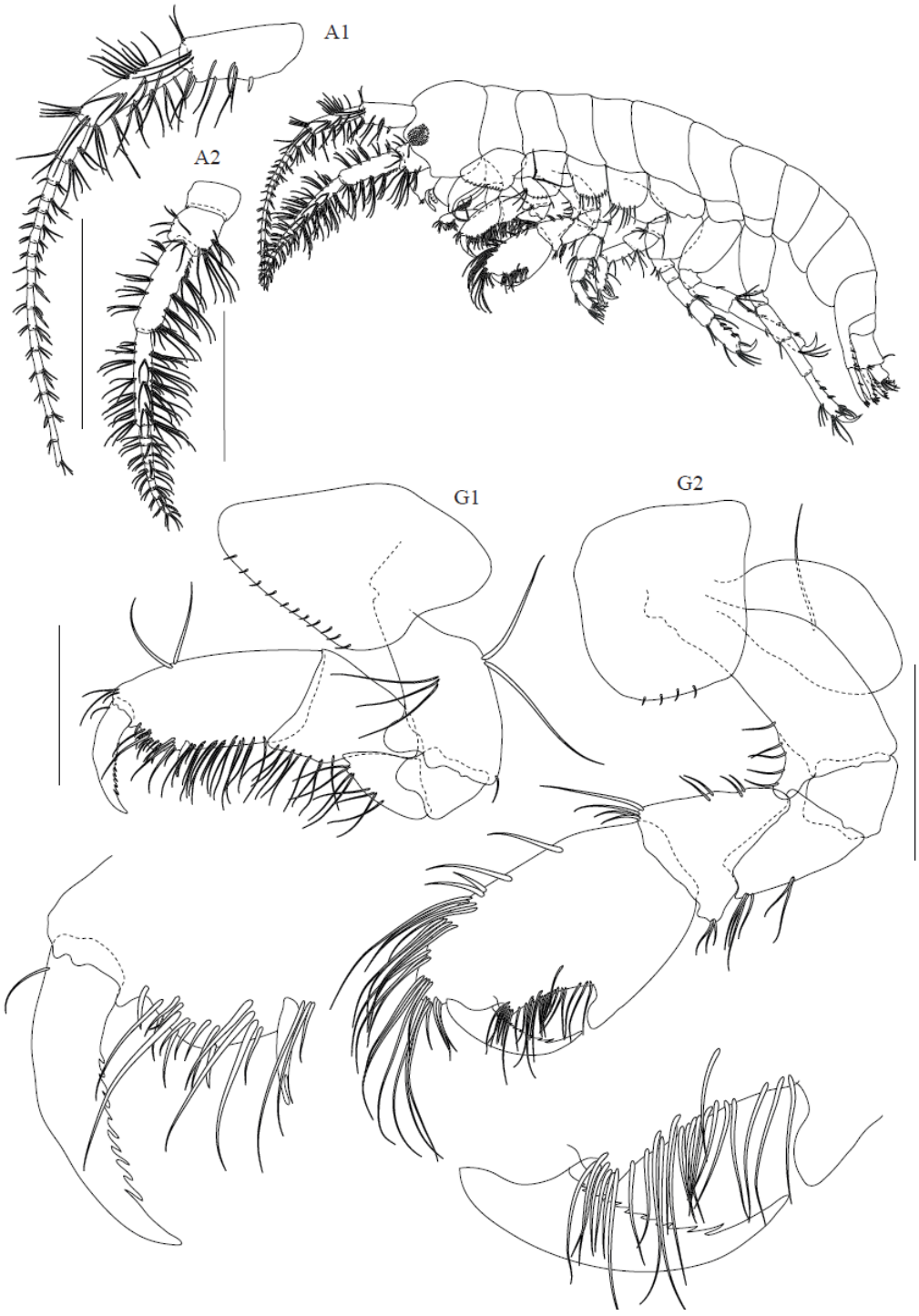


Figure 29 *Ampithoe ramondi* Audouin, 1826 ♂ (103 mm) PSUZC-CR 0201; all scale represent 0.5 mm

Ampithoe africana Barnard, 1926

(Fig. 30)

Ampithoe africana Barnard, 1926; Griffiths, 1976.

Material examined: 2♂8♀, Rab Island, 9°18'42"N 99°57'29"E , algal bed, Darakrai, A. 15-03-2008.

Description

Body laterally compressed, smooth. Head cuboidal, rostrum short, ocular lobe short, blunt, antennal sinus weak. Eye, ovoid, dark brown in alcohol. Both antennae subequal, antenna 1 longer than 2, peduncular article 3 of antenna 1 shorter than both article 1 and 2, accessory flagellum absent, flagellum composed of 16 articles. Epistome unproduced anteriorly, upper lip subrounded, pointed, broader than long. Mandible normal, with large mandibular molar, palp strong, article 1 shortest, article 3 subequal to 2 with 4 distal setae. Lower lip with notched outer lobes, inner lobes moderately developed, mandibular lobe long and blunt. Maxilla 1 inner plate triangular, outer plate with two rows of spines, palp 2-articulate, article 2 longer than 1. Outer plates of maxilla 2 not very broad, inner plate with medial setae. Inner plate of maxilliped with distal spines on medial margin, outer plate with 2 rows of medial spines, palp with 4 articles, article 2 short, article 3 unlobed, article 4 short, with medium nail and setae. Coxae relatively long, weakly overlapping, progressively elongate from 1-4, coxa 1 produced forward, coxa 2 smaller than 1, coxa 4 longer than coxa 1, unlobed, coxa 3 as long as 4, coxae 6-7 much smaller than anterior coxae.

Gnathopods 1-2 weakly diverse, gnathopod 1 subchelate, article 5 subequal to 6, poorly lobed, propodus expanded, palm oblique, bearing setae, without definite spine. Gnathopod 2 enlarged, subchelate, article 4 extended distally along posterior margin of article 5, article 5 shorter than 6, article 6 extended posterior lobe, not excavated, palm oblique with a definite spine. Pereopod 5-7 with large striated robust setae on distal margin of propodi.

Sternal process of thorax absent. Coxal gills present on segment 2-6. Epimeron 3 protuding postetomiddle margin. Uropod 1-2 biramous, outer ramus slightly shorter than inner ramus, peduncle of uropod 1-2 with weak and blunt

ventrodistal process. Uropod 3 stout and short, biramous, both rami very short, peduncle longer than rami, outer ramus recurved apically, with 2 distal hook-spines, inner ramus longer than outer ramus, broad, pad-like and apically setose. Telson entire, broader than long, subglobular with 2 apical spines.

Local Distribution: Nakorn Si Thammmarat

Geographical distribution: Africa, Gulf of Thailand.

Remarks: The examine material agrees with Barnard (1926) description and figures but differs in the palm of ♂ gnathopod 2 straight with a single definite spine while Barnard's specimens gnathopod 2 oblique sinuous palm.

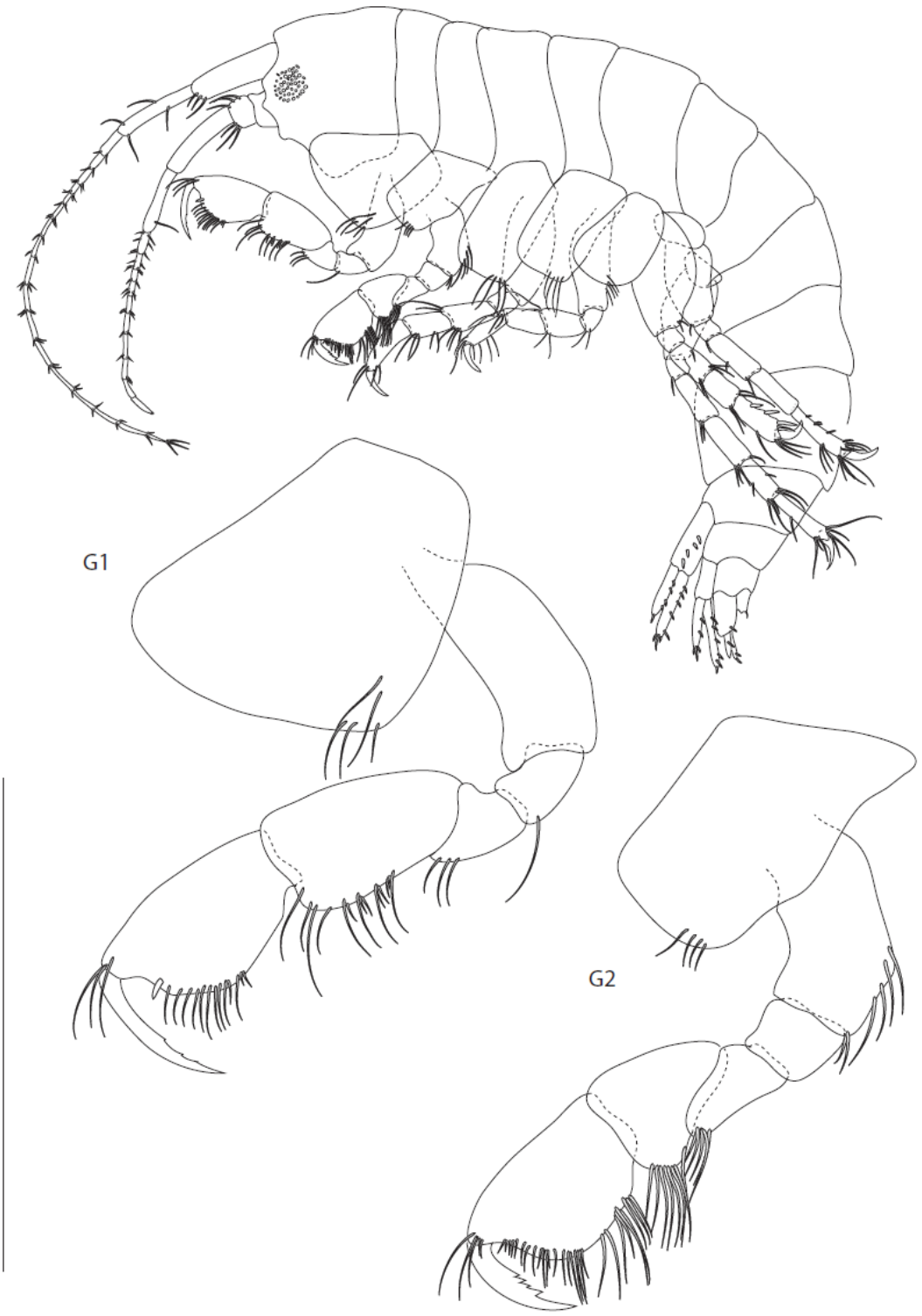


Figure 30 *Ampithoe africana* Barnard, 1926 ♂ (90.3 mm) PSUZC-CR 0201; all scale represent 0.5 mm

Genus *Cymadusa* Savigny, 1816

Diagnosis: Antenna 1 with 1- or 2-articulate accessory flagellum; mandible with palp; gnathopods large, subchelate, gnathopod 2 equal to or larger than 1; article 6 of pereopods 3-5 not apically widened; outer ramus of uropod 3 with two hooks.

Cymadusa pilipes (Ledoyer, 1984)

(Figs 30)

Paradusa biolobata Ruffo, 1969: 64—69, fig 21—23; Wongkamhaeng et. al. 2010: 9—10, fig. 9.

Paradusa bilobata pilipes Ledoyer, 1984: 26, fig. 11.

Cymadusa lunata Myers, 1985: 33, figs 22-23.

Material examined: 3♂5♀, Rab Island, 9° 18'42"N 99° 57'29"E , algal bed, Darakrai, A. 15-03-2008.

Description ♂

Body laterally compressed, smooth. Head subequal to first 3 pereonite, rostrum short, ocular lobe short, blunt, antennal sinus weak. Eye present, suboval.

Both antennae slender, antenna 1 about 0.75 of body length, peduncular article 3 shorter than 1, article 2 and 3 progressively longer, accessory flagellum scale-like. Antenna 2 about 0.33 of body length, peduncular short. Epistome unproduced anteriorly, upper lip subrounded, entire. Mandible molar medium, cylindrically, palp strong, article 1 shortest, article 2 subequal to 2. Lower lip with notched outer lobes and well developed inner lobes, mandibular lobe long and blunt. Maxilla 1 inner plate linguiform with 1 medial seta, outer plate composing of 10 spines; 4 bifid and 6 serrate spine, palp 2-articulate, article 1 about 0.3 of article 2 length. Maxilla 2 inner plate broad, with medial short setae, outer plate slender. Maxilliped inner plate with distal setae, cusp and medial setae, outer exceeding apex of palp article 2 with 8 spines on medial margin, palp with 4 articles, article 2 short, article 3 unlobed, article 4 short, with long nail.

Coxae weakly overlapping, progressively elongate from 1-4, coxa 1 and 2 subequal, subquadrate, coxa 1 produced forward, coxa 4 longer than coxa 1, coxa 5 bilobe, coxae 6-7 much smaller than anterior coxae.

Gnathopods 1-2 alike, of equal size, large, both powerful subchelate, palm oblique, slightly excavate, anterodistally with a spine, article 5 of both gnathopods triangular, shorter than 6, article 6 large, bearing setae posteroventrally.

Pereopods 3-4 similar in shape, basis longer than following 3-7, anterior side of merus expand, bearing setae along posterior side. Pereopod 5 coxa biolobe, article 2-6 stout with setae on each distal end, nail sharp. Pereopod 6-7 alike, basis not posterior expand, article 6 bearing a distal spine. Epimeron 3 not bisinuate. Uropod 1-2 biramous, normal, rami slightly unequal, peduncle of uropod 1-2 with long and sharp ventrodistal process. Uropod 3 stout and short, biramous, both rami very short, peduncle longer than rami, outer ramus recurved apically, with 2 distal hook-spines, inner ramus longer than outer ramus, broad, pad-like and apically setose. Telson entire, as broad as long, ovate with hooked apical cusps.

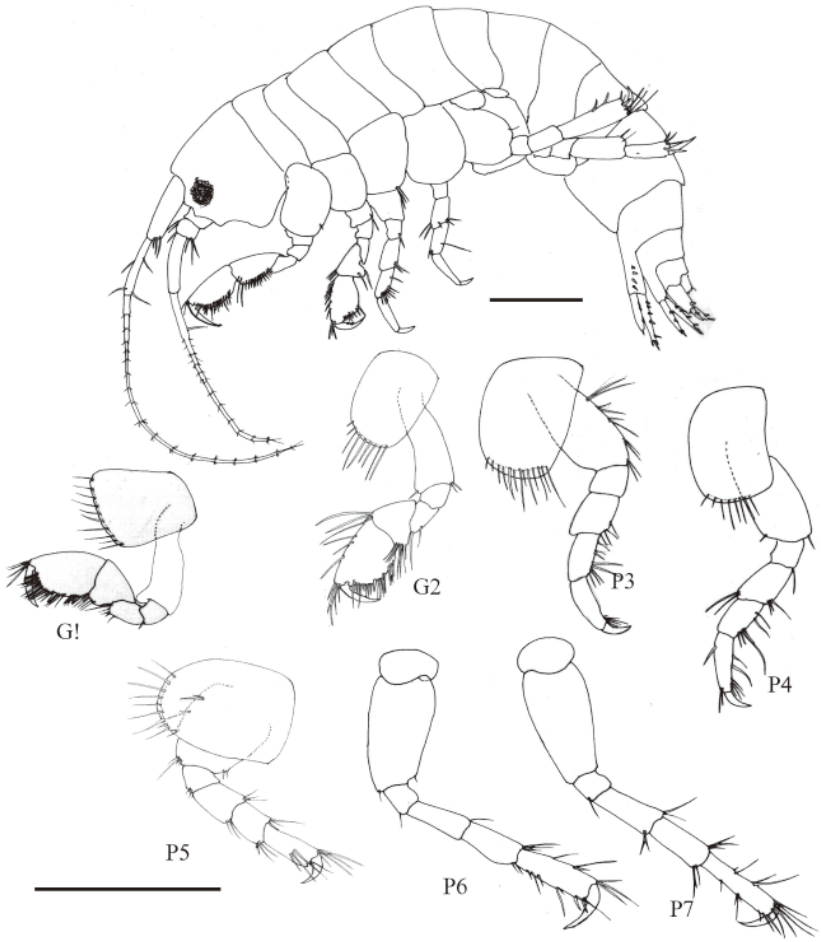


Figure 30 *Cymadusa pilipes* (Ledoyer, 1984) ♂ (8.4 mm) PSUZC-CR 0207; all scale represent 0.5 mm

Local Distribution: Nakorn Si Thammmarat

Geographical distribution: Red Sea (Ruffo, 1969) , New Caledonia (Ledoyer, 1984) and lower Gulf of Thailand (current survey).

Remarks: Ruffo (1969) erected the genus *Paradusa* for a taxa from characters as followed 1) enlarged gnathopods 1 and 2 in the ♂; 2) mandible palp with cylindrical articles and 3) accessory flagellum with a single article. But Myers (1986) decided that these characters were not enough to separate to another genus and other member in *Cymodusa* also contained therese characters. Since that, *Paradusa biolobata* was classified back into *Cymodusa pilipes.*

The examine material is similar to specimens of *Cymodusa pilipes* of Ruffo (1969) described from Red Sea and New Caledonia by Ledoyer (1984). It shows the difference in following small details: outer plates of maxilla 2 broader than Ruffo's and Ledoyer's material and bearing medial setae while Ruffo's material don't have any, gnathopod 1 and 2 subequal while Ruffo's materials gnathopod 2 slightly larger than 1 and the palms excavation of present material is shallower and the mandibular palp of present material article 2 equal to article 3 and article 3 not rectolinear while Ruffo's and Ledoyer's material article 3 of mandibular palp are longest and rectolinear.

FAMILY Aoridae Stebbing, 1899

Diagnosis: Head anteroventral margin moderately excavate. Pereopod 7 very elongate, entire propodus extending beyond pereopod 6.

GENUS *Bemlos* Shoemaker, 1925

Diagnosis: Article 3 of mandibular palp with posterior margin straight or weakly concave, marginal setae of 2 distinct lengths, but terminal setae longer; left mandibular molar with complex plates, rounded or with primary plate falcate; anterior margin of maxilliped [without wing-like flanges]; ♂ gnathopod 1 with propodus very enlarged, carpus generally short, cup-shaped; uropod 3 peduncle short, expanded, outer ramus with small second article, long marginal setae and extremely long distal setae.

Bemlos quadrimanus (Sivaprakasam, 1970)

Lembos quadrimanus Sivaprakasam, 1970: p. 81, fig. 1.

Lembos waipio Ledoyer, 1972: 200, pls 21A, 22, 24.

(not *L. waipio* Barnard, 1970: 85, figs 44, 45).

Lembos quadrimanus mozambicus Myers, 1975: 359, figs 33–39.

Bemlos quadrimanus Myers, 1988: 188. Wongkamhaeng, 2013, 504-509, pl. 2-6.

Material examined: 6 ♂, 6, Phetra Island, 6°46'42"N 99°46'5"E , algal bed, Rodcharoen, E., 27-11- 2011.

Description: See Annex V

Local distribution : Phuket, Satul.

Geographic distribution. East Africa, Madagascar, India, Andaman Sea (current study), Western Australia.

Remarks: Present material studied herein similar to the specimens from Indian, Africa and Australia. It differs from those specimens in its gnathopod 2 dactylus exceeding the palm and the mandibular palp ratios of articles 1–3 1:1.3:2 (vs. 1:2:3 in the original description), antenna 2 article 4 subequal to article 5, female gnathopod 1 merus and carpus venterodistally produced, and uropod 1 peduncle shorter than rami.

Genus *Grandidierella* Coutière, 1904

Diagnosis: Eyes small to medium. Antenna 1, accessory flagellum minute, 1 segmented. Maxilla 1, inner plate vestigial. Coxae very small, relatively short of various sizes and shapes. Gnathopod 1 **(**male) complexly subchelate and greatly larger than gnathopod 2**.** Gnathopod 2 subchelate. Pereopods 6**–**7, dactylus elongate, falcate. Uropods 1**–**2 biramous; rami slighty subequal; peduncle with ventrodistal process. Uropod 3 uniramous. Telson entire.

Grandidierella gilesi Chilton, 1921

Grandidierella gilesi Chilton, 1921: 552, fig. 11; 1925:537; Barnard, 1935, 300; Schellenberg, 1938; Nayar, 1959: 40, pl. 14, fig.6; Imbach, 1967: 90, pl. 33; Sivaprakasam, 1970: 157; Ledoyer, 1979: 152, fig. 8; Myers, 1981: 222, fig. 6; Asari & Myer, 1982: 248—249, fig. 7.

Material examined: 12♀,Phayam Island, 09°47'49.3"N 98°22'52.3"E, 4 m. coral reef, Wongkamhaeng, K. 15-02-2010. 4 ♂,16 ♀,Paklok bay, 08° 01’32’’N 98° 25’45’’E, 1 m. seagrass bed, Wongkamhaeng, K. 12-07-2009. 4♂, 10♀,Yonglam Bay, 07°22'60"N 99°19'60"E , 1.5 m. seagrass bed, Vongpanich, V. 17-07-2008. 7♂,15♀,Samaesan Beach, 12°33'03"N 100°57'05"E,2 m. coral reef, Damrongrojwattana, P. 30-09-2011.1♂,13♀,Bang Saphan,11°05'41"N 99°29'22"E, 3 m. coral reef, Wongkamhaeng, K. 20-08-2010. 4♂13♀, Rab Island, 9°18'42"N 99°57'29"E , algal bed, Darakrai, A. 15-03-2008. 6♂14♀, Ban Bang Ta Wa, 06°56'04'N 101°08'34"E, 2 m. coral reef, Puttapreecha, R. 15-07-2010.

Local Distribution: Chonburi, Prachuab Kirikan, Nakorn Si Thammmarat, Pattani, Ranong, Phuket, Krabi, Trang.

Geographic distribution: Indian Ocean, South China Sea, Australia.

Remarks: *Grandidierella gilesi* collected in this study is similar to those of Indian Ocean and Australian in having gnathopod 2 bearing a row of long pectinate setae, carpus and propodus slender. It differ from the specimen from Indian Ocean in the antenna 1 peduncle article 1—3 without robust setae, and the uropod 3 peduncle is medially expanded.

Grandidierella gravipes Barnard, 1935

Grandidierella megnae Chilton, 1925 : 535, fig. 2; Schellenberg, 1925 161, fig. 7 [non *Grandidierella megnae* (Giles, 1888)].

Grandidierella gravipes Barnard, 1935 : 297, fig. 18 .

Material examined: 4 ♂,10 ♀, Lower Songkhla Lake, 09°18'39.5"N. 99°46'46.4"E, 0.5 m. soft bottom, Puttapreech, R. 1-2-2010.

Local distribution : Outer Songkhla Lake

Geographic distribution: Indian Ocean, Thailand.

Remarks: *Grandidierella gravipes* in present study resemble with specimens from Indian Ocean in male gnathopod 1carpus and propodus subequal, carpus posterior margin with a single tooth and hook shape uropod 3 rami. However it differ in the carpus posterior margin tooth is shorter than those from Indian Ocean.

Grandidierella halophilus Wongkamhaeng, Azman & Pholphunthin, 2012

Grandidierella halophilus Wongkamhaeng et.al. 2012b. 433-447, pl. 2—10.

Description: SeeAnnex III

Local Distribution: Samut Sakhorn

Grandidierella phetraensis Wongkamhaeng, Coleman & Pholpunthin, 2013

Grandidierella phetraensis Wongkamhaeng et.al. 2013b. 512-519. Fig. 8—13.

Description: See Annex V

Local distribution : Satun

Grandidierella sp. A

Figs. 32—34

Material examined. 1 ♂ (6.0 mm), Mae Ramphaung Beach,12°37'3"N 101°22'18"E, 0.5 m. sandy beach, Nabhitabhata, J. 1-10-2008, 2 ♂ and 4 ♀. 5 ♂**,** Talet Bay,09˚18'39.5"N 99˚46'46.4"E, seagrass bed (associated with *Thalassia hemprichii*), Puttapreecha, R. 1-5-2008.

Description

Head. *Head* subequal in length to first 2 pereonites; rostrum not developed; inferior antennal sinus extended near end of the eye , 0.4 times of head length; *eye* distinct. *Antenna 1* longer than antenna 2, ratio of peduncular article 1-3 as 3: 3: 1; article 1 slender, with 5 antero-marginal robust setae; flagellum with 15 articles, subequal to peduncle; accessory flagellum uni-articulate, short. *Antenna 2* peduncle stout; 4 segmented in ratio of 1: 2: 4.5: 4; inner margin of article 4 with group of marginal robust setae and inner margin of article 5 with 2 rows of marginal robust setae; article 5 shorter than 4; flagellum shorter than peduncular article 5, composed of 5 articles; flagellum article 2-4with a pair of curved bifid robust setae on each article.

Lower lip inner plates well developed, oval, mandibular process well developed; outer plate with finger-like setae on the inner face of the outer lobe, covered with thin hairs. *Mandible*, both similar to each other except for number of accessory blades

constituting 4 in right and 5 in left ones; right incisor 4 dentates, left incisor 5 dentates; lacinia mobilis armed with 5 teeth on left side and 4 teeth on right; molar process trituative, armed 5 setae; palp with ratios of 1: 1.2: 1.3, article 3 beset with setae. *Maxilla 1*, inner plate vestigial; outer plate with 9 apical toothed robust setae; palp extending beyond outer plate, biarticulate with 5 apical spines. *Maxilla 2*, inner plate subequal to outer plate with mediofacial row of slender setae, outer margin naked. *Maxilliped*, inner short, beset with several plumose setae and; outer plate broad, almost reaching palp article 2 with 12 marginal robust setae; palp 4-articulate with ratio of 3: 5: 8: 5.

Pereon. *Gnathopod 1* carpochelate, larger than gnathopod 2; coxal plate trapezoid, inner side bearing ventral process; length ratio of articles from basis to dactylus 5:0.5:2: 8: 4: 3; basis slender, anterior margin straight, 2 as long as broad, with 2 short setae on posteriodistal margin; ischium short, subrectangular; merus trapezoidal; carpus 1.5 times as long as broad, posterodistal corner produced with tooth and a large tooth present on inner face, posterior margin setose smooth; propodus slightly longer than dactylus in length, 0.5 times length of carpus, posterior margin proximally concave, distally expanded; dactylus curved. *Gnathopod 2* subchelate; coxal plate subrectangular; length ratio of articles from basis to dactylus 5: 1: 2: 4: 2: 1; basis slender, both margin naked; ischium subrectangular; merus oval, posterior distal angle slightly produced, posterior margin bearing long plumose setae; carpus 2.5 times as long as wide, posterior margin long plumose setae; propodus with plumose setae on both margins, palmar margin posterodistally extended, with 7 robust marginal setae; dactylus slightly longer than palmar margin, inner margin crenulate with several fine setules.

Pereopod 3 slender ; coxal plate shallow with ventral margins posteriorly produced into triangular expansion; length ratio of articles from basis to dactylus 7: 2.5: 6: 3: 4: 4; basis slender; ischium short; merus sparsely marginal setae; carpus suboval, posterior margin with 3 marginal setae; propodus narrow with distal setae; dactylus tapering, subequal to propodus. *Pereopod 4* similar to pereopod 3, coxal plate subtrapezoid; length ratio of articles from basis to dactylus 6: 2: 4: 2.5: 3: 4; basis slender; ischium short, subrectangular; merus slightly slightly produced anterodistally; carpus suboval with setae on posterior margins; propodus long and

narrow, bearing setae on posterior margins ; dactylus curve, tapering. *Pereopod 5* coxa bilobe, posteroventrally expanded; length ratio of articles from basis to dactylus 7:2:3:2.5:3:1.6; basis subrectangular with short setae on margin; ischium short; carpus with 4 robust setae along posterior margin and on posterodistal corner; propodus with 3 robust setae along posterior margin; dactylus short, strongly curved. *Pereopod 6* elongate, 2 times as long as pereopod 5; coxa posteriorly produced with rounded lobe; length ratio of articles from basis to dactylus 8: 3: 7: 4: 7: 3; basis subrectangular with marginal setae on both sides; ischium short, sparsely setae; merus oblong, with marginal robust setae on anterior margin; carpus bearing two rows of bifid robust setae; propodus slender, distally extended, with 2 rows of marginal robust setae and distal setae; dactylus curved, tapering, mediofacial armed with a small teeth. *Pereopod 7* elongate, 1.4 times as long as pereopod 5; coxa subtrapezoid, shallow; length ratio of articles from basis to dactylus 6: 1.5: 5: 4:9: 2; basis anterior margin with a row of robust setae and posterior margin with long plumose setae; ischium short and subrectangular; merus elongate with setae on anterior and posterior margins and 2 distal robust setae; carpus with several midlength setae along anterior margin; propodus elongate and distally expended, slightly curved with robust setae along anterior margin; dactylus tapering to pointed tip.

Uropod peduncle longer than inner and outer rami, fringed 2 rows of robust setae, peduncular apex bearing a posteroventral process; outer and inner margins of both rami lined with a row of robust setae, distal margins beset with several robust setae. *Uropod 2* slightly longer than uropod 3, peduncle shorter than inner and outer rami, both rami fringed with robust setae; outer ramus slightly longer than inner one, distal beset with short and long robust setae. *Uropod 3* uniramous, peduncle much shorter than ramus, not extended; ramus elongate with short second article, both outer and inner margins with a row of long setae; apex with 4 long setae. *Telson* subtrapezoidal, ending with double pointed apex, each with one long robust seta and one short (thin) seta.

♀**.** Total body length 5.0 mm–(sexually dimorphic characters).

Pereon. *Gnathopod 1* subchelate, smaller than that of ♂. Coxal plate suboval, deeper than those of ♂; carpus subtrapezoid, 2.4 times as long as broad, posterior margin setose; propodus oval with 2 submarginal setae, subequal to carpus, palm oblique and

defined by a large robust seta, palmar margin with long plumose setae, distal end sparsely setae; dactylus curved with 4 inner marginal short stout robust setae

Remarks: From all 41 congener, only 6 species bearing sternal process, i.e. *G. bonnieroides* Stephensen, 1948; *G. exilis* Myers, 1981; *G. japonica* Stephensen, 1938; *G. trispinosa* Bano & Kazmi, 2010; *G. spinicoxa* Myers, 1972 and *G. halophilus* Wongkamhaeng et al. 2012 but only *G. exilis* Myers, 1981 and this species show the gnathopod 2 carpus and propodus slender (longer than 3x wide), bearing plumose setae along posterior margin. Howerver, it can be distinguished from *G. exillis* in 1) ♂ coxa 3 posteriorly produced into long triangular expansion (absent in *G. exillis*) 2) ♂ gnathopod 1 posterior margin smooth (vs. arm with 2 robust setae). Moreover, *G. exillis* exist in hypersaline condition (40 ppt) while *Grandidierella* sp. occurs in sandy beach and seagrass bed which the salinity range between 25-30 ppt.

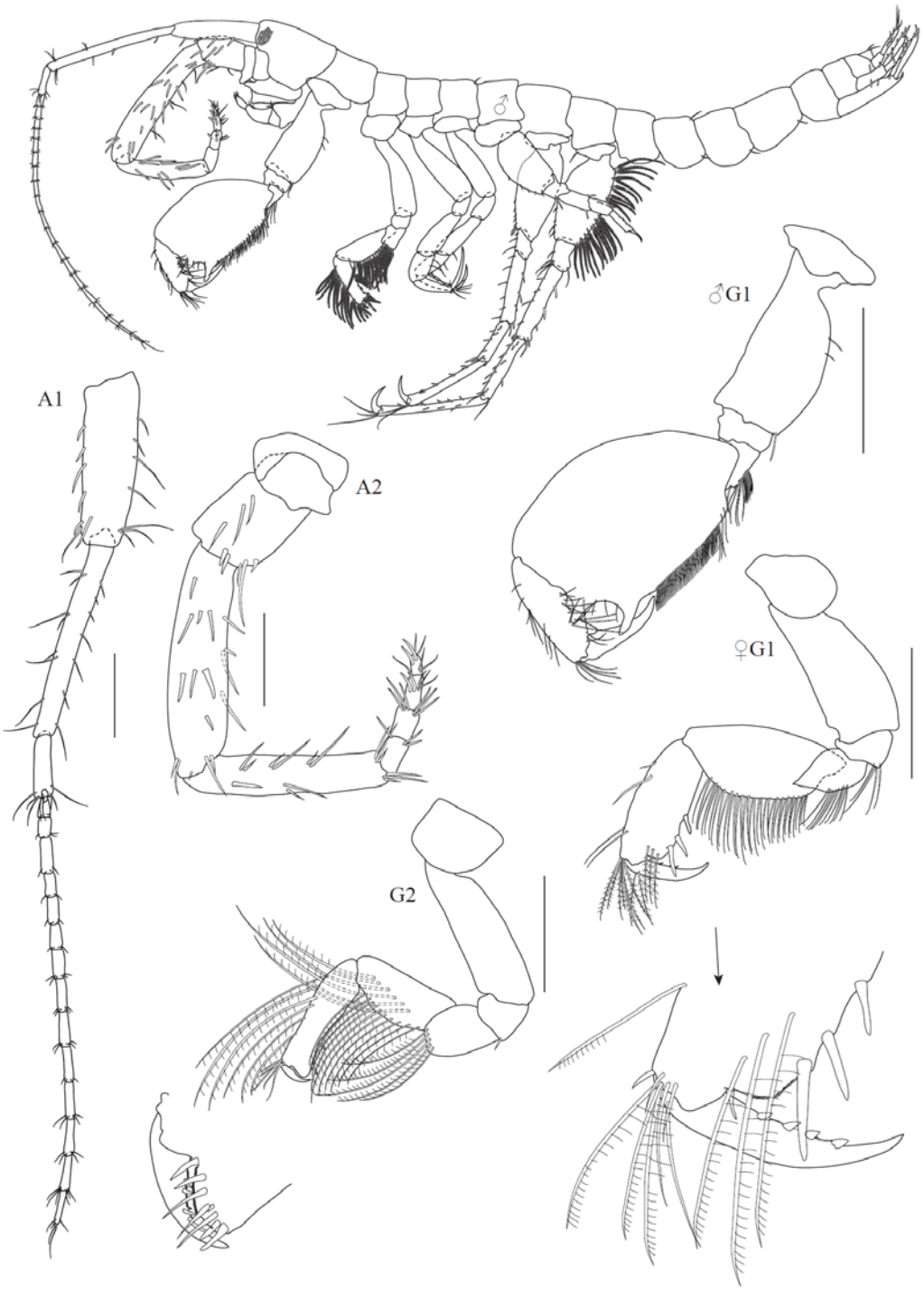


Figure 32 *Grandidierella* sp.A, ♂, (PSUZC-CR-0192), 6.0 mm. Rayong, Gulf of Thailand, ♀, (PSZC-CR-0193). All scale bar present 0.5 mm

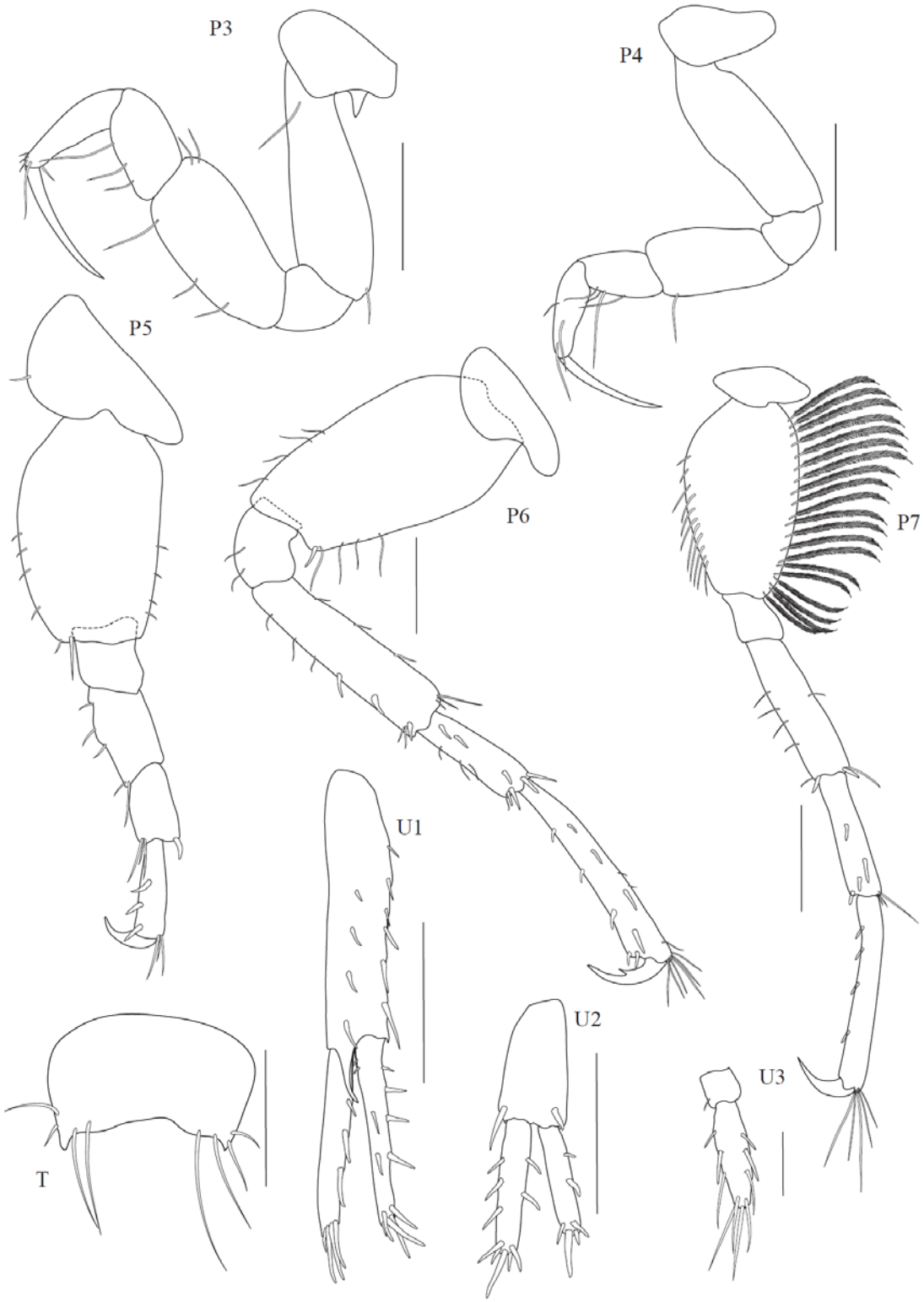


Figure 33 *Grandidierella* sp.A, ♂, (PSUZC-CR-0192), 6.0 mm. Rayong, Gulf of Thailand Scale bars for P3-7, U1 and U2 present 0.5 mm, for T and U3 present 0.2 mm

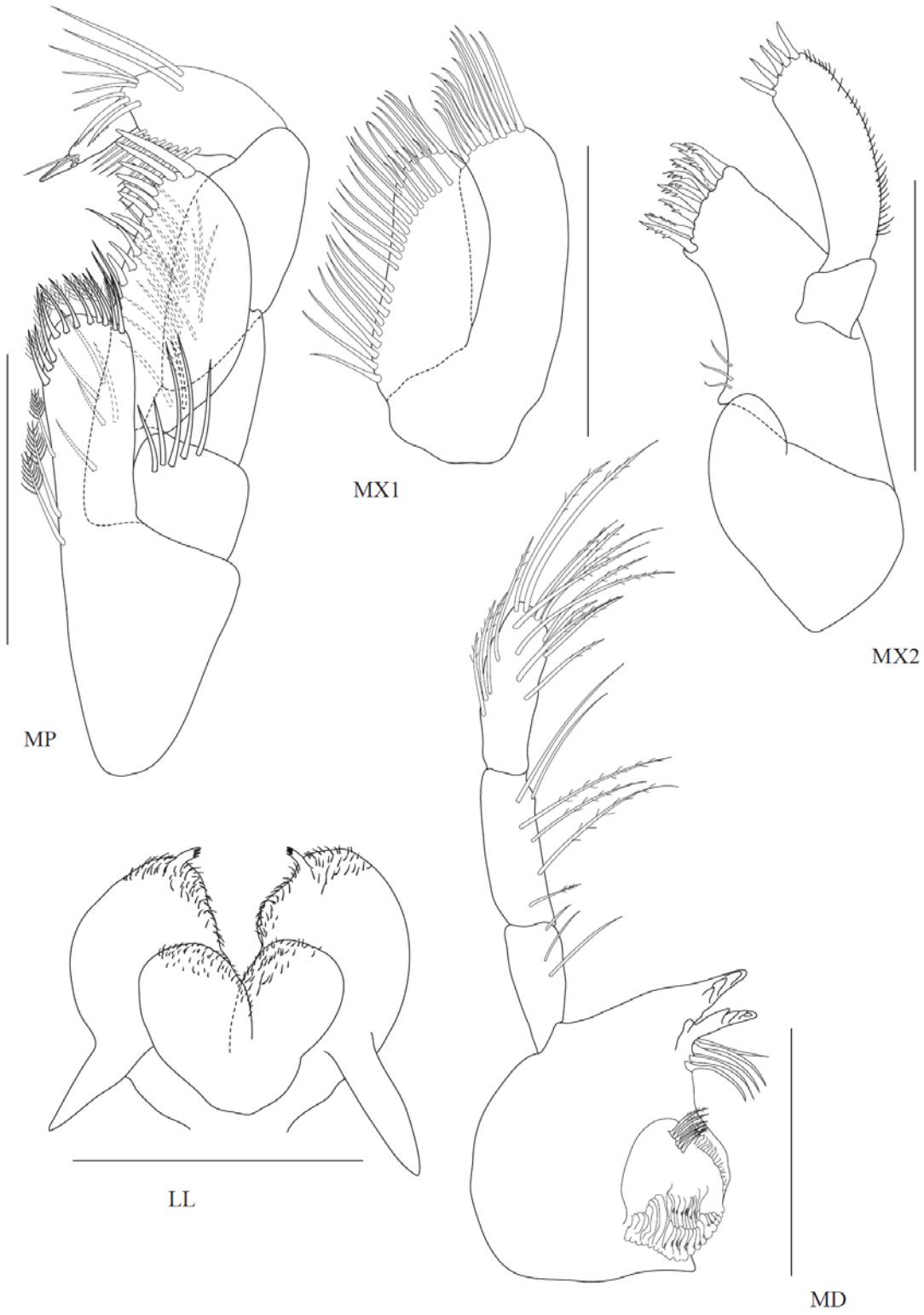


Figure 34 *Grandidierella* sp., ♂, (PSUZC-CR-0192), 6.0 mm. Rayong, Gulf of Thailand . Scale bars for MP, LL and MD present 0.5 mm, for MX1 and MX2 present 0.2 mm

FAMILY Corophiidae Leach, 1814

Diagnosis.—Labium outer plate without distal notch or excavation. Uropod 3 outer ramus without recurved robust setae. Telson cusps absent.

SUBFAMILY Corophiinae Leach, 1814 (Myers & Lowry,2003)

TRIBE Corophiini Leach, 1814 (Myers & Lowry, 2003)

GENUS *Chelicorophium* Bousfield & Hoover, 1997

Diagnosis: Urosome segments not coalesced. Head, rostrum short, not exceeding anterior head lobes; inferior antennal sinus deeply regressed. Antenna 1 elongate, segment 3 medium. Antenna 2 strongly pedifonn and well developed (clasping) in both sexes; peduncular segment 4 with strong bidentate posterodistal process; segment 5 short, usually with median tooth near mid-point, distal process various; flagellum medium, - segment 5; gland cone short, inconspicuous.

Chelicorophium sp. A

(Figs 35—37)

Material examine: 1 ♂. Lower Songkhla Lake 09°18'39.5"N, 99°46'46.4"E, mangrove forest, Puttapreecha, R. 1-2-2012. 1 ♀, collected with ♂.

Description. Urosome segments not coalesced. Head, rostrum short, not exceeding anterior head lobes; inferior antennal sinus deeply regressed. Antenna 1 elongate, segment 3 medium. Antenna 2 strongly pedifonn and well developed (clasping) in both sexes; peduncular segment 4 with strong bidentate posterodistal process; segment 5 short, usually with median tooth near mid-point, distal process various; flagellum medium, - segment 5; gland cone short, inconspicuous.

Mouthparts variably plesiomorphic. Upper lip, epistome produced. Lower lip, mandibular lobes medium. Mandibular palp basic (type PI of Hirayama, 1987b). Maxilla 1, palp sublinear, longer than outer plate. Maxilliped, inner plate short, apex subacute, inner margin with basal spine; outer plate regular, inner margin strongly setose; palp segment 2 medium to long.

Gnathopod 1, regularly subchelate; dactyl short. Gnathopod 2, propod slender, not longer than combined merus and carpus; dactyl short, typically tridentate. Peraeopods 3 & 4, basis broad (glandular); segment 5 medium to short, not overhung by segment 4; dactyl shortmedium. Peraeopods 5 & 6 short, basis setose behind; segment 4 short, lacking anterior lobe; segment 5 short, posterior hook spines strong;

segment 6 and dactyl reversed (usually?). Peraeopod 7, basis strongly setose; segment 5 not elongate; dactyl short. Pleon plate 3, hind comer rounded.

Pleopod peduncles wide, broader than deep. Uropods 1 & 2 medium, peduncles broadening distally; rami short, straight; inner (as well as outer) !llargins often spinose or setose, apex little out-curved. Uropod 3, ramus longer than peduncle, slightly broadened, setose apically. Telson short, broad, spinose hooks at hind comers and dorsally. Coxal gills medium broad, sac-like, on peraeopods 3-6. Brood lamellae short, sublinear, marginal setae not elongate.

♀**.** (sexually dimorphic characters). No sexual difference.

Remarks: *Chelicorophium* sp. A is very similar to *Chelicorophium madrasensis* (Nayar, 1950) and shares many characters including the antenna 2 article 4 inner surface produced 2 proximal spine, epimeron 1 smooth and naked. However, the *Chelicorophium* sp.A can be distinguished from *C. madrasensis* by the following characters: gnathopod 2 both ♂ and ♀ dactylus has 5 dentates (3-dentates in *C. madraensis*) and the telson truncate (point in *C. madraensis*).

Figure 35 *Chelicorophium* sp.♂ (PSUZC-CR-000194) 7 mm. Outer Sonkhla Lake, lower Gulf of Thailand. All scales represent 0.5 mm.

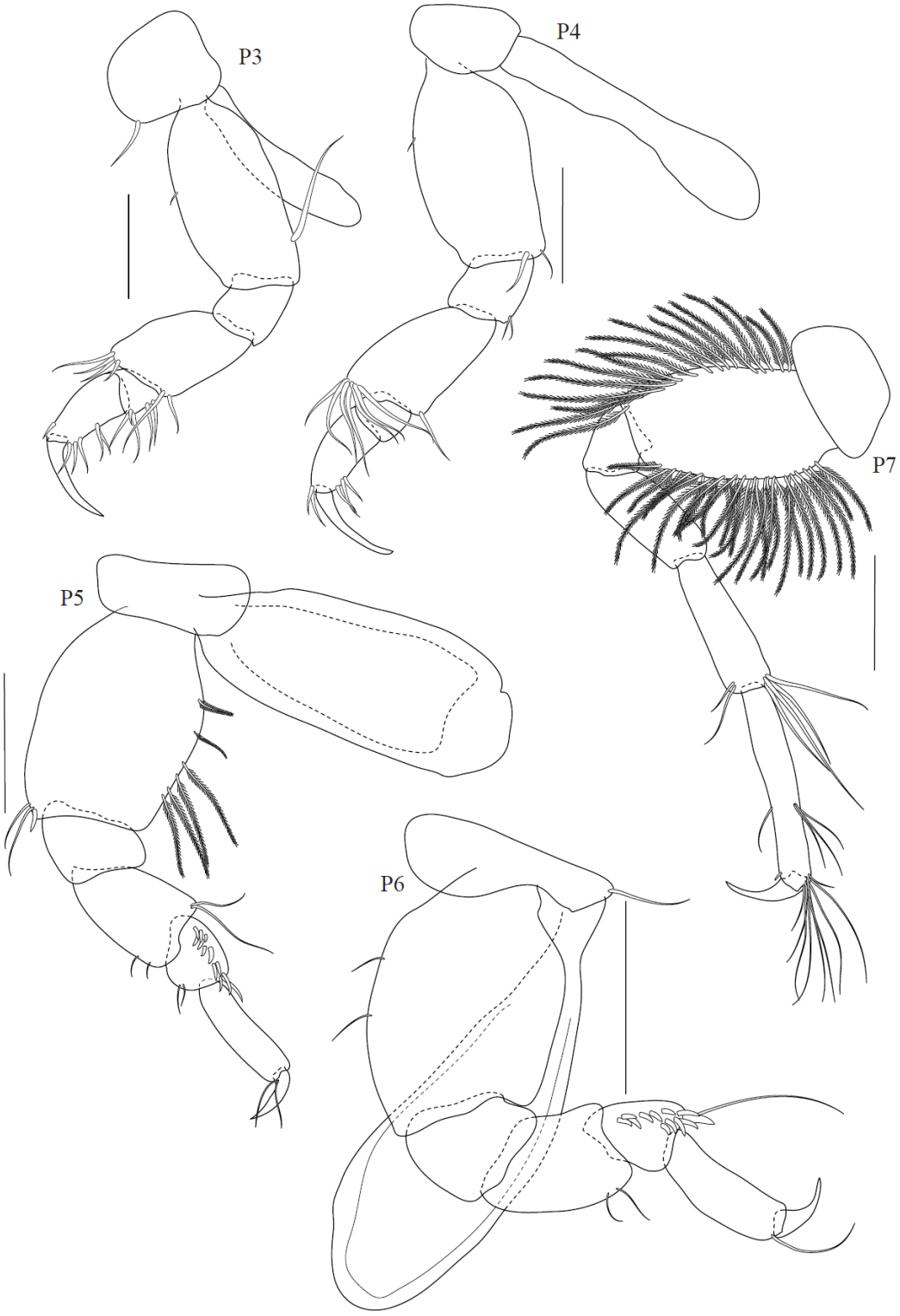


Figure 36 *Chelicorophium* sp., ♂ (PSUZC-CR-000194) 7 mm. Outer Sonkhla Lake, lower Gulf of Thailand. All scales represent 0.5 mm.

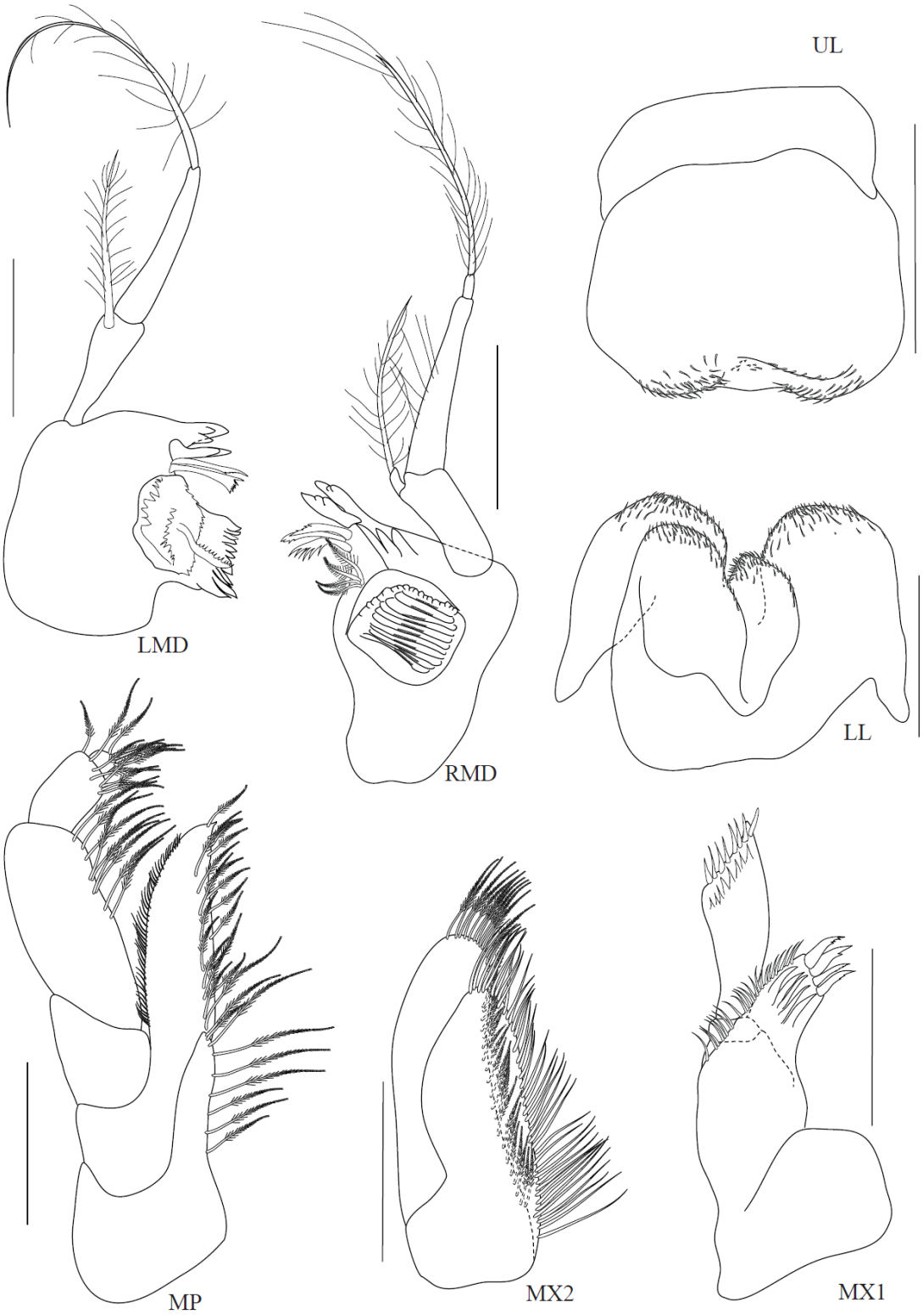


Figure 37 *Chelicorophium* sp. , ♂ (PSUZC-CR-0194) 7 mm. Outer Sonkhla Lake, lower Gulf of Thailand. All scales represent 0.2 mm.

SUBFAMILY Protomedeiinae Myers & Lowry, 2003

Diagnosis.—Gnathopod 1 and 2 not together forming sieving structure. Pereopod 7 not markedly longer than pereopod 6. Uropods 1 and 2 rami lacking dense array of robust setae.

GENUS *Cheiriphotis* (Giles, 1885)

Cheiriphotis megacheles (Giles, 1885)

Melita megacheles Giles, 1885: 69—70.

Cheiriphotis megacheles (Giles).-Walker 1904: 284—285, pl. 6, figs. 42; Stebbing 1910: 461; Schellenberg 1926: 383, fig. 65; Barnard 1937: 167—169, fig. 14; Pirlot 1938: 345; Barnard 1940: 480; Ruffo 1956: 215; Pillai 1957: 57—58, fig. XV; Nayar 1959: 33— 34, pl. XI, figs. 23—25; J. L. Barnard 1962: 17, fig. 4. Salman & Jabbar, 1990. 220—225, figs. 5—8.

Ezlvysthezls monzlropzls Walker 1909: 340-341, pl. 43, fig. 8.

Cheiriphotis durbanensis Barnard 1916: 247—249.

Cheiriphotis walkevi Stebbing 1918: 68-69, pl. 12.

Cheiriphotis delloyei Pirlot 1934: 231—235, fig. 100.

Material examine: 4 ♂8 ♀. Lower Songkhla Lake 09°18'39.5"N, 99°46'46.4"E, mangrove forest, Puttapreecha, R. 1-2-2012.

Local distribution : Songkhla

Geographic distribution: Red Sea, Indian Ocean, Indonesian Archipelago.

Cheiriphotis trifurcata Wongkamhaeng, Azman & Puttapreecha, 2012

Cheiriphotis trifurcata Wongkamhaeng et.al. 2012: 71—89, pl. 2A-3D.

Description Annex II

Local distribution : Songkhla, Satun

FAMILY Dexamidae Leach, 1814

Diagnosis. Head basic; body laterally compressed, at least 2 urosomites coalesced together; coxae ordinary to acuminate. Eyes, if present, ommatidia!. Accessory flagellum 1-2 usually vestigial. Gnathopods 1-2 subchelate, of medium enfeeblement. Pereopods 3-4 not glandular. Pereopod 7 less than 1.2 times as long as pereopod 6, occasionally of different form than 5-6 but article 2 not of shape and setation found in

Ampeliscidae. Uropod 3 biramous. Telson laminar, more or less cleft.

GENUS *Paradexamine* Stebbing, 1899

Diagnosis: Cephalic lobes rounded or pointed. Mandibular palp absent. Inner lobes of lower lip well developed and fleshy. Palp of maxilla 1 1-articulate. Palp of maxilliped 4-articulate, 1 or more posterior body segments with lateral teeth.

Paradexamine latifolia Ren, 2006

(Fig. 38)

Paradexamine latifolia Ren, 2006 437-438 figs 188.

Material examined: 2♂,10♀,Bang Saphan,11°05'41"N 99°29'22"E, 3 m. coral reef, Wongkamhaeng, K. 20-08-2010. 6♀, Rab Island, 9°18'42"N 99°57'29"E , algal bed, Darakrai, A. 15-03-2008.3♂15♀, Lower Songkhla Lake, 09°18'39.5"N. 99°46'46.4"E, 0.5 m. soft bottom, Puttapreech, R. 1-2-2010. 1♂4♀, Ban Bang Ta Wa, 06°56'04'N 101°08'34"E, 2 m. coral reef, Puttapreecha, R. 15-07-2010.

Description

Body laterally compressed, smooth. Head cuboidal, rostrum long, cephalic lobe truncate. Eye raniform, brown colour in alcohol. Antenna 1 slightly longer than antenna 2, accessory flagellum absent, peduncular article 3 of antenna 1 shorter than article 2 and 1. Labrum entired. Mandibular molar large, incisor toothed. Labium inner lobe well developed, outer lobes entired, inner lobes reduced, mandibular lobe large. Maxilla 1 inner plate reduced, outer plate with 8 robust setae, palp 2-articulate. Inner plates of maxilla 2 shorter than outer. Inner plate of maxilliped reduced; outer plate entired, palp with 4 articles.

Coxa 1 broader than lonng, subrectangular, with anteriorventral marginal setae. Coxa 2-4 progressive larger, broader than long. Coxa 4 note excavate. Coxae 5-7 subequal, serrate. Gnathopods 1-2 similar, subchelate, basis slim; ischium short; merus subtriangular, subequal to propodus; palm transverse; dactylus tapering.

Coxal gills present on segment 2-5. Pereopod 5-7 similar with basis extended. Pleonite 1-3 and urosomite 1 serrated. Epimeron 3 produced posteriorly. Uropod 1-3 biramous Uropod 1 rami subequal in length with long marginal robust setae; peduncle shorter than rami, with 3 marginal robust setae and 2 distal robust setae. Uropod 2

biramous, rami subequal; peduncle shorter than rami. Telson deeply cleft, longer than broad.

Local distribution: Prachuab Kirikan, Suratthani, Songkhla and Pattani.

Geographic distribution: China Sea and Gulf of Thailand (current study).

Remarks: The examine material resembles to *Paradexamine latifolia* Ren, 2006 reported from China Sea, especially on the diagnostic characters e.g. lateral cephalic lobe not projected; posteroventral angles of basis of pereopod 6-7 concave but differs in body side which present specimen is 3.0 mm, smaller that those of Ren (5.3 mm).

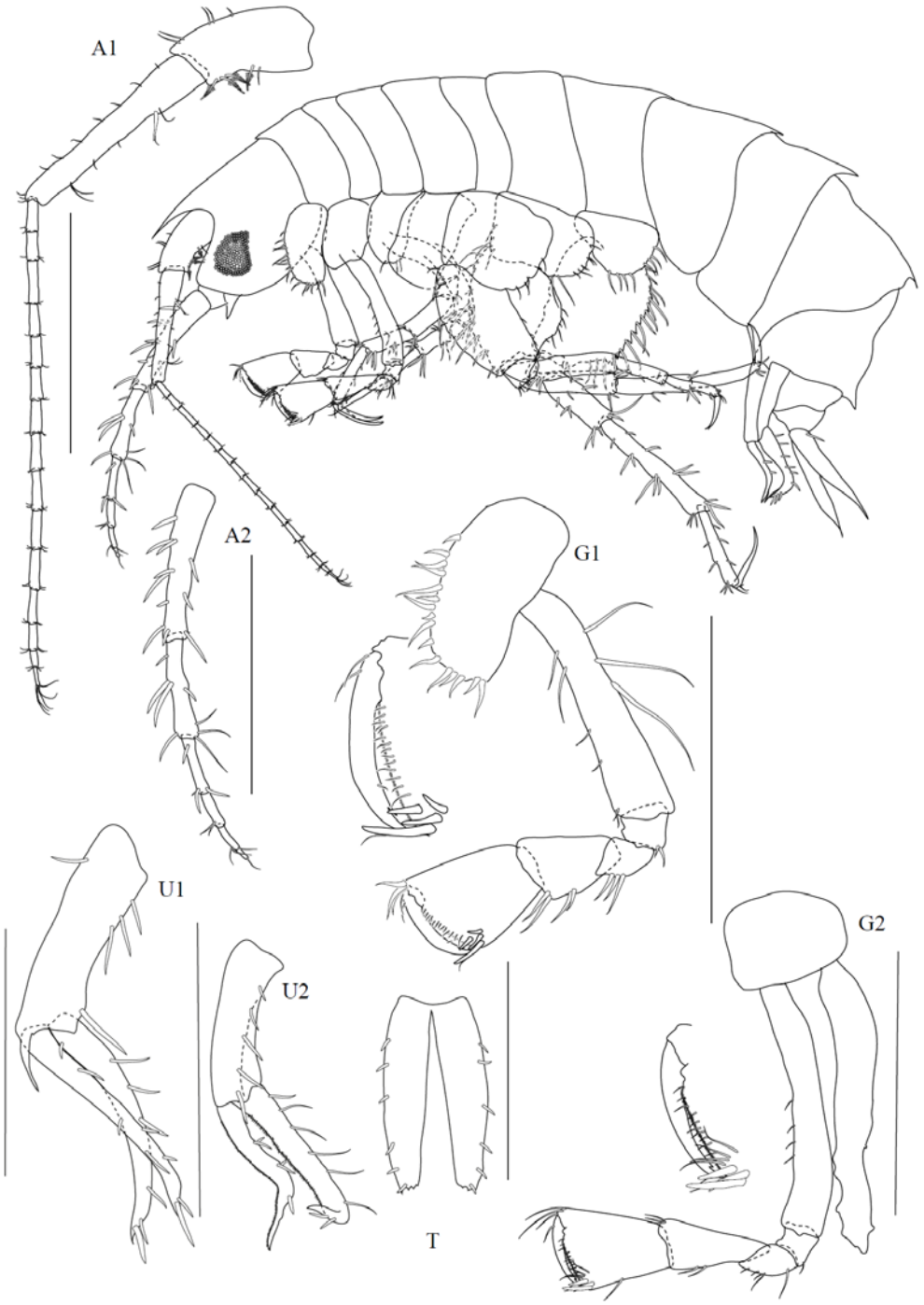


Figure 38 *Paradexamine latifolia* Ren, 2006 ♀ (3.0 mm); all scale represent 0.5 mm

FAMILY Hyalidae Bulycheva, 1957

Diagnosis. Accessory flagellum absent; mandible lacking palp, molar triturative; uropod 3 essentially uniramous though tiny scale-like inner ramus rarely present.

SUBFAMILY Hyalinae Rathke, 1837

GENUS *Parahyale*

Diagnosis: Maxilla 1 bearing large I-articulate palp not reaching base of spines on outer plate. Dactyl of maxilliped unguiform, without long whip-like seta. Gnathopods of both sexes subchelate, male gnathopod 2 larger than 1, article 5 produced between articles 4 and 6; female gnathopod 2 like gnathopod 1 but slightly enlarged. Uropod 3 bearing scale-like inner ramus or vestigial fused replica. Telson cleft, flat.

Parahyale aqulina Barnard, 1935

Amphithoe aquilina	Costa, 1857:202, pl. 2, fig. 7
Nicea fasciculata	Heller, 1866: 6, pl. l, fig. 10—11.
Hyale aquilina	Della Valle, 1893:523, pl. 16, fig. 43—47.
Parhyale aquilna	Krapp-Schickel, 1974: 326, pl. 5-7, Wongkamhaeng et.al, 2010:18—19, Figs 14—15.
Parhyale aquiline	Krapp-Schickel, 1993:754, fig. 516.

Material examined: 4♂8♀, Rab Island, 9°18'42"N 99°57'29"E , algal bed, Darakrai, A. 15-03-2008. 2♀, Ban Bang Ta Wa, 06°56'04'N 101°08'34"E, 2 m. coral reef, Puttapreecha, R. 15-07-2010.

Description Annex I

Local distribution : Suratthani**,** Pattani

Geographic distribution: Napoli, Warm Eastern Atlantic, Mediterranean, Indo-Pacific

FAMILY Liljeborgiidae Stebbing, 1899

Diagnosis: Accessory flagellum 2+articulate. Molar of mandible feeqle, not triturative. Gnathopods powerful, carpus of at least 1 pair well produced. Plates of maxilliped only moderately developed. Telson cleft, each apex with spine(s) in notch.

GENUS *Listriella* J.L. Barnard, 1959

Diagnosis: Accessory flagellum usually 2- (rarely 4) articulate. Epistome poorly produced. Article 1 of mandibular palp elpngate, molar simple. Coxae 1-4 ordinary. Gnathopods variable, either dominant; propodus and carpus not setose anteriorly;

carpus of gnathopods 1-2 moderately to poorly produced. Outer ramus of uropod 3 1- or 2-articulate. Each lobe of telson with 2 apical spines.

Listriella longipalma Othman & Morino, 2006

(Figs 39)

Listriella longipalma Othman & Morino, 2006: 21-32, figs 1-2.

Material examined: 2 ♂ 10 ♀, Talet Bay,09˚18'39.5"N 99˚46'46.4"E, seagrass bed (associated with *Thalassia hemprichii*), Puttapreecha, R. 1-5-2008. 1♂4♀, Ban Bang Ta Wa, 06°56'04'N 101°08'34"E, 2 m. coral reef, Puttapreecha, R. 15-07-2010.

Description

Body laterally compressed, smooth. Head cuboidal, rostrum short, cephalic lobe round. Eye raniform, brown colour in alcohol. Antenna 1 short, extending up to half of article 4 of antenna 2, accessory flagellum 2 articles, peduncular article 1 of antenna 1 longer than article 2 and 1. Antenna 2 length ratio of peduncular articles 3–5 is 1:2:1, peduncle is 1.4x as long as flagellum, flagellum 32 articles, each article broader than long . Labrum entired. Mandibular molar large, incisor toothed. Labium inner lobe well developed, outer lobes entired, inner lobes distinct, outer lobe large mandibular lobe large. Maxilla 1 inner plate reduced, outer plate with 8 robust setae, palp 2-articulate. Inner plates of maxilla 2 shorter than outer. Inner plate of maxilliped reduced; outer plate entired, palp with 4 articles.

Gnathopod 1 subchelate, coxa distally expended, ventral margin rough; basis slender, sparsely setae; ischium short; merus subtriangular; carpus subrectangular with 3 distal setae; propodus suboval, palm oblique, with 2 subrectangular distomedial elevation, palmar margin along with fine setae and 4 distalcorner robust setae; dactylus curve, distally excavated. Gnathopod 2 subchelate; coxa subtriangular, broader than long; basis slender, sparsely setae; ischium short; merus subrectangular; carpus subtriangular; propodus suboval with marginal setae on both margin, palm oblique, slightly convex, setose; dactylus tapering. Pereopods 3-4 similar; coxa 3 shorter than coxa 4, coxa 4 posteriorly excavated; basis slender, ischium short; merus subequal to carpus; propodus longer than carpus; dactylus tapering. Pereopod 5 basis oval, posterior margin slightly produced distally, posterodistal lobe rounded. Pereopod 6–7 similar, basis narrower than pereopod 5, posterodistally produced with short anterior and posterior marginal setae; dactyli curved, tappering.

Epimeron 1-3 round, epimeron 3 distally expanded. Uropod 1-3 biramous. Uropod 1 rami subequal in length with short marginal robust setae; peduncle subequal to rami, with 2 rows of marginal robust setae and 2 distal robust setae. Uropod 2, rami subequal; peduncle shorter than rami. Uropod 3, rami subequal, peduncle shorter than rami with 3 marginal setae and a distal robust seta.Telson deeply cleft, longer than broad, each lobe with 2 distal robust setae.

Remark: The examine material resembles to *Listriella longipalma* Othman & Morino, 2006 reported from Straits of Malacca in 1) having dorso marginal dentation on pleonite 2, posteriorly serrated epimeron 3 and robust setae on uropod 1 peduncle but they show the different in ♂ gnathopod 1 which those of *L. longipalma* shows deep excavated on palm while present specimen shows subrectangular distomedial elevation.

Geological distribution: Malaysia and Gulf of Thailand (current study)

Local distribution: Nakhon Si Thammarat and Pattani.

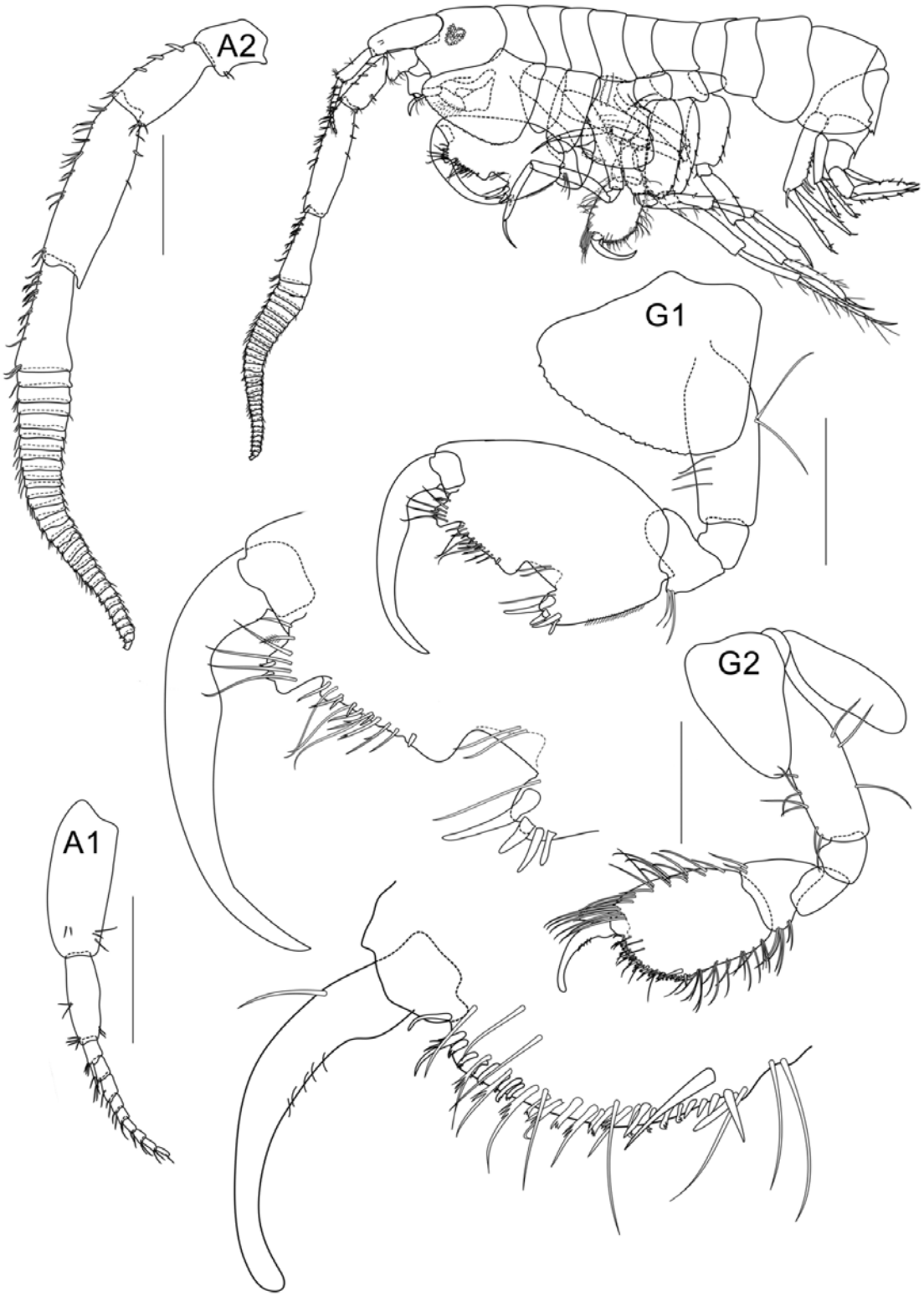


Figure 39 *Listriella longipalma* Othman & Morino, 2006 ♂ (6.0 mm); all scale represent 0.5 mm

FAMILY Kamakidae Myer & Lowry 2003

Diagnosis: Head lateral cephalic lobe weakly extended, or strongly extended, eye, if present, situated proximal to lobe or completely or partially enclosed in extended lobe; anteroventral margin moderately to strongly recessed and moderately excavate. Mandible palp article 3 asymmetrical, distally rounded, setae extending along most of posterodistal margin, or subsymmetrical with setae mostly distal. Gnathopod 2 in male larger than gnathopod 1, merus not enlarged. Pereopods 5–7 not subchelate. Pereopod 7 slightly longer than pereopod 6. Urosomites not coalesced. Uropod 3 peduncle short, parallel-sided; outer ramus without recurved spines. Telson without hooks or denticles.

Genus *Kamaka* Dershavin, 1923

Diagnosis.—Head lateral lobe strongly extended, eye enclosed completely in extended lobe.

Kamaka songkhlaensis Ariyama, Angsupanich & Rodcharoen, 2010

Kamaka cf. taditadi Angsupanich et al., 2005: 375; Ruensirikul et al., 2007: 1233, fig.5.

Kamaka songkhlaensis Ariyama et. al. 2010, 60-67, figs 6-9.

Material examined: 4 ♂ 11♀**,** Talet Bay,09˚18'39.5"N 99˚46'46.4"E, seagrass bed (associated with *Thalassia hemprichii*), Puttapreecha, R. 1-5-2008. 31 ♀. Lower Songkhla Lake 09°18'39.5"N, 99°46'46.4"E, mangrove forest, Puttapreecha, R. 1-2-2012.

Local Distribution: Nakorn Si Thammmarat and Songkhla.

Geographic distribution: Thailand

Remarks: The present specimens are resembled to those of Ariyama et al. (2010) collected from the same location.

FAMILY Lysianassidae Dana, 1849

SUBFAMILY Tryphosinae Lowry & Stoddart, 1997

Diangnisis: Head as long as deep or deeper than long. Antennae: calceoli present or absent. Epistome and upper lip separate. Mandible: incisor smooth; lacinia mobilis present on left side only or rarely absent; accessory setal row without distal setal tuft; molar fully to weakly triturating. Maxilla 1: inner plate weakly setose (6 or less) or without setae; outer plate narrow, with 6-11 setal-teeth in modified 615 arrangement;

palp large, 2-articulate, with terminal robust setae. Maxilliped: with well-developed apical robust setae. Coxae 1 to 4: longer than broad, overlapping; coxa 1 fully developed, reduced, reduced and tapering, or vestigial. Gnathopod l: strongly to weakly subchelate. Peraeopods: simple. Telson: cleft, occasionally entire, dorsal robust setae present.

GENUS *Waldeckia* Chevreux, 1907

Diagnosis: Mouthparts forming quadrate bundle.Labrum and epistome prominent, separate, both well projecting, blunt. Incisor ordinary, molar simple, large, conicolaminate or subconical, setulose; palp attached strongly proximal to molar. Inner plate of maxilla 1 moderately to weakly (2-6) setose (spinose); palp 2-articulate, large. Inner and outer plates of maxilliped well developed, palp slightly exceeding outer plate, dactyl well developed. Coxa 1 large and visible, not tapering. Gnathopod 1 short, simple (type), or poorly subchelate, article 5 shorter than 6, dactyl large; article 6 of gnathopod 2 greatly shorter than article 5, ordinary, propodus subchelate. Inner ramus of uropod 2 without notch. Uropod 3 ordinary, peduncle ordinary, inner ramus slightly shortened, outer ramus 2-articulate. Telson elongate, deeply cleft.

Waldeckia elephas Hirayama & Kikuchi, 1980

(Figure 40)

Waldeckia elephas Hirayama & Kikuchi, 1980, 143-151, figs 1-5.

Material examined: 8 ♀,Phayam Island, 09°47'49.3"N 98°22'52.3"E, 4 m. coral reef, Wongkamhaeng, K. 15-02-2010.

Description

Male. 10.2 mm. Head deeper than long, lateral cephalic lobe slightly produced. Eyes raniform, large. Antenna 1 short; peduncular article 1, 2 and 3 short; accessory flagellum relatively long with 6 articles. Antenna 2 elongate, more than 2 times of body length; peduncle article 3 setose; flagellum about 40 articles, calceoli absent.

Mouthpart, epistome and upper lip fused, upper lip wedge-shaped. Mandible, insicor toothlike, apex rounded; lacinia mobilis with 2 round teeth, molar situated proximally, without grinding structure; palp 3-articulate, article 3 rectolinear. Maxilla 1m inner plate small with 2 terminal setae; outer plate with 6 apical serrated teeth;

palp 2-articulated, apical margin crenulate. Maxilla 2 inner and outer plates narrow, subequal. Maxilliped inner plate large, subrectangular, with marginal setae along on inner side, outer plate naked; dactylus well developed, facate.

Gnathopod 1subchelate; coxa rectangular, distally expanded with small setae on inner sides; basis rectangular with anteromarginal setae; ischium short; merus short, shorter than propodus; propodus large, subrectangular, palm one third of distal width, transverse; Dactylus overlapping stout spine of propodus. Gnathopod 2, coxa rectangular, slightly shorter than coxa 1; basis slender; ischium short with 3 distal robust setae; merus subtriangular, slender; carpus subequal to ischium, in length, setose; propodus suboval, palm formed between noth projecting cusp, curved deeply, with small tooth; dactylus fit with palm. Pereopod 3 coxa large, posterior margin with setae; basis subrectangular; ischium short; merus, antero-distal angle rounded and extended; carpus slender without plumose setae; dactylus short, slender. Pereopod 4 coxa with large posteroventral lobe; merus weakly expanded anteriorly; merus-carpus without plumose setae; propodus narrow; dactylus short, slender. Pereopod 5 coxa equilobate; basis expanded posteriorly, posterior margin smooth; merus expanded posteriorly, with curved posterior margin; propodus narrow; dactylus short, slender. Pereopod 6 coxa small, not lobate posteriorly; basis expanded posteriorly with fine setae along margin; merus expanded posteriorly, with sloping straight posteroproximal margin and straight posterodistal margin; dactylus short, slender. Pereopod 7 basis expanded posteriorly, minutely crenate; merus slightly expanded, with robust setae along posterior margin; propodus slender and narrow; dactylus short. Pleonites 1 – 3 dorsally smooth. Urosomites dorsally smooth.
Uropod 1 peduncle longer than rami, with dorsolateral and several robust setae along margin; outer ramus slightly longer than inner ramus. Uropod 2 peduncle with dorsolateral, and several robust setae on along margin; outer ramus slightly longer than inner ramus. Uropod 3 peduncle short, with dorsolateral, and several robust setae along margin; rami lanceolate, subequal in length; outer ramus 2-articulate, article 2 short; inner ramus with lateral robust setae and slender plumose setae. Telson longer than broad, deeply cleft, with dorsal robust setae on each lobe and apical robust setae on each lobe.

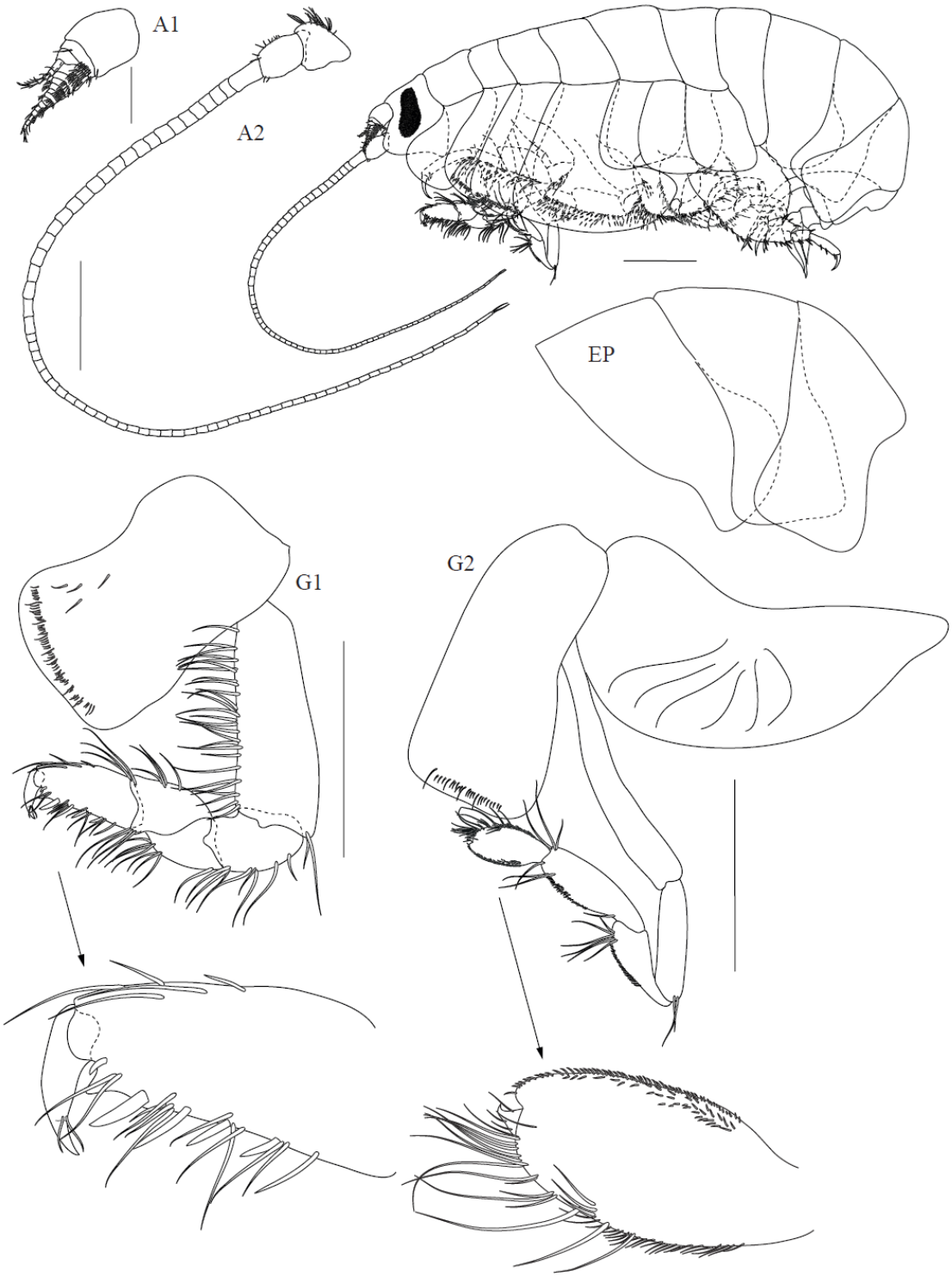


Figure 40 *Waldeckia elephas* Hirayama & Kikuchi, 1980 ♂ (10.0 mm); all scale represent 10 mm

FAMILY Maeridae Krapp-Schickel, 2008

Diagnosis: Eyes reniform or round. Body smooth. Mandible palp article 1 with tooth-shaped distal prolongation, article 3 slender, linear. Maxilla 2 inner plate setation also present laterally. Gnathopods subchelate, both with well-defined palmar corner. Gnathopod 2 dactylus outer margin smooth; palm with small U-shaped excavation, palmar corner with tooth-shaped elevation and bearing. Pereopod dactyli simple. Uropod 3 with subequal rami, distally truncated, no second article on outer ramus visible. Epimera 1–3 smooth, with posterodistal tip. Telson cleft, lobes distally incised, outer end of incision clearly longer than inner one; with 1-2 setae inserted in incision.

GENUS *Ceradocus* Costa, 1853

Diagnosis: Accessory flagelliim 2-articidate; lower lip lacking inner lobes; inner plates of maxillae 1-2 densely setose medially, gnathopods feeble, siibchelate, uropod 3 exceeding uropod 1, rami long, equal, broadly lanceolate, outer 2-articulate ; telson deeply cleft; body lacking dorsal teeth or spines.

Ceradocus andamanensis Wongkamhaeng, Coleman & Pholpunthin, 2013

Ceradocus andamanensis Wongkamhaeng, et.al. 2013b: 519-525, figs 14-18.

Description: See Annex V

Local Distribution : Satun

GENUS *Maeropsis* Chevreux, 1919

Diagnosis: Accessory flagellum more than 4-articulate; lower lip with inner lobes; inner plate of maxilla 1 setose only terminally, of maxilla 2 densely setose medially; gnathopods normal; uropod 3 not exceeding uropod 1, rami equal, rectangular, outer 1-articulate; telson deeply cleft; body lacking dorsal teeth or spines.

Maeropsis paphavasita Wongkamhaeng, Coleman & Pholpunthin, 2013

Maeropsis paphavasita Wongkamhaeng et.al, 2013a, 18-24, figs 2-6.

Description: See Annex IV

Local Distribution : Surat Thani

FAMILY Melitidae Bousfield, 1983

Diagnosis: Body smooth anteriorly, generally slender. Coxal plates shallow, tending to separation at base. Sexual dimorphism of gnathopods marked, secondarily in antennae and uropod 3. Head, eye rounded, small; rostrum lacking; anterior lobe round, antennal sinus sharply incised. Abdominal segments distinct, urosome mucronate, dentate, spinose, or smooth. Mandibular palp slender, reduced, or vestigial, 1-3 segmented. Lower lip, inner lobes large, distinct. Maxilla 1, inner plate with few apical setae; outer plate with 7 apical spine teeth. Gnathopod 2 larger than 1 (both sexes). Peraeopod 7 longest. Uropod 1, peduncle with anterior proximal spine. Uropod 3 large, rami spinose, not foliaceous, inner ramus tending to reduction. Telson deeply cleft, lobes diverging, apices acute, with spine(s). Brood plates narrow, sublinear, with relatively few marginal setae. Coxal gills present on peraeon segments 2-6 only, pedunculate; no accessory gills.

GENUS *Elasmopus* Costa, 1853

Diagnosis: Accessory flagellum 3- or more, occasionally 2-articulate ; lower lip with inner lobes; inner plates of maxillae 1-2 with only terminal setae; gnathopods normal; uropod 3 variable in length, rami equal, rectangular, outer 1-articulate; telson deeply cleft ; urosome occasionally with dorsal teeth

Elasmopus puteus Appadoo & Myers, 2003

Elasmopus puteus Appadoo & Myers, 2003 Wongkamhaeng et.al. 2010, 13-15, figs 12-13.

Description: See Annex I

Local Distribution : Surat Thani

GENUS *Melita* Leach, 1814

Melita latiflagella Ren & Andres, 2012

(Fig.41)

Material examined: 31 ♀. Lower Songkhla Lake 09°18'39.5"N, 99°46'46.4"E, mangrove forest, Puttapreecha, R. 1-2-2012.

Description

Head. Lateral cephalic lobe smooth. Antenna 1 peduncular article 1 longer than article 2, posterior margin with 2 marginal robust setae and 1 ventrodistal robust

seta; flagellum with 19 articles, accessory flagellum 2 articles. Antenna 2 gland cone not reaching to the end of article 3, flagellum with 5 articles. Lower lip inner lobes well developed, outer lobes pubescent. Maxilla 1 inner plate with 3 terminal plumose setae. Mandibular palp article 2 subequal to article 1.

Gnathopod 1 coxa anteroventral corner slightly produced, posteroventral corner expanded, merus-propodus setose; carpus longer than propodus; propodus transverse, venterodistal corner produced, without defining robust seta on anteroventral corner; dactylus overlapping palm. Gnathopods 2 merus posterodistal corner produced; carpus naked; propodus 3 × of carpus length, palmar margin oblique, serrated, longer than hind margin, with 2 robust setae, posterodistal corner produced with a robust seta; dactylus fit with palmar margin. Pereopod 3 coxa subrectangular. Pereopod 4 similar to pereopod 3; coxa distally expanded. Pereopod 5 and 6 basis posterior margin rounded. Pereopod 7 basis posterior margin straight.

Pleon. Epimera 1 -3 rounded. Pleonite 1–3 dorsally smooth. Uropod 1 peduncle with venterodistal spine, bearing marginal robust setae, both rami with a row of marginal robust setae. Uropod 2 peduncle shorter than rami; rami subequal. Telson cleft each half with 2 apical robust setae.

Remarks: Ren & Andres (2012) described *Melita latiflagella* from China Sea with diagnosis character that antenna 2 long and extended. The specimens from this study is also similar to those of Ren but smaller size (total length of the former is 3 mm while the latter is 5 mm).

Distribution. China Sea and Songkhla Lake (this study).

Local distribution: Songkhla

Figure 41 *Melita latiflagella* Ren & Andres, 2012 ♂ (10.0 mm); all scale represent 0.5 mm

GENUS *Parelasmopus* Stebbing, 1888

Diagnosis: Accessory flagellum 2- or 3- articulate; lower lip with inner lobes; inner plate of maxilla 1 setose only terminally, of maxilla 2 generally terminally setose; gnathopods normal; uropod 3 not exceeding uropod 1, rami short, broad, lanceolate, outer 1-articulate; telson deeply cleft; metasome and urosome dorsally carinate, no spines;

Parelasmopus siamensis Wongkamhaeng, Coleman & Pholpunthin, 2013

Parelasmopus siamensis Wongkamhaeng et.al. 2013b, 525-532, figs. 19-24.

Description: See Annex V

Local Distribution : Chonburi

GENUS *Rotomelita* Barnard, 1977

Diagnosis: Accessory flagellum 3+ articulate; mandibular palp thin, weak, articles linear, article 3 bearing few apical setae only; lower lip with small but fully discrete inner lobes; inner plate of maxilla 1 with only terminal setae; inner plate of maxilla 2 lacking medial setae; maxillipedal palp 4-articulate, article 4 unguiform; gnathopods ordinary, gnathopod 2 larger than gnathopod 1, lacking fuzz on article 5; uropod 3 greatly overreaching uropod 1, inner ramus small and scale-like, outer ramus immensely elongate, bearing short article 2; telson short, cleft, lobes very broad and apically truncate; urosomite 1 bearing 1 subdorsal spine on each side, otherwise pleonites dorsally smooth; anterior coxae (1–4) longer than posterior coxae (5–7); some gills pediculate.

Rotomelita longipropoda Wongkamhaeng, Coleman & Pholpunthin, 2013

Rotomelita longipropoda Wongkamhaeng, Coleman & Pholpunthin, 2013, 24-32, figs 7-11.

Description: See Annex IV

Local Distribution : Surat Thani

FAMILY Photidae Boeck, 1871

Diagnosis: Head lateral cephalic lobe weakly extended or strongly extended, eye, if present, situated proximal to lobe or completely or partially enclosed in extended

lobe; anteroventral margin moderately to strongly recessed and moderately excavate. Mandible palp article 3 asymmetrical, distally rounded, setae extending along most of posterodistal margin, or subsymmetrical with setae mostly distal. Gnathopod 2 in male larger than gnathopod 1, merus not enlarged. Pereopods 5–7 not subchelate. Pereopod 7 slightly longer than pereopod 6. Urosomites not coalesced. Uropod 3 peduncle short, with sides expanded, or long, parallel-sided or narrowing distally. Telson without hooks or denticles.

GENUS *Ampelisciphotis* Pirlot, 1938

Diagnosis: Lateral cephalic lobes and article 6 of pereopods 1-2 elongate {combining character); accessory flagellum absent; article 3 of antenna 1 equal to or slightly longer than article 1; gnathopods subchelate; uropod 3 uniramous, ramus shorter than peduncle.

Ampelisciphotis tridens Pirlot, 1938

Ampelisciphotis tridens Pirlot, 1938; Bussarawich, 1984, 4-5.

Material examined: 3 ♂,2 ♀,Paklok bay, 08^{o} 01’32’’N 98^{o} 25’45’’E, 1 m. seagrass bed, Wongkamhaeng, K. 12-07-2009. 4 ♀,07^{o}22'60"N 99^{o}19'60"E , 1.5 m. seagrass bed, Vongpanich, V. 17-07-2008.

Local Distribution : Phuket, Trang

Geographic Distribution: Indonesia Archipelago, Thailand

Remarks: The amphipod resamble to *Ampelisciphotis tridens* from Indonesia Archipelago in having less setose distal margin of coxae 1-5, coxa 3 having same width as coxa 4, basis of pereopod 5 extremely expanded (as long as broad)

GENUS *Gammaropsis* Liljeborg, 1855

Gammaropsis atlantica Stebbing, 1888

(Figure 68)

Gammaropsis atlantica	Stebbing, 1888: 1101, pl, 114. Ruffo, 1969: 43, fig. 13. Barnard, 1970: 174, figs 111-113. Ledoyer, 1972: 239, pls 51-53. Griffiths, 1973: 228.Ledoyer, 1979: 33, figs 13-15. Bussarawich, et al, 1984: 4. Myers, 1985: 80, fig. 60. Ortiz and Lalana, 1997: 107.
Gammaropsis zeylanicus	Walker, 1904: 282, pl.6 fig. 41. Walker, 1909: 339

Gammaropsis gardineri Walker, 1905: 929, pl. 88 figs 11-14, 16-17.

Material examined: 3 ♂,22 ♀,Paklok bay, 08° 01’32’’N 98° 25’45’’E, 1 m. seagrass bed, Wongkamhaeng, K. 12-07-2009. 3 ♂,11 ♀,Pakmeng,07°22'60"N 99°19'60"E , 1.5 m. seagrass bed, Vongpanich, V. 17-07-2008.

Local Distribution : Phuket, Trang

Geographic distribution: Circumtropical

Remarks: The amphipod collected from this study fit with the tropical members (afra-atlantica group) by having an article 2 on the outer ramus of uropod 3 and the inner plate of maxilla 1 has at least 3, often 5+ setae lining the medial margin (Barnard 1970). It shows obvious derivation from the cold temperate Pacific species including the North Atlantic Ocean where it lacks article 2 on the outer ramus of uropod 3. This species also is clearly distinct from all other species by showing the bottle-shaped eyes.

GENUS *Photis* Krøyer, 1842

Photis longicaudata (Bate & Westwood, 1863)

Material examined: 3 ♂,22 ♀,Paklok bay, 08° 01’32’’N 98° 25’45’’E, 1 m. seagrass bed, Wongkamhaeng, K. 12-07-2009. 3 ♂,11 ♀,Pakmeng,07°22'60"N 99°19'60"E , 1.5 m. seagrass bed, Vongpanich, V. 17-07-2008.

Local distribution : Phuket, Trang

Geographic distribution: The specimen closely agrees with the figures given by Nayar (1959).The differences being insignificant. The antennae are slightly shorter, the flagella with less articles.

FAMILY Podoceridae Leach, 1814

Diagnosis.—Head rectangular. Mandibular molar present. Pereopods 314 fully developed. Urosomites 112 not coalesced.

GENUS *Podocerus* Leach, 1814

Diagnosis: Accessory flagellum present; antenna 1 shorter than 2; pleon with six segments and three pairs of uropods; uropod 2 with two rami; uropod 3 lacking rami.

Podocerus andamaniensis (Giles, 1890)

Podocerus andamaniensis (Giles, 1890) Wongkamhaeng et.al. 2010, 17-19, figs 16-17.

Description: See Annex I

Local Distribution : Surat Thani, Nakhon Si Thammarat

Geographic Distribution: Indian Ocean, Thailand

FAMILY Pontogeneiidae Stebbing, 1906

GENUS *Tethygeneia* Barnard, 1972

Tethygeneia khanomensis Wongkamhaeng,Pholpunthin & Darakrai,2010

Tethygeneia khanomensis Wongkamhaeng et.al. 2010, 3-5, figs 2-4.

Description: See Annex I

Local Distribution : Surat Thani, Nakhon Si Thammarat

FAMILY Synopiidae Dana, 1853

Diagnosis: with galeate head or with plough-shaped protuberance on forehead; accessory flagellum of antenna 1 large, multiarticulate; upper lip fleshy, ventrally truncate, rounded, usually with small marginal hairs; mandibles with 3- articulate palp (3 exceptions), molar present and never amalgamated with spine row, latter often vestigial; lower lip with well-developed mandibular lobes, incisor lobes present and separate from each other; maxillae 1-2 well developed , variable, palp of maxilla l 2-articulated, linear, outer plates and palp of maxilligcd well developed, palp usually 4-articulate, rarely 3; coxa 1 and 2 and unhidden by posterior coxae, except coxa 1 rarely narrowed; gnathopod 1 present; gnathopod 2 not enlarged; pereopod 3-5 basic, pereopod 7 not grossly longer than 6 in contrast to Oedicerotidae; uropods 1-3 prescnl, all strongly biramous; telson present.

GENUS *Tiron* Liljeborg, 1865

Tiron sp.A

(Figs. 43—45)

Material examined. 1 male (5.5 mm), THAILAND, Racha Island, Phuket Province, Andaman Sea, (7.60488"N 98.37660"E), coral reef; hand collected; Wongkamhaeng, 1 October, 2010, PSUZC-CR-0190 2 male and 1 female, PSUZC-CR-0191

Description:

Head forming a curve terminating in a short, acute rostrum; eyes raniform, large. Upper lip slightly excavated, pubescent. Mandibular molar trituative, palp 2-articulated with 2 terminal plumose setae. Lower lip, inner lobe small, outer lobe well developed, setose. Maxilla **1;** inner lobes short with median and terminal plumose setae; outer lobe large with 7 terminal serrated tooth; palp large, 2-articulate with 8 terminal robust setae and lateral marginal setae.. Maxilla 2: inner plate and outer plate subqual, with terminal and marginal setae. Antennae 1 and 2 subequal, flagellum of antenna **1** longer than peduncle; accessory flagellum 2-articulate

Gnathopod 1, coxa triangular; basis slender with 2 posteromarginal setae; ischium short, subequal to merus; carpus and propodus posteriorly setose; carpus longer than propodus; propodus suboval, without clear palm; dactylus curved. Gnathopod 2 simple; coxa subrectangular; basis slender; ischium short, shorter than merus; carpus and propodus posterior margin with long plumose setae; dactylus short, curved. Pereopod 3**,** coxa large, subtrapezoid; basis slender with 2 distal setae on posterior side; ischium short; merus subtriangular, anteriorly exposed, longer than carpus; carpus and propodus with long plumose setae on posterior side, dactylus short, tapering. Pereopod 4 subrectangular; basis slender; ischium short; merus subtriangular, anteriorly exposed, longer than carpus; carpus and propodus with long plumose setae on posterior side, dactylus short, tapering. Pereopod 5-7 subequal, basis posteriorly exposed; ischium-propodus with marginal robust setae.

Uropod 1 and 2 similar, peduncle subequal to rami; rami with short marginal setae and 3 terminal robust setae. Uropod 3, peduncle shorter than rami; both rami foliose with long marginal setae. Telson entire, longer than broad with 4 terminal setae.

Remarks: *Tiron* sp. is very similar to *Tiron spiniferum* (Stimpson, 1853) from Sea of Japan inner plate of maxilla 1 fully setose; inner plate of maxilla 2 with medial submarginal row of setae; outer plate of maxilliped normal; dactyls of pereopods 1-5 ordinary; basis of pereopods 5-7 lacking special row of setae, article 2 of pereopod 7 smooth posteriorly, rami of uropod 3 apically pointed; telson lacking large spines or setae dorsally. But the *Tiron* sp. can be distinguished from *T. spiniferum* by pleonite 1-3 dorsally smooth while those *T. spiniferum* is crenulate.

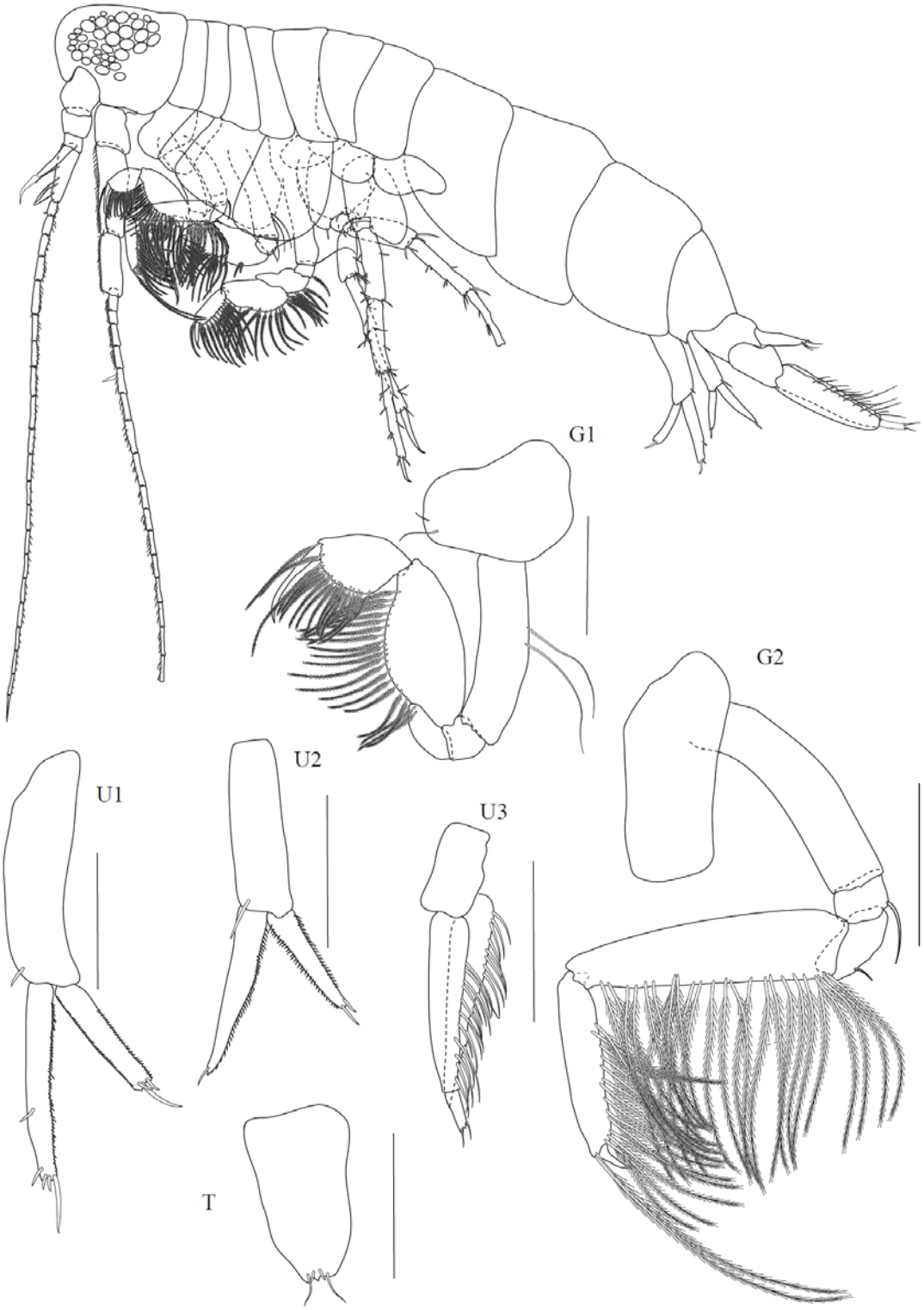


Figure 42 *Tiron* sp. A, ♂ (PSUZC-CR-0190), 5.5 mm. Racha Island, Andaman Sea.

All scale bar present 0.5 mm

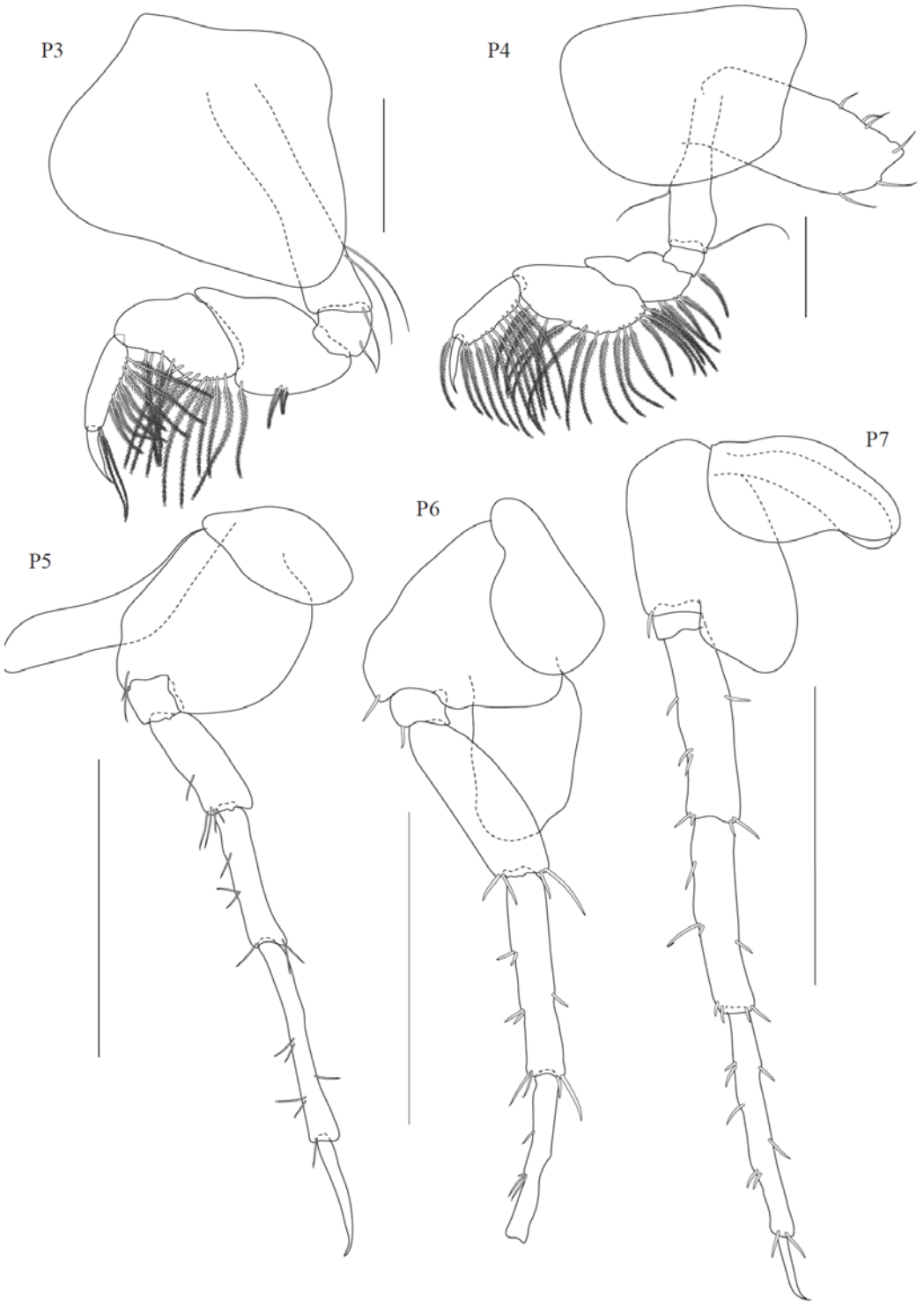


Figure 43 *Tiron* sp. A, ♂ , (PSUZC-CR-0190), 5.5 mm. Racha Island, Andaman **S**ea.

All scale bar present 0.5 mm

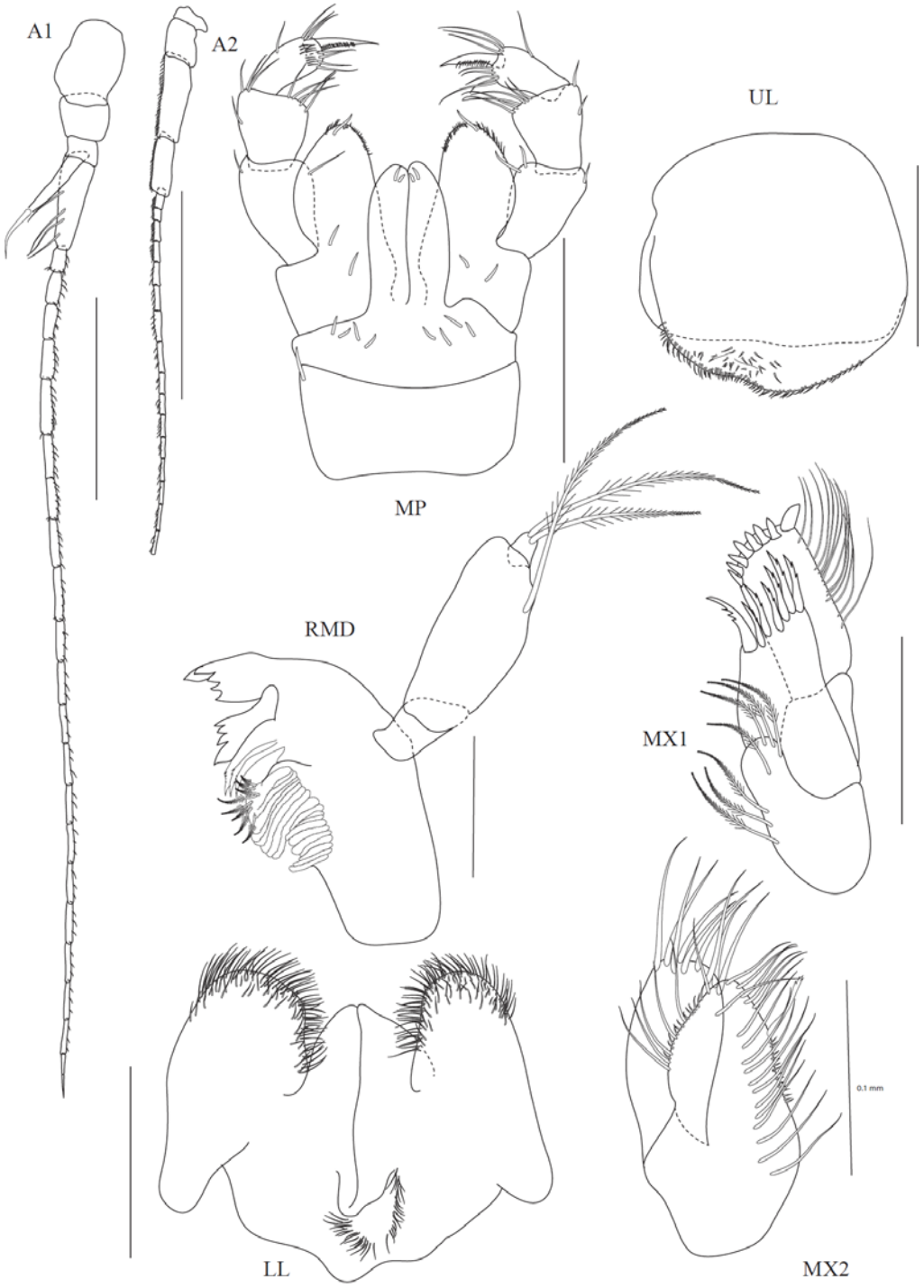


Figure 44 *Tiron* sp. A, ♂ , (PSUZC-CR-0190), 5.5 mm. Racha Island, Andaman Sea.

All scale bar present 0.2 mm

FAMILY Urothoidae Bousfield, 1978

Diagnosis: Molar process moderately to strongly developed. Gnathopods weak, subequal, variously subchelate. Pereopod 5 distinctly 7-segmented. Pereopods 6 and 7 subsimilar in form and size, strongly fossorial. Pereopod 7 not of phoxocephalid form, basis not shield-like. Abdomen not sharply narrowing or fl exed at urosome. Uropod 3 rami subequal; long and slender. Telson deeply cleft.

GENUS *Urothoe* Dana, 1852

Diagnosis: Antenna 1 not geniculate; mandibular palp not on basal process, small, article 3 linear (Phoxocephalopsis) , molar large, poorly ridged; outer plates of maxilla 2 not enlarged; maxillipedal palp 4-articulate; coxae 1-2 of normal size, rounded-quadrate below; gnathopods subchelate, article 5 of gnathopod 1 longer than article 6 ; pereopods dactylate; uropod 3 of medium length, inner ramus half as long as outer; telson deeply cleft

Urothoe spinidigitus Walker, 1904

Urothoe spinidigitus Walker,1904; Bussarawich, 1984, 4-5.

Material examined: 2 ♂,13 ♀, Chalong Bay, 7°48'6"N 98°21'1"E, 5 m. seagrass bed, Wongkamhaeng, K. 08-10-2006.

Local Distribution : Phuket

Geographic distribution: Indian Ocean, Andaman Sea

Remarks: The present specimens similar to the work of Walker (1904).

3.3 Gammarid amphipod habitats

Amphipod collected from this study are from variety of coastal habitats including algae bed, coral reefs, estuary, salt pan, seagrass bed and soft bottom. Coral reef contains highest species number (9 species) following by seagrass bed (8 species), algae bed (7 species), estuary (6 species), soft bottom (2 species) and salt pan (1 species) respectively. (Table 6)

Table 6 Gammarid amphipods species in Thai Water in different habitats

Family/Subfamily	algal bed	coral reef	estuary	salt pan	seagrass bed	soft bottom
Ampeliscidae	-	2	-	-	-	-
Amphilochidae	-	1	-	-	-	-
Ampithoidae	-	-	-	-	3	-
Aoridae	2	-	2	1	-	1
Dexaminidae	-	1	-	-	-	-
Kamakidae	-	-	1	-	-	-
Liljeborgiidae	-	-	-	-	1	-
Lysianassidae	-	-	-	-	-	1
Maeridae	1	-	-	-	1	-
Melitidae	1	1	1	-	1	-
Photidae	-	2	-	-	1	-
Podoceridae	1	-	-	-	-	-
Pontogeneiidae	1	-	-	-	-	-
Synopiidae	-	1	-	-	-	-
Urothoidae	-	1	-	-	-	-
Corophiidae	-	-	1	-	-	-
Hyalinae	1	-	-	-	-	-
Protomedeiinae	-	-	1	-	1	-
Total	**7**	**9**	**6**	**1**	**8**	**2**

3.4 Gammarid amphipod ecology

Barnard (1976) divided tropical amphipods into 8 categories by their ecology which integrated abode and feeding ecology. It's including nestling: nestle in anastomoses, and crevices formed by algal interstices; domicoly: tube-forming; inquilines: parasitic and commensal with other organisms; neritic: which are primarily benthonic but enter the nekton at night or possibly during reproductive phases and strand or semi-terrestrial group. This study contains only 4 groups and the strand

group is not included. The domicolous group are the most diverse followed by nestler, neritic and inquilinous. (Table 7)

Table 7 Gammarid amphipod ecological group

Taxa	neritic	domilolous	inquilinous	nestler
FAMILY Ampeliscidae				
Ampelicsa brevicornis	1			
Ampelisca cyclops	1			
FAMILY Amphilochidae				
Amphilochus justi			1	
FAMILY Ampithoidae				
Ampithoe africana		1		
Ampithoe ramondi		1		
Cymadusa pilipes		1		
FAMILY Aoridae				
Bemlos quadrimanus		1		
Grandidierella gilesi		1		
Grandidierella gravipes		1		
Grandidierella halophilus		1		
Grandidierella phetraensis		1		
Grandidierella sp. A		1		
FAMILY Dexaminidae				
Paradexamine latifolia			1	
FAMILY Kamakidae				
Kamaka songkhlaensis				1
FAMILY Liljeborgiidae				
Listriella longipalma			1	
FAMILY Lysianassidae				
Waldeckia elephas	1			
FAMILY Maeridae				
Ceradocus andamanensis				1
Maeropsis paphavasitae				1
FAMILY Melitidae				
Elasmopus puteus				1
Melita latiflagella				1

Table 7 Gammarid amphipod and their ecological group

Taxa	neritic	domilolous	inquilinous	nestler
Parelasmopus siamensis				1
Rotomelita longipropoda				1
FAMILY Photidae				
Ampelisciphotis tridens		1		
Gammaropsis atlantica		1		
Photis longicaudata		1		
FAMILY Podoceridae				
Podocerus andamaniensis		1		
FAMILY Pontogeneiidae				
Tethygeneia khanomensis	1			
FAMILY Synopiidae				
Tiron sp.A.		1		
FAMILY Urothoidae				
Urothoe spinidigitus				1
FAMILY Corophiidae				
Chelicorophium sp.A		1		
Cheiriphotis megacheles		1		
Cheiriphotis trifurcata		1		
FAMILY Hyalidae				
Parahyale aqulina			1	
Total	**4**	**17**	**4**	**8**

CHAPTER 4

DISCUSSION

4.1 Taxonomic study of gammarid amphipod in Thai Waters

As a result of 33 species from present study, 63 species of marine gammaridean Amphipoda are known to occur in Thai Waters. The 1ist of these species and their current status are presented in Table 8. Of 63 species only 7 species occur in both Gulf of Thailand and Andaman Sea while 37 species were reported only in Andaman Sea and 21 species were recorded in Gulf of Thailand (Table 8).

Table 8 Gammarid Amphipod species in Thai Waters

	Family/Subfamily	Taxa	GT	AS	References
1	Ampeliscidae	*Ampelisca brevicornis*	✓	✓	current study and Bussarawich, 1984
2		*Ampelisca cyclops*	✓	✓	current study and Bussarawich, 1984
3		*Ampelisca misakiensis*		✓	Bussarawish, 1984
4		*Ampelisca zamboangae*		✓	Bussarawish, 1984
5	Amphilochidae	*Amphilochus justi*		✓	current study
6		*Ampithoe africana*	✓	✓	Wongkamhaeng, 2010
7		*Ampithoe ramondi*	✓	✓	Wongkamhaeng, 2010
8		*Cymadusa pilipes*	✓	✓	Wongkamhaeng, 2010
9		*Cymadusa aungtonyae*		✓	Peart, 2002
10		*Cymadusa chalongana*		✓	Peart, 2002
11		*Cymadusa panwa*		✓	Peart, 2002
12		*Ampithoe rachanoi*		✓	Peart, 2002
13	Amaryllididae	*Vijaya tenuipes*		✓	Lowry&Stoddard, 2002
14	Aoridae	*Bemlos quadrimanus*		✓	Wongkamhaeng et.al., 2013b
15		*Bemlos delicatissima*		✓	Myers, 2002
16		*Grandidierella gilesi*	✓	✓	current study and Bussarawish, 1984

Table 7 Gammarid Amphipod species in Thai Waters (continued)

	Family/Subfamily	Taxa	GT	AS	References
17		*Grandidierella gravipes*	✓		current study
18		*Grandidierella halophilus*	✓		Wongkamhaeng et.al., 2012b
19		*Grandidierella phetraensis*		✓	Wongkamhaeng et.al, 2013b
20		*Grandidierella* sp.	✓		current study
21		*Protolembos tegulapodos*		✓	Myers, 2002
22	Corophiinae	*Chelicorophium* sp.	✓		current study
23		*Leptocheirus dufresni*		✓	Bussarawish, 1984
24	Protomedeiinae	*Cheiriphotis megacheles*	✓		current study and Bussarawish, 1984
25		*Cheiriphotis trifurcata*	✓		Wongkamhaeng et.al., 2012a
26	Dexamininae	*Paradexamine latifolia*		✓	current study
27	Hyalinae	*Parahyale aqulina*		✓	Wongkamhaeng et.al., 2010
28	Eriopisidae	*Eriopisella sechellensis*			Bussarawish, 1984
29		*Victoriopisa chilkaensis*			Angsupanich, 2005 and Bussarawish, 1984
30	Ischyroceridae	*Cerapus chaomai*		✓	Lowry & Berents, 2002
31		*Cerapus yuyatalay*		✓	Lowry & Berents, 2002
32	Liljeborgiidae	*Listriella longipalma*	✓		current study
33		*Listriella janisae*		✓	Bussarawish, 1984
34		*Listriella serra*		✓	Bussarawish, 1984
35	Kamakinae	*Kamaka appendiculata*	✓		Ariyama et al. 2010
36		*Kamaka songkhlaensis*			Ariyama et al. 2010
37	Lysianassidae	*Waldeckia elephas*		✓	current study
38		*Lepidepecreum andamanensis*			Lowry&Stoddard, 2002
39		*Lepidepecreum somchaii*			Lowry&Stoddard, 2002
40	Leucothoidae	*Leucothoe furina*	✓	✓	Angsupanich, 2006 and Bussarawish, 1984
41	Maeridae Krapp-Schickel, 2008	*Ceradocus andamanensis*		✓	Wongkamhaeng et.al, 2013b

Table 7 Gammarid Amphipod species in Thai Waters (continued)

	Family/Subfamily	Taxa	GT	AN	References
42		*Maeropsis paphavasita*	✓		Wognkamhaeng et.al., 2013a
43	Megaluropidae	*Megaluropus agilis*		✓	Bussarawish, 1984
44	Melitidae	*Elasmopus puteus*	✓		Wongkamhaeng et.al., 2010
45		*Melita latiflagella*	✓		current study
46		*Parelasmopus siamensis*	✓		Wongkamhaeng et.al, 2013b
47		*Rotomelita longipropoda*	✓		Wongkamhaeng et.al, 2013a
48	Neomegamphopidae	*Konatopus storeyae*		✓	Myers, 2002
49	Nuuanuidae	*Nuuanu kata*		✓	Nuuanu kata Lowry & Watson, 2002
50	Oedicerotidae	*Perioculodes longimanus*		✓	Bussarawish, 1984
51	Phoxocephalidae	*Mandibulophoxus uncirostratus*		✓	Bussarawish, 1984
52		*Paraphoxus rostrata*		✓	Bussarawish, 1984
53	Platyischnopidae	*Indischnopus herdmani*		✓	Bussarawish, 1984
54	Photidae	*Ampelisciphotis tridens*		✓	current study
55		*Gammaropsis atlantica*		✓	current study and Bussarawish, 1984
56		*Latigammaropsis afra*		✓	Bussarawish, 1984
57		*Photis longicaudata*		✓	
58	Podoceridae	*Podocerus andamaniensis*		✓	Wongkamhaeng et.al., 2010
59	Pontogeneiidae	*Tethygeneia khanomensis*	✓		Wongkamhaeng et.al., 2010
60	Synopiidae	*Tiron* sp.		✓	current study
61	Unciolidae	*Wombalano rachayai*		✓	Myers, 2002
62	Urothoidae	*Urothoe spinidigitus*		✓	current study
63	Urothoidae	*Urothoe platydactyla*		✓	Bussarawish, 1984

4.2 Gammarid amphipod habitats

In this study, seagrassbed, coral reef and algal bed contain similar number of amphipod species. Members of family Amphithoidae which are mainly herbivore (Barnard, 1969) are specific to seagrass bed. The members of inquilinous group including Amphilochidae, Dexaminidae and Liljeborgiidae occurred only coral reef which variety of amphipod host i.e. sponge, tunicate, sea anemone are settled. The Lysianassidae which is scarvenger was found only in soft bottom. They mainly feed on fish collected from gill net and normally exist in deeper area. (Lowry & Stoddart, 2009).

Amphipods not only represent their distribution by their feeding ecology but also by their biology. Some amphipod family show which can tolerate to salinity change existed only in estuary such as Aoridae, Kamakidae, Corophiidae and Melitidae, Protonedeiinae (Barnard & Karaman, 1991). The Aoridae occupied widest range of habitats including algal bed, estuaty, salt pan and soft bottom. The genus *Grandidierella* which is a major species in family Aoridae in this study showed the widest tolerant to salinity change. Many works reported that *Grandidierella* species can occur from range of 0 ppt (Myers, 1970, 1981, 1998; Ren, 2006; Bochert & Zettler, 2010; Azman & Othman, 2012) to hypersaline condition, more than 40 ppt, (two existing records of *Grandidierella*; *G. propodentata* Moore, 1986 and *G. exilis* Myers, 1981). From those work, *G. halophilus* was found in 80 ppt which is the highest salinity from previous record.

4.3 Phylogenetic of gammarid amphipod in Thai-Water

Many clades are based on autapomorphies. Strongly supported clades are the *Parahyale aquilina*, *Rotomelita longipropada, Waldeckia elephas, Urothoe spinidigitus, Maereopsis paphavasitae, Parelasmopus siamensis*, *Elasmopus puteus, Cymadusa pilipes* and *Grandidierella* species.

Comparing this tree with the present gammarid amphipod classification, the Ampeliscidae formed a monophyletic group with Urothoidae, comparing with the study by Kim and Kim (1989), told that the member of Corophiidae group formed a monophyletic group with oedicerotid, dexaminid, and ampeliscid amphipods. In their

strict consensus tree, this clade was defined by coalescing of the urosomites but the coalesced urosomites is a homoplastic character state that has been independently derived several times within the corophiidean amphipods and a number of times outside the group.

The previous study of Myers&Lowry (2003) have clarified the phylogenetic position of the corophiidean taxa ad group the members of Ampithoidae, Aoridae and Corophiidae within the same corophiidan clade, which is congruent with this study which these three families formed a monophyletic group and the clade was defined by glands in the basis of pereopods 3–4, slender and robust setae on the rami of uropod 3 and a dorsoventrally telson.

The recent work of Lowry&Myers (2013) have establised suborder Senticaudata which incorporates 95 families formerly in Gammaridea which is composed of largely of freshwater taxa. The senticaudates are a monophyletic clade defined by the presence of robust setae on the apices of uropods 1–2. The Talitrida, Corophiida, Hazaiida, Bogidiellida and Gammarida are included into suborder Senticaudata. The Corophiida is a sister to Hazaiida while in this study member of Hazaiida (*Maeropsis paphavasitae, Parelasmopus siamensis, Ceradocus andamanesnsis, Melita latiflagella* and *Elasmopus puteus)* are included together in Corophiida. In the work of Lowry&Myers (2013) amphilochids, colomastigids and stenothoids that have the rami of uropods 1–2 ending acutely and no, or at most very simple are separated from senticaudates and the family Amphilochidae are outgroup same as this study.

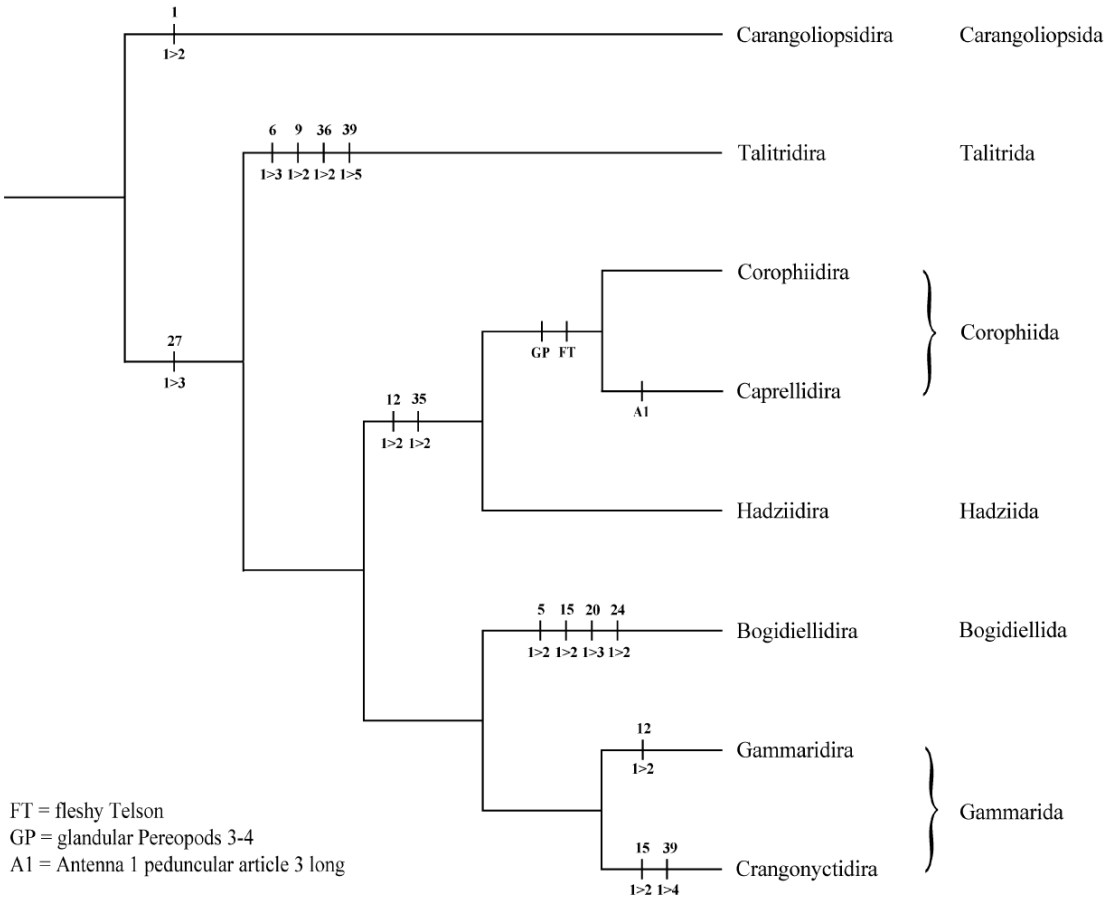


Figure 48 Cladogram of relationships of parvorders within the Senticaudata. (Lowry & Myers, 2013)

4.3 Evolutionary Biology of the Amphipods in Thai Waters

From the cladogram of relationships of amphipod in Thai Water, the inquilinous group, including *Amphilochus justi* are the most primitive, same as the work of Lowry &Myers (2013). Other amphipods which are included in this group are *Paradexamine latifolia* and *Listriella longipalma.* This group has mandible molar weakly developed and smooth or molar absent which modified (Fig 46-MD) for associated with other animals such as sea anemone and tunicate (Barnard, 1976)

The nestler clade is derived from the inquilinous group with fully developed mothparts, gnathopod, pereopod and urosome. This group occurs in various habitat and show the wide verity of feeding ecology. Their mandible are modified with are strong palp, large grinding area and teeth incisor and lacinia

mobilis. This work similar to those of Lowry & Myers (2013) which put the amphipod into Haziida group and analyzed this group into the modern one. They suggest that the hadziids are a clade of freshwater amphipods with a limited global distribution. Morphologically they are scarcely separable from the Maeridae that are a worldwide marine group. The main distingushing characters of the Hadziidae are the double row of robust setae along the palm of gnathopod 1 and 2 that are not present in maerids and the absence of a posteroventral lobe on coxa 4, present in maerids.

In the domiculous clade, corophiidean which characterized by a deep, dorsoventrally thickness telson or reduced uropod 3 is a major group. These characters evolved for tube dwelling. In Myers&Lowry (2003) corophiidean were separated into two group; the Corophiidea and Caprelloidea which show different feeding ecology and also have different pereopod but in present work only three members of Caprelloidea are *Podocerus andamanensis, Kamaka songkhlaensis*, *Ampelisciphotis tridens* and *Gammaropsis atlantica* which are also group together in the same clade and derived from the *Corophium* sp. A.

The problematic clade are the *Mareopsis paphavasitae* clade and the *Elasmopus puteus* clade which are included into the corophoidean. Actually members from both clade are Melitidae which classified as nestler group but they contained some characters of the domicolous or tube dweller group i.e. the uropod 3 modified or reduced and show the sexual dimorphism. During the evolutionary process, it possibly that character state developed by an ancestor may be ‘switched off’ by selection pressure but reappear later in a distant descendant. This case sometime it hard to decided between the homoplasies or homologus character state without other evidence i.e. fossil, behavior or biogeography. This has implications for cladistic analysis. When the same character state appears in widely separated parts of the tree, the state has previously been considered convergent (homoplasious) but in fact it may be homologous and make same character state cannot unite one group of taxa in one part of the tree as well as another group of taxa in another part of the same tree. An ancestral character state may reappear in two or more distantly related taxa and then be passed on to descendants thus forming independent clades exhibiting the same character state. In this study, despite a large amount of field effort, the results of this

study may not show the full picture of gammarid amphipod in this region and there are still gap of knowledge of gammaridean amphipods in Thai Waters. Future studies have to be confined to deeper area and the baited trap method also need to collect the scavenger group. Another missing pieces need to fullfil are the amphipod associated with other animal i.e. mollusk, echinoderm, spiny lobster etc. In term of habitat, the semi-terrestrial and subterranean also need to be explored.

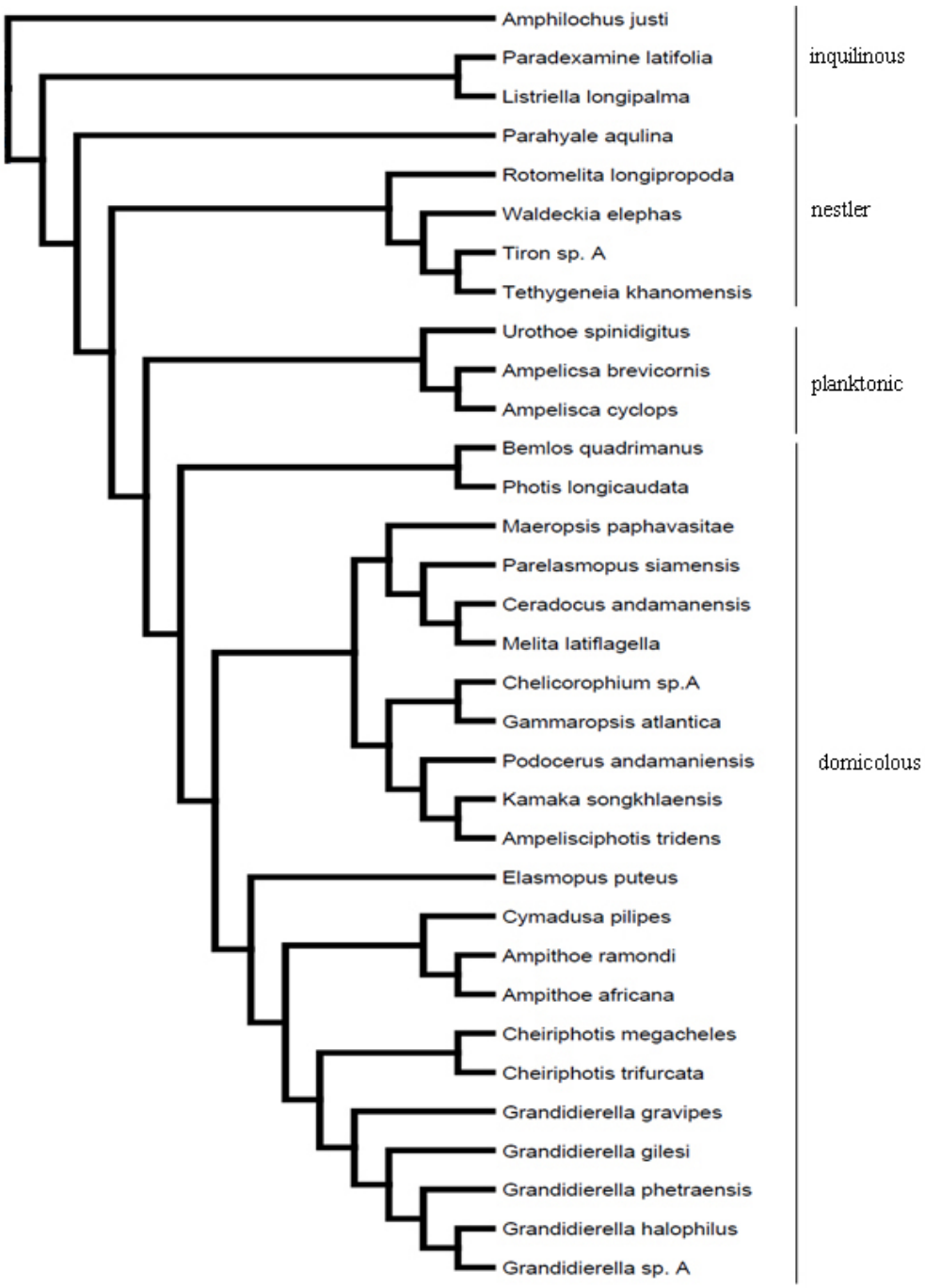


Figure 49 Cladogram of the relationships of ecological groups within the amphipod in Thai-Waters

CHAPTER 5

CONCLUSION

The finding of this study are as follows:

1. The 33 species in 17 families of marine gammaridean amphipod revealed Of these, 8 species were new to science and 8 species were new record to Thai-Waters and 3 species are unidentified. The present species composition of amphipods in Thai Water are 63 species which 37 species are belonged to Andaman Sea and 21 species are in Gulf of Thailand. From those, 7 species are found in both Gulf of Thailad and Andaman Sea

3. Four ecological forms i.e neritic, nestler, domicolous and inquinous are found in Thai Waters.

4. Cladistic methods were used to examine phylogenetic relationships among the genera of marine gammaridean Amphipoda. The phylogeny of the marine gammaridean Amphipoda in Thai Water was created. In this phylogeny, three monophyletic groups i.e. neritic, nestler, and inquilinous. The domicolous. group is polyphyletic. The inquilinous group is the most primitive

References

Angsupanich, S. & Kuwabara, R. 1995. Macrobenthic fauna in Thale Sap Songkla, a brackish lake in southern Thailand. Lakes and Reservoirs: Research and Management, 1: 115–125.

Angsupanich, S. , Siripech A. and Charoenpornthip, M. 2005. Macrobenthic fauna community in the Middle Songkhla Lake, Southern Thailand. Songklanakarin Journal of Science and Technology, 27: 365–390.(in Thai)

Appadoo C. and Myers, A. A. 2003. The genus *Elasmopus* (Crustacea: Amphipoda: Melitidae) from Mauritius (Indian Ocean) with description of five new species. Records of the Australian Museum. 55:61–84.

Ariyama, H., Angsupanich S. and Rodcharoen, E. 2010. Two new species of the genus Kamaka (Crustace: Amphipoda:Kamakidae) from the Songkla Lagoon, southern Thailand.Zootaxa. 2404: 55–68.

Asari, K. P. & A. A. Myers, 1982. Taxonomic studies on the genus *Grandidierella* Coutière (Crustacea, Amphipoda) IV. Indian species. Bulletin du Museum National d'Histoire Naturelle, Paris, 4A: 237–256.

Audouin, V. 1826. Explication sommaire des planches de crustaces de I'Egypte et de la Syrie, publiees par JulesCesar Savigny, member de l'Institut; offrant un expose des caracteres naturels des denres, avec la distinction des expeces. Description de I'Egypte, Histoire Naturella. 1:77—98.

Azman, B. A. R. 2009. Cyproideidae (PDF). In J. K. Lowry & A. A. Myers. "Benthic Amphipoda (Crustacea: Peracarida) of the Great Barrier Reef, Australia". Zootaxa 2260: 380–392.

Barne, D. R. 1987. Invertebrate Zoology. Fifth Edition. Florida: Saunder College publishing.

Barnard, J. L. 1959. Liljeborgiid amphipods of southern California coastal bottoms, with a revision of the family.Pacific Naturalist 1(4): 12-28, 12 figs.

Barnard, J. L. 1962a. A new species of sand-burrowing marine Amphipoda from California. Bulletin of the Society California Academy of Science 61 (4):249-251.

Barnard. J. L. 1965. Marine Amphipoda of the family Ampithoidae from southern California. Proc. U. S. Nat. Mus. 118(3522): 1-46, figs.1-28.

Barnard, J. L. 1969. Family and Genera of Marine Gammaridean Amphipoda. City of Washington : Smithsonian Institution Press. 271: 1-535, 173 figs.

Barnard, J. L. 1970. Sublittoral Gammaridea (Amphipoda) of the Hawaiian Islands. Smithsonian Contributions to Zoology 13. 1-286, 180 figs.

Barnard, J. L. 1972. Gammaridean Amphrpoda of Australia, Part I. Smithsonsan Contrtbutions to Zoology 103: 1-333, 194 figs.

Barnard, J. L. 1977. The cavernicolous fauna of Hawaiian lava tubes 9. Amphipoda (Crustacea) from brackish lava ponds on Hawaii and Maui. Pacific Insects 17: 267–299.

Barnard, J. L and G. S. Karaman. 1983. Australia as a major evolutionary center for Amphipoda (Crustacea). Memoirs of the Australian Museum. 18:45—61.

Barnard, J. L. and G. S. Karaman, 1991. The families and genera of marine Gammaridean Amphipoda (Except marine Gammaroids). Record of the Australian Museum. Supplement 13 (Part 1). Australia: Love computer Typesetting Pty Ltd.

Barnard K. H. 1916. The Amphipoda. Contribution to the crustacean fauna of South Africa. Annals of the South Africa Museum 15:105–304.

Barnard, K. H. 1925. Contributions to the crustacean fauna of South Africa.-No. 8. Further additions to the list of Amphipoda. Annals of the South African Museum 20: 319-380. p1.34.

Barnard, K. H. 1926. Contribution to the crustacean fauna of South Africa, V: the Amphipoda.Annals of the South African Museum 15(3): 105–302

Bamard, K. H. 1935. Report on some Amphipoda, Isopoda, and Tanaidacea in the collections of the Indian Museum.Records of the Indian Museum. 37: 279-319, 21 figs.

Barnard, K. H. 1937. Amphipoda. John Murray Expedition 1933-34. Scientific Reports, British Museum Natural History 4:133-201.

Barnard, K. H. 1940. Contributions to the crustacean faun; of South Africa. XII. Further additions to the Tanaidacea Isopoda, and Amphipoda, together with keys for the identification of the hitherto recorded marine and fresh water species. Annals of the South African Museum 32:381-543, 35 figs.

Barnes, D. R. 1987. Invertebrate Zoology. Fifth Edition. Florida: Saunder College publishing.

Bate, C. S. 1862. Catalogue of the Specimens of Amphipodous Crustacea in the Collection of the British Museum. London : British Museum 399 pp.

Bate, C. S. 1862, Catalogue of the Specimens of Amphipodous Crustacea in the Collection of the British Museum (London: British Museum (Natural History)), 399 pp.

Bate, C. S. and Westwood, J.O. 1868. A history of British sessile-eyed Crustacea. Vol. II. John Van Voorst, London, 536 pp.

Boeck, A. 1871. Bidrag til Californiens Amphipodefauna.brrrhandlinger i Videnskabs-Selskabet i Christiania 1871:32 51, 1 pl.

Bousfield, E. L. 1973. Shallow-water gammaridean Amphipoda of New England. Cornell University Press: Ithaca.

Bousfield, E. L., 1978. A revised classification and phylogeny of amphipod crustaceans. Transactions of the Royal Society of Canada 4: 343-390, 6 figs.

Bousfield, E. L. 1983, Updated phyletic classification and palaeohistory of the Amphipoda, in F. S. Schram (ed.), Crustacean Phylogeny, Vol. l of Crustacean Issues, F. S. Schram (ed.) (Rotterdam: A. A. Balkema), pp. 257-277.

Bousfield, E. L. and Hoover, P. M. 1997. The amphipod superfamily Corophioidea on the Pacific coast of North America. Part V. Family Corophiidae: Corophiinae, new subfamily. Systematics and distributional ecology. Amphipacifica, 2(3): 67-139.

Bulycheva, A. I. 1957 Morskle bloxi morej SSSR .i,sopredel'nyx vod (Amphipoda-Talitroidea). Akademila Nauk SSSR, Opredeliteli po Faune SSSR 65. 185 pp., 66 figs.

Bussarawich, S., Nateewathana, A. and Hylleberg, J. 1984. Distribution of Marine Benthic Amphipods Off Phuket Island, with Emphasis on Tin Mining and a Model of Species- Individual Relationships. Phuket Marine Biological Center Research Bulletin No. 32. 21 pp.

Bussarawich, S. 1985. Gammaridean Amphipoda from mangroves in southern Thailand. Fifth Seminar on Mangrove Ecosystems Phuket, Thailand pp. 1-17.

Chevreux, E. 1907. Diagnose d’amphipodes nouveaux recueillis dans les possessions francaises de L’Oceanie par M.L. Seurat, directeur du laboratoire de recherché biologiques de Rikitea. Bulletin du Museum d’Histoire Naturelle 1907:412—417.

Chevreux, E. 1919. Note preliminaire sur les amphipodes recueillis par les expeditions du Travailleur dt du Talisman (1880-1883). Bulletin du Museum d'Histoire Naturelle 1919: 574-580; 1920: 7-12.

Chevreux, E. & Fage, L. 1925. Faune de France. Amphipodes 9:1-488.

Chilton, C. 1921. Fauna of the Chilka Lake. Amphipoda. Memoirs of the Indian Museum. 5: 519–558.

Chilton, C. 1925. Zoological results of a tour in the Far East. The Amphipoda of Talé Sap. Memoirs of the Asiatic Society of Bengal, 6: 531–539.

Costa, A. 1853. Relazione sulla memoria del Dottor Achille Costa, di ricerche su' crostacei amfipodi del regno di Napoli. Rendiconto della Societa Reale Borbonica,Accademia delle Scienze, new series. 2: 167-178.

Costa, A. 1857. Ricerche sui crostacei amfipodi del regno di Napoli. Memorie della Reale Accademia de Scienze di Napoli 1: 165-235, 4 pls.

Coutiere, N. 1904. Sur un type nouveau d'amphipode Gmndidievella mahajalensis, provenant de Madagascar. Bulletin de la Association Philomatique 6: 166-1741, 18 figs.

Dana, J.D. 1849. Synopsis of the genera of Gammaracear. American Journal of Sciences and Arts, series 2, 8: 135—140.

Dahl, E. 1945. Menigratopsis svennilssoni n. gen. et. spec., a lysianassid amphipod from The Sound. Kungliga Fysiografiska Sallskapets i Lund Forhandlingar 15(24): 7 pp., 4 figs.

Della Valle, A. 1893. Gammarini del Golfo di Napoli. Fauna und Florades Golfes van Neapel. Monogr. 20: 1-948 , pls. 1-61.

Dixon, I. M. T. and Moore, P. G. 1997. A comparative study on the tubes and feeding behaviour of eight species corophioid Amphipoda and their bearing on phylogenetic relationships within the Corophioidea. Philosophy Transaction of Royal Society of London. 352: 93-112.

Englisch, U. and Koenemann, S. 2001. Phylogenetic analysis of subterranean amphipod crustaceans, using small subunit rDNA gene sequence. Organism, Diversity and Evolution. 1: 139-145.

Englisch, U., Coleman, C. O. and Wagele, J. W. 2003. First observations on the phylogeny of the families Gammaridae, Crangonyctidae, Melitidae, Niphargidae, Megaluropidae and Oedicerotidae (Amphipoda, Crustacea) using small subunit rDNA gene sequences. Journal of Natural History. 20:2461-2486.

Giles, G. M. 1890. Descriptions of seven additional new Indian amphipods. Natural history notes from H.M.'s Indian marine survey steamer 'Investigator', commander Alfred Carpenter, R.N., D.S.O., commanding.-No. 15. Journal of the Asiatic Society of Bengal 59: 63-74, pl. 2.

Giles, G. M. 1885. Natural history notes from H.M.'s Indian marine survey steamer 'Investigator', commander Alfred Carpenter, R.N. commanding [sic on comma]. No. 1. On the structure and habits of Cyrtophium calamicola, a new tubicolous amphipod from the Bay of Bengal. Journal of the Asiatic Society of Bengal. 54: 54-59, pl. 1.

Griffith, C. 1973. The Amphipoda of southern Africa. Part I. The Gammaridea and Caprell~dea of southerr1 Mocambique. Annals of the South African Museum 60: 265-306, figs 4-1 1.

Griffith, C. 1976. Guide to the benthic marine amphipods of southern Africa. The Rustica Press, 106 pp.

Jansen, T. and Dinesen. G. 2002. Anamixidae (Amphipoda: Crustacea) from the Andaman Sea, North-Eastern Indian Ocean. Phuket Marine Biological Center Special Publication. 23(1): 265–271.

Heller, C. 1866. Beitrage zur naheren kenntniss der Amphipoden des Adriatischen Meeres. Denkschr. Akad . Wiss. Wien 25(2) : 1-57.

Hirayama, A. and Kikuchi, T. 1980. A new gammaridean Amphipoda, Waldeckia elephas sp. nov., attaching to the net in Tomioka Bay, Amakusa, Japan. Publications liom the Amakusa Marine Biological Laboratory Kyushu Universlty. 5: 143-151, 5 figs

Hirayama, A. 1991. Marine Ampeliscidae (Crustacea: Amphipoda) from HongKong. Asian Marine Biology 8:77-93.

Imbach, M. C. 1967. Gammaridean Amphipoda from the South China Sea. Naga Report, 4: 39-167.

Kaim-Malka, R. A., 1969a. Contribution a I'etude de quelques especes du genre Ampelisca (Crustacea - Amphipoda) en Mediterranee. 11. Tethys 1: 927-975, 23 pls

Karaman, G. S., 197%. Ampelisca dalmatina, n.sp., one new ampeliscid from the Adriatic Sea (Fam. Ampeliscidae). Poljoprivreda i Sumarstvo, Titograd 21: 105-1 12, 4 figs.

Karaman, G. S. and J. L. Barnard, 1979. Classificatory revisions in gammaridean Amphipoda (Crustacea), part 1. Proceedings of the Biological Society of Washington 92: 106-165.

Kim, C. B and Kim, W. 1993. Phylogenetic relationships among gammaridean families and amphipod suborder. Journal of Natural History. 27:933—946.

Kim, H. S. , and Chang, C. Y. 1988. Marine gammaridean Amphipoda (Crustacea) of the family Ampithoidae from Korea . Korean Journal of Systematic Zoology, Special Issue. 2: 107-134.

Krapp-Schickel, G. 1974. Camill Hellers Sammlung adriatischer Amphipoden - 1866 und Heute. Annalen der Naturhistorisches Museum, Wien 78: 319-379, 28 pls.

Krapp-Schickel, T. 1978. Die gattung Amphithoe (Crustacea, Amphipoda) in Mittelmeer. Bijdrag tot de Dierkunde 48(1): 1-15.

Krapp-Schikel, T. 1993: Do algal-dwelling amphipods react to the ‘critical zones’ of a coastal slope. Journal of Natural History. 27: 883-900

Krapp-Schickel, T. 2008. What has happened wih the Maera-clade (Crustacea, Amphipoda) during the last decades? Bollettino del Museo Civico di Storia Naturale di Verona, Botanica Zoologia. 32: 3-32

Krapp-Schickel, T. and Koenemann, S. 2006: Cladistic analysis on the family Stenothoidae (Amphipoda, Crustacea). Contributions to Zoology 75 (3/4), 169-188.

Kröyer, H. 1842. Une nordiske Slaegter og Arter af Amfipodernes Orden, henhorende til Familien Gummarina. (Forelobigt Uddrag af et storre Arbejde). Naturhistorisk Tidsskrift 4: 141-166.

Latreille, P. A. 1802. Histoire naturelle, generale et particuliere des crustaces et des insectes. 3: xii + 468 pp.Paris: F. Dufart.

Latreille, P. A. 1806. Genera crustaceorum et insectorum secundum ordinem naturalen in familias disposita, iconibus exemplisque plurimis explicate I:xviii. 302 pp and emendanda. Parisiis et Argentorati; Amand Koenig.

Leach, W. E., 1814. Crustaceology. The Edinburgh Encyclopaedia 7: 402-403.

Liljeborg,V. 1856. Om Hafs-Crustaceer vid Kullaberg i Skane. Ofversigt af Kongliga Vetenskaps-Akademien Forhandlingar 12: 117-138.

Leach, W. E. 1814. Crustaceology. The Edinburgh Encyclopaedia. 7: 402-403.

Ledoyer, M. 1972. Presence de Perioculodes aequimanus (Kossmann) dans les eaux Mediterraneennes (region de Marseille) et comparison avec P. longimanus (Bate et Westwood) (Crustacea, Amphipoda). Bulletin du Museum National d'Histoire Naturelle, Paris, series 3e(63), Zoologie 49: 775-781, 3 figs.

Ledoyer, M. 1979. Les gammariens de la pente externe du grand recif de Tulear (Madagascar) (Crustacea Amphipoda). Memorie del Museo Civico di Storia Naturale di Verona series 2, Sezione Scienze della Vita, N. 2: 1-150, 91 figs.

Ledoyer, M. 1982. Crustaces amphipodes gammariens familles des Acanthonotozomatidae a Gammaridae. Faune de Madagascar 59(1): 1-598, 226 figs.

Ledoyer, M. 1984. Les gammariens (Crustacea, Amphipoda) des herbiers des phanerogames marines de Nouvelle Caledonie (region des Noumea). Memoires du Museum National D'Histoire Naturelle, new series, serie A, zoologie,129: 113 pp., 48 figs, 4 tables.

Lincoln, R. J., 1979. British Marine Amphipoda: Gammaridea, i-vvi + 658 pp., 280 figs, 3 pls. London: British Museum.

Liljeborg,V. 1855. Om Hafs-Crustaceer vid Kullaberg i Skane. Ofversigt af Kongliga Vetenskaps-Akademien Forhandlingar 12: 117-138.

Lowry, J. K., Berents P. B. and Springthorpe, R. T. 2000. Australian Amphipoda: Families. Version 1: 2 (October 2000) [Computer program]. Australia: Lowry, J. Available from: http://www.crustacea.net, December 25.

Lowry, J. K. and Myers, A. A. 2003. New amphipod crustaceans from the Indo-West Pacific (Amathillopsidae: Eusiridae: Iphimediidae). The Raffles Bulletin of Zoology 51, 219-256.

Lowry, J. K. and Myers, A. A. 2013. A Phylogeny and Classification of the Senticaudata subord. nov. (Crustacea: Amphipoda). Zootaxa. 80 pp.

Lowry, J. K. and Stoddart, H. 2002. First records of lysianassoid amphipods (Crustacea) from the Andaman Sea. Phuket Marine Biological Center, Special Publication 23, 165-183.

Lowry, J. K. and Berents, P. 2002. The genus *Cerapus* in the Andaman Sea (Crustacea, Amphipoda, Ischyroceridae). Phuket Marine Biological Center Special Publication 23, 189-196.

Lowry, J. K. and Watson, M. 2002. Revision of the gammarellid group, with a new species from the Andaman Sea (Crustacea, Amphipoda, Melitidae) . Phuket Marine Biological Center Special Publication 23, 197-212.

McGrouther, M. A. 1983. Comparison of Feeding Mechanisms in Two Intertidal Gammarideans, Hyale rupicola (Haswell) (Crustacea: Amphipoda). Australia Journal of Marine Freshwater Research. 34: 717-726.

Myers, A. A. 1975. Studies on the genus Lembos Bate. 11. Indo-Pacific species: *L. quadrimanus* Sivaprakasam, *L. punctatus* sp. nov.; *L. parahastatus* sp. nov., *L palmatus* (Ledoyer). Bollettino del Museo Civico di Storia Naturale, Verona 1: 359-395, figs 33-60.

Myers, A. A., 1981. Amphipod Crustacea I. Family Aorldae.Memoirs of the Hourglass Cruires 5(5). 1-73, 34.

Myer, A. A. 1985. Shallow-water, coral reef and mangrove Amphipoda (Gammaridea) of Fiji. Records of the Australian Museum, Suppl . 5:1-143.

Myers, A. A. 1988. The genera *Archaeobemlos* n.gen., *Bemlos* Shoemaker, *Protolembos* Myers and *Globosolembos* Myers (Amphipoda, Aoridae, Aorinae) from Australia. Records of the Australian Museum, 40, 265–332.

Myer, A. A. 2002. Marine amphipods of the family Aoridae and Neogamphopidae from Phuket, Thailand. Phuket Marine Biological Center Special Publication. 213-228.

Myer, A. A. and Lowry, J. K. 2003. A phylogeny and new classification of the Corophiidea Leach, 1814 (Amphipoda). Journal of crusracean Biology. 23(2): 443-485.

Nagata, K. 1959. Notes on five species of the amphipod genus Ampelisca from the stomach contents of the triglid fishes. Publication of the Seto Marine Biological Laboratory 7 (2):67-82.

Nagata, K. 1965. Studies on marine gammaridean amphipoda of the Seto Inland Sea. Publication of the Seto Marine Biological Laboratory, 13: 171-186.

Nayar, K. N., 1950. Description of a new species of amphipod of the genus *Corophium* from Adyar, Madras India. Journalof the Washington Academy of Sciences 40: 225-228, 1 fig.

Nayar, K. N. 1959. The Ainphipoda of the Madras Coast.Bulletin of the Madras Government Museum, Natural History Section 6(3): 59 pp., 16 pls.

Ortiz, M. and Lalana, R. 1997. Amphipoda. Travaux du Muséum National d'Histoire Naturelle Grigore Antipa. 38: 29-113.

Othman B. H. R and Morino H. 2006. *Listriella longipalma* sp. nov., a new amphipod species (Crustacea: Liljeborgiidae) from the Straits of Melaka, Malaysia. Zootaxa. 1305: 21-32.

Peart, R. A., 2002. New species of Ampithoidae (Crustacea, Amphipoda, Corophioidea) from the Andaman Sea. Phuket Marine Biological Center Special Publication 23, 229-252.

Pillai, N. K. 1957. Pelagic Crustacea of Travancore, 3: Amphipoda. Bulettin of Central Research Institute, University of Travancore 5:29-68.

Pirlot J. M. 1934. Les amphipodes de l'expedition du Siboga. Deuxieme partie. ... 11. - Les amphipodes de la mer profonde. 2 Hyperiopsidae Jassidae. Siboga-Expeditie 33d: 167-235, figs 61-100.

Pirlot, J. M. 1936. Les amphipods de I'expedition du Siboga. Deusieme pertue. II. – Les amphipodes de la mer profonde. III. Les amphipodes littoraux. I. Lysianassidae Gammaridae. Siboga-Expeditie, 33e:237–328.

Pirlot, J. M. 1938. Les amphipods de I'expedition du Siboga. Deuxieme pertue. II. – Les amphipodes de la mer profonde. III. Les amphipodes littoraux. I. Dexaminidae, Talitridae,Aoridae, Photidae, Ampithoidae, Corophiidae, Jassidae, Cheluridae, et. Podoceridae. Siboga expedition, Monographie. 338:329—359. Fig 147.

Platvoet, D. and Pinkster, S. 1992. Relation between habitat and antennular segmentation in Gammarus and Echinogammarus (Crustacea: Amphipoda). Journal of Zoology. 226(4): 335—641.

Rabindranath, P. 1972. Marine Gammaridea (Crustacea: Amphipoda) from the Indian Region. Family Ampithoidae. Marine Biology 14:161-178.

Rabindranath, P. 1975. Marine Gammaridea (Crustacea: Amphipoda) from the Indian region; Family-Ampeliscidae. Hydrobiologia, 46: 241-262.

Reid, D. M. 1951. Report on the Amphipoda (Gammaridea and Caprellidea) of the Coast of TropicalWest Africa. Atlantidae Report 2:190-291.

Rathke, H. 1837. Zur fauna der Krym. Ein Beitrag. Memoires Presentes a 1'Academie Imperiale des Sciences de Saint-Petersbourg 3: 291-454, 10 pls.

Ren, X. and Andres, H. 2006. Crustacea, Amphipoda, Gamaridea I. Fauna Sinica Invertebrata, 41: i–x, 1–558.

Ren, X. and Andres, H. 2006. Crustacea, Amphipoda, Gamaridea II. Fauna Sinica Invertebrata, 41: i–x, 1–651.

Reunsirikul, J., Angsupanich, S. and Phongdara, A. 2007. Abundance and diversity of amphipod crustaceans in the Upper Songkhla Lagoon. Songklanakarin Journal Science and Technology. 29 (5): 1225—1249.(in Thai)

Ruffo, S. 1969. Studi sui Crostacei anfipodi LXVII. Terzo Contributo alla conoscenza degli anfipodi del mar Rosso. Memorie del Museo Civico di Storia Naturale,Verona 17:1-77.

Salman S. D., Jabbar N. 1990. A new speicies of the Genus *Cheiriphotis* Walker, from the North West Arabian Gulf, with a redescription of C. megacheles (Giles) (Amphipoda, Isaeidae). Crustaceana 58(2): 214–226.

Sar, G. O., 1895, An Account of the Crustacea of Norway with Short Descriptions and Figures of all the Species, Vol. 1, Amphipoda (Christiania: Cammermeyer), pp. 1-711.

Savigny, C. 1816. Observations generales sur la bouche des arachnids, des crustaces et des entomostraces. Second Memorie. pp. 39—117, pls 1—8 of Memories sur les Animaux sans Vertevres. Premiere partue, Paris: Deterville.

Schellenberg, A. 1925. Amphipoda, Beiträge zur Kenntnis der Meeres fauna. Westafrikas, 3: 113–204.

Schellenberg, A. 1926. Die Gammariden der deutschen Sudpolar-Expedition 1901-1903. Deutsch Sudpolar-Expedition. 18:235—414. 68 figs.

Schellenberg, 1942. Krebstiere oder Crustacea IV: Flohkrebse oder Amphipoda. Die Tierwelt Deutschlands, Jena 40: 252 pp., 204 figs.

Shoemaker, C. R., 1925. The Amphipoda collected by the United States Fisheries Steamer 'Albatross' in 1911, chiefly in the Gulf of California. Bulletin of the American Museum of Natural History 52: 21-61, 26 figs.

Shoemaker, C. R. 1933. Two new genera and six new species of Amphipoda from Tortugas. Pap. Tortugas Lab., Carnegie Inst. Washington 28 :245-256, figs. 1-8.

Sivaprakasam, T. E., 1970. Amphipods of the genus *Lembos* Bate from the south-east coast of India. Journal of the Marine Biological Association of India 12: 81-92, 4 figs.

Stebbing, T. R. R., 1888. Report on the Amphipoda collected by H.M.S. Challenger during the years 1873-76. Report on the Scientific Results of the Voyage of H.M.S. Challenger During the Years 1873-1876, Zoology 29: xxiv + 1737 pp.,210 pls. London: Eyre and Spottiswoodie.

Stebbing, T. R. R., 1899. Revision of Amphipoda (continued Annals and Magazine of Natural History, series: 7(4): 201-211.

Stebbing, T. R. R. 1906. Amphipoda. I. Gammaridea. Das Tierreich, 21, 1-806.

Stebbing T. R. R. 1910. Crustacea. Part V. Amphipoda: Scientific results of the trawling expedition of HMSC “Thetis”. Memoirs of the Australian Museum. 4 (2): 564–658.

Stebbing T. R. R .1918. Some Crustacea of Natal. Annals of the Durban Museum 2: 47–75.

Steel, D. H. 1991. Is the oostegite structure of amphipods determined by their phylogeny or is it an adaptation to their environment?. In Walting, L. (eds) Proceedings of the VIIth International Colloquium on Amphipoda held in Walpole, Maine, USA, 14–16 September 1990. Developments in Hydrobiology. 70:27-34.

Stimpson, W., 1853. Synopsis of the marine Invertebrata of Grand Manan: or the region about the mouth of the Bay of Fundy, New Brunswick. Smithsonian Contributions to Knowledge 6: i-iv, 5-66, 3 pls.

Vader, W. 2004. New amphipod species and subspecies described in the year 1974—2004. Amphipod Newsletter 28.

Väinölä R., J. D. S. Witt, M. Grabowski, J. H. Bradbury, K. Jazdzewski and B. Sket. 2008. Global diversity of amphipods (Amphipoda; Crustacea) in freshwater. Hydrobiologia. 595:241—255.

Walker, A. O., 1904. Report on the Amphipoda collected by Professor Herdman, at Ceylon, in 1902. Report to the Government of Ceylon on the Pearl Oyster Fisheries of the Gulf of Manaar. Supplementary Report 17: 229-300, 8 pls.

Walker, A. O. 1905. Marine crustaceans. XVI. Amphipoda. Fauna and Geography of the Maldive and Laccadive Archipelagoes, 2, Supplement 1: 923-932, figs 140-142, pl.88.

Walker, A.O. 1909. Amphipoda Gammaridea from the Indian Ocean, British East Africa, and the Red Sea. Transactions of the Linnean Society of London series 2, Zoology 12:324-344.

Walting, L. 1993. Function morphology of the amphipod mandible. Journal of Natural History. 27: 837—849.

Wongkamhang, K. 2004. Morphology and feeding ecology of gammarid amphipods in coral reef and seagrass communities. Master Thesis. Department of Marine Science, Graduate School, Chulalongkorn University.

Wongkamhaeng, K., Paphavasit, N., Bussarawich S. and Nabhitabhata, J. 2009. Seagrass Gammarid Amphipods of Libong Island, Trang Province, Thailand. The natural history journal of Chulalong University. 9(1):69-83.

Wongkamhaeng, K. Azman B.A.R. and Pholphanthin, P. 2012. *Grandidierella halophilus* a new species of the family Aoridae (Crustacea: Amphipoda) from the saltpans of The Inner Gulf of Thailand. Raffles Bulletin of Zoology. 60(2):433-447.

Wongkamhang, K., Azman, B. A. R. and Puttapreecha, R. 2012. *Cheiriphotis trifurcata*, new species (Crustacea, Amphipoda, Corophiidae, Protomedeiinae) from the seagrass bed of the lower Gulf of Thailand. ZooKeys. 187:71-89.

Wongkamhang, K., Coleman, C. O. and Pholpunthin, P. 2013a. *Maeropsis paphavasitae* and *Rotomelita longipropoda*, two new species (Crustacea, Amphipoda) from Lower Gulf of Thailand. ZooKeys. 307: 15-33.

Wongkamhang, K., Coleman, C. O. and Pholpunthin, P. 2013b. Three new species from the Aoridae and Maeridae (Crustacea, Amphipoda) from Thai waters. Zootaxa 3693: 503-533.

Wongkamhaeng, K. Darakrai, A and Pholphanthin, P. 2010. New species of *Tethygeneia* Eurisidae: Amphipoda) and new records of Algae-Living Gammarid Amphipods Crustaceain South Sea Islands, Marine National Park, Nakhon Si Thammarat Province. In: Harada H. and Shirayama Y. (eds) Selected Papers of the NaGISA World Congress 2009, Publications of the Seto Marine Biological Laboratory, Special Publication Series. 11:1-23.

3.5 Phylogenetic Study

Of the 40 characters used, all characters were unweighted. 30 characters were binary and 10 were multistate . All states were unordered. Amphilochidae was used as outgroup. An shortest PAUP tree was selected. The final tree had a length of 121, Consistency index (CI) = 0.4505, Homoplasy index (HI) = 0.5950 and Retention index (RI) = 0.4286 (Fig. 45).

The first clade, composed of 2 species of amphipod namely *Paradexamine latifolia* and *Listriella longipalma.* This clade defined by a character state. It is mandible molar weakly developed and molar absent (Fig 46-MD)

The *Pahyale aquilina* clade is defined by one homoplastic character, head anteroventral margin poorly to weakly recessed and moderately excavate. The neritic clade, derived from *Parhyale aquilina* composed of 4 amphipod spcecies, including *Rotomelita longipropada, Waldeckia elephas, Tiron* sp.A, *Tethygeneia khanomensis.* This clade is defined by the shape of the head anteroventral margin obliquely truncate on spheroid head or obliquely truncate on spheroid head.

The *Urothoe spinidigitus, Ampelisca brevicornis* and *Ampelisca cyclops* are included in the same clade. The clade is defined by 2 plesiomorphic characters. The first is maxilla 1 inner lobe large and densely setose marginally (46-MX1). The second is pereopod 5-7 unequal in size and form (46-P5—7), and articles broadly expanded and strongly spinose and/or setose (= fossorial).

The *Bemlos quadrimanus* and *Photis longicaudata* clade is definded by 3 character states. The first is head lateral cephalic lobe extended, eye, if present, at least partly enclosed in extended lobe. The second character is gnathopod 1 enlarged in males and females or only in males (46-♂♀).

The next clade is excluded from *Bemlos* clade because the present of telsonic cusp. The *Maeropsis paphavasitae, Parelasmopus siamensis, Ceradocus andamanensis* and *Melita latiflagella* are included in the same clade, defined by the telson shape lobes separated (46 T-B). The *Maeropsis paphavasitae* branch is defined by the telson without hook or denticle while the rest telson do.

The *Chelicorophium* clade separate from the *Bemlos* clade because the telson dorsoventrally thickened (46 T-B). This clade is including *Chelocorophium* sp. A,

Gammaropsis atlantica, Podocerus andamanensis, Kamaka songkhlaensis and *Ampelisciphotis tridens.* This clade is defined by reduced pereopod 5-7.

The *Elasmopus puteus* clade is a strong supported clade. This clade is defined by the primitive character; the female gnathopod 1 coxa small, almost always smaller than coxa 2 and uropod 1-2 rami short with a dense array of strong robust setae (46-U2).

The *Cymadusa pillipes* clade is defined by recurved robust seta on the outer ramus of uropod 3. Only members of the ampithoine clade have a strongly developed notch on the inner margin of the labium and apical cusps on the telson (46-LL) .

The *Cheiriphotis* and *Grandidierella* species are paraphyletic clade, separated from the *Cymadusa* clade. This clade is defined by the mandibular palp article 3 anterior and posterior margins subsymmetrical, distally flattened, setae mostly distal and labium outer lobe inner margin concave with distal slit. The *Grandidierella* clade is separated from the *Cheiriphotis* clade by the former clade gnathopod 1 forming a sieve structure while the latter clade not forming a sieving structure.

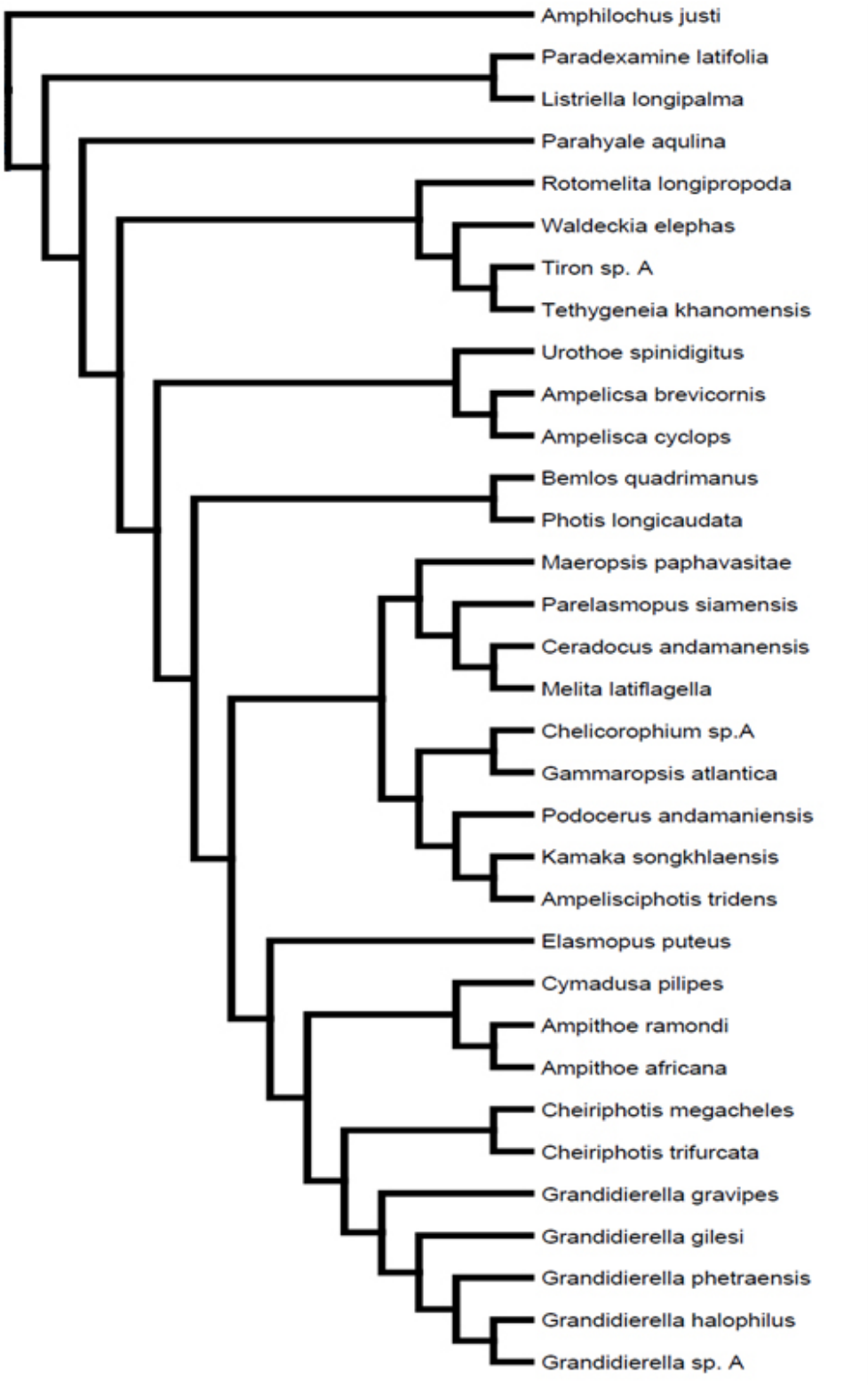


Figure 45 Cladogram of the relationships of taxa within the amphipod in Thai-Waters

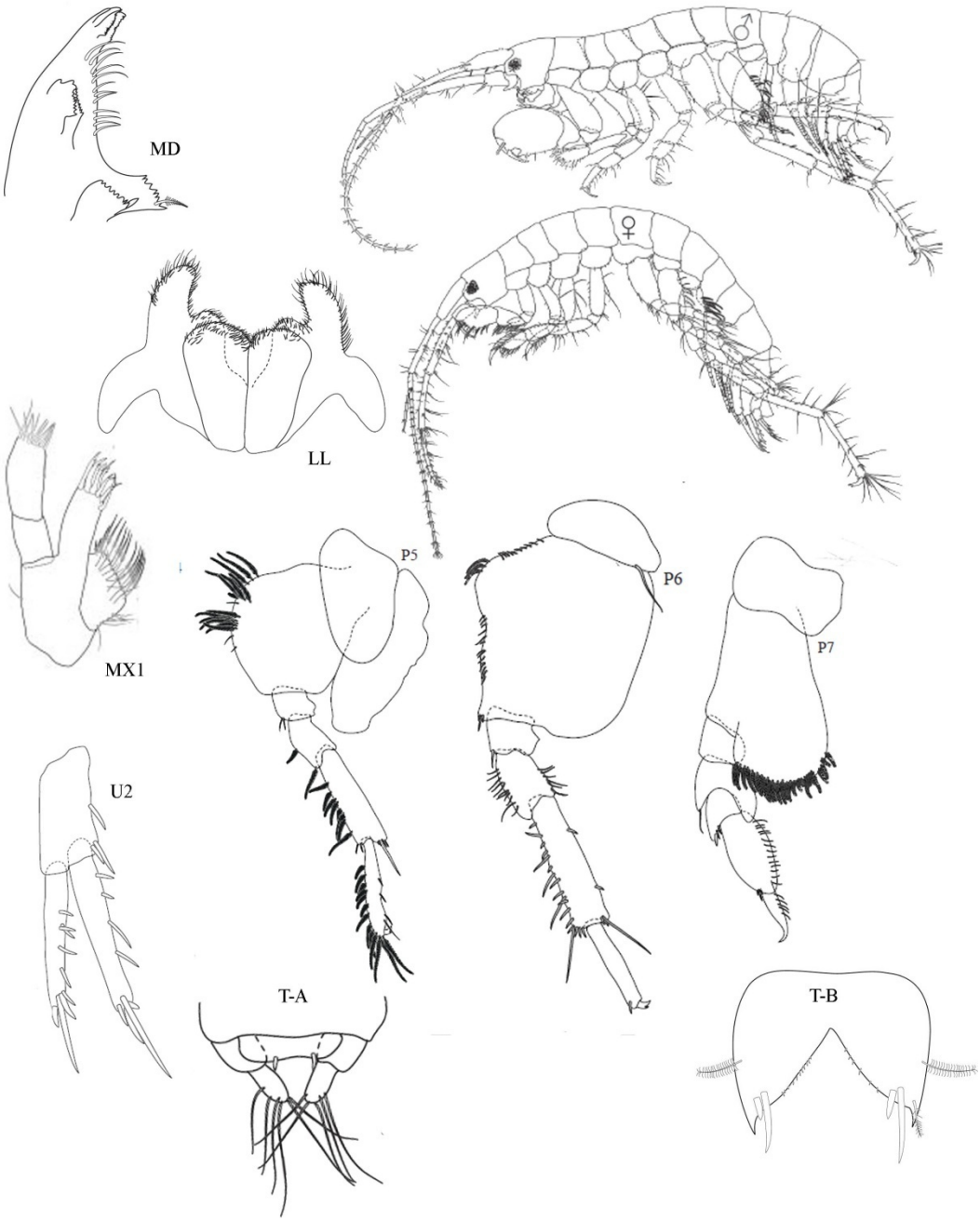


Figure 46 Characters used for defining clade; MD- *Paradexamine latifolia*, LL-*Ampithoe ramondi*, MX1- *Ampelisca brevicornis*, P5—7-*Ampelisca brevicornis*, T-A: entire telson of *Chelicorophium*, T-B: cleft telson of *Ceradovus andamanensis*

3.6 Phylogenetic and classification of gammarid amphipod in Thai-Water

Comparing this tree with the present gammarid amphipod classification, the members of Aoridae are group together, except the *Bemlos quadrimanus* which is separated from other members and show closer relationship with *Photis longimanus*, this latter clade was defined by biramus uropod 3. The members of Maeridae show close relationship with Melitidae, except the *Rotomelita longipropada* which is included with *Rotomelita longipropada, Waldeckia elephas, Tiron* sp.A, *Tethygeneia khanomensis* and share the character of the shape of the head anteroventral margin obliquely truncate on spheroid head or obliquely truncate on spheroid head and *Elasmopus puteus* which is included with the members of Family Ampithoidae, Corophiidae and Aoridae and share the character of the female gnathopod 1 coxa small, almost always smaller than coxa 2 and uropod 1-2 rami short with a dense array of strong robust setae. In this study the Ampeliscidae formed a monophyletic group with Urothoidae. This clade was defined the modified pereopod 5—7 into fossorial form.

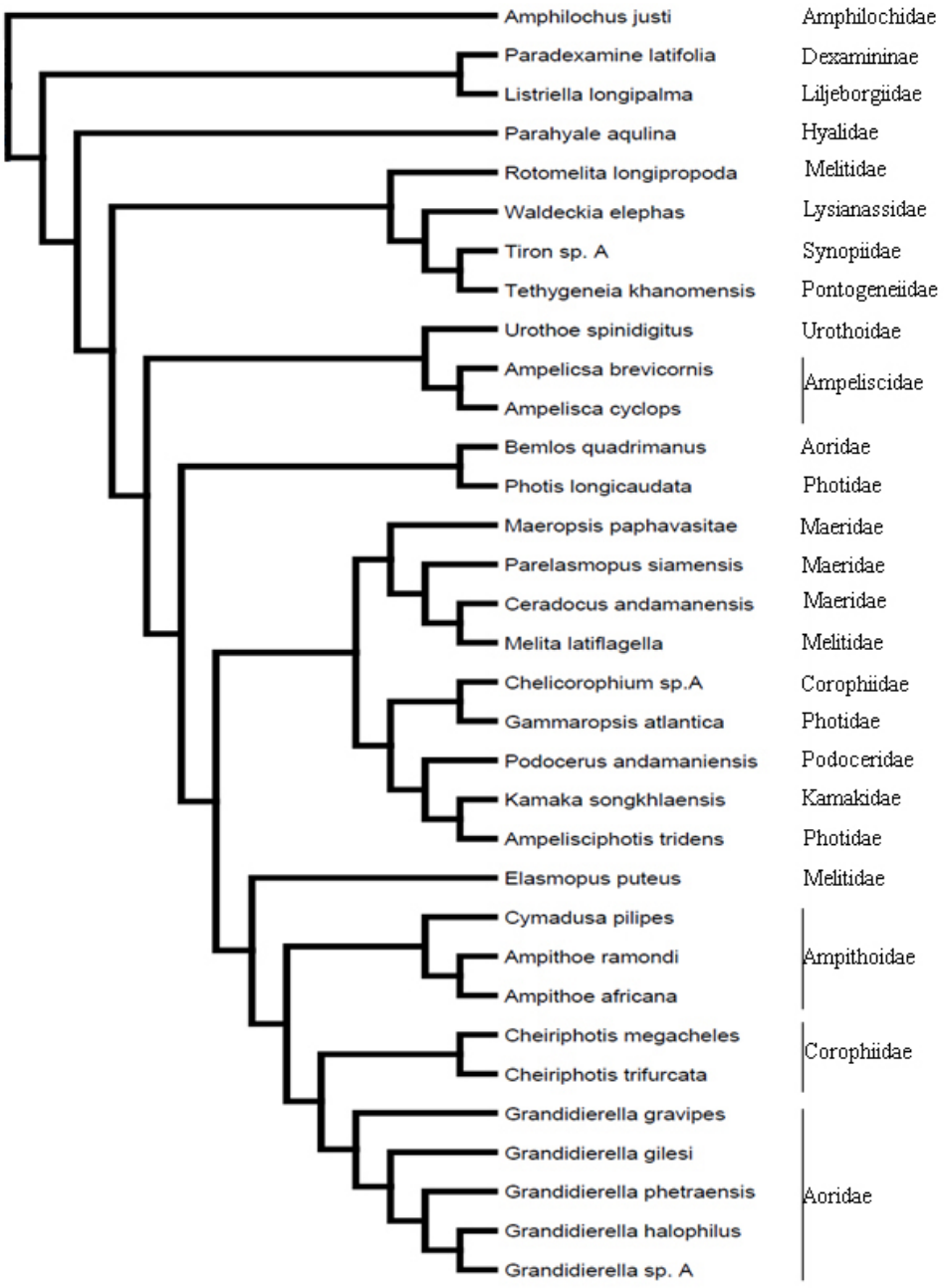


Figure 47 Cladogram of the relationships of the families within the amphipod in Thai-Waters

ANNEX 1

THE NAGISA WORLD CONGRESS: 1-20, 2009

New Species of *Tethygeneia* (Eurisidae: Amphipoda) and New Record of Algae-Living Gammarid Amphipods in South Sea Islands Marine National Park, Nakhon Si Thammarat Province, Thailand

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Abstract The amphipod *Tethegeneia khanomensis* sp. nov. were collected from South Sea Islands, lower Gulf of Thailand. in March 2008. A total of twelve species from seven families was recorded. The common and dominant species were *Paradusa bilobata* and *Podocerus andamanensis* occurred in all stations. The six species are new record for the Gulf of Thailand and South China Sea i.e. *Ampithoe ramondi, Ampithoe africana, Elasmopus puteus, Paradusa bilobata, Parahyale aqulina, Podocerus andamanensis* and *Anamisxis* sp. A is undescribed. Their characters are described and illustrated. All specimens are deposited at Princess Maha Chakri Sirindhorn Natural History Museum, Prince of Songkla University, Thailand.

Key words: gammarid amphipods, algae-bed, South Sea Islands Marine National Park

Introduction

Gammarid amphipods are the common benthos, widely distributed in many marine ecosystems including soft bottom and hard bottom habitats. They are variety in term of species and modes of life. The animals are abundant and play an important role in trophodynamics such as primary consumer in both grazing and detritus food chain. Moreover, amphipods are an important food for fish and larger crustaceans (Stoner, 1979). In Thailand, amphipods are commonly reported as a major group but there is little information about amphipods diversity.

Algae beds commonly located adjacent to coral reefs and seagrass beds. Some algae species associated with dead coral and seagrass leave. Most of Amphipods occupying in algae beds are nestler species that make their nest from algae and debris, i.e. Ampithoidae, Aoridae, Isaeidae and Ischyroceridae (Barnard, 1971). Besides, the inquilline group, Leucothoe and Anamixidae that which associated with other invertebrates such as tunicates, sponges and sea anemone also reported (Appadoo and Steele, 1998).

Southern Islands marine national park are pristine area that contain variety ecosystems including rocky shore, sandy beach, mangrove forest, seagrass bed, coral reef and algae bed. These islands provide habitats for marine flora and fauna. This present study was undertaken with the objective to study the gammarid amphipod species richness in this area and the information will be useful for understanding the amphipods diversity and ecology with particular emphasis on algal substrates in Thailand.

Materials and Methods

Study sites

Study sites composed of 5 islands located in Marine National Park, Amphoe Khanom, Nakorn Si Thammarat Province, lower Gulf of Thailand. (Figure 1).

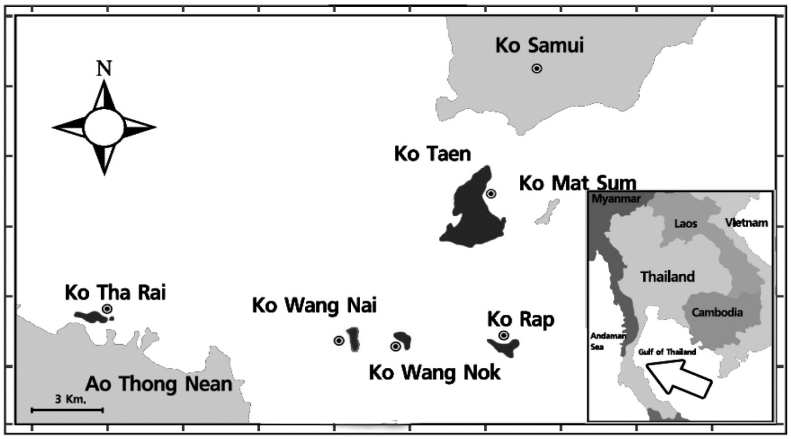

Fig. 1. Study sites in Marine National Park, Nakorn Si Thammarat Province
⦿ sampling site

Table 1. Amphipod distribution in southern Islands

Family	Species	Tarai	Wang Nai	Wang Nok	Rab	Tan
Ampithoidae	*Ampithoe ramondi**	+	-	+	+	+
	*Ampithoe africana**	+	+	+	+	+
Anamixidae	*Paradusa bilobata* *	+	+	+	+	+
	Anamixis sp. A*	-	-	+	+	-
Melitidae	*Maera quadrimana*	-	-	-	+	-
	Elasmopus puteus *	-	-	-	+	+
Photidae	*Gammaropsis abbotti*	-	+	+	+	+
	Grandidierella megnae	-	+	+	+	-
	Photis longicaudata	-	-	-	+	-
Podoceridae	*Podocerus andamanensis**	+	+	+	+	+
Eurisidae	*Tethygeneia* sp.A*	+	-	-	+	+
Hyalidae	*Parahyale aqulina* *	-	-	-	+	-

Specimens sampling

Amphipods were collected from 5 sites of 5 islands in March, 2008. All of the sites were located in the intertidal zone at 1-3 m depth. The sites were visited at low tide and samples were collected from intertidal to subtidal zone. Algae were collected by scarping them from their substrates using a small shovel. The substrates were transferred to plastic bags and preserved in 5 % formalin.

Amphipods were sorted from the substrates under stereo microscope in the laboratory. The protocol for amphipods identification was follow by Barnard and Karaman (1991). Drawings were made using an Olympus CH30 microscope equipped with a camera lucida. Amphipods picture of each species was drawn to illustrate the whole body and dissected to illustrate other diagnosis characters. Type material and additional representative material are deposited in the Princess Maha Chakri Sirindhorn Natural History Museum, Prince of Songkla University, Thailand.

Result

A total of 14 species belonging to 9 families of amphipods were identified (Table 1). Eight

species are reported for the first time in Gulf of Thailand and South China Sea of which one species apparently undescribed. These amphipods mostly associated with algae and some species such as *Anamixis* that associated with tunicate and sponge. The largest number of species is in family Ampithoidae and Photidae (3 species).

Taxonomy

Family Eurisidae
Tethygeneia khanomensis sp. nov.
Fig 2, 3, 4

Material examined

Holotype, male, body length 3.4 mm. (From tip of rostrum to apex of telson), (PSUZC-CR 0212); Paratypes, 1 male and 3 female, Rab Island (PSUZC-CR 0213).

Type locality: Rab Island, Nakorn Si Thammarat Province; among macroalgae, sublittoral; hand collected; coll. A. Darakri 15 March, 2008.

2 specimens, hand collected at low tide from algae and coral rubble near the coral reef, Tarai Island (PSUZC-CR 0214), A. Darakrai 15 March 2008. 1 specimens, hand collected, Tan Island (PSUZC-CR 0215), A. Darakrai 15 March 2008. 8. 2 specimens, hand collected, Rab Island (PSUZC-CR 0216),

Description

Body ordinary, compressed, smooth. Head normal, rostrum large with 25% of head length, lateral cephalic lobes ordinary, anteroventral margin of head not produce. Eyes large, reniform, subround, with clear ommatidia. Both antennae subequal, 1 slightly shorter than 2, peduncular articles of antenna 1 progressively shorter, article 1 shorter than head, article 3 not produce, article 1 of primary flagella short, flagella composed of 17 articles, accessory flagellum absent. Labrum entire, subrounded, broader than long, epistome unproduced. Mandible normal, incisor toothed, molar trituative, columnar, mandibular palp proximal to molar, article 2 longest, unlobed, article 3 with medial setae . Labium; inner lobes absent, mandibular lobe short and point. Maxilla 1: inner plate with 5 medial apical setae, palp long, article 1 short. Maxilla 2: inner plate not broader nor longer than outer, inner plate without facial row of setae. Maxilliped: inner plate not relatively long, outer plate shorter than palp, palp with 4 articles, article 4 not spinose along the inferior margin, coxae ordinary, coxa 1 not produce anteriorly, coxa 4 with posterior lobe, excavate.

Gnathopods 1 and 2 alike, small, not eurisid, carpus of both much shorter than propodus, only gnathopod 2 with strong posterior lobe extending distad, carpus without numerous long setae, propodus rectangular, both propodus oblique with 2 large spine on posteriorventral corner. Pereopods 3-7 ordinary, simple, dactyl simple, article 2 narrow without anterior lobe. Epimeron 3 smooth. Outer rami of uropods 1-2 shortened; rami with lateral and dorsal spines. Uropod 3 ordinary, slightly extend beyond uropod 1 peduncle without large process, rami lanceolate. Telson ordinary, cleft, without long apical armaments.

Distribution

Amphipod this genus commonly distribute in warm and tropical waters. Most of them occur in southern part of the world.

Remark

Tethygeneia sp. A similar to *T. tulkara* J, L Barnard, 1972 in Australia which bear a stout locking spines on pereopod 1-2, long rostrum but otherwise it differs by accessory flagellum absent. The

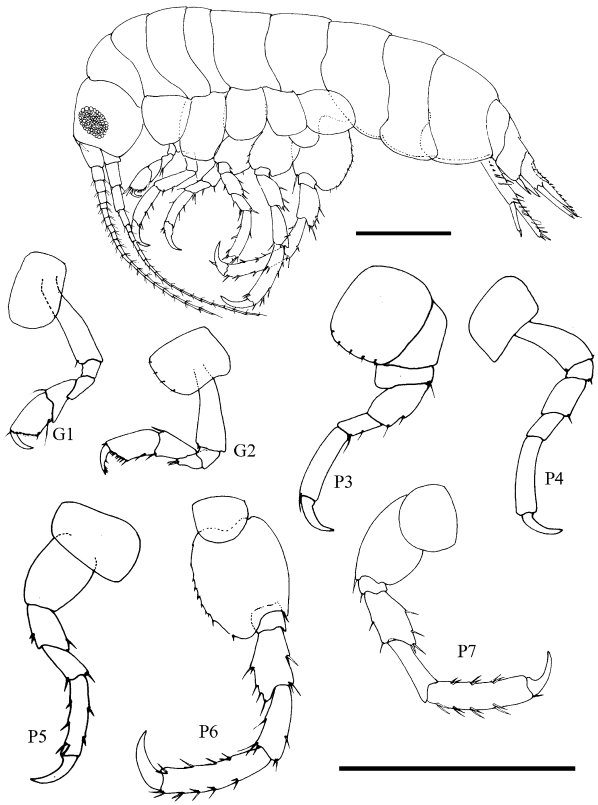

Fig 2. *Tethygeneia khanomensis* sp. nov. Holotype, male, body length 3.4 mm. (PSUZC-CR 0212) Rab Island, Scale for G1 to P7 represent 0.5 mm.

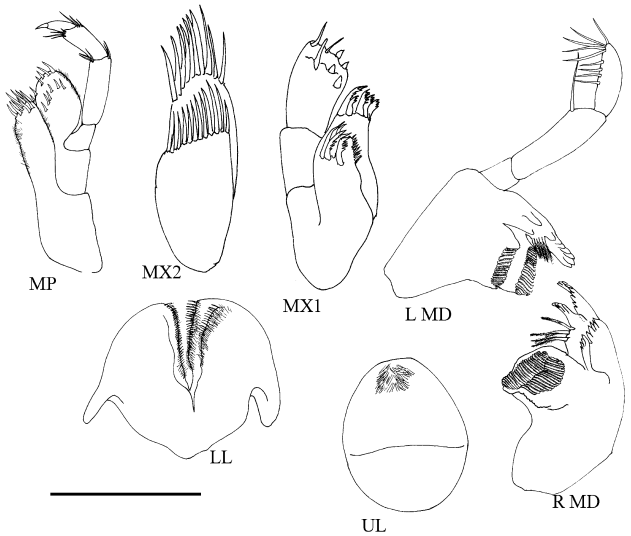

Fig 3. *Tethygeneia khanomensis* sp. nov. Holotype, male, Scale for mouthparts represented 0.25 mm

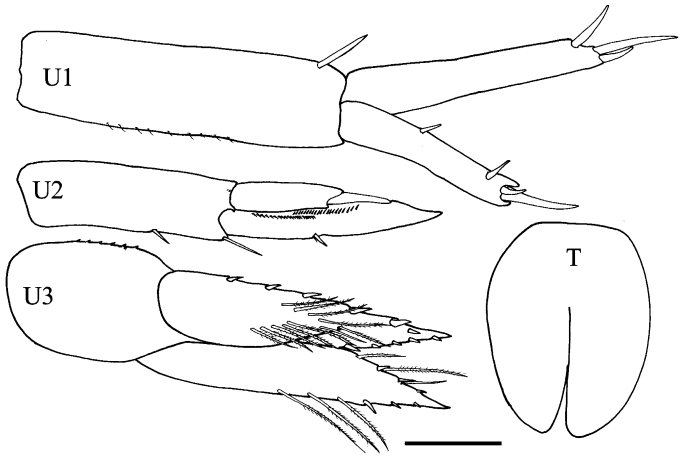

Fig 4. *Tethygeneia khanomensis* sp. nov. Holotype, male, (PSUZC-CR 0212) Rab Island, Scale for mouthparts represented 0.25 mm

animal were very fragile and most of appendages broken.

Etymology

This species is named from Khanom Districted that the Type locality located.

The following species are the new record of the Gulf of Thailand and South China Sea. The description and characters were illustrated.

Family Ampithoidae
Ampithoe ramondi Audouin
Figure 5, 6

Ampithoe ramondi Audouin.-J. L. Barnard, 1965, pp. 28-29; J. L. Barnard, 1970 pp 50-51, fig 18, 19; 1971; Nagata, 1985; Hirayama, 1983; Sivaprakasam, 1970 and Rabindranath, 1972.

Material examined

1 specimens, hand collected at low tide from algae and coral rubble near the coral reef, Tarai Island (PSUZC-CR 00201), A. Darakrai 15 March 2008. 8 specimens, hand collected, Wang Nok Island (PSUZC-CR 00202), A. Darakrai 15 March 2008. 8; 10 specimens, hand collected, Rab Island (PSUZC-CR 00203), A. Darakrai 15 March 2008.

Description

Body lateral compress, smooth, normal, urosomites free,. Head cuboildial, rostrum short, ocular lobe short, blunt, antennal sinus weak. Eye round, brown colour in alcohol. Both antennae subequal; antenna 1 shorter than 2, 50% of body length, accessory flagellum absent, peduncular article 3 of antenna 1 shorter than 1, article 2 and 3 progressive longer. Antenna 2 60% of body. Epistome unproduce anteriorly, Labrum subsounded, entire. Mandible normal, palp strong, article 3 rectolinear, article 3 shorter than 2. Labium with notched outer lobes and well develop inner lobes, mandibular lobe long and blunt. Maxilla 1 inner plate triangular with 2 apical setae, outer plate with 7 spines, palp 2 articulate. Outer plates of maxilla 2 broader than inner. Inner plate of maxilliped with distal spines

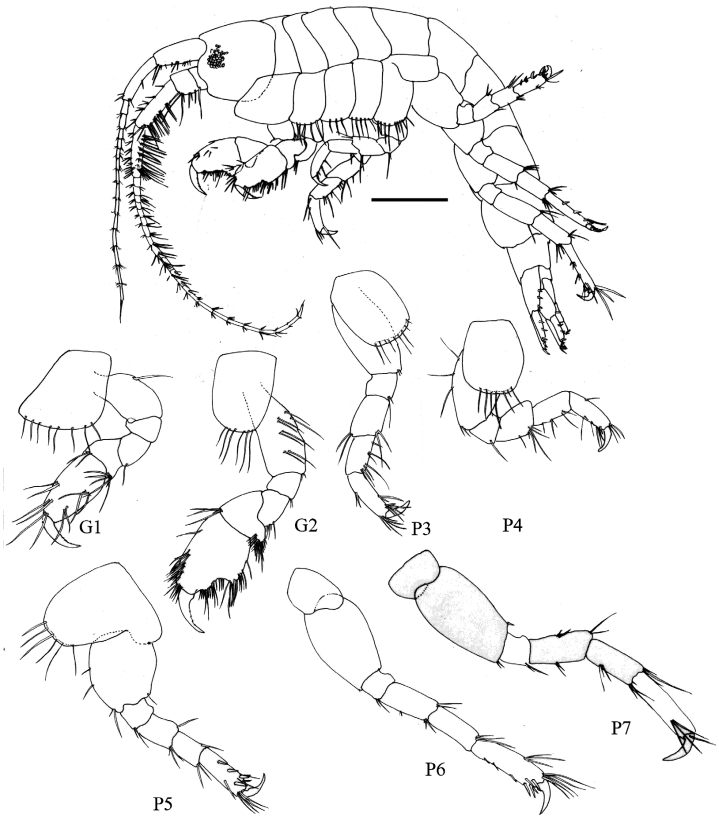

Fig 5. *Ampithoe ramondi* (PSUZC-CR 0201) 5.4 mm. Wang Nok Island. Scale for G1 to P7 represent 0.5 mm.

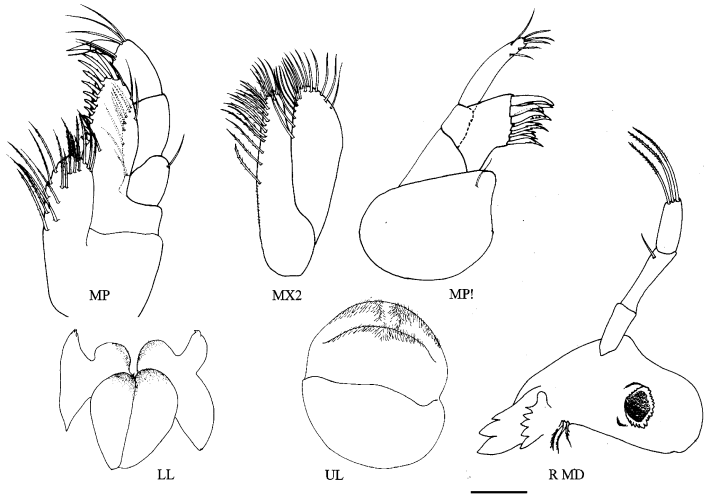

Fig 6. *Ampithoe ramondi* (PSUZC-CR 2001) Wang Nok Island. Scale for mouthparts represented 0.25 mm

on medial margin, palp with 4 articles, article 2 short, article 3 unlobed, article 4 short, with medium nail and setae.

Coxae relatively long, overlapping, coxa 1-4 subquadrate, coxa 1 produce forward, coax 2 smaller than 1, coax 4 longer than coxa 1, unlobed, coxa 4 as long as 4, coxa 4 not excavate, coxae 6-7 much smaller than anterior coxae.

Gnathopods 1-2 weakly diverse,gnathopod 2 slightly larger than 1, article 2 of both gnathopod 1 and 2 apically lobed, gnathopod 1 subchelat, article 5 triangle, shorter than 6, poorly lobed, propodus expanded, palm oblique, anterodistal without spine. Gnathopod 2 enlarged, subchelate, palm deeply excavate, defined by a large single spine, article 4 extend distally along posterior margin of article 5, article 5 shorter than 6, dactyl ordinary.

Sternal process of thorax absent. Coxal gills present on segment 2-6. Pleopod normal. Epimeron 3 smooth. Uropod 1-2 biramous, normal, rami slightly unequal, peduncle of uropod 1-2 without ventrodistal process. Uropod 3 stout and short, biramous, both rami very short, peduncle longer than rami, outer ramus recurved apically, with 2 distal hook-spines, inner ramus longer than outer ramus, broad, pad-like and apically setose. Telson entire, as broad as long, ovate with hooked apical cusps.

Distribution:

A. ramondi are widely distributed. It was first described in Egypt by Audouin in 1826, and subsequently from Japan Sea (Nagata, 1965 and Hirayama, 1983) and Indian Ocean (Sivaprakasam, 1970 and Rabindranath, 1972) to south Africa (Griffith, 1976). It was also recorded in Mediterranean Sea by Krapp-Schickel (1982) and Myer (1985).

Remarks

Our specimens are congruent to what Nagata (1965) reported from Japan Sea and what Barnard (1970) reported from Hawaii except the propodus of gnathopod 2 is more blunt than both. The excavate of gnathopod 2 is shallower than those of Indian and African.

Ampithoe africana K.H. Barnard, 1926
Fig. 7, 8

Ampithoe africana K.H Barnard, 1926; Griffiths, 1976.

Material examined

10 specimens, hand collected, Rab Island (PSUZC-CR 0204), A. Darakrai 15 March 2008.

Body lateral compress, smooth, normal, urosomites free. Head cuboidial, rostrum short, ocular lobe short, blunt, antennal sinus weak. Eye, ovoid, dark brown in alcohol. Both antennae subequal, antenna1 longer than 2 , peduncular article 3 of antenna 1 shorter than 1, article 3 shorter than 2, accessory flagellum absent. Epistome unproduce anteriorly, Labrum subsounded, point. Mandible normal, with large mandibular molar, palp strong, article 3 longer than 2 with distal setae. Labium with notched outer lobes, inner lobes moderately developed, mandibular lobe long and blunt. Maxilla 1 inner plate triangular, outer plate with two rows of spines, palp 2 articulate, article 2 longer than 1. Outer plates of maxilla 2 not very broad, inner plate with mediofacial row of setae. Inner plate of maxilliped with distal spines on medial margin, palp with 4 articles, article 2 short, article 3 unlobed, article 4 short, with medium nail and setae. Coxae relatively long, weakly overlapping, progressively elongate from 1-4, coxa 1 produced forward, coxa 2 smaller than 1, coxa 4 longer than coxa 1, unlobed, coxa 3 as long as 4, coxae 6-7 much smaller than anterior coxae.

Gnathopods 1-3 weakly diverse,gnathopod 2 slightly larger than 1m gnathopod 1 subchelat, article 5 shorter than 6, poorly lobed, propodus expanded, palm oblique. Gnathopod 2 enlarged, subchelate, article 4 extend distally along posterior margin of article 5, article 5 shorter than 6, dactyl ordinary.

Sternal process of thorax absent. Coxal gills present on segment 2-6. Pleopod normal. Epimeron 3 not bisinuate. Uropod 1-2 biramous, normal, rami slightly unequal, peduncle of uropod 1-2 with weak and blunt ventrodistal process. Uropod 3 stout and short, biramous, both rami very short, peduncle longer than rami, outer ramus recurved apically, with 2 distal hook-spines, inner ramus longer than outer ramus, broad, pad-like and apically setose. Telson entire, broader than long, subglobular with 2 apicals spine.

Distribution

This amphipod was found in Africa and described by K. H. Barnard in 1926 and was report again in South Africa by Griffiths (1976).

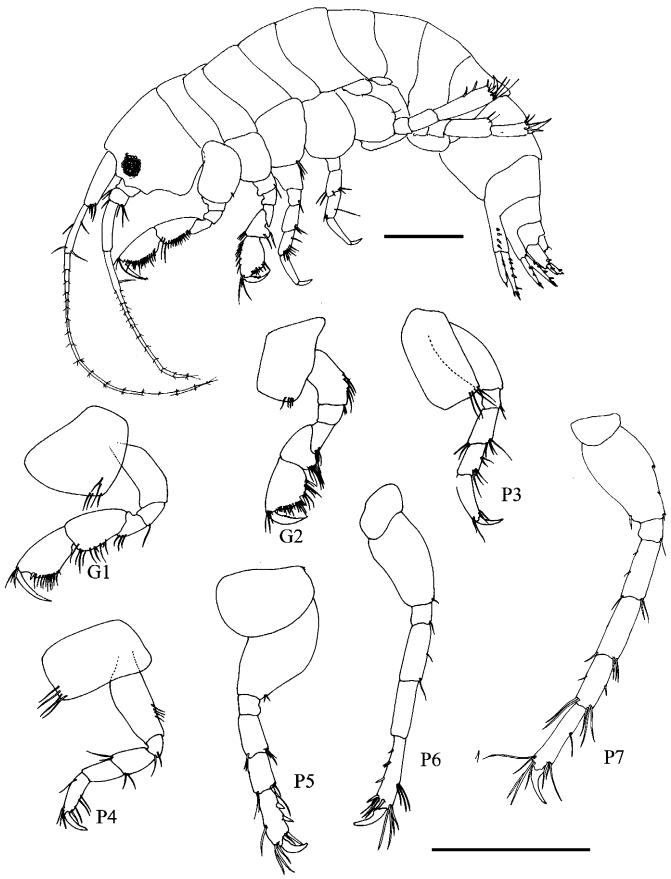

Fig 7. *Ampithoe africana* (PSUZC-CR 0204) Rab Island, 0.67 mm. Scale for G1-P7 represented 0.5 mm.

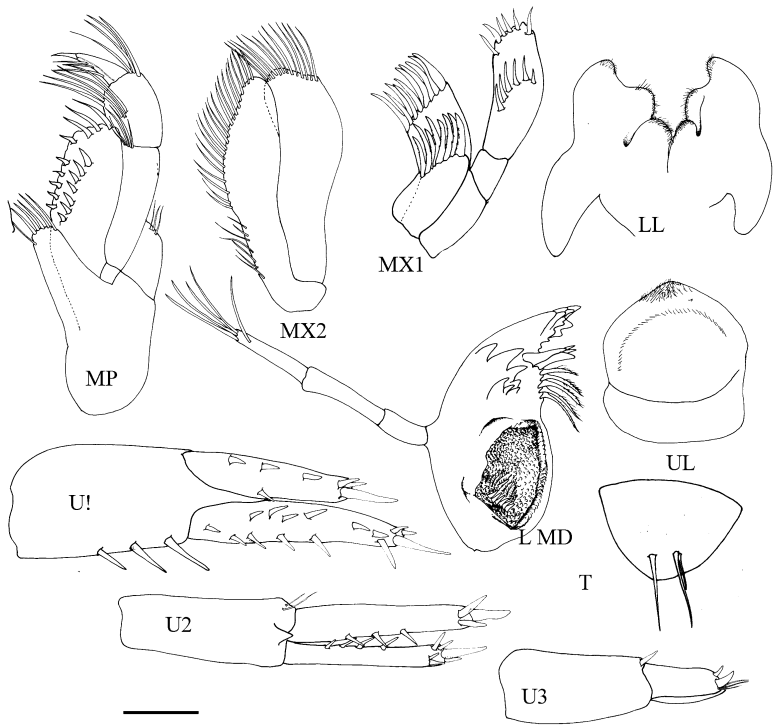

Fig 8. *Ampithoe africana* (PSUZC-CR 0204) Rab Island. Scale for mouthparts represented 0.25 mm

Remark

The animal of this area similar with *A. africana* in palm of male gnathopod 2 straight with a single spine at the posterior distal corner.

Paradusa biolobata Ruffo, 1969
Fig 9, 10

Paradusa biolobata Ruffo, 1969, pp 64-69, fig 21-23 ; Ledoyer, 1984, p 26, fig 11.

Material examined

3 specimens, hand collected at low tide from algae and coral rubble near the coral reef, Tarai Island (PSUZC-CR 0205), A. Darakrai 15 March 2008. 4 specimens, hand collected, Tan Island (PSUZC-CR 0206), A. Darakrai 15 March 2008. 8; 4 specimens, hand collected, Wang Nok Island (PSUZC-CR 0207), A. Darakrai 15 March 2008. 10 specimens, hand collected, Rab Island (PSUZC-CR 0208), A. Darakrai 15 March 2008. 7 specimens, hand collected, Rab Island (PSUZC-CR 0209), A. Darakrai 15 March 2008.

Description

Body lateral compress, smooth, normal, urosomites free. Rostrum short, ocular lobe short, blunt, antennal sinus weak. Eye ordinary. Antennae long, 1 longer than 2, both slender; peduncular article 3 of antenna 1 shorter than 1, article 2 and 3 progressive longer, accessory flagellum scale-like.

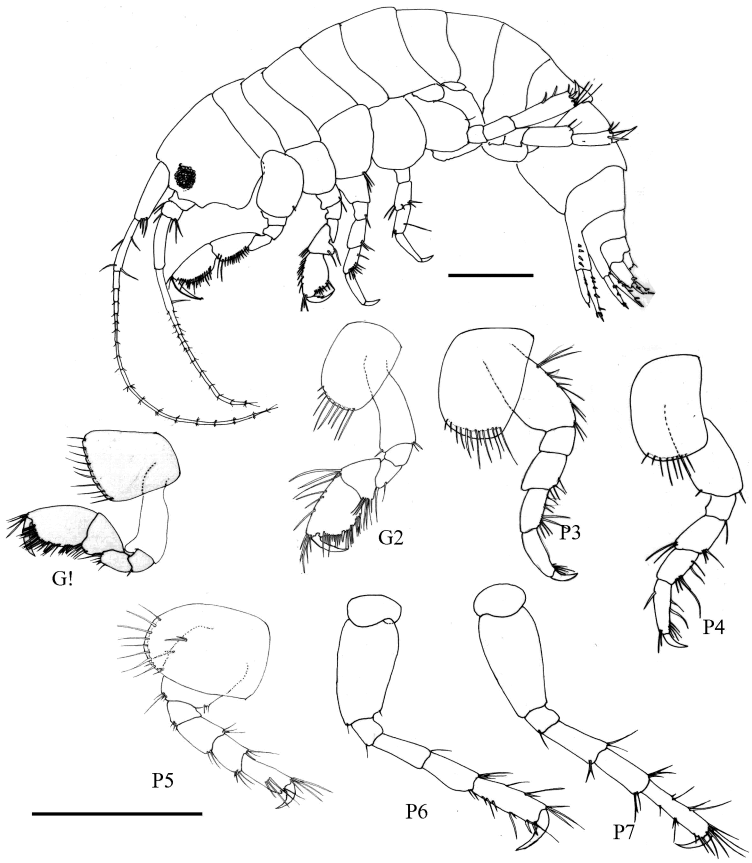

Fig 9. *Paradusa lobata* (PSUZC-CR 0207) Wang Nok Island. Scale for G1-P7 represented 0.5 mm.

Epistome unproduce anteriorly, Labrum subsounded, entire. Mandible normal, palp strong, article 3 rectolinear, article 3 longer than 2. Labium with notched outer lobes and well develop inner lobes, mandibular lobe long and blunt. Maxilla 1 inner plate linguiform with 1 medial setae, outer plate with 9 spines, palp 2 articulate. Outer plates of maxilla 2 slender and inner more narrow, inner plate with mediomarginal of setae. Inner plate of maxilliped with distal setae and cusp, outer plate normal, exceeding apex of palp article 2 with spine on medial margin, palp with 4 articles, article 2 short, article 3 unlobed, article 4 short, with long nail. Coxae relatively long, weakly overlapping, progressively elongate from 1-4, coax 1 barely dilated, produced forward, coax 2 larger than 1, coax 4 longer than coax 1, unlobed, coxa 4 as long as 4, coxae 6-7 much smaller than anterior coxae.

Gnathopods 1-3 alike, of equal size, large, gnathopod 2 slightly scarely longer than , both subchelate, palm oblique, article 5 of both gnathopods very short, shorter than 6, lobed, article 6 large, dactyl ordinary.

Sternal process of thorax absent. Coxal gills present on segment 2-6. Pleopod normal. Epimeron 3 not bisinuate. Uropod 1-2 biramous, normal, rami slightly unequal, peduncle of uropod 1-2 with long and sharp ventrodistal process. Uropod 3 stout and short, biramous, both rami very short,

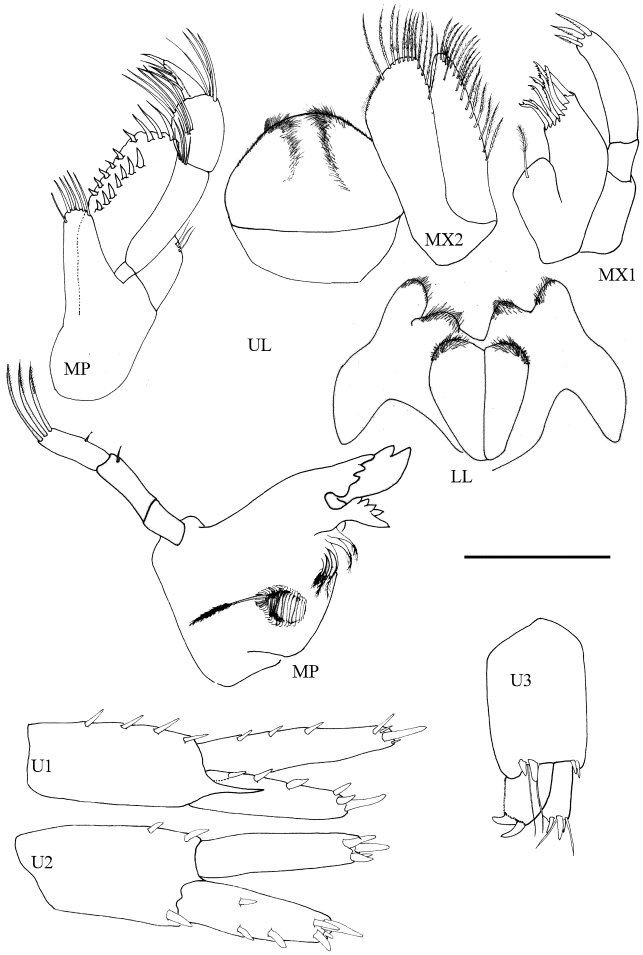

Fig 10. *Paradusa lobata* (PSUZC-CR 0207) Wang Nok Island. Scale for mouthparts and U1-3 represented 0.25 mm

peduncle longer than rami, outer ramus recurved apically, with 2 distal hook-spines, inner ramus longer than outer ramus, broad, pad-like and apically setose. Telson entire, as broad as long, ovate with hooked apical cusps.

Distribution

The animal was first reported in Red Sea (Ruffo, 1969) and New Caledonia (Ledoyer, 1984)

Family Anamixidae
Anamixis sp. A
Fig 11

Material examined

1 specimens, hand collected, Rab Island (PSUZC-CR 0210), 1 specimens, hand collected, Wang Nok Island (PSUZC-CR 0211)

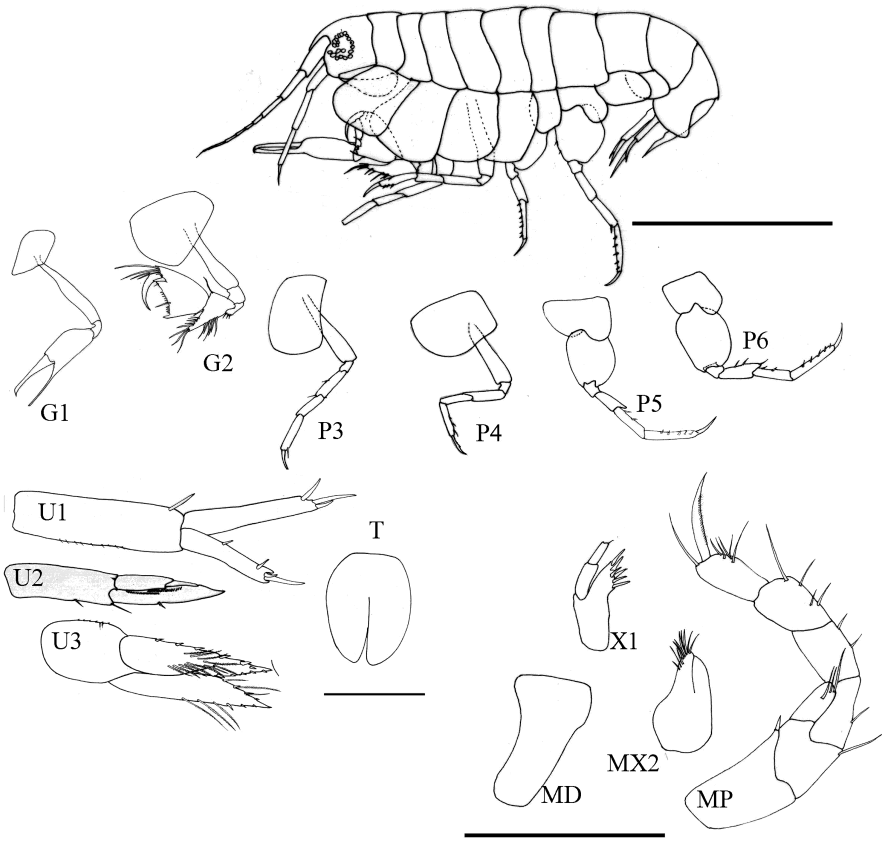

Fig 11. *Anamixis* sp. A (PSUZC-CR 0210) from Rab Island, Scale for G1-P6 represented 0.5 mm. Scale for U1-U3 and T represented 0.025 mm and scale for mouthparts represented 0.025 mm.

Description

Body lateral compress, smooth. Rostrum small, lateral cephalic lobe weak, eyes ommatidial. Antenna 1 slender, peduncle long, article 2 as long as 1, main flagellum sparsely articulate, without accessory flagellum. Antenna 2 slender and feeble. Mouthparts well developed. Epistome strongly produced anteriorly, front of head with midvertical keel, labrun asymmetrical incised. Mouthparts except maxilliped extremely reduced and vestigial, dominate by midventral keel. Mandible lacking molar, raker row long, incisors broad, tooth, wavy, palp slender, feeble, 3 article. Maxilla 1 present with broad inner plate, medial setae sparse but thick and short, spine-like, outer plate much more slender and sparsely setose. Outer plate of maxillipeds moderately well developed, inner plate small and fuse together. Palp long, thin, 4 articulate.

Coxa 1 hidden by shield-like coxae 2-4, coxa 2 largest, 4 longer than 3, coxa 5-7 slightly smaller. Gnathopod 1 small, carpochelate. Gnathopod 2 very large and carpochelate, propodus large, oval, dactyl long, overlapping propodus and carpal process.

Sternal gills absent. Sternal blisters absent. Sternal processes absent. Pereopod 3-4 slender. Pereopods 5-7 alike, short, base expanded, 7 weakly lobate. Pleopods biramus, multiarticulate. Gills

simple, ovate, small. Uropods 1-3 slender, uropod 3 breaking away. Rami lanceolate, outer rami short, weakly spinose. Uropod 3 peduncle elongate, telson short and entire.

Distribution

Amphipod this genus occur in warm and tropical water, cosmopolitant.

Remark

Amphipod this family are remarkable associated with sponge and tunicate and might be included to this study by chance and contained only female that hard to identify.

Family Melitidae

Elasmopus puteus Appadoo& Myers, 2003

Fig. 12, 13

Appadoo & Myer, 2003 p 71, fig 7, 8.

Material examined

3 specimens, hand collected, Tan Island (PSUZC-CR 0217), A. Darakrai 15 March 2008. 8; 2 specimens, hand collected, Rab Island (PSUZC-CR 0218), A. Darakrai 15 March 2008.

Description

Body ordinary, compressed, smooth. Head normal, with subocular notch; eyes, small subround, with clear ommatidia. Antenna 1 longer than antenna 2, peduncle articles sparsely setiferous; peduncle article 2 slightly shorter than article 1; article 3, shorter than article 1; accessory flagellum 1 articles; primary flagellum 7 articles. Antenna 2, peduncle poorly setiferous; article 5 subequal to article 4; flagellum 5 articles, the terminal article progressively small. Mandible normal, mandibular palp article 2 longest, article 3 falcate, subequal with article 2, with comb row of setae and 2 long terminal setae. Maxilla 1, inner plate with 2 terminal plumose setae. Labium, mandibular lobes blunted; outer plate with a blunt stout seta on inner margin. Maxilliped, palp article 3 with a small distal protuberance. Gnathopod 1, coxa produced distally, as long as broad, with very short setae on distal margin; carpus and propodus subequal and each with long setae on the inner face of the anterior margin; propodus with palm oblique with a stout defining robust setae, dactyl with small serrate. Gnathopod 2, coxa broader, distal margin with very short setae, carpus cup-shaped, twice as broad as long; propodus slender, subpyriform, twice as long as broad, palm oblique, posterior margin poorly setiferous, with a small subtriangular process on the inner subdistal face and a medial excavation forming a pit into which fits the tip of the dactylus; dactylus evenly curved, about half length of propodus. Pereopods 3-4 alike, propodus subequal to carpus; dactylus curved. Pereopod 5, basis subquadrate tapering distally, posterior margin weakly crenulate with short setae. Pereopod 6, basis subquadrate, posterior margin weakly convex, crenulate and with short setae. Pereopod 7, basis strongly expanded, posterior margin very convex, crenulate with small setae. Epimeron 1 rounded. Epimera 2-3, produced into a weak posterodistal tooth and with a row of robust setae on the anterodistal margin. Uropod 1, rami subequal to each other and to peduncle. Uropod 2, peduncle inner ramus shorter than inner ramus outer ramus. Uropod 3, peduncle subequal to inner ramus; inner ramus slightly shorter than outer ramus; inner ramus with lateral and terminal robust setae; outer ramus with lateral robust setae and a group of terminal robust setae and 1 long slender seta. Telson, deeply cleft; apices notched.

Distribution

The amphipod was firstly reported at Mauritius Island, Pacific Ocean among algae bed.

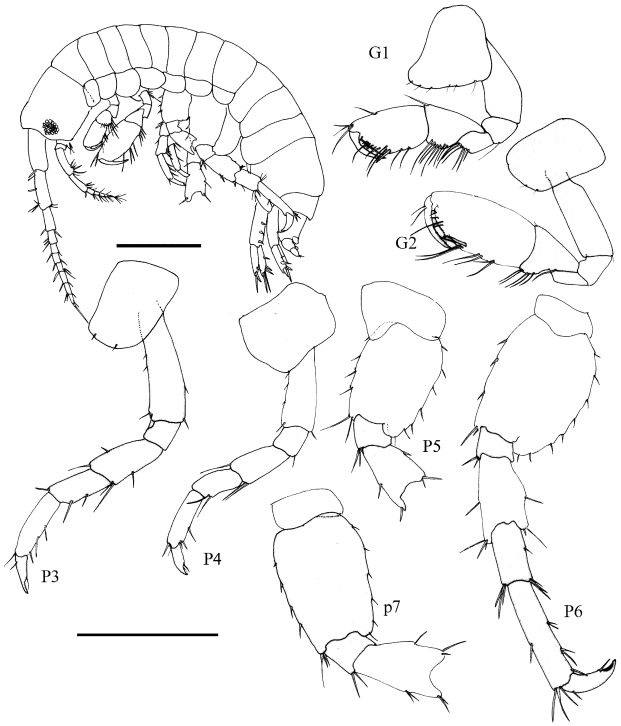

Fig 12. *Elasmopus puteus* (PSUZC-CR 0211) Tan Island. Scale for G1-P7 represented 0.5 mm.

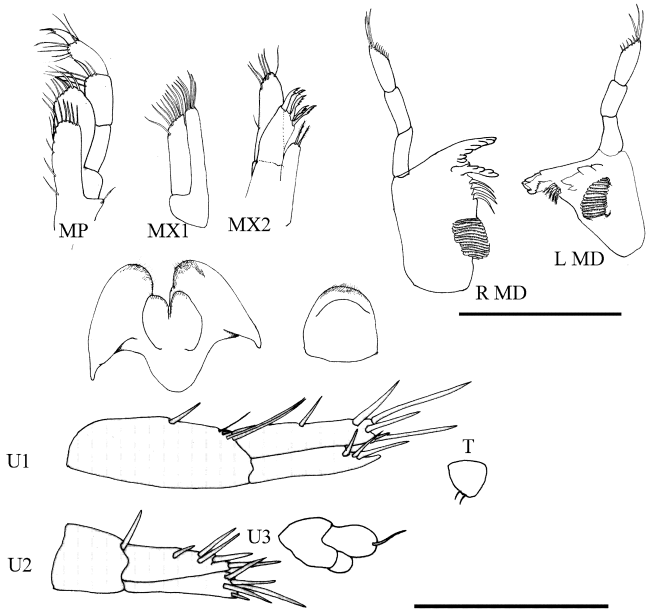

Fig 13. *Elasmopus puteus* (PSUZC-CR 0211) Tan Island. Scale for G1-P7 and U1-U3 and T represented 0.25 mm.

Remark

Amphipods this species is different from those found in Mauritius Island from antenna 1 flagellum composed of 7 article which those has 11 articles and antenna 2 composed only 6 artcicles.

Family Hyalidae
Parahyale aqulina K. H. Barnard, 1935
Fig. 14, 15

Allorchestes aquilinus Chevreux & Fage, 1925:289, fig 300-301.
Parhyale aquilina Krapp-Schickel, 1993:754, fig. 516.

Material examined

2 speciemens, hand collected, Rab Island (PSUZC-CR 0219),

Description

Body smooth, compressed. Head normal. Antenna 1 shorter than antenna 2 Peraeon. Body without dorsal carina. Maxilla 1 bearing large 1 articulate palp with terminal spines. Dactyl of

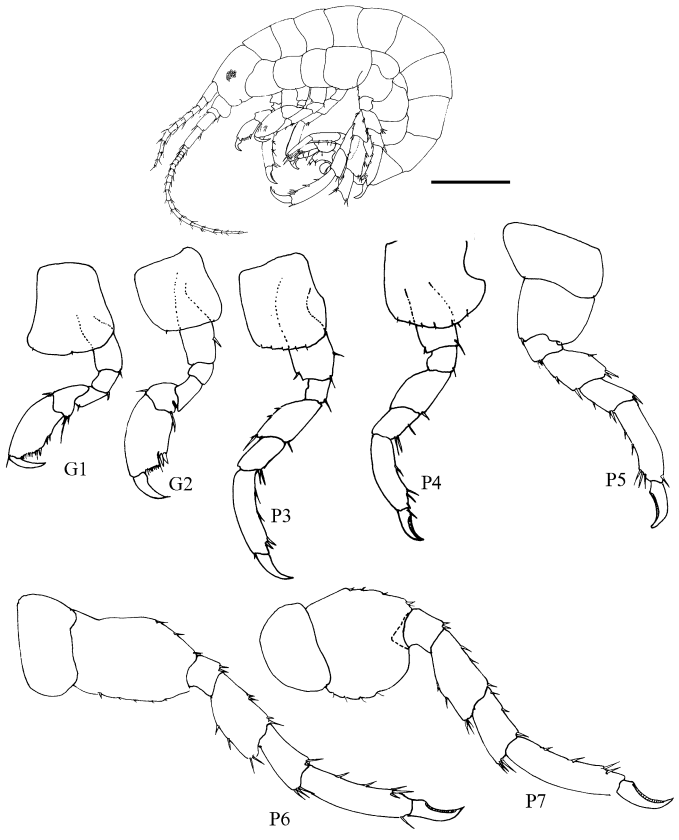

Fig 14. *Parahyale aqulina* (PSUZC-CR 0219), Rab Island. Scale for G1-P7 represented 0.5 mm.

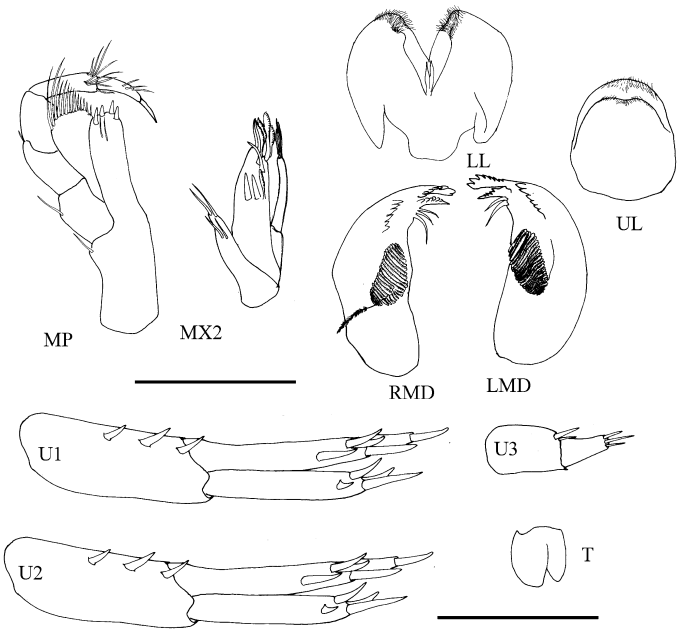

Fig 15. *Parahyale aqulina* (PSUZC-CR 0219), Rab Island. Scale for mouthparts and U1 to U3 and telson represented 0.5 mm.

maxilliped unguiform, with short setae. Coxa 1 and 2 as broad as long, slightly produce forward, coxa 1-4 subequal, coxa 4 excavate posterior. Gnathopod 1 and 2 distinctly different in size. Gnathopod 1 propodus similar length to carpus, palm oblique with a large spine posteriodistal corner. Gnathopod 2, carpus without setae on the posterior margin; 2 propodus enlarged, palm oblique, propodus with robust sedefining palm, with fine setae on distal oblique margin, propodus with robust seate on distal oblique margin. Pereopods 3 to 7 without large robust striated setae on propodus. Pereopods 6 to 7 without tuft of setae at mid length on posterior margin of propodus. Pereopod 7 basis with large flange (about as broad as long). Uropods 1-2 biramus, uropod 3 uniramus, inner ramus vestigial. Telson cleft, flate.

Distribution

The amphipods was firstly described in France by Chevreux and Fage (1925). Krapp-Schickel reported amphipods this species in Indo-Pacific Region.

Remark

Amphipod found in this study different from amphipod of Chevreux and Fage (1925) on maxilliped palp article 3 that naked while those of France densely setose.

Podoceridae

Podocerus andamanensis (Giles, 1890)

Fig 16, 17

Cyrtophium andamanense Giles, 1890, p 72-73, fig. 7.
Podocerus andamanensis Stebbing, 1906. p 702.

Material examined

3 specimens, hand collected at low tide from algae and coral rubble near the coral reef, Tarai Island (PSUZC-CR 0220), A. Darakrai 15 March 2008. 2 specimens, hand collected, Tan Island (PSUZC-CR 0221), A. Darakrai 15 March 2008. 8; 9 specimens, hand collected, Rab Island (PSUZC-CR 0222), A. Darakrai 15 March 2008.

Description

Body not carinate but provide with elevation hump, subcylindrical, Urosomite 1 elongate. Rostrum short, ocular lobe short, blunt, antennal sinus deep. Eyes large, bulging laterally. Epistome produce anteriorly. Labrum incised, bilobe. Mandible normal, palp strong, article 3 clavate, shorter than 2. Labium with entire outer lobes, with well-developed inner lobes, mandibular lobes long, point or blunt. Inner plate of maxilla 1 short with 1 seta, outer plate with 9 spines, palp 2-articulate. Outer plates of maxilla 2 broad, inner plate with only sparse mediomarginal setae. Inner plate of maxilliped with distal spine, outer plate normal, reaching halfway to apex of palp article 2, with spine on medial margin, palp with 4 articles, article 2 long, article 3 unlobed, article 4 short, with long nail and setae.

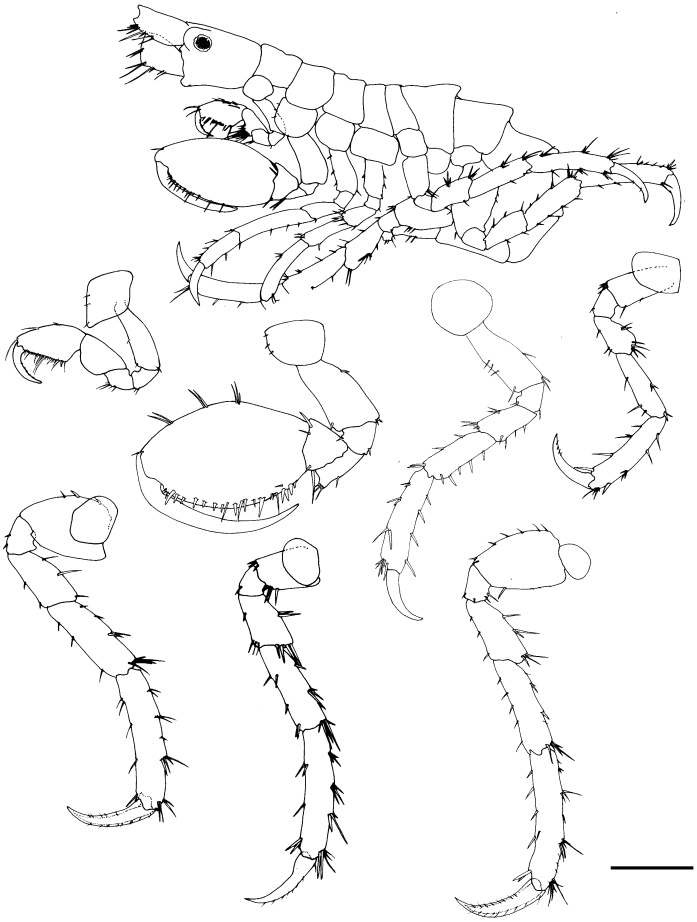

Fig 16. *Podocerus andamanensis* (PSUZC-CR 0220) Rab Island. Scale for G1-P7 represented 0.5 mm.

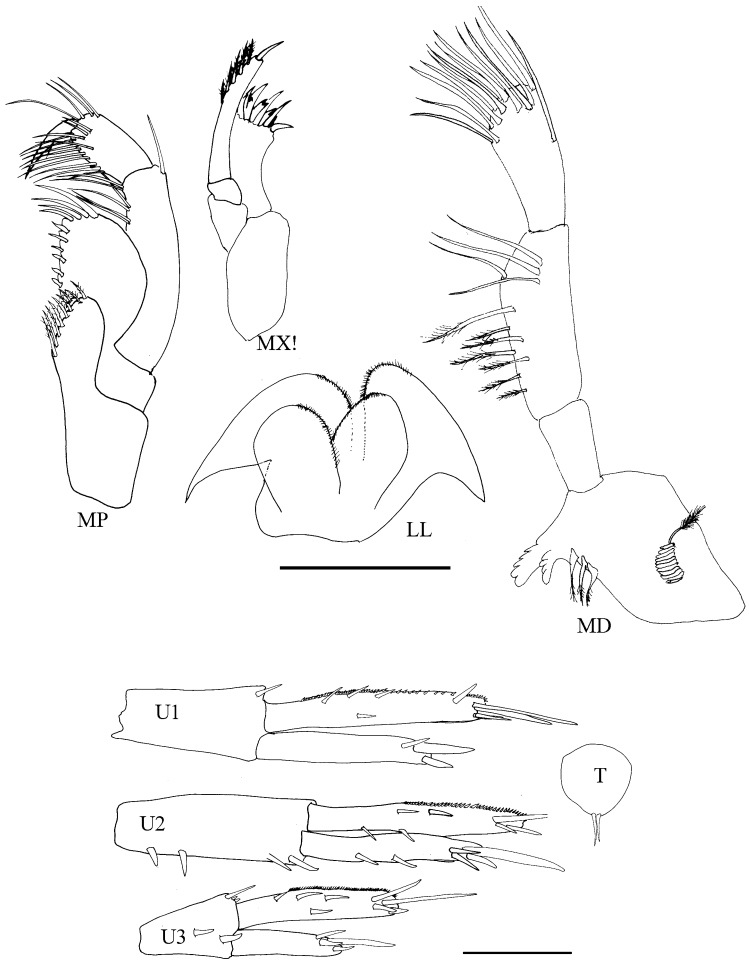

Fig 17. Podocerus andamanensis (PSUZC-CR 0220) Rab Island. Scale for mouthpart and U1-3 and telson represented 0.5 mm.

Coxae very small, short, weakly discontigous, of various sizes and shapes, not progressively elongate from 1 to 4, coxa 1 dilated, not produced forward, coxa 2 longer than 1, not produced, coxa 4 not longer than coxa 1, not lobed, coxa 5 shorter than 4, coxae 6-7 smaller than anterior coxae. Gnathopods 1-2 diverse, gnathopod 2 greatly larger than 1, gnathopod 1 poorly subchelate, article 5 as long as 6, weakly lobed. Gnathopod 2 enlarged, incipiently merochelate, extended and fused distally along posterior margin of article 5, article 5 much shorter than 6, triangular, fused to 4, article 6 dilated, dactylus long.

Pereopods 3-4 longer than gnathopods, similar, with slender article 2, article 4 dilated, dactylus medium. Pereopods 5-7 similar to each other, pereopod 7 longest, pereopods 5-7 with broad unlobed article 2, dactylus long, curved. Sternal precess of thorax absent. Coxal gill present on segment 2-6. Pleopods normal. Epimeron 3 bisinuate. Uropods 1-2 biramous, remi unequal, inner plate longer than outer.Uropod 3 forming small leaf lacking rami. Telson entire, short, broader than long, semicircular.

Distribution

The animal was firstly describe by Giles (1890) in Africa and reported again in south Africa by Stebbing in 1906.

Remark

Amphipod found in this study is similar with those of Giles (1890) but it has small hump on posterior pereon segment while those of Giles smooth.

Discussion

The dominant group in this study are ampithoid that commonly herbivorous and prefer vegetative ecosystem such as seagrass bed and algae bed. (Barnard, 1970 and Myer, 1985). There are rare species such as *Maera quadrimana* that occurred only in Rab Island and *Anamixis* sp. A that found only at Wang Nok and Rab Island. The first one was reported in coral reef and sandy beach while the latter are associate with sponge and tunicate (Barnard and Karaman, 1991). The amphipod found in this study consist of 12 species which 8 species are new record of this area and one species of that should be new to science according to the list of amphipod in South China Sea (Lowry, 2000). It implies that the deep studies of amphipod diversity are need including species richness, amphipods community seasonal variation and also their ecology. Furthermore, the study of amphipod in adjacent habitat such as coral reef, seagrass bed and rocky shore should be investigated to understand amphipod distribution and migration.

Acknowledgments

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References

Appadoo, Ch. and Myers, A.A. 2003. The genus *Elasmopus* (Crustacea: Amphipoda: Melitidae) from Mauritius (Indian Ocean) with description of five new species. Records of the Australian Museum 55, 61-84.

Appadoo, C. and Steele, D. H. 1998. Shallow-water marine gammaridean amphipods of Mauritius Island. Crustaceana, 71(6): 633-645.

Barnard, J.L., 1970. Sublittoral Gammaridea (Amphipoda) of the Hawaiian Islands. Smithsonian Contributions to Zoology, 34 : 1-286.

Barnard, J. L. 1971. Keys to the Hawaiian marine Gammaridea, 0-30 meters. Smitnsonian Contributions to Zoology, 58: 1-135.

Barnard, J.L. 1972. Gammaridean Amphipoda of Australia, Part I. Smithsonian Contributions to Zoology, 103: 1-333.

Barnard, J. L. and Karman, G. S. 1991. The families and genera of marine Gammaridean Amphipoda (Except marine Gammaroids). Record of the Australian Museum. Supplement 13. Australia: Love computer Typesetting Pty Ltd. 866 pp.

Barnard. K. H., 1925. Contributions to the crustacean fauna of South Africa, no. 8. Further additions.to the list of amphipoda. Ann. South Africa Mus., 20 : 319-380.

Giles, G. M. 1890. Description of seven additional new Indian amphipods. Journal of the Asiatic Society of Bengal, 59: 63-74.

Griffith, C. 1975. The amphipoda of Southern Africa. Part 5. The Gammaridea and Caprellidea of the Cape Province West of Cape Agulhas. Annals of the South African Museum, 67: 91-181.

Griffith, C. 1976. Guide to the benthic marine amphipods of southern Africa. The Rustica Press, 106 pp.

Hirayama, A. 1983. Taxonomic studies on the shallow water gammaridean Amphipoda of West Kyushu, Japan. I Acanthonotozomatidae, Ampeliscidae, Ampithoidae, Amphilochidae, Anamixidae, Argissidae, Atylidae and

Colomastigidae. Publication of Seto Marine Biological Laboratory, 29 (1/3): 1-92.

Krapp-Schikel, 1993: Do algal-dwelling amphipods react to the 'critical zones' of a coastal slope. Journal of Natural History. 27, 883-900

Ledoyer, M. 1984. Les gammariens (Crustacea, Amphipoda) des herbiers des phanergames marine de Nouvelle Caledonie (region des Noumea). Memoires du Museum National D'Historie Naturelle, new series, serie A, Zoologie, 129: 113 pp.

Ledoyer, M. 1979. Expedition Rumphius II. Crustaces parasites, commensaux, ets (Th. Monod et R. Serene, ed). Crustaces amphipods gammarideans. Bulletin du Museu, National d'Histoire Naturalle Paris, series 4, 1: 137-181. 19 figs.

Lowry, J.K. 2000. Taxonomic status of amphipod crustaceans in the South China Sea with a chicklist of known species. The Raffles Bulletin of Zoology, Supplement no.8, 309-342.

Myers, A.A. 1985. Shallow-water, coral reef and mangrove Amphipoda (Gammaridea) of Fiji. Records of the Australian Museum supplement 5, 144 pp. 109 figs.

Nagata, K. 1965. Studies on marine gammaridean Amphipoda of the Seto Inland Sea. I. Publications of the Seto Marine Biological Laboratory, 13: 131-170.

Rabindranath, P. 1972. Marine Gammaridea (Crustacea: Amphipoda) from the Indian region. Family Amphithoidae. Marine Biology, 14: 161-178.

Ruffo, S. 1969. Terzo contributo alla conoscenza degli anfipodi del Mar Rosso. Memorie del Museo Civio di Storia Naturale. Verona, 17: 1-77.

Sivaprakasam, T. E. 1970. Amphipods of the family Ampithoidae from the Madras Coast. Journal of the Marine Biological Association of India, 12: 64-80.

Stebbing, T.R.R. 1906. Amphipoda I. Gammaridea. Das Tierreich. 21: 806 pp. 127 figs.

Stoner, A. W. 1979. Species-specific predation on amphipod Crustacea by the pinfish Lagodon rhomboides: mediation by macrophyte standing crop. Marine Biology, 55: 201-207.

ANNEX 2

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RESEARCH ARTICLE

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Cheiriphotis trifurcata, new species (Crustacea, Amphipoda, Corophiidae, Protomedeiinae) from the Seagrass Bed of the Lower Gulf of Thailand

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Abstract

A new species of corophiid Amphipoda, *Cheiriphotis trifurcata*, collected from the seagrass bed of the Lower Gulf of Thailand, is described. *Cheiriphotis trifurcata* is characterized by its trifurcated tip of the modified setae on the outer ramus in male pleopod 3. In this paper, the new species is fully described and compared with related species and a complete key of the 16 valid species in the genus *Cheiriphotis* is given.

Keywords

Crustacea, Amphipoda, Isaeidae, *Cheiriphotis trifurcata*, Gulf of Thailand, taxonomy

Introduction

Species of the genus *Cheiriphotis* Walker, 1904, are predominant and widespread in both marine circumtropical and warm-temperate waters of the world. Of the 15 valid species that have been described so far, only *C. megacheles* (Giles, 1885) was reported

in the Andaman Sea while the Gulf of Thailand has no reports of amphipods in this genus (e.g. Angsupanich and Kuwabara 1995; Angsupanich et al. 2005; Ariyama et al. 2010; Bussarawich 1985; Chilton 1925; and Ruensirikul et al. 2007).

Cheiriphotis megacheles was first described from the Bay of Bengal in 1885 by Giles, and later reported from Sri Lanka (Ceylon) by Walker in 1904. However, the specimens from the two localities are clearly distinctive in male gnathopod 1 and uropod 3 which Walker (1904) concluded as an ontogeny. Salman and Jabbar (1990) redescribed *C. megacheles* based on material collected from the north-west of the Arabian Gulf and found that the variation between Giles's and Walkers' specimens is not an ontogeny, instead they are two distinct species. In the present study we provide a detailed description and illustration of both male and female species of *Cheiriphotis trifurcata* new species collected from the seagrass bed area. This description represents the first record of the genus *Cheiriphotis* in the Gulf of Thailand. A key for the genus *Cheiriphotis* is also presented.

Material and methods

Amphipods were collected using a 20×20 cm^2 Ekman's grab in a seagrass bed of Talet bay (Figure 1). The sites were visited at low tide and amphipods were collected from the subtidal zone. Seagrass and sediment were sieved with a 0.5 mm sieve. Amphipod specimens were sorted out and fixed in formalin for 1 week and then stored in 70% alcohol. In the laboratory, the animals were examined using a compound microscope and later selected for dissection. The appendages were examined and figures were produced using an Olympus CH30 light microscope with a camera lucida. The following abbreviations are used: A, antenna; G, gnathopod; HD, head; LL, lower lip; MD, mandible; MX, maxilla; MP, maxilliped; P, pereopod; Pl, pleopod; T, telson; U, uropod; UR, urosome; UL, upper lip; r, right; l, left; ♂, male; ♀, female. The type material of the new species is deposited at Prince of Songkla University Zoological Collection (PSUZC) and the Universiti Kebangsaan Malaysia Muzium Zoologi (UKMMZ), Malaysia.

Results

Corophiidae Leach, 1814
Protomedeiinae Myers & Lowry, 2003

***Cheiriphotis* (Giles, 1885)**
http://species-id.net/wiki/Cheiriphotis

Type species. *Melita megacheles* Giles, 1885 by monotypy.

Diagnosis. Eyes small. Antenna 1, accessory flagellum pluriarticulate. Mandibular palp article 3 rectolinear or clavate. Coxae small, relatively short, coxa 1 dilated, pro-

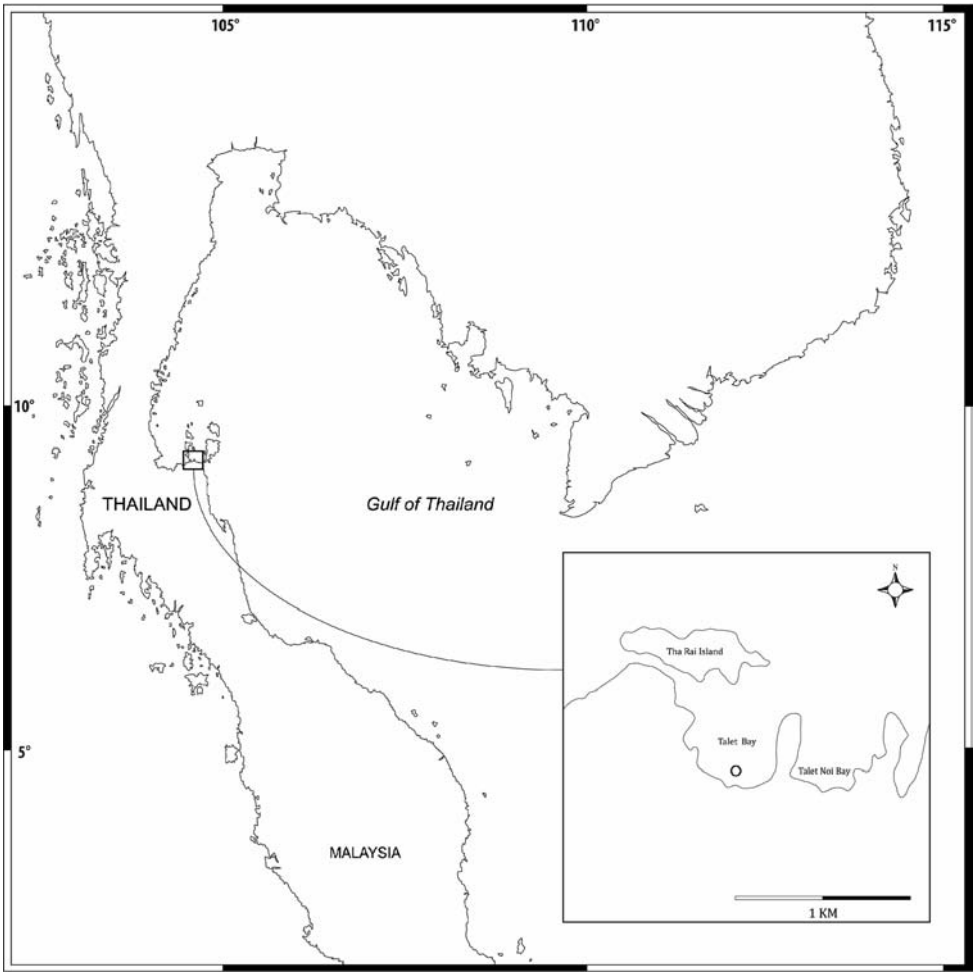

Figure 1. Map of sampling area

duced forward. Gnathopod 1 (male) subchelate. Gnathopod 2 subchelate and greatly larger than gnathopod 1. Pereopods 6–7, dactylus elongate, falcate. Uropods 1 – 2 biramous; rami slighty subequal; peduncle with ventrodistal process. Uropod 3 uniramous. Telson entire.

Species composition. *Cheiriphotis* contains 16 species: *Cheiriphotis australiae* Stebbing, 1910; *C. delloyei* Pirlot, 1934; *C. durbanensis* K.H. Bamard, 1916; *C. erythraeus* Ruffo, 1969; *C. geniculata* K.H. Barnard, 1916; *C. madagascarensis* Ledoyer, 1979; *C. mediterranea* Myers, 1983; *C. megacheles* (Giles, 1885); *C. minima* Ledoyer, 1982; *C. neotropicalis* Valerio-Berardo, 2007; *C. pediformis* Myers, 1995; *C. quadrichelatus* Ortiz & Lalana, 1997; *C. rotui* Myers, 1989; *C. walkeri* Stebbing, 1918; *C. williamsoni* Salman & Jabbar, 1990;

***Cheiriphotis trifurcata* sp. n.**
urn:lsid:zoobank.org:act:37DAB18F-70EF-42C3-BD57-0E0911C11128
http://species-id.net/wiki/Cheiriphotis_trifurcata

Type material. *Holotype*. ♂, THAILAND, Lower Gulf of Thailand, Talet Bay (09°18'39.5"N, 99°46'46.4"E), seagrass bed (associated with *Thalassia hemprichii*), 24 September 2008, Puttapreecha, R., PSUZC-CR-0264.

Allotype. ♀, collected with holotype, PSUZC-CR-0265 (adult female, 4.16 mm)

Other material. Same data as for holotype, UKMMZ-1446 (5♂; 15♀); PSUZC-CR-0266 (5♂; 20♀)

Description. Male (*holotype*). Total body length 3.5 mm (from tip of rostrum to apex of telson). *Body* rather slender and subcylindrical. *Head* subequal in length to first 2 pereonites; rostrum not developed; inferior antennal sinus short and concave, about 0.3 times of head length; *eye* distinct. *Antenna 1* slightly longer than antenna 2, ratio of peduncular article 1–3 as 5:9:8; article 1 slender, with 2 postero-marginal setae; flagellum with 10 articles, 0.7 times as long as peduncle; accessory flagellum with 4 articles, last article scale-like. *Antenna 2* peduncle slender; article 1–4 in ratio of 2:5:4:2; inner margin of article 4 and 5 with long postero-marginal setae; article 5 shorter than 4; flagellum short with long setae, subeaqual in length to peduncular article 5, composed of 7 articles, last article scale-like.

Upper lip or labrum round and broad, with small depression in the middle and pubescent on each lobe. *Lower lip* inner lobe small and pubescent, mandibular process well developed; outer plate with a group of finger-like setae on the inner face of the outer lobe, covered with thin hair-like setae. *Mandible*, both incisors with 5 teeth; lacinia mobilis armed with 4 teeth on the left side and 5 teeth on the right side; molar process columnar, ridged distally; palp 3-articulate with ratios of 1:3:3, article 1 with 2 marginal setae, article 2–3 with apical and marginal setae. *Maxilla 1*, inner plate small with 2 apical setae, outer plate with 8 apical and marginal serrate robust setae; palp extending beyond outer plate, biarticulate with 6 apical serrate robust setae. *Maxilla 2*, inner plate with 19 slender marginal setae; outer plate larger than inner plate with 20 slender setae. *Maxilliped*, inner plate broad and short, reaching half of outer plate, apically provided with 4 conate setae and fine setae; outer plate broad, almost reaching palp article 2 with 7 conate setae; palp 4-articulate with ratio of 3:5:2:1.

Pereon. *Gnathopod 1* subchelate, smaller than gnathopod 2; coxal plate subtriangular, produced anteriorly with long fine setae on anteroventral corner; length ratio of articles from basis to dactylus about 14:5:6:13:10:9; basis slender, broader distally, posterior margin bearing long setae; ischium short, subrectangular with apical setae; merus subtriangular with posteromarginal setae, longer than ischium; carpus longer than propodus with plumose setae on posterior margin; propodus shorter than dactylus, palm oblique with a robust seta at the proximal half, surface of palm toothed; dactylus slightly longer than palm, falcate, inner margin with a robust seta,. *Gnathopod 2* subchelate; coxal plate short and wide, subrectangular, length ratio of articles from basis to dactylus about 9:5:8:8:19:19; basis robust, nearly as long as wide, broader

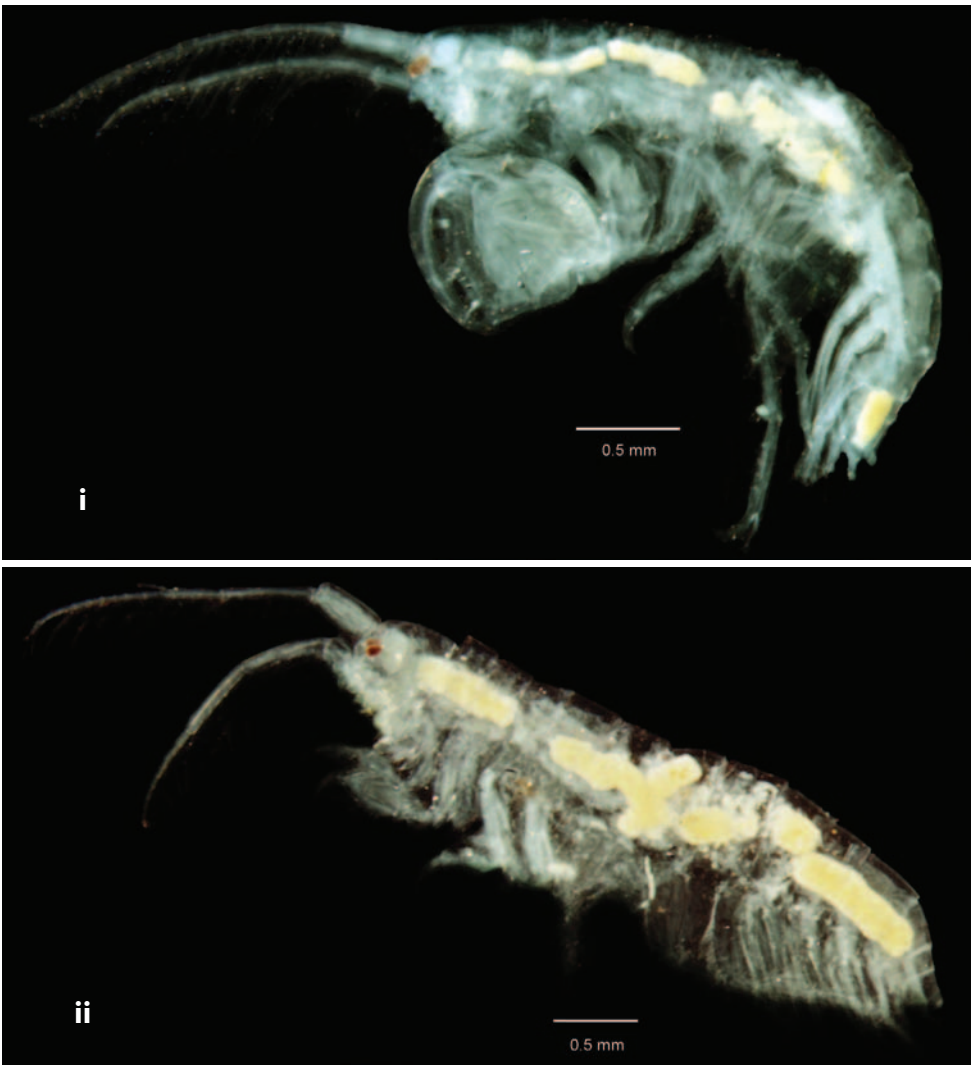

Figure 2A. Photography of *Cheiriphotis trifurcata* sp. n. **i** holotype, male, (PSUZC-CR-0264), 3.47 mm. **ii** allotype, female, (PSUZC-CR-0265), 4.16 mm. Talet Bay, Lower Gulf of Thailand.

distally, anterior margin straight, both sides naked; ischium subrectangular; merus longer than ischium; carpus distal and anterior margin fused with propodus; propodus enlarged, as long as wide, anterior margin with a row of plumose setae, posterior margin with short setae; palm transverse, with 4 blunt teeth and one acute palmar corner; dactylus slightly longer than palmar margin, inner margin smooth.

Pereopod 3 slender and elongate; coxal plate small and suboval, with 3 plumose setae on anterior side; length ratio of articles from basis to dactylus 10:3:6:2:6:4; basis slender, distally extended; ischium short, subrectangular; merus longer than carpus, slightly

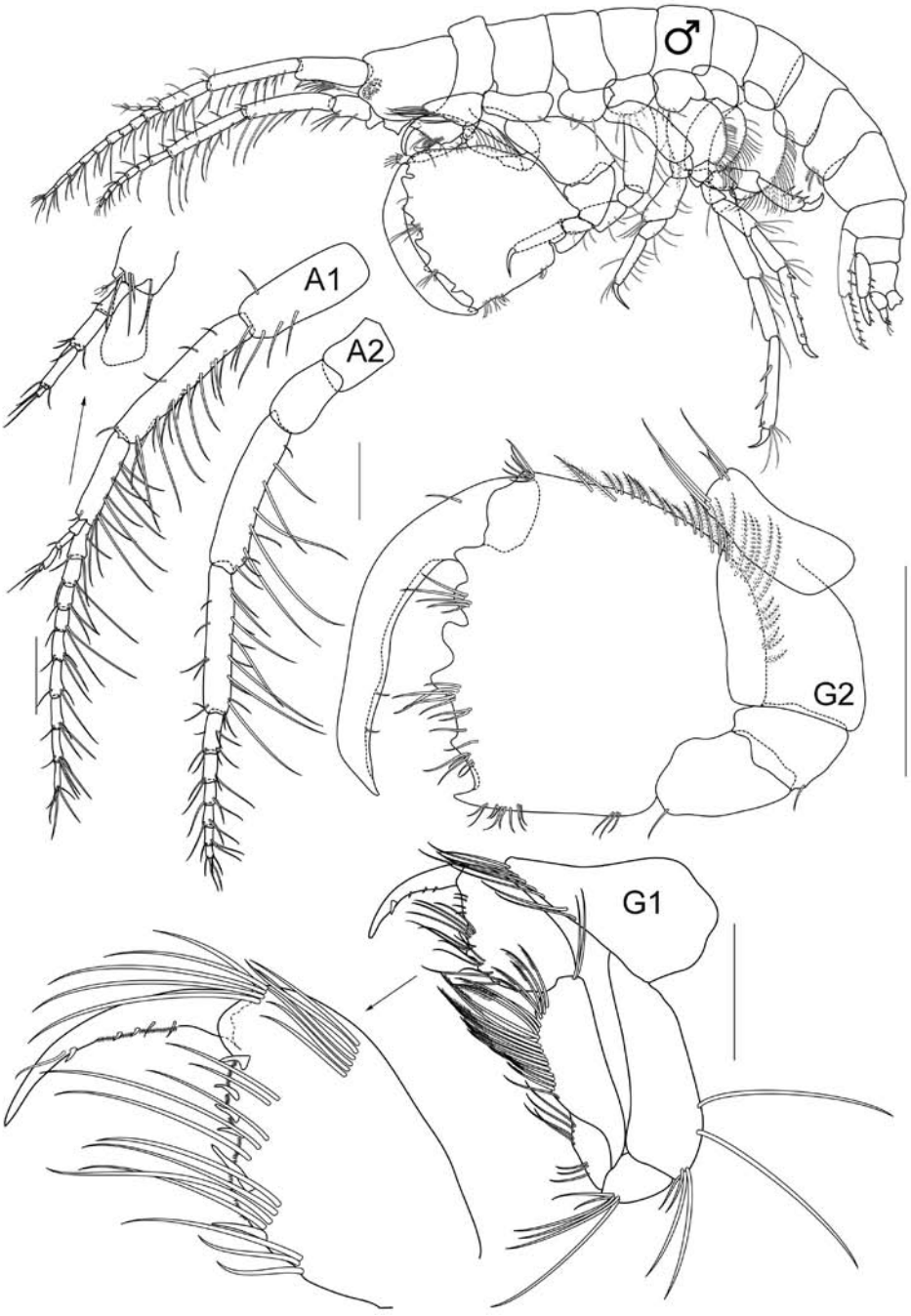

Figure 2B. *Cheiriphotis trifurcata* sp. n., holotype, male, (PSUZC-CR-0264), 3.47 mm. Talet Bay, Lower Gulf of Thailand. All scales represent 0.2 mm.

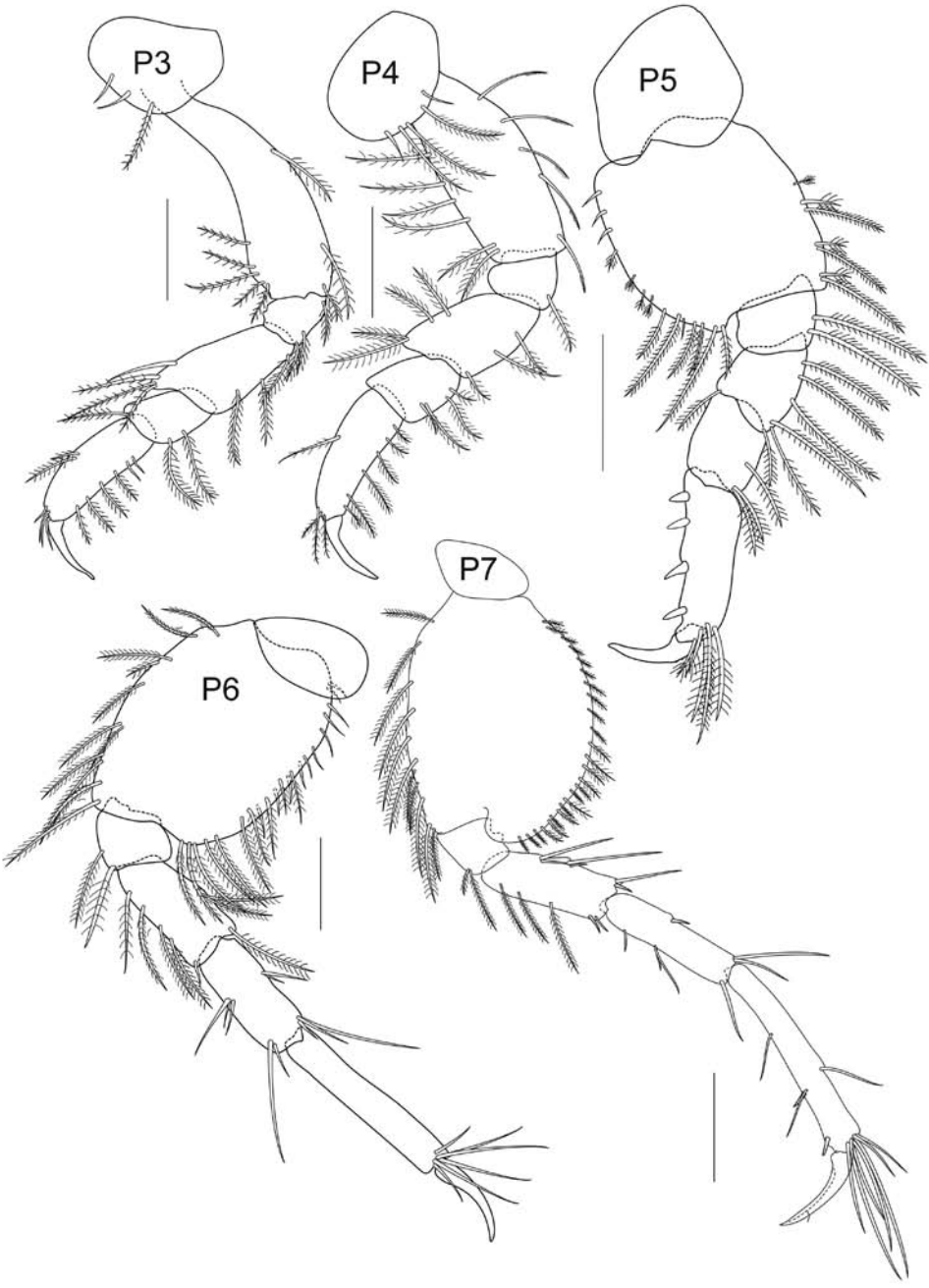

Figure 2C. *Cheiriphotis trifurcata* sp. n., holotype, male, (PSUZC-CR-0264), 3.47 mm. Talet Bay, Lower Gulf of Thailand. All scales represent 0.2 mm.

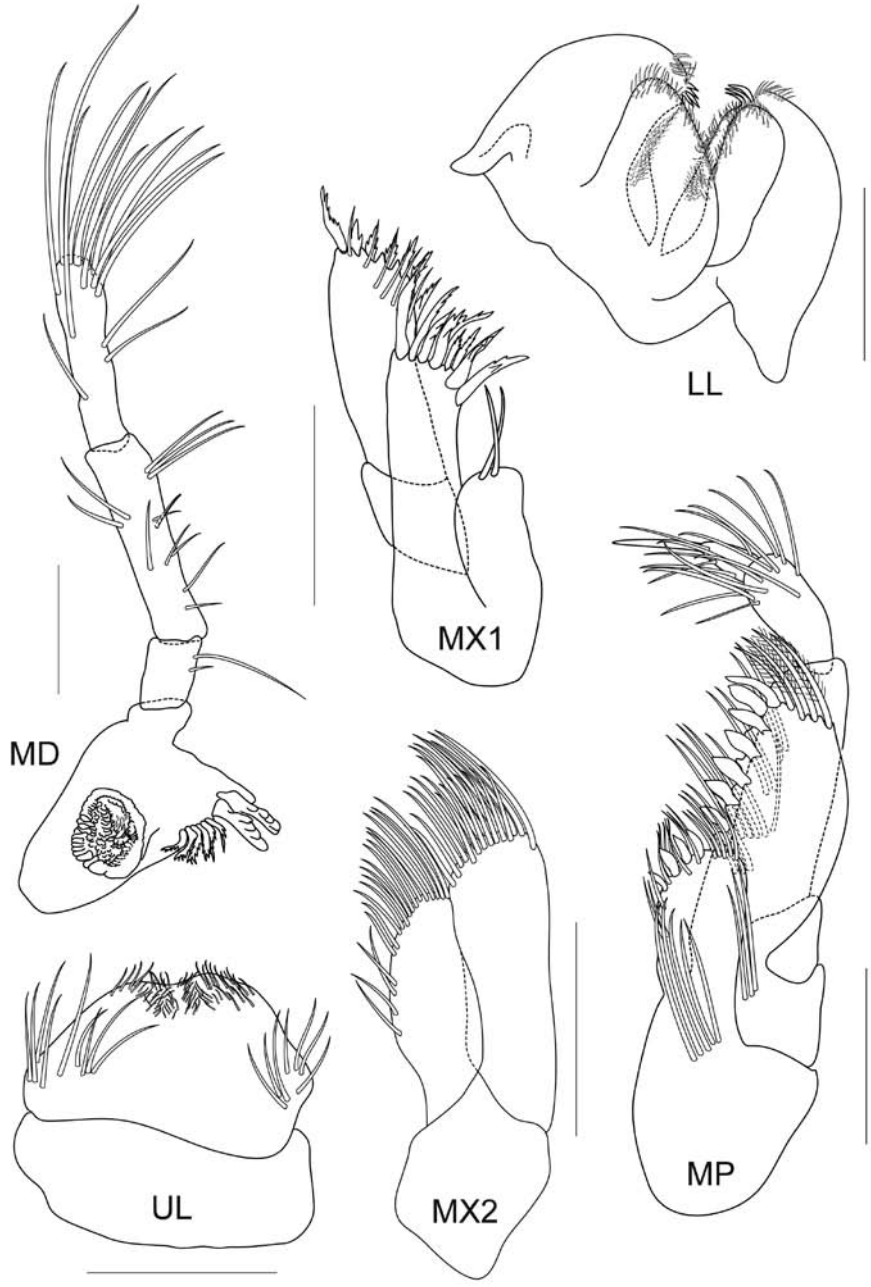

Figure 2D. *Cheiriphotis trifurcata* sp. n., holotype, male, (PSUZC-CR-0264), 3.47 mm. Talet Bay, Lower Gulf of Thailand. All scales represent 0.1 mm.

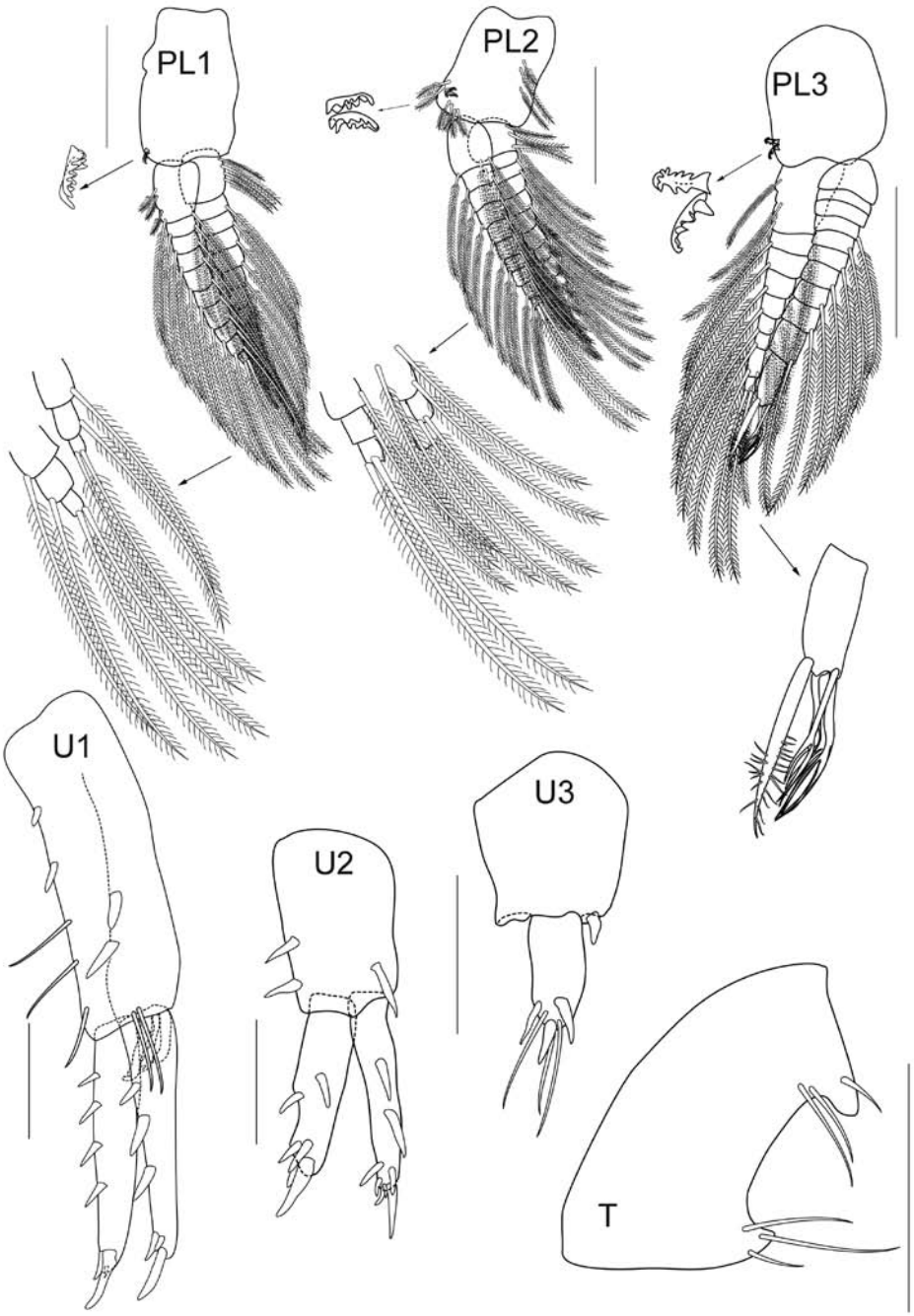

Figure 2E. *Cheiriphotis trifurcata* sp. n., holotype, male, (PSUZC-CR-0264), 3.47 mm. Talet Bay, Lower Gulf of Thailand. Scales for U1– U3 and T represent 0.1 mm; PL1 – PL3 represent 0.2 mm.

produced anterodistally; carpus subrectangular, medially broad, posterior margin setose; propodus subrectangular; basis – propodus bearing plumose setae on both sides; dactylus falcate, long and thin, shorter than propodus. *Pereopod 4* rather similar to pereopod 3, coxal plate suboval with plumose setae on ventral side; length ratio of articles from basis to dactylus about 10:2:5:3:6:4; basis slender; ischium short, subrectangular; merus longer than carpus, slightly produced anterodistally; carpus subquadrate, shorter than propodus; basis to propodus with plumose setae on both margins; propodus long and narrow; dactylus long and thin, shorter than propodus. *Pereopod 5* shorter than pereopod 6 and 7; coxa bilobed; length ratio of articles from basis to dactylus about 14:2:3:3:6:3; basis subrectangular with plumose setae on both margins; ischium shortest with posteromarginal plumose setae; merus subequal to carpus, with posteromarginal plumose setae and 1 anterodistal seta; carpus with posteromarginal plumose setae; propodus with 4 robust setae along posterior margin; dactylus short, strongly curved. *Pereopod 6* elongate, 1.5 times as long as pereopod 5; coxa posteriorly produced with rounded lobe; length ratio of articles from basis to dactylus about 5:2:3:3:5:2; basis oval with plumose setae on both margins; ischium short with plumose setae on anteroventral corner; merus oblong, with plumose setae on both margins; carpus shorter than propodus, bearing long setae; propodus slender with marginal robust setae and setose posterodistally; dactylus falcate. *Pereopod 7* elongate, 1.6 times as long as pereopod 5; coxa short and wide, subtriangular, anteriorly produced; length ratio of articles from basis to dactylus about 13:5:7:7:11:6; basis posteriorly produced, bearing plumose setae on both margins; ischium short and subquadrate with plumose setae on anterodistal corner; merus elongate with plumose setae on both sides; carpus subequal to merus, both margins with sparse setae; propodus slender, longer than merus, distally extended; bearing setae on both margins and one robust seta on anterodistal corner; dactylus falcate, with one thin seta at 2/3 from proximal end.

Pleon. *Pleopods 1–2* well developed; peduncles subcylindrical, longer than broad and fringed with several plumose setae and a pair of retinaculae on the inner margin; inner ramus subequal to peduncle with 9–10 articles, outer ramus shorter than inner ramus, both rami with facial setae.

Pleopod 3 similar to pleopod 1 and 2 except the tip of outer ramus modified; bearing long setae with sparse setule and having three additional modified setae with three forked tips respectively, outer ramus longer than inner ramus.

Uropod 1 longest, extending beyond uropods 3; peduncle longer than both rami, beset with robust setae, peduncular apex bearing 3 posteroventral robust setae; outer and inner margins of both rami lined with a row of robust setae, distal margin rounded and bearing several robust setae. *Uropod 2* not reaching uropod 3, peduncle shorter than rami, both outer and inner margins with a row of robust setae; outer ramus slightly longer than inner one, both rami lined with a row of robust setae and distal margin bearing several short and long robust setae. *Uropod 3* uniramous, peduncle extended with robust seta on apex, subequal to ramus; apically 3 robust setae and 2 setae. *Telson* subtrapezoidal, distally excavated with long simple setae near both distal corners.

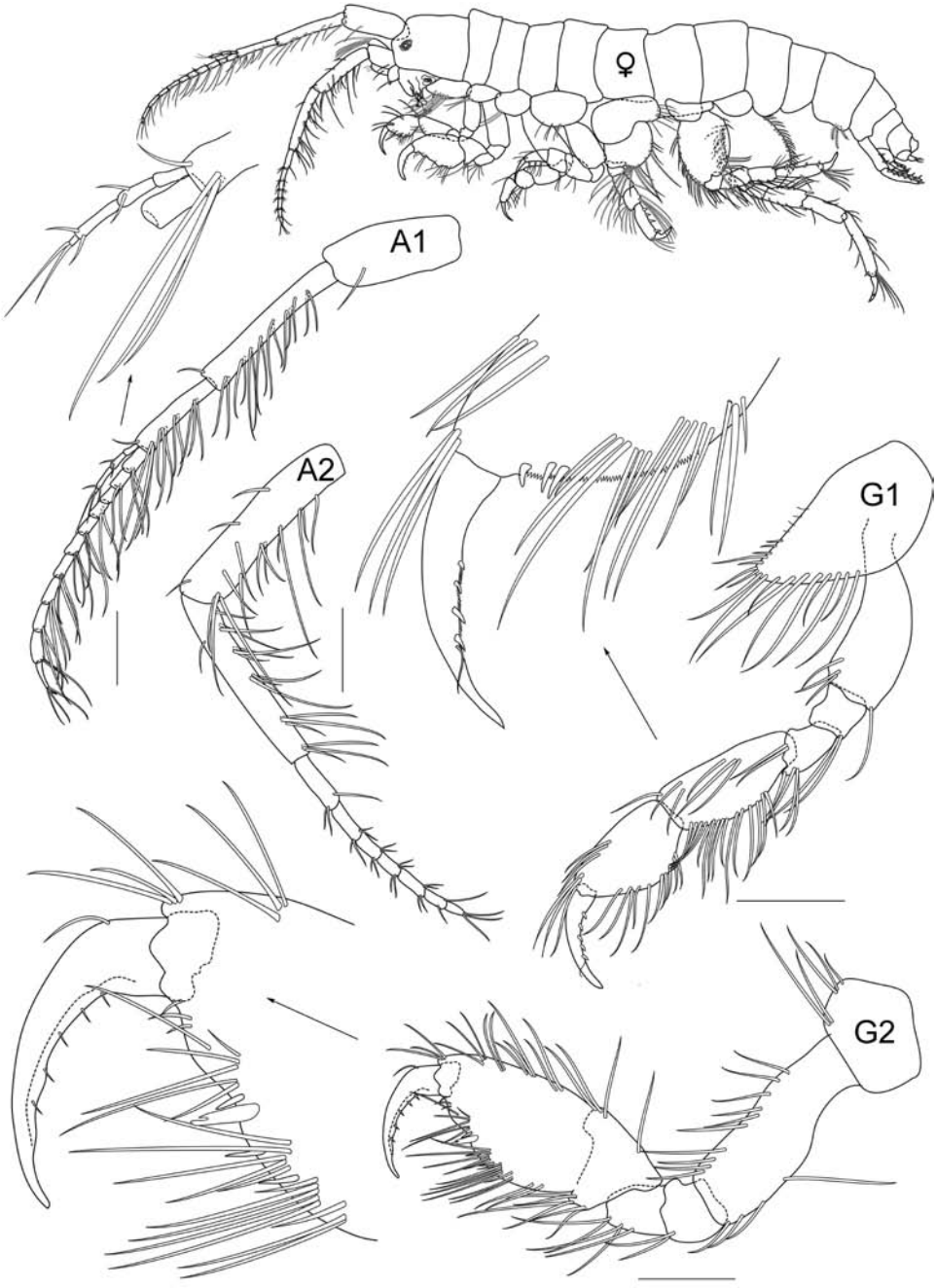

Figure 3A. *Cheiriphotis trifurcata* sp. n., allotype, female, (PSUZC-CR-0265), 4.16 mm. Talet Bay, Lower Gulf of Thailand. All scales represent 0.2 mm.

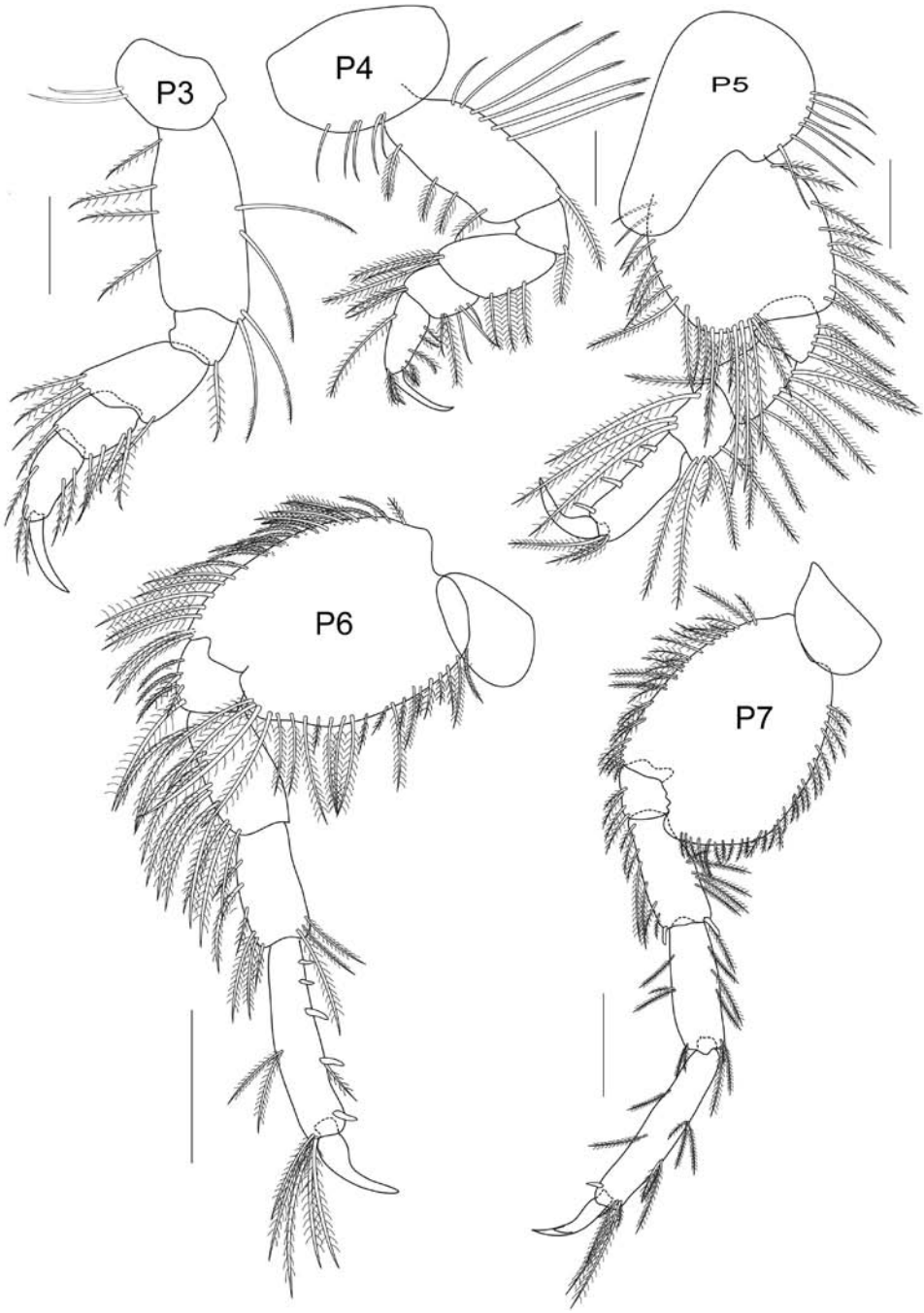

Figure 3B. *Cheiriphotis trifurcata* sp. n., allotype, female, (PSUZC-CR-0265), 4.16 mm. Talet Bay, Lower Gulf of Thailand. All scales represent 0.1 mm.

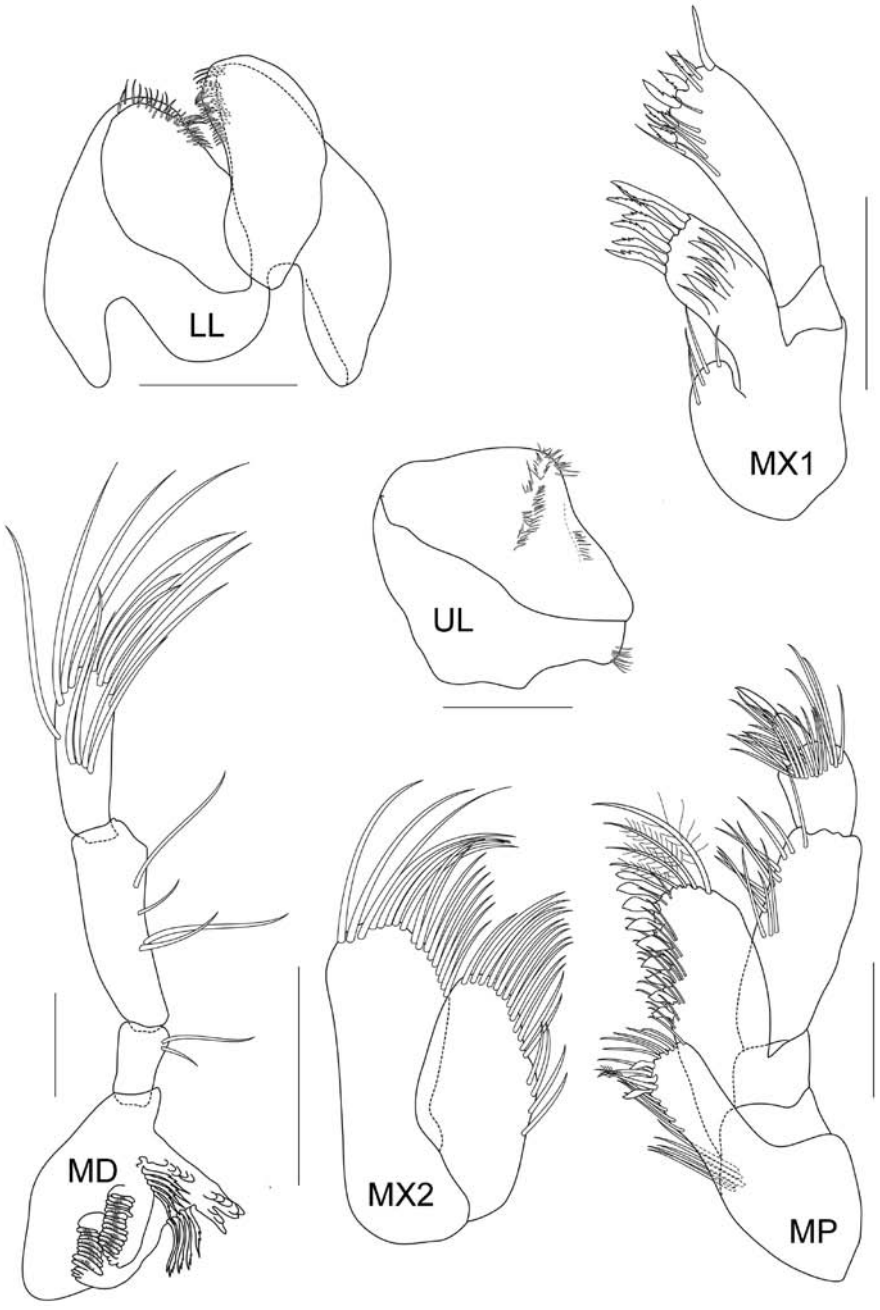

Figure 3C. *Cheiriphotis trifurcata* sp. n., allotype, female, (PSUZC-CR-0265), 4.16 mm. Talet Bay, Lower Gulf of Thailand. All scales represent 0.1 mm.

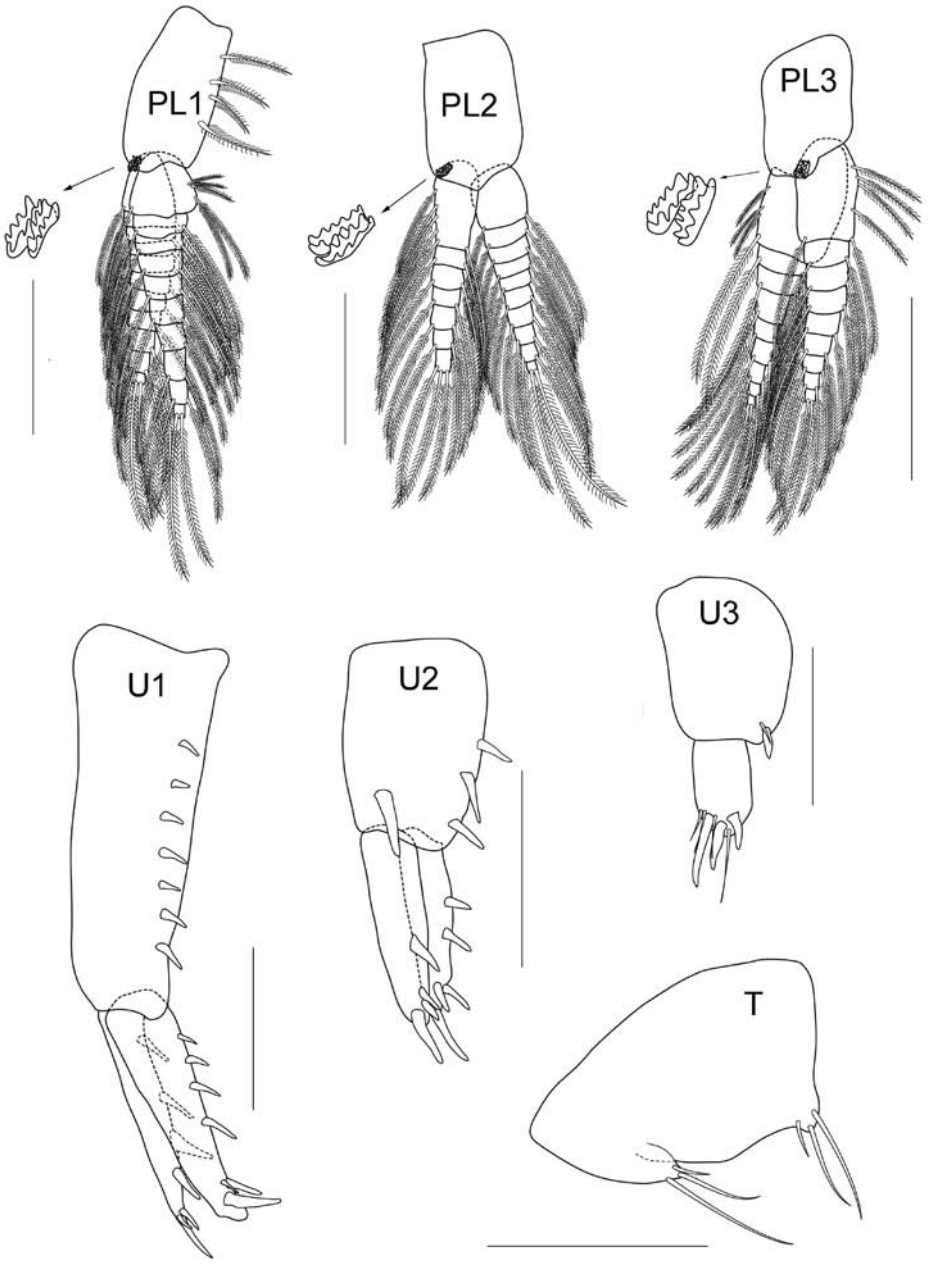

Figure 3D. *Cheiriphotis trifurcata* sp. n., allotype, female, (PSUZC-CR-0265), 4.16 mm. Talet Bay, Lower Gulf of Thailand. Scale for U1-U3 and T represents 0.1 mm; remaining represents 0.2 mm.

Female. (*allotype*). Total body length 4.2 mm (from tip of rostrum to apex of telson). – (sexually dimorphic characters).

Antenna 1 flagellum with 12 articles.

Pereon. *Gnathopod 2* subchelate, smaller than that of male, basis to propodus setose; basis more slender, about 2.3 times as long as broad; carpus subtriangular, as long as broad; propodus suboval, longer than carpus, palm oblique and defined by a large bifid robust seta, palmar margin convex, distal end covered with sparse setae; dactylus curved with 5 inner marginal short setae. Coxa 4 and 5 longer than those of male.

Pleopod 3 without modified tip of outer ramus.

Etymology. The specific name "*trifurcata*" is from latin 'tri = three' and 'furcated = forked', referring to the distinct three forked tips of the modified setae on the outer ramus in male pleopod 3.

Remarks. Even *Cheiriphotis trifurcata* shows a distinct character, with the presence of the three additional modified setae in male pleopod 3 and each seta equipped with three forked tips, but this character might be overlooked in other species. Besides, the general characters in the present species are closely related to *C. williamsoni*, *C. neotropicalis*, *C. mediterranea* and *C. walkeri* especially in the; 1) fused carpus-propodus of male gnathopod 2; 2) propodus with transverse palm and; 3) uropod 3 uniramus. Further examination on the present species also indicated that *C. trifurcata* can be distinguished from *C. williamsoni* by the male gnathopod 1 which has the carpus longer than the propodus and the palm of male gnathopod 2 which bears 4 blunt teeth and 4 blunt teeth and one acute palmar corner. The present species also differs from *C. neotropicalis* in the carpus of male gnathopod 1 which is longer than the propodus and the propodus of male gnathopod 2 as long as broad in contrast to *C. neotropicalis* where the carpus of gnathopod 1 is subequal to propodus and propodus of gnathopod 2 is broader than long.

Cheiriphotis trifurcata shares a character of epimeron 2 with plumose setae on the ventral margin of epimera 2 with four known congeners, *C. erythraeus*, *C. mediterranea*, *C williamsoni* and *C. neotropicalis.* The former can be distinguished from *C. erythraeus* by the carpus of the male gnathopod 1 which is partly fused with the propodus, the transverse palm which has 4 blunt teeth and the uniramus uropod while in the latter the carpus of the male gnathopod 1 is not fused with the propodus, the palm is medially V-shaped excavated with two teeth on both sides and the uropod is biramus. *Cheiriphotis trifurcata* is easily separated from *C. mediterranea* by the distally expanded peduncle of uropod 3 (vs. peduncle of uropod 3 not expanded distally).

To date, only one species of *Cheiriphotis* (i.e. *C. megacheles*) has been reported from the Andaman Sea and the South China Sea (Imbach 1967 and Rabindranath 1971). The absence of robust setae along the palm of gnathopod 1, the unfused carpus-propodus of the male gnathopod 2, a rounded epimeron 2, and the biramus uropod 3 in *C. megacheles* readily differentiates that species from the present one.

Table 1. Comparison of some distinguished characters between *Cheiriphotis trifurcata* sp. n. and the related species

Characters	Accessory flagellum	♂ G1 palm	♂ G1 carpus: propodus	♂G2 carpus and propodus	♂G2 propodus	♂ G2 palm	epimeron 2	♂pleopod 3	U3
C. trifurcata	4 articles	oblique with a robust seta at the proximal half	>	fused	as broad as long	palm transverse, with 5 blunt teeth	with plumose setae on ventral margin	outer ramus last article modified	uniramus peduncle expanded distally
C. erythraeus Ruffo,1969	4 articles	oblique, palm longer than posterior margin	=	not fused	longer than broad	palm transverse, half way excavated with two teeth on both side and a defining tooth	with plumose setae on ventral margin	normal	biramus, inner ramus small
C. mediterranea Myers, 1983	4 articles	oblique, posterodistal excavated	>	fused	broader than long	palm transverse, with 3 rounded lobes and a defining tooth	with plumose setae on ventral margin	normal	uniramus, peduncle poorly expanded
C. megacheles (Giles,1885)	5 articles	oblique, not distinctly defined,	>	not fused	as long as broad	palm oblique, palmar corner with a strong tooth projecting posteriorly	round	normal	biramus, inner ramus small
C. neotropicalis Valerio-Berado et al. 2007	3 articles, last article small	palm excavate, defining palm with subdistal robust seta	=	fused	broader than long	palm transverse, with three rounded lobes and a defining tooth	with plumose setae on ventral margin	normal	uniramus, peduncle poorly expanded
C. walkeri Stebbing, 1918	no data	palm oblique, emarginate at anterior margin	>	fused	broader than long	palm transverse with 2 depressions	round	normal	uniramus
C. williamsoni Salman & Jabbar, 1990	4 articles	palm oblique, longer than posterior margin	<	not fused	slightly longer than broad	palm transverse, with 3 large blunt teeth and a defining tooth,	round	normal	uniramus, peduncle broad

World key to species of *Cheiriphotis*

1 Male gnathopod 2 carpus vestigial, partly fused with propodus **2**
– Male gnathopod 2 carpus not fused with propodus **6**
2 Male gnathopod 1 palm excavate, palmar corner with subdistal robust seta, carpus subequal to propodus..... ..... ***C. neotropicalis*** **Valerio-Berardo, de Sousa&Rodigues, 2007**
– Male gnathopod 1 palm not excavate..... **3**
3 Male gnathopod 1 carpus shorter than propodus, palm longer than hind margin ..... ***C. williamsoni*** **Salman & Jabbar, 1990**
– Male gnathopod 1 capus longer than propodus, palm shorter than hind margin **4**
4 Epimeron 2 without plumose setae on ventral margin, male gnathopod 2 basis dilated in anterodistal corner ..... ***C. walkeri*** **Stebbing, 1918**
– Epimeron 2 with plumose setae on ventral margin, male gnathopod 2 basis not dilated in anterodistal corner **5**
5 Male outer ramus of pleopod 3 tip modified into fork shape, gnathopod 2 carpus rectangular..... ***C. trifucata*** **sp. n.**
– Male outer ramus of pleopod 3 not modified, gnathopod 2 carpus triangular ..... ***C. mediterranea*** **Myers, 1983**
6 Accessory flagellum 2 articles ..... ***C. minima*** **Ledoyer, 1982**
– Accessory flagellum more than 2 articles 7
7 Male gnathopod 2 palm oblique **8**
– Male gnathopod 2 palm transverse..... **14**
8 Male gnathopod 1 palm acute, longer than hind margin..... ..... ***C. australiae*** **Stebbing, 1910**
– Male gnathopod 2 palm not as above, not longer than hind margin **9**
9 Uropod 3 uniramus **10**
– Uropod 3 biramus, inner ramus small..... **13**
10 Male gnathopod 1 carpus subequal to propodus ..... ***C. delloyei*** **Pirlot, 1934**
– Male gnathopod 2 carpus longer than propodus 11
11 Male gnathopod 2 propodus as long as broad .... ***C. megacheles*** **(Giles, 1885)**
– Male gnathopod 2 propodus longer than broad **12**
12 Epimeron 2 with 2 notches on distoinferior corner..... ..... ***C. pediformis*** **Myers, 1995**
– Epimeron 2 round on distoinferior corner .... ***C. madangensis*** **Ledoyer, 1979**
13 Male gnathopod 2 basis robust, wider than half of the length .... ***C. durbanensis*** **K.H. Barnard, 1916**
– Male gnathopod 2 basic slender, not wider than half of the length .... ***C. rotui*** **Myers, 1989**
14 Palm not excavated and smooth, defining tooth long like a finger, directed fore and upward..... ***C. quadrichelatus*** **Ortiz & Lalana,1997**
– Palm medially V-shaped excavated with two teeth on both sides and a not much longer defining tooth ..... ***C. erythaeus*** **Ruffo, 1969**

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References

Angsupanich S, Kuwabara R (1995) Macrobenthic fauna in Thale Sap Songkla, a brackish lake in southern Thailand. Lakes & Reservoirs: Research and Management 1: 115–125. doi: 10.1111/j.1440-1770.1995.tb00012.x

Angsupanich S, Siripech A, Charoenpornthip M (2005) Macrobenthic fauna community in the Middle Songkhla Lake, Southern Thailand. Songklanakarin Journal of Science and Technology 27 (1): 365–390.

Ariyama H, Angsupanich S, Rodcharoen E (2010) Two new species of the genus *Kamaka* (Crustace: Amphipoda: Kamakidae) from the Songkla Lagoon, southern Thailand. Zootaxa 2404: 55–68.

Barnard KH (1916) The Amphipoda. Contribution to the crustacean fauna of South Africa. Annals of the South Africa Museum 15:105–304.

Bussarawich S (1985) Gammaridean Amphipoda from mangroves in southern Thailand. In Fifth Seminar on Mangrove Ecosystems Phuket, Thailand, 1–17.

Chilton C (1925) The Amphipoda of Tale Sap. Zoological result of a tour in far East. Memoirs of the Asiatic Society of Bengal 6: 531–539.

Giles GM (1855) Natural history notes from H.M.'s Indian marine survey steamer 'Inverstigator', commander Alfred Carpenter, R.N. commanding [sic on comma]. No.1. On the structure and habitats of *Cyrtophium calamicola*, a new tubicolous amphipod from the Bay of Bangal. Journal of the Asiatic Society of Bengal 54: 54–59, pl.1.

Imbach MC (1969) Gammaridean Amphipoda from the South China Sea. Naga Report 4: 39–167.

Leach WE (1814) Crustaceology. – The EdinburghEncyclopaedia 7: 383–437.

Ledoyer M (1979) Les gammariens de la Pente externe du grand reçif de Tulear (Madagascar) (Crustacea Amphipoda). Memorie del Museo Civico di Storia Naturale di Verona (2nd Ser.) 2: 1–150.

Ledoyer M (1982) Faune de Madagascar. Crustacés Amphipodes Gammariens;Families des Haustoriidae a' Vitjazianidae. Centre National de la Recherche Scientifique-Paris 59 (2).

Myers AA (1983) A new species of *Cheiriphotis* Walker from the Mediterranean Sea (Amphipoda: Iseidae). Bolletino Museo Civio Storia Naturale Verona 10: 541–542

Myers AA (1989) Amphipoda from the South Pacific: the Society Islands. Records of the Australian Museum 41(1): 63–82. doi: 10.3853/j.0067-1975.41.1989.136

Myers AA (1995) The Amphipoda (Crustacea) of Madang Lagoon: Aoridae, Isaeidae, Ischyroceridae, and Neomegamphopidae. Records of the Australian Museum Suppl. 22: 22–95.

Myers AA, Lowry JK (2003) A Phylogeny and a new Classification of the Corophiidea Leach, 1814 (Amphipoda). Journal of Crustacean Biology 23(2): 443–485. doi: 10.1651/0278-0372(2003)023[0443:APAANC]2.0.CO;2

Ortiz M, Lalana R (1997) Amphipoda. Travaux du Muséum National d`Histoire Naturelle "Grigore Antipa" 38: 29–113.

Pirlot JM (1934) Les amphipodes de l'expédition du Siboga. Deuxième partie: Les amphipodes gammarides, II. Les amphipodes de la mer profonde 2. (Hyperiopsidae, Pardaliscidae, Astyridae nov. fam., Tironidae, Calliopiidae, Paramphithoidae, Amathillopsidae nov. fam., Eusiridae, Gammaridae, Aoridae, Photidae, Ampithoidae, Jassidae. Siboga-Exped. Monogr. 33d: 167–235.

Rabindranath P (1971) On a collection of Isaeidae (Crustacea Amphipoda) from the southern Indian region. Bijdragen tot de Dierkunde 41(2): 67–93.

Ruensirikul J, Angsupanich S, Phongdara A (2007) Abundance and diversity of amphipod crustaceans in the Upper Songkhla Lagoon. Songklanakarin Journal of Science and Technology 29: 1225–1249.

Ruffo S (1969) Studi sui Crostacei anfipodi LXVII. Terzo contributo alla conoscenza degli anfipodi del mar Rosso. Memorie del Museo Civico di Storia Naturale Verona 17: 1–77.

Salman SD, Jabbar N (1990) A new speicies of the Genus *Cheiriphotis* Walker, from the North West Arabian Gulf, with a redescription of *C. megacheles* (Giles) (Amphipoda, Isaeidae). Crustaceana 58(2): 214–226. doi: 10.1163/156854090X00129

Stebbing TRR (1910) Crustacea. Part V. Amphipoda: Scientific results of the trawling expedition of HMSC "Thetis". Memoirs of the Australian Museum 4 (2): 564–658.

Stebbing TRR (1918) Some Crustacea of Natal. Annals of the Durban Museum 2: 47–75.

Valério-Berardo MT, De Souza AMT, Rodrigues CW (2007) A new species of *Cheiriphotis* (Crustacea : Amphipoda: Corophiidae: Protomedeiinae) from the coast of Southeastern Brazil, with a key to species in the genus. Zootaxa 1646: 41–49.

Walker AO (1904) Report on the Amphipoda collected by professor Herdman, at Ceylon, in 1902. Report to the Government of Ceylon on Pearl Oyster Fisheries of the Gulf of Manaar, Supplementary Report 17: 229–300.

ANNEX 3

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GRANDIDIERELLA HALOPHILUS A NEW SPECIES OF THE FAMILY AORIDAE (CRUSTACEA: AMPHIPODA) FROM THE SALTPANS OF THE INNER GULF OF THAILAND

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ABSTRACT. — A new species of *Grandidierella* is described from the Inner Gulf of Thailand. This species inhabits high saline waters of abandoned saltpans from the Samut Sakorn district, Thailand. It appears to be closely related to *Grandidierella propodentata* Moore, 1986, also collected at hypersaline environments, in having an accessory flagellum; and arborescent setae on the inner face of the outer lobe of lower lip. The main diagnostic features of *Grandidierella halophilus* new species are a coxal plate 2 with ventral margin posteriorly produced into triangular expansion; uropod 3 peduncle inflated with ramus bearing a small second article; lower lip with arborescent setae on the inner face of the outer lobe; and bifid robust setae on antennae 1–2, gnathopods 1–2, pereopods 5–7, and uropods 1–2. This combination of characters has not been recorded previously in the *Grandidierella*.

KEY WORDS. — *Grandidierella halophilus*, new species, taxonomy, saltpans, Gulf of Thailand

INTRODUCTION

Species of the genus *Grandidierella* Coutière, 1904, are predominant and widespread in brackish, estuarine and coastal waters worldwide. There is extensive literature on the occurrence of *Grandidierella* species from the marine habitats (Myers, 1970, 1981, 1998; Ren, 2006; Bochert & Zettler, 2010; Azman & Othman, 2012), yet there are only two existing records of *Grandidierella* (*G. propodentata* Moore, 1986 and *G. exilis* Myers, 1981) from hypersaline environments. There are many reports of the 40 described species of *Grandidierella* worldwide. However, only three *Grandidierella* species are reported from the waters of Thailand and adjacent archipelagos, namely *G. gilesi* Chilton, 1921, *G. taihuiensis* Morino & Dai, 1990, and *G. gravipes* K. H. Barnard, 1935 (Chilton, 1925; Bussawich, 1985; Angsupanich & Kuwabara, 1995; Angsupanich et al., 2005; Ruensirikul et al., 2007; Ariyama et al., 2010). In the present study we provide a detailed description of both male and female specimens of *G. halophilus* new species collected from abandoned saltpans in the inner Gulf of Thailand. Interestingly, although *G. halophilus* is fairly abundant in these saltpans, there has been no detailed study on this organism.

MATERIAL AND METHODS

This study is based upon material collected from various abandoned saltpans of the Samut Sakorn Province (Fig. 1), Inner Gulf of Thailand in Feb.2011. Samples were collected from the host plant (*Ruppia maritima* Linnaeus) and wet sieved through a 0.55-mm mesh sieve. The materials retained on the sieve were then carefully transferred into plastic containers and fixed in 10% buffered formalin. In the laboratory, amphipod specimens were sorted out and stored in 70% alcohol. The animals were then examined under a compound microscope and later selected for dissection. The appendages of the dissected specimens were examined and figures were produced using a Leica DMLB light microscope with a camera lucida. All illustrations were digitally 'inked' following Coleman (2003). Figure legend: A, antenna; G,

gnathopod; HD, head; LL, lower lip; MD, mandible; MX, maxilla; MP, maxilliped; P, pereopod; Pl, pleopod; T, telson; U, uropod; UR, urosome; UL, upper lip; R, right; L, left; ♂, male; ♀, female. Type material is deposited at Prince of Songkla University Zoological Collection with the prefix PSUZC for museum numbers and the Universiti Kebangsaan Malaysia Muzium Zoologi with the prefix UKMMZ for museum numbers.

TAXONOMY

Genus *Grandidierella* Coutière, 1904

Diagnosis. — *Eyes* small to medium. *Antenna 1*, accessory flagellum minute, 1-segmented. *Maxilla 1*, inner plate vestigial. *Coxae* very small, relatively short of various sizes and shapes. *Gnathopod 1* (male) complexly subchelate and greatly larger than gnathopod 2. *Gnathopod 2* subchelate. *Pereopods 6–7*, dactylus elongate, falcate. *Uropods 1–2* biramous; rami slighty subequal; peduncle with ventrodistal process. *Uropod 3* uniramous. *Telson* entire.

Species composition. — *Grandidierella* contains 41 species: *G. africana* Schellenberg, 1936; *G. bispinosa* Schellenberg, 1938; *G. bonnieroides* Stephensen, 1948; *G. cabindae* (Schellenberg, 1925); *G. chelata* K. H. Barnard, 1951; *G. chaohuensis* Hou & Li, 2002; *G. dentimera* Myers, 1970; *G. elongata* (Chevreux, 1926); *G. exilis* Myers, 1981; *G. fasciata* Ariyama, 1996; *G. gilesi* Chilton, 1921; *G. gravipes* K. H. Barnard, 1935; *G. grossimana* Ledoyer, 1967; ***G. halophilus* new species, 2011**; *G. indentata* Ledoyer, 1979; *G. insulae* Myers, 1981; *G. ischienoplia* Bochert & Zettler, 2010; *G. japonica* Stephensen, 1938; *G. kanakensis* Myers, 1998; *G. koa* J. L. Barnard, 1977; *G. lignorum* K. H. Barnard, 1935; *G. longidactyla* Ledoyer,1982; *G. lutosa* K.H. Barnard,1952; *G. macronyx* K. H. Barnard, 1935; *G. mahafalensis* Coutière, 1904 **(Type species)**; *G. makena* J. L.Barnard, 1970; *G. malaccaensis* Azman & Othman, 2012; *G. nottoni* Shoemaker, 1935; *G. nyala* Griffiths, 1974; *G. osakaensis* Ariyama, 1996; *G. palama* J. L. Barnard, 1977; *G. perlata* Schellenberg, 1938; *G. propodentata* Moore, 1986; *G. robusta* Ledoyer, 1982; *G. rhizophorae* Myers, 2009; *G. spinicoxa* Myers, 1972; *G. taihuensis* Morino & Dai, 1990; *G. teres* Myers, 1981; *G. trispinosa* Bano & Kazmi, 2010; *G. unidentata* Ren, 2006; *G. vietnamica* Dang, 1968.

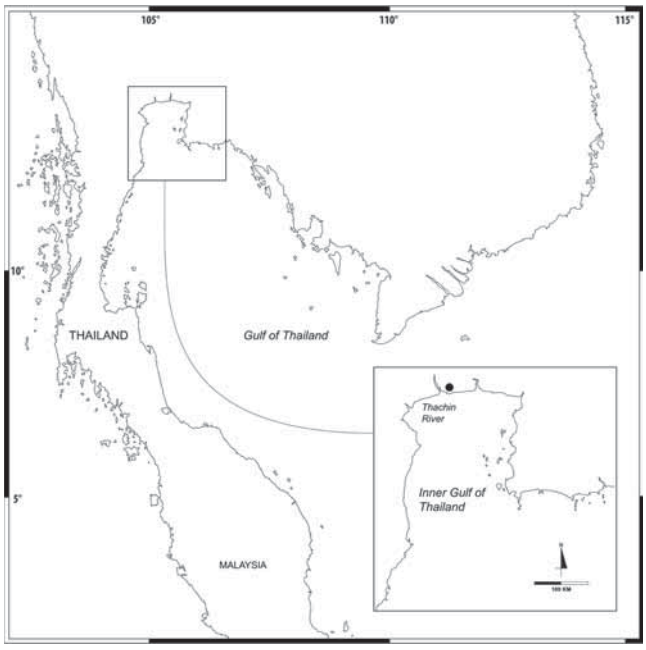

Fig. 1. Map showing the sampling area.

Grandidierella halophilus, new species

(Figs. 2–10)

Type Material. — *Holotype*. Male, THAILAND, Inner Gulf of Thailand, Samut Sakorn (13.5100768°N, 100.3525478°E), abandoned saltpans (associated with *Ruppia maritima* Linnaeus), 24 Feb.2011, Phenpraphai, P., PSUZC-CR-0261.
Allotype. Female, collected with holotype, PSUZC-CR-0262 (adult female, 3.9 mm).
Other material. Same data as holotype, UKMMZ-1431 (10♂; 15♀); PSUZC-CR-0263 (10♂; 20♀).

Description. — **Male** (*holotype*) (Figs. 3–6). Total body length 6.9 mm. *Body* slender and subcylindrical.

Head. *Head* subequal in length to first 2 pereonites; rostrum not developed; inferior antennal sinus moderate and concave, 0.3 times of head length; *eye* distinct. *Antenna 1* (Fig. 3A1) slightly longer than antenna 2, ratio of peduncular articles 1–3 as 1: 1.7: 1.1; article 1 slender, with 2 postero-marginal spines; flagellum with 22 articles, 1.4 times as long as peduncle; accessory flagellum uni-articulate, short. *Antenna 2* (Fig. 3A2) peduncle stout; 4 segmented in ratio of 1: 3: 10: 7; inner margin of article 3 with 3 robust setae and 2 posterodistal robust setae; article 5 shorter than 4; flagellum short, subequal in length to peduncular article 5, composed of 7 articles; flagellum articles 2–7 with a pair of curved bifid robust setae on each article.

Upper lip (Fig. 5UL) or labrum round and broad, with small depression in the middle and pubescent on each lobe. *Lower lip* (Fig. 5LL) inner plates well developed and subtriangular in shape, mandibular process narrow but well developed; outer plate with arborescent setae on the inner face of the outer lobe, covered with thin hairs. *Mandible* (Fig. 5MD), both similar to each other except for number of accessory blades constituting 4 in right and 5 in left ones; right incisor 4 dentates, left incisor 5 dentates; lacinia mobilis armed with 4 teeth on left side and 5 teeth on right; molar process medium, ridged distally and serrate marginally, armed a single seta; palp triarticulate with ratios of 1: 1.2: 1.1, article 3 with apical setae and marginal setae. *Maxilla 1* (Fig. 5MX1), inner plate small; outer plate with 8 apical robust setae; palp extending beyond outer plate, biarticulate with 6 apical spines. *Maxilla 2* (Fig. 5MX2), inner plate with mediofacial row of 25 slender setae and one robust seta located in the middle, outer margin naked; outer plate subequal in size with inner plate. *Maxilliped* (Fig. 5MP), inner plate broad and short, apically provided with several plumose setae and 3 marginal setae; outer plate broad, almost reaching palp

article 2 with 13 marginal spines; palp 4-articulate with ratio of 2: 3: 3.2 : 1.

Pereon. *Gnathopod 1* (Fig. 3G1) carpochelate, larger than gnathopod 2; coxal plate subrectangular, inner side bearing ventral process; length ratio of articles from basis to dactylus 7.8: 1: 2.7: 8: 3.5: 3.5; basis slender, anterior margin straight, 3.9 as long as broad, with one fine seta on posteriodistal margin; ischium short, subrectangular; merus trapezoidal, anterodistally produced; carpus 1.6 times as long as broad, posterodistal corner produced with tooth and a smaller tooth present on inner face, posterior margin setose with a small tooth; propodus subequal to dactylus in length, 0.5 times length of carpus, posterior margin proximally concave, distally expanded; dactylus fairly curved, distal end concave with 2 robust setae. *Gnathopod 2* (Fig. 3G2) subchelate; coxa plate shallow with ventral margins posteriorly produced into triangular expansion; length ratio of articles from basis to dactylus 4.6: 1: 1.7: 3.8: 3.3: 1.8; basis slender, as long as articles 5 and 6 combined, anterior margin straight with 6 fine setae; ischium subrectangular; merus trapezoidal, posterior distal angle produced, posterior margin bearing long setae; carpus 2.5 times as long as wide, posterior margin crenulate, bearing 25 dense setae; propodus palmar margin transverse, with fine setae, bearing a bifid robust seta at posterodistal corner and 2 bifid robust setae on posterior margin; dactylus slightly longer than palmar margin, inner margin crenulate with several fine setules.

Pereopod 3 (Fig. 4P3) slender ; coxa plate small, subquadrate; length ratio of articles from basis to dactylus 4.8: 1: 2.5: 1.7: 1.7: 1.2; basis slender, sparsely setose on anterior and posterior margins and posterodistal corner; ischium short, subrectangular; merus slightly produced anterodistally; carpus suboval, posterior margin setose; propodus narrow, both margin bearing setae; dactylus long and thin, shorter than propodus. *Pereopod 4* (Fig. 4P4) similar to pereopod 3, coxal plate with ventral margin medially produced triangular; length ratio of articles from basis to dactylus 4.1: 1: 2.5: 1.4: 1.6: 1.1; basis slender, with short setae on anterior margin; ischium short, subrectangular; merus slightly produced anterodistally; carpus oval with setae on both anterior and posterior margins; propodus long and narrow, bearing setae on both anterior and posterior margins ; dactylus long and thin. *Pereopod 5* (Fig. 4P5) coxa posteroventrally expanded into long, narrowly obtuse angle; length ratio of articles from basis to dactylus 5.8: 1: 2.2: 1.8: 0.8; basis subrectangular with fine setae along anterior margin; ischium short; carpus with two robust setae along posterior margin and on posterodistally; propodus with four robust setae along posterior margin; dactylus short, strongly curved. *Pereopod 6* (Fig. 4P6) elongate, 1.6 times as long as pereopod 5;

Fig. 2. Photography of Grandidierella halophilus new species, holotype, male, (PSUZC-CR-0261), 6.9 mm; allotype, female, (PSUZC-CR-0262), 3.9 mm, Samut Sakorn, Inner Gulf of Thailand.

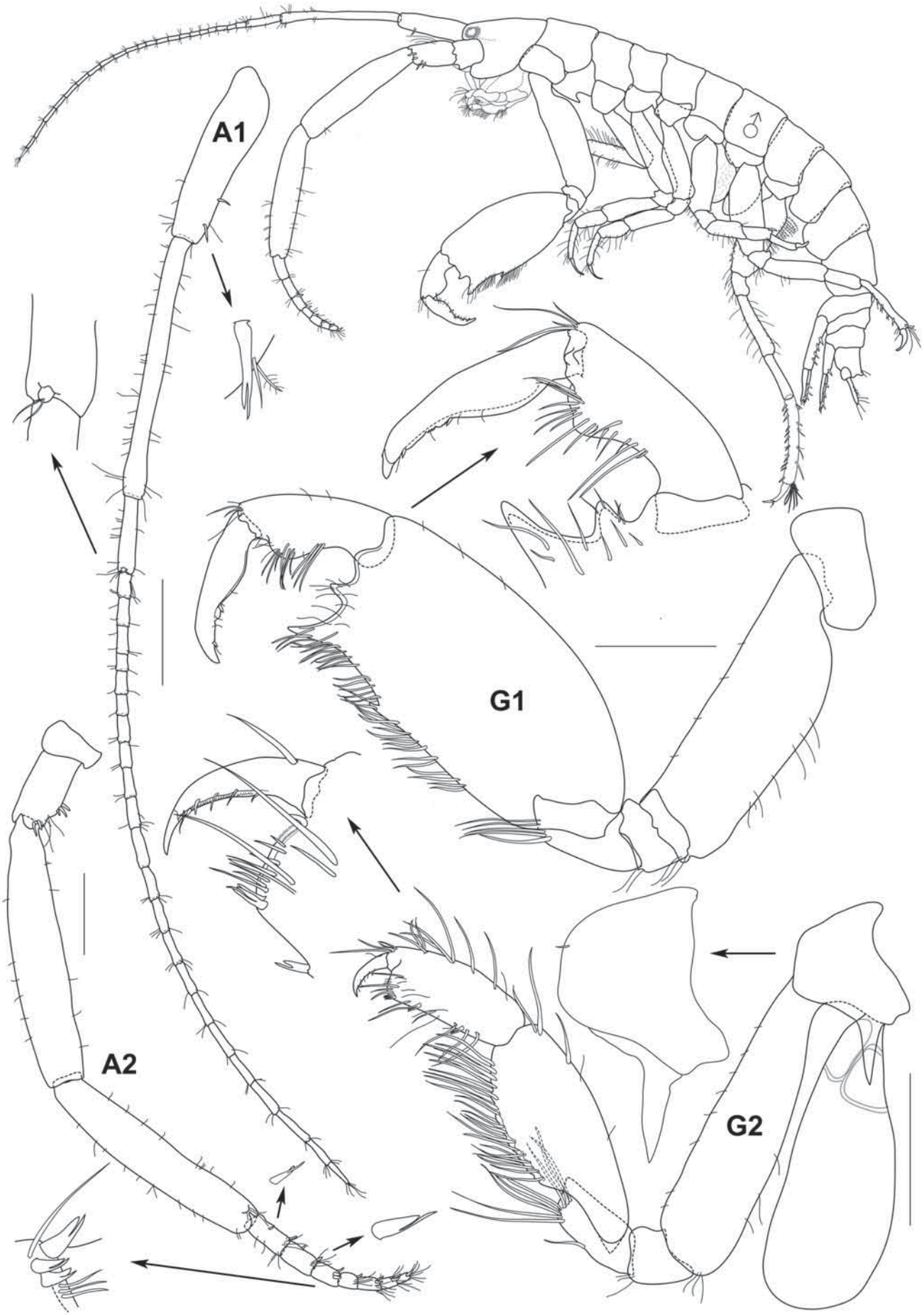

Fig. 3. *Grandidierella halophilus* new species, holotype, male, (PSUZC-CR-0261), 6.9 mm. Samut Sakorn, Inner Gulf of Thailand. All scale bars represent 0.5 mm.

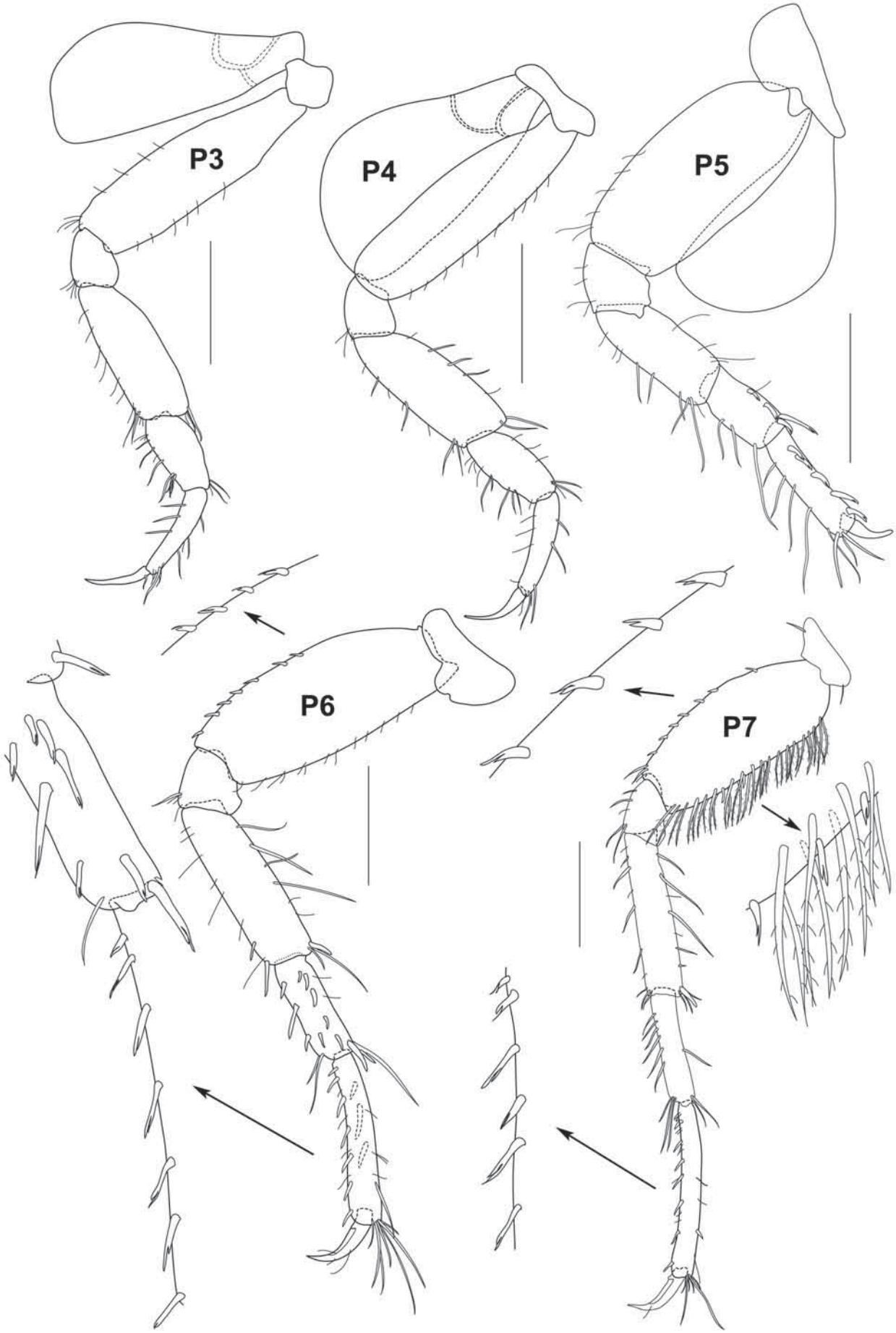

Fig. 4. *Grandidierella halophilus* new species, holotype, male, (PSUZC-CR-0261), 6.9 mm. Samut Sakorn, Inner Gulf of Thailand. All scale bars represent 0.5 mm.

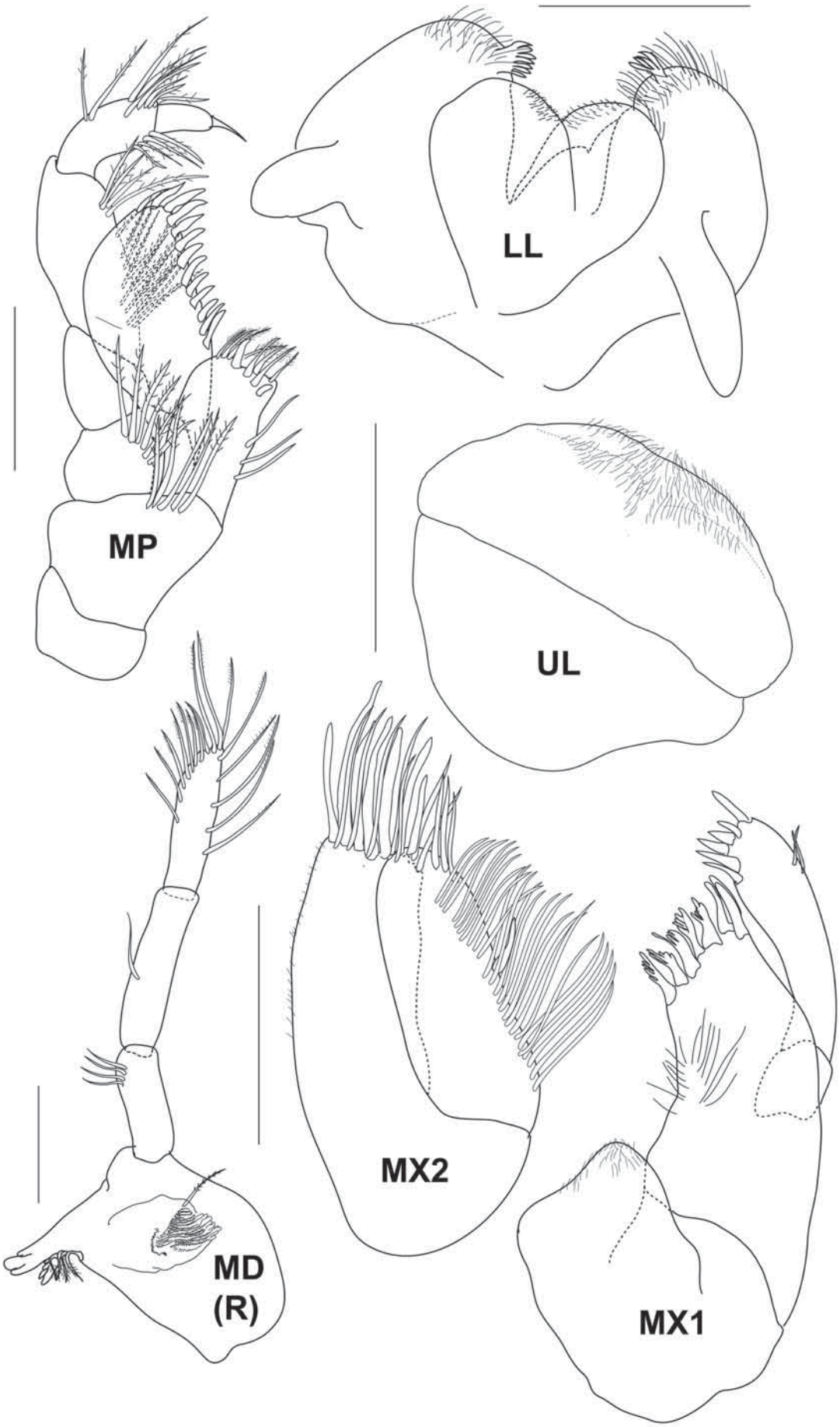

Fig. 5. *Grandidierella halophilus* new species, holotype, male, (PSUZC-CR-0261), 6.9 mm. Samut Sakorn, Inner Gulf of Thailand. All scale bars represent 0.2 mm.

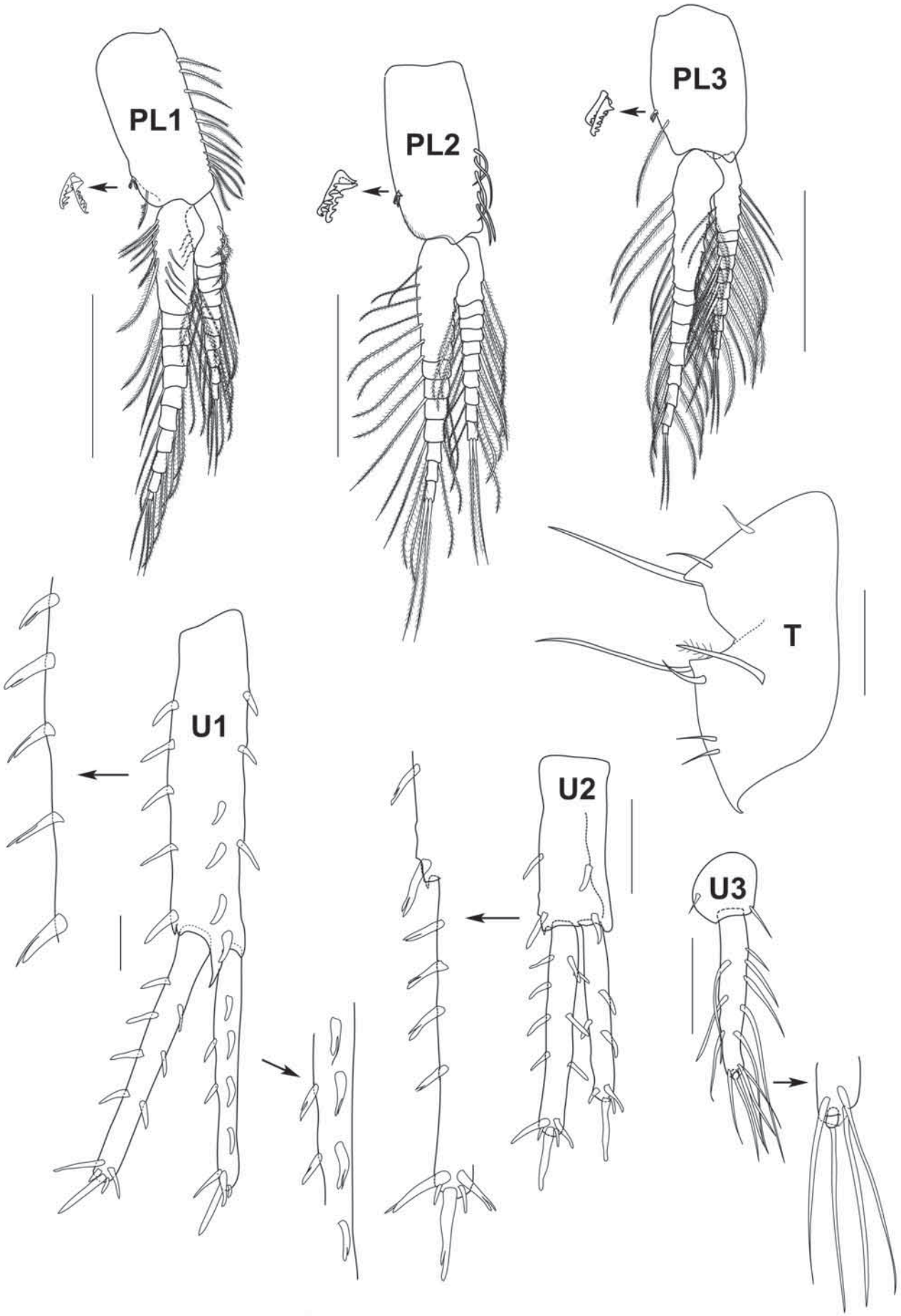

Fig. 6. *Grandidierella halophilus* new species, holotype, male, (PSUZC-CR-0261), 6.9 mm. Samut Sakorn, Inner Gulf of Thailand. Scale bars for U1–U3 represent 0.1 mm; PL1–PL3 represent 0.5 mm; T represents 0.05 mm.

coxa posteriorly produced with rounded lobe; length ratio of articles from basis to dactylus 3.7: 1: 2.7: 1.7: 3.3: 1; basis almost linear, with 7 small bifid robust setae along anterior margin; ischium short with setae on anteroventral corner; merus oblong, with bifid marginal robust setae on both anterior and posterior margins; carpus bearing two rows of bifid robust setae; propodus slender, slightly curved with two rows of marginal robust setae and setose posterodistally; dactylus tapering to a sharply pointed tip, subapex bearing small setae on both sides. *Pereopod 7* (Fig. 4P7) elongate, 1.8 times as long as pereopod 5; coxa bilobed, shallow; length ratio of articles from basis to dactylus 3.3: 1: 2.3: 1.7: 2.7: 1; basis anterior margin with a row of bifid robust setae and posterior margin with long plumose setae bifid robust setae; ischium short and subrectangular; merus elongate with setae on anterior and posterior margins, with one bifid robust seta posterodistally; carpus shorter and narrower than merus with several midlength setae along anterior margin; propodus elongate and slender, slightly curved with bifid robust setae along anterior margin; dactylus tapering to pointed tip, with one thin setae 2/3 from proximal end.

Pleon. *Pleopods 1–3* (Fig. 6PL1-PL3) well developed; peduncles cylindrical, longer than broad and fringed with several plumose setae and a pair of retinaculae on anterior margin; inner ramus slightly longer than peduncle with 9–10 articles, outer ramus shorter than inner ramus, both rami with facial setae.

Uropod 1 (Fig. 6U1) not extending beyond ends of other uropods; peduncle longer than inner and outer rami, fringed with bifid robust setae, peduncular apex bearing a posteroventral process; outer and inner margins of both rami lined with a row of robust setae, distal margins rounded and bearing with several robust setae. *Uropod 2* (Fig. 6U2) slightly longer than uropod 3, peduncle shorter than inner and outer rami, both with two bifid robust setae; outer ramus slightly longer than inner one, both rami lined with a row of bifid robust setae and distal margin bearing short and long robust setae. *Uropod 3* (Fig. 6U3) uniramous, peduncle much shorter than ramus; ramus elongate with short second article, both outer and inner margins with a row of long setae; apex with 4 long stiff setae. *Telson* (Fig. 6T) subtrapezoidal, ending with double pointed apex, each with one long robust seta and one short (thin) seta.

Female. (*allotype*) (Figs. 7–10). Total body length 3.9 mm (from tip of rostrum to apex of telson). – (sexually dimorphic characters).
Antenna 1 (Fig. 7A1) without accessory flagellum, flagellum with 15 articles. *Antenna 2* (Fig. 7A2) peduncular article 3 with 2 bifid robust setae at ventrodistal corner. Maxilla 2, inner plate without robust setae.

Pereon. *Gnathopod 1* (Fig. 7G1) subchelate, smaller than that of male. Coxal plate deeper than those of male; basis more robust, 1.8 times as long as broad; carpus subtriangular, 1.5 times as long as broad, posterior margin setose, with the posterior distal margin produced into a short stout tooth; propodus oval, shorter than carpus, palm oblique and defined by a large bifid robust seta, palmar margin with short setule, distal end covered sparse plumose setae; dactylus curved with 3 inner marginal short stout robust setae. *Gnathopod 2* (Fig. 7G2) similar to that of male, slightly smaller to gnathopod 1;basis slender; carpus 2.2 times as long as wide; propodus wider than that of male, palm transverse and defined by 2 large bifid robust setae; dactylus curved, grasping margin with fine setule and 5 short stout robust setae.

Etymology. — The specific name "*halophilus*" is a combination of the Greek *halos* = salt and *philus* = friend, loving, referring to the habitat in which this species lives.

Remarks. — The specimens of *Grandidierella halophilus* new species were collected in a hypersaline habitat (~80 ppt) and associated with seagrass (*Ruppia maritima* Linnaeus). To date, only two *Grandidierella* species have been reported from hypersaline environments (*G. propodentata* and *G. exillis*). The former species shows a distinctive similarity with *G. halophilus* in the existence of the unusual arborescent setae on the inner face of the outer lobe of the lower lip (Moore, 1986: Fig. 2e. In addition, several differences also can be seen in comparing with *G. propodentata*, including (1) the spout-like male antenna 2 article 4 (vs. normal) (Moore, 1986: Fig. 2a); (2) the inwardly directed proximal tooth on male gnathopod 1 propodus (vs. posterior margin proximally concave, distally expanded; Moore, 1986: Fig. 1a) and (3) male gnathopod 1 carpus triangular with two large subequal teeth at posterodistal corner (vs. posterodistal corner with produced tooth and posterior margin setose with a small tooth; Moore, 1986: Fig. 1a). The new species differs from *G. exillis* in the presence of an accessory flagellum (Fig. 3A1); presence of the arborescent setae on the inner face of the outer lobe of the lower lip (Fig. 5LL); and by the presence of a second article on uropod 3 ramus (Fig. 6U3).

A sternal process in the male *G. halophilus* new species is seems to be unique among *Grandidierella* members. Only four species, *G. bonnieroides*, *G. exillis*, *G. trispinosa*, and *G. spinicoxa* share this distinct character. The new species, *Grandidierella halophilus*, is similar to *G. bonnieroides* in having the male sternal process; gnathopod 1 carpochelate with posterodistal corner with a produced tooth, inner face with a produced small tooth and posterior margin setose with a small tooth. As reported by Myers (1970), in his investigations on material from the Caribbean and Gulf of Mexico, the sternal process in *G. bonnieroides* shows considerable variation between populations, suggesting that most of the populations are genetically distinct. In agreement with Asari & Myers (1982), the south Indian *G. bonnieroides* also exhibits distinct local variations displaying the possibility of group sibling species.

Grandidierella halophilus can be easily distinguished from all other known species of the genus in the combination of the following characters: (1) coxal plate 2 with ventral margin posteriorly produced into triangular expansion (Fig. 3G2); (2) uropod 3 peduncle inflated with ramus bearing a small second article (Fig. 6U3); (3) lower lip with arborescent setae on the inner face of the outer lobe (Fig. 5LL). Moreover, all

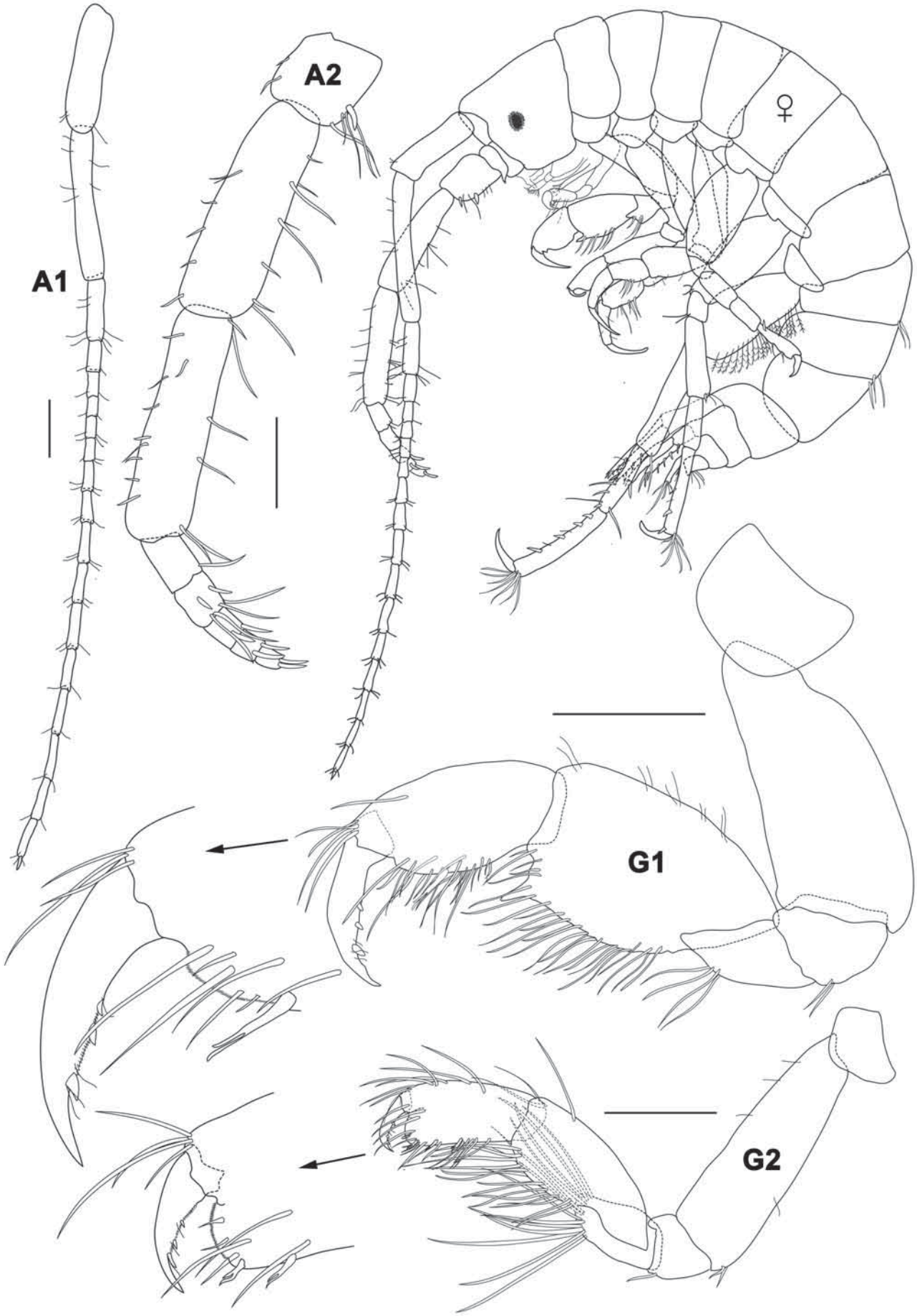

Fig. 7. *Grandidierella halophilus* new species, allotype, female, (PSUZC-CR-0262), 3.9 mm. Samut Sakorn, Inner Gulf of Thailand. All scale bars represent 0.2 mm.

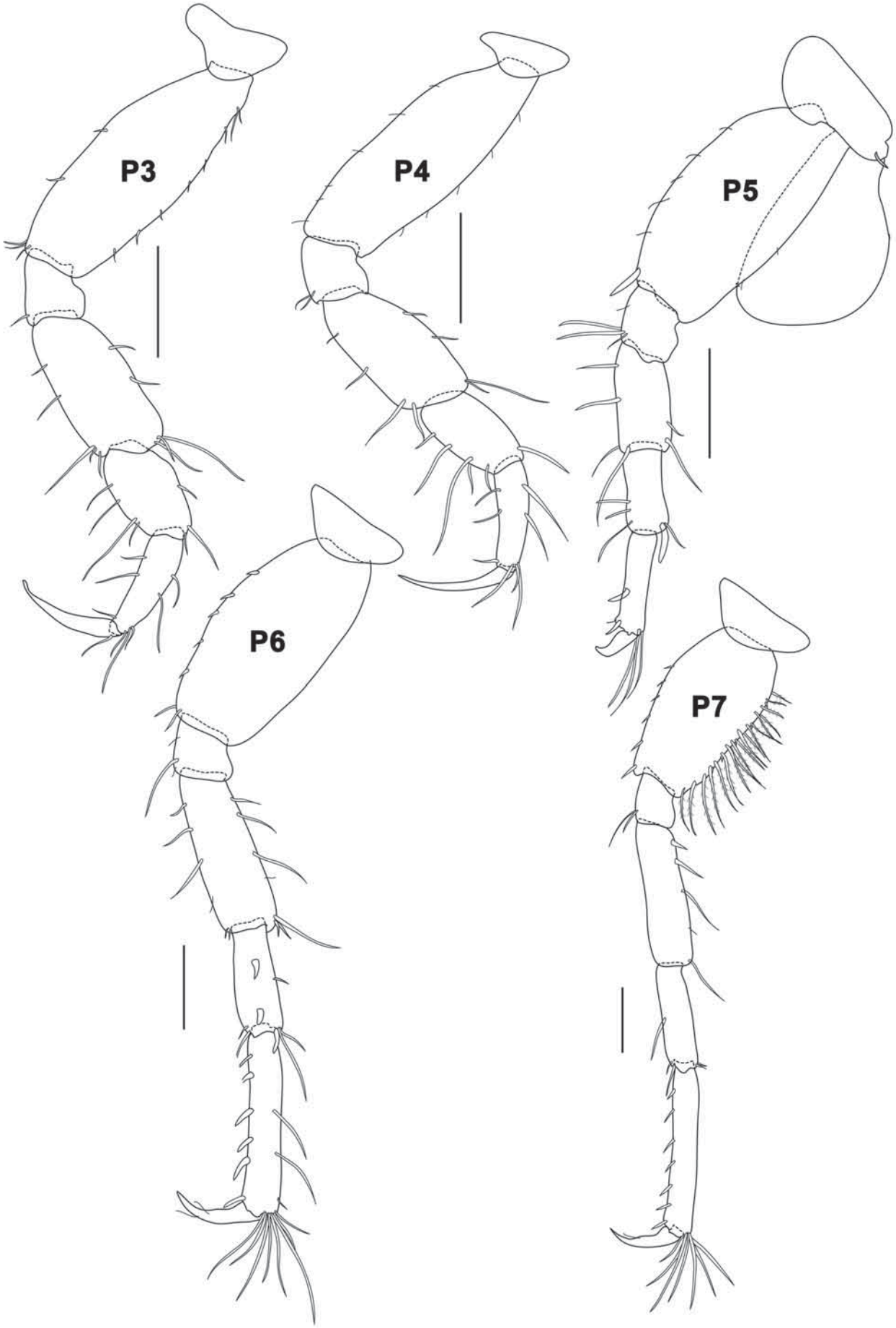

Fig. 8. *Grandidierella halophilus* new species, allotype, female, (PSUZC-CR-0262), 3.9 mm. Samut Sakorn, Inner Gulf of Thailand. All scale bars represent 0.2 mm.

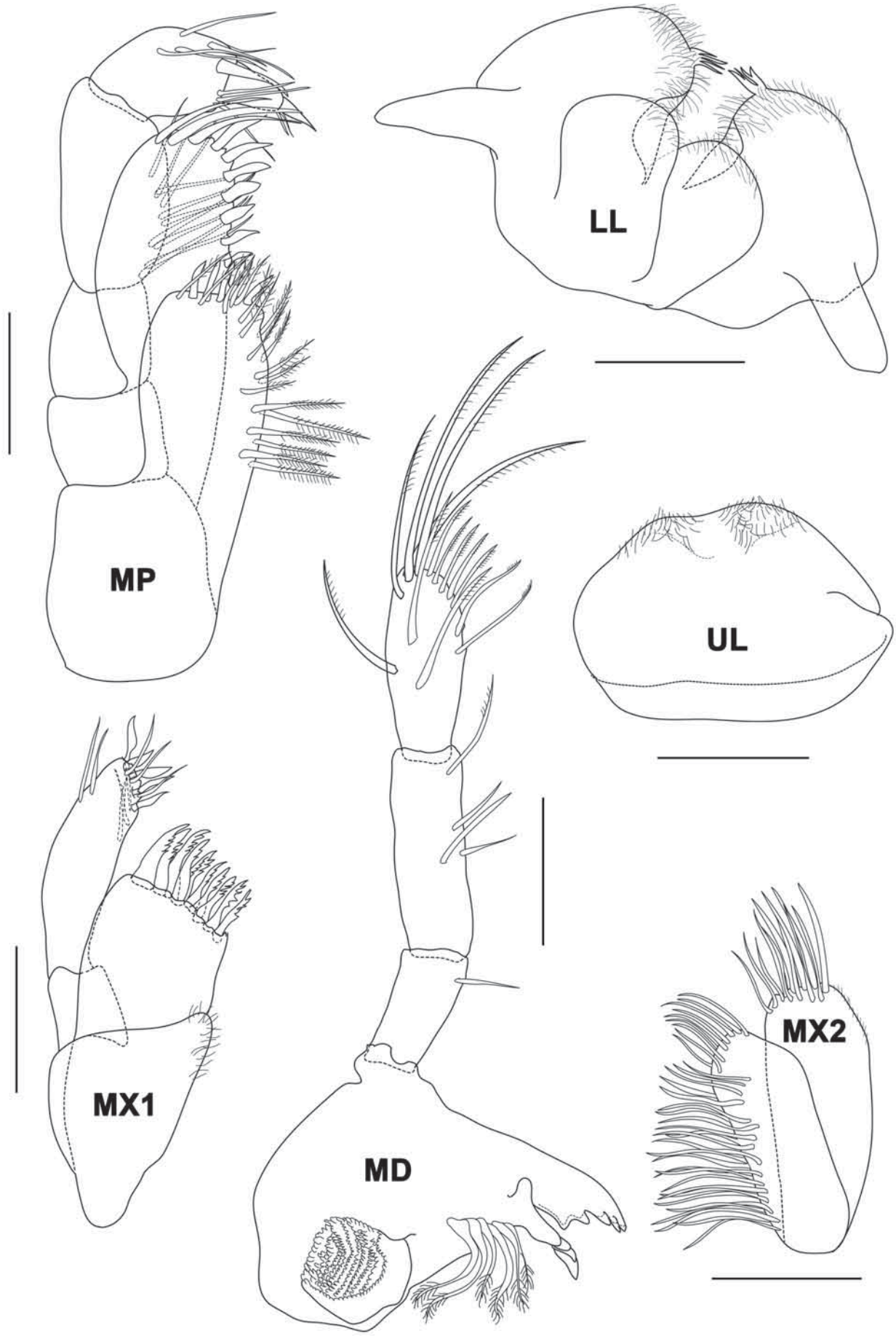

Fig. 9. *Grandidierella halophilus* new species, allotype, female, (PSUZC-CR-0262), 3.9 mm. Samut Sakorn, Inner Gulf of Thailand. All scale bars represent 0.1 mm.

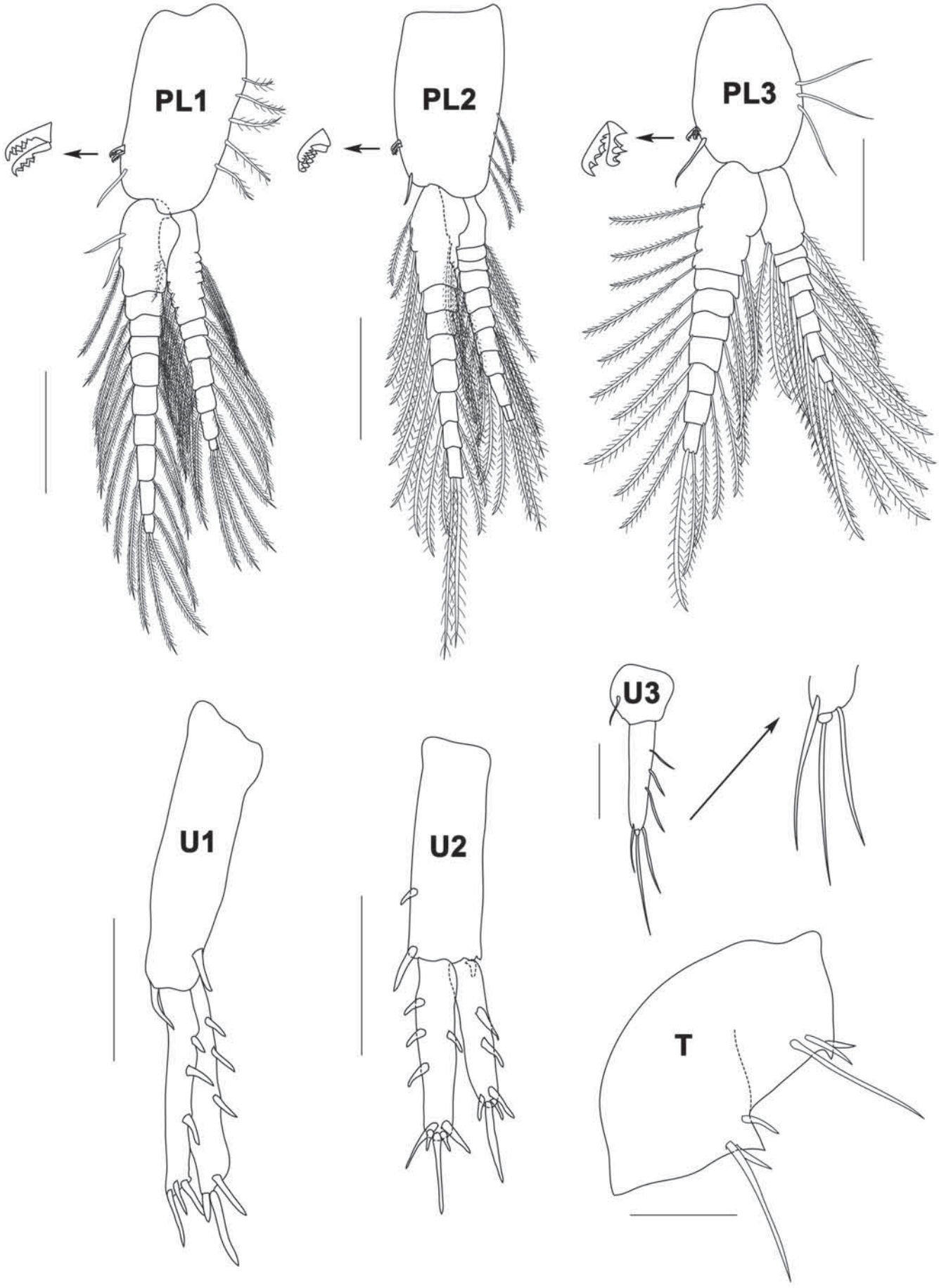

Fig. 10. *Grandidierella halophilus* new species, allotype, female, (PSUZC-CR-0262), 3.9 mm. Samut Sakorn, Inner Gulf of Thailand. Scale bar for U3 represents 0.05 mm; U2, U3 and T represent 0.1 mm, remaining represents 0.2 mm.

Table 1. Comparison of diagnostic character in some closely related *Grandidierella* species.

	Body length (mm)	Accessory flagellum	Lower lip	Sternal spine	Basis of male G1 (Length/Width)	G1 (Carpus: Propodus)	Propodus of male G1	Carpus of G1 (posterior margin)	Basis of G2 (length/width)	Coxae 2–4	Basis of P6 & P7	U3 rami
G. halophilus	6.9	present	outer plate with two finger-like robust setae on lobes	present	slender (4×)	2.9×	posterior margin distally expanded	with a tooth	slender (2.06×) anterior margin smooth	coxa 2 produced anteriorly	anterior with small bifid robust setae	elongate with short second article
G. bispinosa Schellenberg, 1938	4.5	present	outer plate well developed with britle shoulders	absent	stout (2.18×)	2.25×	posterior margin distally expanded	smooth	slender (2.53×), crenulate anterior margin	coxae 2–4 not produced	anterior with small robust setae	elongate with short second article
G. bonneieroides Stephensen, 1948	4.5	absent	outer plate well developed with britle shoulders	present	slender (2.25×)	2×	inflated in the middle	with a tooth	slender (3.2×) anterior margin smooth	coxae 2–4 not produced	anterior with small robust setae	elongate with one article
G. exillis Myers, 1981	7.5	absent	outer plate well developed with britle shoulders	present	slender (2.46×)	2×	inflated in the middle	smooth	slender (5×) anterior margin smooth)	coxae 2–4 not produced	anterior margin with long plumose setae	elongate with one article
G. mahafalensis Coutière, 1904	6.7	present	outer plate well developed with britle shoulders	absent	slender (2.63×)	2.06×	posterior margin distally expanded	with a tooth	slender (3.04×) anterior margin smooth)	coxae 2–4 not produced	anterior margin with long setae	elongate with one article
G. propodentata Moore, 1986	8.2	present	outer plate with two finger-like robust setae on lobes	absent	slender (2.76×)	1.46×	with tooth on basal	smooth	slender (4.29×) anterior margin smooth)	coxae 2–4 not produced	anterior margin with small setae	elongate with one article
G. spinicoxa Myers, 1972	8.0	present	outer plate well developed with britle shoulders	present	slender (2.11×)	2.24×	inflated in the middle	smooth	slender (4×) anterior margin smooth)	coxa 2–4 produce anteriorly	anterior margin with long setae	elongate with one article
G. trispinosa Bano & Kazmi, 2010	6.6	no data	no data	present	slender (2.9×)	3×	posterior margin distally expanded	smooth	slender (3.6×) anterior margin smooth	coxa 2–4 produced anteroirly	anterior margin with long setae	elongate with one article

of the robust setae occurring on antennae 1–2, gnathopods 1–2, pereopods 5–7 and uropods 1–3 are bifid. This character has not been reported elsewhere in the genus but has been shown in illustrations for *G. mahafalensis* (Ruffo, 1958) and *G. propodentata* (Moore, 1986). A summary of the distinguishing characters of the species discussed here given in Table 1.

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LITERATURE CITED

Angsupanich, S. & R. Kuwabara, 1995. Macrobenthic fauna in Thale Sap Songkla, a brackish lake in southern Thailand. *Lakes & Reservoirs: Research and Management*, **1**: 115–125.

Angsupanich, S., A. Siripech & M. Charoenpornthip, 2005. Macrobenthic fauna community in the Middle Songkhla Lake, Southern Thailand. *Songklanakarin Journal of Science and Technology*, **27**: 365–390.

Ariyama, H., 1996. Four species of the genus *Grandidierella* (Crustacea: Amphipoda: Corophiidae) from Osaka Bay and the northern part of the Kii Channel, central Japan. *Publications of the Seto Marine Biological Laboratory*, **37**: 167–193.

Ariyama, H., S. Angsupanich & E. Rodcharoen, 2010. Two new species of the genus *Kamaka* (Crustace: Amphipoda: Kamakidae) from the Songkla Lagoon, southern Thailand. *Zootaxa*, **2404**: 55–68.

Asari, K. P. & A. A. Myers, 1982. Taxonomic studies on the genus *Grandidierella* Coutière (Crustacea, Amphipoda) IV. Indian species. *Bulletin du Museum National d'Histoire Naturelle, Paris*, **4A**: 237–256.

Azman, B. A. R. & B. H. R. Othman, 2012. Two new species of amphipods of the superfamily Aoroidea (Crustacea: Corophiidea) from the Strait of Malacca, Malaysia, with a description of a new genus. *Zoological Studies*, **51**: 232–247.

Bano, H. & Q. B. Kazmi, 2010. *Grandidierella trispinosa*, a new species of amphipod from the Karachi coast, Pakistan (Crustacea: Amphipoda: Aoridae). *Turkish Journal of Zoology*, **34**: 151–157.

Barnard, J. L., 1970. Sublittoral Gammaridea (Amphipoda) of the Hawaiian Islands. *Smithsonian Contributions to Zoology*, **34**: 1–286.

Barnard, J. L., 1977. The cavernicolous fauna of Hawaiian lava tubes 9. Amphipoda (Crustacea) from brackish lava ponds on Hawaii and Maui. *Pacific Insects*, **17**: 267–299.

Barnard, K. H., 1935. Report on some Amphipoda, Isopoda, and Tanaidacea in the collections of the Indian Museum. *Records of the Indian Museum*, **37**: 279–319.

Barnard, K. H., 1951. New records and description of new species of isopods and amphipods from South Africa. *Annals Magazine of Natural History*, **4**: 698–709.

Barnard, K. H., 1952. Description of a new species of amphipod. *Transactions of the Royal Society of South Africa*, **33**: 279–282.

Bochert, R. & M. L. Zettler, 2010. *Grandidierella* (Amphipoda, Aoridae) from Angola with description of a new species. *Crustaceana*, **83**: 1209–1219.

Bussarawich, S., 1985. Gammaridean Amphipoda from mangroves in southern Thailand. *Fifth Seminar on Mangrove Ecosystems.* Phuket, Thailand. Pp. 1–17.

Chevreux, E., 1926. Amphipodes, 1: Gammariens (Cont.). *Voyage de la Goelette France*, **20**: 365–398.

Chilton, C., 1921. Fauna of the Chilka Lake. Amphipoda. *Memoirs of the Indian Museum*, **5**: 519–558.

Chilton, C., 1925. Zoological results of a tour in the Far East. The Amphipoda of Talé Sap. *Memoirs of the AsiaticSociety of Bengal*, **6**: 531–539.

Coleman, C. O., 2003. "Digital inking": How to make perfect line drawings on computers. *Organism, Diversity and Evolution, Electronic Supplement*, **14**: 1–14. http://senckenberg.de/odes/03-14.htm.

Coutiére, H., 1904. Sur un nouveau d'Amphipode *Grandidierella mahafalensis* provenant de Madagascar. *Bulletin de la Societe de Philomath, Paris*, **6**: 166–174.

Dang, N. T., 1968. Nouveaux amphipods des eaux douces et saumatres du Nord Viet Nam. *Zooligichesky Zhurnal*, **47**: 212–222.

Griffiths, C. L., 1974. The Amphipoda of southern Africa. Part 3. The Gammaridea and Caprellidea of Natal. *Annals of the South African Museum*, **62**: 209–264.

Hou, Z. E. & S. Q. Li, 2002. A new species of the genus *Grandidierella* from Lake Chaohu, China (Crustacea: Amphipoda: Aoridae). *Acta Zootaxonomica Sinica*, **27**: 225–234.

Ledoyer, M., 1967. Amphipodes gammariens des herbiers de phanerogammes marines de la region de Tulear (Republique Malgache). *Etude systematique et l'Universite de Madagascar*, **5**: 121–170.

Ledoyer, M., 1979. Expedition Rumphius II (1975). Crustaces parasites, commensaux etc.VI. Crustaces Amphipodes Gammariens. *Bulletin du Museum National d'Histoire Naturelle, Paris*, **1**: 137–181.

Ledoyer, M., 1982. Crustaces Amphipodes Gammariens Famille des Acanthonoozomatidae a Gammaridae. Faune de Madagascar, 59: 1–598. *Bulletin du Museum National d'Histoire Naturelle, Paris*, **3**: 213–226.

Moore, P. G., 1986. A new species in the genus *Grandidierella* Coutière (Crustacea: Amphipoda) from an Australian solar salt-works. *Journal of Natural History*, **20**: 1393–1399.

Morino, H. & A. Dai, 1990. Three amphipod species (Crustacea) from the east China. *Publications of the Itako Hydrobiological Station*, **4**: 7–27.

Myers, A. A., 1970. Taxonomic studies on the genus *Grandidierella*, with a description of *G. dentimera* sp. nov. *Bulletin of Marine Science*, **20**: 135–147.

Myers, A. A., 1972. Taxonomic studies on the genus *Grandidierella* Coutiére (Crustacea: Amphipoda) II. The Malagasy species. *Bulletin du Museum National d'Histoire Naturelle, Paris*, **64**: 789–796.

Myers A. A., 1981. Taxonomic studies on the genus *Grandidierella* Coutière (Crustacea, Amphipoda). III. Fijian, Australian and Saudi Arabian species. *Bulletin du Museum National d'Histoire Naturelle*, **3A**: 213–226.

Myers, A. A., 1998. The Amphipoda (Crustacea) of New Caledonia: Aoridae. *Records of the Australian Museum*, **50**: 187–210.

Myers, A. A., 2009. Aoridae. In: Lowry, J. K. & A. A. Myers (eds.), *Benthic Amphipoda (Crustacea: Peracarida) of the Great Barrier reef, Australia*. *Zootaxa*, **2260**: 220–278.

Ren, X., 2006. Crustacea Amphipoda Gammaridea (I). *Fauna Sinica Invertebrata*, **41**: 1–588.

Ruensirikul, J., S. Angsupanich & A. Phongdara, 2007. Abundance and diversity of amphipod crustaceans in the Upper Songkhla Lagoon. *Songklanakarin Journal of Science and Technology*, **29**: 1225–1249.

Ruffo, S., 1958. Amphipodes Terrestres et des eaux continentales de Madagascar, des Comores et de la Reunion (Etud.es sur les Crustacés Amphipodes. - L). *Mémoires de L'institut Scientifique de Madagascar*, **12**: 35–66.

Schellenberg, A., 1925. Amphipoda, Beiträge zur Kenntnis der Meeres fauna. *Westafrikas*, **3**: 113–204.

Schellenberg, A., 1936. Zwei neue Amphipoden des Stillen Ozeans und zwei Berichtungen. *Zoologischer Anzeiger*, **116**: 153–156.

Schellenberg, A., 1938. Littoral Amphipoden des Topischen Pazifics. *Kungliga SvenskaVetenskapsakademiens Handlingar*, **16**: 1–50.

Shoemaker, C. R., 1935. A new species of amphipod of the genus *Grandidierella* and a new record for *Melita nitida* from Sinaloa, Mexico. *Journal of the Washington Academy of Sciences*, **25**: 65–71.

Stephensen, K., 1938. *Grandidierella japonica* n.sp. A new amphipod with stridulating organ from brackish water in Japan. *Annotationes Zoologicae Japoneses*, **17**: 179–184.

Stephensen, K., 1948. Amphipods from Curaçao, Bonaire, Aruba and Margarita. *Studies on the Fauna of Curaçao, Aruba, Bonaire and the Venezuelan Islands*, **3**(11): 1–20.

ANNEX 4

ZooKeys 307: 15–33 (2013)
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RESEARCH ARTICLE

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Maeropsis paphavasitae and *Rotomelita longipropoda*, two new species (Crustacea, Amphipoda) from Lower Gulf of Thailand

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Abstract

Two new species of maerid and melitid Amphipoda, *Maeropsis paphavasitae* and *Rotomelita longipropoda,* respectively, collected from a seagrassbed of the Lower Gulf of Thailand, are described. *Maeropsis paphavasitae* is characterized by it seven teeth on the palm of gnathopod 2 and *R. longipropoda* can be recognized by its long gnathopod 1 propodus. Their characters are described and illustrated. All specimens are deposited at Princess Maha Chakri Sirindhorn Natural History Museum, Prince of Songkla University, Thailand and the Museum für Naturkunde, Berlin.

Keywords

Crustacea, Amphipoda, Maeridae, Melitidae, *Maeropsis paphavasitae*, *Rotomelita longipropoda*, seagrass bed, Gulf of Thailand, new species, taxonomy

Introduction

The Gulf of Thailand contains many seagrass beds on the coast both the mainland and the islands along the gulf. There are 12 species of seagrass reported from this area. The seagrass habitats in Thailand have been investigated since 1902, covering various topics from both fauna and flora (Prathep et al. 2010). However, only one contribution deals with gammaridean amphipods, *Cheiriphotis trifurcata* was report (Wongkamhaeng et al. 2012). In this study, we describe the two new gammaridean species *Maeropsis paphavasita* sp. n. and *Rotomelita longipropoda* sp. n. , both of which were found in the seagrass. The discovery of them represents the first record of these two genera in South China Sea. Figures and descriptions of both species are provided.

Material and methods

Amphipods were collected using a 20×20cm^2 Ekman's grab in the mix of species seagrass beds of Talet Bay and Phangan Island (Figure 1).The sites were visited at low tide and the specimens were collected from the subtidal zone (2–5 m). The sediment was sieved with a 0.5 mm sieve. Amphipod specimens were sorted out and preserved in 70% ethanol. In the laboratory, the animals were examined using a compound microscope and later selected for dissection. The appendages were examined and figures were drawn using an Olympus CH30 light microscope with a camera lucida. The following abbreviations are used : A, antenna; G, gnathopod; HD, head; LL, lowerlip; MD, mandible; MX, maxilla; MP, maxilliped; P, pereopod; Pl, pleopod; T, telson; U, uropod; UR, urosome;UL, upperlip; r, right;l, left; ♂, male; ♀, female. The type material of the new species is deposited at Prince of Songkla University Zoological Collection (PSUZC) and the Museum für Naturkunde, Berlin (ZMB).

Results

Systematics

Maeridae Krapp-Schickel, 2008

Maeropsis Chevreux, 1919

http://species-id.net/wiki/Maeropsis

Diagnosis (modified from Krapp-Schickel 2008). Eyes reniform or round. Body smooth. Mandible palp article 1 with tooth-shaped distal prolongation, article 3 slender, linear. Maxilla 2 inner plate setation also present laterally. Gnathopods subchelate,

Figure 1. Map of sampling area.

both with well-defined palmar corner. Gnathopod 2 dactylus outer margin smooth; palm with small U-shaped excavation, palmar corner with tooth-shaped elevation and bearing. Pereopod dactyli simple. Uropod 3 with subequal rami, distally truncated, no second article on outer ramus visible. Epimera 1–3 smooth, with posterodistal tip. Telson cleft, lobes distally incised, outer end of incision clearly longer than inner one; with 1-2 setae inserted in incision.

Type species. *Maeropsis perrieri* Chevreux, 1919 (type by monotypy).

Species composition. *Maeropsis brevispina* (Kim & Kim, 1991); *Maeropsis cobia* Krapp-Schickel, 2009; *Maeropsis griffini* (Berents, 1983), *Maeropsis perrieri* Chevreux, 1919 (type species); *Maeropsis paphavasitae* sp. n. (this study); *Maeropsis rathbunae* (Pearse, 1908); *Maeropsis revelata* (Krapp et al., 1996); *Maeropsis serratipalma* (Nagata, 1965).

***Maeropsis paphavasitae* sp. n.**
urn:lsid:zoobank.org:act:103B72E3-73B0-4DA4-A1CC-CC0BFD3D0C72
http://species-id.net/wiki/Maeropsis_paphavasitae

Type material. *Holotype.* ♂, THAILAND, Lower Gulf of Thailand, Talet Bay (09°18'39.5"N, 99°46'46.4"E), seagrass bed (associated with *Thalassia hemprichii*), 1 May 2008, Puttapreecha, R., PSUZC-CR-0198.

Paratypes, collected with holotype ZMB 27979 (3♀); PSUZC-CR-0199 (3♂; 5♀)

Description. Based on male holotype. Body length 5.1 mm (from tip of rostrum to apex of telson). *Body* compressed, subcylindrical. *Head,* lateral cephalic lobe truncate, without rostrum, eyes round. *Antenna 1*, ratios of peduncular articles 1–3 9:10:2.5; peduncular article 1 with a ventromarginal robust seta and a distoventral robust seta; accessory flagellum with 6 articles.

Upper lip, (labrum) distally rounded. *Lower lip,* inner lobes small, pubescent; outer lobes covered with thin hair-like setae. *Mandible,* both incisors with 7 teeth; lacinia mobilis armed with 5 teeth on the left side and 4 teeth on the right side; molar short, cylindrical; palp 3-articulate with ratios of 4:9:3, article 2 with marginal setae and article 3 with apical setae. *Maxilla 1,* inner plate with 3 plumose setae apically and marginal fine setae medially; outer plate with 6 serrate robust setae apically; palp 2-articulate with apical fine setae. *Maxilla 2*, inner plate with lateral and medial marginal setae; outer plate broader than inner plate, distally setose. *Maxilliped*, inner plate with 9 plumose setae; outer plate semi-oval, inner margin with 9 robust setae distally; palp 4-articulate, article 3 with 15 fine setae, article 4 with 6 fine marginal setae.

Pereon. *Gnathopod 1* subchelate, smaller than gnathopod 2; coxa anterodistally produced; basis posterior margin with 3 setae, longer than ischium and merus combined; carpus posterior margin and lateral surface densely setose; palm oblique. *Gnathopod 2*, basis with 2 posterior marginal setae; ischium and merus short; carpus triangular; propodus robust, subrectangular, 1.5 × longer than broad with posterior marginal plumose setae, palm transverse with 6 blunt teeth and an acute palmar corner, inner face bearing 1 subposterodistal robust seta; dactylus fits with palm, inner margin smooth, outer margin with 1 long seta. *Pereopod 3–4* similar to each other, basis with anterior and posterior marginal setae. *Pereopod 5* basis oval, posterior margin slightly produced distally, posterodistal lobe rounded. *Pereopod 6–7* similar, basis broader than pereopod 5, posterodistally produced with short anterior and posterior marginal setae; dactyli curved.

Pleon. *Epimera 1–2* posteroventral corner smooth, not produced. *Epimeron 3* produced posteroventrally, with 3 short ventral setae. *Uropod 1* longest, peduncle longer than rami, posterior margin fringed with robust setae, anterior with 1 basofacial robust seta. *Uropod 2,* peduncle shorter than both rami; inner ramus longer than outer ramus. *Uropod 3,* peduncle shorter than rami; inner ramus subequal to outer ramus, distally truncate; inner ramus bearing only 1 proximal robust seta and 4 terminal setae. Telson longer than wide, cleft more than 95% of its length, lobes

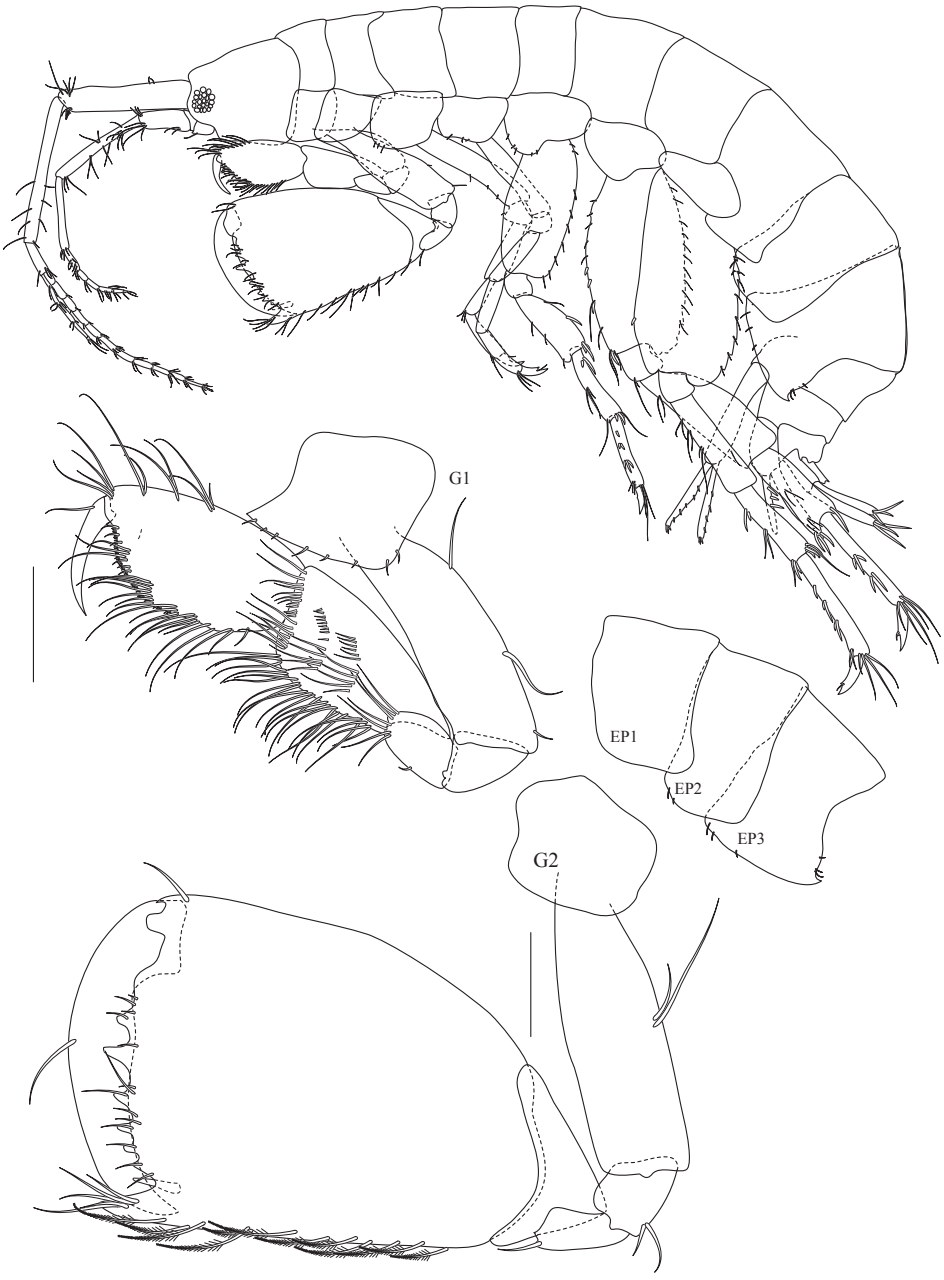

Figure 2. *Maeropsis paphavasitae* sp. n. holotype, male, (PSUZC-CR-00198), 5.1 mm. Talet Bay, Lower Gulf of Thailand. All scales represent 0.2 mm.

distally incised, outer end of incision longer than inner one, with 3 long apical setae and 2 lateral plumose setae.

Female. (sexually dimorphic characters). No sexual difference.

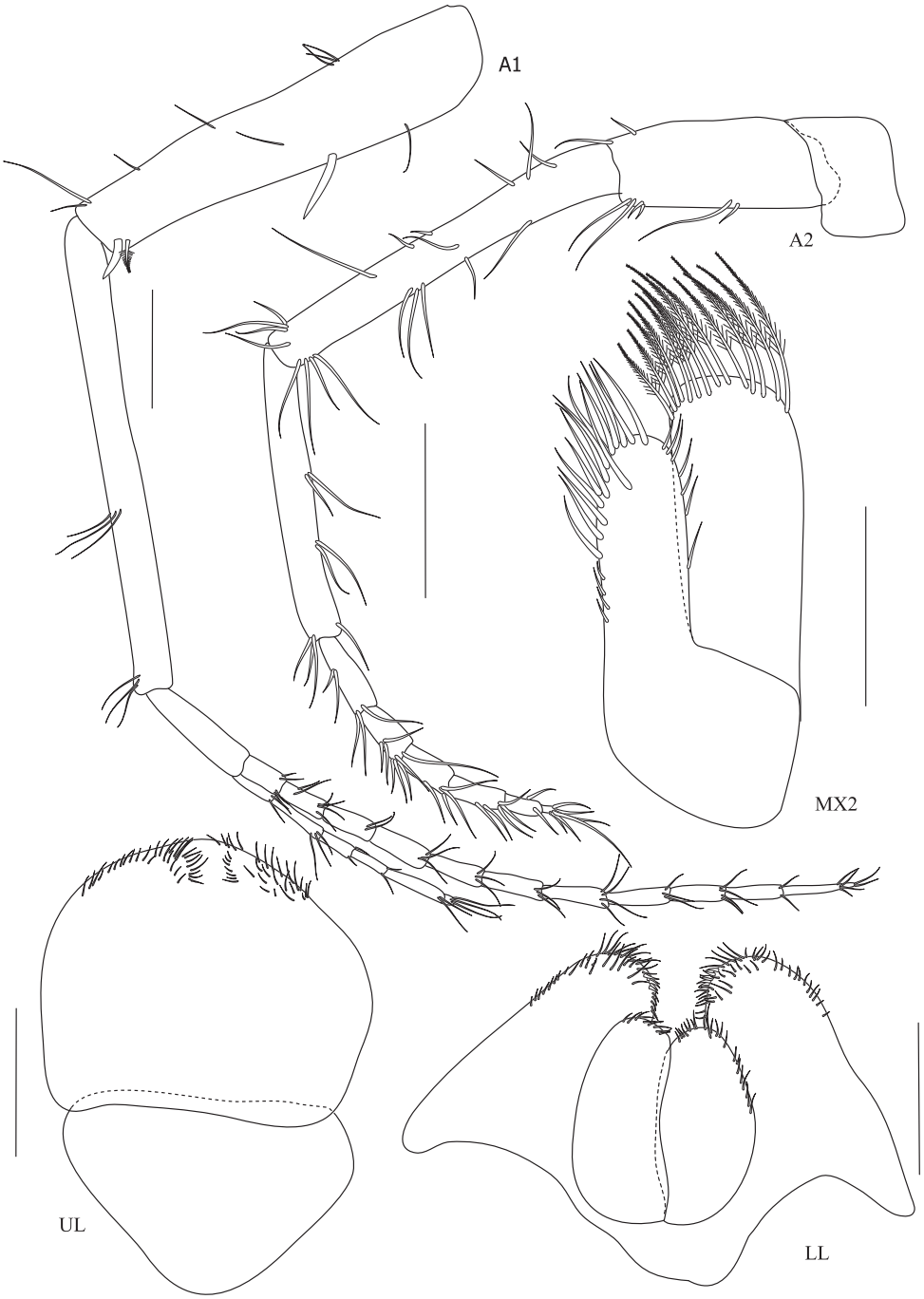

Figure 3. *Maeropsis paphavasitae* sp. n. holotype, male, (PSUZC-CR-00198), 5.1 mm. Talet Bay, Lower Gulf of Thailand. Scales for A1 and A2 represent 0.2 mm; MX2, LL, UL represent 0.1 mm.

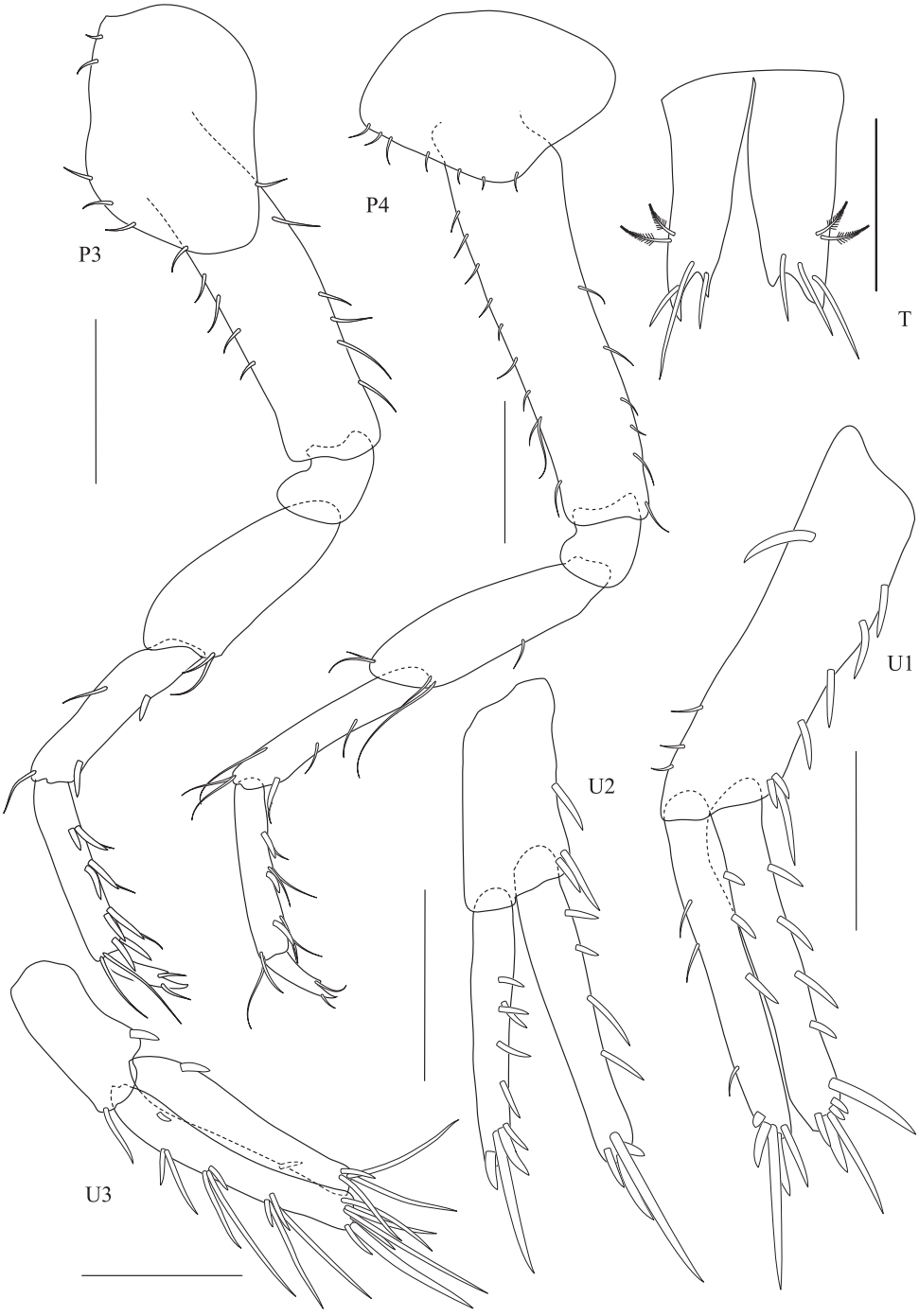

Figure 4. *Maeropsis paphavasitae* sp. n. holotype, male, (PSUZC-CR-00198), 5.1 mm. Talet Bay, Lower Gulf of Thailand. Scales for P3, P4, U1-3 represent 0.2 mm;T represents 0.1 mm.

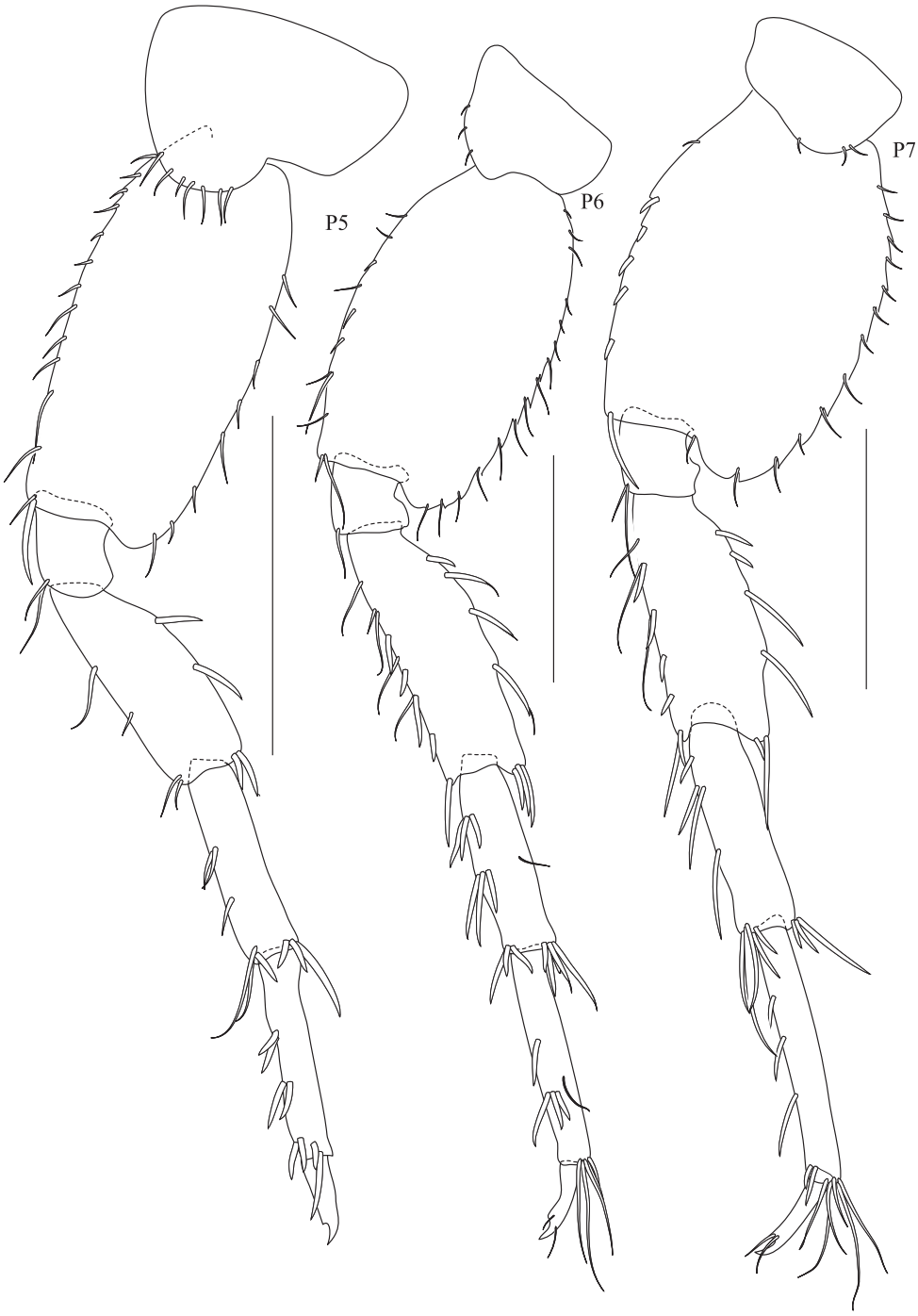

Figure 5. *Maeropsis paphavasita* sp. n. holotype, male, (PSUZC-CR-00198), 5.1 mm. Talet Bay, Lower Gulf of Thailand. All scales represent 0.5 mm.

Figure 6. *Maeropsis paphavasita* sp. n. holotype, male, (PSUZC-CR-00198), 5.1 mm. Talet Bay, Lower Gulf of Thailand. All scales represent 0.1 mm.

Etymology. The species is named in honor of Associate Professor Nittharatana Paphavasit of Chulalongkorn University, Thailand who contributed to the knowledge on seagrass habitats in Thailand.

Remarks. *Maeropsis paphavasitae* sp. n. is very similar to *Maeropsis serratipalma* (Nagata, 1965) in the palm of gnathopod 2, which is transverse with 6 blunt teeth and a large defining tooth in both species. But the new species can be distinguished from *M. serratipalma* by the following characters: gnathopod 1 palm without clear defining palmar corner; gnathopod 2, merus not produced into a posterodistal tooth (vs. produced); propodus of gnathopod 2 subtriangular (vs. subrectangular), palm inner surface with 1 subposterodistal robust seta (vs. without); dactyli of pereopods 3-7 curved and smooth (vs. bearing two minute teeth); uropod 3 inner ramus with only 1 proximal seta (vs. armed with several marginal robust setae) and telson longer than broad (vs. broader than long).

Melitidae Bousfield, 1973

Rotomelita J.L. Barnard, 1977

http://species-id.net/wiki/Rotomelita

Diagnosis (from Barnard 1977). Accessory flagellum 3+ articulate; mandibular palp thin, weak, articles linear, article 3 bearing few apical setae only; lower lip with small but fully discrete inner lobes; inner plate of maxilla 1 with only terminal setae; inner plate of maxilla 2 lacking medial setae; maxillipedal palp 4-articulate, article 4 unguiform; gnathopods ordinary, gnathopod 2 larger than gnathopod 1, lacking fuzz on article 5; uropod 3 greatly overreaching uropod 1, inner ramus small and scale-like, outer ramus immensely elongate, bearing short article 2; telson short, cleft, lobes very broad and apically truncate; urosomite 1 bearing 1 subdorsal spine on each side, otherwise pleonites dorsally smooth; anterior coxae (1–4) longer than posterior coxae (5–7); some gills pediculate.

Type species. *Rotomelita lokoa* J.L. Barnard, 1977 (type by original designation).

Species composition. *Rotomelita ana* J.L. Barnard, 1977; *Rotomelita lokoa* J.L. Barnard,1977; *Rotomelita longipropoda* sp. n. (this study).

Rotomelita longipropoda sp. n.

urn:lsid:zoobank.org:act:DAC77E5F-B08A-4640-96B9-A269E74ADABB
http://species-id.net/wiki/Rotomelita_longipropoda

Type material. *Holotype*. ♂ (1.65 mm), THAILAND, Lower Gulf of Thailand, Phangan Island (9°41'48"N, 100°0'2"E), seagrass bed (associated with *Thalassia hemprichii* and *Halophila ovalis*), 1 July 2009, Bantiwiwatkul, N.,PSUZC-CR-0195.

Allotype. ♀, collected with holotype,PSUZC-CR-0196 (gravid female, 1.66 mm) *Other material*. Same data as for holotype, PSUZC-CR-0197 (5♂; 5♀)

Description. Based on male holotype. Total body length 1.65 mm (from tip of rostrum to apex of telson). *Body,* rather slender and subcylindrical. *Head,* slightly shorter than first 2 pereonites; rostrum not developed; inferior antennal sinus shorter than eyes, concave, about 0.2 times head length; eye distinct. *Antenna 1,* longer than antenna 2, ratios of peduncular articles 1–3 2:2:1; article 1 slender; flagellum with 16 articles plus 1 rudimentary article, 2 times as long as peduncle; accessory flagellum with 3 articles, last article scale-like. *Antenna 2,* peduncle slender; gland cone fleshy, short, not reaching to end of peduncular article 3; articles 2-5 ratios 1:1:3:3; inner margin of article 4 and 5 with sparse setae; article 5 slightly shorter than 4; flagellum short with sparse setae, longer than peduncular article 5, composed of 7 articles, last article scale-like.

Upper lip (labrum), round and broad. *Lower lip,* inner lobe small, outer lobe pubescent, mandibular process well developed. *Mandible*, left incisor with 6 teeth and right incisor with 5 teeth; lacinia mobilis armed with 4 teeth on both sides; molar triturative; palp 3-articulate with ratios 1:2:3, article 3 with 3 apical setae. *Maxilla 1*, inner plate triangular, small, with 3 apical robust setae, outer plate with 8 apical serrate robust setae; palp 2-articulate, article 1 shorter than 2, article 2 apical margin with 4 robust setae. *Maxilla 2*, inner plate with 5 slender apical setae; outer plate subequal to inner plate, with 8 slender setae. *Maxilliped*, inner plate narrow, short, reaching half of outer plate, apically provided with 6 plumose setae and 3 stout robust setae; outer plate broad, subrectangular, almost reaching palp article 3, with 5 apical and marginal setae and 2 apical robust setae; palp 4-articulate, with ratios 4.5:4:4:3, article 4 unguiform.

Pereon. *Gnathopod 1*, subchelate, smaller than gnathopod 2; coxal plate subrectangular; length ratios of articles from basis to dactylus about 10:4:4:7:6:4; basis slender, posterior margin bearing long setae; ischium short, subrectangular with short posteromarginal setae;merus subrectangular with long and short posteromarginal setae; carpus trapezoidal with long setae on posterior margin; propodus subtriangular, shorter than carpus, palm transverse, produced, with sparse setae, posterodistal corner minutely serrate, slightly bending inwards; dactylus shorter than palm, falcate. *Gnathopod 2,* subchelate; coxal plate short and wide, subrectangular, length ratios of articles from basis to dactylus about 14:5:5:6:16:12; basis slender, 3 times as long as wide, anterior margin straight;ischium subrectangular, subequal to merus; carpus triangular; propodus enlarged, oval, 2 times as long as wide, palm strongly oblique with sparse setae; dactylus falcate, slightly shorter than palmar margin, inner margin smooth, the inner surface not excavate.

Pereopod 3, slender and elongate; coxal plate small and subtrapezoidal, with 5 fine setae on anterioroventral margin; length ratios of articles from basis to dactylus 10:2:6:5:6:2; basis slender; ischium short, subrectangular; merus slightly longer than carpus, produced anteriorly; carpus slender with apical setae; propodus subrectangular; basis to propodus bearing sparse setae on both sides; dactylus falcate,

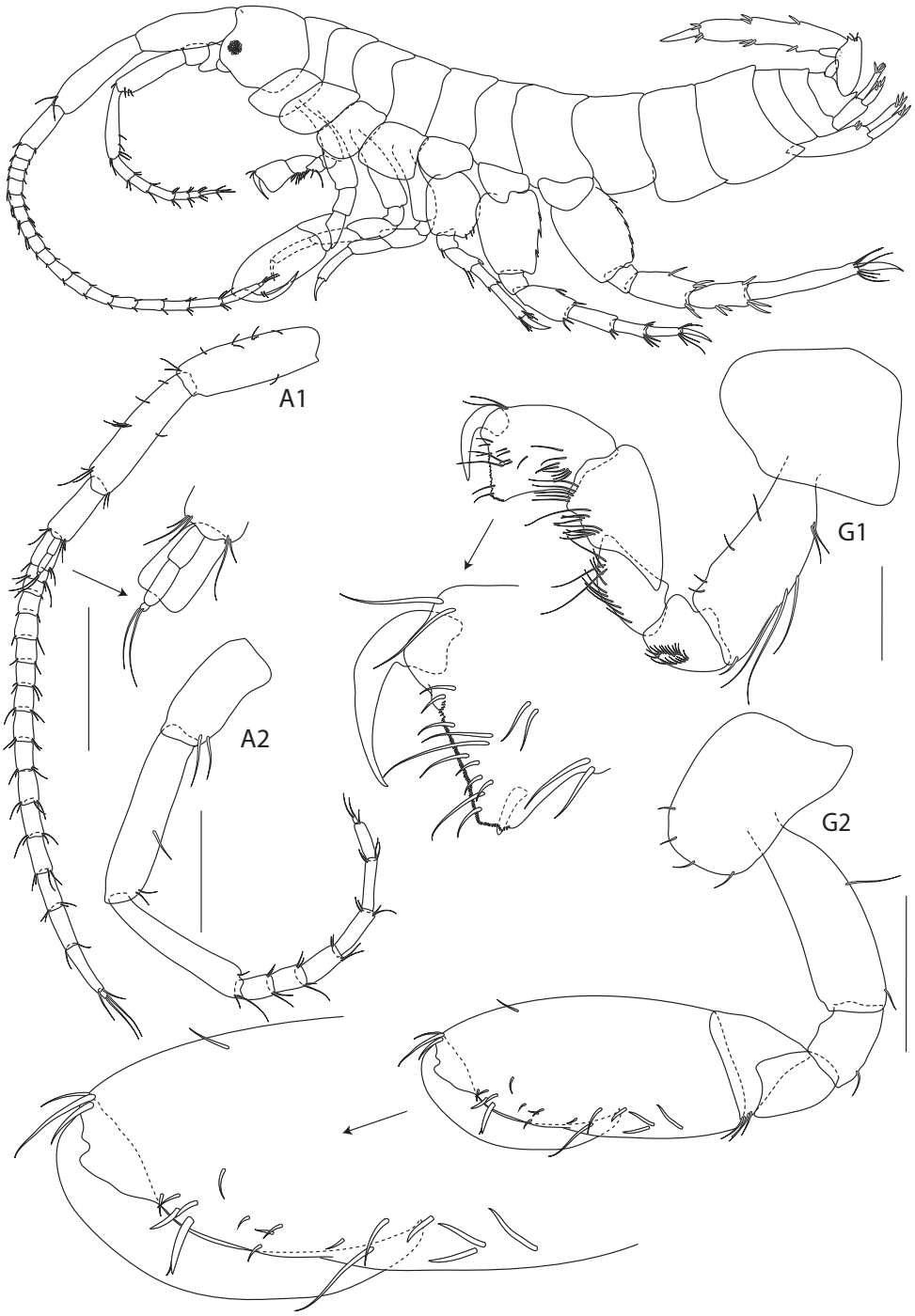

Figure 7. *Rotomelita longipropoda* sp. n. holotype, male, (PSUZC-CR-00195), 1.65 mm, Phangan Island, Lower Gulf of Thailand. All scales represent 0.2 mm.

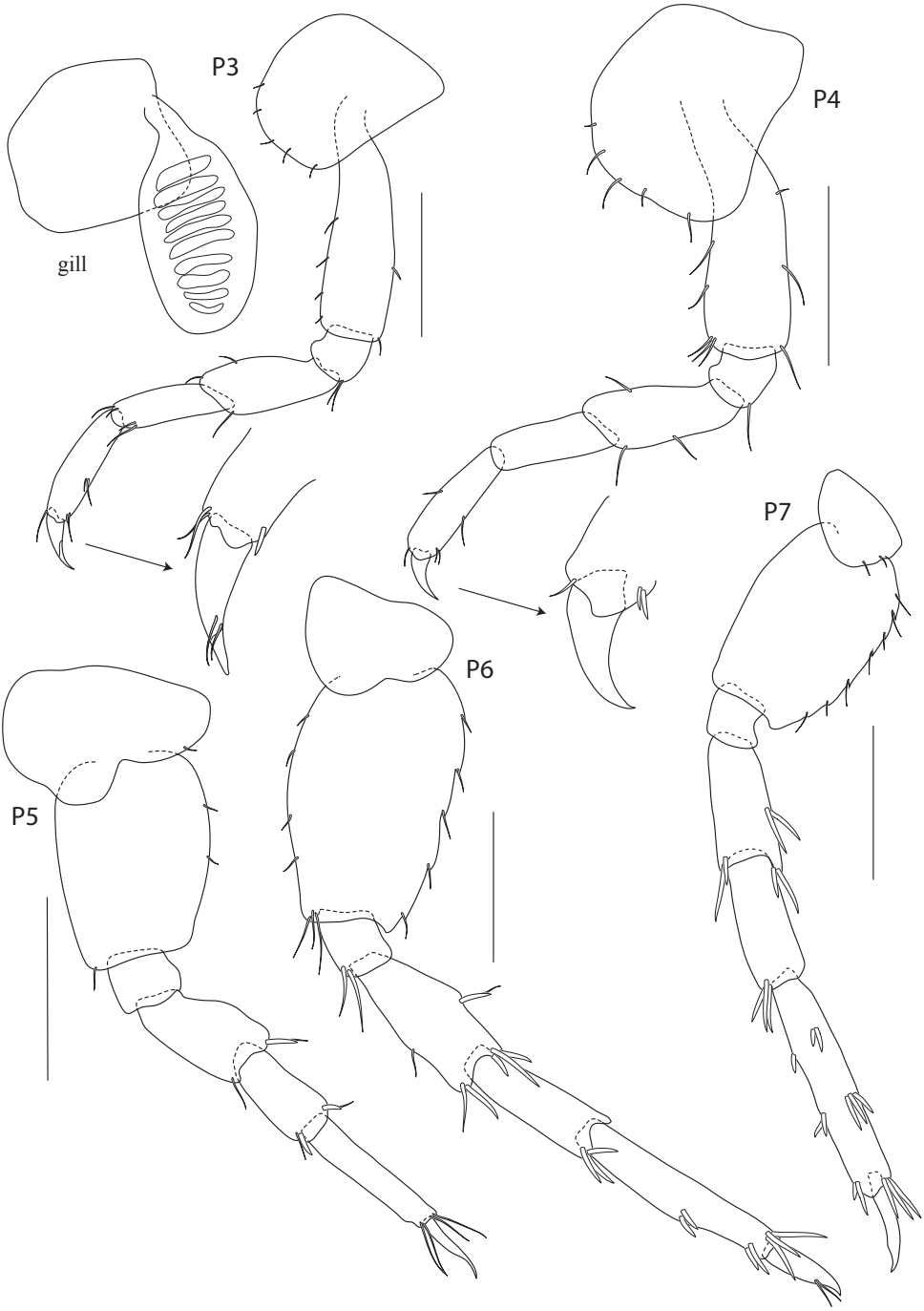

Figure 8. *Rotomelita longipropoda* sp. n. holotype, male, (PSUZC-CR-00195), 1.65 mm, Phangan Island, Lower Gulf of Thailand. All scales represent 0.2 mm.

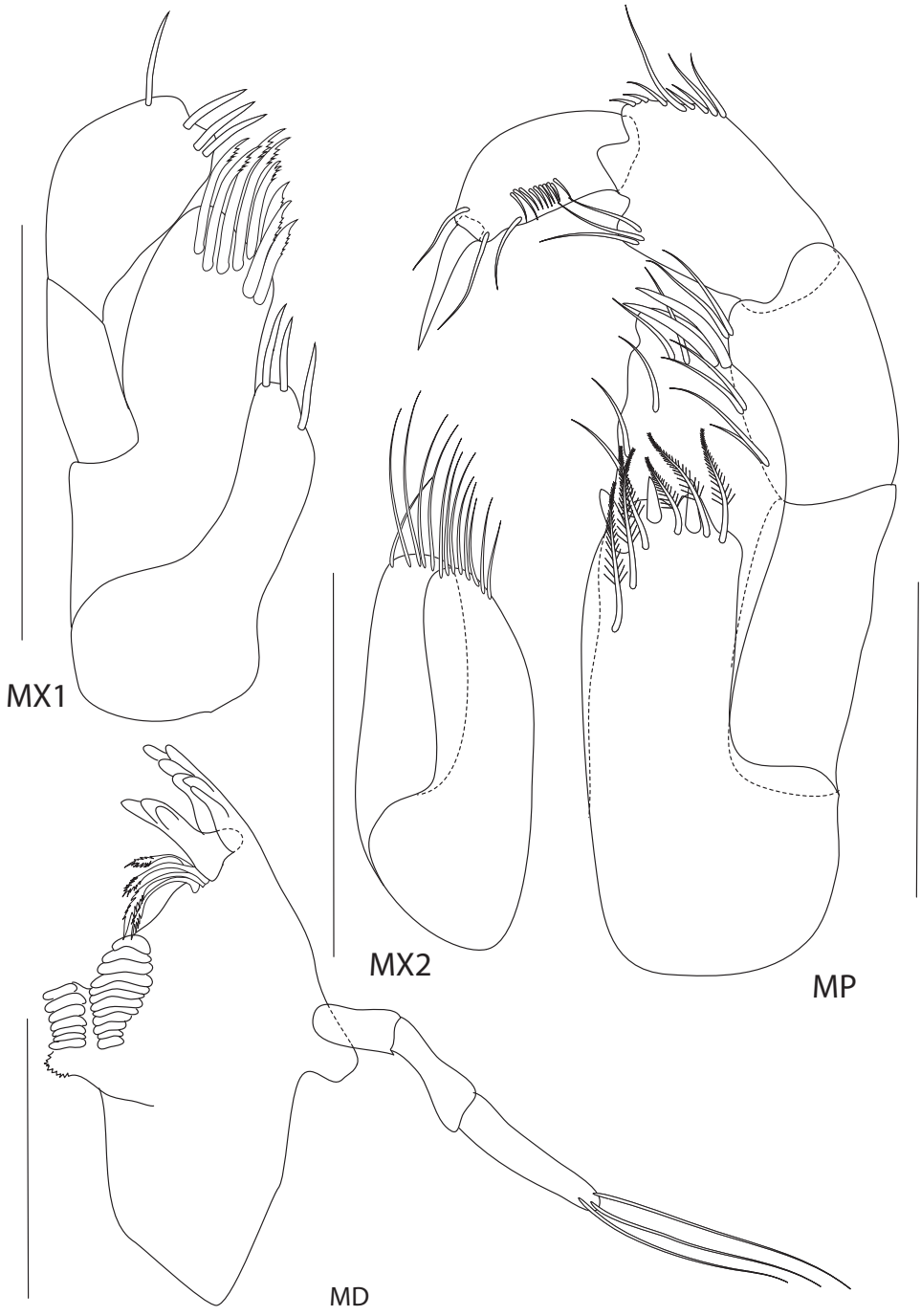

Figure 9. *Rotomelita longipropoda* sp. n. holotype, male, (PSUZC-CR-00195), 1.65 mm, Phangan Island, Lower Gulf of Thailand. All scales represent 0.1 mm.

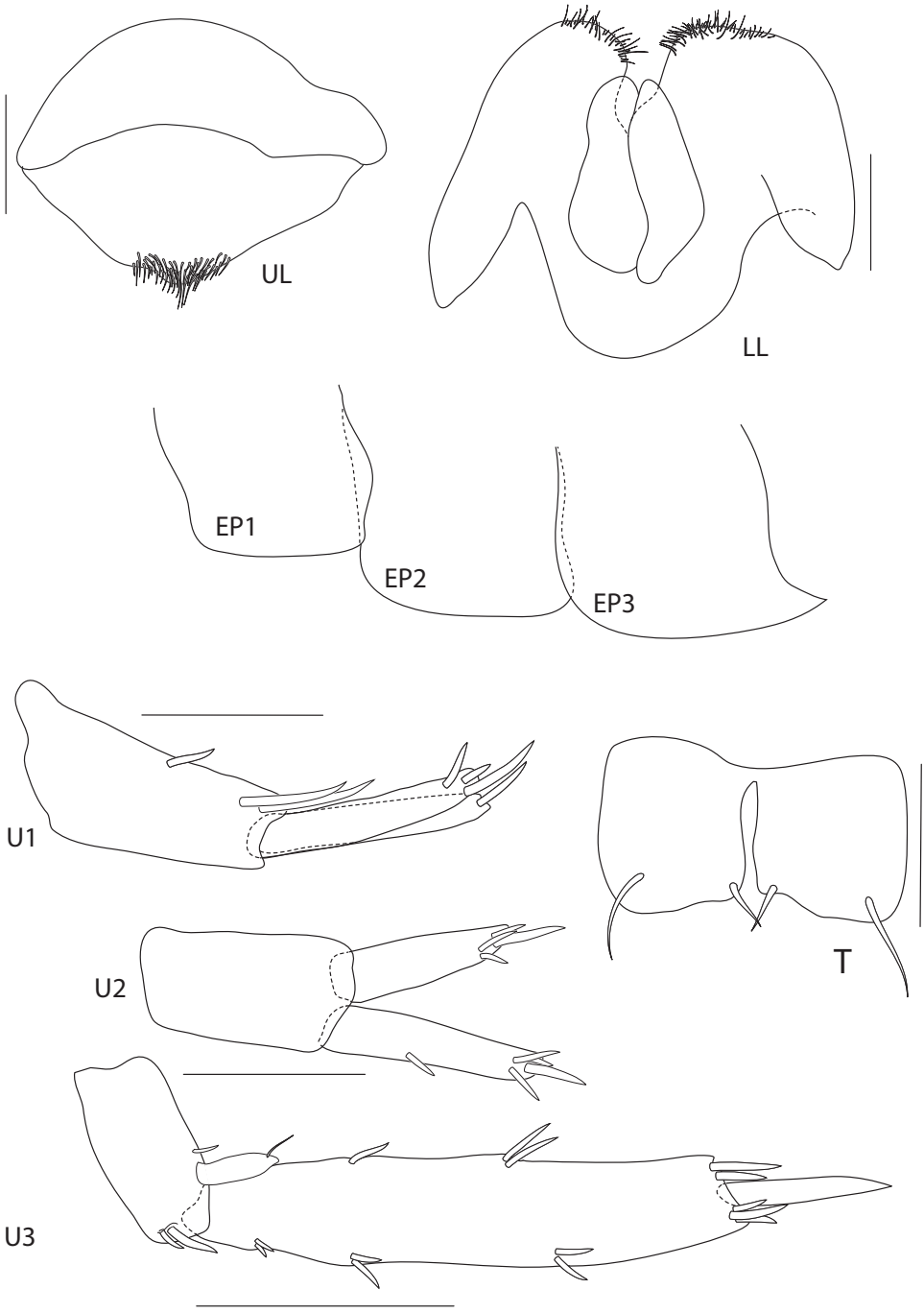

Figure 10. *Rotomelita longipropoda* sp. n. holotype, male, (PSUZC-CR-00195), 1.65 mm, Phangan Island, Lower Gulf of Thailand. All scales represent 0.05 mm.

Figure 11. *Rotomelita longipropoda* sp. n. allotype, female, (PSUZC-CR-00196), 1.66 mm, Phangan Island, Lower Gulf of Thailand. All scales represent 0.2 mm.

shorter than propodus. *Pereopod 4*, similar to pereopod 3, coxal plate subrectangular with fine setae on anteroventral margin; length ratios of articles from basis to dactylus about 12:2:6:5:6:2; basis slender; ischium short, subrectangular; merus produced anterodistally; carpus slender, subequal to propodus; basis to propodus with sparse setae on both margins; propodus long and narrow; dactylus falcate and short. *Pereopod 5,* shortest; coxa bilobed; length ratios of articles from basis to dactylus about 8:2:5:4:6:3; basis subrectangular with short fine setae on posterior margin; ischium shortest; merus with a posterodistal robust seta and 1 anterodistal seta; carpus with distal robust setae on both sides; propodus with 4 distal long fine setae; dactylus short and curved. *Pereopod* 6 elongate, 1.6 times as long as pereopod 5; coxa posteriorly produced with rounded lobe; length ratios of articles from basis to dactylus about 12:3:8:7:11:4; basisposterior margin straight with minute castellations, with fine setae on both margins;ischium short with fine setae on anteroventral corner; merus oblong, with robust setae on posterior margins and posterodistal corner; carpus subrectangular with 3 anterodistal robust setae; propodus oblong, slender with marginal robust setae,setose posterodistally; dactylus falcate. *Pereopod 7,* subequal to pereopod 6; coxa short and wide, semicircular; length ratios of articles from basis to dactylus about 12:3:8:8:14:5; basis posteriodistally produced, bearing fine setae on posterior margin; ischium short and subquadrate; merus elongate with robust setae on both sides; carpus subequal to merus, bearing 3 anterodistal robust setae; propodus oblong, longer than merus, bearing robust setae on both margins and anterodistal corner; dactylus falcate.

Pleon. *Epimera 1–3* each with small posterodistal tooth. *Uropod 1,*peduncle with 2 distal robust setae; rami slightly shorter than peduncle, armed with 3 apical robust setae.*Uropod 2,* peduncle subequal to rami; rami subequal, outer ramus with a marginal robust seta and apex armed with several long and short robust setae. *Uropod 3,* biramous; inner ramus minute, pointed apically, bearing 1 apicomedial robust seta; outer ramus biarticulate, with marginal robust setae, distal article short. *Telson,* broader than long, cleft, lobes very broad and apically truncate, each lobe with 2 apical setae.

Female. (allotype) (sexually dimorphic characters). Total body length 1.66 mm (from tip of rostrum to apex of telson).

Pereon. *Gnathopod 1*, subchelate, smaller than gnathopod 2; coxal plate subrectangular; length ratios from basis to dactylus about 10:4:4:6:5:4; propodus subtriangular, longer than dactylus, palm transverse with short marginal setae; dactylus falcate, tapering distally. *Gnathopod 2,* subchelate; length ratios from basis to dactylus about 10:5:5:6:8:5; basis slender, 2.5 times as long as wide, anterior margin weakly produced with sparse setae; ischium subrectangular; carpus triangular; propodus suboval, 1.6 times as long as wide, palm oblique, defined by 2 robust setae; dactylus falcate, slightly shorter than palmar margin, inner margin smooth.

Etymology. The specific name "longipropoda" is from latin 'longi = long' and 'propoda = propodus', referring to the relatively long propodus of male gnathopod 2 compared to congeners.

Remarks. *Rotomelita longipropoda* new species shares some characteristics with *R. lokoa* Barnard, 1977 and *R. ana* Barnard, 1977 from Hawaii by having stalked coxal gills; weakly sexually dimorphic gnathopod 1 and 2; coxa 1 not expanded distally; coxa 4 proximally excavated, smooth pleon segments 1-3 and urosomite 1, and a deeply cleft telson, with truncate lobes.

However, the new species can be easily distinguished from its congeners by having eyes (vs. lacking eyes in *R. lokoa* and *R. ana*); antenna 1 peduncle without robust setae (vs. with 2 robust setae on ventroproximal margin in *R. lokoa* and *R. ana*); male gnathopod 2 with relatively long propodus (2.7 times as long as carpusvs, 1.6 times in the two other species) and the uropod 3 rami are shorter (2.2 times as long as peduncle) compared to the other two species (3.3 times as long as peduncle).

Rotomelita longipropoda is also similar to other *Rotomelita* subgroup i.e. *Nainaloa* Karaman & Barnard, 1979 and *Tegano* Barnard & Karaman, 1982. *R. longipropoda* can be distinguished from *Nainaloa* as follows: *R. longipropoda* gnathopod 1 palm has inner surface not excavate (inner face of propodus excavate in *Nainaloa*); pediculate gills (figure 8) (simple gill in *Nainaloa*); article 2 of pereopods 5—7 not lobed (lobed in *Nainaloa*) and truncate lateral cephalic lobes (prominent in *Nainaloa*). Besides, *Rotomelita longipropoda* is also allied to member of genus *Tegano* occurring in Indo-Pacific. They differ as follows: *R. longipropoda* has mandibular palp article 3 longer than article 2, bearing 3 apical setae (article 3 reduced with 1 apical seta in *Tegano*) and the telson short, cleft, lobes very broad and apically truncate (tapering and apically point in *Tegano*).

In terms of ecology *Rotomelita*, *Nainalao* and *Tegano* are recorded from fresh to brackish water (Barnard 1977; Bousfield 1971 and Lowry and Springthorpe, 2009) while *R. longipropoda* was collected from seagrass beds in a salinity range of 28—32 ppt. However, there is a small creek located 1 km northern of seagrass patch. The amphipods also can be considered as a brackish species. It is the first record of this genus from West Pacific.

Acknowledgements

The authors would like to thank Mrs Ratchanee Puttapreecha (Southern Marine and Coastal Resources Research Center) and Mrs Natthawadee Bantiwiwatkul (Marine and Coastal Resources Research Center, The Central Gulf of Thailand) for providing us withspecimens for this study. We are grateful to the Department of Biology, Faculty of Science, Prince of Songkla University and Museum für Naturkunde, Germany for the laboratory facilities. Part of this work was supported by the Higher Education Research Promotion and National Research University Project of Thailand. The senior author likes to thank the Graduate School of the Prince of Songkla University for a scholarship which made an oversea research stay in Germany possible . We also thank Dr. Azman Abdul Rahim for drawing the map of the sampling area.

References

Barnard JL (1977) The cavernicolous fauna of Hawaiian lava tubes 9. Amphipoda (Crustacea) from brackish lava ponds on Hawaii and Maui. Pacific Insects 17: 267–299.

Barnard JL, Karaman G (1982) Classificatory revisions in Gammaridean Amphipoda (Crustacea), Part 2. Proceedings of the Biological Society of Washington, 95(1): 167–187.

Berents PB (1983) The Melitidae of Lizard Island and Adjacent Reefs, The Great Barrier Reef, Australia (Crustacea: Amphipoda). Records of the Australian Museum 35:101–143. doi: 10.3853/j.0067-1975.35.1983.313

Bousfield EL (1971) Amphipoda of the Bismarck Archipelago and adjacent Indo-Pacific islands (Crustacea). Steenstrupia. 1, 255–293

Bousfield EL (1973) Shallow-water gammaridean Amphipoda of New England. Ithaca and London: Cornell University Press, 312 pp.

Chevreux E (1919) Note préliminaire sur les amphipodes recueillis par les expéditions du Travailleur et du Talisman (1880–1883). Bulletin du Muséum national d'Histoire naturelle, Paris 25(7): 574–580.

Karaman G, Barnard JL (1979) Classificatory revisions in Gammaridean Amphipoda (Crustacea), Part 1. Proceedings of the Biological Society of Washington, 92(1): 106–163.

Kim W, Kim CB (1991) The marine amphipod crustacean of Ulreung Island, Korea: Part III. The Korean Journal of Systematic Zoology 34: 323–337.

Krapp-Schickel T (2008) On the genera *Meximaera*, *Ruffomaera* gen. nov., *Maeropsis* and *Ceradocus* from Atlantic coasts (Amphipoda: Melitidae). Journal of the Marine Biological Association of the United Kingdom, 88: 1425–1432. doi: 10.1017/S0025315408002014

Krapp-Schickel T (2009) Maeridae, the *Ceradocus* group In: Lowry JK, Myers AA (Eds) (2009) Amphipoda (Crustacea: Peracarida) of the Great Barrier Reef, Australia. Zootaxa 2260: 1–930.

Krapp T, Marti A, Ruffo S (1996) Three new Mediterranean *Maera* with remarks on the *quadrimana* complex. Beaufortia, 46: 27–51.

Lowry JK, Springthorpe RT (2009) Melitidae, the Melita group.718–735. In: Lowry JK, Myers AA (Eds) Benthic Amphipoda (Crustacea: Peracarida) of the Great Barrier Reef, Australia. Zootaxa 2260: 1–930.

Nagata K (1965) Studies on marine gammaridean Amphipoda of the Seto Inland Sea III. Publication of Seto Marine Biological Laboratory 13: 291–326.

Pearse AS (1908) Descriptions of four new species of amphipodous Crustacea from the Gulf of Mexico. Proceedings of the United States National Museum 34: 27–32, 24 figs.

Prathep A, Rattanachot E, Tuntiprapas P (2010) Seasonal variations in seagrass percentage cover and biomass at Koh Tha Rai, Nakhon Si Thammarat Province, Gulf of Thailand. The Songklanakarin Journal of Science and Technology, 32 (5): 497–504.

Wongkamhaeng, K, Azman BAR, Puttapreecha R (2012) *Cheiriphotis trifurcata*, new species (Crustacea, Amphipoda, Corophiidae, Protomedeiinae) from the Seagrass Bed of the Lower Gulf of Thailand. ZooKeys 187: 71–89. doi: 10.3897/zookeys.187.3219

ANNEX 5

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Three new species from the Aoridae and Maeridae (Crustacea, Amphipoda) from Thai Waters

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Abstract

Four species of amphipods from the families Aoridae and Maeridae were collected from Thai Waters in 2011. Three species, *Grandidierella phetraensis* **sp. nov.**, *Ceradocus andamanensis* **sp. nov.** and *Parelasmopus siamensis* **sp. nov.** are new to science and *Bemlos quadrimanus* (Sivaprakasam, 1970) has not been previously reported from Thai Waters. Their characters are described and illustrated. All specimens are deposited at Princess Maha Chakri Sirindhorn Natural History Museum, Prince of Songkla University, Thailand and the Museum für Naturkunde, Berlin.

Key words: Crustacea, Amphipoda, new species, taxonomy, Thai Waters, Aoridae, Maeridae

Introduction

Thai Waters consist of the Gulf of Thailand and the Andaman Sea, containing a variety of marine habitats. However, taxonomic knowledge on gammaridean amphipods is still poor and fragmented. Only 58 species from 17 families have been reported from Phuket Island, Andaman Sea (Bussarawich *et al*. 1984; Bussarawich 1985; Lowry & Berents 2002; Lowry & Stoddart 2002; Lowry & Watson 2002; Myers 2002; Peart 2002; Jansen & Dinesen 2002 & Lowry & Myers 2003) and 35 species from 17 families from the Gulf of Thailand where most studies focused on Songkhla Lake (Angsupanich & Kuwabara, 1995; Angsupanich *et al*., 2005; Ariyama *et al*., 2010 and Wongkamhaeng *et al*., 2012).

In this study, we found a new species belonging to the Aoridae, *Grandidierella phetraensis* **sp. nov.** and other two new species of Maeridae, *Ceradocus andamanensis* **sp. nov.** and *Parelasmopus siamensis* **sp. nov.** Figures and descriptions of these amphipods are provided.

Material and methods

Amphipods were collected by hand in a coral reef of Lidee Island, Satul Province and Samaesarn Island, Chonburi Province (Fig. 1). The sites were visited at low tide and amphipods were collected from the subtidal zone. Sediment was sieved with a 0.5 mm sieve. The amphipod specimens were sorted out and fixed in formalin for 1 week and then stored in 70% alcohol. In the laboratory, the animals were examined using a compound microscope and later selected for dissection. Dissected appendages were mounted on non-permanent slides in glycerol for study and later transferred into small glass tubes and kept with the specimens. The appendages were examined and drawn using a Leica DMLB light microscope with a camera lucida. The descriptions were generated from a DELTA database (Dallwitz, 2005). Illustrations were made using the methods described in Coleman (2003). The following abbreviations are used: A, antenna; G, gnathopod; LL, lower lip; MD, mandible; MX, maxilla; MP, maxilliped; P, pereopod; PLN, pleonite; Pl, pleopod; T, telson; U, uropod; UR, urosome; UL, upper lip. The type

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material of the new species is deposited at Prince of Songkla University Zoological Collection (PSUZC) and Museum für Naturkunde, Berlin (ZMB).

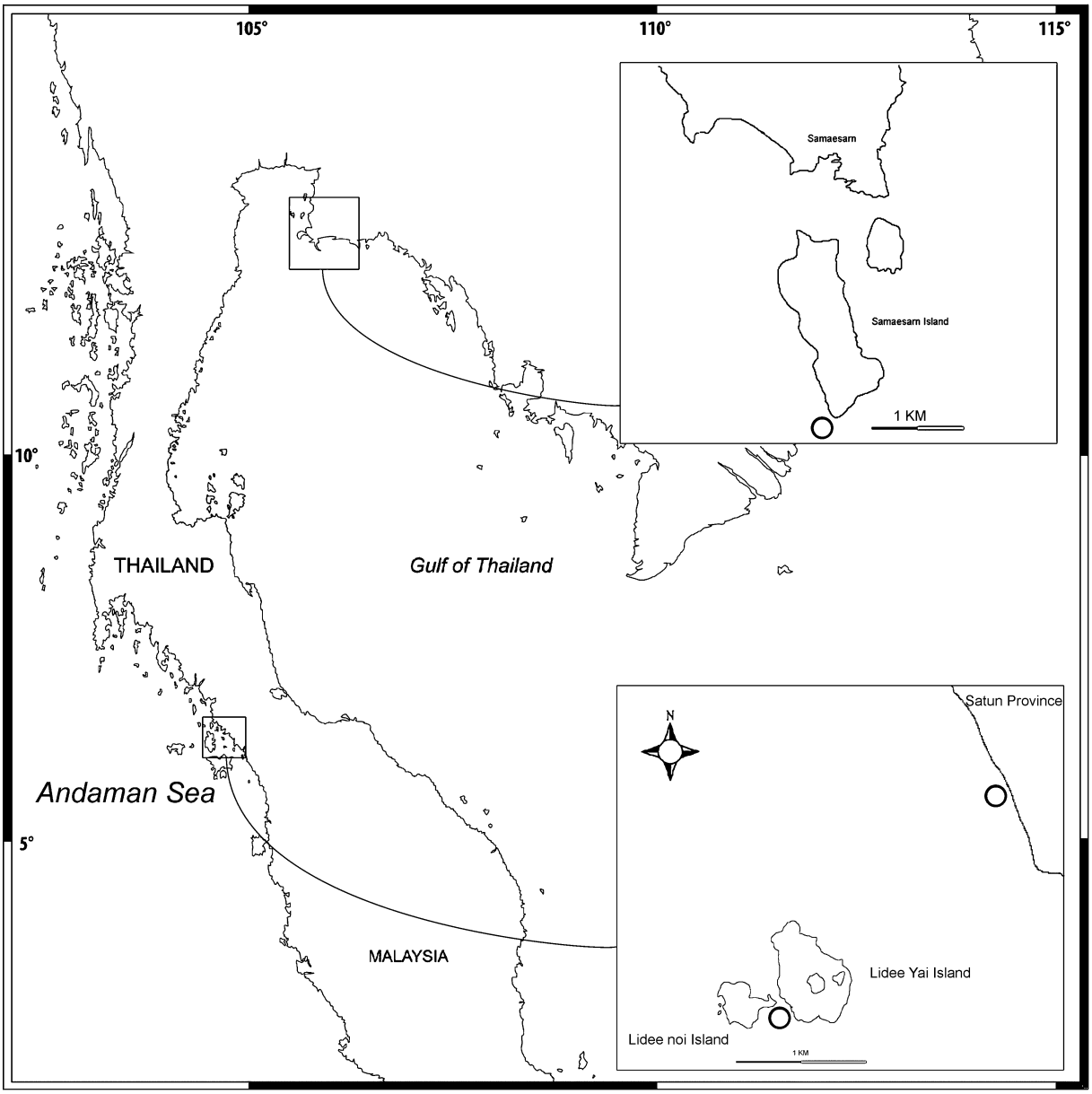

FIGURE 1. Map showing the sampling area.

Systematics

Aoridae Stebbing, 1899

Bemlos Shoemaker, 1925

Bemlos quadrimanus (Sivaprakasam, 1970)

(Figs 2–7)

Lembos quadrimanus Sivaprakasam, 1970: p. 81, fig. 1.
Lembos waipio.—Ledoyer, 1972: 200, pls 21A, 22, 24.
(not *L. waipio* Barnard, 1970: 85, figs 44, 45).
Lembos quadrimanus mozambicus Myers, 1975: 359, figs 33–39.
Bemlos quadrimanus.—Myers, 1988: 188.

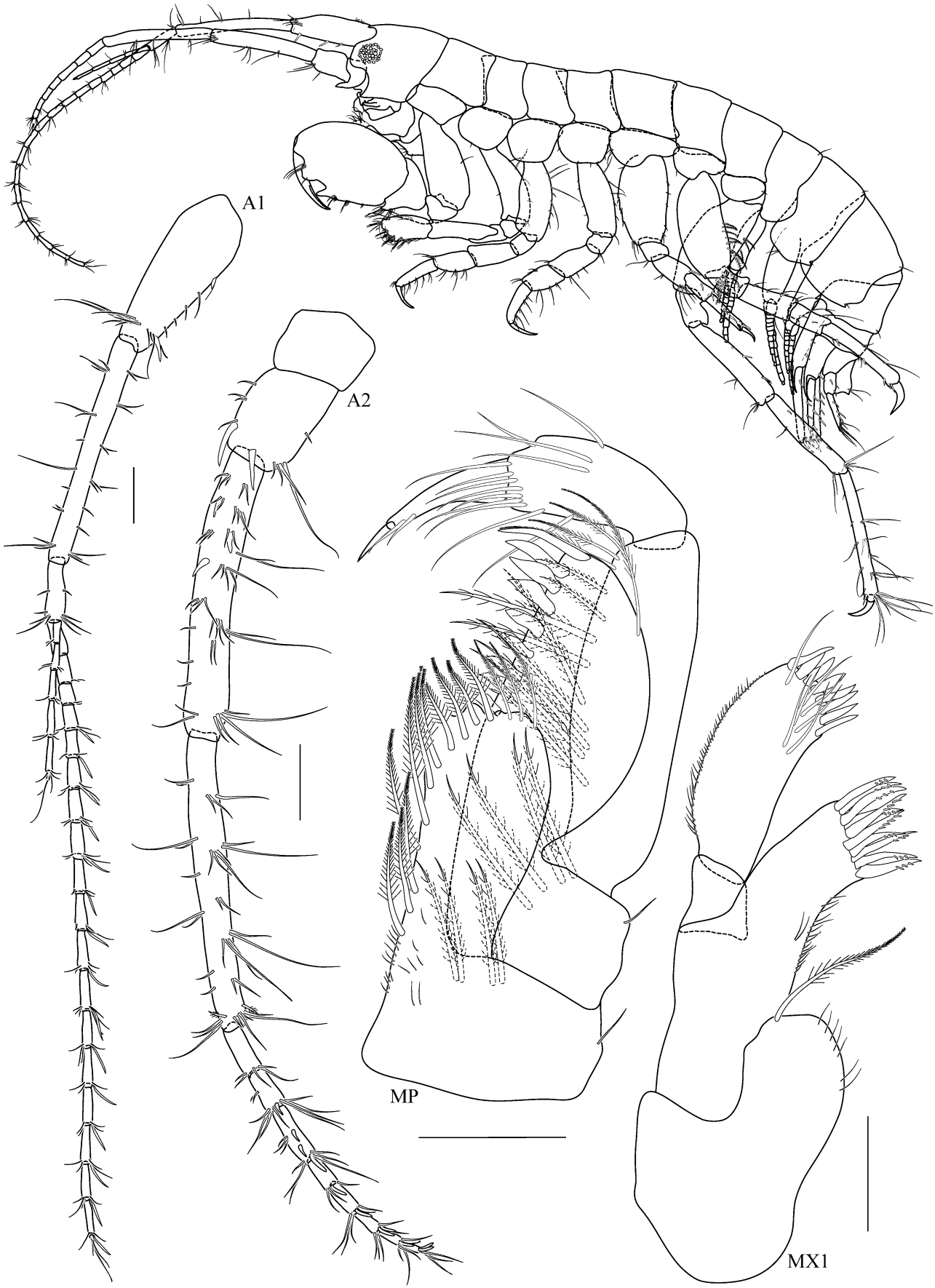

FIGURE 2. *Bemlos quadrimanus* (Sivaprakasam, 1970), male, 5.4 mm (PSUZC-CR-0266), Lidee Noi Island, Andaman Sea. Scale bars: A1-2 = 0.2 mm; MP,MX1= 0.1 mm.

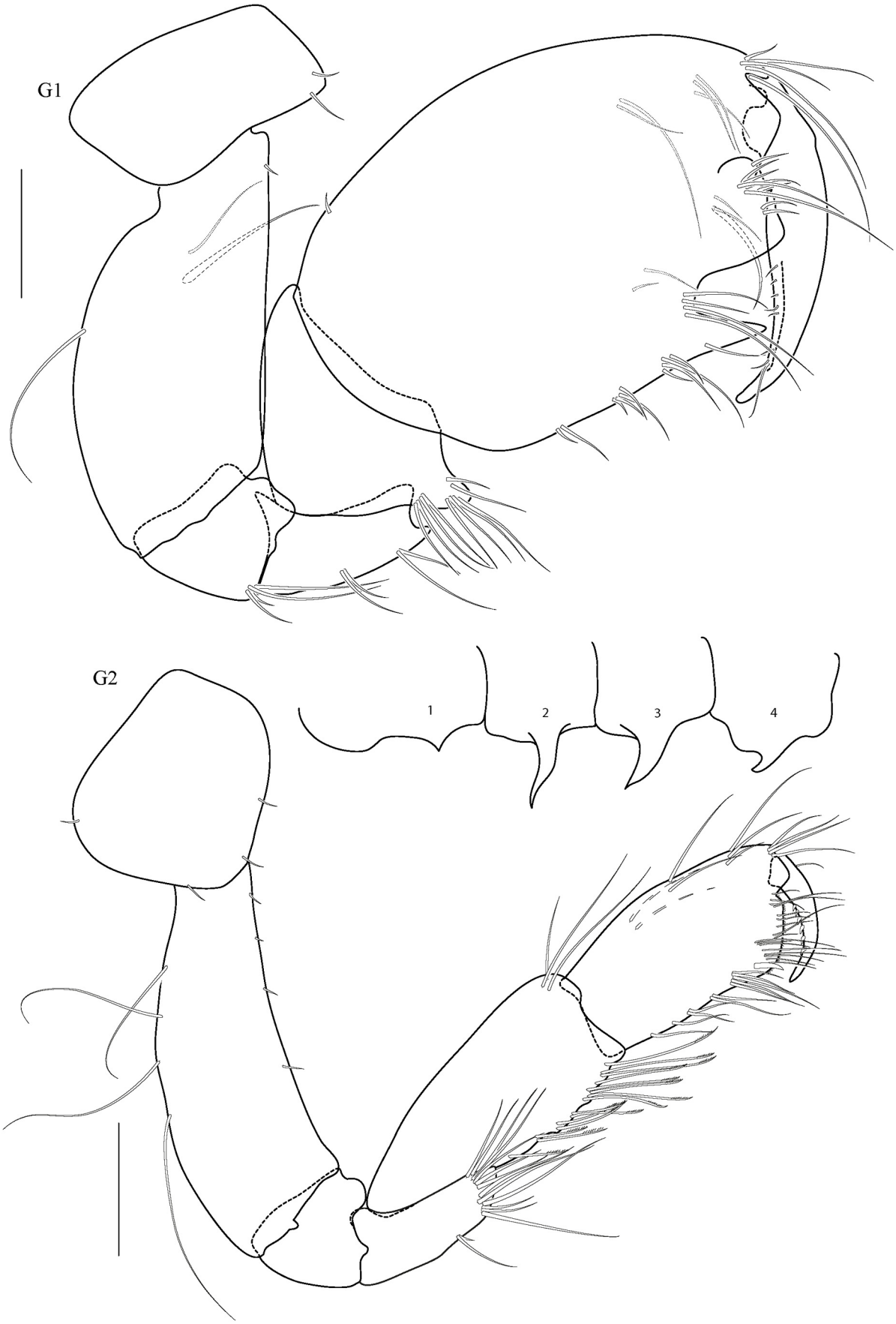

FIGURE 3. *Bemlos quadrimanus* (Sivaprakasam, 1970), male (PSUZC-CR-0266), 5.4 mm, Lidee Noi Island, Andaman Sea. All scale bars represent 0.2 mm.

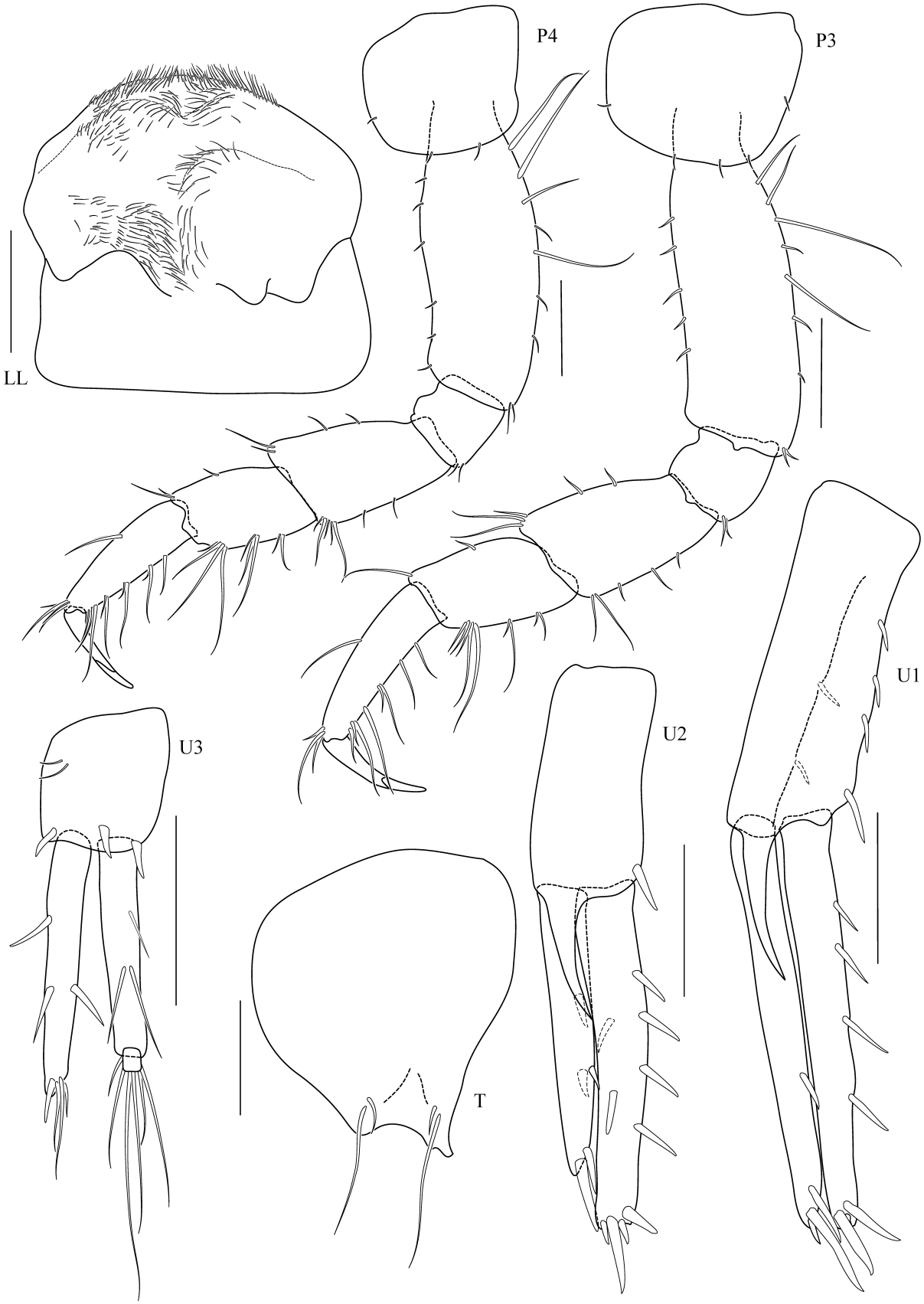

FIGURE 4. *Bemlos quadrimanus* (Sivaprakasam, 1970), male (PSUZC-CR-0266), 5.4 mm, Lidee Noi Island, Andaman Sea. Scale bars for UL and T represent 0.1 mm., remaining represent 0.2 mm

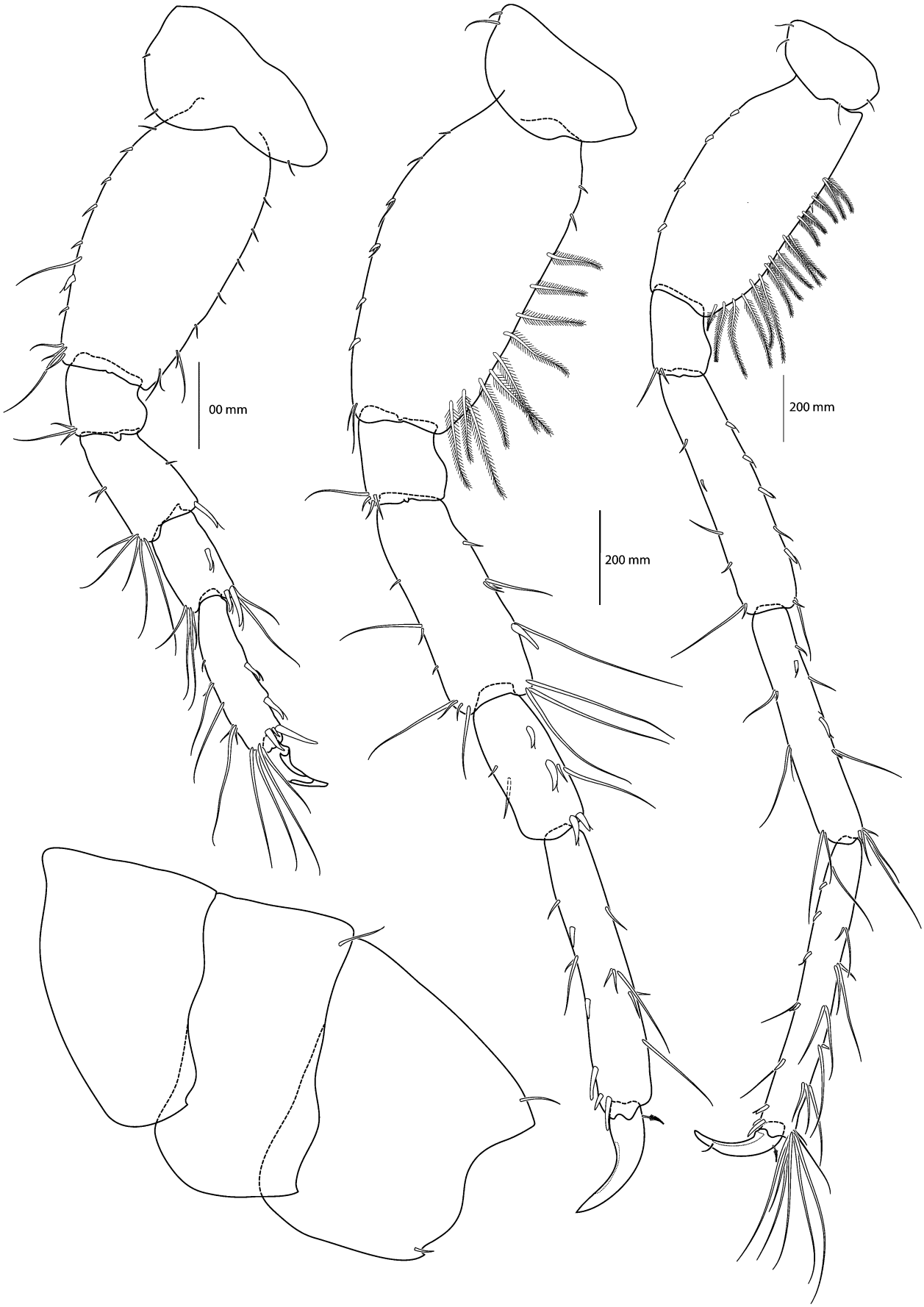

FIGURE 5. *Bemlos quadrimanus* (Sivaprakasam, 1970), male (PSUZC-CR-0266), 5.4 mm, Lidee Noi Island, Andaman Sea. All scale bar represents 0.2 mm.

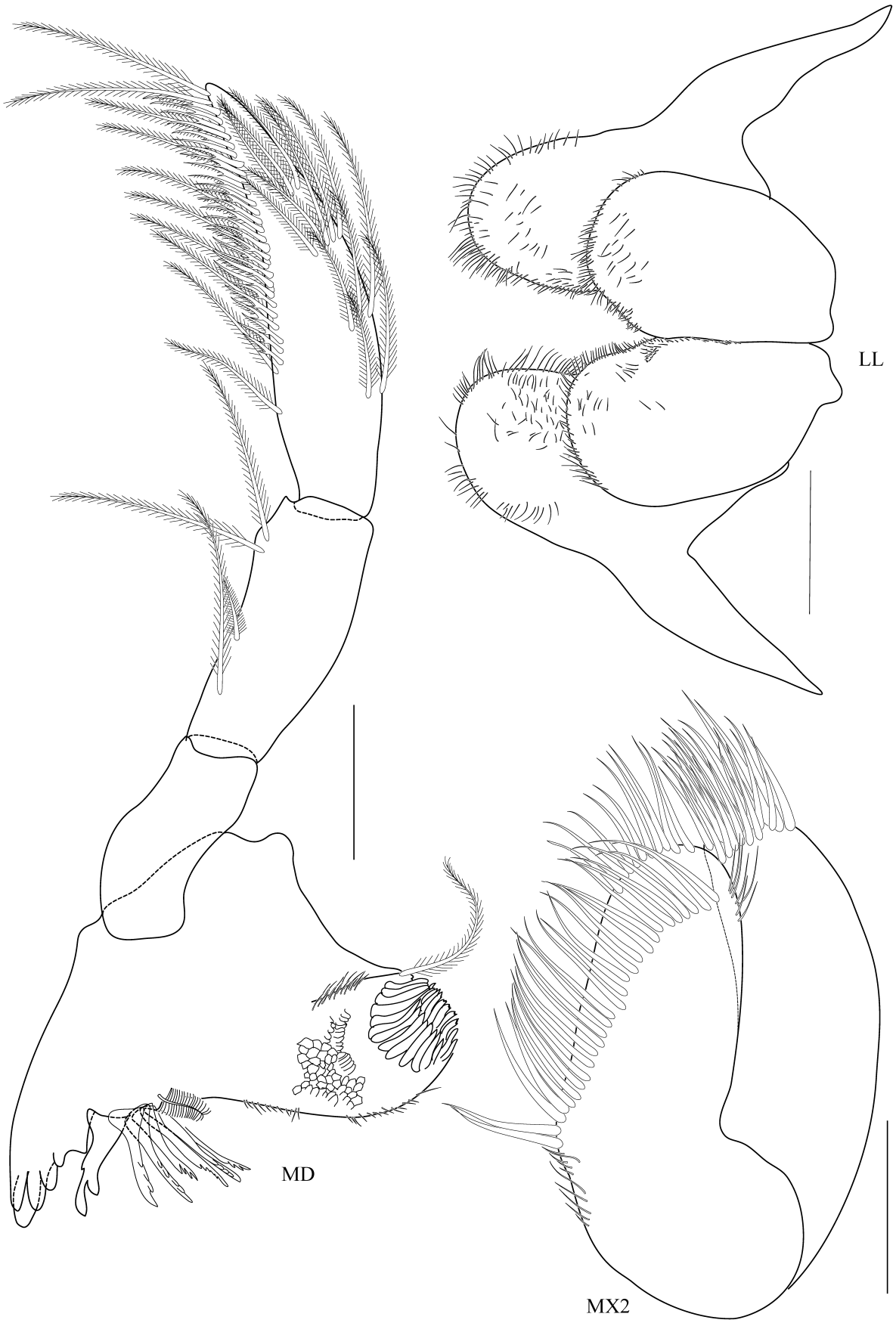

FIGURE 6. *Bemlos quadrimanus* (Sivaprakasam, 1970), male (PSUZC-CR-0266), 5.4 mm, Lidee Noi Island, Andaman Sea. All scale bar represents 0.1 mm.

FIGURE 7. *Bemlos quadrimanus* (Sivaprakasam, 1970), female (PSUZC-CR-0267), 5.0 mm, Lidee Noi Island, Andaman Sea. All scale bar represents 0.2 mm.

Material examined. 1 male 5.4 mm, PSUZC-CR-266. 1 female 5.0 mm, PSUZC-CR-267, ZMB 27983 5 male 5 gravid females, PSUZC-CR-278, 6 males and 6 females, 6°46'42"N 99°46'5"E, algae bed of Lidee Noi Island, Satun Province, Andaman Sea, Thailand, Rodcharoen, E., hand-collecting**,** 27 November 2011.

Type locality. Gulf of Mannar, Eastern India, Indian Ocean.

Description. Based on male, 5.4 mm.

Head. Lateral cephalic lobes truncate, anteroventral margin moderately recessed, anteroventral corner with small tooth, eyes present, oval shaped. *Antenna 1* longer than antenna 2; flagellum with 19 articles; accessory flagellum with 6 articles, the terminal article rudimentary. *Antenna 2* peduncle article 4 subequal to article 5; flagellum with 8 articles. *Upper lip* ventral margin slightly excavated. *Lower lip* outer lobe covered by long fine setae. *Mandible* incisors with 6 teeth, lacinia mobilis present with 3 teeth; setal row with 6 setae; mandibular palp articles 1–3 ratio 1:1.3:2, article 2 sparsely setose, article 3 slightly falcate, inner margin with 10 long plumose setae and 24 short bifid plumose setae. *Maxilla 1* inner plate small with single long plumose setae; palp article 2 with 8 terminal robust setae.

Pereon. *Pereonites* 1–4 bearing 4 sternal processes, sternal spines not bifid. *Gnathopod 1* larger than gnathopod 2, subchelate, coxa subrectangular, poorly setose; basis robust, 2 × as long as broad, anterior margin straight, mediofacial excavated; ischium rectangular; merus posterodistally produced into a tooth; carpus shorter than propodus, subtriangular, posterodistally produced; propodus robust, posterodistal margin sparsely setose, palm oblique with a deep excavation and subrectangular serrated distomedial edge; dactylus overlapping palm. *Gnathopod 2* subchelate, coxa rounded; basis slender, much less than half as broad as long, with anterodistal tooth; ischium smooth; carpus longer than propodus; palm oblique with a defining robust seta; dactylus overlapping palm. *Pereopod 3* and 4 similar, basis smooth; merus weakly setiferous; dactylus shorter than propodus. *Pereopods 5–7* in the length ratio 1: 1.5:2, *pereopods* 6 and 7 basis with plumose setae on posterior margin.

Pleon. *Epimera 2–3* with small posterodistal tooth and a setule on each posterodistal notch; *epimeron 2* sparsely setose ventrally. Uropod 2 peduncle with ventrodistal process; rami 1.5 × peduncle. *Uropod 3* peduncle with 3 robust setae; rami obtuse distally, subequal; peduncle shorter than rami, outer ramus without article 2. Telson longer than broad, with group of terminal setae, pointed apically.

Female -sexually dimorphic characters. Based on female 5.0 mm, PSUZC-CR-0267 (fig. 7). **Pereon.** Without sternal processes. *Gnathopod 1* basis slender, 2.5 × as long as broad; merus short, posterodistal produced; carpus subtriangular, 1.3 × as long as propodus length; palm oblique with a defining robust seta; dactylus with accessory teeth, overlapping palm. *Gnathopod 2* similar to that of male, basis slender; carpus subequal to propodus; palm oblique; dactylus overlapping palm.

Habitat. Among *Padina* and *Halimeda* algae, in coral rubble.

TABLE 1. Morphological differences between populations of *Bemlos quadrimanus.*

	antenna 2 article 4: article 5	mandibular palp ratio of article 1–3	female gnathopod 1 merus and carpus	gnathopod 2 dactylus	epimeron 2	uropod 1 peduncle: rami
Sivaprakasam 1970	<	1:2:3	not produced	fitting palm	without plumose setae	=
Ledoyer 1972	-	1:2:3	posterodistal produced	fitting palm	without plumose setae	=
Myers 1975	=	1:1.5:2.3	posterodistal produced	fitting palm	with plumose setae	<
Myers 1988	=	1:1.5:2.3	posterodistal produced	fitting palm	without plumose setae	=
Current study	=	1:1.3:2	posterodistal produced	overlapping palm	without plumose setae	<

Remarks. *Bemlos quadrimanus* material studied herein resembles specimens from other populations from Indian, Africa and Australia. However, it differs from those specimens in its gnathopod 2 dactylus which is exceeding the palm and the mandibular palp ratios of articles 1–3 1:1.3:2 (vs. 1:2:3 in the original description). It also shows the following differences from the original description: antenna 2 article 4 subequal to article 5 (vs.

shorter), female gnathopod 1 merus and carpus venterodistally produced (vs. unproduced) and uropod 1 peduncle shorter than rami (vs. subequal). Other morphological differences are concluded into Table 1. On the basis of morphology we cannot decide if our material belongs to a separate species or if the small differences are in the range of a normal variability.

Distribution. East Africa (Myers 1975), Madagascar (Ledoyer 1972), India (Sivaprakasam 1970), Andaman Sea (current study), Western Australia (Myers 1988).

Grandidierella Coutière, 1904

Grandidierella phetraensis sp. nov.

(Figs 8–13)

Type material. Holotype, male, 7.2 mm, PSUZC-CR-0268, sandy beach of Satun province 6°50'7"N 99°45'20"E Thailand, 27 November 2011, 2 m, Rodcharoen, E. Allotype: female, 7.1 mm, PSUZC-CR-0269, same station data. Dissected appendages were kept in six semi-permanent slides mounted on glycerol. Paratype, 4 males and 2 females, ZMB 27976 same station data.

Additional material. PSUZC-CR-275 5 males and 2 females, same station data.

Type locality. Phetra Beach Satun Province, Thailand, Andaman Sea.

Etymology. This species is named after the type locality.

Description. Based on holotype male, 7.2 mm, PSUZC-CR-0268.

Head subequal in length to first 2 pereonites. *Antenna 1* longer than antenna 2, peduncular article 1–3 ratio 7:8:2; flagellum longer than peduncle with 14 articles, each article with short setae distally and last 8 article additionally with aesthetascs; accessory flagellum uni-articulate. *Antenna 2* peduncle stout, inner margin of article 3 with a robust seta; article 5 shorter than 4; flagellum short, with 4 articles, all article setiferous with a pair of curved robust setae. *Mandible*, both incisors 4-dentate; lacinia mobilis armed with 3 teeth on left and 4 teeth on right side; molar armed a single seta; palp article 1–3 subequal.

Pereon lacking sternal processes. *Gnathopod* 1 coxal plate suboval, unproduced; basis stout, 1.8 × as long as broad; carpus 1.5 times as long as broad, posterodistal corner produced into a tooth, inner face oblique with two smaller teeth, posterior margin smooth and setose; propodus longer than dactylus in length, posterior margin proximally excavate, distally expanded; dactylus curved, distal end concave with 3 robust setae. *Gnathopod 2* subchelate; coxa posteroventrally produced into a tooth; basis slender, not expanded distally; carpus longer than propodus, 2.2 × as long as wide, posterior margin crenulated, bearing pectinate setae; propodus palmar margin transverse, with fine setae and 2 defining bifid robust setae; dactylus slightly longer than palmar margin, inner margin with accessory tooth and 3 robust setae. *Pereopod 3 and 4* similar, coxal plate slightly posteroventrally produced; basis slender, sparsely setose; propodus narrow, both margin bearing setae; dactylus long and slender, shorter than propodus. *Pereopod 5–7* length ratios 5: 8:11, *pereopod* 7 basis with plumose setae on posterior margin.

Pleopod. *Uropod 1* peduncle longer than both rami, fringed with robust setae, peduncular apex bearing a posteroventral process; rami lined with a row of robust setae, distal bearing several robust setae. *Uropod 2* peduncle shorter than both rami with two apical robust setae, rami beset with robust setae; outer ramus longer than inner one. *Uropod 3* uniramous, peduncle expanded, much shorter than ramus with a distal robust seta; ramus with short second article, apex with 3 long setae. *Telson* subtrapezoidal, ending in two pointed telsonic angles providing a long robust seta plus one short seta on each lobe.

Female - sexually dimorphic characters. (Based on allotype female, 7.1 mm, PSUZC-CR-0269).

Pereon. *Gnathopod 1* coxa not produced; basis more slender, 2.8 × as long as broad; carpus trapezoid, about 2.4 × as long as broad, posterior margin setose; propodus oval, shorter than carpus, palm oblique and defined by a robust seta, palmar margin with short setules, distal end sparsely covered with setae; dactylus curved with 4 short stout robust setae on inner marginal. *Gnathopod 2* similar to that of male, slightly smaller than gnathopod 1; basis slender; carpus about 1.8 × as long as wide; propodus with 3 bifid robust setae on posterior margin; dactylus curved, grasping margin with fine setules and 4 short stout robust setae.

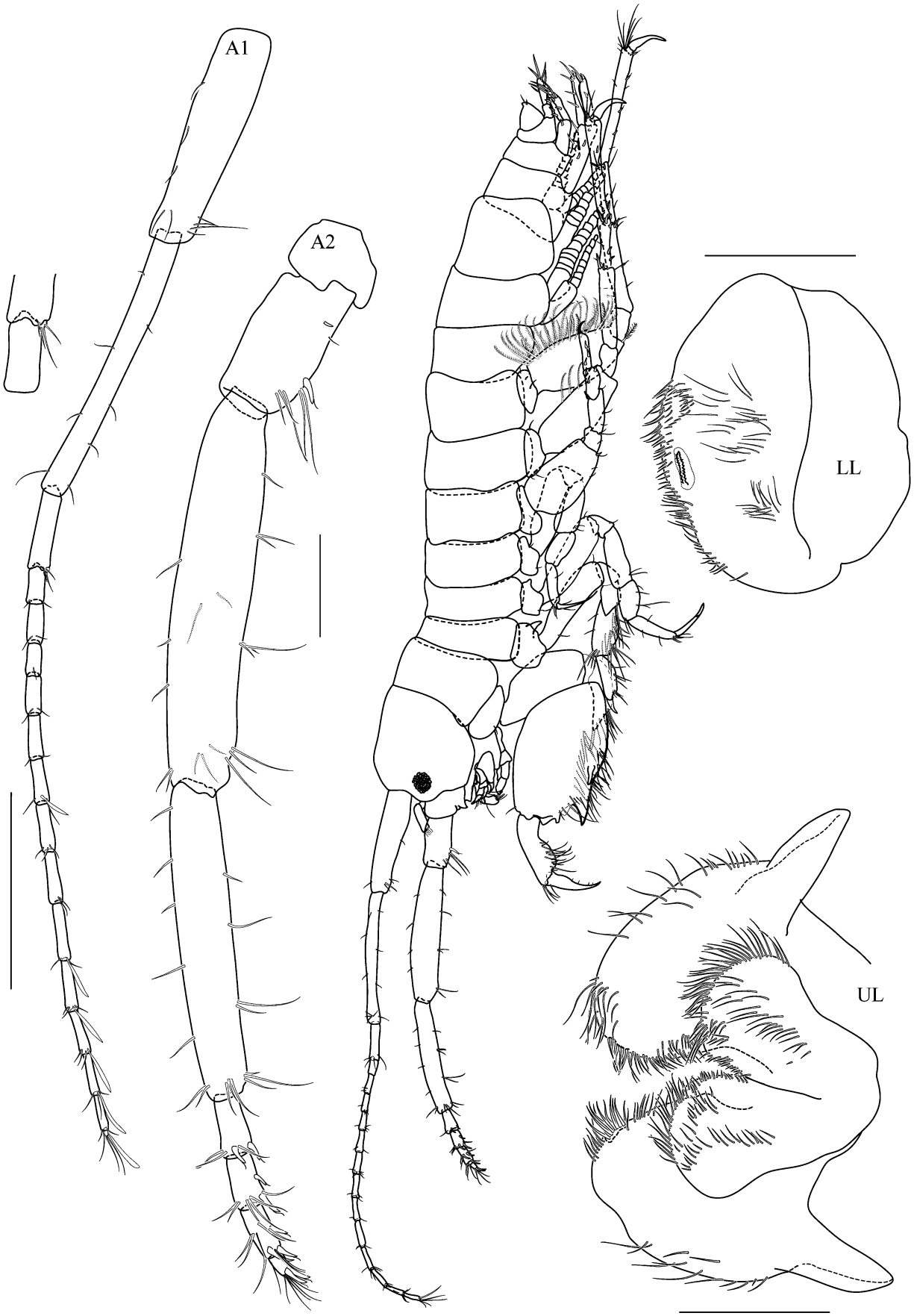

FIGURE 8. *Grandidierella phetraensis* **sp. nov.**, holotype, male (PSUZC-CR-0268), 7.2 mm, sandy beach of Satun province, Andaman Sea. Scale bars for A1 represent 0.5 mm, A2 0.2 mm, UL and LL 0.1 mm.

FIGURE 9. *Grandidierella phetraensis* **sp. nov.**, holotype, male, (PSUZC-CR-0268), 7.2 mm, sandy beach of Satun province, Andaman Sea. All scale bars represent 0.1 mm.

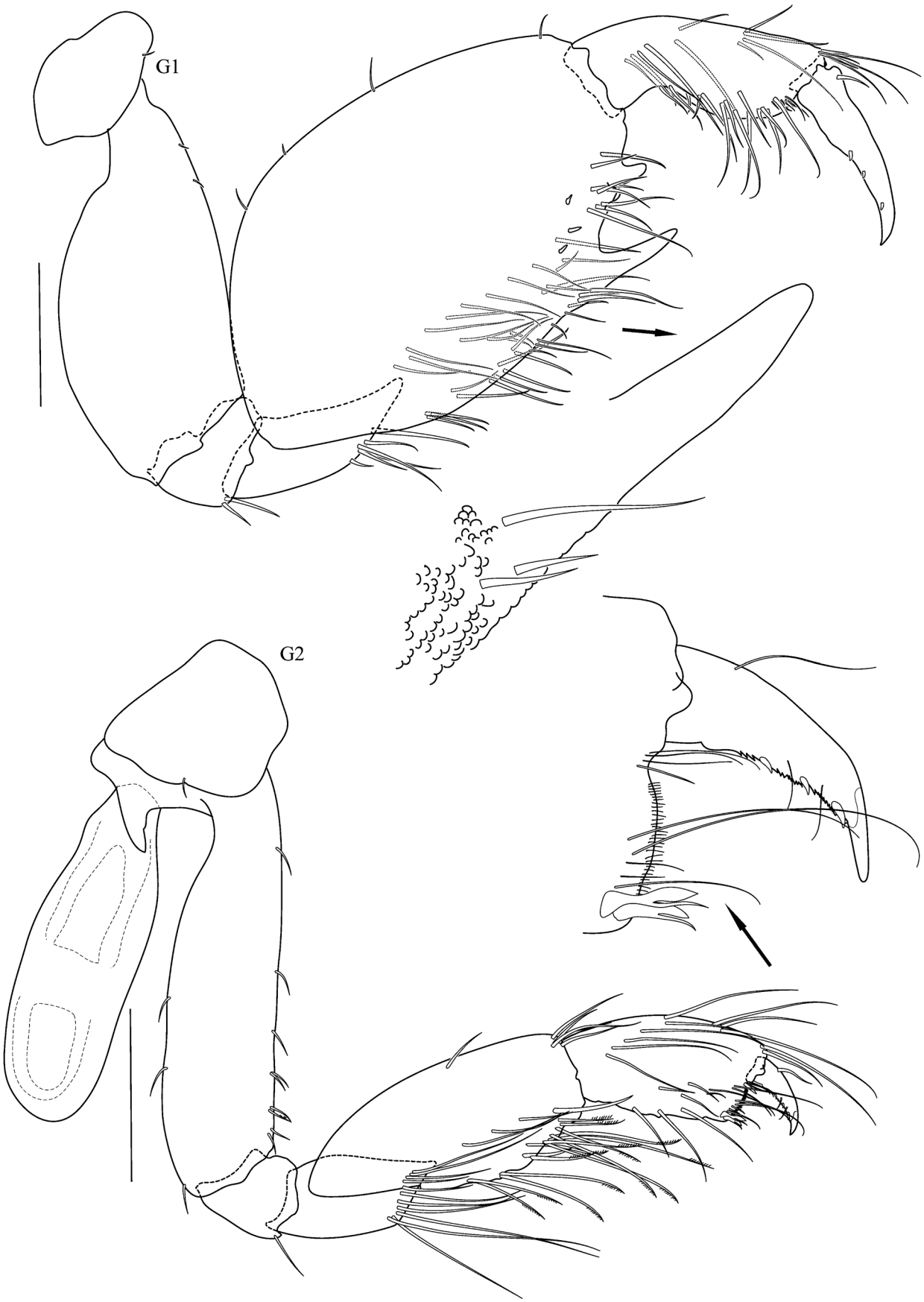

FIGURE 10. *Grandidierella phetraensis* **sp. nov.**, holotype, male (PSUZC-CR-0268), 7.2 mm. sandy beach of Satun province, Andaman Sea. All scale bars represent 0.2 mm.

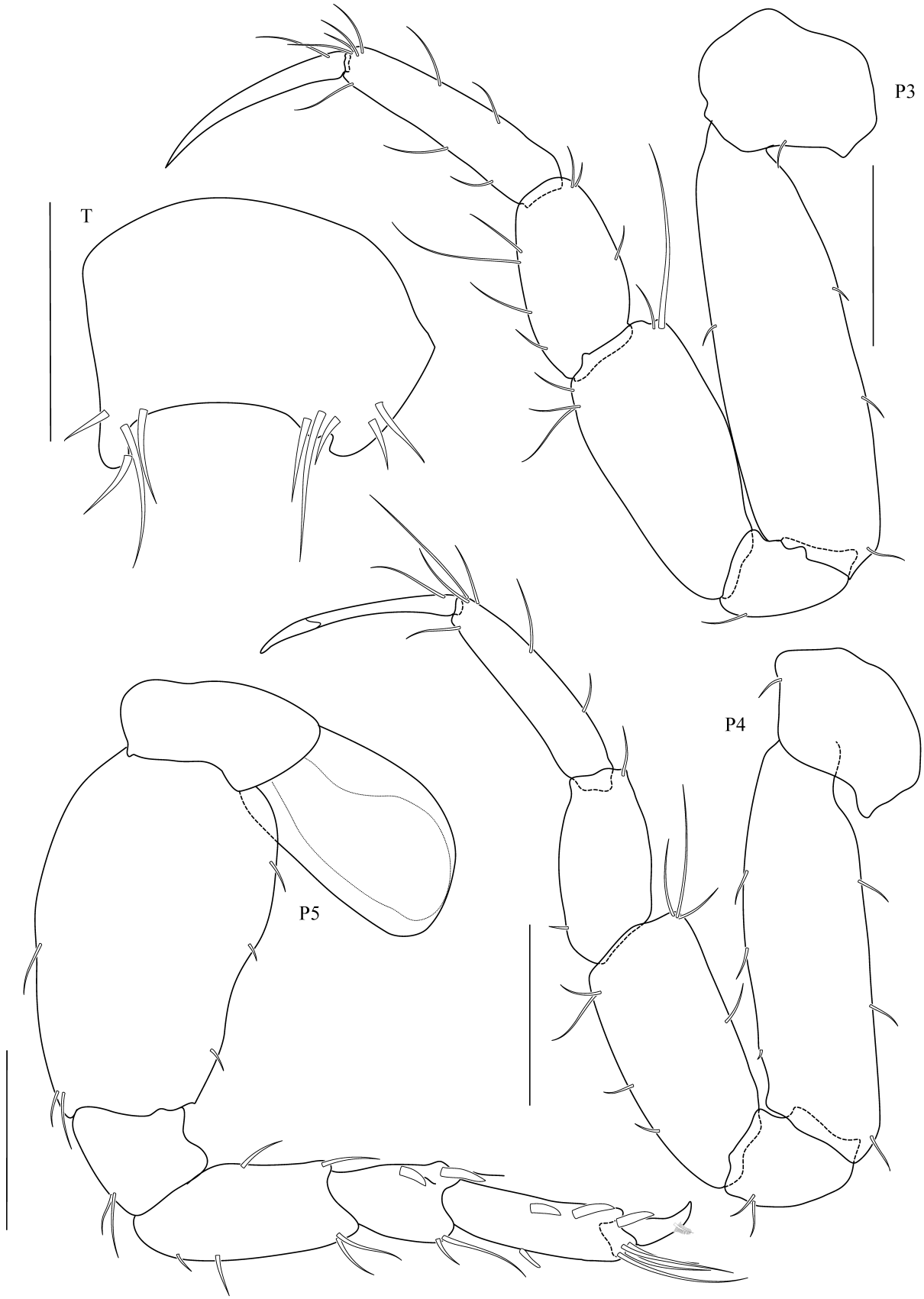

FIGURE 11. *Grandidierella phetraensis* **sp. nov.**, holotype, male (PSUZC-CR-0268), 7.2 mm, sandy beach of Satun province, Andaman Sea. Scale bar for T represents 0.1 mm, remaining represent 0.2 mm.

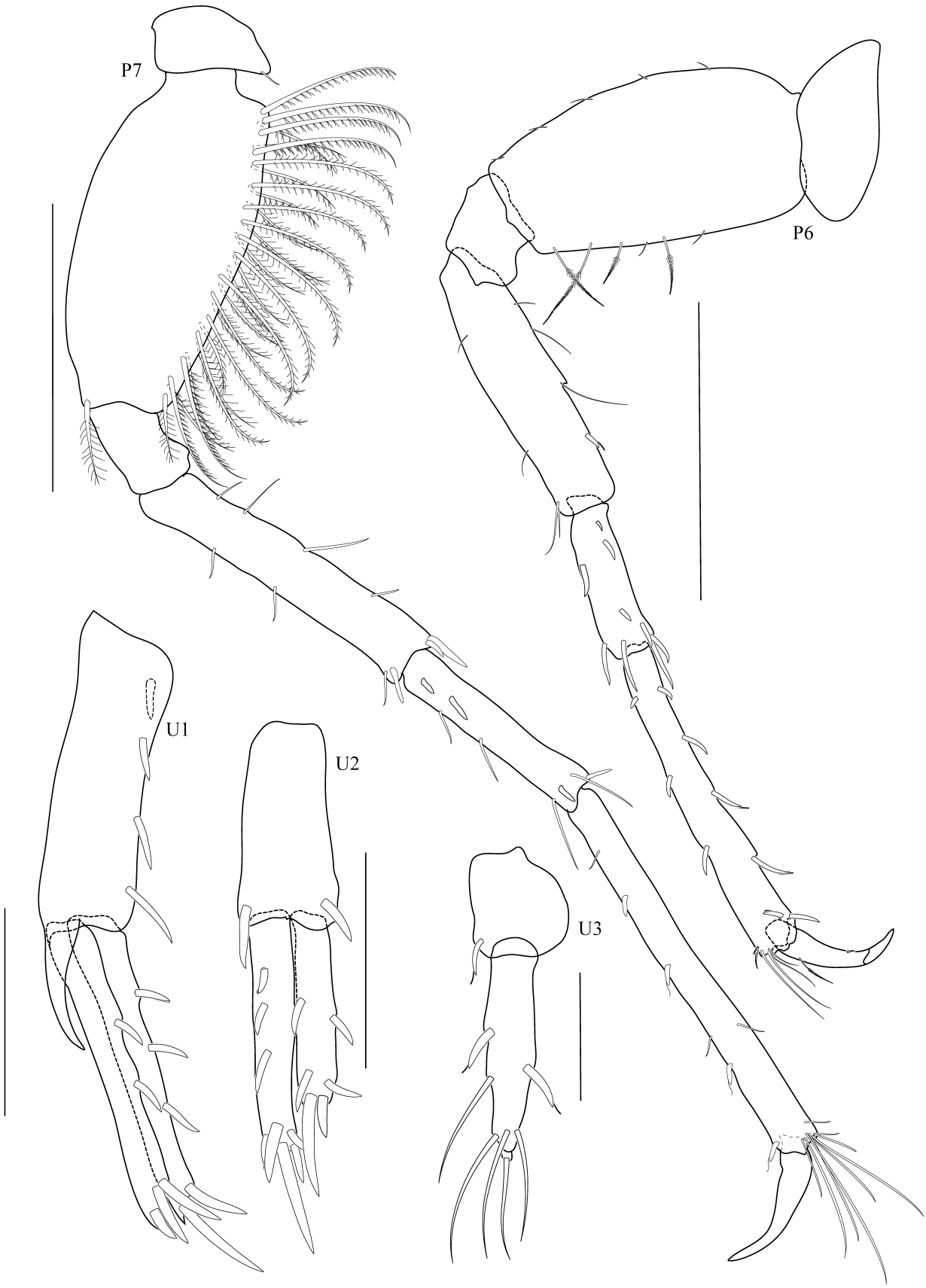

FIGURE 12. *Grandidierella phetraensis* **sp. nov.**, holotype, male (PSUZC-CR-0268), 7.2 mm. sandy beach of Satun province, Andaman Sea. Scale bars for P6 and P7 represent 0.5 mm, U1 and U2 represent 0.2 mm, U3 represents 0.1 mm.

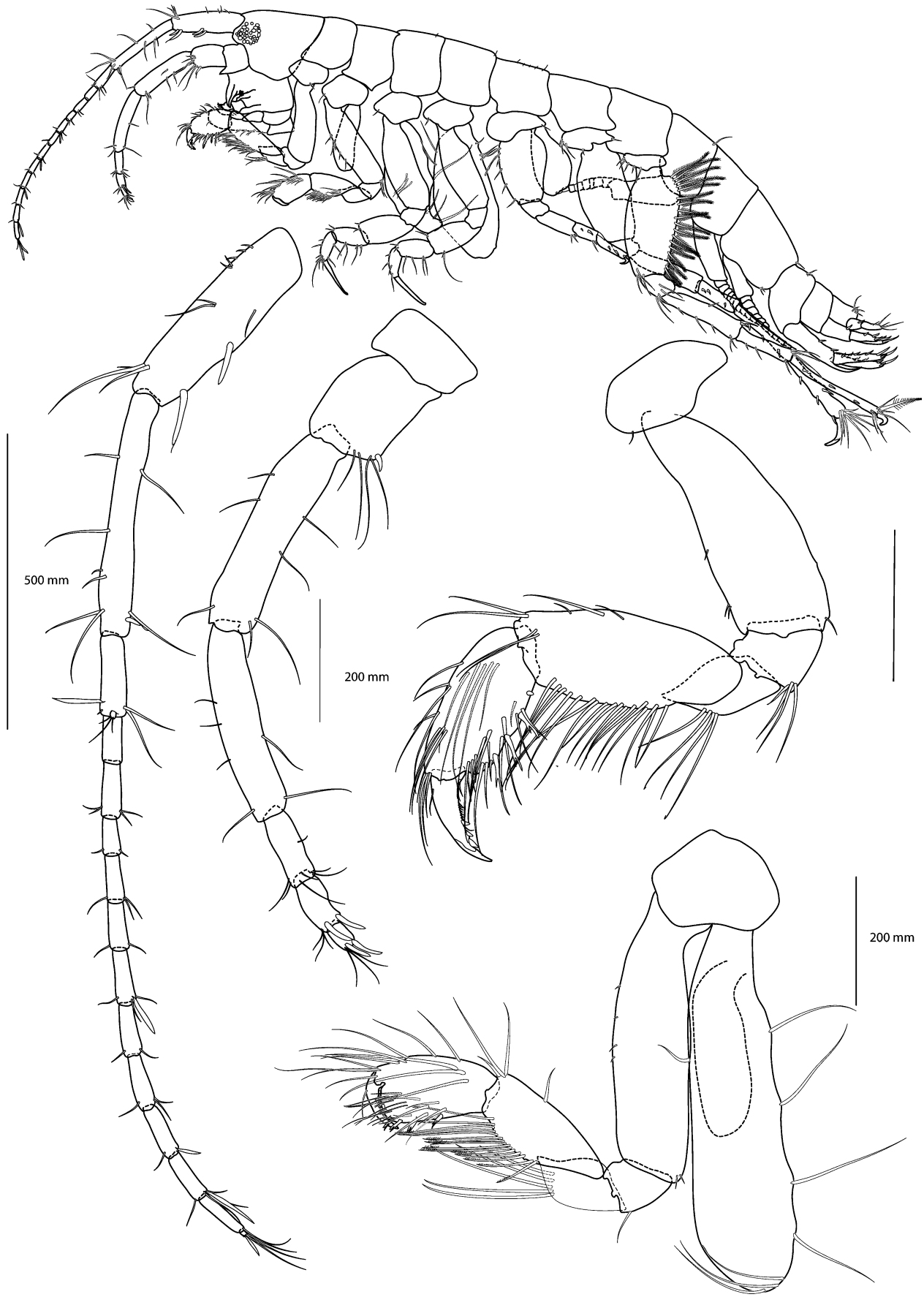

FIGURE 13. *Grandidierella phetraensis* **sp. nov.**, alllotype, female (PSUZC-CR-0269), 7.1 mm, sandy beach of Satun province, Andaman Sea. Scale bar for A1 represents 0.5 mm, remaining represent 0.2 mm.

Remarks. This species resembles *Grandidierella trispinosa* Bano & Kazmi, 2010 from India and *Grandidierella bonnieroides* (Stephensen 1948) which is distributed in the Atlantic and the Indian Ocean in the following: gnathopod 1 basis robust, less than 2 × as long as broad; coxa 2 produced posteriorly into a tooth; uropod 3 peduncle expanded, rami with 2 articles, second article rudimentary. However, the current species differs from both species in not having any sternal processes (vs. with sternal processes in both species), male gnathopod 1 without posteromarginal tooth (vs. bearing posteromarginal tooth) and the ratio of mandibular palp articles is 1:1:1 while that of *G. bonnieroides* is 5:8:8 and that of *G. trispinosa* is 2:3:3.

Ceradocus Costa, 1853

Ceradocus andamanensis sp. nov.

(Figs 14–18)

Type material. Holotype, male, 7.0 mm, PSUZC-CR-0270, algae bed of Lidee Noi Island, Satun Province, 6°46'42"N 99°46'5"E, 27 November 2011, 2 m, Rodcharoen, E. Allotype: female, 7.7 mm, PSUZC-CR-0271, same station data.

Additional material. PSUZC-CR-276 1 male and 4 female, same station data.

Type locality. Lidee Noi Island, Satun Province, Thailand, Andaman Sea.

Etymology. This species is named after the region of type locality for the first record of this genus in this area.

Description. Based on holotype male, 7.0 mm, PSUZC-CR-0270**.**

Head. Lateral cephalic lobe notch and recessed. *Antenna 1* peduncular article 1 slightly shorter than article 2, posterior margin with 2 marginal robust setae and 1 ventrodistal robust seta; flagellum with 19 articles, accessory flagellum 5 articles. *Antenna 2* gland cone not reaching to the end of article 3, flagellum with 12 articles. *Lower lip* inner lobes well developed, outer lobes with 5 blunt stout setae on both inner margins. *Maxilla 1* inner plate with marginal plumose setae and mediofacial setae. *Mandibular palp* article 3 subequal to article 1, article 1 distally acutely drawn out.

Pereon. *Gnathopod 1* coxa anteroventral corner produced, posteroventral corner notched, ventral margin not serrate; merus posterodistrally produced; carpus suboval with two rows of plumose setae and a row of setae on mediofacial margin; propodus oblique, palm longer than hind margin with group of short and long setae, with a defining robust seta on anteroventral corner. *Gnathopods 2* from left and right side symmetrical; merus posterodistal corner produced; carpus anterior margin without dense brush of long simple setae; propodus 3 × of carpus length, palmar margin oblique with 11 robust setae, posterodistal corner produced with 2 robust setae and few long fine setae; dactylus fit with palmar margin. *Pereopod 3* coxa posterodistal corner notched, merus slightly anterodistally produced with a long robust seta. *Pereopod 4* similar to pereopod 3. *Pereopod 5* and *6* basis posterior margin rounded. *Pereopod 7* basis posterior margin sigmoid.

Pleon. *Epimera 1 and 2* posteroventral corner sparsely serrated. *Epimera 3* posteroventral corner serrated above and below. *Pleonite 1–3* dorsally serrated. *Urosomite 1 and 2* evenly serrated. *Urosomite 3* smooth. *Uropod 1* peduncle with venterodistal spine, bearing 1 basofacial robust seta and two rows of marginal robust setae, both rami with a row of marginal robust setae, outer ramus with short setae along distofacial margin. *Uropod 3* inner ramus slightly shorter than outer ramus, rami about 1.4 × peduncle length. *Telson* each half with 2 apical robust setae and 1 lateral seta, moderately cleft, telsonic lobe reaching more than halfway along longest spine.

Female - sexually dimorphic characters. Based on allotype female, 7.7 mm, PSUZC-CR-0271. *Gnathopod 2* propodus 1.36 × carpus length, palm with 3 robust setae on anterodistal corner, not anterodistally produced. *Epimera 1 and 2* posteroventral corner serration deeper than those of male.

Remarks. Sheard 1939 divided *Ceradocus* into 2 subgenera, i. e., *Ceradocus (Ceradocus)* and *Ceradocus (Denticeradocus)*. Our new species can be classified as *Ceradocus (Denticeradocus)* by the following characters: maxilla 1 inner plate setose along inner margin, uropod 3 outer ramus uniarticulate, lower lip with inner plate and pleon segments posterodorsally multidentate. There are 18 species in this subgenus. From those 18 species, only 3 species have symmetrical gnathopods 2 including, *Ceradocus cotonensis* Appadoo & Myers, 2006, *Ceradocus dooliba* Barnard, 1972 and *Ceradocus sheardi* Shoemaker, 1948. In *C. cotonensis* the inner plate of maxilla 1 is setose at the apex while in *C. andamanensis* **sp. nov.** it is setose along the inner margin and coxa 1 of the new

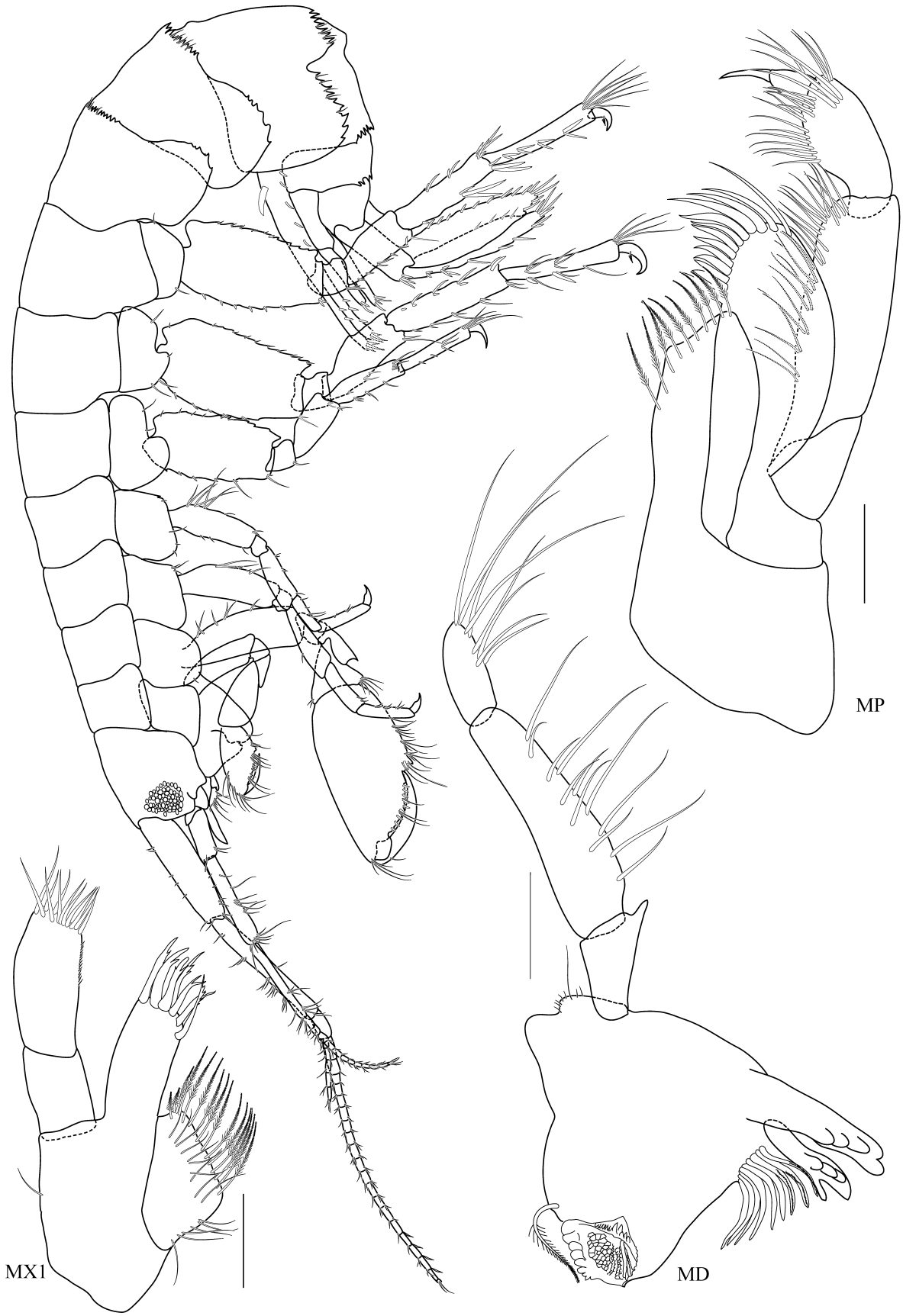

FIGURE 14. *Ceradocus andamanensis* **sp. nov.**, holotype, male (PSUZC-CR-0270), 7.7 mm, algae bed of Lidee Noi Island, Andaman Sea. All scale bars represent 0.1 mm.

FIGURE 15. *Ceradocus andamanensis* **sp. nov.**, holotype, male (PSUZC-CR-0270), 7.7 mm. algae bed of Lidee Noi Island, Andaman Sea. Scale bar for T represents 0.2 mm, for LL represents 0.2 mm, remaining represent 0.5 mm.

FIGURE 16. *Ceradocus andamanensis* **sp. nov.**,, holotype, male (PSUZC-CR-0270), 7.7 mm, algae bed of Lidee Noi Island, Andaman Sea. Scale bar for G1 represents 0.2 mm, for G2 represents 0.5 mm, remaining represent 0.1 mm.

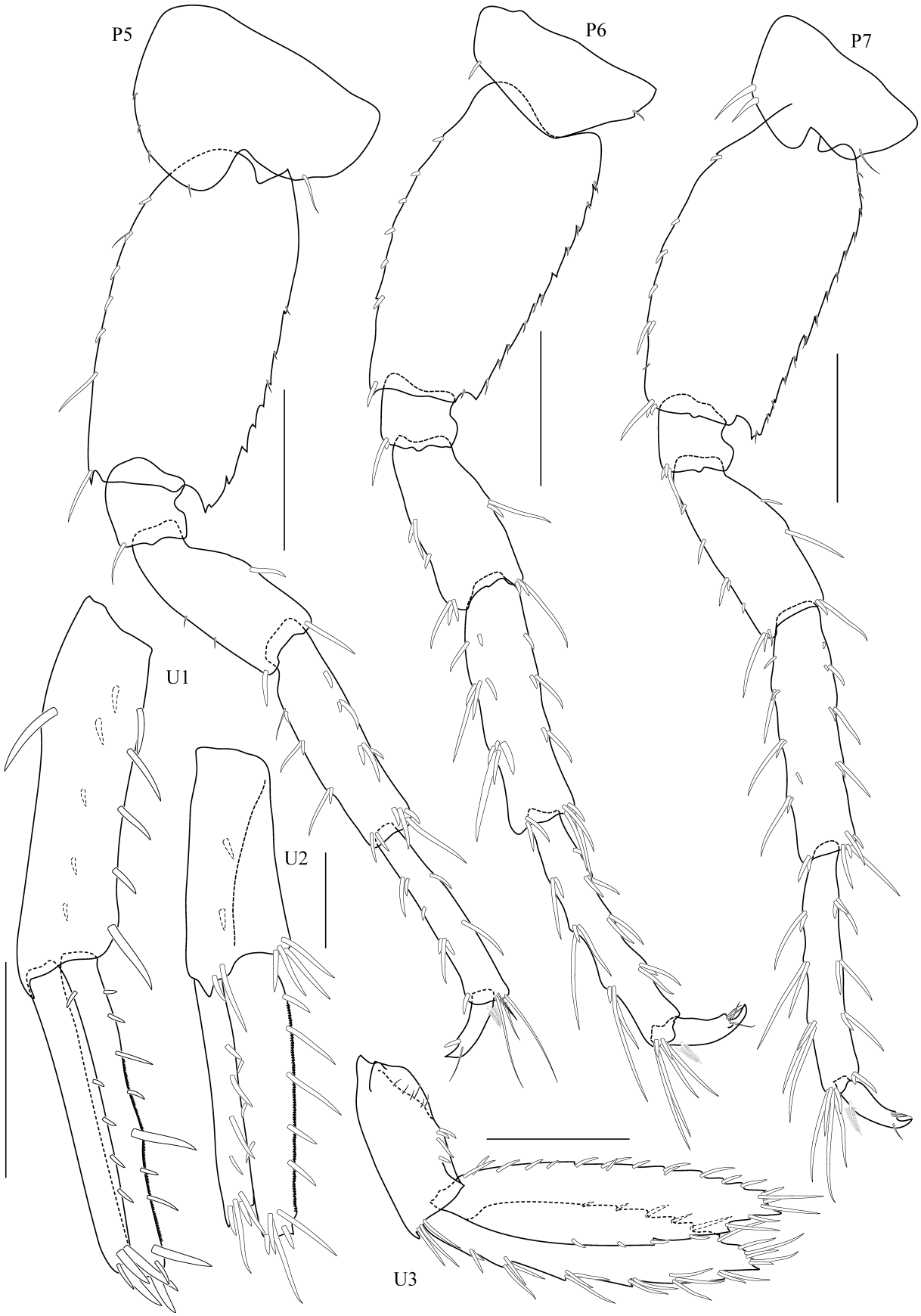

FIGURE 17. *Ceradocus andamanensis* **sp. nov.**, holotype, male (PSUZC-CR-0270), 7.7 mm. algae bed of Lidee Noi Island, Andaman Sea. Scale bar for U2 and U3 represents 0.2 mm, remaining represent 0.5 mm.

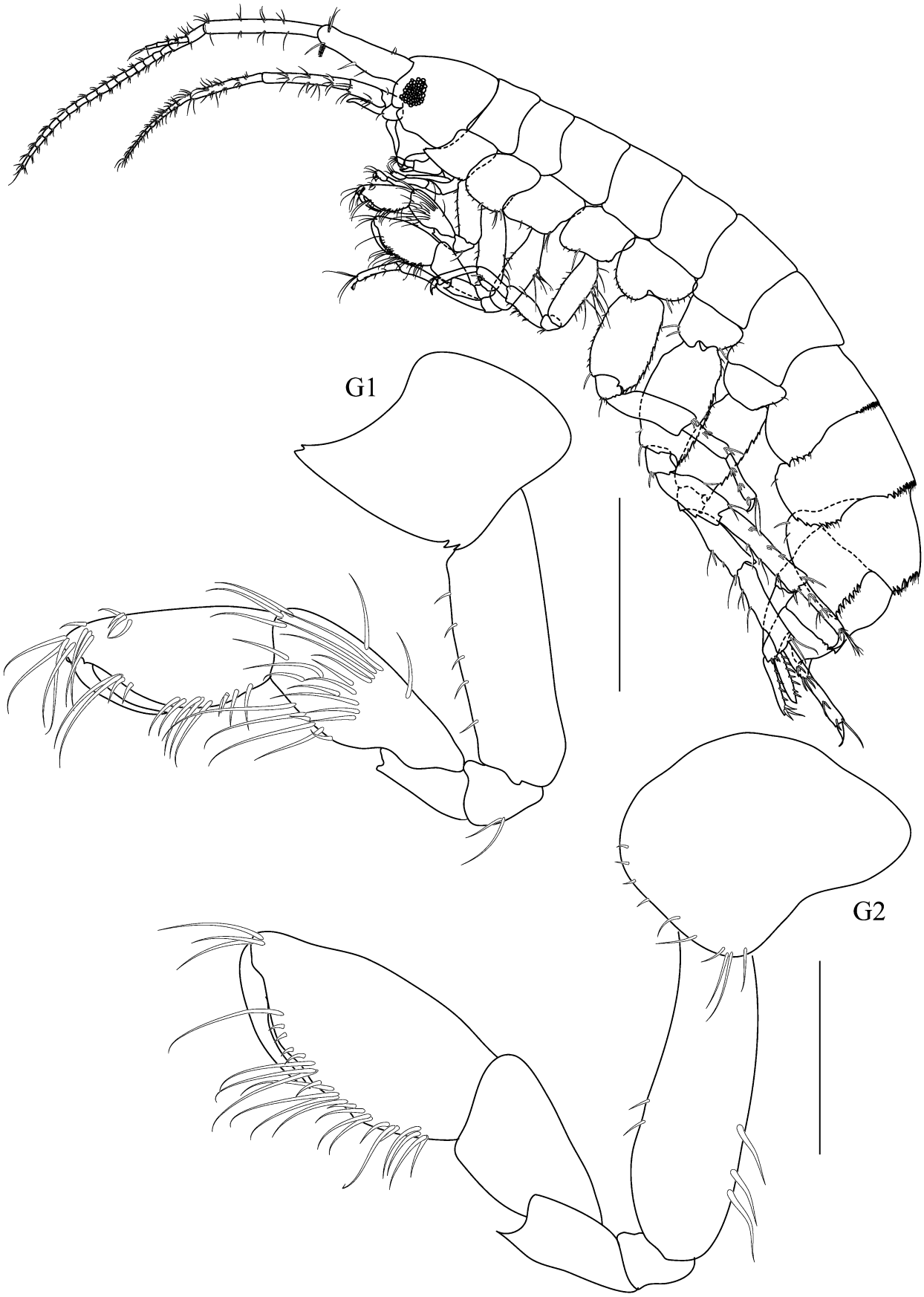

FIGURE 18. *Ceradocus andamanensis* **sp. nov.**, alllotype, female (PSUZC-CR-0271), 7.7 mm. algae bed of Lidee Noi Island, Andaman Sea. All scale bars represent 0.2 mm.

species is notched on both, the anteroventral and posteroventral corner (vs. smooth in the former). *Ceradocus dooliba* which is a considerably larger amphipod (20 mm) is different from *C. andamanensis* on urosomite 1 and 2 dorsum unevenly serrated while the latter is evenly serrate. *Ceradocus andamanensis* is easily separated from *C. sheardi* by antenna 1 accessory flagellum which is 5 articulate while the latter is 9 articulate. Moreover, the palmer margin of the former is smooth while the palmer margin of *C. sheardi* has a broad sinus.

Parelasmopus Stebbing, 1888

Parelasmopus siamensis sp. nov.

(Figs 19–23)

Type material. Holotype, male, 10.4 mm, PSUZC-CR-0272, coral reef of Samaesarn Island, Chonburi Province, 12°33'03"N 100°57'05"E, 30 September 2011, 4 m, Damrongrojwattana, P. Allotype, female, 7.7 mm, PSUZC-CR-0273, same station data.

Additional material. PSUZC-CR-277, 5 males and 2 females, same station data.

Type locality. Samaesarn Island, Chonburi Province, Inner Gulf of Thailand.

Etymology. This species is named after the type locality for the first record of this genus in this area.

Description. Based on holotype male, 10.4 mm, PSUZC-CR-0272.

Head. Anteroventral margin with notch. *Antenna 1* peduncular article 1 subequal to article 2, with 1 robust seta; flagellum with 38 articles; accessory flagellum with 3 articles. *Antenna 2* cone gland exceeding peduncular article 3; article 4 longer than 5; flagellum with 10 articles. Mandible incisor with 3 teeth; lacinia mobilis with 5 teeth; accessory setal row with 3 setae; mandibular palp article 2 shortest, geniculate; article 3 subequal to article 1 with 2 long fine apical setae.

Pereon. *Gnathopod 1* coxa ventral margin serrate, anteroventral corner produced, truncate, posteroventral corner with notch; merus not produced; carpus subequal to propodus, palm oblique, without posterodistal robust setae. *Gnathopod 2* larger than gnathopod 1, coxa with notch on posteroventral margin; merus posterodistally produced; propodus distally expanded, posterior margin slightly excavated distally; palm transverse with subrectangular distomedial elevation with 6 robust setae, palmar margin with 2 robust setae; dactylus toothed on mid-posterior margin. *Pereopod 3* coxa ventral margin serrate. *Pereopod 4* coxa smooth. *Pereopods 5–6* basis straight, posterior margin weakly serrate with short setae. *Pereopod 7* basis posterior margin bulging outward, serrate with long fine setae. *Pereonite 7* with dorsal teeth.

Pleon. *Pleonites* 1–3 with paired mid-dorsal teeth on posterior margin. *Epimera 1–2* smooth. *Epimeron 3* margin serrate below posteroventral margin. *Urosomite 1* dorsally with paired mid-dorsal teeth on posterior margin. Uropod 1 peduncle with two rows of basofacial robust setae. *Uropod 3* rami distally truncated with long and short apical setae, inner ramus 1.5 × of peduncle, subequal to outer ramus. *Telson* deeply cleft, as long as broad, lobes distally truncated, with 5 to 7 long apical robust setae.

Female- sexually dimorphic characters. Based on allotype female, 7.7 mm, PSUZC-CR-0273. Antenna 1 flagellum with 23 articles, accessory flagellum with 5 articles. *Gnathopod 2,* merus not produced, propodus not distally expanded, longer than that of male, palm oblique, dactylus without tooth on mid-posterior margin, with dorsal teeth. Pleonite 1 with dorsal teeth.

Remarks. *Parelasmopus* is a small genus, endemic to the Indo–West Pacific (Lowry & Hughes 2009). From 12 *species* of *Parelasmopus, Parelasmopus siamensis* **sp. nov.** has dorsal teeth on pereonite 7 which are of similar shape in six other species, namely *Parelasmopus cymatilis* Lowry & Hughes, 2009*, Parelasmopus echo* Barnard, 1972*, Parelasmopus poorei* Hughes, 2009*, Parelasmopus setiger* Chevreux, 1901*, Parelasmopus suensis* (Haswell, 1879) and *Parelasmopus suluensis* Dana, 1852. Moreover, only *P. poorei* and *P. setiger* have a tooth on the mid-posterior margin of the dactylus of gnathopod 2 in the male sex. *Parelasmopus siamensis* **sp. nov.** can be separated from *P. poorei* by: - the lack of any robust setae on posterodistal corner of gnathopod 1 (vs. presence of 2 such setae), - its gnathopod 2 palm having a distomedial elevation while the latter has a posteroproximal elevation - and the basis of pereopod 7 is bulging outward (vs. sigmoidal-shaped).

Parelasmopus siamensis **sp. nov.** is very similar to *P. setiger* and shares many characters including the gnathopod 2 palmar margin with posteroproximal elevation with 6 robust setae, the midposterior toothed dactylus

FIGURE 19. *Parelasmopus siamensis* **sp. nov.**, holotype, male (PSUZC-CR-0272), 10.4 mm, coral reef of Samaesarn Island, Chonburi Province, Gulf of Thailand. All scale bars represent 0.5 mm.

FIGURE 20. *Parelasmopus siamensis* **sp. nov.**, holotype, male (PSUZC-CR-0272), 10.4 mm, coral reef of Samaesarn Island, Chonburi Province, Gulf of Thailand. Scale bars for MD and LL represents 0.2 mm, remaining represent 0.5 mm.

FIGURE 21. *Parelasmopus siamensis* **sp. nov.**, holotype, male (PSUZC-CR-0272), 10.4 mm, coral reef of Samaesarn Island, Chonburi Province, Gulf of Thailand. All scale bars represent 0.2 mm.

FIGURE 22. *Parelasmopus siamensis* **sp. nov.**, holotype, male (PSUZC-CR-0272), 10.4 mm, coral reef of Samaesarn Island, Chonburi Province, Gulf of Thailand. Scale bar for T represents 0.2 mm, UL represents 0.1 mm, remaining represent 0.5 mm.

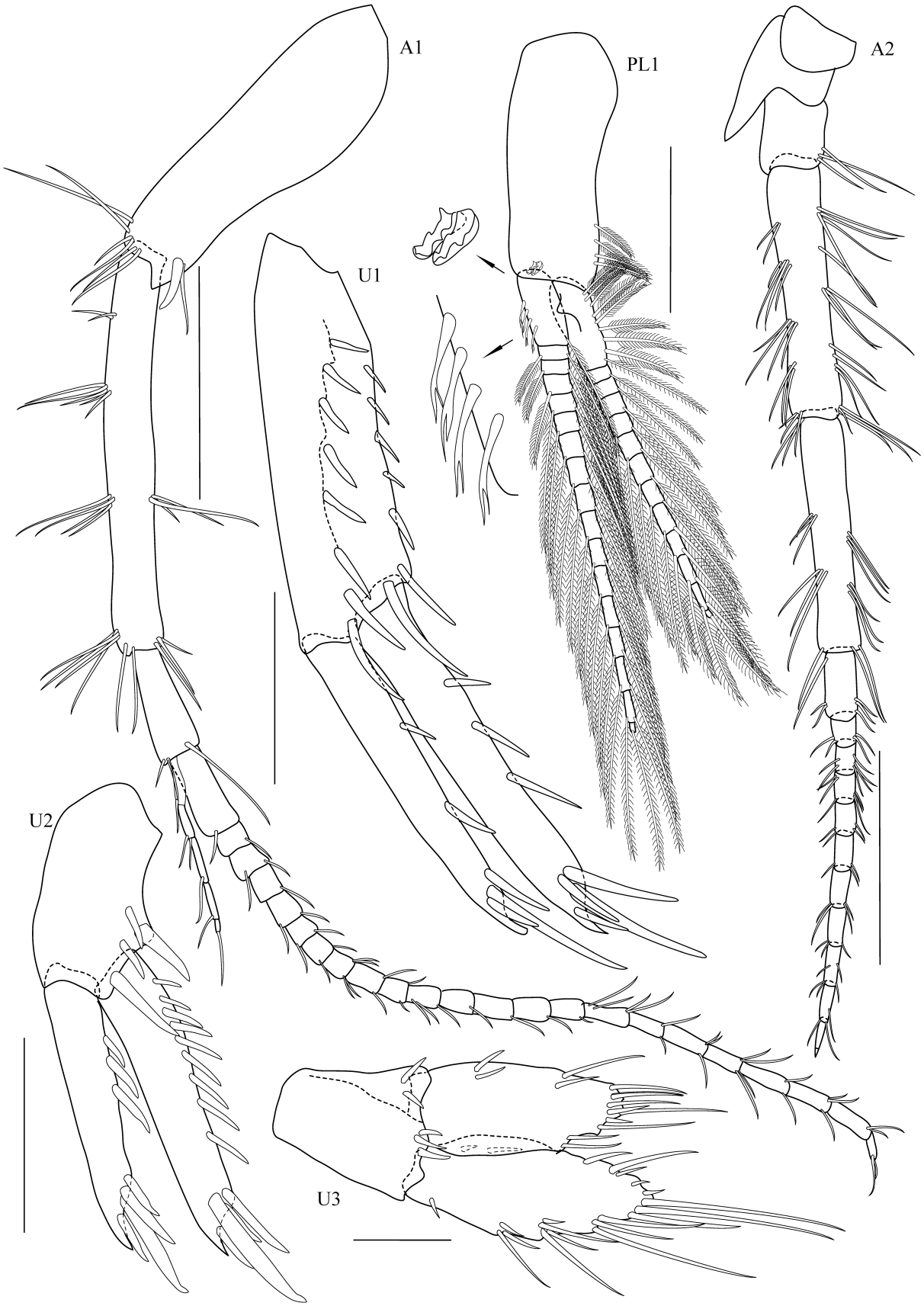

FIGURE 23. *Parelasmopus siamensis* **sp. nov.**, PL1, U1–3 holotype, male (PSUZC-CR-0272), 10.4 mm. A1–2 allotype, female (PSUZC-CR-0273), coral reef of Samaesarn Island, Chonburi Province, Gulf of Thailand. Scale bar for U3 represents 0.2 mm, remaining represent 0.5 mm

FIGURE 24. *Parelasmopus siamensis* **sp. nov.**, allotype, female (PSUZC-CR-0273), 10.4 mm. coral reef of Samaesarn Island, Chonburi Province, Gulf of Thailand. All scale bars represent 0.5 mm.

and the serration on coxa 1–3. However, the new species can be distinguished from *P. setiger* by the following characters—articulate accessory flagellum in the male (5-articulate in the female sex) while the latter has 4 articles in both sexes—the mandibular palp article 1 of the new species is subequal to article 3 (vs. article 1 longer than article 3)—merus of gnathopod 2 in females of *P. siamensis* **sp. nov.** posterodistally produced (vs. not produced) and coxa 6 posterodistally serrate (vs. smooth).

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References

Angsupanich, S. & Kuwabara, R. (1995) Macrobenthic fauna in Thale Sap Songkla, a brackish lake in southern Thailand. *Lakes & Reservoirs: Research and Management,* 1, 115–125.

Angsupanich, S., Siripech, A. & Charoenpornthip, M. (2005) Macrobenthic fauna community in the Middle Songkhla Lake, Southern Thailand. *Songklanakarin Journal of Science and Technology,* 27, 365–390.

Appadoo, C. & Myers, A.A. (2006) Melitids (Crustacea: Amphipoda) of the genera *Ceradocus* and *Mallacoota* from Rodrigues Island (Indian Ocean). *Zootaxa,* 1370, 1–22.

Ariyama, H., Angsupanich, S. & Rodcharoen, E. (2010) Two new species of the genus Kamaka (Crustacea: Amphipoda: Kamakidae) from Songkhla Lagoon, southern Thailand. *Zootaxa*, 2404, 55–68.

Bano, H. & Kazmi, Q.B. (2010) *Grandidierella trispinosa*, a new species of amphipod from the Karachi coast, Pakistan (Crustacea: Amphipoda: Aoridae). *Turkish Journal of Zoology,* 34, 151–157.

Barnard, J.L. (1970) Sublittoral Gammaridea (Amphipoda) of the Hawaiian Islands. *Smithsonian Contributions to Zoology*, 34, 1–286, 180 figs.
http://dx.doi.org/10.5479/si.00810282.34

Barnard, J.L. (1972) Gammaridean Amphipoda of Australia, Part 1. *Smithsonian Contributions to Zoology*, 103, 1–333, 194 figs.
http://dx.doi.org/10.5479/si.00810282.103

Bussarawich, S. (1985) Gammaridean Amphipoda from mangroves in southern Thailand. *In:* NRCT (Ed), *Fifth Seminar on Mangrove Ecosystems*, Phuket, Thailand, pp. 1–17.

Bussarawich, S., Nateewathana, A. & Hylleberg, J. (1984) Distribution of marine benthic amphipods of Phuket Island, with emphasis on tin mining and A model of species-individual relationships. *Phuket Marine Biological Center Research Bulletin,* 32, 1–21.

Chevreux, E. (1901) Crustaces amphipodes. Mission scientifique de M Ch. Alluaud aux lies Sechelles (Mars, Avril, Mai, 1892). *Mémoires de la Société zoologique de France*, 14, 388–438, 65 figs.

Coleman, C.O. (2003) "Digital inking": How to make perfect line drawings on computers. *Organism diversity&evolution,* 3, 1–14.
http://dx.doi.org/10.1078/1439-6092-00081

Costa, A. (1853) Relazione sulla memoria del Dottor Achille Costa, di ricerche su' crostacei amfipodi del regno di Napoli. *Rendiconto della Societa Reale Borbonica, Accademia delle Scienze*, new series, 2, 167–178.
http://dx.doi.org/10.5962/bhl.title.2070

Coutière, H. (1904) Sur un type nouveau d'amphipode *Grandidierella mahafalensis*, provenant de Madagascar. *Bulletin de la Association Philomatique,* 6, 166–174.

Dallwitz, M.J. (2005) *Overview of the DELTA System*. Available from: http://delta-intkey.com/www/overview.htm (Accessed 12 Jul. 2013)

Dana, J.D. (1852) On the classification of the Crustacea Choristopoda or Tetradecapoda. *American Journal of Sciences and Arts*, series 2, 14 (41), 297–316.

Haswell, W.A. (1879) On Australian Amphipoda. *The Proceedings of the Linnean Society of New South Wales,* 4, 245–279.

Hughes, L.E. (2009) *Parelasmopus poorei* a New Species of Maeridae (Crustacea: Amphipoda) from Southern Australia. *Memoirs of Museum Victoria,* 66, 77–80.

Jansen, T. & Dinesen, E. (2002) Anamixidae (Amphipoda. Crustacea) from the Andaman Sea, north-eastern Indian ocean. *Phuket Marine BioIogical Center Special publication,* 23(1), 265–272.

Ledoyer, M. (1972) Amphipodes gammariens vivant dans les alvéoles des constructions organogènes récifales intertidales de la région de Tuléar (Madagascar). Étude Systématique et Écologique. *Tethys,* 3, 165–286.

Lowry, J.K. & Berents, P.B. (2002) The genus *Cerapus* in the Andaman Sea (Crustacea, Amphipoda, Ischyroceridae). *Phuket Marine Biological Center Special Publication*, 23 (1), 189–196.

Lowry, J.K. & Hughes, L.E. (2009) Maeridae, the *Elasmopus* group, *In*: Lowry, J.K. & Myers, A.A. (eds), Benthic Amphipoda (Crustacea: Peracarida) of the Great Barrier Reef, Australia. *Zootaxa,* 2260, pp. 643–702.

Lowry, J.K. & Myers, A.A. (2003) New amphipod crustaceans from the Indo-West Pacific (Amathillopsidae: Eusiridae: Iphimediidae). *The Raffles Bulletin of Zoology,* 51, 219–256.

Lowry, J.K. & Stoddart, H. (2002) First records of lysianassoid amphipods (Crustacea) from the Andaman Sea. *Phuket Marine Biological Center Special Publication*, 23(1), 165–188.

Lowry, J.K. & Watson, M.J. (2002) Revision of the Gammarellid group, with a new species from the Andaman Sea (Crustacea: Amphipoda: Melitidae), 2002. *Phuket Marine Biological Centre Special Publication*, 23 (1),197–212.

Myers, A.A. (1975) Studies on the genus *Lembos* Bate. II. Indo-Pacific species: *L. quadrimanus* Sivaprakasam, *L. punctatus* sp. nov.; *L. parahastatus* sp. nov., *L. palmatus* (Ledoyer). *Bollettino del Museo Civico di Storia Naturale, Verona,* 1, 359–395.

Myers, A.A. (1988) The genera *Archaeobemlos* n.gen., *Bemlos* Shoemaker, *Protolembos* Myers and *Globosolembos* Myers (Amphipoda, Aoridae, Aorinae) from Australia. *Records of the Australian Museum,* 40, 265–332.
http://dx.doi.org/10.3853/j.0067-1975.40.1988.158

Myers, A.A. (2002) Marine amphipods of the family Aoridae and Neogamphopidae from Phuket, Thailand. *Phuket Marine BioIogical Center Special publication,* 23(1), 13–28.

Peart, R.A. (2002) New species of Ampithoidae (Crustacea, Amphipoda, Corophioidea) from the Andaman Sea. *Phuket Marine BioIogical Center Special publication,* 23(1), 229–252.

Sheard, K. (1939) Studies in Australian Gammaridea. The genus *Ceradocus*. *Records of the South Australian Museum,* 6, 275–295.

Shoemaker, C.R. (1925) The Amphipoda collected by the United States Fisheries Steamer 'Albatross' in 1911, chiefly in the Gulf of California. *Bulletin of the American Museum of Natural History*, 52, 21–61, 26 figs.

Shoemaker, C.R. (1948) The Amphipoda of the Smithsonian-Roebling Expedition to Cuba in 1937. *Smithsonian Miscellaneous Collections*, 110(3), 15 pp., 3 figs.

Sivaprakasam, T.E. (1970) Amphipods of the genus *Lembos* Bate from the south-east Coast of India. *Journal of the Marine Biological Association of India,* 12, 81–92.

Stebbing, T.R.R. (1888) Report on the Amphipoda collected by H.M.S. Challenger during the years 1873-76. *Report on the Scientific Results of the Voyage of H.M.S. Challenger During the Years 1873-1876*, Zoology, 29, xxiv + 1737 pp., 210 pls. London: Eyre and Spottiswoodie.

Stebbing, T.R.R. (1899) Revision of Amphipoda (continued). *Annals and Magazine of Natural History*, Series 7, 4, 205–211.
http://dx.doi.org/10.1080/00222939908678185

Stephensen, K. (1948) Amphipods from Curaçao, Bonaire, Aruba and Margarita. *Studies on the Fauna of Curaçao, Aruba, Bonaire and the Venezuelan Islands*, 3, 1–20.
http://dx.doi.org/10.1007/978-94-015-3018-7

Wongkamhaeng, K., Azman, B.A.R. & Puttapreecha, R. (2012) *Cheiriphotis trifurcata*, new species (Crustacea, Amphipoda, Corophiidae, Protomedeiinae) from the Seagrass Bed of the Lower Gulf of Thailand. *ZooKeys,* 187, 71–89.
http://dx.doi.org/10.3897/zookeys.187.3219

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Wongkamhaeng, K., Coleman, C.O. and Pholpunthin, P. 2013. Three new species from the Aoridae and Maeridae (Crustacea, Amphipoda) from Thai Waters. Zootaxa. 3693 (4): 503–533.

Wongkamhaeng, K. Azman B.A.R. and Puttaprecha, R. 2012. *Cheiriphotistrifurcata*, new species (Crustacea, Amphipoda, Corophiidae, Protomedeiinae) from the Seagrass Bed of the Lower Gulf of Thailand. ZooKeys 187: 71–89

Wongkamhaeng, K. Azman B.A.R. and Pholphanthin, P. 2012. *GrandidierellaHalophilus* a new species of the family Aoridae (Crustacea: Amphipoda) from the saltpans of The Inner Gulf of Thailand. Raffles Bulletin of Zoology 2012;60(2):433-447.

Wongkamhaeng, K. Darakrai, A and Pholphanthin, P. 2010. New species of *Tethygeneia*Eurisidae: Amphipoda) and new records of Algae-Living Gammarid Amphipods Crustaceain South Sea Islands, Marine National Park, Nakhon Si Thammarat Province. In: Harada H. and Shirayama Y. (eds) Selected Papers of the NaGISA World Congress 2009, Publications of the Seto Marine Biological Laboratory, Special Publication Series Vol. 11. pp 1-23.