สัณฐานวิทยาและนิเวศวิทยาการกินของแกมมาริดแอมฟิพอดที่อาศัยอยู่ในแนวปะการังและในหญ้าทะเล

นางสาวกรอร วงษ์กำแหง

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต

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MORPHOLOGY AND FEEDING ECOLOGY OF

GAMMARID AMPHIPODS IN CORAL REEF AND SEAGRASS COMMUNITIES

Miss Koraon Wongkamhaeng

A Thesis Submitted in Partial Fulfillment of the Requirements

for the Degree of Master of Science in Marine Science

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นางสาวกรอร วงษ์กำแหง : สัณฐานวิทยาและนิเวศวิทยาการกินของแกมมาริดแอมฟิพอด ที่อาศัยอยู่ในแนวปะการังและในหญ้าทะเล. (MORPHOLOGY AND FEEDING ECOLOGY OF GAMMARID AMPHIPODS IN CORAL REEF AND SEAGRASS COMMUNITIES) อ. ที่ปรึกษา :ร.ศ. ณิฏฐารัตน์ ปภาวสิทธิ์, อ.ที่ปรึกษาร่วม : ดร. สมชัย บุศราวิช 174 หน้า. ISBN 974-17-6873-7.

การศึกษาสัณฐานวิทยาและนิเวศวิทยาการกินของแกมมาริดแอมฟิพอดได้จากตัวอย่างแอมฟิพอดที่อาศัยอยู่ในแนวปะการังบริเวณเกาะค้างคาว จังหวัดชลบุรี ในเดือนเมษายน พ.ศ. 2544 และตัวอย่างแอมฟิพอดที่อาศัยอยู่ในแนวหญ้าทะเล เกาะลิบง จังหวัดตรังในเดือนธันวาคม พ.ศ. 2546 ตามลำดับ ลักษณะการกินอาหารของแกมมาริดแอมฟิพอดในแนวปะการังและแนวหญ้าทะเลมี 4 แบบ คือ กลุ่มที่กรองกินบริเวณหน้าดิน กลุ่มที่กรองกินอาหารและเป็นผู้ล่า กลุ่มที่กัดกินสาหร่ายหน้าดิน และกลุ่มที่กินอินทรีย์สาร ลักษณะสัณฐานวิทยาของแอมฟิพอดแตกต่างกันตามลักษณะการกินอาหารโดยเฉพาะรยางค์ปาก คือ mandibles maxillipeds และ maxilla คู่ที่ 1 และ 2, รยางค์ที่ช่วยหาอาหารคือ antennae และรยางค์ที่ช่วยในการจับอาหารคือ gnathopods แกมมาริดแอมฟิพอดที่มีการกินอาหารแบบเดียวกันในแนวปะการังและแนวหญ้าทะเลมีลักษณะสัณฐานวิทยาคล้ายคลึงกันแต่ต่างกันที่พฤติกรรมในการกินอาหารและสัดส่วนของอาหารหลัก นอกจากนี้ยังพบว่าแอมฟิพอดสกุลเดียวกันที่ดำรงชีวิตอยู่ในที่อยู่อาศัยต่างกันมีลักษณะสัณฐานวิทยาต่างกัน โดยแอมฟิพอดที่อาศัยอยู่ในแนวปะการังมีการปรับเปลี่ยนลักษณะขาที่บางยาวและแบน มีขนลักษณะคล้ายขนนกเพื่อใช้ในการว่ายน้ำขณะที่แอมฟิพอดที่อาศัยอยู่ในแนวหญ้าทะเลมีลักษณะขาแข็งแรง สั้น และมีขนตลอดจนหนามหนาแน่น และยาวเพื่อช่วยในการขุดดิน

พบแอมฟิพอดในแนวปะการังเกาะค้างคาวรวม 14 ชนิด ใน 10 ครอบครัวโดยมี แอมฟิพอดชนิด *Ampelisca brevicornis* เป็นกลุ่มเด่นที่พบทุกสถานี แอมฟิพอดชนิดนี้มีการกินอาหารแบบกรองกินบริเวณหน้าดิน อาหารหลักของแอมฟิพอดกลุ่มนี้คือสาหร่ายหน้าดินขนาดเล็กและสาหร่ายหน้าดินขนาดใหญ่ กลุ่มแอมฟิพอดที่พบรองลงมาคือกลุ่มที่กินอินทรีย์สารเป็นหลัก *Urothoe simplingnathia* แอมฟิพอดกลุ่มเด่นอีกกลุ่มหนึ่งที่พบในแนวปะการังคือ *Eriopisa* sp.A ซึ่งเป็นเป็นกลุ่มที่กินพืชด้วยวิธีกัดและกินสาหร่ายหน้าดินขนาดเล็กและขนาดใหญ่เป็นอาหาร นอกจากนี้ยังพบแอมฟิพอดที่ดำรงชีวิตอยู่ทั้งบริเวณหน้าดินและในมวลน้ำซึ่งสามารถกินอาหารได้ทั้งแพลงก์ตอนพืช สาหร่ายหน้าดิน แพลงก์ตอนสัตว์และสัตว์ทะเลหน้าดิน ได้แก่ *Grammaropsis* sp. A., *Ceradocus* sp.A และ*Melita appendiculata*

ในบริเวณแนวหญ้าทะเล เกาะลิบงพบแอมฟิพอด 6 ชนิดใน 5 ครอบครัวโดยมีแอมฟิพอดชนิด *Kamaka* sp. A เป็นกลุ่มเด่น แอมฟิพอดชนิดนี้เป็นกลุ่มกินพืชด้วยวิธีกัดกินและกินสาหร่ายหน้าดินขนาดใหญ่และขนาดเล็กเป็นหลัก สามารถพบแอมฟิพอดชนิดนี้กระจายได้ทั่วไปในตะกอนดินและบริเวณใบหญ้าทะเล แอมฟิพอดกลุ่มเด่นที่พบรองลงมาคือ *Ampelisca cyclop* ซึ่งกรองอาหารกินจากมวลน้ำ ส่วนแอมฟิพอดกลุ่มที่กินอินทรีย์สารคือ *Urothoe spinidigitus* พบได้เป็นกลุ่มเด่นเช่นเดียวกัน การศึกษาครั้งนี้สามารถสรุปได้ว่าแกมมาริดแอมฟิพอดที่อาศัยอยู่ในแนวปะการังและแนวหญ้าทะเลมีบทบาททั้งในห่วงโซ่อาหารในมวลน้ำและในบริเวณพื้นท้องทะเล

ภาควิชา..........วิทยาศาสตร์ทางทะเล... ลายมือชื่อนิสิต..
สาขาวิชา.........วิทยาศาสตร์ทางทะเล... ลายมือชื่ออาจารย์ที่ปรึกษา...................................
ปีการศึกษา……2547…………………..ลายมือชื่ออาจารย์ทีปรึกษาร่วม.............................

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KEY WORD: AMPHIPODS/MORPHOLOGY/FEEDING ECOLOGY/CORAL REEFS/SEAGRASS COMMUNITIES/

MISS KORAON WONGKAMHAENG : MORPHOLOGY AND FEEDING ECOLOGY OF GAMMARID AMPHIPODS IN CORAL REEF AND SEAGRASS COMMUNITIES. THESIS ADVISOR : ASSOCIATE PROFESSOR NITTHARATANA PAPHAVASIT, THESIS COADVISOR : DR. SOMCHAI BUSSARAWICH, 174 pp. ISBN 974-17-6873-7.

Morphology and feeding ecology of gammarid amphipods in coral reef and seagrass communities were compared from amphipods collected from coral reefs in Kang Kao Island, Chonburi Province during April, 2001 and from seagrass bed in Libong Island, Trang Province during December, 2003. It can be concluded that there were four feeding modes in gammarid amphipods in the coral reef and seagrass communities namely filter feeders, filter feeders-predator, grazers and detritus feeders. Gammarid amphipods displayed array of feeding structures, in particular mouthparts mandibles, maxillipeds and two pairs of maxilla, according to different feeding modes. Their associated feeding appendages, antennae and gnathopods also varied accordingly. However the feeding structures in gammarid amphipods which shared the same feeding modes from the two habitats were similar. The feeding behavior and the composition of food items differed according to habitats. Moreover, amphipods from the two habitats also showed different morphological adaptations by those residing in the coral reefs were with thin and slender legs with feather-like setae for swimming. Amphipods in the seagrass beds had stout and short legs with numerous long setae or spines for digging into the sediment.

Amphipods of 14 species from 10 families were found in the Kang Kao Island reefs with *Ampelisca brevicornis*, the benthic filter feeder, as the most dominant species. Benthic microalgae and macroalgae were the major food items for this species. The detritus feeding amphipod, *Urothoe simplingnathia*, was next in term of abundance. *Eriopisa* sp. A., grazing amphipod, was also common. Filter feeder-predator amphipods, feeding on phytoplankton, benthic microalgae, zooplankton and benthos, were also found such as *Gammaropsis* sp. A., *Ceradocus* sp. A. and *Melita appendiculata.*

Six amphipods in 5 families were found in the seagrass beds in Libong Island. *Kamaka* sp. A., grazing amphipod, was the dominant species. They feed on benthic micro-and macroalgae. This amphipod species was widely distributed in the sediment and on the seagrass leaves. The filter feeding amphipod, *Ampelisca cyclop*, was next in term of abundance. *Urothoe spinidigitus*, the detritus feeding amphipod, was also common.

This study revealed that gammarid amphipods in coral reef and seagrass communities play the roles in both the pelagic and benthic food chains.

Department ….. Marine Science... Student’s signature…………………………………

Field of study.....Marine Science....Advisor’s signature……………...........................

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CHAPTER I

INTRODUCTION

Theoretical Background

Gammarid amphipods are common macrofauna widely distributed in marine and freshwater systems. They are diversified in term of species and niches. They can be classified according to habitats as epifaunal, infaunal, and demersal planktonic amphipods. Amphipods also play different roles in the trophodynamic relationship as primary consumers, omnivores, carnivores, and opportunistic feeders that change their feeding modes according to food availability. 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.

Coral reef and seagrass beds are representatives of two different marine communities namely hard-bottom and soft-bottom communities respectively. Major primary producers in coral reefs are benthic microalgae and seaweeds. Habitats for amphipods in coral reefs are coral heads, dead coral pieces or among dead coral rubbles and other organism tubes. Amphipods in different trophic levels as grazers, filter feeders, deposit feeders, detritus feeders, predators and opportunistic feeders can be found in coral reefs. Major primary producers in seagrass beds are seagrass, benthic microalgae and seaweeds. There are two major groups of amphipods namely epizoites group, occupying seagrass leaves and trunks and epifauna group. Most of them are herbivores and feed on epiphytes including algae and benthic diatoms attaching to sand grain. There are also tube-building amphipods attaching to seagrasses trunks, algae and other substrates. Infaunal amphipods can be found residing in fine sediment among seagrass roots and rhizomes. Amphipods of different feeding types as grazers, filter feeders, deposit feeders, predators and opportunistic feeding amphipods can be found in seagrass ecosystems.

Comparisons of morphology and feeding ecology in gammarid amphipods in coral reefs and seagrass communities will focus on amphipods feeding modes, their feeding appendages and adaptations to microhabitats. The stomach content study will also be included. This study will be useful in understanding the gammarid amphipod biology and ecology. It will also provide more insight on amphipod diversity in coastal habitat in Thailand.

Hypothesis

The hypotheses of this study are as follows:

1. Gammarid amphipods living in different habitats, coral reef and seagrass bed will require different adaptation in morphology and feeding.

2. Amphipods that live in coral reefs with hard substrates are mainly omnivore and deposit feeders while amphipods that living in seagrass bed with rich plant biomass and epiphytes are mainly herbivores.

Objective

The objective of this study is to compare the morphology and the feeding ecology of gammarid amphipods in different habitats: coral reef and seagrass bed.

Expected Results

The findings from this study are expected to contribute to the following benefits:

1. To contribute better understanding in morphology and feeding ecology of gammarid amphipods in order to evaluate the ecological roles of gammarid amphipods living in coral reefs and seagrass beds.

2. The result of this study is useful in amphipod identification in the coastal area of Thailand.

Literature Reviews

1. General Characteristics of Amphipods

Amphipods are member of arthropod crustaceans in Order Amphipoda. This order contains a great diversity of species, which are places within over 100 families. Most are marine group. There are families of brackish, freshwater and terrestrial forms. The body of amphipod tends to be laterally compressed, giving the animal a somewhat shrimp-like appearance.

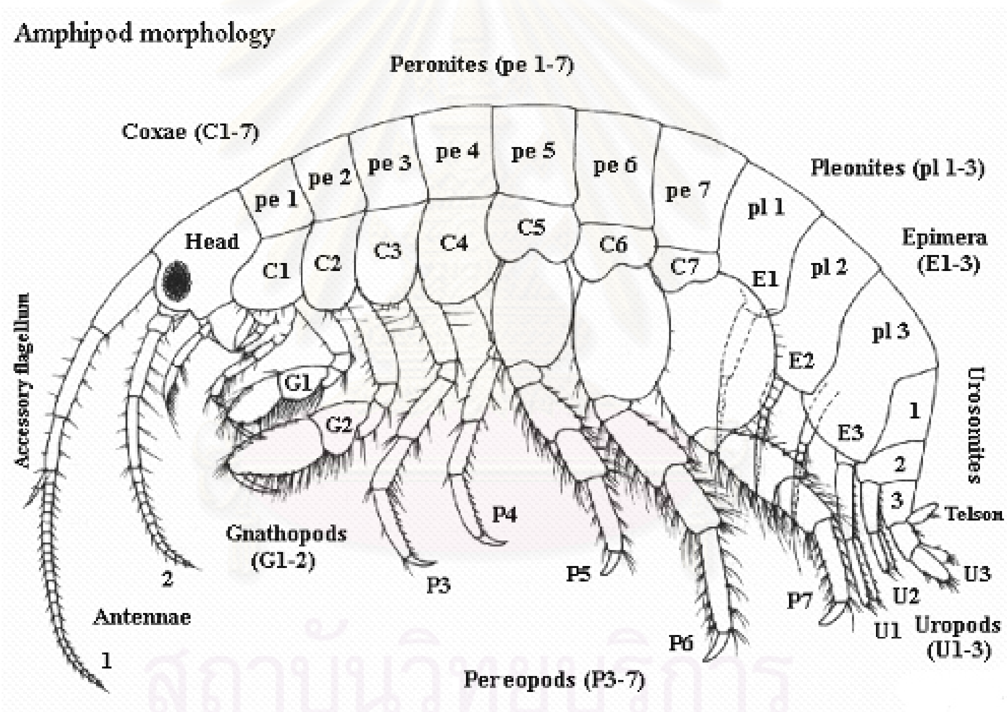
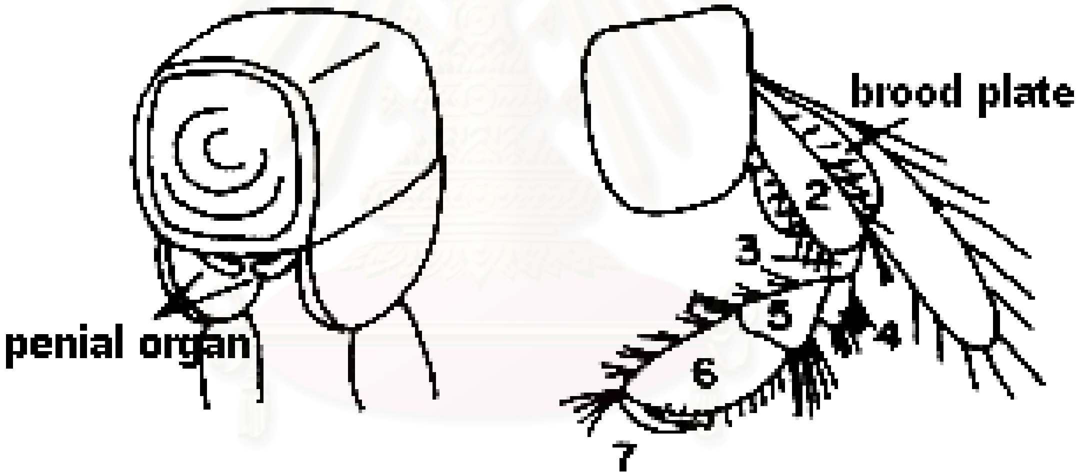


Figure 1 General morphology of amphipods (Lowry *et al.,* 2000)

Amphipods are distinguished from other crustacean by their unstalk eyes, lacking of carapace and their last three appendages (uropods) of the pleon. Amphipods have seven pair of thoracic appendages called pereopods. Each pereopods compose with seven articles. Male and female can be separated by their morphology. The male amphipod is determined by the ventral surface of thoracic segment between pair of pereopod 7. Small pair of penial projection occurs on adult males. Adult female amphipods have gill modified as brood lamellae (Figure 2). Some amphipods express the distinguished external characters between male and female such as large gnathopods, long antennae and uropods in male amphipods. Amphipods body size range from 0.1-28 cm. The largest amphipod is undescribed benthic Lysianassid amphipod from 5,300 meters found in the Pacific Ocean. Most amphipods are translucent, brown and gray in color. But some species are red, green, or blue-green. (Barne, 1987)



A. B .

Figure 2 Reproductive organ of male and female amphipods

A. Male amphipods penial organ

B. Female amphipods brood plate on pereopod (Otiz, 2004)

2. Systematics Resume of Order Amphipoda

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 (Figure 3 A.).

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. (Figure 3 B.)

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. (Figure 3 C.)

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. (Figure 3 D.)

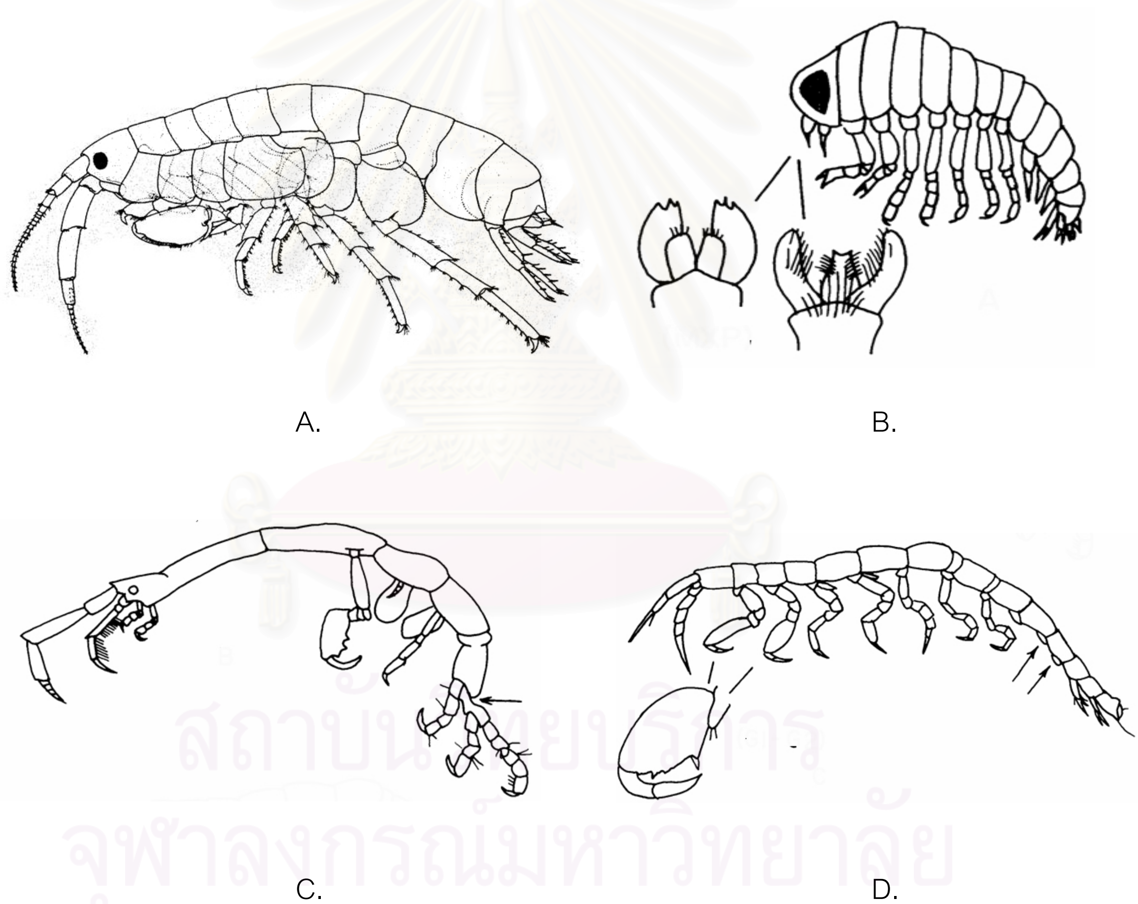


Figure 3 Order Amphipoda (Modified from Otiz, 2004)

A. Suborder Gammaridea

B. Suborder Hyperiidea

C. Suborder Caprellidea

D. Suborder Ingolfiellidea

Key to Common Families Amphipod Gammaridea (Thanh, 2004)

1. Antenna 1 , peduncular article 1 stout, flagellum shorter than peduncule. Gnathopod 2 with article 3 greatly longer than article 4. Uropod 3 biramous. Telson bilobed

LYSIANASSIDAE

2. Antenna 1 peduncular article 1 normal, flagellum subequal or longer than peduncle. Gnathopod 1 with article 3 not longer than article 4 3

3. Head with 2 – 4 corneal lenses, antennaeriorly truncate. Antenna 1 greatly shorter than Antenna 2. Urosomites 2 – 3 coalesced. Uropod 3 biramous. Telson bilobed

AMPELISCIDAE

4. Head with 2 compound eyes or no eyes, anteriorly acuminate. Antenna 1 usually subequal or slightly shorter than Antenna 2. Urosomites 2 – 3 free 5

5. Eyes very great, dorsally contiguous. Rostrum well developed. Gnathopod 1 – 2 usually chelate. Uropod 3 biramous, with elongate peduncle

OEDICEROTIDAE

6. Eyes and rostrum normal. Gnathopod 1 – 2 and Uropod 3 variable in shape 7

7. Pereopod 3 – V burrowing type, with articles 4 – 6 largely expanded, and densely armed with spines and setae. Gnathopod 1 – 2 similar in shape. Uropod 3 biramous. Telson cleft

HAUSTOROIIDAE

8. Pereopod 3 – V running type, with normal articles 4 – 6. Gnathopod 1 – 2 and Uropod 3 variable in shape

9. Antenna 1 much longer than Antenna 2. Gnathopod 1 – 2 similar in shape, but not chelate. Uropod 3 biramous 10

10. Uropod 3 with both rami equal in length 11

11. Uropod 3 with ramus much shorter than basal article. Accessory flagellum Antenna 1 uniarticulate. Telson entire

AMPHITHOIDAE

12. Uropod 3 with ramus subequal or longer than basal article. Accessory flagellum Antenna 1 multiarticulate

GAMMARIDAE

13. Uropod 3 with ramus very unequal in length, outer ramus usually very small 14

14. Body with groups of dorsal spinules on pleon segments. Outer ramus fingerform

ANISOGAMMARIDAE

15. Body without groups of dorsal spinules on pleon segments, but sometimes with a median dorsal tooth. Outer ramus scalelike

MELITIDAE

16. Antenna 1 shorter or subequal to Antenna 2. Gnathopod 1 – 2 variable in shape, sometimes chelate 17

17. Gnathopod 1 chelate. Antenna 1 with flagellum shorter than peduncle. Uropod 3 biramous. Telson elongate, triangular

LEUCOTHOIDAE

18. Gnathopod 1 not chelate. Antenna 1 with flagellum longer than peduncle. 19

19 Antenna 1 shorter or subequal to Antenna 2 peduncle. Gnathopod 1 – 2 similar in shape. Uropod 3 biramous, ramus much longer than basal article. Telson bilobed

LILJEBORGIDAE

20. Antenna 1 longer than Antenna 2 peduncle 20

21. Antenna 1 shorter than Antenna 2. Uropod 3 uniramous, ramous shorter than basal part. Telson entire or cleft

HYALIDAE

22. Antenna 1 subequal to Antenna 2. 23

23. Body laterally compressed. Antenna 1 - 2 filiform, similar. Uropod 3 biramous, ramus long coniform, shorter than basal article.

PHOTIDAE

24. Body dorsoventrally compressed. Antenna 1 – 2 not similar. Uropod 3 uniramous, fingerform or scalelike.

COROPHIIDAE

3. Gammarid Amphipod Morphology

Gammarid amphipods, like other peracarids, are lack of a carapace covering the thorax. Their seven thoracic segments are called pereonites. The first thoracic segment with its appendage (maxilliped) has become fused to the head. They have three pairs on the pleopods (swimmerets) and two or three pairs of uropods on the pleon (abdomen). There are at least six pairs of thoracic appendages, five-plus pairs of gills and four pairs of brood lamellae in females. Most of them have long and compressed body.

3.1 Head Structure

The head shape is highly variable in amphipods. General gammarid amphipods head is as long as 1.5 of pereonites (thoracic segment) (Figure 4A.). Some families are much shorter than first pereonite. Some families have elongate head that as long as the first three pereonite combined such as in families Ampeliscidae and Phoxocephalidae (Figure 4B) Two families, Synopiidae and Oedicerotidae, have massive head (Figure 4C). Head appendages are consisted of the following structures:

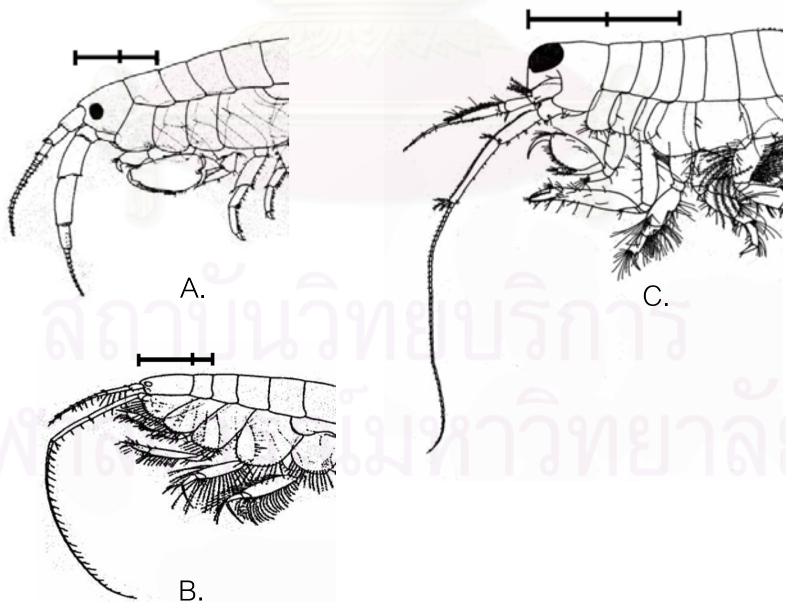


Figure 4 A. General amphipod head
B. Elongate head of amphipod family Ampeliscidae
C. Massive head of amphipod family Odicerotidae
(Modified from Bosfield, 1973 and Than, 2004)

A. Antennae: The head of amphipods bear two pairs of antennae. The first three articles of the first pair are known as peduncle and the remaining smaller articles, the flagellum. Some species bear accessory flagellum from the end of the third peduncular article. This accessory flagellum may be elongate or reduces to three, two or one articles. The second antennae bear five peduncular articles followed by a single flagellum. Male antennae are often longer than female antennae.

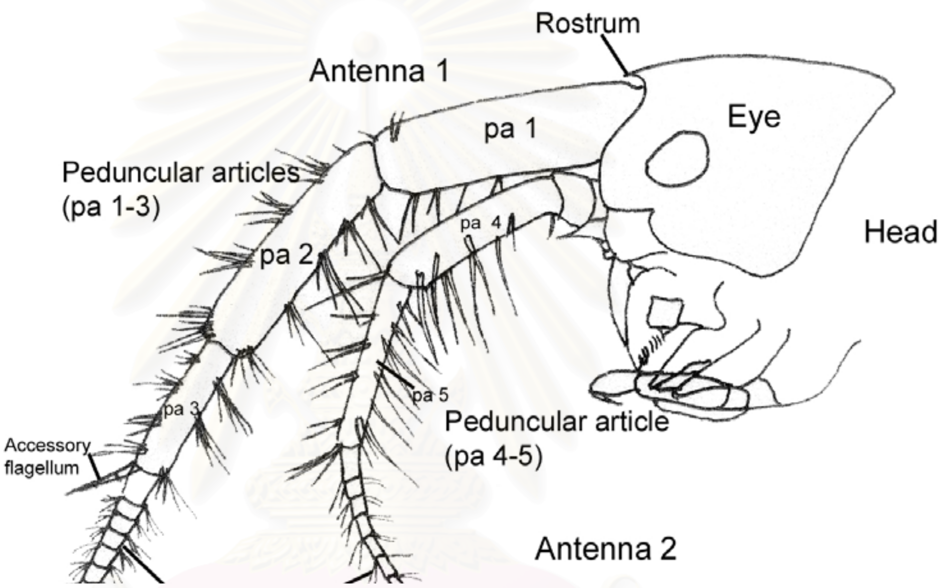


Figure 5 Head structure of amphipods (Lowry *et al.,* 2000)

Amphipods use their antennae for searching and collecting food such as *Corophium bonellii* and *Lembos websteri* use their antennae for grooming food together with gnathopods. They also use their gnathopods for cleaning and sending food to their mouths (Dixon and Moore, 1997). Moreover, several filter feeding amphipods use their antennae as sieves, filtering particles. Infaunal amphipods such as amphipods in the families, Corophiidae and Ampeliscidae, use their antennae for scraping food materials from underside (Mclaughlin, 1983). Predatorial amphipods detect their preys with antennae. They sometime use antennae together with their gnathopods or use only gnathopods for capturing their prey such as *Epimeriella walkeri, Euserus perdentatus, E. antarcticus* and *Rhachotrophis Antarctica* (Broyer *et al.,* 1999).

B. Mouthparts: amphipod mouthparts are highly variable intergenerically and consisted of the following structures.

- **Upper lip**: A single lobe or flap anterior to the mouth. Its function is unknown. In some species, the anterior cephalic surface above the upper lip is produced into a point, keel, or lobe, known as epistome (Figure 6). Detritivorous amphipods trap food by epistome. (Barnard and Karaman, 1991).

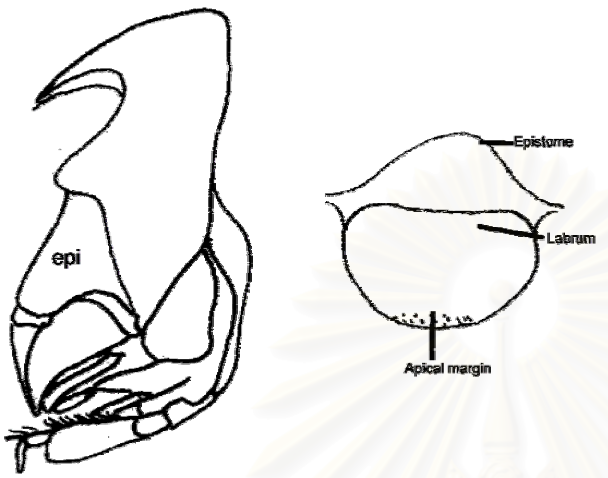


Figure 6 A Epistome (side view)
B Epistome (front view)
(modified from Barnard and Karaman,1991 and Bousfield, 1983)

- **Lower lip**: It is consisted of a pair of lateral lobes situated posterior to the mandible. This also known as labium. Large number of gammarid amphipods have lower lips that produced lateral edge that sometimes acutely or bear a cusp (Barnard and Karaman, 1991). Amphipods use their lower lip after they cut the food material by mandible and sent it to lower lip by second maxilla. After that, the material is grinded again by lower lip and the incisor of mandible (Figure 7).

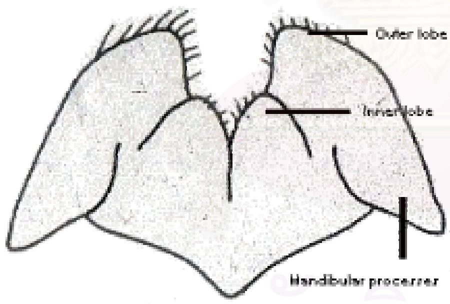
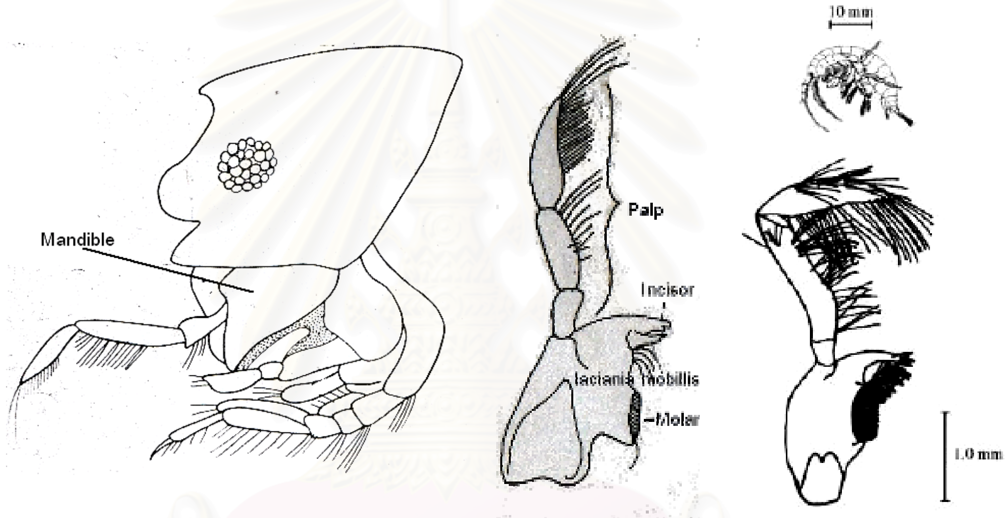


Figure 7 Lower lip
(modified from Barnard, 1991)

- **Mandibles**: The mandibles are paired appendages attaching to the upper and lower lips and forming a box around the mouth (Figure 8 A). The mandibles are powerful because of their large muscles. They are consisted of anterodistal (incisor) cutting into a series of teeth for bitting. Moreover, there are laciania mobillis (accessory plate) which may occur on only one of mandibles. A molar with a grinding surface often occurs on the medioventral surface of the mandible (Figure 8 B). Mandibular molar of herbivorous amphipods have ridged (also known as trituative) while the molar of detritivorous amphipods such as *Echinogammarus* spp. are smooth or absent. The molars in the later group are big (Agnew and Moore, 1986).



A. B. C.

Figure 8 A. Mandible position in mouthparts

B. Mandible structure (Barnard and Karaman, 1991)

C. Mandible of filter feeding amphipods *Gammarus wilkitzkii* (Poltermann, 2001)

Most amphipods have palp attaching to the lateral side of the mandible. This palp is used to clean the base of the antennae. This palp is important for filter feeding and suspension feeding group such as *Dyopedos monacantus* and *Gammarus wilkitzkii.* (Figure 8 C) These species have special setae for traping food on their mandibular palp and also on the two maxillae and maxilliped. (McGrouther, 1983).

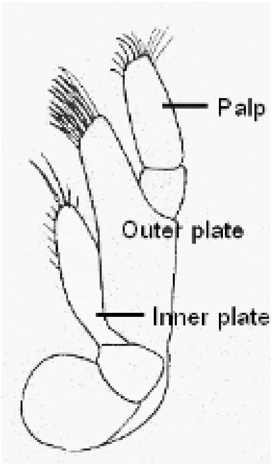


Figure 9 First maxillae (Barnard and Karaman, 1991)

- **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. (Figure 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 and Moore, 1997)

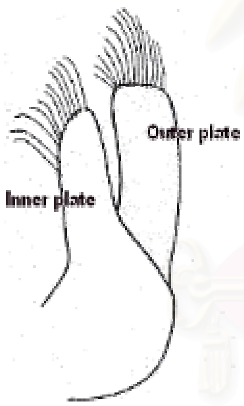


Figure 10 Second maxillae (Barnard and Karaman, 1991)

- **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. (Figure 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 and Moore, 1997)

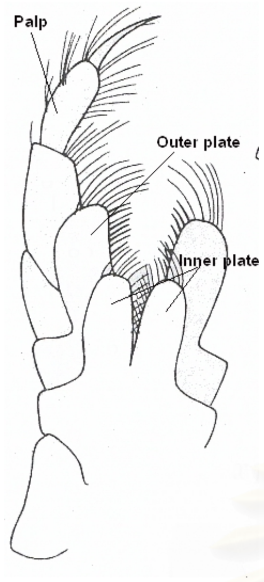


Figure 11 Maxilliped (Barnard and Karaman, 1991)

- **Maxillipeds:** One pair of appendage posterior to the maxillae. Each maxilliped consisted of an inner lobe, an outer lobe, and a palp of two to four articles. In the percaridean phylogeny, the maxillipeds were originally the first pair of thoracic appendages. However, they have become incorporated into the cephalic complex. Amphipods ingest their food by the outer plate of maxilliped. They also use maxilliped palp for carrying food inside their mouth. Moreover, filter feeding amphipods use maxilliped for sieving food. The maxillipeds inner plate margin in filter feeding amphipods usually consisted of numerous setae (McGrouther, 1983). Predatorial amphipods such as those in the family Leucothoidae have small inner plate with few setae. (Barnard, 1969)

3.2 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 (Figure 12). Sometime we can use the number instead the name of each appendages.

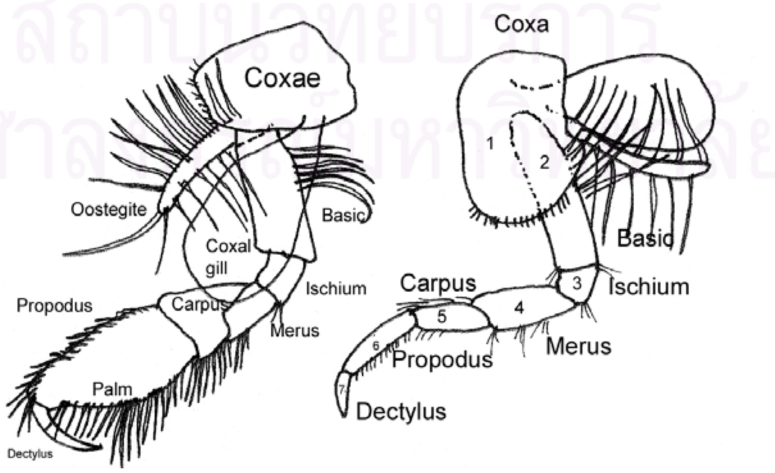


Figure 12 Thoracic appendages of amphipod (Lowry *et al.,* 2000)

- **Gnathopods**: Gnathopods are the first two pairs of thoracic appendages. They usually are prehensile. Six and seven articles form into chaelate or subchaelate gnathopods (Figure 13).

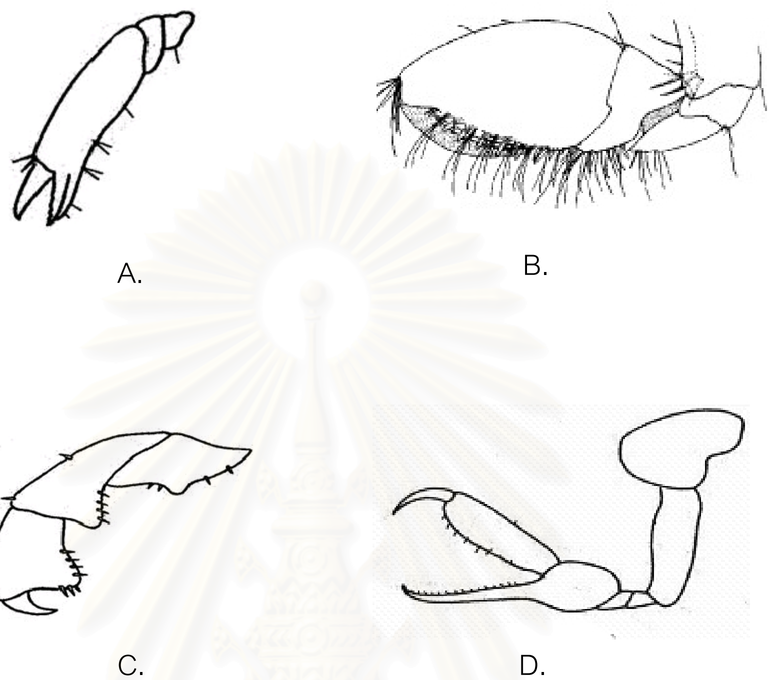


Figure 13 Structure of gnathopods (Modified from Bousfield, 1983 and Thomas, 1993)

A. Chaelate gnathopods

B. Gnathopods of filter feeding amphipod

C. Subchaelate gnathopods

D. Carpochaelate gnathods

Gnathopods function as appendages for collecting and cutting food. Grazing amphipod, *Paracalliope australis*, mainly feeds on microalgae uses gnathopods to manipulate their food to the mouth (McGrouther, 1983). Filter feeding amphipods use gnathopods together with antennae for filtering food partices. These latter groups have distinctive gnathopods with numerous setae. (Figure 13 D.) Predatorial amphipods such as *Dikerogammarus villosus* use their subchelate gnathopods for killing their preys and sending to the mouth. (Dick and Platvoet, 2001). Amphipods in the families

Leucothoidae and Anaximidae, commensal on sponges or tunicates, usually feed on their hosts; have special form of gnathopods called carpochaelate. (Figure 13 D.).

Moreover, male amphipods show sexual dimorphism by having enlarged second gnathopod and rarely in first gnathopod. The second gnathopods of female and juvenile amphipods are alike. Male amphipod uses gnathopod for grasping female during copulation. He climbs onto the dorsal side of female amphipod, and hook gnathopods into fifth coxae and rest until the female molt. After that, male amphipod emits sperm into female brood chamber where the fertilization take place. (Barnard, 1969)

- **Pereopods**: 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 14 B.)

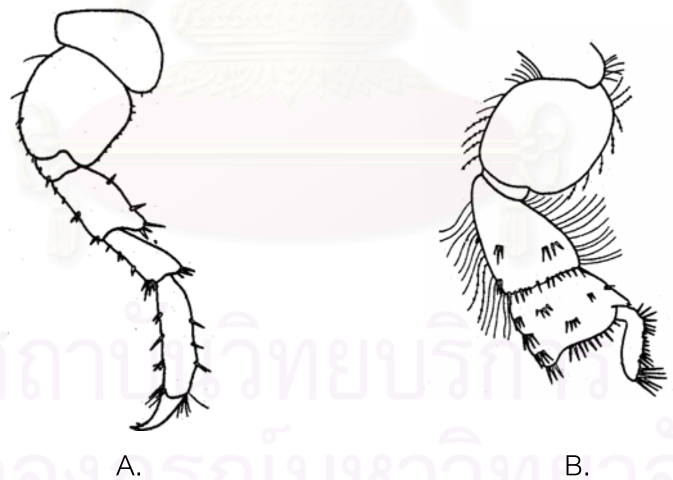


Figure 14 Pereopods

A. Simple pereopods

B. Fossorial pereopods in burrowing amphipods (Modified from Bousfield, 1983 and Thomas, 1993)

- **Gill**: Gills are thorcic appendages and generally attached to the medial surfaces of coxae 2-7. They are simply buds in young females. But as the body growth enlarge, they become longer and more heavily setose. The gills are interlocked by their setae to form a cradle enclosing the eggs.

3.3 Pleon (abdomen) appendage

- **Pleopods:** Paired pleopods on the first three segments of the pleon are biramous, the rami multisegmented and strongly setose. Minute coupling hooks on the medial edges of the peduncle are used to engage the pairs of pleopods for coordinated paddling (Figure 12A). Amphipods are good swimmer. Moreover, filter feeding amphipods living in tube create feeding current by using pleopods and uropods. (Moore and Dixon, 1997)

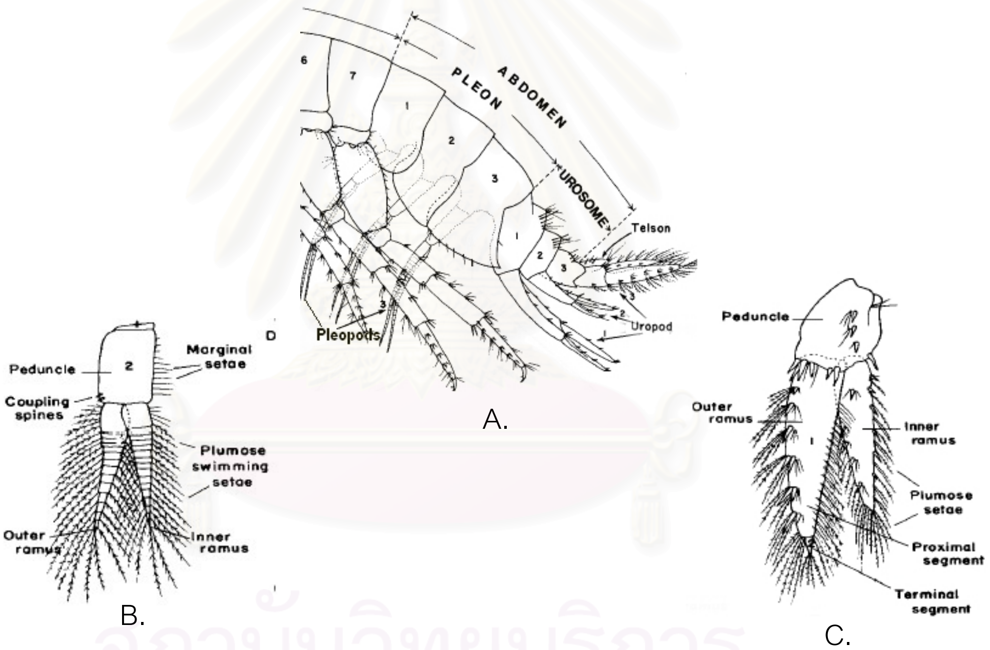


Figure 15 Pleon appendages

A. Amphipods abdomen and appendages

B. Pleopods

C. Uropods (Modified from Bousfield,1983)

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)

4. Amphipods Habitats

Gammarid amphipods can be divided into five types according to their life style: nestler, domicolous, inquiline, fossorial and nektonic.

4.1 Nestler

This group of amphipods lives among algae leaves, under debris or in cravices in the seafloor. They make their nest from plant fragments or debris. Some species are bottom dweller, crawling among leaves, animal colonies, under stone, or into ground. (Kaestner, 1970)

Dead coral rubble is the richest biotope for amphipods in coral reefs in tropical regions. Nestler amphipods live in fine sediment, dead coral rubbles, or gravels. Some species live inside dead coral rubble pieces while other live among coral rubbles. (Myers, 1985)

Nestler amphipods in seagrasses live in bare sand between seagrass roots and rhizomes or unvegetative area near seagrass bed. This area has rhizome layer that binded and increased the compaction of sediment. Most of amphipods living here are non-selective deposit feeders. They usually feed on organic matter that deposited in the sediment. Macroinvertebrate burrowers including polychaetes, echinoderms, bivalves and other crustaceans that have hard bodies can also be found in the same area. (Brenchley, 1982 cite in Orth *et al.,* 1984) Amphipods in this group are more abundant in seagrass bed than bare sand outside seagrass bed.

4.2 Domicolous

This group of amphipods built their tubes by releasing webs from the tips of four legs. These sticky webs often trap particles and sediment which make their tubes thicker such as in *Corophium acherusicum.* Some species used other animal tubes such as *C. acherusicum* using the empty calcareous tubes of serpulid polychaete, *Hydrodes pacificus.* This amphipod can be found on habour, building tube on pilling boats and dock. (Barnard, 1971)

Some amphipods are tube builders such as those in the family Ampeliscidae (Thomas, 1993). They live in self- constructed domicile. They burial under sea floor and secrete mucous inorder to build their tubes by trapping sediment and attaching their tubes onto the seafloor. Some species can be found in the muddy and silty bottom such as *Grandiderella gilesi,* build their tubes on mollusc shells or on stone. (Mayer, 2002)

Most epiphytic amphipods in seagrasses beds are tube builders that attached their tubes with seagrass leaves and shoots. (Nelson *et al.,* 1982) *Corophium acherusium*, and *Corophium acutum* tended to be more abundant at the base of shoots while some caprellids amphipods increase in density further up the shoots. (Nagle, 1968 cites in Nateekanjanalarp, 1990)

4.3 Inquiline

This is the dominant group in the tropics, living with invertebrate host including corals, sponges, polyzoans, zoanthids, sea anemone, tunicates and maldanids polychaetes. The relationship between amphipods and their hosts are both commensalism and parasitism. Their distributions depend on their host densities.

4.4 Fossorial

This group are burrowing species. They are mostly deep sea species. They have long setae of the distal of posterior pereopods that use for burrowing.

4.5 Nektonic

This group of amphipods are usually good swimmers and with bodies developed for floating. Most of them are normally benthic but they can swim upward in the water column for feeding at night (Reish and Barnard, 1979). These nektonic amphipods can be found in coral reef. They live in coral head and in the sediment during the day and swim in the water column at night as demersal plankton. They use coral head as refuges. Demersal plankton may be found abundant in seagrass bed at night. They live in seagrass roots and leaves during the day as refuges. (Thayer et al., 1984)

Table 1 Amphipods habitats and their adaptations

Type of Amphipods According to Habitats	Amphipods Morphological Adaptation	Microhabitats in Coral Reefs	Microhabitats in Seagrass
Nestler (Reish and Barnard, 1979)	• pereopods with numerous of setae for burrowing • well developed pleopods for active swimming • well developed uropods	• among coral rubbles • in sediment • inside coral pieces	• bare sand between roots • on seagrass leafs and shoots
Domicolous (Barnard and Karaman, 1991)	• mostly with depressed bodies • article 2 or 4 of pereopods 3 and 4 with mucus glands for building their tubes • pereopods 5-7 reduced and bent backward to attach to tubes • pleopods enlarged in filter feeder to create feeding current in tubes	• tube in sediment • tube attaching to plant and other substrate	• tube attaching to base if seagrass rhizome • tube in sediment
Inquiline (Poore et al., 2000)	• reduced pereopods • small mothparts or tube like/ sucking mouthparts	• invertebrates host such as sponges, zoanthids, tunicates	• not recorded
Fossorial (Reish and Barnard, 1979)	• mostly with depress bodies • long setae or spine on distal end of posterior pereopods for burrowing • reduce pleopods for sedentary life • well developed uropods	• in sediment	• in sediment
Nektonic (Reish and Barnard, 1979 and Thayer et al., 1984)	• lateral compressed bodies • large coxae and flat basic pereopods • well developed pleopods for swimming • well developed uropods	• coral heads	• seagrass roots and shoots

5. Feeding Modes in Gammarid Amphipods

Amphipods have a wide variety of feeding modes. There are selective and non-selective feeding amphipods. Filter feeders, grazers and predatorial amphipods are selective feeders. The non-selective feeding groups are suspension feeders and opportunistic feeders. Niche-shift during the life history appears in several species of amphipods. (Reish and Barnard, 1979 and Yu *et al.,* 2003) Amphipods in the same genera with similar mouthparts may have different feeding modes and food items, depending on their habitats. Feeding modes in gammarid amphipods can be categorized as follows:

5.1 Grazers

Most amphipods are grazers such as members of family Ampithoidae, Calliopiidae, Corophiidae, Eusiridae, Gammaridae, Hyalidae, Ischyroceridae, Talitridae. Grazing amphipods are common in coastal ecosystem: coral reef seagrass bed, rocky shore, and sandy beach. Major food items for this group of amphipods are drift algae, perennial algae (e.g., *Fucus* and *Chondrus*), ephemeral algae (e.g., *Ulva* and *Chondria*), filamentous algae and microalgae such as diatom. Grazing amphipods are selective feeders. Each amphipods species display different food preferences. *Ampithoe ramondi* feed only microalgae. while *A. mea, A. lecertosa, A. longimana* and *A. marcuzii* feed mainly on macroalgae. (Brawley, 1992) Grazing amphipods can be found both free living and tube dwelling.

Most grazing amphipods that are free living usually have strong and numerous small setae on second maxilla and maxilliped. Their mandibles have tooth incisor and trituative mandibular molar for cut and grinding food respectively. They use their second maxilla for biting. Their antennae are long with dense of setae for touching and searching food on substrate such as sand, coral rubbles, rock, macroalgae or seagrass leaves. Their gnathopods are strong and used for cropping food particles. Their pereopods are fleshy inorder to their movement. (Caine, 1974, McLaughlin, 1983, Parker *et al.,* 1993 and Dauby *et. al,* 2001)

Sessile group such as *Ampithoe valida* have similar processes of feeding. They are tube-dweller amphipods, rarely leave their tube except under stress. However under adverse conditions, individuals can move and capable of swimming rapidly for short periods. (Skutch, 1926 cites by Nicotri, 1980) They feed on algae. They use their antennae to search for food around their tubes and send it to the mouthparts. They have strong and numerous small setae on second maxilla and maxilliped. Their mandibles have tooth incisor and trituative mandibular molar for cut and grinding food respectively. This amphipod can select their food by the setae on maxillipeds and second maxila. Most of pereopods are small except pereopods 4-5 are long for attachment to their tube.

In coral reef, amphipods mainly feed on benthic microalgae attaching with sand or dead coral rubbles. They also feed on filamentus algae and macroalgae. (Brawley, 1992 cite in Carpenter, 1997) Amphipods such as *Elasmopus pectenicus* , *Hyale macrodactyla, Ampithoe* spp. and *Lembos* sp. feed on many macroalgae in including *Padina* sp. *Sargassum* sp. and *Dictyopteris delicatula.* (Paul *et al.,* 1987) Herbivorous amphipods in coral reefs can be found as free living and tube building.

Important food sources for amphipods in seagrass beds are seagrasses, algae and benthic diatoms attaching on sand. Common amphipods in family Ampithoidae *Ampithoe longimana* and *Cymadusa compta*, tube building amphipods are found attaching to seagrasses, algae and other substrates. They sometimes go out their tube for feeding (Kikuchi, 1966.) They also feed on benthic microalgae and seagrass leaves. (Nelson, 1980) Motile amphipods, *Tethygeneia gammarid* feed on seagrass epiphyte algae. (Howard, 1982 cite in Kitting 1984) Some Caprellidae feed mainly on benthic diatom. (Kaestner, 1970, Caine, 1974, McLaughlin, 1983 and Dauby *et. al,* 2001) They play the role in controlling epiphyte diversity on seagrass leaves. They also enhance the decomposition of seagrass leaves by contribute finer materials for bacterial decomposition. (Montfrans *et al.,* 1984 and Mukai and Iljima, 1994)

5.2 Filter feeders

Amphipods in this group are typically epibenthic and feed on plankton and faecal pellet, suspended particulate organic materials. (Dauby *et al*, 2001) They are common in high sedimentation areas including seagrass bed or sheltered coastal bay.

(McLaughlin, 1983) Free living and tube building species are found in the filter feeding group.

Two filter feeding modes can be categorized in filter feeding amphipods. In the first group, current are created by the antennae together with thoracic limbs to sieve out food particles. *Ampelisca richardsoni,* usually built bivalve shell-like hole made from fine grain and hide inside their holes. They project their antenna outside with the first antenna sweep vertically while second antenna sweep the sediment. Feeding currents are created from the movement from head to telson. They trapped food by the setae on antennae. Food is remove from antennae to mouth by gnathopods. *Haploops tubicola,* another tube building species, rest at the top of the tube and bear their antennae through the water for catching food. Food materials are send to the mouthparts by the pleopod current. Moreover, some filter feeders make feeding currents by the movement of uropods and filter detritus from water. *Dikerogammarus* filter floating detritus by the setae of the third uropods. After that they clean their uropods by the anterior pereopods inorder to send the detritus to the maxilliped endopodites. (Kaestner, 1970 and McLaughlin, 1983) Inactive filter feeding amphipods, *Melphidipella antarctica,* stay motionless upside-down on the bottom with all appendages direct towards the water column. They feed directly on sinking particles and planktons. (Dauby et al., 2001) Filter feeding amphipods in this group have antenna 1 and 2 with high density of setae for filtering. Their mouthparts also with dense and long setae along the median edge of inner plate of second maxilla and maxilliped and mandibular palp. Their mandibles are strong with trituative mandibular molar and tooth incisors. (Dauby, et al., 2001).

Another group of filter feeding amphipods create feeding currents by their first and second maxilla. They use their maxilliped for sieving food particles such as in amphipod, *Paracalliope australis.* They are capable of filter feeding by the movement involving only the mouthparts. They swing the second maxilla anteriorly against the first maxilla for creating the filtration chamber in their maxilliped. Amphipods in this group have smaller antennae comparing to the first group of filter feeding amphipods. Their antennae usually have small number of setae. They are weakly motile. Most of them are tube builder. (Mcgrouther, 1983)

Some filter feeding amphipods in coral reefs such as *Bemlos delicatissima*, *Ampelisca* spp. and *Byblis* spp. are found living among dead coral rubbles. In seagrass bed, especially amphipods in families Corophioidae and Aoroidae which are, tube builder usually attached their tubes to seagrass shoots and rhizomes. They play important role in filtering and controlling local densities of suspended particles in the system. (Lemmens *et al.,* 1996)

5.3 Suspension feeders

Suspension feeding amphipods are typically epibenthic organisms. They feed on particulate organic matter. Amphipods in the families Podoceridae, Melphidippidae and Ischyroceridae are dominant. These animals are weakly motile or sedentary. The members of the family Podoceridae: *Dyopedos monacanthus*, *D. porrectus* and *D. tuberculata* are found living in the seagrass bed. They secrete mucus from gland underneath dense setae on the pereopods. Each antenna has long setae near the joints between articles assisting in expanding the mucus net. The extended mucus threads by the antennae are used to collect seston particles. First and second gnathopods are used for handling food. Amphipods use their maxillipeds, maxillae, and mandibles together for grinding their food. From this feeding process, suspension feeding amphipods must have glanular tissue, a solid spinning at dactylar tip of pereopods 3-4 for secreting mucus net. (Mattson and Cedhagen, 1989)

5.4 Deposit feeders

Amphipods of this group are usually weakly motile endo-or epibenthic form. They feed on organic matter in deposited sediments. Some species are weakly motile and live in dead animal body such as crushed amphipods or pieces of polychaete. There are both selective and non-selective deposit feeders. Some amphipods sort their food outside their mouth such as *Corophium volutator.* Feeding currents are created by the movement of gnathopods and burrowing activities. The amphipods sort their food according to size by the setae on gnathopods. They could only feed effectively on the 4-63 μm particles. (Kaesttner, 1970, Grahame, 1983 and Reish and Barnard, 1979) *Oediceroides calmani* is non-selective deposit feeders, feeding with the antenna 1 erected while the antenna 2 skimming the sediment and last pereopods bent upward.

(Dauby *et al.,* 2001) They use the antenna 1 to trap particles and gnathopods for catching food. Crustaceans, polychaetes, holothurioid ossicles, hydrozoan perisarcs and plankton are major preys. Sometime they also grasp sand grain together with food. Amphipods in this group usually have large stomach (up to 18% of total body length) for the assimilation various food items. (Daudy *et al.,* 2001)

Most amphipods in coral reef are deposit feeders. Most of them are nestler, either nestling free in seafloor or live in self-constructed domiciles under coral head. Some species live in fine sand. (Myer, 1985)

Deposit feeding amphipods in seagrass bed usually found living in sediment, bare sand between seagrass roots and rhizomes or in sediment near seagrass bed. Seagrass bed roots and rhizomes make sediment more compacted. Most of amphipods living in these habitats are non-selective deposit feeder feeding on organic matter in the sediment. They usually are more abundant in seagrass bed than in bare sand outside seagrass bed. (Brenchley, 1982 cite in Orth *et al.,* 1984)

5.5 Detritus Feeder

Amphipods in these groups can be found as free living and tube building species. They are selective feeding such as *Parhyale hawaiensis,* dominant amphipod that living in mangrove forest prefer *Rhizophora* leaf types containing low tannin levels. They gain nutrients from associated microbiota on decomposing leaves. (Poovachiranon *et al.,* 1986) *Echinigammarus pirloti* , amphipod found on bloulder shore, sheltering under the stone during period of tidal emersion. They feed on macroalgae and prefer soft old food material with high bacterial grows. (Agnew and Moore, 1986)

Amphipods in this group usually have small mandible and mandibular molars. Some species do not have mandibular palp such as amphipods in family Lysianassidae. Their inner plate of second maxilla and maxilliped have sparse of small setae. Their antennae are long for searching food particles. Their gnathopods are with dense setae for collecting food.

Detritus feeders in coral reef are found inhabited on surface and in the sediment as active burrowers. They feed on decaying algae, organic materials and sheded exoskeleton. (Thomas, 1993) Major food items for the amphipods residing in the seagrass bed are epiphyte, periphytons and decaying seagrass. They commonly found in bare sand between seagrass roots such as amphipods in superfamily Talitroidea. (Reise, 1991; Brawley, 1991)

5.6 Predator

Most amphipods are inactive predator such as *Caprella* sp., *Paracaprella* sp., *Luconacia* sp. Most of these amphipods can be found in coral reefs, shallow water and surf zone. Their food sources are meiobenthos such as copepods, smaller amphipods, polychaetes, nematodes, and carcass. Sometime animal parts as preys which are larger than the amphipod can be found in gut contents. These predatorial amphipods could be shift to become detritus feeders. In temperate zone, seasonality may alter the food availability. Amphipods, *Synchelidium lenorostratum*, usually are predators which consumes mainly hapacticoid copepods and small portions of detritus. However they switch their feeding mode to detritivore during Autumn due to the abundance of food availabled. (Yu *et al.,* 2003) There are also parasitic amphipods including the amphipods family Cyamidae that feed on the soft skin of whales.

Predator amphipods use their gnathopods to kill or catch their preys. Their gnathopods are powerful. They are raptorial and have strong pereopods. These predators use antenna 2 and gnathopods 2 together for catching their preys and mobilise their preys to mouthparts. Amphipods in this group often have strong and sharp maxilliped and molar. (Reish and Barnard, 1979 and Grahame, 1983)

Some amphipods in coral reefs are micropredators feeding on small part from sessile animals. They usually do not kill their preys. Most of preys are colonial forms including sponge, bryozoa, coral head and periphyton. (Dauby *et al,* 2001) .

Main predatorial amphipods in seagrass beds are Caprellid amphipods. They are inactive predators that feed on smaller animal such as copepods, polychaetes and nematodes, etc. They can change their preys according to food availability and season as in the case in Thailand. The seagrass communities decrease during the monsoon season affecting some epizoites abundance. Thus the predatorial amphipods change their prey items accordingly. (Terrados *et al.,* 1998 and Neilson *et al.,* 2002)

5.7 Opportunistic feeders

Amphipods of this group are usually epibenthic. They feed on miscellaneous small materials that are detected by their antennae. These preys are grasped by the gnathopods such as diatoms, carcass, vegetation windfalls, and mud. Most of them are weakly motile but able to walk on the seafloor in order to search for food. This group can be found occupying in various places occupy in lack of food source such as under ice, oligotrophic gyres and deep sea. Most of amphipods in family Lysianassidae are opportunistic feeders (Reish and Barnard, 1979). In *Epimeral macrodinta,* an opportunistic predator, chemoreception is not important for searching food. The amphipod gut contents in the experiment revealed various food items, both living and dead. They also fed on colonial organisms. They are usually actively capture small living prey. (Dauby *et al,* 2001)

Opportunistic feeding amphipods use antennae for searching food. Food are grasped by their gnathopods. They often have big gut. They are able to kill preys. Many species have strong gnathopods. Most of them belong to Lysianassidea. (Dauby, *et al.,* 2001)

Opportunistic feeders in coral reefs feed on detritus, benthic diatoms, mucus secreted from corals and other colonial animals. They are free living and occupy in sand grain under coral heads or near coral heads. They also found among dead coral rubbles and surf zones, feeding on smaller animals and carcass. (Myer, 1985 and Paul *et al.,* 1987)

Opportunistic feeders in seagrass beds, on the other hand, feed on detritus and diatoms associated with sand grains gathered by the feeding currents set up by their appendages. For example, infaunal amhpipods *Ampelisca abdita* of the family Ampeliscidae, builts parchment tubes. The end of the tube project above the sediment. These amphipods usually feed while remaining in the top of the tube with ventral surface turned upward. (Mills, 1967 cite in Nelson, 1980)

Table 2 Amphipods feeding modes and their adaptation

Feeding Modes	Amphipods Adaptation	Coral reefs	Seagrass beds
Grazers (Caine, 1974, McLaughlin, 1983, Parker *et al.,* 1993 and Dauby *et. al,* 2001)	• actively motile • long antennae for searching food • strong gnathopods • strong mandibular molar • plumose setae on maxilliped and second maxilla for sorting food	*Eriopisa* sp. *Ampithoe* sp. *Elasmopus pectenicus* *Lembos* sp.	*Quadrivisio bengalensis* *Eriopisella* *Ampithoe longimana* and *Cymadusa compta*
Filter feeders (Lemmens *et al.,* 1996)	• weakly motile • long antennae with long setae for searching and trapping food • gnathopods with dense of setae • strong mandibular molar • plumose setae along median edeges of maxilliped and second maxilla for sorting food	*Bemlos delicatissima* *Ampelisca* spp. *Byblis* spp.	Corophioidae and Aoroidae
Suspension feeders weakly motile (Mattson and Cedhagen, 1989)	• weakly motile • long antennae for extension of mucus net • special gland on pereopods for mucus secreting		*Dyopoides monacanthus* *Dryopoides porrectus* *Dryopoides tuberculata*

Table 2 (cont'.)

Feeding Modes	Amphipods Adaptation	Coral reefs	Seagrass beds
Deposit feeders (Kaesttner, 1970, Grahame, 1983 and Reish and Barnard, 1979)	• weakly motile and burrowing species • long antennae for searching food • small mandible and mandibulae molar • maxilla and maxilliped with dense of setae for selecting food particles	*Corophium* spp.	*Corophium* spp.
Detritus feeders (Agnew and Moore, 1986)	• weakly motile • long antennae for searching food • small mandible and mandibulae molar • few setae appear on mouthparts	*Echinigammarus pirloti*	Talitroidea
Predators (Reish and Barnard, 1979 and Grahame, 1983)	• large eyes • long antennae • powerful gnathopods for capturing prey • strong pereopods for active movement	*Leucothoe* spp. *Synchellidium* spp.	*Caprella* sp. *Paracaprella* sp *Luconacia* sp .
Opportunistic feeders (Mills, 1967 cite in Nelson, 1980)	• long antennae for searching food • large gnathopods for capturing prey • large gut according to body volume	Lysianassoidea	*Ampelisca abdita*

6. Distribution of Amphipods in Thailand

There is high diversity of amphipods in marine ecosystems. Some species are cosmopolitan and some species are endemic species. Most of them are specific to habitat types. The common families that found in coral reefs of the Gulf of Thailand are Corophiidae, Gammaridae, Leucothoidae and Haustoriidae. They often occupy among dead rubbles and in the sediment in coral reefs. Most of them are deposit feeders and omnivores. (Wongkamhaeng et al, 2002) The common families that found in seagrass beds in the Gulf of Thailand are Hyalidae, Oedicerotidae, Corophiidae, Isaeidae, and Gammeridae. They live on seagrass blades and in the sand between the seagrass trunks and rhizomes. (Nateekanjanalarp, 1990 and Intrasook, 1999)

In Andaman Sea, coral reefs are usually found in the deeper water than the Gulf of Thailand. The common family amphipods that can be found in coral reefs are Amaryllididae, Lysianassidae, and Aoridae that live among dead coral in deep water (40-60m). (Lowry and Stoddart, 2002, Lowry and Berents, 2002, Myers, 2002, and Peart, 2002).

Table 3 Distribution of amphipods in the Gulf of Thailand

(Data compiled from Intrasook, 1999, Wongkamhaeng *et al* , 2001)

Family	Genus	Feeding Types	Ecosystem	Microhabitat	Depth
Hyalidae	*Parhyale*	omnivores and detritus feeders	seagrass bed and mud flat	sand with debris	intertidal
Oedicerotidae	*Oediceroides*	not clear	seagrass bed and mud flat	sand with debris	intertidal
Aoridae	*Aoroides* *Dryopoides* *Paraoides* *Lembos*	not clear filter feeders not clear filter feeders	coral reef coral reef coral reef coral reef	muddy sand muddy sand muddy sand muddy sand	0-10 m 0-10 m 0-10 m 0-10 m
Corophiidae	*Corophium* *Camacho* *Grandidierella*	filter feeders not clear filter feeders	coral reef coral reef seagrass bed and mud flat	muddy sand muddy sand sand with debris	0-10 m 0-10 m intertidal
Gammeridae	*Ceradocus* *Elasmopus* *Ericthonius* *Meara* *Quadrivisio bengalensis* *Eriopisella*	omnivores filter feeders not clear detritus feeders grazers grazers	coral reef coral reef coral reef coral reef and fish cage seagrass bed and mud flat seagrass bed and coral reef	muddy sand muddy sand muddy sand muddy sand sand with debris sand with debris	0-10 m 0-10 m 0-10 m 0-10 m intertidal intertidal
Isaeidae	*Cheriphotis* *Gammaropsis* *Microphotis* *Promedeia* *Photis*	predators omnivores predators not clear omnivores and detritus feeders	coral reef coral reef coral reef coral reef seagrass bed and mud flat	muddy sand muddy sand muddy sand muddy sand sand with debris	0-10 m 0-10 m 0-10 m 0-10 m intertidal
Ischyroceridae	*Jassa*	not clear	coral reef	muddy sand	intertidal
Haustoriidae	*Urothoe*	detritus feeders	coral reef	muddy sand	intertidal
Oedicerotidae	*Carolobatae*	opportunistic feeders	coral reef	muddy sand	intertidal

Table 4 Distribution of Amphipods in Andaman Sea

(Data compiled from Lowry and Stoddart, 2002, Lowry and Berents, 2002, Myers, 2002, and Peart, 2002)

Family	Genus	Feeding	Ecosystem	Microhabitat	Depth
Amaryllididae	*Vijaya*	opportunistic feeders	shallow tropical water	muddy sand	60 m
	Vijaya tenuipes	opportunistic feeders		muddy sand	68 m
Lysianassidae	*Lepidepecreum andamanensis*	opportunistic feeders		muddy sand	61 m
	Lepidepecreum somchaii	opportunistic feeders		muddy sand	31- 61 m
Corophioidea	*Cerapus chaomai*	filter feeder with tubes	Seagrass bed, mangrove area	sand with debris	3 m
	Cerapus yuyatalay	filter feeders with tube	seagrass dweller	sand with debris	
	Nuuanu kata	detritus feeders	anchialine, marine interstitial, invertebrate associates	vary	32 m
Aoridae	*Wombalno rachayai*	omnivores		muddy sand	40 m
	Bemlos quadrimanus	omnivores	shallow water among algae, sponges and coral rubble	muddy sand	0.5 m
	Bemlos delicatissima	filter feeders	shallow water among coral rubbles	muddy sand	intertidal
Aoridae	*Grandidierella bonnieroides*	detritus feeders	mangrove detritus	high detritus area	intertidal

Table 4 (cont')

Family	Genus	Feeding	Ecosystem	Microhabitat	Depth
	Leptpcheirus dufresni	herbivores/ opportunistic feeders	calcareous algae	muddy sand with shell fragment	40 m
	Protolembos tegulapodus	herbivores/ opportunistic feeders	coral rubbles	muddy sand	intertidal
	Xenocheira	herbivores/ opportunistic feeders		muddy sand with algae, coral rubble and shell fragment	40 m
Neomegam phopidae	*Konatopus storeyae*	herbivores/ opportunistic feeders	dead coral rubbles	muddy sand	9-20 m
Ampithoidae	*Ampithoe rachanoi*	herbivores	old rope	substrate	intertidal
	Cymadusa aungtunyae	herbivores	old rope	substrate	intertidal
	Cymadusa chalongana	predators	rope, sandflat	sand and substrate	intertidal
	Cymadusa panwa	herbivores	rope, sandflat	sandy beach	intertidal

Some amphipods may be found associated to specific microhabitats such as *Cerapus chaomai* living in both mangrove area and seagrass beds. These habitats are soft bottom and with high amount of debris. Moreover, amphipods living in soft bottom usually with modified appendages by having longer legs than amphipods living in hard bottom. Many species are sessile fauna. Amphipods in different habitat types sharing the same feeding modes may evolved different morphology in the appendages such as filter feeding amphipod that live in seagrass usually have longer setae on gnathopods than those living in coral reefs.

Terminology in Amphipod Morphology

Accessory flagellum: The secondary ramus of antenna 1, often absent or vestigal, attached medially to peduncular article 3.

Acute: shape: coming to a point.

Aequiramous: Uropod 3 with equal rami

Aesthetascs: chemosensory appendages located on the antennae (Barnard and Karaman, 1991). See also calceoli. Sensory setae of antennae, flattened and nontapering.

Antenna 1: The first pair of antennae on the head. The first three articles are the peduncle with the rest of the articles known as the flagellum. In some species an accessory flagellum is present, emerging from the end of the third peduncular article and can be both long and short (Barnard and Karaman, 1991).

Antenna 2: The second pair of antenna located on the head. The first five articles form the peduncle and the rest of the articles are the flagellum.

Anterior and Posterior: a position: (relates to the body) anterior indicates that an appendage is located near the head end of the body as opposed to the rear end of the body (the posterior).

Article: The segment of an appendage.

Baler lobe: An accessory lobe at the base of maxilla or maxilliped.

Basis: Second article (from body) of leg or maxilliped or the sixth segment from distal end of limb.

Beveled: The slant or slope of a line when not at right angles with another. That Refer to the apex of mandibular palp article 3 when truncated diagonally or the anteroventral coners of coxae which are lopped off.

Biramous: An appendage composed of two rami or branches.

Bisinuate: shape: a margin possessing two concavities.

Button comb: A seta or setule modified into a plaque with fringe

Calceoli: small sensory organs found on the antennae. Different kinds of calceoli have been found to correspond to different families of amphipods (Lincoln and Hurley, 1981). However most calceoli are lost due to sampling processes and so are rarely used in taxonomic keys.

Calynophore: A cluster of aesthtascs in a transverse row, forming a brush (Lowry, 1986; Barnard and Karaman, 1991).

Carina: A keel-like or ridge structure, for example that found in some amphipods dorsally on the urosome.

Carpochaelate: Immovable finger of prehensile appendage occurring on carpus article; examples: *Leucothoe, Microdeutopus.*

Carpus:a The fifth leg article from the body or the third article from distal end of thoracic appendage (gnathopod, pereopod).

Cheek: The lateral side of the head below the eye or ocular lobe and above the mandible.

Chela: Immovable finger of prehensile appendage.

Chelate (chelate, claw): When the propodus and dactylus form a pincer-like structure (the dactylus articluates against the propodus).

Claw, claw-like: Description of a talon or simple, tapering nail.

Compressed: Flattened from side to side.

Concave: shape: to curve inwards.

Conical mouthparts. From lateral view mouthpart field (enclosed by prebuccal mass anteriorly and maxillipeds posteroventrally) group with ventral margin of maxilliped forming tangential line at angle to anterior margin of prebuccal mass of significantly less than 90^{o}.

Conjoint: Describing the basal amalgamation of flagellar articles on antennae. Usually associated with a callypnophore.

Convex: shape: to curve outwards.

Corneal lens: A biconvex cuticle body occurring directly in or on the cephalic cuticle (particularly in Ampeliscidae); contrasted with

Coxa (sing), coxae (pl), coxal plate: First or proximal article of leg or maxilliped and is the segment of the leg directly attached to the sternite of body. [Term for other articles of the appendages such as basis, ischium, merus, carpus, propodus and dactyl are frequently but not universally used in Gammaridea; instead, the articles are simply numbered.]

Cuticular lense: A brightly shining circular or ovate thickening of the cuticle on the head; one assumes the lens focuses light on the brain or pigment surrounding parts of the brain; common in Ampeliscidae.

Dactyl (dactylus): Terminal or distal article of leg, sometimes modified into the movable finger of the cheliped (claw).

Degraded: Severely reduced or with loss of normal structure.

Dentate: A margin with tooth-like projections.

Depressed: Flattened dorsalventrally.

Dispariramous: Uropod 3 with rami unequal either in length, shape or armament.

Distal and Proximal: a position: (usually relates to the appendages and their position in regards to the body) distal is the part of the article furthest from the body and proximal is the part closest to the body.

Dominant: Used herein to denote conditions opposite to 'inferior'; use especially where a morphological part is larger or more setose than comparative parts.

Dorsal and Ventral: a position: (relates to the body) dorsal relates to the topside of the animal and ventral is the underside.

Elogate urosome I: Five times as long as urosomite 2 and in most species concerned (such as Podoceridae and Iciliidae) at least slightly longer than pleonite 3.

Emarginate: Descriptive of the concave posterior end of an unclef telson.

Entire: Descriptive of an unclef telson.

Epimera (pl) Epimeron (sing): In amphipods this is the lateral projection of the pleonite(s).

Epistome: The anterior surface of the head above the labrum; this area is often extend ventrally to appear as a part of the labrum and may be anteriorly produced as a cusp or lobe.

Falcate: shape: sickle shaped, curved and tapering to a point.

Flange: A protruding rim or edge.

Fossorial: Associated with the habit of burrowing, often referring to the excessively spinose or setose condition of appendages use for burrowing by Gammaridea; especially applicable to Haustorioidea, Oedicerotidae and Phoxocephalidae, with some setae of article 4-6 of pereopods 5-7 more than haft as long as those articles

Ischium: The third segment of the leg from the body or the fifth article from distal end of leg (usually first large article of maxilliped).

Labium (Lower Lip): Flat, non-segmented, bilobed structure situated posterior to the mandibles. (Holdich and Jones, 1983). The lateral edges are often produced, sometimes acutely, and sometimes bear a cusp associated with the salivary duct (Barnard and Karaman, 1991).

Labrum (Upper Lip): An unpaired, flat segment of the cephlon anteriorly covering the mandibles. (Wilson, 1989). In some amphipod species the labrum can be produced to a point, keel or lobe, which is known as the epistome (Barnard and Karaman, 1991).

Lateral: a position: the side, or outer edge of an article facing away from the body.

Mandible: The third cephalic appendage, and first mouthpart appendage of amphipods, used to masticate food. It generally has a lateral three-articled palp (used for cleaning the bases of the antennae) and is made up of the incisor process, lacinia mobilis, spine row and molar process (Moore and McCormick, 1969; Barnard and Karaman, 1991).

Maxilla 1: (Maxillule): small pair of mouthparts situated posterior to the labium (lower lip). Each maxilla 1 is made up of a medial free lobe, an outer lobe with many robust setae, and sometimes a palp (which is variable and can be absent or up to two articles) attached to the outer lobe (Barnard and Karaman, 1991).

Maxilla 2: (Maxilla): Paired mouthparts used to filter food particles from the water. They are located immediately posterior to maxilla 1. Each maxilla 2 is commonly composed of a medial and lateral plate but these can be reduced in some amphipods. Setation of the inner plate is used often in taxonomic keys (Barnard and Karaman, 1991).

Maxilliped: A pair of appendages situated posterior to the maxillae and derived from the first pair of thoracic appendages. Each maxilliped consists of an inner lobe, outer lobe and a palp of two to four articles (although this can be reduced in some amphipod families).

Medial: a position: usually the inside face of an article (that facing the body).

Merus: Fourth article from distal end of leg (can be called the 'arm' in gnathopods).

Palm: Expansion of the disto-lateral edge of an article to form a chelate articulation with the next distal article. Commonly found on the propodus of gnathopods 1 and 2 but also found on the carpus (carpochelate), and merus (merochelate).

Peduncle: The three proximal segments of the antennule and the five proximal segments of the antenna.

Pereon: Thoracic segments 2-8 bearing the locomotory appendages, or pereopods (gnathopods 1 and 2, pereopods 3-7). (Thoracic segement 1 is part of the cephalon and bears the maxilliped) (Wilson, 1989).

Pereonite: A single thoracic segment of the pereon.

Pereopod: locomatory appendage (or leg) of the pereon that consists of the following segments (in order from distally to proximally): coxa, basis, ischium, merus, carpus, propodus, dactylus. In amphipods the pereopods consist of the modified (chelate) gnathopods 1 and 2, and pereopods 3 to 7 which are locomotory.

Pleon: The first three segments of the abdomen (Barnard and Karaman, 1991). The pleon bears the pleopods.

Pleonites: the three individual segments of the pleon in amphipods.

Pleopods: paired biramous appendages (composed of a peduncle and two rami) on the three segments of the pleon. Each pair can be clasped together via small coupling hooks on the peduncles and used in amphipods for swimming (Barnard and Karaman, 1991).

Propodus: Article 6 of the pereopod or the second article from distal end of the leg.

Ramus (sing), Rami (pl): Branch of a limb or other appendage (commonly used for pleopods and uropods).

Rostrum: Anteromedial projection of frontal margin of head.

Serrate: Edged with toothlike projections, as in a saw.

Seta (sing), Setae (pl): Hair-like process of cuticle that is clearly articulated with the basal cuticle (see spine). Some authors call very solid, thickened setae "spines," but "spinose setae" or "spine-like setae" is more accurate. Robust setae are very stout setae, as opposed to slender setae. Plumose setae have small setules, giving a feather-like appearance (Wilson, 1989). Pectinate setae have small spines, giving a comb-like appearance.

Spine: A pointed outpocketing of the cuticle that is not articulated with the cuticle at its base (Wilson, 1989). (See Seta)

Sternal spines: A non-articulated projection from the mid-section of ventral surface.

Stridulating ridges (or organ): Structure in which two parts of exoskeleton are rubbed together in order to produce sound, one part consisting of ridge or tuberculate or cross-ridged surface which is apposed to another part usually having single transverse ridge or tubercle. (Moore and McCormick, 1969)

Subacute: shape: a blunt point.

Telson: the plate attached to the sixth abdominal segment (urosome 3) and covering the anus. The morphology of the telson (i.e. shape, ornamentation, degree of cleft ness) is important to taxonomic keys.

Truncate: shape: a blunt, squared off end.

Uropods: Paired (usually biramous but can be uniramus) appendages on the urosome. Sometimes used for swimming but usually used in the 'flipping' motion and to help the moulting process, as the rami can be armed with robust setae and spines (Barnard and Karaman, 1991).

Urosome: The last three segments of the abdomen (Barnard and Karaman, 1991). The urosome bears the uropods.

Uniramous: Composed of a single branch. When used in reference to an appendage (usually a uropod), it usually implies the loss of the exopod, as in a walking leg (Wilson, 1989).

CHAPTER II

MATERIALS AND METHODS

Study Sites

1. Kang Kao Island

Kang Kao Island is one of the small island in the Si Chang Island, Chonburi Province. It is located at latitude 76°06’35” - 76°07’30”N longitude 100°30’20”-100°40’50”E, southern of the Si Chang Island. This island has area coverage of 0.25 km^2. The total coastline approximately 3 km. around the island are listed below (Figure 16). These stations have been continuously monitored since Sakai *et al* (1986, 1989)

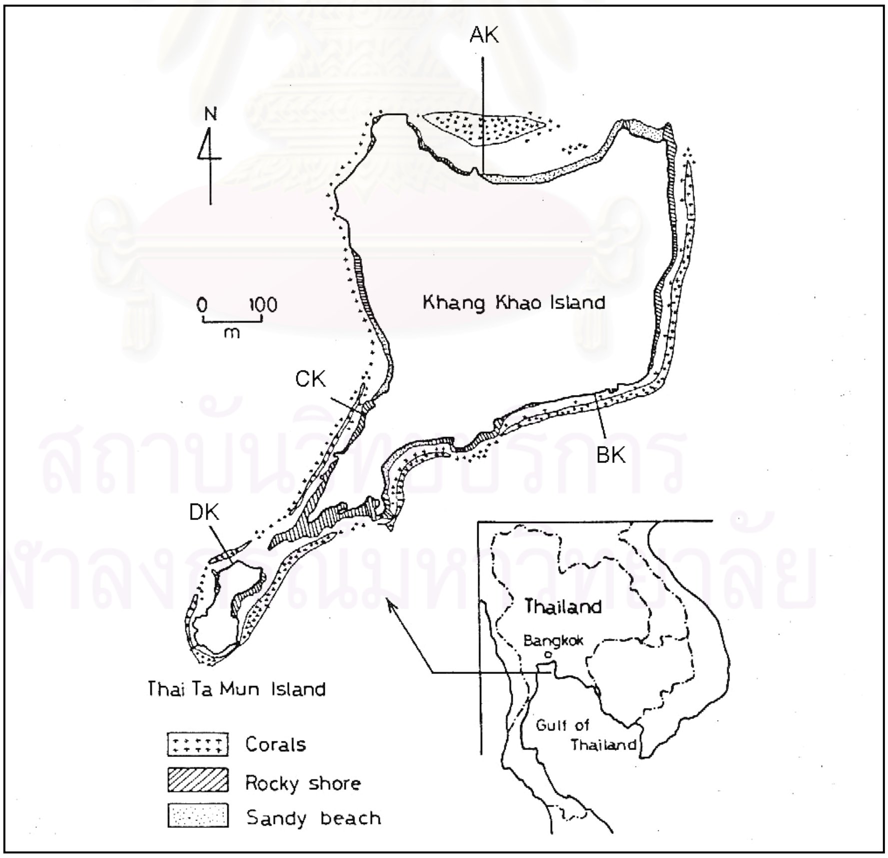


Figure 16 Study sites at Kang Kao Island, Chonburi Province (Modified from Sakai *et al.*, 1986, 1989)

Station AK located on the northern side of the island equivalent to station A in Sakai *et al* (1986, 1989). This side of the island is a shallow bay with calcareous and sandy beach. Coral communities appeared along the bay. *Porites lutea* was the dominant coral species. The ratio between living coral and dead coral was 9:1. Micro habitats for amphipods ranged from dead coral pieces, coral head, rocks and in sand. There are also sea anemone and zoanthid that provided habitat for commensal amphipods. During the northeast monsoon in October – Febuary, strong waves appeared in this station. Station AK received both sediment and nutrient load from Si Chang Island and main land.

Station BK located on eastern side of the island equivalent to previous station C in Sakai *et al* (1986, 1989) living coral communities along the sheltered coast. Dominant coral species were *Porites* spp., *Pocillopora* spp. and *Pavona* spp. Coral communities were more diversed than rhose found at station AK. The live and dead coral ratio was 8.9:1. Microhabitats for amphipods were similar to station AK which were dead coral pieces, coral head, rock and in sand. Commensal amphipods can also be found among sea anemone and zoanthid. This site was under the influence of the Southwest Monsoon. The beach is with higher slope than station AK.

Station CK located on the western side of the island. Only small and young coral communities thrived in the area. The dominant coral species were *Porites* spp., *Goniastrea* spp. and *Pocillopora* spp. respectively. Most of the substrate were rock and sand. Open spaces were more frequent than the two previous stations. Sponges, anemone, soft coral and zoanthid can be found in the area. During the Southwest Monsoon, this station received strong wind and wave actions.

Station DK located on the southwestern side of the island. The slope on this station was steep with rocky substrates. Small patches of young coral and soft coral distributed in the area. Live and dead coral ratio was 5.1:1 Microhabitats for amphipods were few consisting of dead coral pieces and sand. Sponges provide the habitat for commensal amphipods.

Station CK and station DK represented the previous station in Sakai, *et al* (1986, 1989) as D and H respectively.

2. Libong Island

Libong Island located at latitude 07°14' - 07°17'N and longitude 099°22' - 09°27'E on the western coastline of Amphoe Kantang, Trang Province. This island is approximately 3 km from the mainland. Two monsoon seasons can be distinguished in this area. The rainy southwest monsoon period start from June to October and the dry northeast monsoon period from November to February. Strong winds and wave action during the southwest monsoon can be found on this coast. Libong Island have diverse ecosystem including coral reefs, mangrove forests and seagrass bed. The study site situated on the east coast of the island where large patch of seagrass beds can be found. There were 8 species of seagrass: *Halophila ovalis, Halodule uninervis, Halodule pinifolia, Thallssia himprichii, Cymodocea rotundata, Enhalus acoroides, Cymodocea serrulata, Syringodium isoetifolium* and dominant species are *Halophila* spp., *Halodule* spp. and *Cymoducea* spp. The island received large sediment loading from Trang River which affected the seagrass beds around the island.

Station AL was bare sand adjacent to seagrass bed. This station was abundant with silt as death seagrass leaf litters deposited into the sediment.

Station BL was located offshore compared to Station AL. This station had small-leaf seagrass including *Thalassia hamprichii, Cymoducea* spp., and *Halophilla ovalis.*

Station CL was in the deeper area than station BL. There was densely-populated long-leaf seagrass *Enhalus acoroides*.

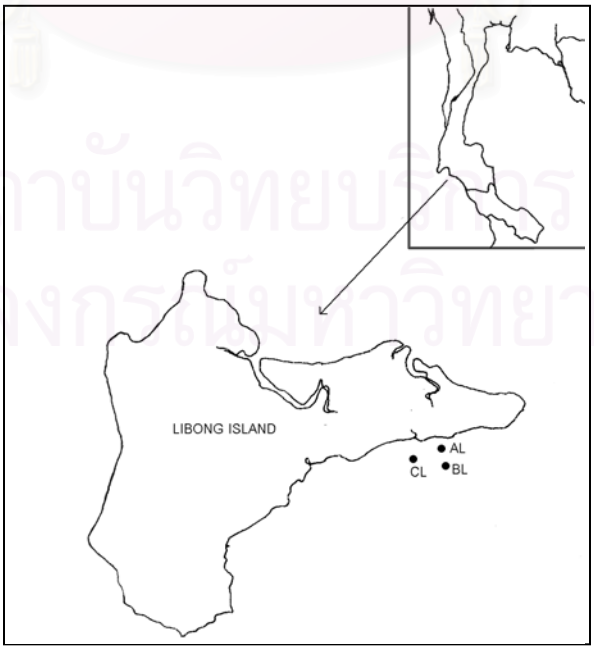


Figure 17 Study sites at Libong Island, Trang Province

Amphipods Sampling and Identification

1. Kang Kao Islands

Amphipods were collected in the 30x30 cm quadrats by SCUBA diving during low tide. Quadrate were placed on the sediment surface and sediment within the 5 cm depth were collected in plastic bags. A total of 20 quadrates were conducted at each station. The samples were preserved in 10% formalin seawater. Sorting of samples were carried out in the laboratory.

2. Libong Island

Amphipods were also collected during low tide using 30x30 cm quadrats. Amphipods were separated into two groups, those found associated with seagrass leaves and the infauna groups. When place quadrates, seagrass leaves and stems were cut to collected associated amphipods in plastic bags. After that, rhizomes and sediments were collected to the depth of 5 cm in separated plastic bags. Preserved all samples with 10% formalin seawater, sorting of samples were carried out in the laboratory.

The sediment samples collected from both habitats were washed through the 0.5 mm mesh size sieve. Amphipods retaining on the sieve were hand picked and identified to species level by the various document as in Table 5.

Table 5 Major documents for amphipods identification

Amphipods groups	Major document for identification
Gammaroidea	Barnard (1969), Thanh, (2004)
Other amphipods groups	Barnard and Karaman(1991)
Amphipods in coral reef community	Barnard (1971); Myer (1985) and Imbach (1967)
Amphipods in seagrass community	Barnard and Karaman(1991)

Amphipods descriptions and drawings were made after the identification under the camera lucida. Amphipods characteristics were recorded in the amphipods analytical sheet modified from Barnard (1969).

Amphipods Stomach Content Analysis

Amphipod stomachs were dissected inorder to determie their feeding mode by using forceps and dissect pin. The digestive tract was cut at oesophagus level and extract together with midgut gland from the body. Spread the digestive tract content on the slide. The whole slide surface was examined under a compound microscope.

The amount of food in stomach (Cs) and gut (Cg), respectively, was coded with arbitrary scores (4: 75 to 100% of the volume is filled; 3: 50 to 75%; 2: 25 to 50%; 1: 0 to 25%). Every food items presented in the digestive tract was determined to the lowest possible taxonomic group, and their proportions were coded using a similar coefficient (Ps, Pg = 1, 2, 3 or 4). A semi-quantitative approach, related to the 'percentage points' method (Hynes, 1950; Williams, 1981 cite by Broyer *et al,* 2001), has been adopted using the formulas:

$$I\ (i) = \Sigma\ Cs(n) \times Ps\ (n) + Cg(n) \times Pg\ (n)$$

where I(i), dimensionless, is the importance of item i in the diet of a given species

$$R\ (i) = (I(i)/ \Sigma\ I(n)) \times 100$$

where R(i), in %, represents the relative importance of item i in the total diet of a given species.

Environmental Parameters

Several environmental parameters are measured in situ

- Depth: using measuring string with depth label.
- Temperature: using Sinar Salt Meter Model NS-3P
- Salinity : using Sinar Salt Meter Model NS-3P
- pH : using pH meter

Grainsize and Organic Matter Analysis

Grainsize and organic matter analysis were condicted in laboratory. Sediment were left air-dry. Sieve the sediment through series of sieve of mesh size 1.0, 0.425, 0.250, 0.125, 0.063 and 0.032 mm. Median grain size was calculated from the cumulative weight of sediment retaining on the series of sieves. Organic matter in the sediment was determined by Ignition Loss Method. (Paphavasit, 1981)

Analysis of Data

Two indices, species diversity index and evenness index were calculated. The diversity Shannon-Weaver index (H') was calculated from the equation.

$$H' = -\sum(n_i/N)\ln(n_i/N)$$

H' = Diversity index (Shannon-Weaver index)

n_i = Amount of amphipods each species

N = Amount of all amphipods

Eveness index (J') of amphipods communities in each site was calculated from the equation.

$$J' = H'/H'_{max}$$

J' = Eveness index

H' = Diversity index (Shannon-Weaver index)

H'_{max} = Maximum diversity index (Shannon-Weaver index)

The relationship between dominant amphipod distribution and certain environmental factors were tested by coefficient test and linear relationship.

Amphipod Analytical Sheet

Body

General, segments:

☐ Abnormal disproportion or enlargement.

☐ Cylindricalization.

☐ Dorsal depression with or without splaying of coxae.

Ornamentation:

☐ Teeth, doral and lateral; pereon 1, 2, 3, 4, 5, 6, 7; pleon 1, 2, 3, 4, 5, 6.

☐ Spine groups, dorsal, especially on pleon 1, 2, 3, 4, 5, 6.

Elongation of metasome

....

Pleonal epimera:

☐ Shape and ornamentation from lateral view.

Urosome:

☐ Coalescence of segments: 1-2, 1-3, 2-3.

☐ Dorsal depression.

☐ Elongation of urosomite 1.

Coxae

Size:

☐ Normal.

☐ Elongation.

☐ Reduction.

☐ Disproportional sizes of 1-4: 1 long, 2 shorter, 3 shorter, 4 long.

☐ Coxa 1 absent or vestigial.

☐ Coxa 1 reduced in size and partially to fullly covered by following coxae.

☐ Coxae 1-2 or 1-3 reduced in size and covered by following coxae.

☐ Coxa 3 larger than 4.

☐ Coxa 5 as long as 4.

Position:

☐ Serial contiguity: coxae contiguous or overlapping.

☐ Serial discontiguity.

☐ Concealment of one coxae by another.

☐ Lateral splaying.

Shape:

☐ Coxae 1-4 subquadrate.

☐ Acumination of coxae 1, 2, 3, 4.

☐ Excavation posteriorly of coxa 4.

☐ Coxa 1 tapered, expanded, oval, semicircular, quadrate, conical, acutely lobed.

☐ Ventral serration.

Special patterns:

…………………………………………………………………………………………………..

Head

Size:

☐ Length as a function of one or more pereonites.

☐ Massive.

Shape:

☐ Normal (cuboidial).

☐ Globular: sub sphereoid; neck cylindrical.

☐ Galeate.

Rostrum:

Length in relation to head; ……%, relation to article 1 of antenna 1; ……%.

Shape:

☐ acute ☐ spatulate ☐ horizontal ☐ deflexed

Lateral lobe:

☐ Shape extent of projection

☐ Notch or ornamentation

☐ Ocular bulge on side of head

☐ Marginal details of antroventral corner of head near insertion of antenna 2

Eyes

Composition:

☐ Presence ☐ absence

☐ Paired ommatidial mass below cephalic cuticle

☐ Cuticular lense in lateral pairs

☐ Diffusused pigment or stain

☐ Quadrigeminous lenticular bodies

☐ Bright pigment masses wnveloping brain

Shape:

☐ oviod ☐ flask-like ☐ reniform

Position:

☐ Near lateral cephalic surface

☐ In lateral lobes

☐ In restrum

☐ Dorsally confluent

☐ Accessory detached ommatidia

☐ Occupying cephalic extend almost fully

Antenna 1

Length:

☐ ………% of total body

☐ ………% of antenna 2

Flagellum:

☐ Proportion of peduncle (…..%)

☐ Elongation of basal article

☐ Proportion to peduncle article 3

Number of articles: …………………..

Peduncle: proportion to head

Relative length of all 3 articles

1 = 100 %, 2 = …….%, 3 = ………%

☐ Ornamentation on any articles, all side

☐ Distinctive spine or setal bundle

☐ Possible geniculation between articles

Accessory flagellum:

Number of article ……..

☐ A fuse scale

☐ Special shape ……….

☐ Elongation of basal article

Accessory organs:

☐ Calceoli

☐ Aesthetases

Antenna 2

Length : ……….% of body

Peduncle: ……….% of head

Relative proportion of article: 4 = 100%, 5 = ……%

☐ Tumodity of article 3, 4 or 5 , article 1 large and subsperical

☐ Glane cone and/or ensiform process on article 2 and 1: extreme enlargement

Flagellum: ………..% of peduncle ……..% of article 5

Number of articles ……….

Ornaments:

Aestheases, calceoli on peduncle and/ or flagellum

Distinctive spine groups

Mouthparts

From lateral view

☐ Conical bundle below head

☐ Quadrate bundle

☐ Amalgamation of mandibles and maxillae into ventral keel

Epistomal - Larbal Complex

Lateral view:

☐ Epistome and labrum separates by notch or coalesed

☐ Epistome formed as lobe dominating labrum, vice versa, or produce together

Shape of lobes:

☐ Epistome: flat, rounded, acute

☐ Labrum: flat, rounded, acute

Prebuccal mass inconspicuous and of normal gammaridean proportions

Upper lip (anterior view)

Ventral margin:

☐ Rounded ☐ Truncate ☐ Incised ☐ Lobedd asymmetrically ☐ Symmetrically

Mandible

Shape and size of body:

☐ Bulky ☐ Styliform ☐ Clytriform ☐ Normal

Incisor:

☐ Normal ☐ Extremly broadened ☐ Needle like ☐ Toothed ☐ Intoothed ☐ Teeth separated by flat margin

Lacinia mobilis:

☐ absent

☐ present : right or left mandible, toothed, special shape

Spines proximal to lacinia mobilis: 1-2, 3-6, 7+

Molar: ☐ Absent

☐ Present

Size: ☐ Small ☐ Medium ☐ Large ☐ Fully dominating mandible

Shape: ☐ Cylindrical ☐ Cuboidal ☐ Laminate ☐ Conical ☐ Tuberous

Texture: ☐ Tritutative ☐ Spinose ☐ Setulose ☐ Minutely ☐ Fuzzy ☐ Striate ☐ Smooth

☐ Accessory seta or spine on triturative molar

Palp:

Number of article: 0, 1, 2, 3

Attachment position relative to molar: ☐ Over ☐ Distal to ☐ Proximal to

Relative length of article: 1= (….. %), 2 = (……%), 3 =(…….%)

Shape:

Article 3: ☐ Cylindrical ☐ Falconiform ☐ Tuberculiform

Article 2: ☐ Curve strongly

Article 1 ☐ distal cusp

Setation: ☐ Article 3 ☐ Medial

Lower Lip

☐ Normal

Inner lobes: ☐ weak ☐ absent

Mandibular projection of outer lobes: ☐ Poited ☐ Optuse ☐ Absent

Outer lobes: ☐ Distally notches ☐ Medially excavate

Special shapes………………..

Maxilla 1

Inner plate:

Size: ☐ Absent ☐ Small ☐ Medium ☐ As large as outer plate

Setation: ☐ Terminal ☐ Medial

Number of setae: 1, 2, 3, 4-6, 6-12

Structure of setae: ☐ Normal ☐ Sickle-shaped ☐ Strongly constricted

Outer plate:

Number of spines: 1-4, 5-6, 7-8, 9-11+

Shape of spine: ☐ Slender ☐ Stout ☐ Bifid ☐ Some serrate ☐

In two distinct groups by position or structure

Palp:

Number of article: 0, 1, 2

☐ Article 1 short and article 2 long

☐ Article 1 long and article 2 short

Modifications: ☐ Strongly bent ☐ Foliaceous ☐ Bearing scales

Maxilla 2

☐ Normal gammaridean

Abnormal small: ☐ Plates partially coalesed ☐ Setae very sparse

Breadth of lobes: ☐ Subequal ☐ Inner broader ☐ Outer broader

☐ Axial divergence of lobes

☐ Extension of outer plate on basal article

☐ Specialized spines

☐ Extent of medial setation on inner plate: ☐ Strong ☐Sparse ☐ Absent

Maxilliped

Inner lobes:

Size: ☐ Vestigal ☐ Normal

Abnomal shape: ☐ Foliaceus ☐ Styliform

Outer lobes:

Size relative to inner: ☐ Larger ☐ Vestigal ☐ Foliaceous

Spination: ☐ Absent ☐ Medial ☐ Distal

Palp:

Extension relation to outer plate: ☐ Shorter ☐ Equal ☐ Longer

Number of articles: 0, 2, 3, 4

Medial or terminal extentions of articles: ☐ 1 ☐2 ☐ 3

Elongation of article ☐ 1 ☐ 2 ☐ 3

Terminal palp article: ☐ Claw-like ☐ Barrel-shaped ☐ Vestigal ☐ Bearing distal nail ☐ Spine ☐ Setae

Gnathopods

☐ Gnathopods 1-2 feeble together

☐ Normal; gnathopods 2 powerful

☐ Powerful together

Gnathopod 1

☐ Present ☐ Vestigal ☐Absent

Size relative to gnathopod 2 : ☐ Smaller ☐ Equal ☐ Larger

Sexual dimorphism: ☐ Similar ☐Different

Article:

2: Length in relative to coxa 1

3: Length ☐ normal ☐ elongate

4: Merochelation: with strong thumb-like extension

5: Length relative to article 6 ……….%

Posterior lobe: ☐ Present ☐ Weak ☐ Absent

Carpochelation: ☐ strong distoposterior tooth

6: Breadth relative to article 5 : ☐ wider ☐ equally wide ☐ narrower

Shape: ☐ ovate ☐ pyriform ☐ quadrangular ☐ rectangular ☐ linearly rectangular ☐ styliform

Palm: ☐ present ☐ absent

Slope: ☐ transverse ☐ oblique ☐ slight ☐ moderate ☐ extreme

Chela: ☐ parachelate

Proximoposterior corner of palm: ☐ spines ☐ protuberance ☐ tooth ☐ change in slope only

Ornamentation: ☐ special spine ☐ teeth

7: Fit of dactyl to palm: ☐ congruent ☐ overlapping ☐ not fitting

shape and ornament: ☐ claw-like ☐ vestigal ☐ absent ☐ with special setae or apine ☐ hidden in setae or ciri ☐ flaglliform

Distal articles article espectially scaly or with small setae

Gnathopod 2

Articles:

3: Length normal: elongate

4: Merochelation: with strong thumb-like extension

5: Length relative to article 6 ……….%

Posterior lobe: ☐ Present ☐ Weak ☐ Absent

Carpochelation: ☐ strong distoposterior tooth

6: Breadth relative to article 5: ☐ wider ☐ equally wide ☐ narrower

Shape: ☐ ovate ☐ pyriform ☐ quadrangular ☐ rectangular ☐ linearly rectangular ☐ mitten-like

Palm: ☐ present ☐ absent

Slope: ☐ transverse ☐ oblique ☐ slight ☐ moderate ☐ extreme

Chela: ☐ parachelate

Proximoposterior corner of palm: ☐ spines ☐ protuberance ☐ tooth ☐ change in slope only

Ornamentation: ☐ special spine ☐ teeth

7: Fit of dactyl to palm: ☐ congruent ☐ overlapping ☐ not fitting

shape and ornament: ☐ claw-like ☐ vestigal ☐ absent ☐ with special setae or apine ☐ hidden in setae or ciri ☐ flaglliform

Pereopod 1-2

Internal gland: ☐ present ☐ absent

Orientation of pereopod 2 like that of pereopods 3

☐ chelation ☐ prehensile

☐ Articles 4-5 ☐ 4-6 ☐ 4, 5, 6 inflat strongly

☐Article 4 extraordinarily elongate

Special spines on article 6 near claw: ☐ Spines striate ☐ Hooked

☐ Article 7 absent

Pereopods 3-5

Relative legths: pereopods 3 …….%; 4= 100%; 5=……%

General structure:

☐ All similar in structure and slightly longer successive

☐ Article 2 expanded: ( ) pereopod 3 ( ) pereopod 4 ( ) pereopod 5

☐ Chelate ☐ Subchelate ☐ Prehensile

Fossorial setation: ☐ Present ☐ Absent

☐ Article 7 absent: pereopods 3, 4, 5

Pereopod 5 reduced to fewer than 6 article

Pleopods

Relative length to each pair: 1= 100%; 2=……%; 3=……%

Length of longest ramus relative to peduncle ………%

Length of inner ramus to outer……..%

Shape of coupling hooks on peduncle

☐ Lobation of peduncle

Uropods

☐ Absent ☐ Present

Projection along following uropods

☐ Uropod 1 reaching (…..%) along uropod 2; (……%) along uropod 3

☐ Uropod 2 reching (……%) along uropod 3

Relative length of rami: ☐ outer ☐ inner shortened; ☐ inner absent or vestigal

☐ Spination density of peduncle and rami

☐ Incision of inner ramus

Uropod 3

☐ Absent ☐ Present☐Rami absent

Length relative to other uropod: extension beyond longest of other uropods (……% of its own length)

Length of peduncle relative to uroposomal segment 3 (……%) to peduncles of other uropods (……..% of peduncle of uropod 1, or to telson (……%)

Length of inner ramus to outer (…….%)

Shape of rami: ☐ styliform ☐ lanceolate ☐ barrel-shaped ☐ foliaceous

Article of outer ramus ☐ 1 ☐ 2

☐ Minute ornamentation and hooks on rami

☐ Special peduncular processes

Telson

☐ Absent ☐ Present

☐ Fused to urosomite 3

☐ General shape and length

Length in relation to urosomite 3 (……%) or uropod 3 (……%)

Degree of cleft between lobes (……..%),☐ Emarginate only

Ornamentation: ☐ Apically pointed ☐ Notched ☐ Trifid ☐ Truncate ☐ Rounded ☐ Concave

☐ Greatly enlarged and with ventral keel ☐ Forming dorsalventral plate

☐ Dorsalventrally thickened ☐ Bearing lateral nobs ☐ Scales ☐ Hooks

Sexual dimorphism

Especially:

☐ Antennae:

☐ Eyes:

☐ Gnathopods:

☐ Coxae:

☐ Pleonal epimera 1-3:

☐ Uropod 3:

☐ Urosomal teeth:

Feeding morphology

☐ Filter feeding

Antennae ☐ long ☐setose

Mouthparts ☐ plumose maxilla inner plate

☐ flat and strong maxilla

☐ small mandibular incisors

Gnathopods

☐ large ☐ setose

Pleopods and uropods ☐ long ☐ setose

☐ Herbivore

Mouthparts ☐ large mandible with mandibular palp

☐ mandibular with trituative surface

Gnathopods ☐ large ☐ chaelate or subchaelate

Stomach ☐ large

☐ Scarvenger

Mouthparts ☐ small mandible

☐ smooth molar

☐ large molar with setular velvet

☐ mandible with mandibular palp

Gnathopods ☐ Large

Pereopods ☐ Setose

☐ Predator

Mouthpart ☐ large mandible

Gnathopods ☐ Large ☐ Chaelate or subchaelate

Stomach ☐ short

Other behavior morphology

☐ Swimming ability

☐ large lateral shield ☐ long pleopods

☐ leaf like rami of uropods 1, 2

☐ Borrowing

☐ fossorial uropods 1, 2

☐ thick and fixed abdomen

☐ Sedentary or tube building

☐ reducing uropod 3 and fuse urosome

CHAPTER III

RESULTS

Distribution and Abundance of Amphipods

1. Kang Kao Island, Chonburi Province

Fourteen species of amphipods from nine families were found at Kang Kao Island, Chonburi Province. These amphipods can be divided into four feeding modes; filter feeders, grazers, filter feeder-predator and detritus feeders. Filter feeding amphipods in Kang Kao coral reef consisted of *Ampelisca brevicornis, Ampithoe* sp. A, *Paracorophium* sp. A, *Elasmopus* sp. A, *Leucothoe furina* and *Listriella* sp. A. Only one species of grazers was found namely *Eriopisa* sp. A. Three species of filter feeder-predator amphipods; *Ceradocus* sp. A, *Gammaropsis* sp. A and *Melita appendiculata* were recorded in the area. Detritus feeding amphipods were also observed namely *Leucothoe alcyone, Idunella janisae* and *Urothoe simplingnathia*.

Considering the habitats of these amphipods species, nine species were benthic and five species were demersal plankton. The latter group consisted of *Gammaropsis* sp. A, *Ampithoe* sp. A, *Elasmopus* sp. A, *Hyale* sp. A and *Ampelisca brevicornis*. *Ampelisca brevicornis, Eriopisa* sp., *Idunella janisae* and *Urothoe simplingnathia* were the four common species in this reef. (Table 6)

These amphipods occurred in greatest abundance at Station DK, which was mainly rocky substrate. However, Station DK had the lowest diversity index of 1.6365 (Table 7). At station AK, several microhabitats could be found among the thriving coral communities. Highest diversity index of amphipods was observed at this station of the value 2.355. Most amphipods species showed the higher ratio of females than males.

Table 6 Distribution and abundance of amphipods in Kang Kao Island, Chonburi Province (individual/m^2)

Feeding Mode	Family	Genera/Species	AK		BK		CK		DK	
			male	female	male	female	male	female	male	female
Filter feeders	Ampeliscidae	*Ampelisca brevicornis*	33	22	56	44	78	100	367	289
	Ampithoidae	*Ampithoe* sp. A	11	33	0	0	0	11	0	0
	Corophiidae	*Paracorophium* sp.	33	44	0	0	22	33	44	78
	Leucothoidae	*Leucothoe furina*	0	0	0	0	0	0	11	33
	Gammaridae	*Elasmopus* sp.A	0	11	0	0	0	0	0	0
	Lilijeborigiidae	*Listriella* sp.A	33	100	0	0	0	0	22	0
	Hyalidae	*Hyale* sp.A	11	22	0	0	0	0	0	0
Grazers	Melitidae	*Eriopisa* sp.A	78	111	33	11	33	44	89	67
Filter feeder-predator	Gammaridae	*Ceradocus* sp.	56	44	0	0	0	0	11	11
		Gammaropsis sp.A	33	67	22	33	0	22	44	56
		Melita appendiculata	33	0	0	0	0	0	0	0
Detritus feeders	Leucothoidae	*Leucothoe alcyone*	22	44	11	56	0	0	22	22
	Lilijeborigiidae	*Idunella janisae*	0	11	11	33	11	33	0	33
	Urothoidae	*Urothoe simplingnathia*	22	44	0	22	33	56	244	411
		Total	365	553	133	199	177	299	854	1000

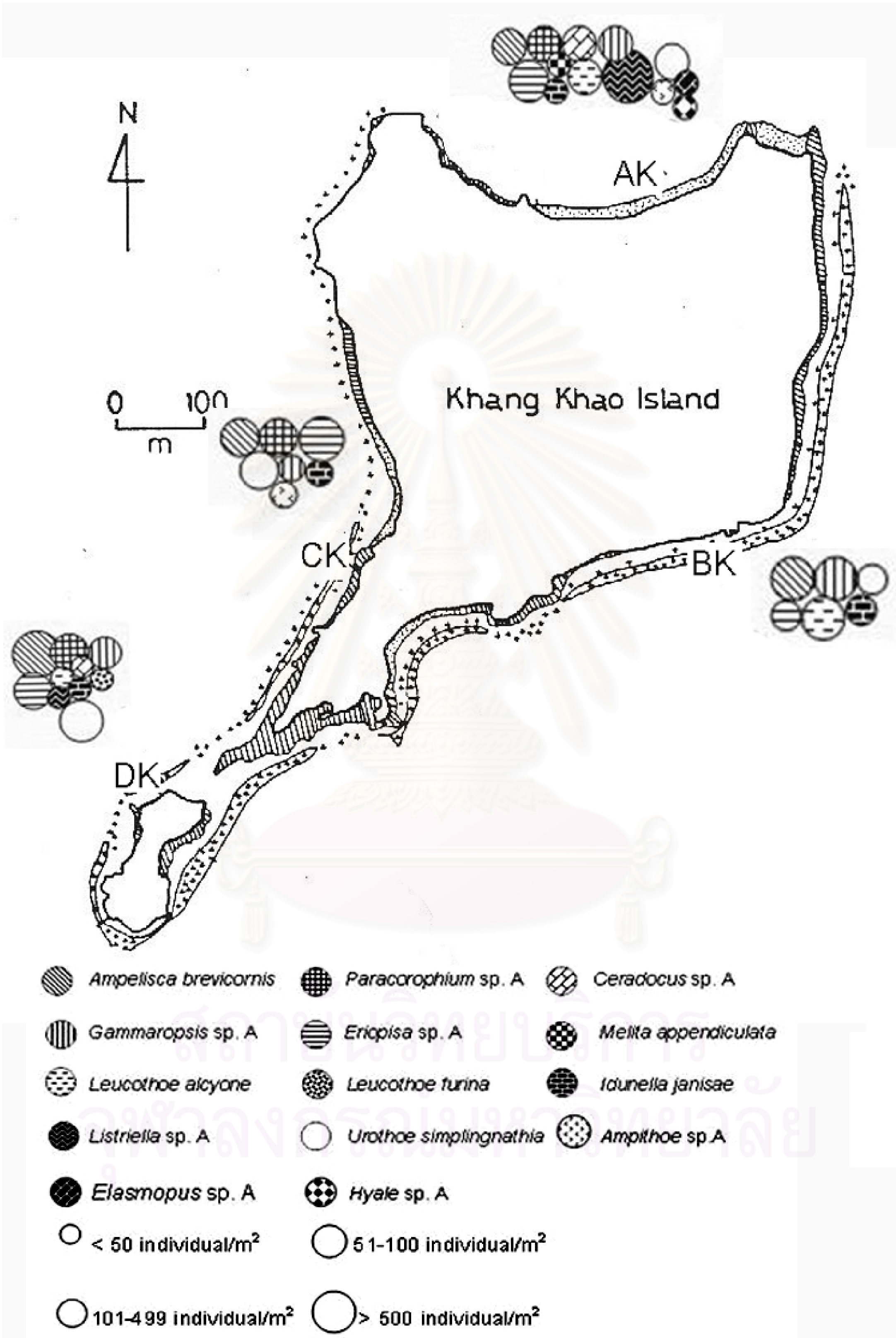


Figure 18 Amphipods Distribution in Kang Kao Island, Chonburi Province

Table 7 Diversity index and eveness index of study sites at Kang Kao Island, Chonburi Province

Indice	Station			
	AK	BK	CK	DK
Diversity index (H')	2.3355	1.6996	1.6771	1.6365
Eveness index (J')	0.8850	0.6440	0.6355	0.6201

2. Libong Island, Trang Province

Six species of amphipods from five families were found in Libong Island, Trang Province. Two species of filter feeding amphipods: *Ampelisca cyclop* and *Ampelisca* sp. A were recorded. Grazing amphipods, *Eriopisella* sp. A and *Kamaka* sp. A were found. The latter species was the most dominant amphipods in the area. Two detritus feeders were also observed namely, *Synchelidum* sp. A and *Urothoe spinidititus.* All five species were infaunal with only *Kamaka* sp. A as epizoites. High density of amphipods were noted at station BL, where *Halophila ovalis* (small-leave seagrass) dominated. Station AL consisted mainly of bare sand near seagrass bed. This station showed the highest diversity of amphipods of 1.3741 (Table 9). Three most common species in the seagrass bed in Libong Island were *Kamaka* sp. A, *Urothoe spiniditus* and *Ampelisca cyclop* respectively. (Table 8)

Table 8 Distribution and abundance of amphipods in Libong Island, Trang Province (individual/m^2)

Feeding modes	Family	Genus/Species	AL		BL		CL	
			male	female	male	female	male	female
Filter feeders	Ampeliscidae	*Ampelisca cyclop*	16	8	12	8	8	4
		Ampelisca sp. A	4	12	0	0	4	0
Grazers	Gammaridae	*Eriopisella* sp.A	0	0	0	24	0	0
	Ischyroceridae	*Kamaka* sp.A	12	36	24	72	18	50
Detritus feeders	Odicerotidae	*Synchelidium* sp.A	4	4	0	0	0	0
	Urothoidae	*Urothoe spinidigitus*	4	4	8	12	10	30
Total			40	62	44	116	40	84

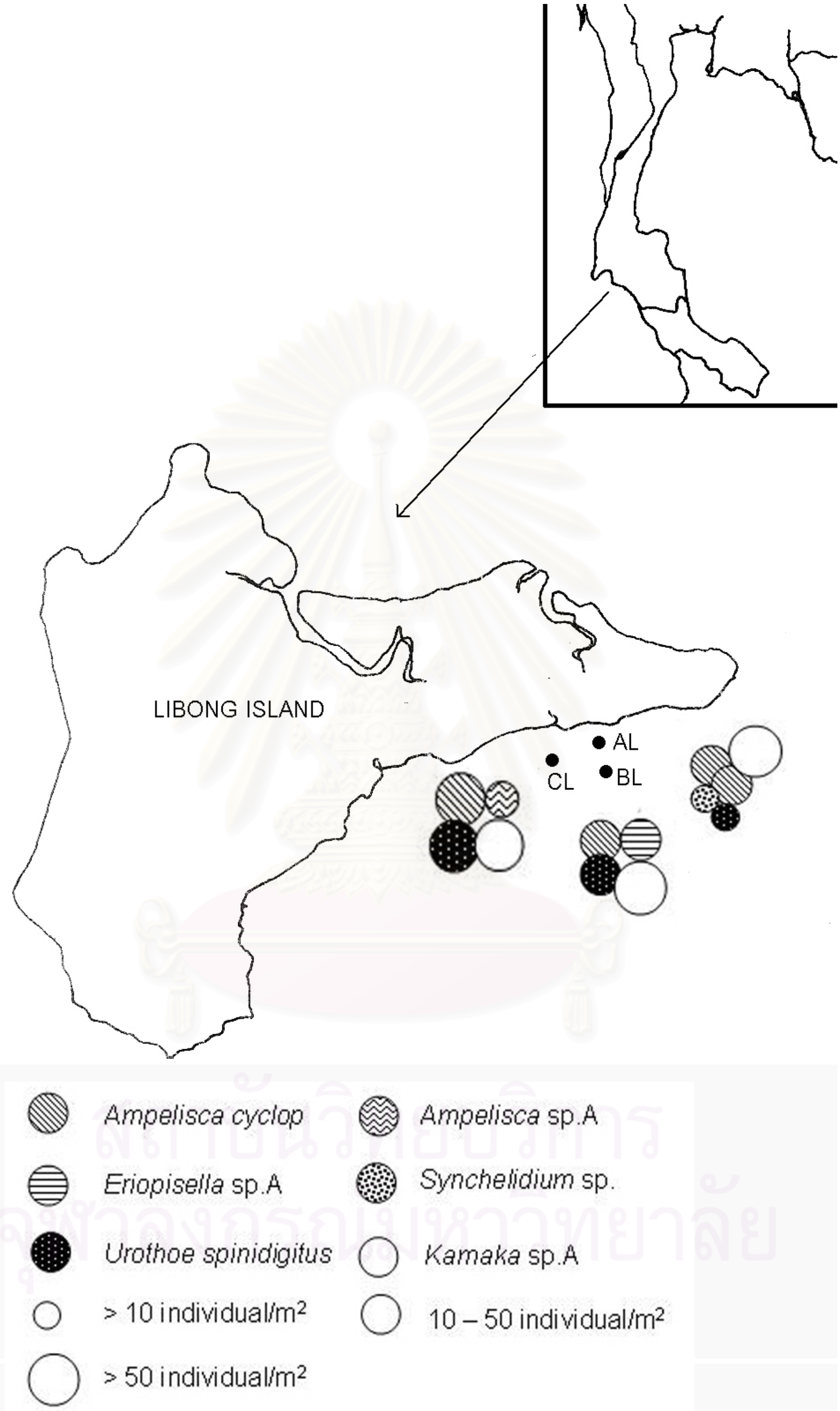


Figure 19 Amphipods distribution in Libong Island, Trang Province

Table 9 Diversity index and eveness index of study site at Libong Island, Trang Province

Indice	Station		
	AL	BL	CL
Diversity index (H')	1.3741	1.1094	1.0301
Eveness index (J')	0.7669	0.6192	0.5749

Morphological Adaptation to Habitats

1. Kang Kao Island

Amphipods found in Kang Kao Island can be divided into habitat types; nestler, dimicolous, fossorial and nektonic or demersal. These amphipods showed several morphological adaptations according to their habitat.

1. 1 Nestler

Most amphipods found in coral reefs at Kang Kao Island are nestlers. They consisted of *Paracorophium* sp. A, *Leucothoe furina, Listriella* sp. A, *Eriopisa* sp. A, *Ceradocus* sp. A, *Melita appendiculata* and *Idunella janisae.* These amphipods distributed densely in station DK and AK that have highest percentages of life coral, 80.0 % and 68.08 % respectively. (Table 10)

Nestler amphipods live among coral rubbles, under coral head, sand bottom and filamentous algae. They adapted their morphology for living under these substrates. They live mainly on or under the sediment that required have lateral compress body. Their antennae are long with small setae for food searching and environmental detection. Their gnathopods are diversed depending on their feeding modes. Their pereopods 3 -7 are thin and long with small setae. These pereopods are useful for moving in situ in the sediment, among sand grain or among coral debris. Their pereopods 5-7 are backward and have flat article 2. Their uropods are well-develop for swimming. However, these amphipods are not good swimmer due to their small coxae.

1.2 Domicolous

Domicolous amphipods found in Kang Kao Island are tube dweller namely *Ampelisca brevicornis*. They are common species that found in every station. They are lateral compressed. They have long thin second antennae. They usually live under the sediment and exposed their antennae outside their tube. for searching food and environmental detection. Their pereopods are strong with thin and sharp dactylus for digging in the sediment. The pereopods consisted of numerous long feather-like setae. Their coxae are large and very broad, almost covering the entire of the pereopods. They have special gland on their pereopods 5 for secreting mucus while building their tubes. Their pleopods and uropods are well developed indicated that this amphipods are good swimmer.

1.3 Fossorial

Fossirial amphipods found in this study are *Urothoe simplingnathia*. They are active motile species. They usually live under the sediment. They have depressed body. Their antennae are long for searching foods. Their pereopods are very strong with numerous spine and feather-like setae. The dactylus of the pereopods are thick in order to enhance their burrowing. Their pleopods and uropods are strong for supporting their movement.

1.4 Nektonic

Nektonic amphipods are found in coral reef and most abundance at station AL. They are active motile species. Most of them are filter feeding except for *Gammaropsis* sp. A, the filter feeding – predatorial amphipod. They have lateral compressed body. Their antennae are long with dense long setae for creating the feeding current. They also have large coxae and thin long pereopods for swimming. Their pleopods and uropods are well-developed.

Table 10 Amphipod microhabitats in Kang Kao Island, Chonburi Province (Adapted from Platong et al., 2002)

Habitat	Station			
	AK	CK	DK	HK
Live coral (%)	68.08	55.34	53.79	80.00
Death coral (%)	7.15	21.10	1.63	
Zoanthid (%)	0.17	0.67	1.00	
Anemone (%)	0	0	0.25	
Soft coral (%)	0	0	0.04	
Sponge (%)	0	0	2.67	
Encrusting sponge (%)	0	0	4.46	
Sand (%)	24.04	11.90	2.21	
Rock (%)	0.56	10.80	33.46	
Massive coral				
Cyphastrea spp.	✓		✓	
Favia abdida		✓		
Favia spp.	✓	✓	✓	
Favites halicora			✓	
Favites spp.		✓	✓	
Goniastrea retiformis		✓		
Goniastrea spp.			✓	
Goniopora sp.	✓		✓	
Lepthastrea transvera	✓		✓	
Leptoastrea spp.		✓		
Montipora sp.			✓	
Platygyra chinensis			✓	
Platygyra spp.		✓	✓	
Pocillopora damicornis	✓	✓	✓	
Porites Lutea	✓	✓	✓	✓
Psammocora profundiferra	✓	✓		
Symmphyllia sp.			✓	
Foliaceous coral				
Montipora sp.		✓	✓	
Pavona decussata	✓	✓	✓	
Pavona frondiferra	✓	✓		
Pavona varians		✓		
Symohyllia spp.				
Turbinaria fronds			✓	
Tabulate coral				
Acropora digitate			✓	
Encrusting coral				
Coscinaria sp.			✓	
Galaxia fascicularis			✓	
Lithophyton undulatum				
Solitary coral				
Heterocyathus aequnicostatus	✓	✓	✓	
Hetersammia cochlea	✓	✓	✓	✓
Diaseris disorta	✓			
Fungia spp.	✓	✓		
Stylaraea sp.A	✓			

With the exception of grain size and organic matter, other environmental factors were quite similar in four stations. Grain size analysis in station AK and BK (both were located in coral reef areas) revealed that they were mostly of very coarse sand. Grain size found in station CK and DK were medium sand and coarse sand respectively. The organic matter of station AK was highest because of the effect from sedimentation load from main land.

Table 11 Environmental factors in Kang Kao Island, Chonburi Province

Environmental Factors	Station			
	AK	BK	CK	DK
Depth (m)	4	4	5	3
Temperature (^{o}C)	30.27	30.87	30.21	30.56
Salinity (psu)	31	31	31	31
pH	8.21	8.20	8.21	8.24
Sediment Texture	Very coarse sand	Very coarse sand	Medium sand	Coarse sand
Median grainsize	0.707 mm.	0.897 mm.	0.397 mm.	0.726 mm.
Organic matter (%)	3.41-3.84	3.64-5.17	2.09-3.94	2.7-3.53

2. Libong Island

Major factors that affect amphipods distributions are types of microhabitats. Station AL, bare sand with seagrass leave litter had high density of nestler amphipods. Station BL with highest diversity of seagrass species, had highest density and diversity of amphipods. Station CL with dense *Enhalus acoroides*. Dense *Enhalus* seagrass make the sediment very compacted thus prevent amphipod from burrowing. (Table 12)

Environtmental factors in every station was quite similar. Station AL had highest amount of silt and clay and organic matter. The organic matter in seagrass bed is lower than that of coral reefs (Table 13)

Table 12 Amphipod microhabitats in Libong Island, Trang Province (Terrados et al., 1998; Lewmanomont and Supanwanid, 1999 and Nakaoka and Supanwanid, 1999)

Habitat	Station		
	AL	BL	CL
Enhalus acoroides			✓
Thalassia hemprichii		✓	
Cymoducea spp.		✓	
Halophilla ovalis		✓	
Sand	✓	✓	✓

Table 13 Environmental Factors in Libong Island, Trang Province

Environmental Factors	Station		
	AL	BL	CL
Depth (m)	0.5	1	1
Temperature (^{o}C)	30.50	30.20	30.20
Salinity (psu)	31	31	31
PH	8.25	8.23	8.21
Sediment Texture	sandy loam	loamy sand	loamy sand
Organic matter (%)	0.23	0.20	0.22

Amphipods adaptation to their habitats can be found in seagrass communities as following.

2.1 Nestler

Nestler amphipods are common in the seagrass bed. There are *Eriopisella* sp. A, *Kamaka* sp. A and *Synchellidium* sp. A. These amphipods distributed densely in station BL where *Halophila ovalis* (small-leave seagrass) dominated. They live among seagrass leaves and seagrass fragments. Their adaptations are similar to those nestler in coral reefs. They have thin and long pereopods with small setae on articles 5-7. The dactylus of pereopods are naked and sharp for holding the seagrass leaves. The infaunal species *Synchellidium* sp. A have their pereopods with numerous of setae for burrowing under the sediment.

1.2 Domicolous

Domicolous amphipods found in this study are tube dweller. This group consisted of *Ampelisca cyclop* and *Ampelisca* sp. A in seagrass beds. *Ampelisca cyclop* are common species that found in every station. Both species have lateral compressed body. They usually live under the sediment between seagrass rhizomes or between seagrass leave litter. They have long antennae for searching food and environmental detection. Their pereopods are strong with thin, sharp, and naked dactylus for digging in the sediment. The pereopods consisted of numerous long setae from basic to propodus. Their coxae are large and very broad, almost covering the entire of the pereopods. They have special gland on their pereopods 5 for secreting mucus while building their tubes.

1.3 Fossorial

Fossorial amphipods found in this study are *Urothoe spinidigitus* in the seagrass bed. They are active motile species. They have depressed body. Their antennae are long for searching foods. Their pereopods are very strong with numerous spines and very long setae. The dactylus of the pereopods are thick in order to enhance their burrowing. Their pleopods and uropods are well developed for supporting their movement. *Urothoe spinidigitus* has extended merus with very long setae on posterior side that prevent them for sinking in the soft sediment.

Amphipods Food Items

Amphipod feeding modes found in this study can be evaluated by their mouthparts together with their stomach contents. Amphipod feeding modes can be catagorized into 4 types; filter feeders, grazers, filter feeder-predators and detritus feeders (Table 14). Amphipods, which share the same feeding modes, may have different food items depending on their habitats and feeding mechanisms.

1. Filter feeders

The dominant amphipods feeding groups in coral reefs were filter feeders. Amphipods of this feeding mode have two habitat types, nestler and domicolous. Centric and pennate diatoms found in amphipods stomach contens indicate that these amphipods feed mainly on sediment or in water column. In *Ampelisca brevicornis,* the major food items consisted of pennate diatoms (40%), centric diatoms (10%), cyanobacteria and sand grain. Amphipods of this species are tube dwellers and demersal plankton that feed both in sediment and in water column. Their antennae are the major appendages used for searching and trapping their food while residing in sediment. They swim and filter their food in the water column at night.

Paracorophium sp. A, *Leucothoe furina* and *Listriella* sp. A are nestler species. They feed mainly on the sediment. Their stomach contents contained benthic microalgae and macroalgae. *Paracorophium* sp. A have gnathopods with long setae. They use their gnathopods for trapping and collecting food. Their stomach contents consisted not only 40% of pennate diatoms but also macroalgae, organic materials and sand grains. *Leucothoe furina* stomach contents showed similar food compositions to *Paracorophium* sp. A. They use their long antennae mainly for both searching and trapping food. Their gnathopods are also use for collecting food in the sediment. Major food items of *Leucothoe furina* are 60% of pennate diatoms and 10% of centric diatoms and organic materials. *Listriella* sp. A., weakly motile filter feeder that swing first and second maxilla for creating water currents in mouthparts, feed only on the sediment. Their food items contained 60% of pennate diatoms and organic materials.

There are two species of filter feeding amphipods in seagrass beds. Both of them are domicolous. Their food items were similar. *Ampelisca cyclop* and *Ampelisca* sp. A fed mainly on pennate diatoms and macroalgae. Other than pennate diatoms and macroalgae, *Ampelisca* sp. A had 10% of centric diatoms. Sand grains also found in the stomachs of both species.

The stomach contents *Ampelisca cyclop* were similar to those of grazing amphipods *Eriopisella* sp. A and *Kamaka* sp. A (Figure 19). However, they feed by different mechanisms. *Ampelisca cyclop* and *Ampelisca* sp. A are tube dwellers that live under the sediment. They use their long antennae for searching food. Food items in their stomach contents were smaller than those in grazing amphipods.

2. Grazer

Eriopisa sp. A is the only grazing amphipods found in coral reefs. They feed mainly on pennate diatoms, macroalgae and cyanobacteria. This species of amphipods are active motile that feed mainly on the sediment. They also able to swim in the water column. Their antennae are long with small setae for food detection. Their major food item is *Navicular* sp. Amphipods of this species are common in coral reef.

Eriopisella sp. A and *Kamaka* sp. A are grazing amphipods found in seagrass beds. Their food composition in the stomach contents were similar with 40 % of pennate diatoms, macroalgae and 10% of organic. However they live in different microhabitats. *Eriopisella* sp. A were found near seagrass rhizome while *Kamaka* sp. A were dominant on seagrass leaves. *Eriopisella* sp. A are active motile while *Kamaka* sp. A are weakly motile. The major food items of *Kamaka* sp. A were pennate diatoms, epiphyte macroalge and organic materials. Food items of *Eriopisella* sp. consisted of pennate diatoms, macroalgae and organic materials.

3. Filter feeding-predator

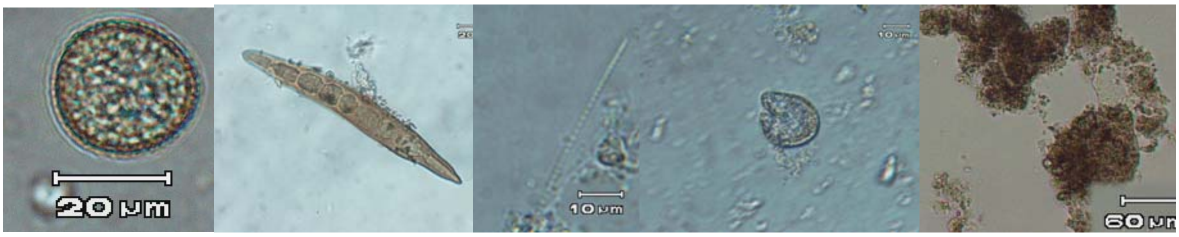
Filter feeding-predatorial amphipods were found only in coral reefs. These amphipods feed mainly on microalgae and macroalgae as the filter feeders. Their food items were diverse. They had also animal fragments in their stomachs. *Melita appendiculata* feed both on sediment and in water column. There stomach contens consisted of pennate diatoms, centric diatoms, cyanobacteria, organic materials. The animal frangments in *Melita* *appendiculata* included polychaete setaes and crustacean fragments. Another filter-feeding predator, *Ceradocus* sp. A, feed mainly on sediment. They feed on pennate diatoms, macroalgae and organic materials. Animal fragments that found in *Ceradocus* sp. stomachs were mainly crustacean fragments and nematocysts of cnidarian. *Gammaropsis* sp. A are filter feeders that swim and filter their food particles in the water column. They mainly feed on centric and pennate diatoms. Animal fragments in the stomach of *Gammaropsis* sp.A consisted only crustacean fragments.

4. Detritus feeders

Detritus feeding amphipods in coral reefs and seagrass beds had different food items. Detritus feeders in coral reefs also feed on detritus and small pennate diatoms. *Leucothoe alcyone* and *Idunella janisae* are nestler while *Urothoe simplingnathia* are fossorial. *Leucothoe alcyone* and *Idunella janisae* feed mainly on the sediment and in the water column while *Urothoe simplingnathia* feed mainly in sediment. *Leucothoe alcyone* feed on decaying animal. *Urothoe simplingnathia* stomach contents showed some sand grains.

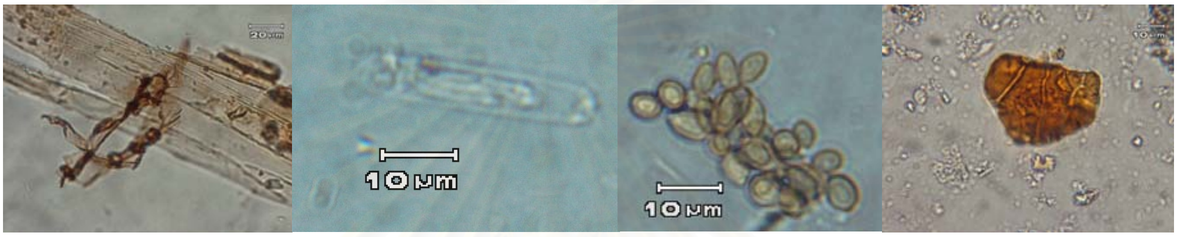
Detritus feeders in seagrass beds showed similar food items in their stomach contents. *Synchellidum* sp. A feed mainly on the sediment while *Urothoe spinidigitus* are fossorial species that feed in the sediment. They feed on both organic materials and small amount of sand grain.

Filter feeders



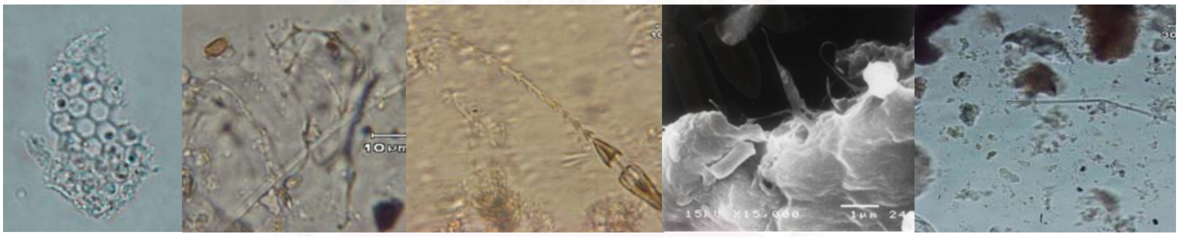
Centric diatoms Pennate diatoms Cyano bacteria Dinoflagellate Organic materials

Grazers



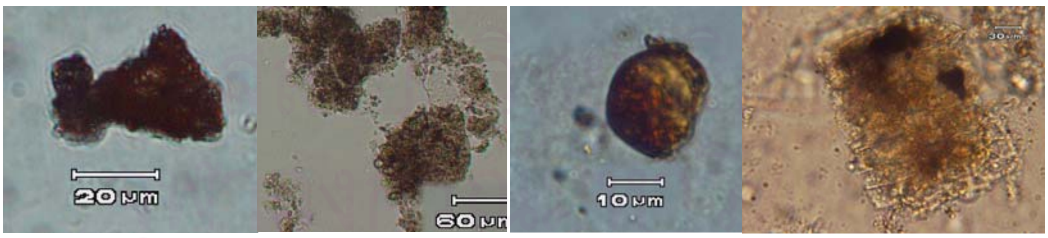
Macroalgae Pennate diatoms Sand grains

Filter feeder-predators



Centric diatoms Crustacean fragments Cnidaria pneumatocyst Polychaete setae Organic materials

Detritus feeders



Organic materials Sand grains Decayed algae

Figure 20 Food Items of amphipods according to their feeding modes

Table 14 Food Items of Amphipods in Kang Kao Island, Chonburi Province

Genus/Species	Feeding modes	Food items					
		Cyano bacteria	Diatoms	Macro algae	Organic	Sand grain	Animal fragment
Ampelisca brevicornis	Filter feeder	+	+++		+		
Ampithoe sp. A	Filter feeder		++	+			
Paracorophium sp.A	Filter feeder		++	+	+	+	
Elasmopus sp.A	Filter feeder		++				
Leucothoe furina	Filter feeder		+++		+		
Listriella sp.A	Filter feeder		++		++		
Hylale	Filter feeder		++				
Eriopisa sp.A	Grazer	+	++	++			
Ceradocus sp.	Filter feeder-predator		+	+	+		+
Gammaropsis sp.A	Filter feeder-predator		++	+			+
Melita appendiculata	Filter feeder-predator	+	++		+		++
Leucothoe alcyone	Detritus feeder		+				+
Idunella janisae	Detritus feeder		+	+	+		+
Urothoe simplingnathia	Detritus feeder		++		++	+	

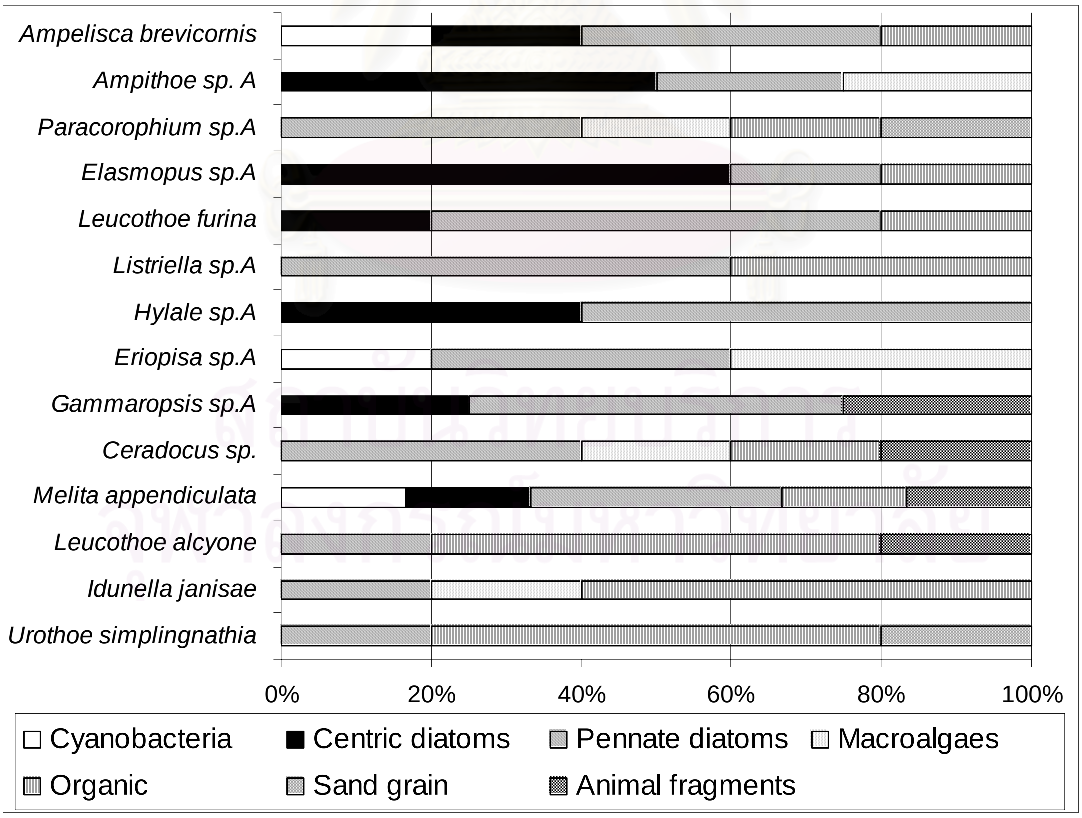


Figure 21 Food items of amphipods that found in coral reef, Kang Kao Island, Chonburi Province

In seagrass bed, the dominant amphipods are filter feeders and grazers. These amphipods did not feed on seagrass, however they fed mainly on macroalgae occurring on seagrass blades instead. In the stomach of both filter feeding and grazing amphipods also contained organic matter. But grazing amphipods have larger food size than those found in the filter feeding amphipods. Detritus feeding amphipods, *Synchelidium* sp. A and *Urothoe spinigitus* fed mainly on organic matters and sand grains.

Table 15 Food Items of Amphipods in Libong Island, Trang Province

Genus/Species	Feeding Modes	Food items			
		Diatom	Macroalgae	Organic	Sand grain
Ampelisca cyclop	Filter feeder	+	++	++	
Ampelisca sp.A	Filter feeder	+	++	++	
Erioposella sp.	Grazer	+	++	+	
Synchelidium sp.A	Detritus feeder			+++	+
Urothoe spinidigitus	Detritus feeder			+++	+
Kamaka sp.A	Grazer	+	++	+	

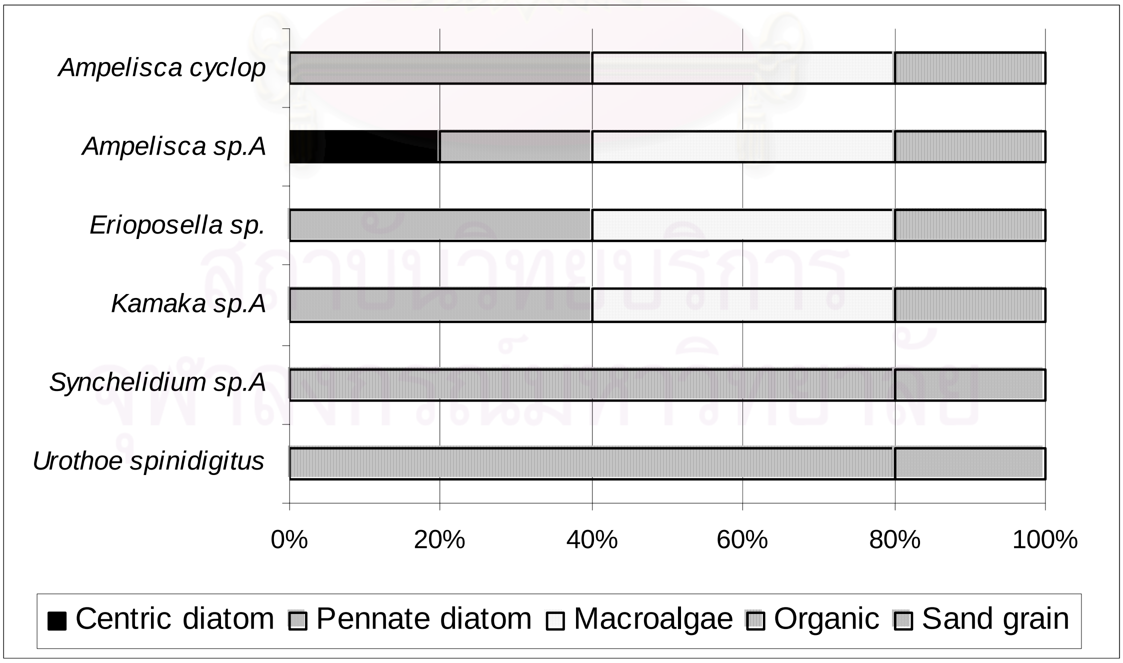


Figure 22 Food items of amphipods that found in seagrass bed, Libong Island, Trang Province

Comparison Between Amphipods Morphology and Their Feeding Ecology

1. Filter feeding amphipods

Filter feeding amphipods found in this study have lateral compress body. Their eyes are small. They can be divided into 2 feeding mechanisms. Both of them filter their food particles from the water column by feeding currents created by appendages. First group of amphipods create feeding currents by their long antennae with long fine setae for trapping food particles. They have numerous setae on maxilliped palps for cleaning or combing the base of the antennae. They use their gnathopods as filtering basket for sieving food particles from water currents. Therefore, they have dense setae on posterior sides of their both gnathopods. Their mouthparts consisted of maxillipeds, first and second maxilla with long fine setae along the medial edge of inner plate for selecting their food particles. Most filter feeding amphipods found in coral reefs and seagrass communities feed by this mechanisms. There were nestler, demersal, and domicolous filter feeding amphipods found in coral reefs. The nestler species are *Paracorophium* sp. A, *Leucothoe furina*. There are demersal plankton species including *Ampithoe* sp. A, *Elasmopus* sp. A and *Hyale* sp. A. The only domicolous filter feeding amphipods *Ampelisca brevicornis* lived in coral reefs. Filter feeding amphipods found in seagrass communities are domicolous species, *Ampelisca cyclop* and *Ampelisca* sp. A.

Another group of filter feeding amphipods create feeding currents by their mouthparts directly. These amphipods usually have big eyes. Their antennae usually short and weakly setose. These amphipods use their eyes and antenna only for searching their food and environmental detection. Their mandibular palps have short setae only at the terminal. These indicate that their antennae were not used in create feeding currents. Instead these amphipods create feeding currents by moving the first and second maxilla in the mouthparts chamber. Their inner plates of maxilliped and second maxilla are usually broad with numerous setae. The mandible with trituative surface usually bear numerus rakaers. They select their food particles by their maxillipeds and second maxilla. Their weakly setose gnathopods do not used for sieving food particles. They use their gnathopods for gathering their food. Only filter feeding amphipods, *Listriella* sp. A found in coral reefs employ this feeding mechanism.

2. Grazing amphipods

Grazing amphipods graze their food particle directly from the seafloor. They share similar feeding morphology with filter feeding amphipods. Their antennae are long with small setae. Their eyes are large for searching food. Their inner plates of first and second maxilla have dense setae only at the terminal. They do not have setae along the medial edge. Their mandibles are large with trituative mandibular molar. Their incisor and lacinia mobilis with numerous tooth are working together for biting. Their mandibular palps usually with setae for cleaning their antennae while feeding. Food size in grazing amphipods are usually larger than those of filter feeding amphipods. Their gnathopods often large and subchelate. There are numerous of setae on gnathopods especially on propodus article for collecting food. These amphipods are active motile species. They have strong pereopods, pleopods and well-developed uropods. Grazing amphipods found in this study feed mainly on the seafloor. There are three species of amphipods, *Eriopisa* sp. A in coral reefs and *Eriopisella* sp.A and *Kamaka* sp. A in seagrass communities. *Kamaka* sp. A are distinguished from other two species with small antennae. Their eyes are large and face downward to the seafloor for searching food. Their pereopods do not strong. They are not as active as the other two species. They are found abundance on seagrass leaves.

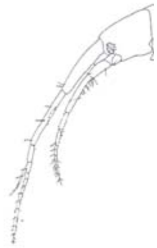
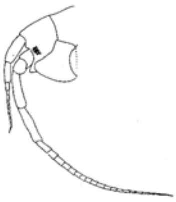
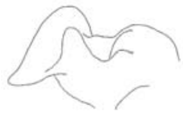
3. Filter feeding-predatorial amphipods

Filter feeding-predatorial amphipods are common in coral reefs. They have lateral compress body for active movement. Their antennae are long with small setae and their eyes are large for searching preys. Their first gnathopods have dense setae on the posterior sides that create sieving basket inorder to trap food. Their second gnathopods are large and strong with numerous spine for hunting preys. Their first and second maxilla have inner plates densely short setose medially as in the filter feeding species. Maxilliped palps have dense fine long setae. They use their second maxilla and maxilliped for sorting food. This species of amphipods have mandibles that consisted of group of tooth incisor and lacinia mobilis for biting. Their mandibular molars have accessory spine on trituative molar for grinding. Mandibular palps are slender with small setae for cleaning their antennae. Their mouthparts are similar to mouthparts of filter feeding amphipods. Filter feeding-predatorial amphipods found in this study are good swimmers. They have well developed pereopods, pleopods and uropods. *Gammaropsis* sp. A are also found in demersal group. *Melita appendiculata* also the good swimmers. Amphipods of this species show distinctive sexual dimorphism. Male amphipods have larger second gnathopods than female. However the food items in male and female amphipods are similar.

4. Detritus feeding amphipods

Detritus feeding amphipods found in this study are active motile species. There are both epifuana and infauna in coral reefs. Epifaunal species, *Idunella janisae* and *Leucothoe ayone* have lateral compress body with well developed pereopods, pleopod and uropods. Infaunal species, *Urothoe simplingnathia,* have depress body and strong setose pereopods for digging in the sediment. Only infaunal detritus feeding amphipods are found in seagrass communities. Both amphipods, *Urothoe spinidigitus* and *Synchellidium* sp. A have depress body with setose pereopods for digging in sediment. When comparing the amphipods eyes, epifaunal amphipods have small eyes while infaunal amphipods have larger eyes. Detritus feeding amphipods have long thin antennae for searching food. Their mandible and mandibular molar are small. Except for amphipods *Idunella janisae,* that do not have mandibular molar. Most gnathopods in the detritus feeding amphipods are chelate or subchelate for collecting food. They have small mouthpart especially small mandibular molar. Their mandibles consisted of small dentate incisor. Their maxilliped, fist and second maxilla are small with few setae.

Table 16 Comparison of amphipods morphology according to feeding modes

Function	Appendages	Filter feeder	Grazer	Filter feeder - predator	Detritus feeder
Searching Food Appendages	Eyes Antennae				
Food collecting Appendages	Gnathopods				
Feeding Appendage	Maxilliped				
	Second maxilla				
	First maxilla				
	Mandible				
	Lower lip				

Description of Amphipods Species

Amphipod characteristics for identification listed below included feeding appendage characteristics. Feeding appendage characteristics revealed the appendages that used for food searching (i.e. antennae and eyes), for collecting food (i.e. gnathopods) and for feeding (i.e. mouthparts). The Identification of amphipods was based on "Key to Common Families Amphipod Gammaridea" (Modified from Thanh, 2004)

1. Amphipods of Kang Kao Island

1.1 Filter feeders

Family Ampeliscidae

Amphipods in this family have very large head and their eyes often consisted of 2-4 external cuticle lenses. They do not have accessory flagellum. Their gnathopods are feeble. Their pereopods 5-6 alike but the pereopod 7 has distinct structure. The second article of the pereopod 7 is broad with posteroventral lobe. Their pereopods 3 and 4 have elongate article 4. These pereopods are glandular. Their urosomites 2-3 are coalesced. The uropod 3 is biramous and their telson are laminar form.

Ampeliscisca brevicornis

Description

A. brevicornis have large head with 4 eyes with cuticle lenses in lateral pair. The pair of first antenna locate between both eyes and the pair of second antenna situate at ventral corner of the head. Antenna 2 are longer than antenna 1. Mouthparts from lateral view form quadrate bundle. Upper lip is round. Mandibles are normal with toothed incisor. The lacinia mobilis is present in right mandible. Mandibular molar is small. Mandibular palps have dense fine setae along 3 articles. The lower lip is normal with inner lobe. First maxilla has inner plate with 8 sickle shaped spines. The outer plates of first maxilla have 4 serrate spines. Second maxilla have equal inner and outer lobes with dense long setae. Maxilliped have outer lobe that larger than inner lobe. The palps are longer than outer lobe with 3 articles. The terminal of articles of palps are claw-like. Gnathopods 1 and 2 have sharp article 7 and broad article 2-4. Pereopods 3-4 are similar in structure with article 2-4 are much broader than article 7. Pereopods 5-6 are similar in structures, articles 2 are simple and article 3 are longer than article 4. Articles 4 of pereopods 5-6 produce small lobe that fully cover article 5. Articles 6 are inflated and longer than article 7. Pereopod 7 have broad article 2 that produce posteroventral lobe. The pleons segments have round posteroventral corner without tooth. The first urosomal segment has large dorsal process. Uropod 1 are exceed end of uropod 2. Outer ramus of uropod 1 are naked and inner ramus bearing a few spine. Both rami of uropod 2 have spines. Uropods 3 are subfoliaceous, outer and inner rami are equal. Telson is cleft with apices acute and one seta at each tip.

Feeding Morphology

Ampelisca brevicornis are filter-feeding species. Their major food items are pennate diatoms. Centric diatom and cyanobacteria in equal amount are also presented. Their antennae are long with dense long fine setae. They use their antennae for searching and create feeding currents to their gnathopods with dense setae are used to collect foods. Both gnathopods are feeble. They are equipped with dense long fine setae from article 2-6 aid in trapping food. Their inner plates of maxilliped and second maxilla have feather-like setae. Their inner plates of first maxilla have spines together with setae. They select the food particles by the maxilliped and second maxilla. Their mandibular molars are trituative with tooth incisor and lacinia mobilis that use for bitting food. The mandibular palps have fine long setae along 3 articles that used for cleaning the base of their antennae. *Ampelisca brevicornis* is one of the demersal groups that feed on microalgae attaching on sand grain during the day and swim in the water column during the night to feed.

Habitat

Amphipods of this species occupied in sand near coral reef but they able to swim. They are domiciles groups that living in their tubes. *A. brevicornis* pereopods have sharp and naked dactylus that aid in digging sediment. These amphipods are able to swim. Their coxae are large and articles 2-5 of pereopods have numerous setae that prevent the animals from sinking in water coloumn. These amphipods could be found in every station and abundance in station AK and DK.

Distribution

A. brevicornis is distributed in the coastal area from South China Sea to Pacific Ocean in particular Vietnam, Indonesia and Japan. They distributed along India coast and South Africa coast. (Imbach, 1967; Barnard; 1969)

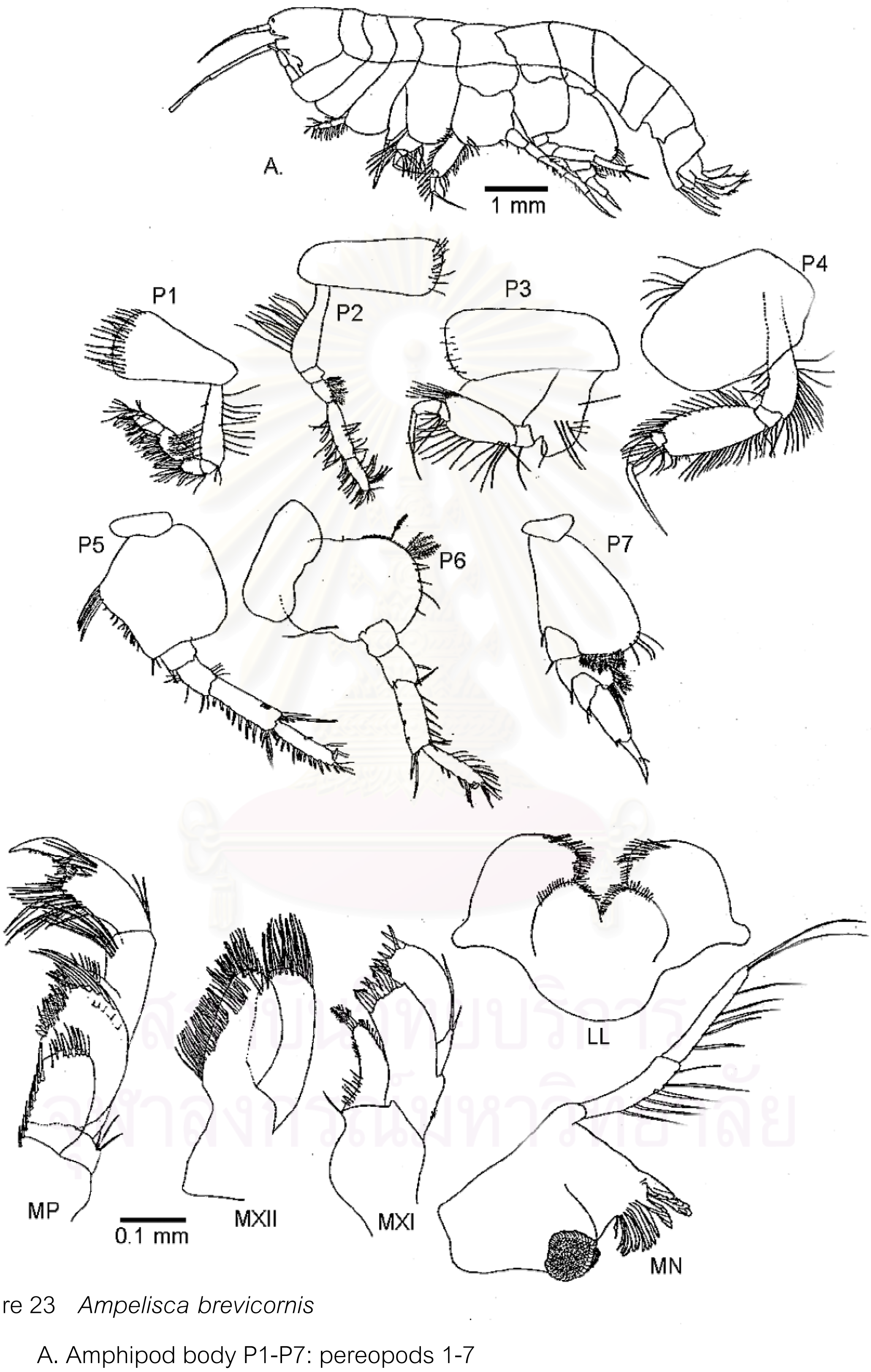


Figure 23 *Ampelisca brevicornis*

A. Amphipod body P1-P7: pereopods 1-7

MP:Maxillipeds; MX1:First maxilla; MX II:Second maxilla; MN:Mandible; LL:Lower lip

Family Ampithoidae

Their bodies are subcylindrical. Their urosome, some or all urosomite are coalesced. Their coxae are large and touching each other. Mouthparts are basic. Gnathopods often subchelate. Uropods 1 and 2 are normal and uropods 3 are variety form, that can be bearing two rami, inner ramus reduce in size, bearing one rami, or rami absent. Peduncles of uropod 3 often longer than rami. Their telson can be entire, fleshy, circular, or symmetrically trapezoidal or very broad and short. Their pereopod 7 are occasionally very elongate and bearing long setae.

Ampithoe sp. A

Description

Their bodies are subcylindrical. Their urosomites are free. The rostrum and ocular lobe is short. The antennal sinus is moderate. Their eyes are small. Antenna 1 are longer than antenna 2. Mouthparts from lateral view form quadrate bundle. Upper lip is round. Mandibles are normal with toothed incisor. Mandibular molar are trituative. Mandibular palps are stout with 3 articles. The lower lip process notch at outer lobe and well-developed inner lobe. First maxilla has inner plates with 7 slender spines. The outer plates of first maxilla have 8 slender spines. Second maxilla have inner lobe smaller than outer lobes with dense long setae. Maxilliped has outer plate that is larger than inner plate. The palps are longer than outer lobe with 4 articles; articles 2 are long, article 3 are unlobed, article 4 are short with long spine and setae.

Their coxae are long and strongly overlapping. Gnathopods 1-2 are simple and stong subchaelate with plumose setae. Pereopods 3-4 are normal and similar in shape with slender article 2, and long article 7. Pereopods 5-6 are shorter than pereopods 7. Pereopods 5 and 6 have broad article 2. Pleopods are normal. Uropods 1 and 2 are biramus with rami are equal with peduncles. Uropods 3 are biramus but both rami are very short. Telson is entire, short, and broader than long with 2 hooks at apice.

Feeding Morphology

These amphipod are filter feeder. Their major food items consisted of centric diatoms, pennate diatoms, macroalgaes and organic particles respectively. They feed mainly in water column. They usually filter their food particles while they are swimming. They use both of their gnathopods equipped with very long dense setae together with their antennae for trapping food. Their inner plates of maxilliped have feather-like setae that amphipods used for selecting food particles. Their inner plates of second maxilla and first maxilla have slender setae that use together for grinding food. Their mandibular molars are trituative with tooth incisor used for biting food. Their mandibular palps, used for cleaning the base of antennae, consisted of three articles with setae along the palps.

Habitat

These amphipod are demersal plankton living within sand substrate near coral reef. They can also be found among living and dead corals. They were distributed at station AK. *Ampithoe* sp.A have strong flat coxae and pereopods that help them to swim. Amphipods this genus can also be found in sandy beach near coral reefs in Andaman Sea.

Distribution

Ampithoe sp.A is distributed in marine, brackish water and fresh water in the Gulf of Thailand, Andaman Sea, Vietnam, New Zealand, Chile and Palau. (Barnard; 1969; Barnard and Karaman, 1991)

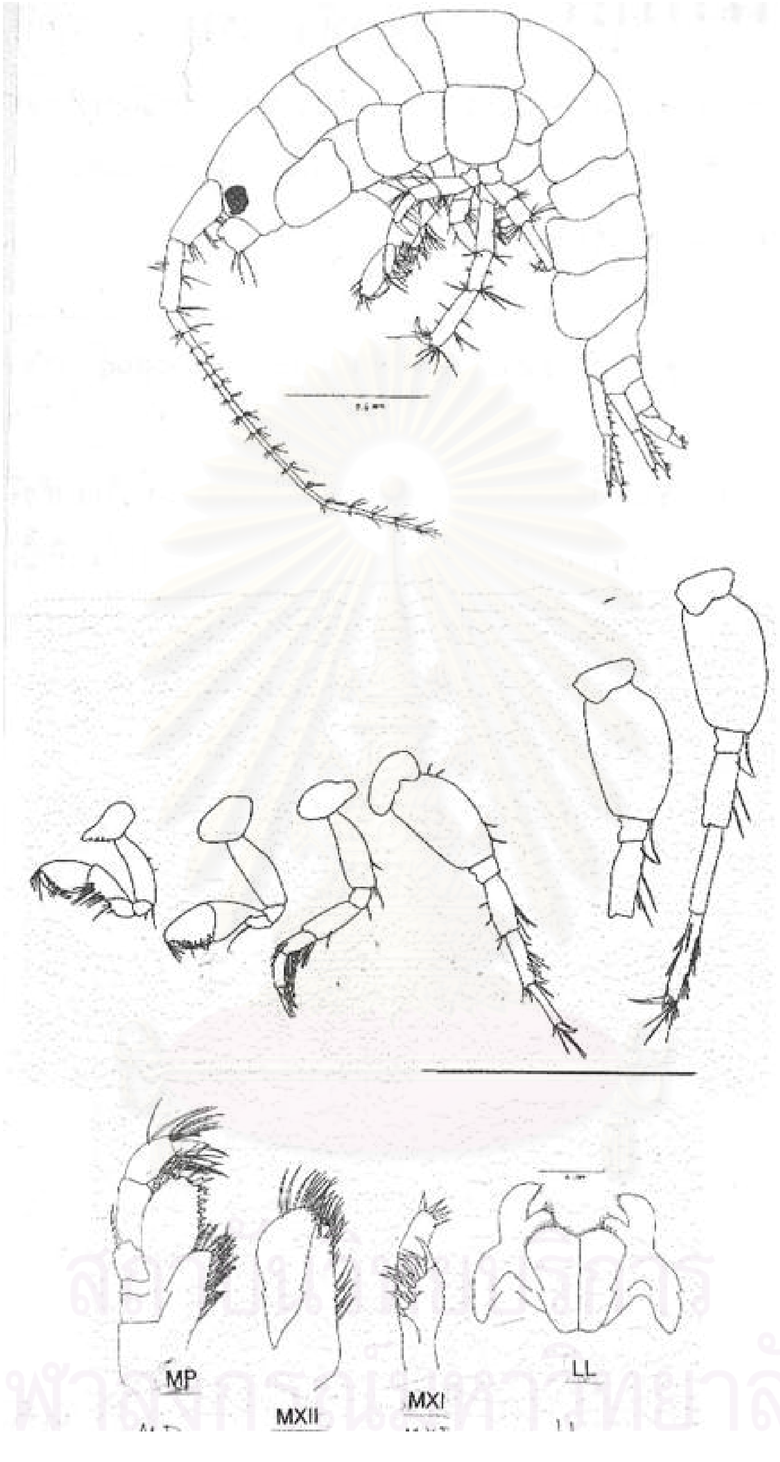


Figure 24 *Ampithoe* sp. A

A. Amphipod body

P1-P7: pereopods 1-7

MP:Maxillipeds; MX1:First maxilla; MX II:Second maxilla; MN:Mandible; LL:Lower lip

Family Cophiidae

Amphipods in this family have a variety of accessory flagella. Their body is subcylindrical. Their urosome, some or all urosomite are coalesced. Their coxae are variety and often not touching each other. Mouthparts are basic except mandibular palps occasionally reduce to one or two articles and upper lip occasionally bilobed. Gnathopods often subchelate. Uropods 1 and 2 are normal and uropod 3 are variety form, that can be bearing two rami, inner ramus reduce in size, bearing one rami, or rami absent. Their telson can be entire, fleshy, circular, or symmetrically trapezoidal or very broad and short. Their pereopod 7 are occasionally very elongate and bearing long setae.

Paracorophium sp.

Description

Their bodies are subcylindrical. Their urosomites are free. The rostrum and ocular lobe is short. The antennal sinus is moderate. Their eyes are small. Antenna 1 is longer than antenna 2. Mouthparts from lateral view form quadrate bundle. Upper lip is round. Mandibles are normal with toothed incisor. Mandibular molar are small in tube form. Mandibular palps are slender with 3 articles. The lower lip is normal with entire outer lobe and well-developed inner lobe. First maxilla have inner plates with 7 slender spines. The outer plates of first maxilla have 8 slender spines. Second maxilla have inner lobe smaller than outer lobes with dense long setae. Maxilliped have outer plate that larger than inner plate. The palps are longer than outer lobe with 4 articles, articles 2 are long, article 3 are unlobed, article 4 are short with long spine and setae.

Their coxae are long and strongly overlapping. Gnathopods 1-2 are simple and feeble. There are dense setae on both gnathopods. Pereopods 3-4 are normal and similar in shape with slender article 2, and long article 7. Pereopods 5-6 are shorter than pereopods 7. Pereopods 5 and 6 have broad article 2. Pleopods are normal. Uropods 1 and 2 are biramus with rami are equal with peduncles. Uropods 3 are biramus but both rami are very short. Telson is entire, short, and broader than long with 2 hooks at apice.

Feeding Morphology

These amphipods are filter feeder. Their major food items are pennate diatom and organic materials. They feed mainly on the seafloor. Amphipods of this specie have short antennae with small setae. They do not create the feeding currents by their long antennae like other filter feeding species. Instead they use both of their gnathopods with very long dense setae for trapping their food particles directly. Their first gnathopods have numerous setae on posterior side while their second gnathopods with very long setae on anterior side. Amphipods use both gnathopods together for trapping their food before sending them to their mouth. Their inner plates of maxilliped, second maxilla and first maxilla have slender setae along the median edges that amphipods use for selecting food particles. The mandibular incisors have 3 tooth and molar are big. The mandibular palps have almost naked 3 articles. They do not use their mandibular palp for cleaning their antennae. They select the food particles by using the maxilliped and second maxilla.

Habitat

This amphipods species is usually epifauna residing in sand near the coral reef. They are nestler groups. They distributed in station AK, CK and DK. *Paracorophium* sp.A have plumose pereopods and sharp dectylus that assisted in for clawing on the sea floor.

Distribution

Paracorophium sp. A distribute in both marine and brackish and fresh water in New Zealand, Chile and Palau. (Barnard; 1969; Barnard and Karaman, 1991)

Figure 25 *Paracorophium* sp. A

A. Amphipod body

P1-P7: pereopods 1-7

MP:Maxillipeds; MX1:First maxilla; MX II:Second maxilla; MN:Mandible; LL:Lower lip

Family Gammaridae

The Gammaridae are variable with many genera forming linkages to other families. Accessory flagellum are always present but varying from one long article to more than 20 short articles. Peduncles of antenna 1 are elongate. Upper lip is not incised. Their mandibles are always bearing strong trituative molar and 3 articulate palp. Their lower lip is variable but never bearing notch. Their maxillae are fully developed. Their maxilliped have well developed plates.

Gnathopods are usually powerful and subchelate. Gnathopod 1 rarely larger than gnathopod 2. Uropod 3 are highly variable but rami never shorter than peduncle and usually flattened. Inner rami are occoasionally very short. Their telson are not elongate, usually deeply cleft but occasionally broader than long.

Elasmopus sp. A

Description

Their bodies are compressed. Their urosomites are free. The rostrum and ocular lobe is short. The antennal sinus is moderate. Their eyes are small. Antenna 1 is longer than antenna 2. Mouthparts from lateral view form quadrate bundle. Upper lip is round. Mandibles are normal with toothed incisor. Mandibular molar are trituative. Mandibular palps are stout with 3 articles. The lower lip has round outer lobe and well-developed inner lobe. First maxilla have inner plates with two rows of 8 slender spines. The outer plates of first maxilla have 8 slender spines. Second maxilla have inner lobe smaller than outer lobes with dense long setae. Maxilliped have outer plate that larger than inner plate. The palps are longer than outer lobe with 4 articles, articles 3 are long, article 4 are short with long spine and setae.

Their coxae are long and strongly overlapping. Gnathopods 1 and 2 are stong and subchaelate with plumose setae on posterior part. Pereopods 3-4 are normal and similar in shape with slender article 2, and long article 7. Pereopods 5-6 are shorter than pereopods 7. Pereopods 5 and 6 have broad article 2. Pleopods are normal. Uropods 1 and 2 are biramus with rami are equal with peduncles. Uropods 3 are biramus but both rami are very short. Telson is entire with 2 hooks at apice.

Feeding Morphology

These amphipods are filter feeder. Their food items consisted of centric diatoms, pennate diatoms and organic particles. They are free-living. Feeding currents are created by their long antennae. Both gnathopods have very long dense setae that amphipods used for trapping food. Their inner plates of maxilliped, second maxilla and first maxilla have slender setae. The setae on inner plate of maxilliped and second maxilla are wider than other amphipods which allow them to consume larger food particles. Their mandibular molars are small. Their incisor beared numerous tooth. This species of amphipods do not have mandibular palp indicating that the antennae was not used for trapping food particles.

Habitat

Amphipods of this species are demersal plankton living on sand near coral reef. They are found distributed in station AK. *Elasmopus* sp.A have long flat pereopods for swimming.

Distribution

Elasmopus sp.A distributed in the Gulf of Thailand, Vietnam, Bay of Bengal, New, Zealand, Chile and Palau. (Barnard; 1969; Barnard and Karaman, 1991)

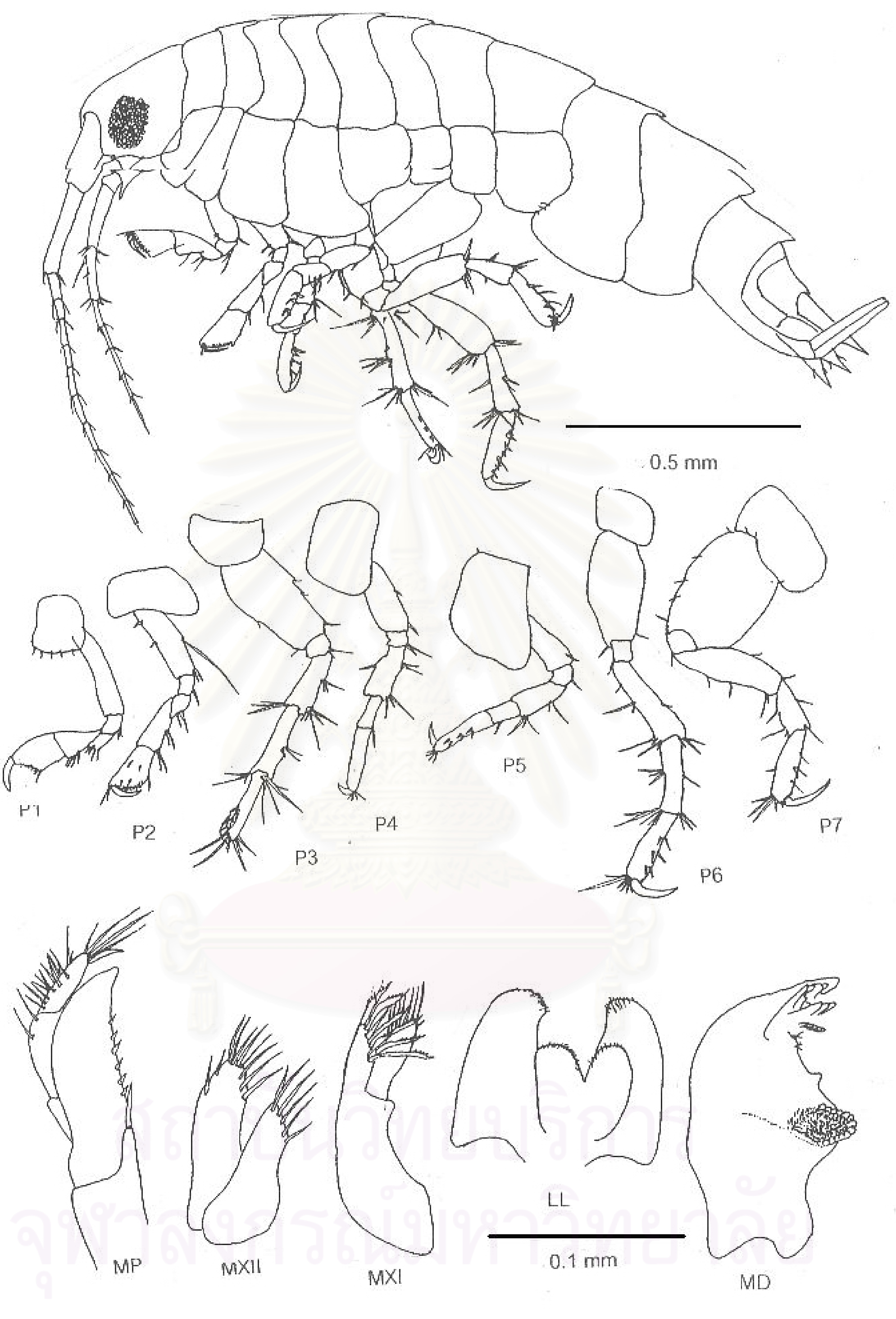


Figure 26 *Elasmopus* sp.A

A. Amphipod body

P1-P7: pereopods 1-7

MP:Maxillipeds; MX1:First maxilla; MX II:Second maxilla; MN:Mandible; LL:Lower lip

Family Leucothoidae

Their bodies are laterally compressed. Heads have rostrum that can be short, moderate, or long. Eyes are well developed or obsolescent. Antenna 1 can be equall or shorter or longer than antenna 2. Accessory flagellum is vestigal or absent. Mandible incisors are dentate. Maxilla 1 have small inner plate present that have weakly setose apically or without setae. Maxilla 2 are feeble. Inner plates are broad. Maxilliped have well develop inner and outer plates with palps.

Coxae 1-4 are overlapping. Gnathopod 1 are smaller than gnathopod 2, or subequal to gnathopod 2. Gnathopod 2 can be carpochelate, or subchelate. Pereopod 3 and 4 are well developed. Pereopods 5-7 have few robust or slender setae. Pereopod 5 can be shorter than pereopod 6, or subequal in length to pereopod 6. Articles 2 of pereopod 5 can be expanded or slightly expanded, subrectangular or subovate. Pereopod 6 can be shorter than pereopod 7, or subequal in length to pereopod 7. Urosomites 1 to 3 are free. Urosomite 1 is much longer than urosomite 2. Uropods 1-2 have apices of rami with robust setae, or without robust setae. Uropods 1-3 are similar in structure and size. Uropods 1 and 2 peduncles are naked. Uropods 3 have elongate peduncle and outer rami are shorter than peduncle. Telson is laminar and entire.

Leucothoe furina

Description

Their bodies are laterally compressed. Heads have short rostrum. Eyes are well developed. Antenna 1 are shorter than antenna 2 and do not have accessory flagellum. Mandible incisors are dentate. Mandibular molars are trituative. Mandibular palps are 2 article and have setae on the terminal. Maxilla 1 has small inner plates that have highly setose. Maxilla 2 has broad inner plates that have long setae on medial. Maxilliped have well develop inner and outer plates with palps.

Coxae 1-4 are overlapping. Gnathopod 1 are smaller than gnathopod 2. Gnathopod 1 are carpochelate and gnathopod 2 are subchelate. Pereopod 3 and 4 are similar shape with slender articles 2-7. Pereopods 5-7 have few robust or slender setae. Pereopod 5 are shorter than pereopod 6. Articles 2 of pereopod 5 are expanded. Pereopod 6 are subequal in length to pereopod 7. Urosomites 1 to 3 are free. Urosomite 1 is much longer than urosomite 2. Uropods 1-2 have apices of rami without robust setae. Uropods 1-3 are similar in structure and size. Uropods 1 and 2 peduncles are naked. Uropod 3 have elongate peduncle and outer ramus are shorter than peduncle. Telson is laminar and triangle.

Feeding Morphology

This species of amphipod are filter feeders. Their major food items are pennate diatoms, centric diatoms and organic materials. This amphipods feed mainly on the seafloor. They have long antennae with small setae that use only for searching food particles. Their gnathopods are large with gnathopod 1 carpochelate and gnathopod 2 subchelate. They grasp food particles directly by their gnathopods and send them to the mouthparts. They create feeding current for by the first maxilla together with second maxilla in mouthparts chamber in the same mechanism as *Listriella* sp. A. Their maxillipeds select particles according to sizes. Maxilla 1 have small inner plates that highly setose. Second maxilla has broad inner plates that have long setae on the medial. Maxilliped have well developed inner and outer plates with palps. This amphipod species have dentate mandible incisors. Mandibular molars are big and tritulative. Mandibular palps are with three articles with setae on the terminal that aid in cleaning the base of antennae.

Habitat

These amphipods are nestler species that occupy in sediment near coral reefs, in living coral and coral rubbles. They were found only in station DK on the rocky shore. Their legs are long and thin that allow them to easily glide under the rock and coral rubbles. Their legs are stronger than *Leucothoe alcyone* that associated with other invertebrates.

Distribution

These amphipods are distributed in the Gulf of Thailand, Red Sea, East Africa, Arabian Sea, Bay of Bengal, Indonesia and North Australia, Pacific Ocean (Imbach, 1967)

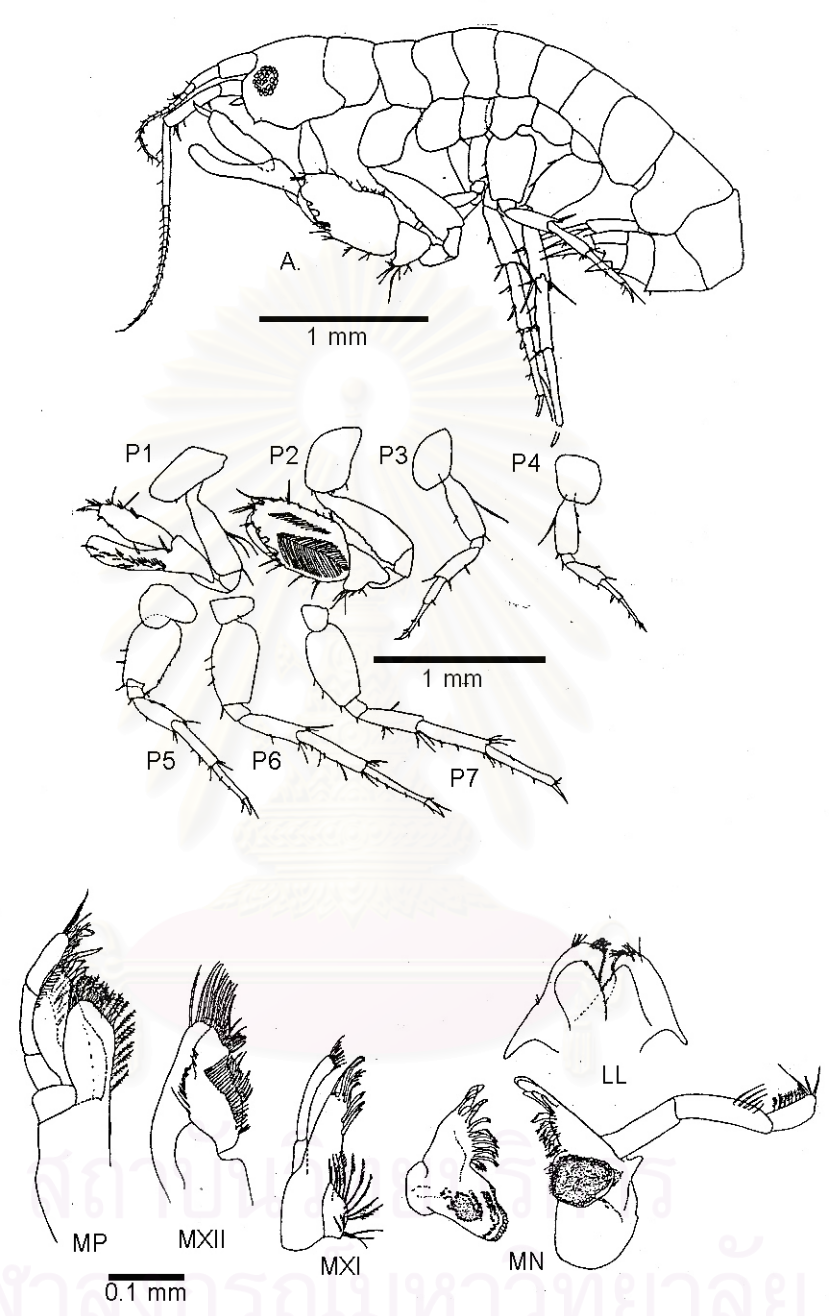


Figure 27 *Leucothoe furina*

A. Amphipod body

P1-P7: pereopods 1-7

MP:Maxillipeds; MX1:First maxilla; MX II:Second maxilla; MN:Mandible; LL:Lower lip

Family Lilijeboriidae

These amphipods have head that can be as long as deep, or longer than deep. Their rostrum is present or absent and short. Their eyes are well developed or obsolescent, or absent. Their bodies are laterally compressed.

Antenna 1 are shorter than antenna 2 or subequal to antenna 2. Mouthparts are well developed. Mandible incisors are dentate, or minutely serrate. Lacinia mobilis are present on both sides. Molars are medium and non-triturative or absent. Palps are present. Maxilla 1 have inner plates present with weakly setose apically. Maxilla 2 have inner plates and outer plate. Maxilliped have variety form inner and outer plates well developed or reduced, palps present, well developed or reduced; inner plates well developed or reduced, separate; outer plates present, small or vestigial.

Coxae 1-4 are longer than broad and overlapping. Gnathopod 1 are subequal to gnathopod 2 or larger than gnathopod 2. Gnathopod 2 can be carpochelate, or subchelate. Pereopod 3 and 4 are similar shape. Pereopods 5-7 have few robust or slender setae. Pereopod 5 are shorter than pereopod 6. Article 2 of pereopod 5 are expanded into subrectangular or with posteroventral lobe. Pereopod 6 and 7 are similar in structure and do not have dense slender setae.

Urosomites 1 to 3 are free. Urosomite 1 are subequal to urosomite 2, or longer than urosomite 2. Uropods 1-2 have naked apices of rami. Uropods 1-3 are similar in structure and size. Uropod 1 peduncle are naked. Uropod 2 have ventromedial spur and inner ramus subequal to outer ramus. Uropods 3 have short peduncle short and outer ramus are subequal to peduncle or longer than peduncle. Telson is laminar and cleft and than broad.

Listriella sp.A

Description

Antenna 1 is subequal to peduncle of antenna 2. Accessory flagellum has 2 articles. Mandible incisors are dentate. Molars are non-triturative. Lacinia mobilis are present in both side of mandible. Palps have 3 articles. Articles 1 of mandibular palps are elongate. Maxilla 1 have inner plates present with weakly setose apically. Maxilla 2 has inner plates and outer plate. Maxilliped have inner plates with long setae. Outer plates are shorter than peduncle and the terminals of peduncles are claw-like.

Coxae 1-4 are longer than broad and overlapping. Gnathopod 1 are subequal to gnathopod 2. Gnathopod 2 are subchelate. Pereopod 3 and 4 are similar shape with naked articles. Pereopods 5-7 have short setae at joints of each articles. Pereopod 5 are shorter than pereopod 6. Article 2 of pereopod 5 are expanded into subrectangular or with posteroventral lobe. Pereopod 6 and 7 are similar in structure.

Urosomites 1 to 3 are free. Urosomite 1 are longer than urosomite 2. Uropods 1-2 have naked apices of rami. Uropods 1-3 are similar in structure and size. Uropod 1 peduncles are naked. Uropod 2 have ventromedial spur and inner ramus subequal to outer ramus. Uropod 3 have short peduncle short and outer ramus are subequal to peduncle or longer than peduncle. Telson is laminar and cleft and longer than broad.

Feeding Morphology

The feeding modes of these amphipods are filter feeding. Their major food items are pennate diatoms and organic materials. They feed mainly on the sea floor. Their antennae are short and weakly setose. Their mandibular palps have short setae only at the terminal indicating that they do not used for creating current while feeding. They use their first and second maxilla to create the feeding current in their mouthparts chamber. Their inner plates of maxilliped and second maxilla are usually broad with numerous setae. The mandible with trituative surface bear numerous rakers. They select their food particles by their maxillipeds and second maxilla. Their gnathopods are simple and weakly setose. These amphipods have big eyes. Amphipods use their eyes and antenna only for searching food. After that, they use their gnathopods for gathering food. Food particles are filtered directly by their mouthparts.

Habitat

These amphipods are nestler species that occupy in sediment near coral reefs or among coral rubbles or under the rock. They have thin and long pereopods that assisted them in gliding under coral pieces or the rock. They could be found in station AK and DK.

Distribution

Amphipods of this genus distributed cosmopolitan especially circumtropical. (Barnard, 1969)

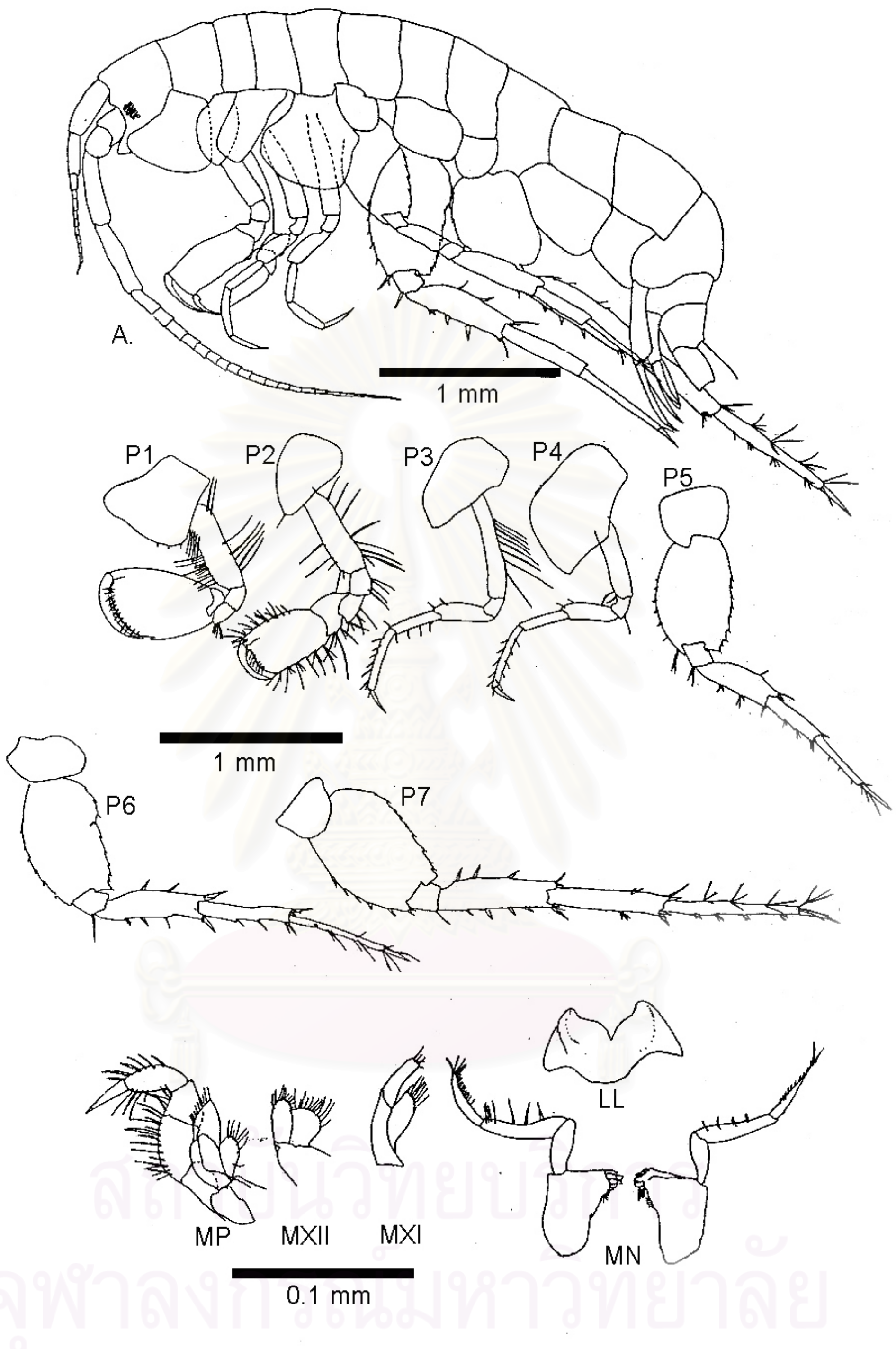


Figure 28 *Listriella* sp.A

A Amphipod body

P1-P7: pereopods 1-7

MP:Maxillipeds; MX1:First maxilla; MX II:Second maxilla; MN:Mandible; LL:Lower lip

Family Hyalidae

Amphipods in this family do not have accessory flagellum. Their mandible are lacking palp. Their molars are trituative. Their uropod 3 are uniramous. Their coxae are medium size and coxa 4 are excavate. Their telson can be cleft of uncleft.

Hyale sp. A

Description

Their bodies are compressed. Their urosomites are free. The rostrum and ocular lobe is short. The antennal sinus is moderate. Their eyes are big. Antenna 1 are shorter than antenna 2. Mouthparts from lateral view form quadrate bundle. Upper lip is round. Mandibles are normal with toothed incisor. Mandibular molar are trituative. The mandibles are without mandibular palps. The lower lip has round outer lobe and well-developed inner lobe. First maxilla have inner plates with two rows of 8 slender spines. The outer plates of first maxilla have 8 slender spines. Second maxilla have inner lobe smaller than outer lobes with dense long setae. Maxilliped have outer plate that larger than inner plate. The palps are longer than outer lobe with 4 articles, articles 3 are long, article 4 are short with long spine and setae.

Their coxae are long and strongly overlapping. Gnathopods 1-2 are and stong subchaelate with plumose setae on posterior part. Pereopods 3-4 are normal and similar in shape with slender article 2, and long article 7. Pereopods 5-6 are shorter than pereopods 7. Pereopods 5 and 6 have broad article 2. Pleopods are normal. Uropods 1 and 2 are biramus with rami are equal with peduncles. Uropod 3 are biramus but both rami are very short. Telson is entire with 2 hooks at apice.

Feeding Morphology

These amphipods are filter feeder. Their food items consisted of diatoms, macroalgaes and organic particles. They create the feeding current by their long plumose antennae. Both of their gnathopods have dense long setae that amphipods used for trapping their food particles. Their inner plates of maxilliped, second maxilla and first maxilla have slender setae. They select the food particles by the maxilliped and second maxilla. Food particles are grinded by first maxilla together with lower lips and mandibles.

Habitat

Amphipods of this specie are demersal plankton that can be found on sand near coral reef, among coral debris and in coral head. They have broad coxae that can help for swimming and floating. Their pereopods are prehensile useful for digging in the sediment. They are distributed in the coral reef at station AK.

Distribution

Hyale sp.A are found distributed cosmopolitan in marine habitats including in the exposed reefs and seagrass beds in shallow water . (Barnard and Karaman, 1991, Myer, 1985)

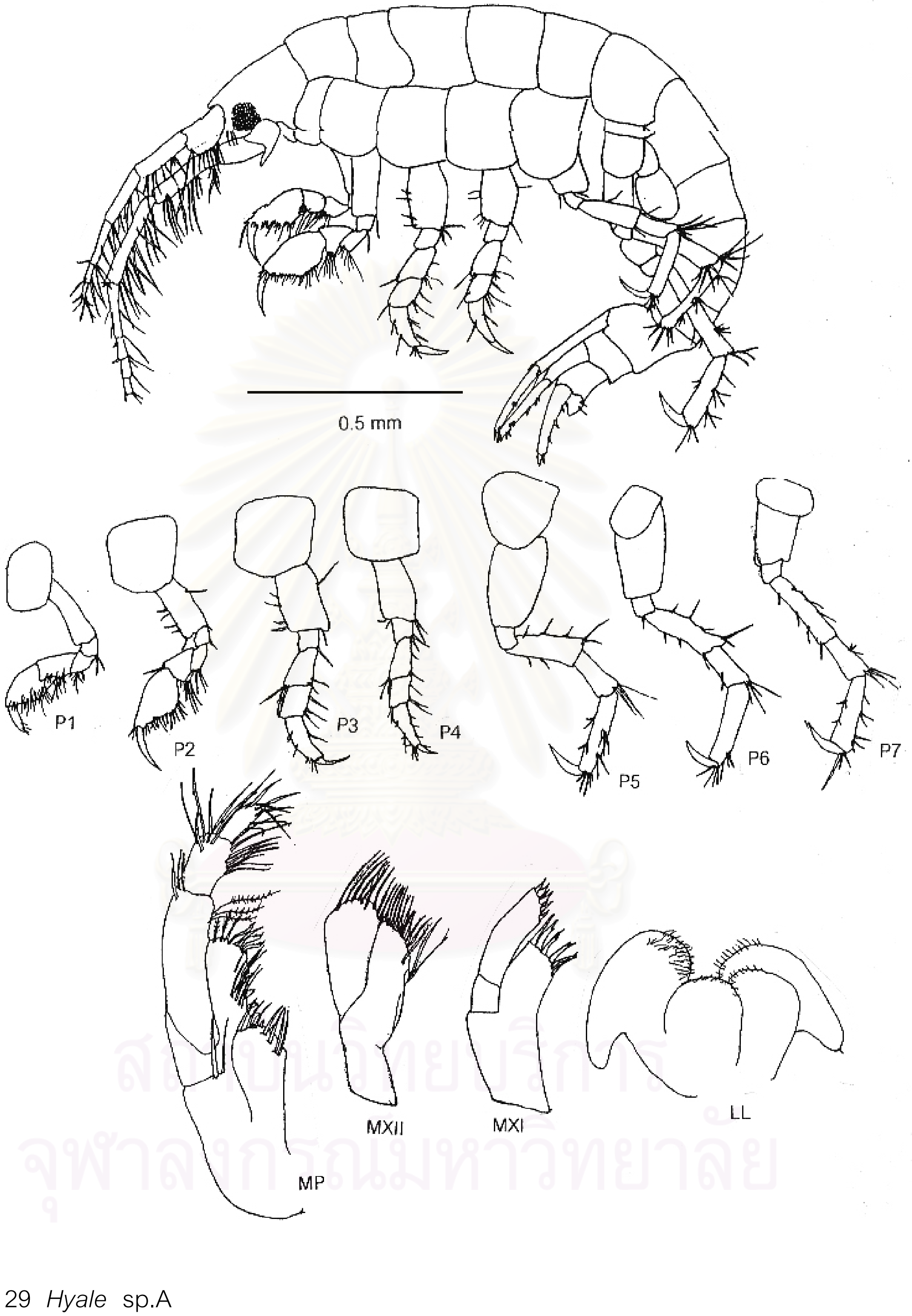


Figure 29 *Hyale* sp.A

A. Amphipod body

P1-P7: pereopods 1-7

MP:Maxillipeds; MX1:First maxilla; MX II:Second maxilla; MN:Mandible; LL:Lower lip

1.2 Grazer

Family Melitidae

Eriopisa sp.A

Description

The head is free and as long as deep. The body is subcylindrical and smooth. Eyes are present and ovoid shape and situate in lateral lobe.

Antenna 1 are longer than antenna 2. There are small setae at the joint along antenna 1 and 2. Mandible incisors are dentate. The mandibular molars are conical. Mandibular palps are 3 articles and locate proximal to molar. There are fine and long setae along mandibular palp. Lower lip is normal with small inner lobe. Maxilla 1 have inner plates with dense setose along medial margin. Maxilla 2 have inner plate that smaller than outer plate. Maxilliped have inner and outer plates with palps. Outer plates are larger than inner plates. There are numerous spines along medial edge. Palps are longer than outer plates. Terminal palp articles are claw-like.

Gnathopod 1 subequal to gnathopod 2. Both gnathopods are subchelate. The pair of Coxa 1 is vestigal. Other coxae are longer than broad and do not overlapping. Pereopod 3 and 4 are similar in shape and size. Pereopods 5-7 have slender setae on articles 2-6. Article 7 of pereopods 3 and 4 are sharp and naked. Pereopod 5-7 are similar in shape, with broad article 2. Pereopod 6 and 7 are longer than pereopod 5.

Urosomites 1 to 3 are free. Urosomite 1 is longer than urosomite 2. Uropods 1-2 apices of rami have robust setae. Uropod 1 and 2 are similar in shape, inner ramus subequal to outer ramus. Uropod 3 are greatly exceed uropod 1 and have peduncle that shorter than outer ramus. Outer rami are 2-articulate. Inner ramus of uropod 3 are very short. Telson is laminar and deeply cleft. Telson is longer than broad and apical has robust setae.

Feeding Morphology

Amphipods of this species are grazer. Their major food items are pennate diatoms and macroalgae and cyanobacteria. They have long antennae with dense small setae that use for searching food particles. Both gnathopods are subchaelate and have dense long fine setae from article 2-7 that amphipods use for trapping food. They grazed on food directly. The mandibular incisors are consisted of tooth and large trituative molars. They use their incisors for biting food. Their mandibles are using for grinding food together with lower lips. Their inner plates of first maxilla have spines. Their inner plates of maxilliped and second maxilla have slender setae that amphipods use for selecting food particles. The mandibular palps have fine long setae along 3 articles that amphipods use for brushing food particles from their antennae.

Habitat

Amphipods in this species are nestler that occupy in sand bottom near coral reef. They have thin and long leg for gliding under sand bottom and rock. These amphipods are common in every station.

Distribution

Amphipods in this genus are cosmopolitan and generally living in littoral area. Some can be found in the bathyal area. They can be found in coral reefs, sandy beach and seagrass beds. (Myer, 1985; Barnard and Karaman, 1991)

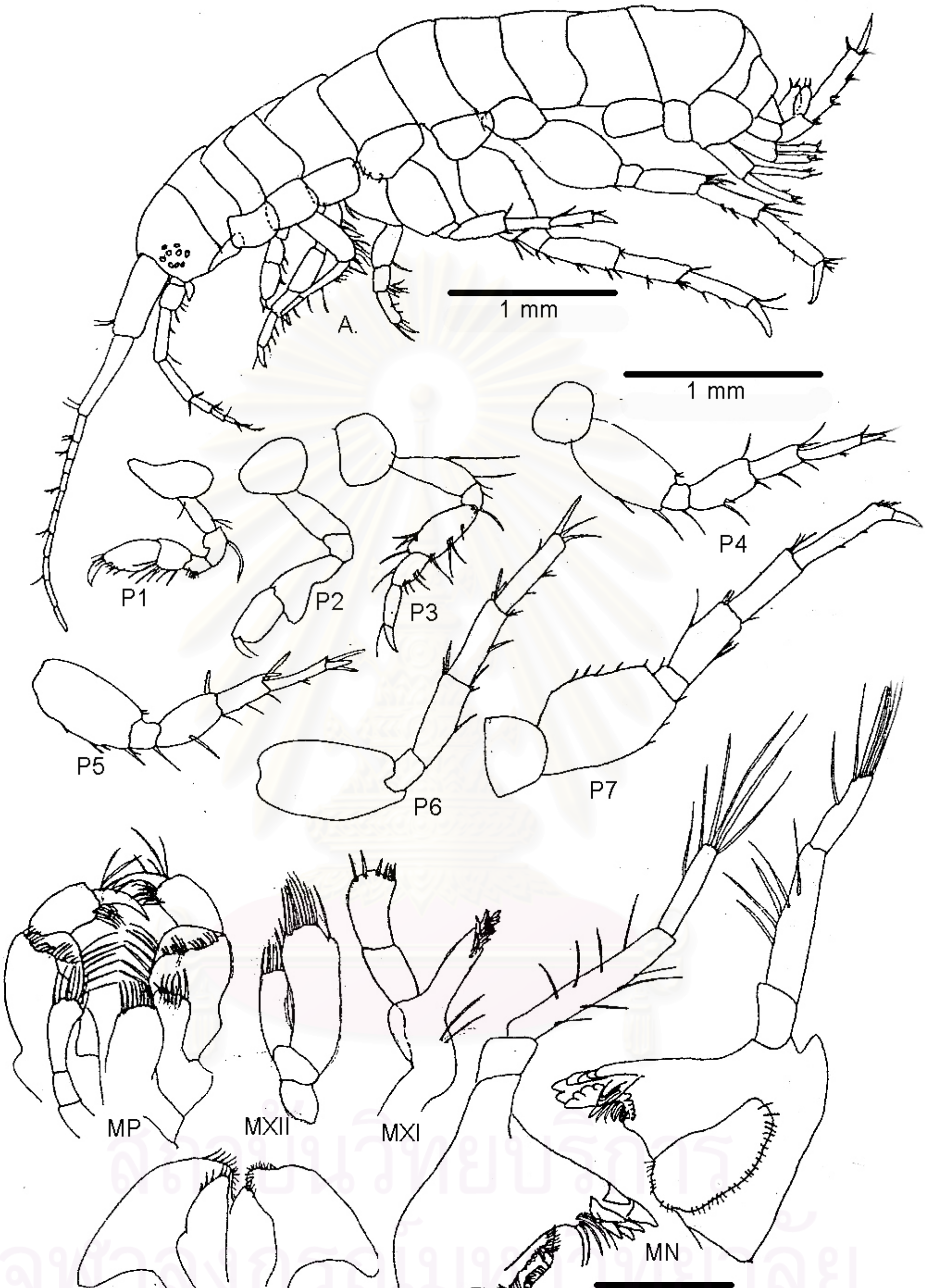


Figure 30 *Eriopisa* sp.A

A. Amphipod body

P1-P7: pereopods 1-7

MP:Maxillipeds; MX1:First maxilla; MX II:Second maxilla; MN:Mandible; LL:Lower lip

1.3 Filter feeder-predators

Family Gammaridae

Ceradocus sp. A

Description

Their bodies are compress. Their urosomites are free. Antenna 1 are longer than antenna 2. Mouthparts from lateral view form quadrate bundle. Upper lip is round. Mandibles are normal with group of tooth that forming incisor. Mandibular molar are big and trituative. The left mandible is bearine accessory spine. Mandibular palps are slender with 3 articles. The lower lip is normal with entire outer lobe and well developed inner lobe. First maxilla have inner plates densely short setose medially. Second maxilla have strongly short setose medially. Maxilliped have outer plate that larger than inner plate. The palps are longer than outer lobe with 4 articles. All of 4 articles have dense fine long setae. The terminals of the palps are claw like. Their coxae are long and strongly overlapping.

Gnathopods 1-2 are strong and subchelate. Gnathopods 1 are smaller than gnathopod 2. There are dense setae on both gnathopods. Pereopods 3-4 are normal and similar in shape with long and slender article 2. Pereopods 5-7 are similar in shape and size; the articles 2 are slightly broad. Pleopods are normal. Uropods 1, 2 and 3 are biramus with rami are equal with peduncles. All rami of uropods 1, 2 and 3 have spines. Telson is cleft and laminar.

Feeding Morphology

Amphipods of this species are filter feeder-predator amphipods. They feed mainly on microalgae and macroalgae. Moreover, they feed on polychaetes, small crustaceans and cnidarians. They have long antennae with small setae and big eyes for searching preys. Their second gnathopods are usually large for hunting their preys. Their first gnathopods have dense setae on posterior side that create sieving basket in order to trap food. First maxilla have inner plates densely short setose medially. Second maxilla have strong short setose medially. Maxilliped palps have dense long fine setae. They use their second maxilla together with maxilliped for sorting food. Amphipods of this species have mandibles that consisted of group of teeth incisor. Mandibular molars have accessory spine on trituative molar that can aid in cutting food. Mandibular palps are slender with 3 articles and have small setae for cleaning their antennae. These amphipods feed both in the water column and at the seafloor.

Habitat

Amphipods of this species are epifauna that occupy on sand near coral reef. *Ceradocus* sp.A have compressed body with plumose and long pereopods that aid in gliding on the sea floor. They are found at station AK in the coral communities and station DK in the rocky shore.

Distribution

Amphipods in this genus are cosmopolitan and generally living in littoral area. (Barnard, 1969 and Barnard and Karaman, 1991)

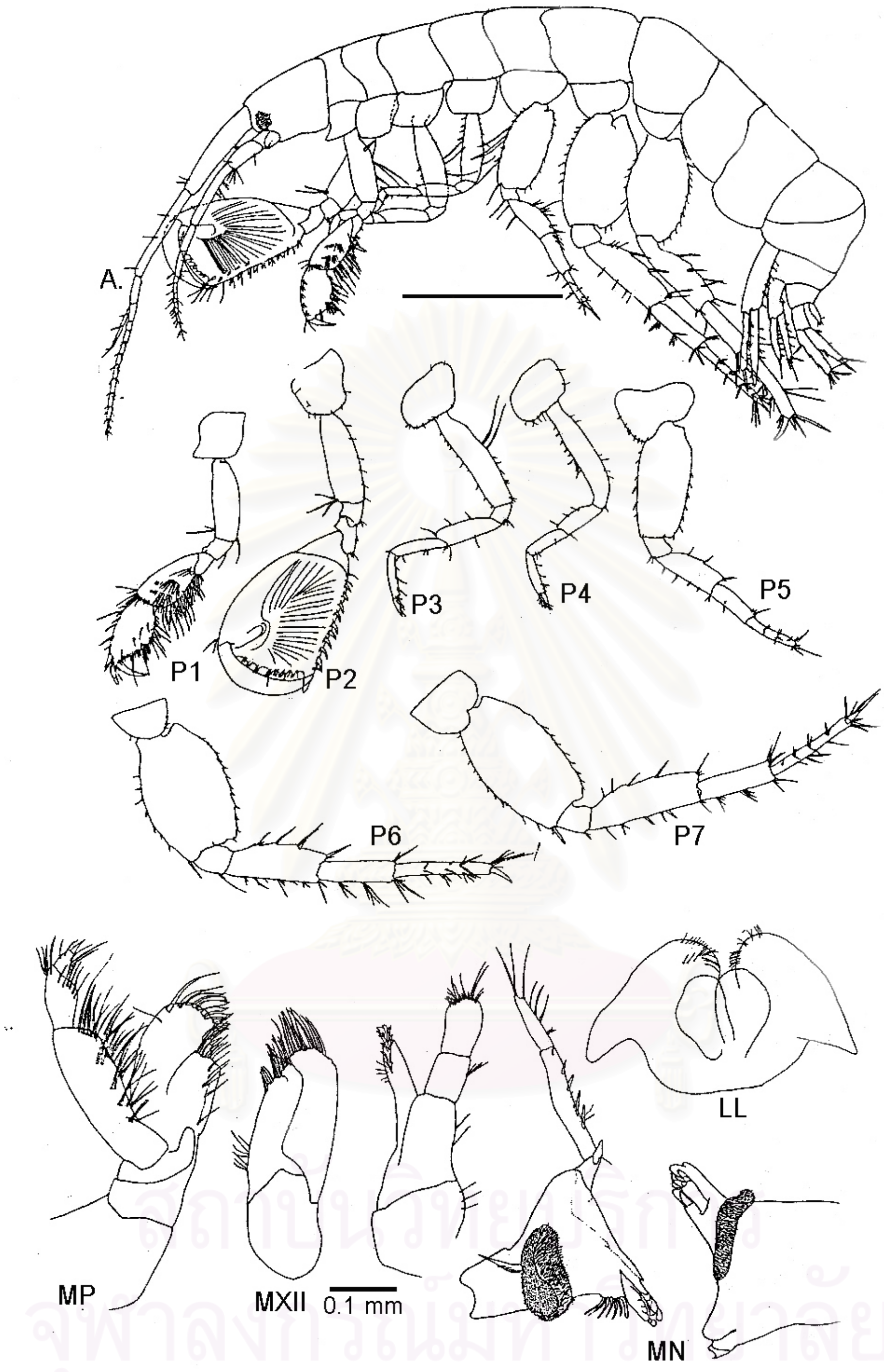


Figure 31 *Ceradocus* sp. A

A. Amphipod body

P1-P7: pereopods 1-7

MP:Maxillipeds; MX1:First maxilla; MX II:Second maxilla; MN:Mandible; LL:Lower lip

Family Isaeidae

Their accessory flagellums varied from absent to long and multiarticulate. Their bodies are smooth and rostrums are absent. Their coxae are round or quadrate ventrally, long or short. Their mouthparts are basic. The gnathopods are usually powerful and subchelate. Uropod 3 are shorts and rami are as long as peduncle. In some species have inner ramus reduce or absent. Their telson can be entire, short, fleshy, nearly circular or square occasionally falsely cleft.

Gammaropsis sp.

Description

Their bodies are subcylindrical. Their urosomites are free. Antenna 1 are longer than antenna 2. Accessory flagellums are 4 articles. Both antennae have plumose setae. Mouthparts from lateral view form quadrate bundle. Upper lip is round. Mandibles are normal with group of tooth that forming incisor. Mandibular molar are big and trituative. Mandibular palps are slender with 3 articles. The terminals of mandibular palps have dense long setae. The lower lip is normal with entire outer lobe and well developed inner lobe. First maxilla have inner plate with spine and setae. Second maxilla have strongly long setose medially. Maxilliped have outer plate that larger than inner plate. The palps are longer than outer plate with 4 articles. All of 4 articles have dense fine long setae. The terminals of the palps are claw like. Their coxae are long and overlapping. Gnathopods 1-2 are strong and subchelate. Gnathopod 1 are smaller than gnathopod 2. Pereopods 3-4 are normal and similar in shape with long and slender article 2. Pereopods 5-7 are similar in shape and size, the article 2 are slightly broad. Pleopods are normal. Uropods 1, 2 and 3 are biramus with rami are equal with peduncles. All rami of uropods 1, 2 and 3 have spines. Telson is entire.

Feeding Morphology

These amphipods are filter feeder-predator that used their antennae for searching food together with gnathopods for collecting food. They have plumose and long antenna 1 and 2. The gnathopods 1-2 are strong and subchelate. Dense fine setae on the posterior parts of the gnathopods are used for trapping food. They feed mainly on macro and microalgae. They also feed on small crustaceans that were captured by using the gnathopods. These amphipods have large eyes for searching their preys. Their mandibles are trituative with sharp accessory flagellum on molar. Their mandibles are consisted of group of tooth incisor. They use their incisor for biting food and use their mandibular molar for grinding food. First maxilla has inner plate densely short setose medially. Second maxilla have strongly short setose medially. They use second maxilla together with maxilliped for sorting food. Mandibular palps are slender with 3 articles and have long setae in the terminal. The lower lip is normal with entire outer lobe and well-developed inner lobe. Maxilliped palps have dense fine long setae using for cleaning base of antennae while feeding.

Habitat

Amphipods of this species are widely distributed in sand near coral reef. They are nestler living among coral rubbles and in coral head. They have broad coxae and their articles 2 of pereopods enlarged aid in swimming. *Gammaropsis* sp. A are demersal plankton that can be found in the water column at night in the reefs.

Distribution

Amphipods in this genus are cosmopolitan and generally living in littoral area. Some can also be found at 310 meters depth. (Barnard, 1969; Barnard and Karaman, 1991)

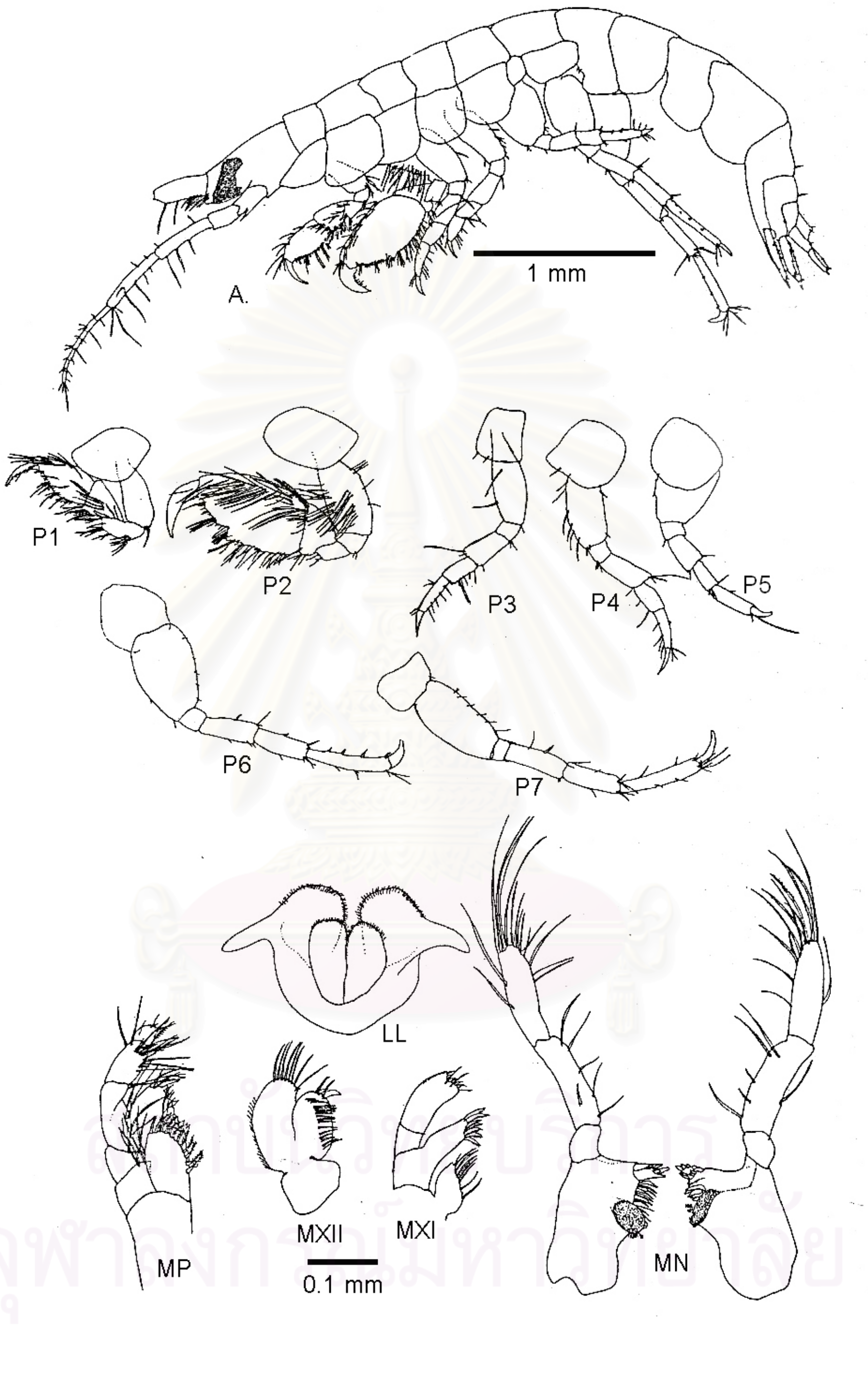


Figure 32 *Gammaropsis* sp. A

A. Amphipod body

P1-P7: pereopods 1-7

MP:Maxillipeds; MX1:First maxilla; MX II:Second maxilla; MN:Mandible; LL:Lower lip

Family Melitidae

Their head are free and have anteroventral margin notched. Their eyes are present, well developed or obsolescent, or absent; not coalesced. Their bodies are laterally compressed; cuticle smooth. Antenna 1 are subequal to antenna 2 or longer than antenna 2. Mouthparts are well developed. Mandible incisors are dentate and lacinia mobilis are present on both sides. The mandibular molar are present, medium, triturative or non-triturative. Maxilla 1 have inner plate with dense setose along medial margin. Maxilla 2 have both inner plate and outer plate. Maxilliped have inner and outer plates with palps. Coxae 1-7 are well developed. Gnathopod 1 are smaller than gnathopod 2, or subequal to gnathopod 2 and both are subchelate. Pereopods are heteropodous (3-4 directed posteriorly, 5-7 directed anteriorly) Pereopods 5-7 have few robust or slender setae; article 7 without slender or robust setae. Pereopod 5 are well developed; shorter than pereopod 6. Pereopod 6 are subequal in length to pereopod 7.

Urosomites 1-3 are free. Urosomite 1 is longer than urosomite 2. Uropods 1-2 have apices of rami with robust setae. Uropod 1 peduncle can be with long plumose setae, with 1 or 2 basofacial robust setae or without ventromedial spur. Uropod 2 are well developed and can be without ventromedial spur or without dorsal flange. Inner ramus can be subequal to outer ramus or longer than outer ramus. Uropod 3 do not represent sexually dimorphic, peduncles are short and outer ramus are longer than peduncles can be 1-articulate or 2-articulate. The rami do not have recurved spines. Telson is laminar and can be deeply cleft; longer than broad, or as long as broad; apical robust setae present.

Melita appendiculata

Description

The head is free and as long as deep. There are anteroventral margin notched. Rostrum is short. The body is subcylindrical and smooth. Eyes are present and ovoid shape and situate in lateral lobe.

Antenna 1 is subequal to antenna 2. Mandible incisors are dentate and lacinia mobilis are present on both sides. The mandibular molars are present in tube form and trituative. Mandibular palps are 3 articles and locate proximal to molar. Lower lip is normal with inner lobe. Maxilla 1 has inner plate with dense setose along medial margin. Maxilla 2 has equal inner plate and outer plate. Maxillipeds have inner and outer plates with palps. Outer plates are larger than inner plates. There are numerous spine along medial edge. Palps are longer than outer plates. Terminal palp articles are claw-like.

Gnathopod 1 are not sexually dimorphic and smaller than gnathopod 2, or subequal to gnathopod 2. Both gnathopods are subchelate. Gnathopod 2 show sexully dimorphisms by male amphipods have large right or left subchaelate gnathopod. Pereopods are heteropodous (3-4 directed posteriorly, 5-7 directed anteriorly. Pereopod 3 and 4 are similar in shape and size. Pereopods 5-7 have slender setae on articles 2-6 and naked article 7. Pereopod 5-7 are similar in shape with broad article 2. Pereopod 6 and 7 are longer than pereopod 5. Pleon segments have dorsal serrates and cusp. Urosomites 1 to 3 are free. Urosomite 1 is longer than urosomite 2. Uropods 1-2 apices of rami have robust setae. Uropod 1 and 2 are similar in shape, inner ramus subequal to outer ramus. Uropod 3 have peduncle that shorter than outer ramus. Outer rami are 2-articulate. Telson is laminar and deeply cleft. Telson is longer than broad and apical has robust setae.

Feeding Morphology

Melita appendiculatar are filter feeder-predator species. They capture their prey by their large gnathopod 2. They also use their antennae together with both gnathopods for searching and trapping food. Amphipods of this species have long antennae with dense fine setae. The mandibular palps have fine long setae along 3 articles for cleaning their antennae. Both gnathopods are subchaelate with dense long fine setae from article 2-7 for trapping food. They select the food particles by the maxilliped and second maxilla. Food particles are grinded by first maxilla together with lower lips and mandibles. Their inner plates of maxilliped and second maxilla have slender setae. Their inner plates of first maxilla have spines together with setae. The mandibular incisors are consisted of tooth and trituative molars.

Habitat

These amphipods are found in sediment in coral reef at station AK. They are nestler amphipods living among coral rubbles and under the rock. Their pereopods are long and thin allow them to glide under coral rubbles and rocks. These amphipods are recorded as one of the dominant species in the fouling communities in Sichang Island, Chonburi Province.

Distribution

These amphipods are commonly found in Pacific Ocean in coral reefs among green filamentous algae and seagrass beds. (Myer, 1985 and Barnard and Karaman, 1991)

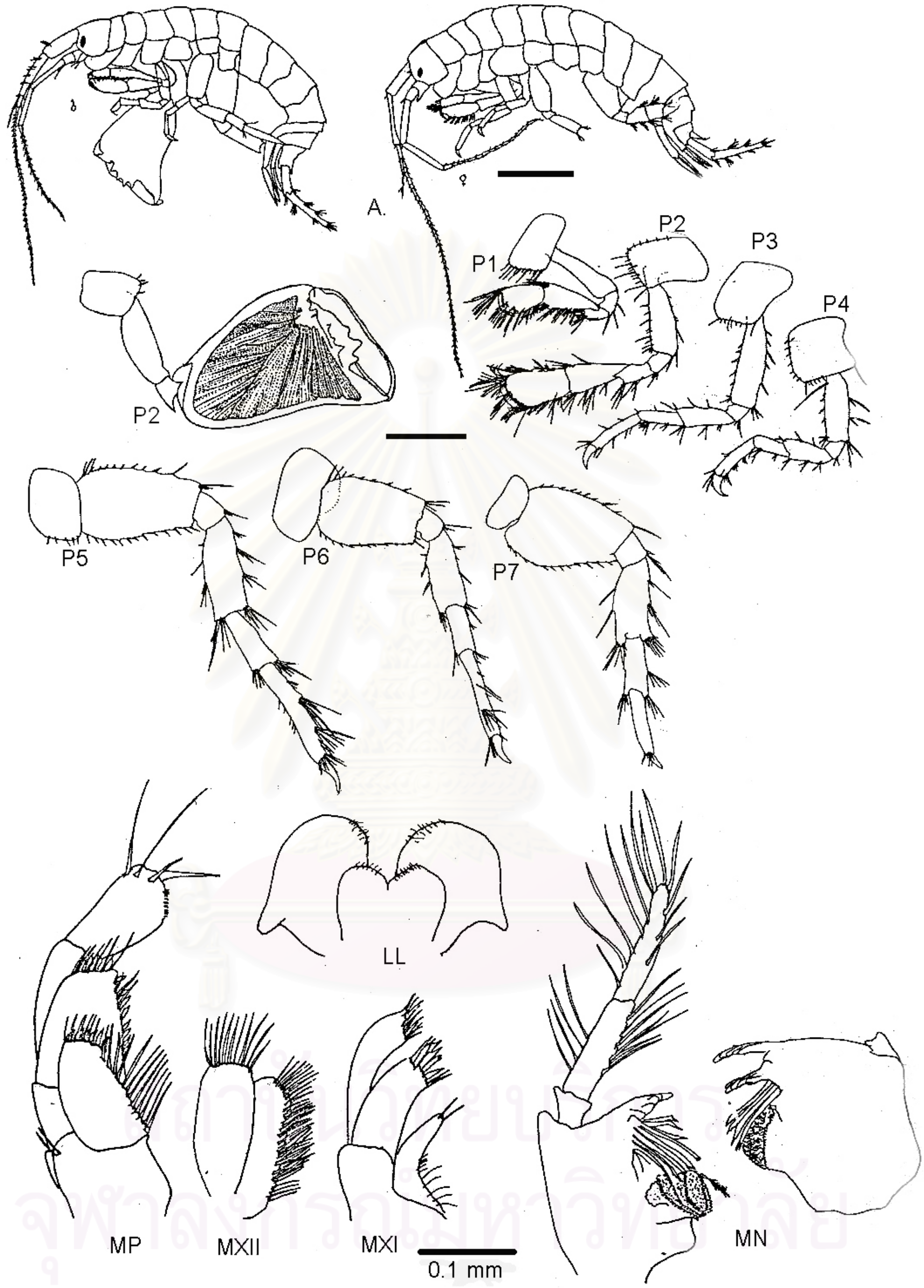


Figure 33 *Melita appendiculata*

A. Amphipod body

P1-P7: pereopods 1-7

MP:Maxillipeds; MX1:First maxilla; MX II:Second maxilla; MN:Mandible; LL:Lower lip

1.4 Detritus feeders

Family Leucothoidae

Leucothoe alcyone

Description

Their bodies are laterally compressed. Heads have short rostrum. Eyes are well developed. Antenna 1 are longer than antenna 2 and do not have accessory flagellum. Mandible incisors are dentate. Mandibular molars are not trituative. Maxilla 1 have small inner plates that have weakly setose. Maxilla 2 are feeble. Inner plates are broad. Maxilliped have well develop inner and outer plates with palps.

Coxae 1-4 are overlapping. Gnathopod 1 are smaller than gnathopod 2. Gnathopod 1 are carpochelate and gnathopod 2 are subchelate. Pereopod 3 and 4 are similar shape with slender articles 2-7. Pereopods 5-7 have few robust or slender setae. Pereopod 5 are shorter than pereopod 6. Articles 2 of pereopod 5 are expanded. Pereopod 6 are subequal in length to pereopod 7. Urosomites 1 to 3 are free. Urosomite 1 is much longer than urosomite 2. Uropods 1-2 have apices of rami without robust setae. Uropods 1-3 are similar in structure and size. Uropods 1 and 2 peduncles are naked. Uropod 3 have elongate peduncle and outer ramus are shorter than peduncle. Telson is laminar and triangle.

Feeding Morphology

These amphipods are detritus feeder, feed mainly on organic matters in sediment. Their antennae are short and almost naked. They have dentate mandible incisors. Mandibular molars are small. Maxilla 1 have small inner plates that have weakly setose. Maxilla 2 are feeble. Inner plates are broad. Maxillipeds have well developed inner and outer plates with palps. Their first gnathopods are carpochelate and second gnathopods are large and subchelate. Gnathopods are use mainly for collecting food. These amphipods can be free living and associated with other invertebrate including tunicates and sponges.

Habitat

These amphipods are commonly associated with invertebrate hosts in coral reefs. Their pereopods are thin and prehensiled for holding onto their hosts. They are common aggregated in group throughout in station AK, BK and DK.

Distribution

These amphipods are widely distributed in the Gulf of Thailand and South China Sea. (Imbach, 1967)

Figure 34 *Leucothoe alcyone*

A. Amphipod body

P1-P7: pereopods 1-7

MP:Maxillipeds; MX1:First maxilla; MX II:Second maxilla; MN:Mandible; LL:Lower lip

Family Lilijeboriidae

Idunella janisae

Description

Antenna 1 are subequal to peduncle of antenna 2. Mandible incisors are dentate. Molars are non-triturative. Palps have 3 articles. Maxilla 1 have inner plates present with weakly setose apically. Maxilla 2 have inner plates and outer plate. Maxilliped have small inner plates with long setae. Outer plates are shorter than peduncle and the terminals of peduncles are claw-like.

Coxae 1-4 are longer than broad and overlapping. Gnathopod 1 are subequal to gnathopod 2. Gnathopod 2 are subchelate. Pereopod 3 and 4 are similar shape with naked articles. Pereopods 5-7 have short setae at joint of each articles. Pereopod 5 are shorter than pereopod 6. Article 2 of pereopod 5 are expanded into subrectangular or with posteroventral lobe. Pereopod 6 and 7 are similar in structure.

Urosomites 1 to 3 are free. Urosomite 1 are longer than urosomite 2. Uropods 1-2 have naked apices of rami. Uropods 1-3 are similar in structure and size. Uropod 1 peduncle are naked. Uropod 2 have ventromedial spur and inner ramus subequal to outer ramus. Uropod 3 have short peduncle short and outer ramus are subequal to peduncle or longer than peduncle. Telson is laminar and cleft and longer than broad.

Feeding Morphology

These amphipods are detritus feeder that feed mainly on organic materials in the sediment. They have long antennae with setae at joint for searching food. Their mandibles with small molar and non-trituative surface. They select their food particles by their mandibular palps with setae along 3 articles and maxillipeds. They use their maxilla 1 for grinding food with lower lip. Their mandibular molars are not trituative. Their gnathopods are weakly setose and subchaelate for collecting food.

Habitat

These amphipods occupy in sediment near coral reefs. They are widely distributed at all stations in the reef.

Distribution

These amphipods are widely distributed in the Gulf of Thailand and South China Sea. (Imbach, 1967)

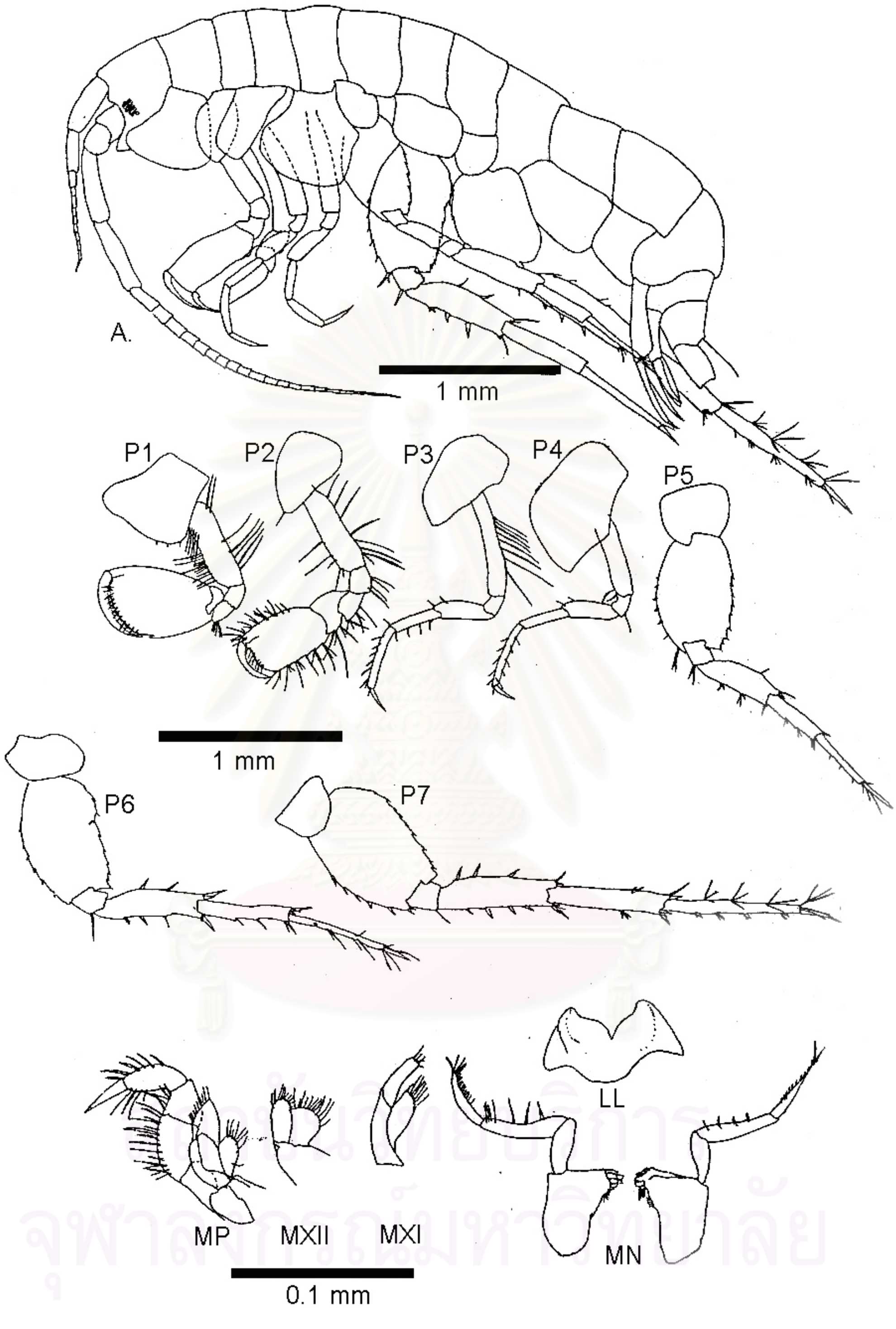


Figure 35 *Idunella janisae*

A. Amphipod body

P1-P7: pereopods 1-7

MP:Maxillipeds; MX1:First maxilla; MX II:Second maxilla; MN:Mandible; LL:Lower lip

Family Urothoidae

These amphipods have deeper head with sort rostrum. Their eyes are well developed or obsolescent, or absent. Their bodies are laterally compressed.

Antenna 1 can be shorter than antenna 2 or subequal to antenna 2 or longer than antenna 2. Antenna 2 can be short, long, or greater than body length. Mandible incisors aredentate and lacinia mobilis are present on both sides. Molars are triturative. Maxilla 1 has inner plate with strongly setose along medial margin. Maxilla 2 has both inner plates and outer plates. Maxillipeds have inner and outer plates with 4 articles palp.

Coxae 1-4 are longer than broad and overlapping. Gnathopod 1 are subequal to gnathopod 2. Both gnathopod are subchelate. Pereopod 3 and 4 are similar shape.. Pereopods 5-7 have many rows of facial and marginal robust setae, or with many marginal slender setae and few or no robust setae. Pereopod 5 are shorter than pereopod 6. Article 2 expanded, check. Pereopod 6 are longer than pereopod 7 and have similar structure.

Urosomites 1 to 3 are free. Urosomite 1 is longer than urosomite 2. Uropods 1-2 apices of rami can be with robust setae or without robust setae. Uropods 1-3 are similar in structure and size. Uropod 1 peduncles do not have long plumose setae. Uropods 2 have inner ramus shorter than outer ramus or subequal to outer ramus. Uropods 3 have short peduncle short those outer rami are longer than peduncle. Telson is laminar that can be cleft or emarginate or entire and do not apical robust setae.

Urothoe simplingnathia

Description

Antenna 1 are shorter than antenna 2. Antenna 2 are greater than body length. Mandible incisors are dentate and lacinia mobilis are present on both sides. Molars are triturative. Maxilla 1 have inner plate with strongly setose along medial margin. Maxilla 2 have both inner plates and outer plates. Maxilliped have inner and outer plates with dense setae and 4 articles palp. The terminals of palps are claw-like.

Coxae 1-4 are overlapping. Gnathopod 1 are subequal to gnathopod 2. Both gnathopod are subchelate. Pereopod 3 and 4 are similar shape with dense long setae. Pereopods 5-7 have many rows of facial and marginal robust setae and feather like setae. Pereopod 5 are shorter than pereopod 6. Article 2 expanded, check. Pereopod 6 are longer than pereopod 7 and have similar structure.

Urosomites 1 to 3 are free. Urosomite 1 is longer than urosomite 2. Uropods 1-2 apices of rami can be with robust setae or without robust setae. Uropods 1-3 are similar in structure and size. Uropod 1 peduncles do not have long plumose setae. Uropod 2 have inner ramus shorter than outer ramus or subequal to outer ramus. Uropod 3 have short peduncle short that outer ramus are longer than peduncle. Rami of uropod 3 have dense feather like setae. Telson is laminar and cleft.

Feeding Morphology

These amphipods are detritus feeder that feed mainly on organic matter and benthic algae attaching to sediment. They feed in situ in the sediment. Their mouthparts are well developed. Their maxilla 1 and 2 have robust setae for feeding on hard food. Their maxillipeds have dense fine setae for sorting food. Their mandibular molars are trituative. These amphipods have pereopods adapted for digging in the sediment.

Habitat

These amphipods are nestler species living in sediment near coral reefs and under coral rubbles. Their pereopods have numerous spines that help digging in sediment. Their pereopods 5 -7 are strong and have dense feather-like setae. These adaptations prevent sinking the amphipods from sinking from in sediment.

Distribution

This genus is cosmopolitan especially circumtropical. (Imbach, 1967; Barnard, 1969 and Barnard and Karaman, 1991)

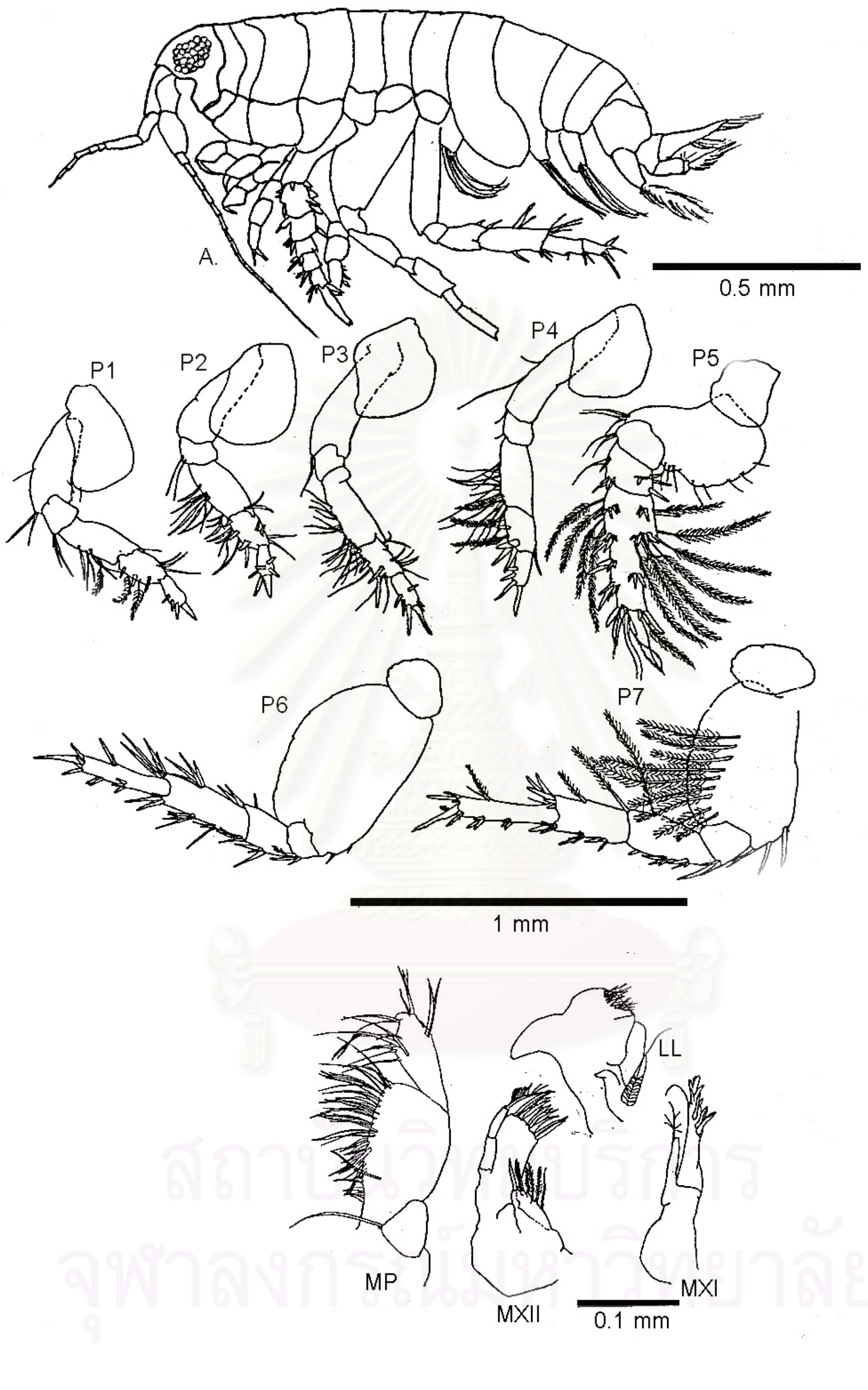


Figure 36 *Urothoe simplingnathia*

A. Amphipod body

P1-P7: pereopods 1-7

MP:Maxillipeds; MX1:First maxilla; MX II:Second maxilla; MN:Mandible; LL:Lower lip

2. Amphipods of Libong Island, Trang Province

2.1 Filter feeders

Family Ampeliscidae

Ampeliscisca cyclop

Description

A. cyclop have large head with 4 eyes, cuticle lense in lateral pair. The pair of first antenna locate between both eyes and the pair of second antenna situate at ventral corner of the head. Antenna 2 are longer than antenna 1. Mouthparts from lateral view form quadrate bundle. Upper lip is round. Mandibles are normal with toothed incisor. The lacinia mobilis is present in right mandible. Mandibular molar is small. Mandibular palps have dense fine setae along 3 articles. The lower lip is normal with inner lobe. First maxilla have inner plate with 8 sickle shaped spines. The outer plates of first maxilla have 4 serrate spines. Second maxilla have equal inner and outer lobes with dense long setae. Maxilliped have outer lobe that larger than inner lobe. The palps are longer than outer lobe with 3 articles. The terminal of articles of palps are claw-like. Gnathopods 1 and 2 have sharp article 7 and broad article 2-4. Pereopods 3-4 are similar in structure with article 2-4 are much broader than article 7. Pereopods 5-6 are similar in structure, articles 2 are simple and article 3 are longer than article 4. Articles 4 of pereopods 5-6 produce small lobe that fully cover article 5. Articles 6 are inflated and longer than article 7. pereopod 7 have broad article 2 that produce posteroventral lobe. The pleons segments have round posteroventral corner without tooth. The first urosomal segment has large dorsal process. Uropod 1 are exceed end of uropod 2. Outer ramus of uropod 1 are naked and inner ramus bearing a few spine. Both rami of uropod 2 have spines. Uropod 3 are subfoliaceous, outer and inner rami are equal. Telson is cleft with apices acute and one seta at each tip.

Feeding Morphology

Amphipods of this species are filter feeders. They feed mainly on epiphytic macroalgae, centric diatoms and pennate diatoms respectively. They have long antennae with long dense fine setae for searching food and creating feeding currents. Their gnathopods have dense setae for collecting and trapping food. Their inner plate of maxilliped and second maxilla have feather-like setae. Their inner plates of first maxilla have spines together with setae. The mandibular incisors and molar are small. The mandibular palps have fine long setae along 3 articles for cleaning their antennae.

Habitat

Amphipods of this species can be found in bare sand near seagrass roots. They have sharp pereopods for digging sediment. Their coxae and their pereppods 5-6 are extended for swimming and filtering their food in water column. These amphipods are common and widely distribution at all stations.

Distribution

Ampelisca cyclop are found distributed in Indian Ocean and Pacific Ocean. They usually found in shallow water in seagrass beds (Barnard, 1935; Nayar, 1959, Nagata, 1965)

Figure 37 *Ampelisca cyclop*

A. Amphipod body

P1-P7: pereopods 1-7

MP:Maxillipeds; MX1:First maxilla; MX II:Second maxilla; MN:Mandible; LL:Lower lip

Ampelisca sp. A

Description

Ampelisca sp. A have smaller head than *A. cyclop* with 4 eyes, cuticle lense in lateral pair. Their eyes are bigger than *A. cyclop.* The pair of first antenna locates between both eyes and the pair of second antenna situate at ventral corner of the head. Antenna 2 is longer than antenna 1. Mouthparts from lateral view form quadrate bundle. Upper lip is round. Mandibles are normal with toothed incisor. The lacinia mobilis is present in right mandible. Mandibular molar is small. Mandibular palps have dense fine setae along 3 articles. The lower lip is normal with inner lobe. First maxilla has inner plate with 8 sickle shaped spines. The outer plates of first maxilla have 4 serrate spines. Second maxilla have equal inner and outer lobes with dense long setae. Maxilliped have outer lobe that larger than inner lobe. The palps are longer than outer lobe with 3 articles. The terminals of article of palps are claw-like. Gnathopods 1 and 2 have sharp article 7 and broad article 2-4. Pereopods 3-4 are similar in structure with article 2-4 are much broader than article 7. Pereopods 5-6 are similar in structure, articles 2 are simple and article 3 are longer than article 4. Articles 4 of pereopods 5-6 produce small lobe that fully cover article 5. Articles 6 are inflated and longer than article 7. pereopod 7 have broad article 2 that produce posteroventral lobe. The pleons segments have round posteroventral corner without tooth. The first urosomal segment has large dorsal process. Uropod 1 are exceed end of uropod 2. Outer rami of uropod 1 are naked and inner ramus bearing a few spines. Both rami of uropod 2 have spines. Uropods 3 are subfoliaceous, outer and inner rami are equal. Telson is cleft with apices acute and one seta at each tip.

Feeding Morphology

This is one of filter feeding amphipods. Their major food items are epiphytic macroalgae, pennate diatoms and centric diatoms respectively. They have long antennae with short dense setae. Four large eyes together with antennae are used for searching foods. The mandibular palps have long fine setae only on the terminal of the palp. This indicated that the amphipods do not use their antennae as major appendage for collecting food but they use their pereopods instead. Their gnathopods have dense setae that can be used for collecting and trapping food. Their inner plates of maxilliped and second maxilla have feather-like setae. Their inner plates of first maxilla have spines together with setae. The mandibular incisors and molar are small.

Habitat

These amphipods are tube dweller in the sediment. Their pereopods have dense setae with sharp dectylus. Their pereopods 5-7 are backward similar to other tube-building amphipods such as *Ampithoe valida* and *Cerapus* spp. Their coxae are extended for swimming. They can be found under bare sand near seagrass roots and among algae turfs. They have sharp pereopods for digging into sediment. These amphipods can be found in station AL, bare sand and at station CL in sand near *Enhalus* sp. roots.

Distribution

Ampelisca sp. A is cosmopolitan species in marine habitats. (Barnard and Karaman, 1991)

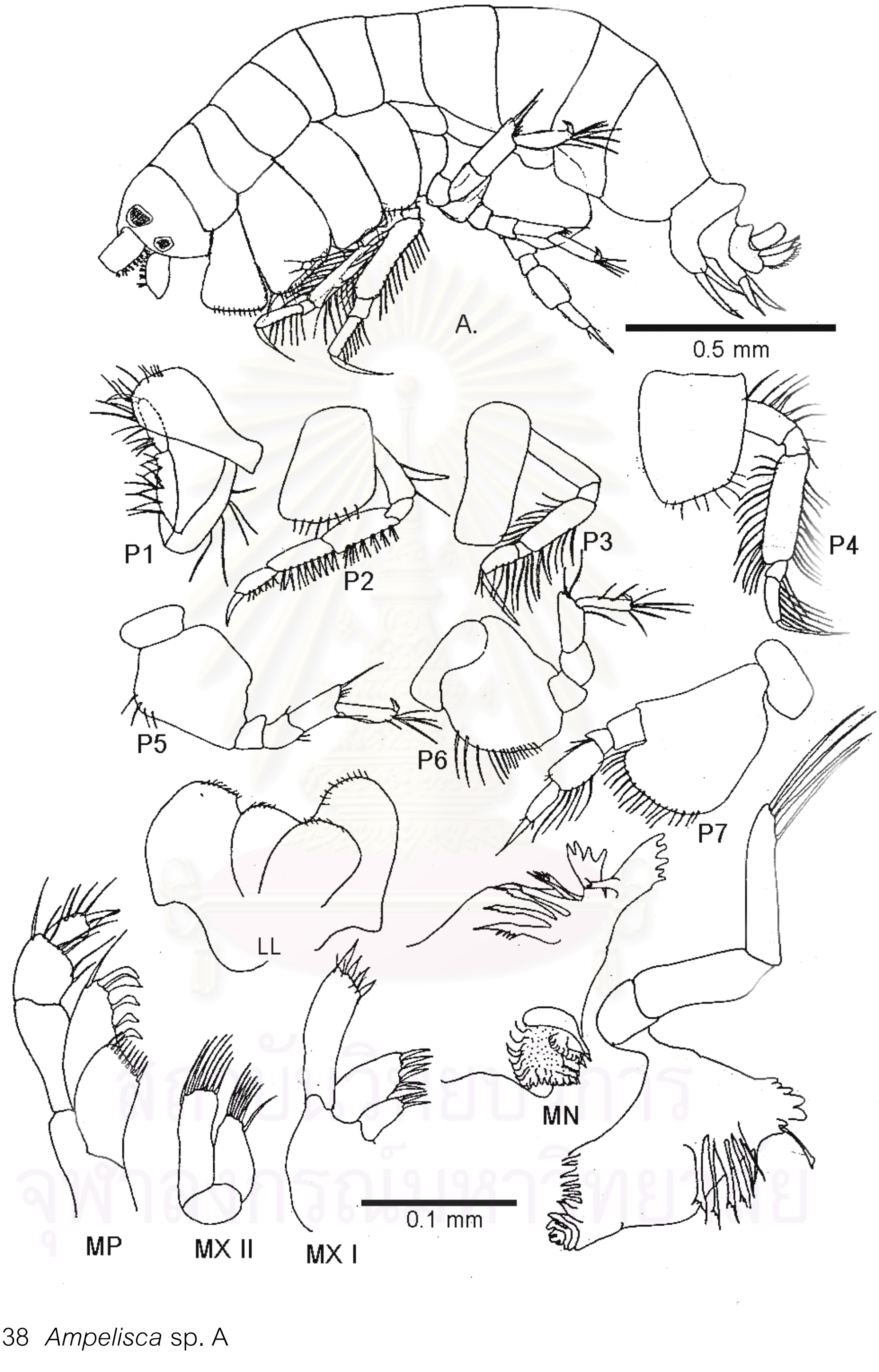


Figure 38 *Ampelisca* sp. A

A. Amphipod body

P1-P7: pereopods 1-7

MP:Maxillipeds; MX1:First maxilla; MX II:Second maxilla; MN:Mandible; LL:Lower lip

2.2 Grazers

Family Gammaridae

Eriopisella sp. A

Description

The amphipods heads are free, not coalesced with peraeonite 1. Their rostrum are present and short. Eye are present and. Their bodies are laterally compressed.

Their antenna 1 are longer than antenna 2. Their mouthparts are well developed. Mandible incisor are dentate with lacinia mobilis. Their molars are present and triturative with palps. Maxilla 1 are present with strongly setose inner plates. Maxilla 2 have both inner and outer plates. Maxilliped inner and outer plates are well developed. Palps have 4-articulate, article 3 without rugosities. Labium smooth.

Coxae 1-4 are longer than broad and overlapping. Gnathopod 1 are subequal to gnathopod 2. Gnathopod 2 are subchelate. Pereopod 3 and 4 are similar shape with naked articles. Pereopods 5-7 have short setae at joints of each articles. Pereopod 5 are shorter than pereopod 6. Article 2 of pereopod 5 are expanded into subrectangular or with posteroventral lobe. Pereopod 6 and 7 are similar in structure.

Urosomites 1 to 3 are free. Urosomite 1 are longer than urosomite 2. Uropods 1-2 have naked apices of rami. Uropods 1-3 are similar in structure and size. Uropod 1 peduncle are naked. Uropod 2 have ventromedial spur and inner ramus subequal to outer ramus. Uropod 3 have short peduncle short and outer ramus are subequal to peduncle or longer than peduncle. Telson is laminar and cleft and longer than broad.

Feeding Morphology

Eriopisella sp. A are grazers. Their major food items are epiphytic macroalgae, pennate diatoms and organic matter respectively. They use their long antennae with dense long fine setae for searching and collecting foods. They select the food particles by the maxilliped and second maxilla. Food particles are grinded by first maxilla together with lower lips and mandibles. Their inner plate of maxilliped and second maxilla have feather-like setae. Their inner plates of first maxilla have spines together with setae. The mandibular incisors and molar are large. The mandibular palps have long fine setae along 3 articles. Both gnathopods are strong with dense long fine setae from article 2-6. Articles 7 of both gnathopods are sharp and bare for collecting food.

Habitat

These amphipods occupy sandy bottom among algae near *Halophila ovalis* beds. They are nestler species with thin and long pereopods for gliding under the algae. Their pereopods have small setae along articles 4-7 that allow them to move freely in the sediment. Their articles 2 of pereopods 5-7 are extended for swimming.

Distribution

These amphipods can be found in seagrass bed in Pattani Province. They also found distributed in the Indian Ocean and Pacific Ocean. (Barnard, 1935; Nayar, 1959, Nagata, 1965, Intrasook, 1999)

Figure 39 *Eriopisella* sp. A

A. Amphipod body

P1-P7: pereopods 1-7

MP:Maxillipeds; MX1:First maxilla; MX II:Second maxilla; MN:Mandible; LL:Lower lip

Family Ischyroceridae

Amphipods in this family have a variety of accessory flagella. Their bodies are subcylindrical. Their urosome, some or all urosomite are coalesced. Their coxae are variety and often not touching each other. Mouthparts are basic except mandibular palps occasionally reduce to one or two articles and upper lip occasionally bilobed. Gnathopods often subchelate. Uropods 1 and 2 are normal and uropod 3 are variety form, that can be bearing two rami, inner ramus reduce in size, bearing one rami, or rami absent. Their telson can be entire, fleshy, circular, or symmetrically trapezoidal or very broad and short. Their article 5 of pereopods 3-6 are short and renifor.Their pereopod 7 are occasionally very elongate and bearing long setae.

Kamaka sp. A

Description

Their bodies are subcylindrical. Their urosomites are free. The rostrum and ocular lobe is short. The antennal sinus is moderate. Their eyes are large in occular lobe. Antenna 1 are as long as than antenna 2. Mouthparts from lateral view form quadrate bundle. Upper lip is round. Mandibles are normal with toothed incisor. Mandibular molar are small in tube form. Mandibular palps are slender with 3 articles. The lower lip is normal with entire outer lobe and well developed inner lobe. First maxilla have inner plates with 7 slender spines. The outer plates of first maxilla have 8 slender spines. Second maxilla have inner lobe smaller than outer lobes with dense long setae. Maxilliped have outer plate that larger than inner plate. The palps are longer than outer lobe with 4 articles, articles 2 are long, article 3 are unlobed, article 4 are short with long spine and setae.

Their coxae are long and strongly overlapping. Gnathopods 1-2 are simple and feeble. There are dense setae on both gnathopods. Pereopods 3-4 are normal and similar in shape with slender article 2, and long article 7. Pereopods 5-6 are shorter than pereopods 7. Pereopods 5 and 6 have broad article 2. Pleopods are normal. Uropods 1 and 2 are biramus with rami are equal with peduncles. Uropod 3 are biramus but both rami are very short. Telson is entire, short, and broader than long with 2 hooks at apice.

Feeding Morphology

These amphipods are grazers. Their food items consisted of benthic diatoms, macroalgaes and organic particles. They use their antennae for searching food and grazed on food directly. Their antennae are short. Their eyes usually located in ocular lobe assisted in searching food. The mandibular palps have almost naked 3 articles. Their inner plates of maxilliped, second maxilla and first maxilla have slender setae only in the terminal. Their mandibular molar are large and mandibular incisors with 3 tooth They select the food particles by the maxilliped and second maxilla. Food particles are grinded food particle by first maxilla together with lower lips and mandibles.

Habitat

Amphipods of this species can be found both on seagrass leaves and on sand near seagrass. They are nestler amphipods that distributed mainly on seagrass leaves and on seafloor. They are dominant in every station. Their pereopods are thin, long and naked. The broad second articles of pereopods are for swimming.

Distribution

Kamaka sp.A are widely distributed in the Indo-Pacific, Hawaii to Madagasscar in littoral areas including in seagrass beds and lakes. (Barnard; 1969; Barnard and Karaman, 1991)

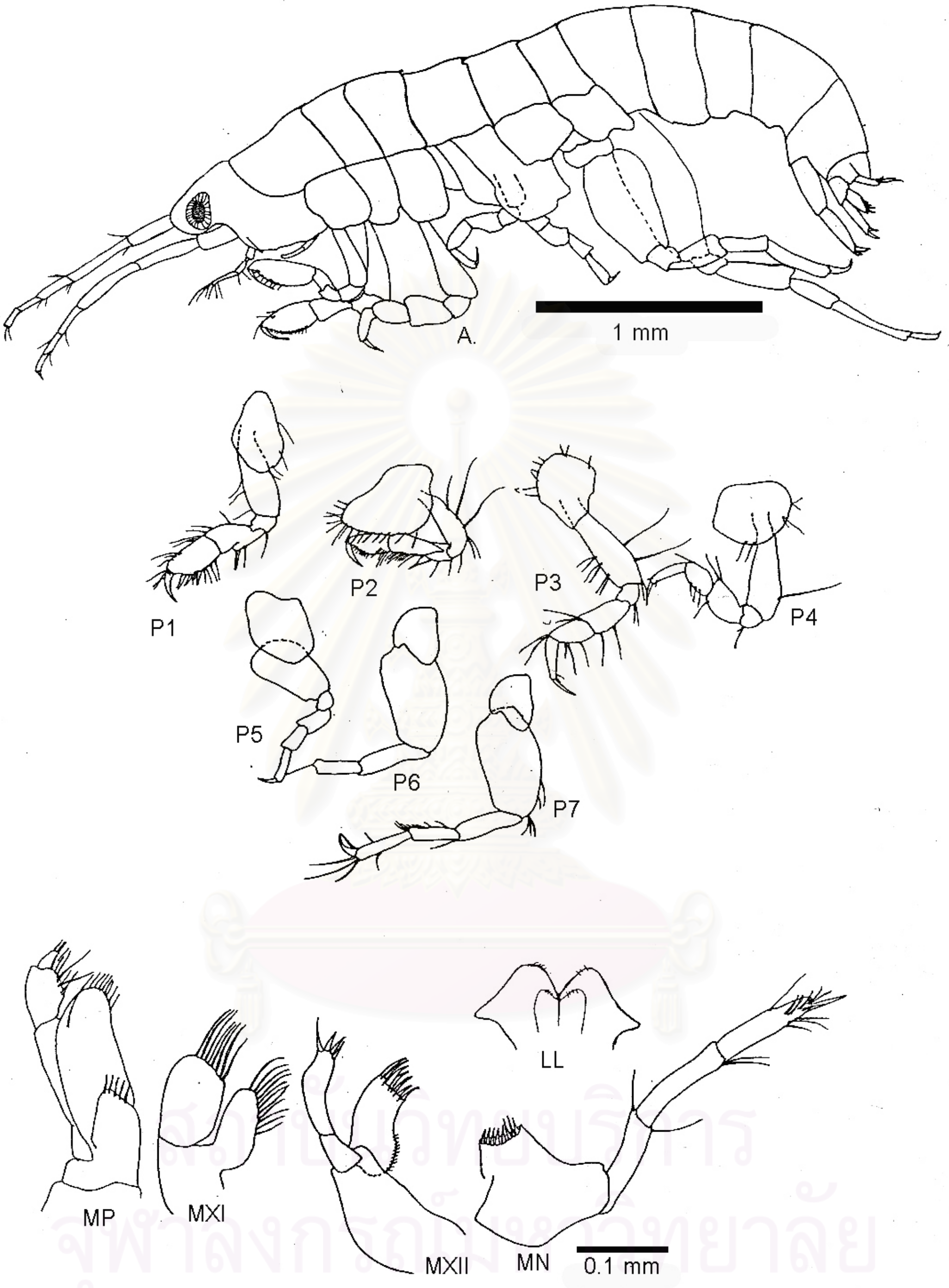


Figure 40 *Kamaka* sp. A

A. Amphipod body

P1-P7: pereopods 1-7

MP:Maxillipeds; MX1:First maxilla; MX II:Second maxilla; MN:Mandible; LL:Lower lip

Family Oedicerotidae

Synchelidium sp. A

Description

Their head are free, not coalesced with peraeonite 1. Their rostrum are present and short. Eye are present and. Their bodies are laterally compressed.

Mandible incisor are dentate with lacinia mobilis. Their molars are present and triturative with palps. Maxilla 1 are present with strongly setose inner plates. Maxilla 2 have both inner and outer plates. Maxilliped inner and outer plates are well developed. Palps have 4-articulate, article 3 without rugosities. Labium smooth.

Coxae 1-4 are longer than broad and overlapping. Gnathopod 1 are subequal to gnathopod 2. Gnathopod 2 are subchelate. Pereopod 3 and 4 are similar shape with naked articles. Pereopods 5-7 have short setae at joints of each articles. Pereopod 5 are shorter than pereopod 6. Article 2 of pereopod 5 are expanded into subrectangular or with posteroventral lobe. Pereopod 7 are much longer than pereopod 5 and 6

Urosomites 1 to 3 are free. Urosomite 1 are longer than urosomite 2. Uropods 1-2 have naked apices of rami. Uropods 1-3 are similar in structure and size. Uropod 1 peduncle are naked. Uropod 2 have ventromedial spur and inner ramus subequal to outer ramus. Uropod 3 have short peduncle short and outer ramus are subequal to peduncle or longer than peduncle. Telson is laminar and cleft and longer than broad.

Feeding Morphology

Synchelidium sp. A are detritus feeding group. They feed mainly on organic matter. Their antennae are usually short. They have large eyes that help for searching food. Their gnathopods are large with dense setae for collecting food particles and sent them to their mouth. They select the food particles by the maxilliped and second maxilla. Food particles are grinded by first maxilla together with lower lips and mandibles. Their inner plates of maxilliped and second maxilla have setae. Their food particles are much larger than those of other detritus feeders found in the same area. They prefer soft particles due to their small mandibular incisors and molar. The mandibular palps have long fine setae along 3 articles for cleaning and collecting food particles attached on their antennae. Articles 7 of both gnathopods are sharp and naked for digging in the sediment

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Habitat

These amphipods can be founded in bare sand and among the seagrass debris. They can be found only in station AL where sediment was not compacted by seagrass roots. Their pereopods have dense setae that help them for digging in the sediment.

Distribution

They are widely distributed in the Indian Ocean and Pacific Ocean. (Barnard, 1935; Nayar, 1959, Nagata, 1965)

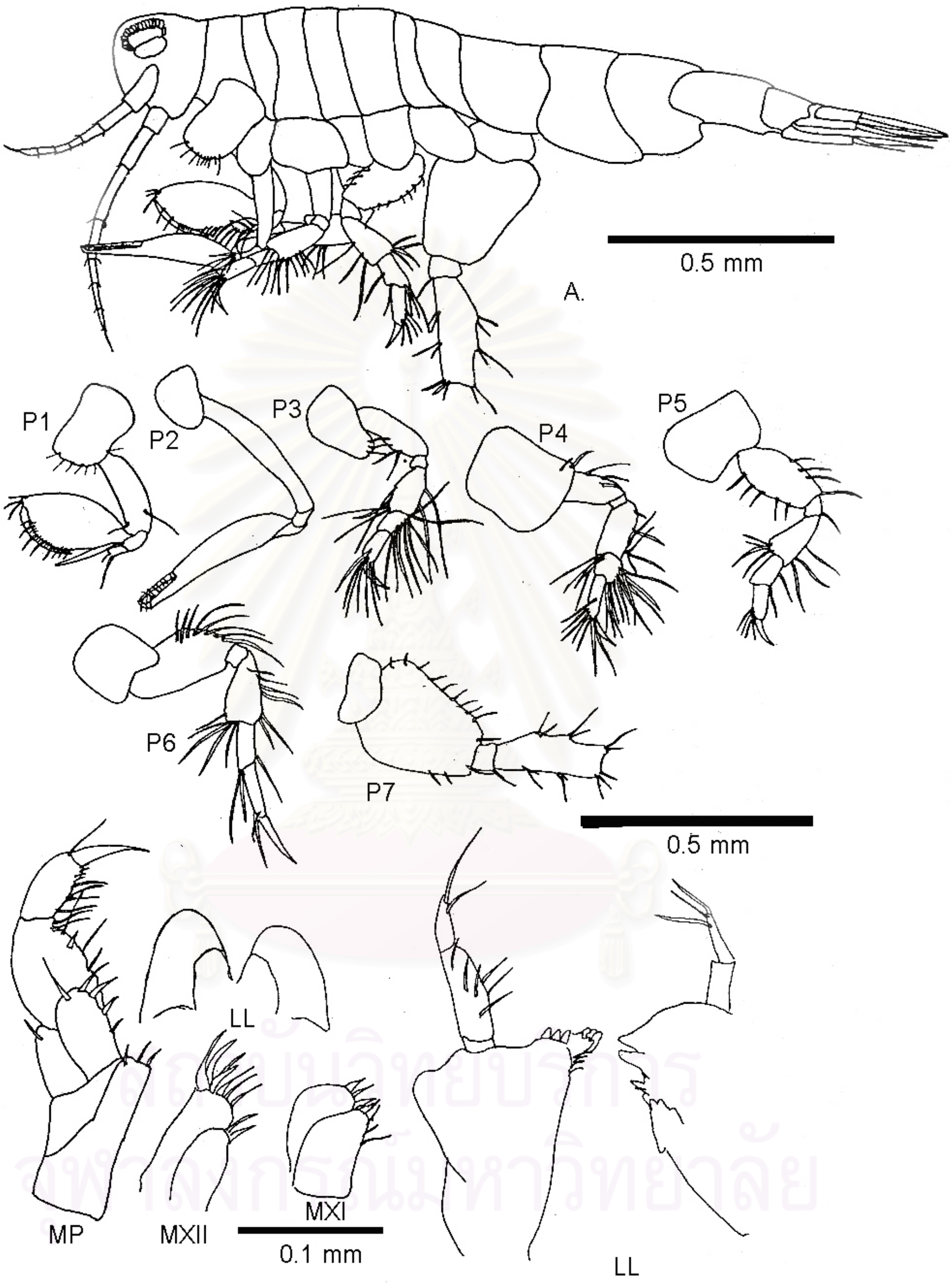


Figure 41 *Synchelidium* sp. A

A. Amphipod body

P1-P7: pereopods 1-7

MP:Maxillipeds; MX1:First maxilla; MX II:Second maxilla; MN:Mandible; LL:Lower lip

Family Urothoidae

Urothoe spinidigitus

Description

Antenna 1 are shorter than antenna 2. Antenna 2 are greater than body length. Mandible incisors are dentate and lacinia mobilis are present on both sides. Molars are triturative. Maxilla 1 have inner plate with strongly setose along medial margin. Maxilla 2 have both inner plates and outer plates. Maxilliped have inner and outer plates with dense setae and 4 articles palp. The terminal of palps are claw-like.

Coxae 1-4 are overlapping. Gnathopod 1 are subequal to gnathopod 2. Both gnathopod are subchelate. Pereopod 3 and 4 are similar shape with dense long setae. Pereopods 5-7 have many rows of facial and marginal robust setae and feather like setae. Pereopod 5 are shorter than pereopod 6. Article 2 expanded, check. Pereopod 6 are longer than pereopod 7 and have similar structure.

Urosomites 1 to 3 are free. Urosomite 1 is longer than urosomite 2. Uropods 1-2 apices of rami can be with robust setae or without robust setae. Uropods 1-3 are similar in structure and size. Uropod 1 peduncles do not have long plumose setae. Uropod 2 have inner ramus shorter than outer ramus or subequal to outer ramus. Uropod 3 have short peduncle short that outer ramus are longer than peduncle. Rami of uropod 3 have dense feather like setae. Telson is laminar and cleft.

Feeding Morphology

These amphipods are detritus feeders. They feed mainly on organic matter in the sediment. They have long setae with small antennae and large eyes that they used for searching food. Their gnathopods are small with dense setae that use for collecting food. Their maxilla 1 and 2 have robust setae that allow feeding on hard food. Their maxillipeds have dense fine setae for sorting food. Their mandibular molars are soft with small tooth incisor. These amphipods can consume small particles due to dense setae on their maxillipeds and second maxilla. They have spinose pereopods for digging in the sediment.

Habitat

These amphipods are nestler found in bare sand near seagrass roots at all stations. High density was recorded at station CL where *Enhalus* sp. thrived in compacted sediment. Their pereopods are spinose allow amphipods to dig in compacted sediment in dense seagrass area.

Distribution

Amphipods of this species are widely distributed in the Arabian Sea, India, Bay of Bangal and South China Sea. They are commonly found in littoral area including seagrass beds and lakes. (Imbach, 1967 and Barnard, 1959)

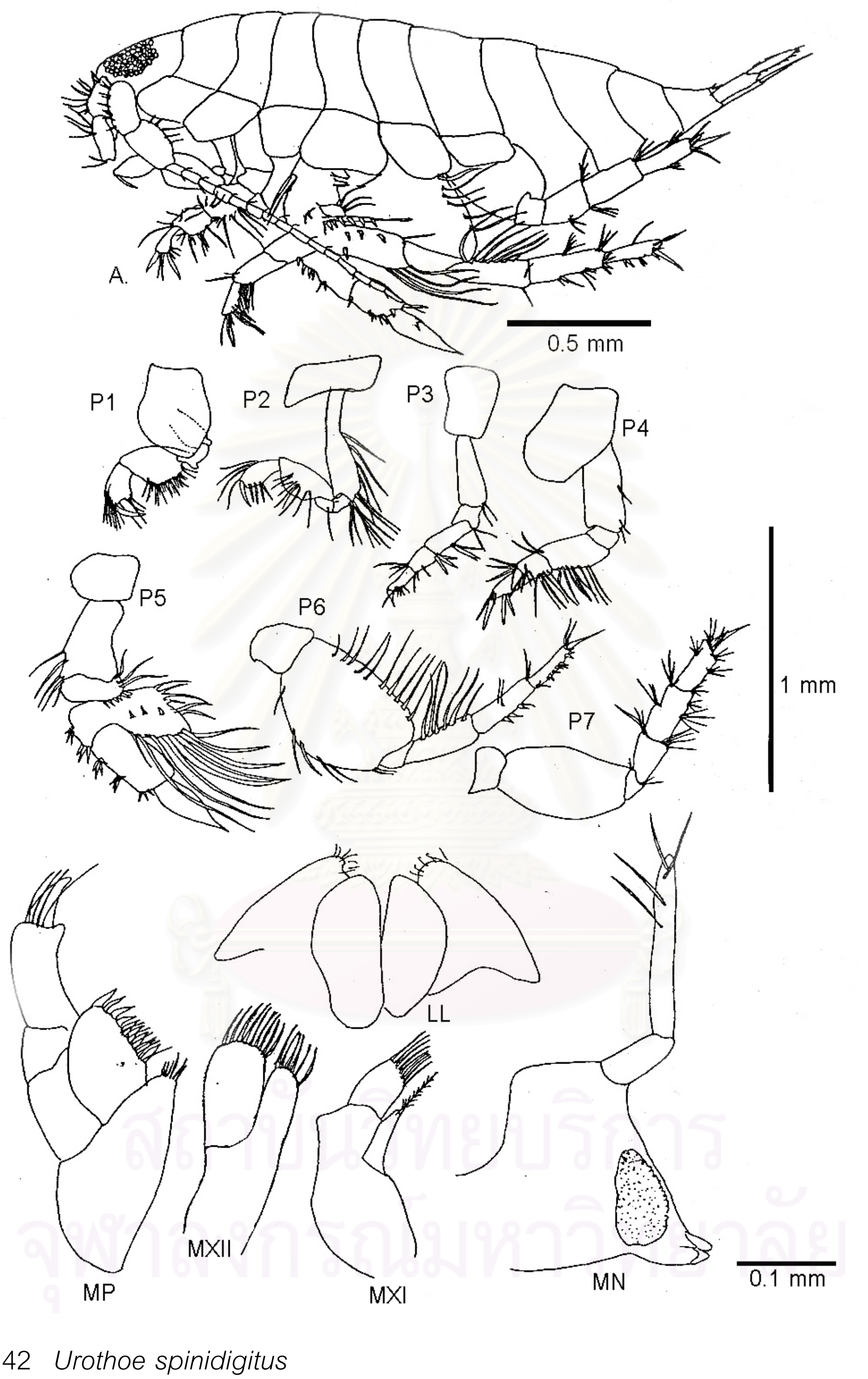


Figure 42 *Urothoe spinidigitus*

A. Amphipod body

P1-P7: pereopods 1-7

MP:Maxillipeds; MX1:First maxilla; MX II:Second maxilla; MN:Mandible; LL:Lower lip

CHAPTER IV

DISCUSSION

Distribution and Abundance of Amphipods

1. Coral reefs

Amphipods were found in abundance in station DK, AK, CK and BK respectively. At station AK have amphipods can be found distributed at every depth while at station BK, CK and DK amphipods limited their distribution only in the deeper area. This was dued to the different beach profiles. The beach at station AK was slightly elevated and sheltered bay while the slopes at station BK CK and DK were steep with respect to depths.

The common species found in this area were *Ampelisca brevicornis* and *Urothoe samplingnathia*, filter feeding and deposit feeding amphipods respectively. Other two in Kang Kao coral reefs were *Eriopisa* sp. A and *Idunella janisae* sp. A. The former was the grazer species while the latter was the detritus feeder species. Filter feeder-predatorial amphipods, *Gammaropsis* sp. A and *Ceradocus* sp. A also found in abundance at station AK. Filter feeder-predator species, *Melita appendiculata* were found only at station AK.

The other two species of amphipods, *Paracorophium* sp. A and *Leucothoe alcyone* were found abundance in station AK, CK and DK. The former was filter feeding amphipods that feed mainly pennate diatoms while the latter was the detritus feeder species. Both species are feed mainly on the sediment and weakly motile.

Most amphipods found in coral reef at Kang Kao Island were nestlers. They consisted of *Paracorophium* sp. A., *Leucothoe furina, Listriella* sp. A, *Eriopisa* sp. A, *Ceradocus* sp. A., *Melita appendiculata* and *Idunnella janisae.* These amphipods distributed densely at station DK and AK. *Ampelisca brevicornis,* one of the common amphipods in the Kang Kao reefs, were domicolous amphipods living in tubes. There were demersal species, *Gammaropsis* sp. A, *Ampithoe* sp. A, *Elasmopus* sp. A, *Hyale* sp. A and

Ampelisca brevicornis. These amphipods were abundance in station AK. These amphipods were connected with the bottom microhabitats. They lived in or on bottom solid substrates during days and lived in the water column during night. They were hiding in the colonies of gorgonarians and corals, in periphyton over the dead corals and within sand or coral rubbles. Most of demersal amphipods were filter feeders excepted for *Gammaropsis* sp. A as filter feeder-predators.

There are relatively few literatures on amphipods taxonomy and feeding ecology in the coral reefs in the Gulf of Thailand. Most of the work identified amphipods as a taxa group. Few literatures identified these groups to genera. Gammaridean amphipods were common to these reefs. These amphipods were usually reported as associated fauna in different forms of corals as in the studies carried out previously in Sichang Island (Sudara *et al.,* 1986 and Tsuchiya *et al.,* 1986) Amphipods in the genera *Urothoe, Eriopisella, Ceradocus, Grandidierella* were reported from Sichang Island. (Wongkamhaeng *et al.,* 2002) Most of the feeding modes in these amphipods were filter feeders and detritus feeders. Amphipods in the Andaman Sea were extensively studied.

Amphipods in coral reefs of Andaman Sea were distributed in various microhabitats. Many amphipods recorded in the intertidal area. *Bemlos quadrimanus*, omnivorous amphipods lived in shallow water, among algae, sponges, coral rubbles and macroalgae, *Padina* spp. Amphipods species *Bemlos delicatissima, Protolembos tegulapodus*, filter feeders and herbivorous opportunistic feeders were found among coral rubbles. *Konatopus storeyae*, another herbivorous opportunistic feeding amphipods distributed in wider rage from 9-20 meter lived in coral rubble pieces. (Myer, 2002)

Amphipods in family Ampithoidae usually found associated in algal mats and on old rope. *Ampithoe rachanoi*, herbivorous species, residing in with red gorgonacean at 10 meter depth. They also found on old rope. *Cymadusa aungtunyae, Cymadusa chalongana* and *Cymadusa panwa* usually found with old ropes and *Padina* spp. in coral reefs in the intertidal area. (Peart, 2002)

There are some amphipods that can be found in coral reef at 40 meter depth. *Leptocherirus dufresni,* herbivorous amphipods lived among calcareous algae. There were *Xenochiera* sp., herbivorous opportunistic feeding amphipods, lived among coral rubble at 40 meter depth. (Myer, 2002)

Amphipods are distributed according to habitats, available food supplied and specific feeding adaptations. (Thomas, 1993) Amphipods distributions in coral reef of Kang Kao Island can be explained as follows:

1.1 Habitat heterogeneity

Amphipods in coral reef can be found in the sediment, among dead coral rubbles, among algae and associated with coral heads (Myer, 1985). Wide ranges of habitats found at any coral reef (sediment, various types of algae, diversity of coral, coral rubbles and sessile invertebrates, etc.) provide a diverse range of microhabitats. Diversity of corals and ratio between living corals and dead corals also contributed to the differences in amphipod abundance. Several studies had been carried out to demonstrate the relationship between associated invertebrates and coral size and forms in the coral reefs. Sudara et al (1986) had found that different forms of coral namely *Porites* sp., *Acropora* sp. and *Pavona* sp. contributed to the difference in the abundances of associated zooplankton *Pavona* spp., the foliaceus corals, common at station AK, BK and CK, were found with numerous associated amphipods. This corresponded to Tsuchiya *et al* (1986) findings on the effect of colony size of hermatypic coral, *Pavona frondifera* on the community structure of the associated fauna. They concluded that coral heads of *Pavona* were hemispherical and made by many small plate-like structures. These narrow spaces among these plates were used by many associated animals such as amphipods and other crustaceans. They also found that the number of individuals of associated animals showed the positive correlation with the coral size. Station AK provided the diverse range of microhabitats for various amphipod species. Most diverse forms of amphipods were recorded from this station. Station AK in the Kang Kao Island had the widest reefs on the island. It was located on the sheltered bay. *Porites lutea* was the dominant species covering the sandy beach. These *Porites* colonies were quite large with diameter more than 2 meters. The species richness of associated fauna may arise from the high ratio of living and dead corals of 9.5:1. The slope of the beach was slightly elevated providing microhabitats of coral heads, sand, rock and dead corals. As *Porites lutea* dominated the area, other coral species could settled on availabled bare substrates in respective order of *Pocillopora damicornis, Pavona frondifera* and *Pavona decussata.* (Platong *et al.,* 2002) High density of amphipods was also recorded at station DK. This station was located on the western side of the island. The coral communities were mostly growing wirh *Porites lutea* as dominant species of approximately 80% in coverage. The sediment was mainly coarse sand. Echinoderms, free-living corals, sponges and bivalves were common.

Sediment reworking activity created and maintain the heterogeneity of the seafloor. Tsuchiya *et* al (1989) studied the environmental heterogeneity created by the spatangoid urchin, *Brissus latecarinatus* and its effect on sandy bottom communities at Sichang Island. They found that these urchins made mounds consisting of small particles and funnels with high proportion of large particles. These bottom surface irregularities reflected the difference in amphipod species and density. From their data, amphipods appeared more abundant and diverse in the shallow funnels than the mounds. They also detected the *Modiolus* patches provided microhabitats for these associated fauna. According to Chunhabandit *et al* (2002), *Brissus latescarinatus* were found abundant at station AK and BK. Thus sediment reworking activities of these urchins created the habitat heterogeneity for amphipods and other associated invertebrates. *Brachiodontes emarginatus,* another bivalve, form extensive mussel bed at station CK and DK. *Modiolus metcalfei* patches were also found at station DK. These mussel patches also provided microhabitats for amphipods reside in.

Sediment texture also contributed to the difference in amphipods density. Many amphipods showed preference in living mainly in the sediment. *Gammaropsis* sp. A, the demersal species, showed the positive correlation with grainsize ($p<0.05$). Most of the amphipods in the Kang Kao coral reefs were found in the sediment grainsize range of 0.6-0.8 mm. As already mentioned that most of the amphipods were nestlers such as *Eriopisa* sp.A, *Ceradocus* sp. A and *Melita appendiculata.* Others that showed affinity with the sediment grainsize were fossorial species *Urothoe simplingnathia* and domicolous species, *Ampelisca brevicornis*. Bussarawich (1984) studied the amphipods distribution in the western coast of Phuket Island, Thailand. The area were previously tin mining area. He found that the silt-clay condition contributed to the amphipod density and the distribution. Amphipods were found in high density in the area of coarse sediment and the lowest fraction of silt-clay particles of less than 10%. He suggested that the effects of offshore tin mining on the amphipods density and distribution was the increased sedimentation. Amphipods could be a good indicator of silt-clay conditions in the seafloor.

1.2 Available food supplies

Amphipods distribution showed the correlations to their feeding modes. Station AK revealed the most diversed feeding modes of amphipods. The dominant groups found at this station were filter feeders and filter feeder-predator, of 38.45% and 25.38% respectively. Detritus feeding amphipods of 40.06% and filter feeding amphipods of 30.12% were found at station BK. Filter feeding and detritus feeding amphipods were abundance at station CK, consisted of 51.26% and 27.94% of total density. Station DK had the highest density of amphipods. However two groups of filter feeders, *Ampelisca brevicornis* and detritus feeders, *Urothoe simplingnathia* were dominant.

Table 17 Amphipods of different feeding types in Kang Kao Island, Chonburi Province

Feeding Modes	Amphipods Distribution (species)density(individual/m^2)							
	AK	Percentage	BK	Percentage	CK	Percent	DK	Percent
Filter feeders	(6)353	38.45	(1)100	30.12	(3)244	51.26	(4)844	45.52
Grazers	(1)189	20.59	(1)44	13.25	(1)77	16.18	(1)156	8.41
Filter feeder-predators	(3)233	25.38	(1)55	16.57	(1)22	4.62	(1)122	6.58
Detritus feeders	(3)143	15.58	(3)133	40.06	(2)133	27.94	(2)732	39.48
Total	918		332		476		1854	

Filter feeding amphipods were common in the coral reefs at Kang Kao Island. These filter feeding amphipods created feeding current by beating of the antennae or pleopods. The food were trapped on their gnathopods, antennae and mouthparts. Filter feeding amphipods usually found underside coral rubbles, underside of the coral heads (Myer, 1985 and Thomas, 1993). *Ampelisca brevicornis, Paracorophium* sp. A, *Leucothoe furina,* the three filter feeding amphipods that feed mainly on the seafloor were found densely in station DK. This station was with high coverage percentage of living corals and high wave action that stirs up food particles. At station AK, high suspended solid particles that provided food items for filter feeding and filter feeder-predator amphipods. The phytoplankton communities at Kang Kao Island were quite productive of more than 34 genera. Diatoms dominated the area. These diatoms are important as food sources for these amphipods. Filter feeder-predators were also abundance in station AK. They are active swimmers hunting for their preys. They consume mainly on microalgae and zooplanktons.Zooplanktons found in this area including calanoid copepods, polychaete larvae and cnidarian zooplankton. (Rungsupa and Songroop, 2002)

Eriopisa sp. A were common at all station. These amphipods were grazers. They usually crop benthic microalgae from the substrates. The amphipods densities are related to abundance of microalgae. Grazing amphipods found in this study are selective feeder. They feed mainly on *Navicula, Rhizosolenia, Thalassiosira* and *Oscillatoria.* These microalgae were common and found in station AK.

Several amphipods occupied the same niche in the coral reefs in particular the two common species, *Ampelisca brevicornis* and *Urothoe simplingnathia*. Both amphipods are infaunal species. *A. brevicornis* are filter feeders while *U. simplingnathia* are detritus feeders. The common food sources for these two amphipods are pennate diatoms. *Ampelisca brevicornis* also found in association with *Gammaropsis* sp. A. Both amphipods are demersal feed mainly on centric diatoms and pennate diatoms.

1.3 Specific adaptation

Amphipods adaptations in morphology and feeding modes allow these amphipods to occupy niches in the coral reef.

Adaptations by their feeding modes

- Filter feeders

These groups of amphipods were the dominant groups in coral reefs. Their mandible are strong and trituative. They have 7-12 of raker spines on their mandibles. They have special morphology used for creating the current while they are feeding. There are numerous long fine setae along the medial edge of inner plates on maxillipeds and second maxilla for selecting food particles. Their maxilliped palps are long and exceed the outer plates. The terminals of maxilliped palps are claw-like. On their antenna, numerous long fine setae appeared at the end of each joint and along the articles. *Ampelisca brevicornis*, *Gammaropsis* sp. A, *Paracorophium* sp. A and *Leucothoe furina* have first and second gnathopods with dense long fine setae on anterior side that aid in trapping food particles and creating the feeding currents together with the antennae. This feeding mechanism is similar to corophioid amphipods that filter food by creating the feeding currents with antennae and trapping food particles by their gnathopods. The setae on their gnathopods gather food like a filtering basket. After the food was sent to the mouthparts, they would clean their gnathopods using maxilliped palps. They select their food particle size by their maxilliped and second maxilla. (Dixon and Moore, 1997) Other filter feeding, *Listriella* sp. A amphipods have short antennae and weakly setose. Their major food items are pennate diatoms and organic materials. Their mouthparts are like other filter feeding amphipods with long maxilliped palps, long find setae on medial edge of maxilliped and second maxilla and trituative mandibular molar with long mandibular palp. However, their mandibular palps have short setae only at the terminal indicating that these were not involved in creating feeding currents. These morphological adaptations are similar to those found in *Paracalliope australis* that capable of filter feeding by an action involving only the mouthparts. They swing the second maxillae anteriorly against the first maxilla for creating the current in filtration chamber in their mouth. The setae on second maxilla are able to trap and transfer food particles inside their mouth. (Figure 40) (Mcgrouther, 1983).

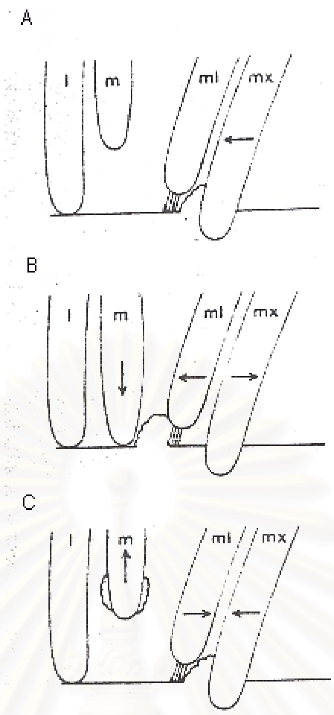


Figure 43 Amphipods setae tranfer (Mcgrouther, 1983).

A. Maxilliped outer plate swing together to the food

B. Second maxilla swing and cutting the food area that has been rasped by maxilliped

C. Mandible incisor lift the fod that cut by second maxilla

- Grazers

Only one species of grazing amphipods, *Eriopisa* sp. A was found. *Eriopisa* sp.A have very long antennae (as long as the body length) with small setae. They use their antennae for searching food. Their eyes are similar to euphausiids and mysids eyes that have accessory retina for monitoring other directions. (Nilsson, 1996) From this morphology, *Eriopisa* sp.A use their eyes, antennae and mandibular palp together for searching their food. Their major food items are pennate diatoms, macroalgae and cyanobacteria. Both gnathopods are subchelate with dense long fine setae from article 2-7 for trapping food. Their mandible are large with trituative molars for bitting food. Food particles were selected by maxilla and maxillipeds. Their antennae can be cleaned by the mandibular palps.

- Filter feeder-predators

Amphipods of this feeding mode, *Ceradocus* sp.A and *Melita appendiculata* were found abundant only in station AK. Another species, *Gammaropsis* sp. A were common at all station. They have long antennae with small setae that are used for food searching. Their eyes are often large. Their mouthparts are similar to those of filter-feeding amphipods. They have numerous long fine setae along the medial edge of inner plates on maxillipeds. Their maxilliped palps are long and exceed the outer plates. The terminals of maxilliped palps are claw-like. They have adaptations in their mandible with sharp teeth incisor and lacinia mobilis. Their molars are eminent with raspy surface. There is also a sharp accessory spine on right trituative mandibular molar. Their first gnathopods have numerous long fine setae on anterior and posterior side that create sieving basket inorder to trap food. Their second gnathopods are large and strong, subchaelate with spines on propodus and sharp dactylus. Their gnathopods allow them to process large preys such as polycheates, small crustaceans or cnidarians. They are usually good swimmers. Filter feeder-predator amphipods found in this study feed mainly on diatoms and organic particles. They also feed on polychaetes, small crustaceans and cnidarians. Filter-feeding amphipods like *Lembos webstri* use their gnathopods to catch hapacticoid copepods which entered their tubes. (Shillaker and Moore, 1987)

- Detritus feeder

These amphipods can be distinguished by their small mandibular molar. Their antennae are long for searching food particles. Their gnathopods are with dense setae for collecting food. *Urothoe simplingnathia* and *Idunella janisae* also have some diatom and macroalgae in their gut. Similar to *Echinogammarus pirloti* that Agnew and Moore (1986) identified, they are primary macrophagus detritivore but they also feed on microalgae.

1.4 Predation pressure

Predator pressure can be another important factor contributing to amphipod density and distribution. This need further investigation. However from this study, most of the amphipods were nestlers. They could hide from their predators by living in the sediments, coral rubbles and inside the coral heads. As the ratio of living and dead coral and large coral communities also reflected the diversity of associated fauna, high densities of amphipod predators such as *Diadema setosum* and other demersal fishes were found at station AK and BK. Most of the amphipods found at station BK are detritus feeding amphipods. These amphipods are burrowers and feed mainly in the sediment so that they can hide from their predators.

2. Seagrass beds

Amphipods with different feeding modes, filter feeders, grazers and detritus feeders were found in Libong Island, Trang Province corresponding to different vegetative area. High density of amphipods were found in station BL where *Halophila ovalis* were dominated. *Cymoducea* sp. and *Thallasia hemprichii* also found in the area. Station AL, unvegetated bare sand with debris deposited had highest diversity of amphipods species. Station CL has dense vegetation of *Enhalus acoroides.*

Common amphipods that can be found in every station were *Kamaka* sp. A, grazing amphipods and *Urothoe spindigitus*, detritus feeding amphipods. *Ampelisca cyclop,* filter feeding amphipods, were also found distributed at all stations. *Kamaka* sp. A occupied both on seagrass leaves and bare sand. They feed mainly on macroalgae and organic matter. Most of the amphipods in the seagrass beds were infaunal except for *Kamaka* sp. A being epizoits.

A total of 13 families of amphipods found in the seagrass beds from Samui Island, Gulf of Thailand. (Nateekanjanakarp, 1990) From this study, the different plant forms and seagrass biomass contributed to difference in amphipods density and diversity. *Enhalus acoroides* bed had the highest diversity of associated benthic fauna followed by the *Halodule uninervis* bed, mix species of *H. uninervis, Halophila ovata* and *H. ovalis* bed and the mixed *H. ovata, H. ovalis* and *H. decipiens* bed respectively. Small organisms like amphipods, polychaetes and mollusc dominated the small seagrass species such as *Halodule uninervis, Haliphila ovalis* and *H. ovata.* In these areas, amphipods in the families *Corophiidae* and *Isaeidae* dominated the area. Amphipods in the family Ampithoidae dominated the *Enhalus acoroides* beds. *Grandidierella*, filter feeders in the Family

Corophiidae had been reported from seagrass bed and mudflats in the Gulf of Thailand while *Photis,* a member of the Family Isaeidae, play the roles of omnivore and detritus feeder in the same habitat. (Intrasook, 1999)

Local differences in amphipod species composition were related to several factors as follows:

2.1 Vegetation area

In most studies, amphipods showed preferences to vegetated substrates than bare sand area (Stoner, 1980; Young, 1981 and Nateekanjanalarp, 1990). Highest density of amphipods found at station BL where most diversed seagrass were found. Grazers, *Kamaka* sp. A and *Eriopisella* sp. A dominated the area. These amphipods did not feed on the seagrass blades but mainly on the epiphytic algae. The major food items for *Eriopisella* sp. A and *Kamaka* sp. A were epiphytic macroalgae, pennate diatoms and organic matters. However, *Eriopisella* sp. A occupy sandy bottom among algae near *Halophila ovalis* beds, while *Kamaka* sp. A can be found both on seagrass leaves and on sand near seagrass. The *Enhalus acoroides* bed at station CL also provide habitat for amphipods in term of density in respective order from station BL. *Kamaka* sp. A and *Urothoe spinidigitus*, detritus feeders, dominated the area. Dense *Enhalus acoroides* bed may have the pronounced impact on the sediment. They make the sediment more compacted and prevent amphipod burrowing.

Station AL, bared sand near seagrass bed had the most diversed form of amphipods but lowest density. Two filter feeding amphipods, *Ampelisca cyclop* and *Ampelisca* sp. A were found. *Ampelisca cyclop* have diverse food items including macroalgae, diatoms and organic matter. *Kamaka* sp. A also dominated the area. *Synchelidium* sp. A was the detritus feeding amphipods that limited their distribution only at station AL. All these amphipods are burrowing species except for *Kamaka* sp. A that can be found in the sediment and as epizoited.

Table 18 Amphipods of different feeding types in Libong Island, Trang Province

Feeding Modes	Amphipods Distribution (species)density(individual/m^2)					
	AL	Percentage	BL	Percentage	CL	Percentage
Filter feeders	(2)40	26.32	(1)20	7.14	(2)16	8.33
Grazers	(1)48	31.58	(2)120	42.86	(1)68	35.42
Detritus feeders	(2)16	10.53	(1)20	7.14	(1)40	20.83
total	152		280		192	

2.2 Seagrass forms and density

Unlike other seagrass studies, seagrass density and forms may not be the major factors contributing to amphipods diversity and abundances in Libong Island. Amphipods densities were related to seagrass biomass and blade characteristics in particular surface area: biomass (Stoner, 1980 and Lewis *et al,* 1983). In this study, amphipods were found randomly distributed in the area mainly in the short-leaves seagrass beds and bare sand area. Bare sand area near seagrass bed contained a large amount of debris deposited provided the suitable habitats for detritus feeding amphipods, filter feeders and grazers. Lewis *et al* (1983) found that in seagrass bed where food was not limiting factor, amphipod distribution depended on the feeding ecology and behavior. Non-selective deposit feeders were found in abundant at the seagrass rhizomes where high organic matter occurred. Large number of amphipods could also be found in bare sand among seagrass hiding from predators.

2.3 Predator pressure

Habitat preference and interactions with other animals such as competition and predation may further regulated the local distribution of amphipods other than the physiological tolerance and morphological constrains (Stoner, 1980). Nelson (1982) found that predation also played roles in controlling the amphipod population in *Halodule* sp. and *Zostera* sp. communities.

Most amphipods found in Libong Island were tube-dweller and burrower species. Both common species, *Ampelisca cyclop* and *Urothoe spinidigitus,* were tube-dweller and burrower respectively. *Eriopisella* sp. A and *Kamaka* sp. A were active motile epifaunal.

Eriopisella sp. A were good swimmer with large pereopods, pleopods and coxae. They limited their distribution found only in short-leave seagrass area usually in the shallower area than the long-leaves seagrass area. The latter area were usually with higher density of predators.

Most amphipods found in this area had dark brown coloration for hiding from their predators. *Kamaka* sp. A had yellow color.

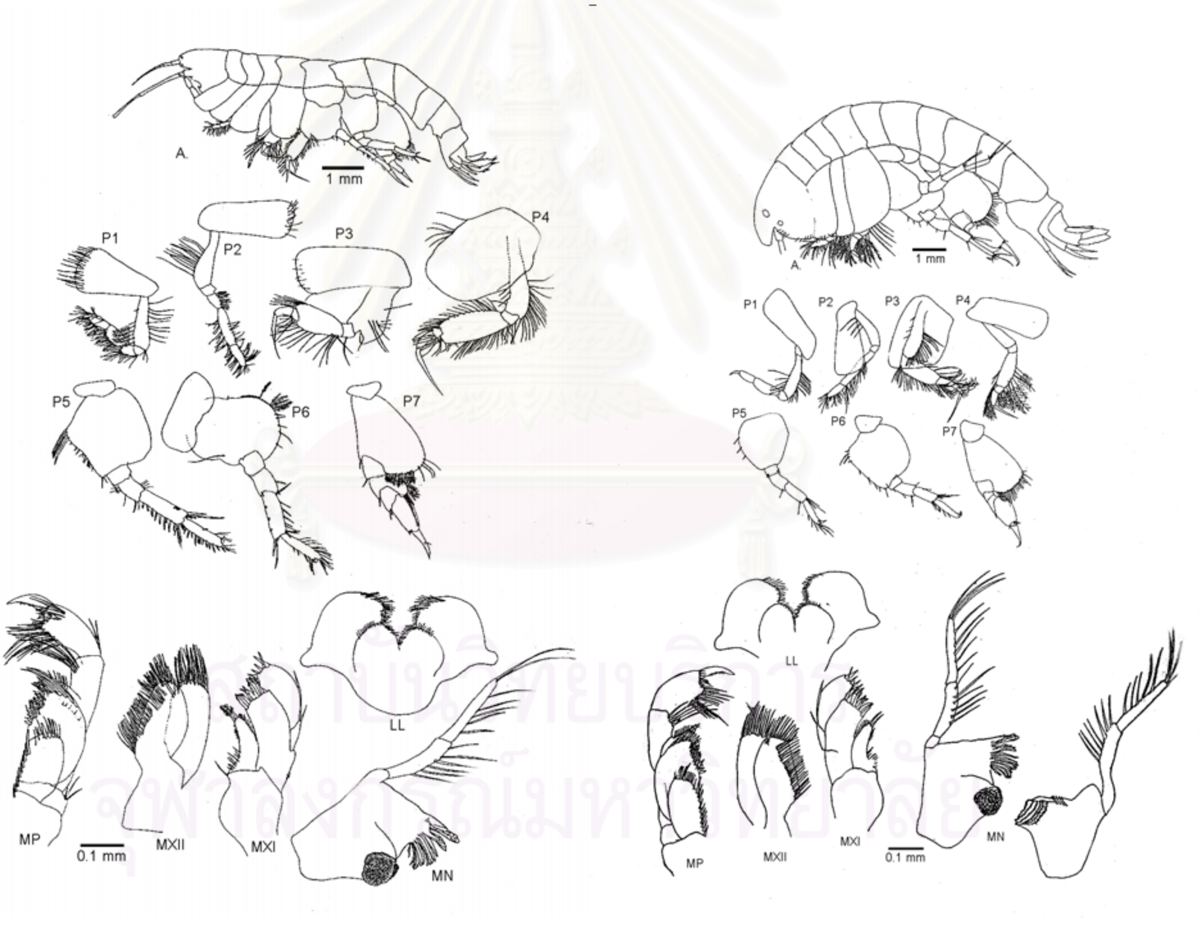
Table 19 Amphipods adaptations and habitat preference in Libong Island, Trang Province

Species	Feeding Modes	Motile/ None Motile	Cryptic Colouration	Cryptic Behavior Burrowing	Habitat Preference
Ampelisca cyclop	filter feeders	weakly motile	dark brown	tube - dweller	AL, BL
Ampelisca sp. A	filter feeders	weakly motile	dark brown	tube - dweller	AL, CL
Eriopisella sp. A	grazers	active motile	dark brown	-	BL
Kamaka sp.A	grazers	active motile	yellow	epizooids	BL, CL, AL
Synchellidium sp.A	detritus feeders	active motile	dark brown	burrower	AL
Urothoe spinidigitus	detritus feeders	active motile	dark brown	burrower	CL,BL, AL

Seasonal change can affect the amphipod communities in seagrass beds. During the southwest monsoon season, seagrass in Libong Island usually decreased due to high sedimentation in this area. (Lewmanomont and Supanwanid, 1999 and Nakaoka and Supanwanid, 1999) Nelson *et al* (1982) found that amphipod predators communities changed according to season. Major predators of amphipods are fishes such as *Lagodon lembroides* , decapod crustaceans and small squids that feed mainly on amphipods. These predation pressure may altered the amphipods diversity and abundances.

Comparison of Feeding Morphology in Common Amphipods Found in Coral Reef and Seagrass Communities

There are two genera of amphipods, *Ampelisca* and *Urothoe*, that are the common species in both coral reefs and seagrass beds. *Ampelisca brevicornis* and *Urothoe simplingnathia* were found in coral reef. *Ampelisca cyclop* and *Urothoe spinidigitus* found in seagrass beds. *Ampelisca* spp. found in both coral reef and seagrass bed are filter feeding amphipods. They are nestler species. *Urothoe* spp. found in this study are detritus feeding amphipods. They are fossorial amphipods. These amphipods in the same genera shared similar morphology. However, their morphological adaptations and their food sources are different according to their habitats.



A. B.

Figure 44 *Ampelisca* spp., filter feeding amphipods

A. *Ampelisca brevicornis,*common amphipods found in coral reef

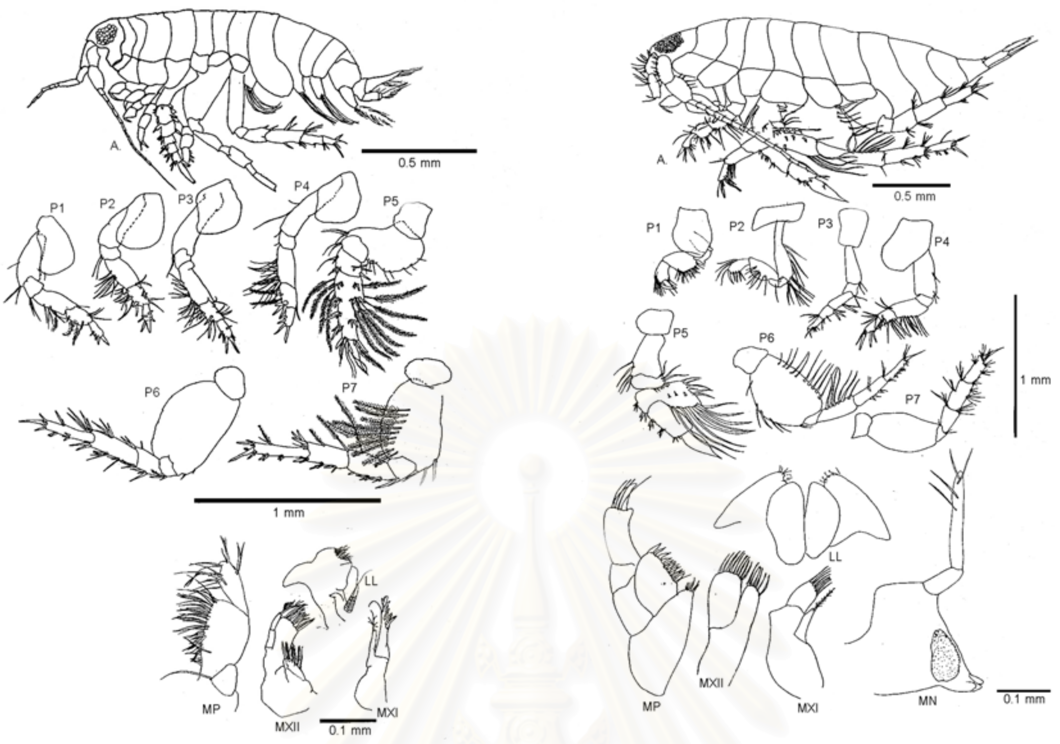
B. *Ampelisca cyclop*, common amphipods found in seagrass beds.

1. *Ampelisca* spp.

Both amphipods have similar structure with lateral compress body. They have long head with four eyes. The long antennae are use for searching food and creating feeding currents. Their mouthparts are similar of filter feeding types.

A. brevicornis are domicolous species that can be found swimming in the water column during the night. Their coxae and the second articles of pereopods 3-7 are wider than *A. cyclop*. *A. brevicornis* pereopods have sharp and naked dactylus that aid in digging sediment, Coxae of *A. cyclop* especially coxae 4-7 are very small indicated that this amphipods are mainly living in the sediment. Their pereopods 5 are backward to dosal side for holding their body while they living in their hole. The third uropods and telson of *A. brevicornis* are large with long setae while those of *A, cyclop* are with smaller setae.

The food items of these two amphipods are also different. *A. brevicornis* food items consisted of pennate diatoms, centric diatoms and cyanobateria while *A. cycolp* feed mainly on pennate diatoms and macroalgaes. Amphipods morphology and their food items reflected the different feeding behaviors of *A. brevicornis* and *A. cyclop*. *A. brevicornis* are filter feeding amphipods that living in their tubes and creating their feeding current with antennae. They also feed while swimming similar to *Cerapus* spp. These amphipods allow water flow through their body while they swimming and filtering the food particles in the water column. *A. cyclop* are feed mainly at their tube entrance and use the antennal grooming food particles outside the tube.



A. B.

Figure 45 *Urothoe* spp., detritus feeding amphipods

A*. Urothoe simplingnathia,* common amphipods found in coral reef

B. *Urothoe spinidigitus*, common amphipods found in seagrass beds.

2. *Urothoe* spp.

Urothoe simplingnathia and *Urothoe spinidigitus* have depressed body. Their eyes are large and their antennae are long. Their pereopods are strong with numerous spine and setae. These amphipods are detritus feeder. They are fossorial amphipods that living mainly under the sediment.

However, there are some different morphology between *U.simplingnathia* and *U. spinidigitus.* The gnathopods of *U. simplingnathia* are simple while *U. spinidigitus* are subchelate. The pereopods of *U. samplingnathia* especially broader coxae and second article showed the adaptation for swimming. There are feather-like setae on their pereopods while *U. spinidigitus* have long simple setae. The pereopods of *U. spinidigitus* showed the adaptation for burrowing. Their pereopods contain numerou spines. Their article 4 of pereopods 5 exposed to posterior to support their burrowing. The mouthparts of both amphipods also different. Maxillipeds and maxilla of *U. simplingnathia* bear numerous feather-like setae while *U. spinidigitus* have only short setae at the terminal. The food items of *U. simplingnathia* comsisted of organic materials and pennate diatoms while *U. spinidigitus* feed mainly on organic materials. *U. simplingnathia* feed mainly on detritus around them by using their pereopods to grasp on the sediment. They also feed on benthic diatoms. *U. spinidigitus* use their subchelate gnathopods for collecting organic materials.

Important Characteristics for Identification of Feeding Modes in Amphipods

Many important characteristics that can be used for identifying amphipods feeding modes such as their eyes, antennae, mouthparts, gnathopods, pereopods and uropods. Moreover, the food items in their gut content also contributed more in understanding their feeding ecology.

1. Amphipods antennae and eyes

The antennae and amphipods eyes are the major parts that amphipods use for searching foods. Most of filter feeding amphipods use their antennae for searching and trapping food particles. Predatorial amphipods usually have large eyes and long antennae with plumose setae for detecting their prey. The detritus feeding amphipod usually have small antennae and eyes.

2. Amphipods mouthparts

The herbivorous group, filter feeding and grazer amphipods have similar mouthparts with numerous setae on their inner plate of maxilliped and second maxilla and on their mandibular palp. They use their setae to select food particles. Their mandibular molar are big and tooth. Their incisor are tooth and sharp for bitting their food particles. Grazing amphipods inner plate of maxilliped and second maxilla have setae only at the terminal.

Detritus feeding amphipods mandibles are weak, small and sometime without mandibular molar. Their inner plate of maxilliped and second maxilla almost naked and have only small setae at the joint.

3. Amphipods gnathopods and pereopods

Amphipods gnathopods indicated their feeding modes. They use gnathopods for collecting food. Filter feeding amphipods often use gnathopods as sieving basket and they usually have dense long fine setae on gnathopods. Grazing amphipods use gnathopods for grasping food. They usually have subchelate gnathopods with larger area than those in filter feeders on their palms for collecting food. Predatorial amphipod use their gnathopods for capturing their preys. They have powerful gnathopods with sharp spine on propodus for killing their preys. The detritus feeders often use the gnathopods in the same way as the grazers. Gnathopods are similar in term of morphology in grazing and detritus feeding amphipods

The pereopods in amphipods can indicate that those amphipods are actively motile or weakly motile. Morover, pereopods also related to the habitats of amphipods. Amphipods that able to swim have large coxae and second articles of pereopods. Amphipods that usually inhabitat in sediment usually with spinose and setose pereopods.

Role of Amphipods in the Marine Food Chains

Amphipods played the ecological roles in both the pelagic and benthic food chains. Four feeding modes in gammarid amphipods in the coral reef and seagrass were identified namely filter feeders, grazer, filter feeder-predators and detritus feeders. Common amphipods in both habitats are filter feeding amphipod *Ampelisca* spp. and detritus feeding amphipods *Urothoe* spp.

In coral reef, filter feeding and grazing and filter feeder-predator amphipods play the ecological roles as the linkages of primary producers to other consumers. Primary producers including benthic microalgae, macroalgae, cyanobacteria and phytoplankton are their major food items. Fishes; *Plotosus lineatus, Gerres oyana, Uoeneus tranula,Cryptocentrus* spp., *Diodon liturosus* and *Monacanthus chiensis* are their major predators. (Platong *et al*, 2002 and Chunhabantit *et al*, 2002). Moreover, these filter feeding amphipods also shared the roles in controlling the phytoplankton communities. Cloern (1982 cited by Lemmen et al., 1996) suggest that grazing by benthos and filter feeding were the major mechanisms in controlling the phytoplankton community. Filtering capacity of amphipods usually high compare with smaller filter feeding crustaceans such as copepods and barnacles (Conover, 1966, Mclaughlin, 1983 and Anderson, 1981). *Lembos websteri* have filtration rate 0.7 and 1.3 ml/h and *Corophium benelli* have filtration rate between 6.0 and 7.4 ml/h while pumping between 51 -86% of the total time. (Foster-Smith and Shillaker, 1977 cited by Lemmen et al., 1996 and Shillaker and Moore, 1987)

Demersal amphipods form important linkage between benthic and pelagic food chain. Demersal amphipods live in seafloor and occasionally enter the water column. They are usually found in the plankton at night on the reefs. (Sudara et al, 1986, Myer, 1986 and Thomas et al., 1993) Four of five species of demersal amphipods found in this study, namely *Ampelisca brevicornis, Ampithoe* sp. A, *Elasmopus* sp. A, *Hyale* sp. A are filter feeders. Only *Gammaropsis* sp.A are filter feeding-predator. Filter feeding-predatorial amphipods also feed on small animals such as polychaetes, cnidarians and crustaceans. There are also detritus feeding amphipods that feed on detrital, animal carcass and organic materials attaching on sand grains. Detritrus feeding amphipods increased the decomposition by bacteria on detritus. (Agnew and Moore, 1986)

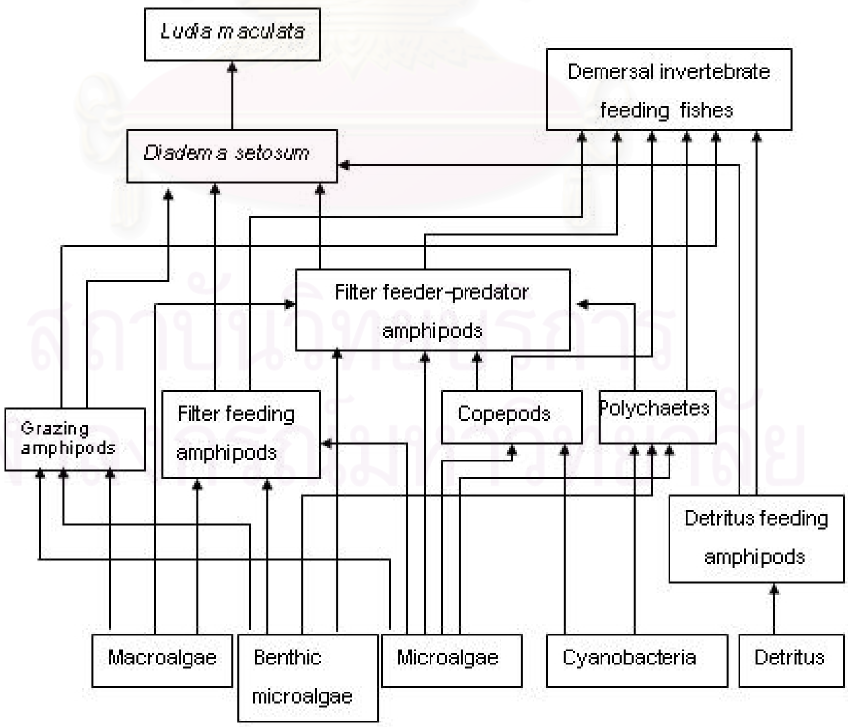


Figure 46 Role of amphipods in marine food chains in coral reef

In seagrass, dominant amphipod group are grazers, *Kamaka* sp. A and filter feeding amphipods, *Ampelisca cyclop.* Filter feeding amphipods control the phytoplankton communities in seagrass beds. They also controlled the suspended organic matters in the water column in seagrass. These amphipods feed on the primary producers including macroalgae, benthic microalgae and epiphyte. Animals in higer trophic level that feed on amphipods are decapods; Portunid crabs, Xanthid crabs and Caridean shrimps; invertebrate feeding fishes; *Manacanthus chiensis, Upeneus tragula* and *Siganus canaliculatus*. (Nojima et al., 1999)

Grazing amphipods not only consume primary producer in seagrass bed but also control the epiphyte density. *Ampithoe longimana* and *Cymadusa compta* that feed on benthic microalgae and seagrass epiphyte algae. Their feeding controlled the epiphyte densities and enhanced epiphyte diversities on seagrass leaves (Howard, 1982 cite in Kitting 1984). Moreover, they also contribute finer materials for bacterial decomposition. (Montfrans *et al.,* 1984 and Mukai and Iljima, 1994)

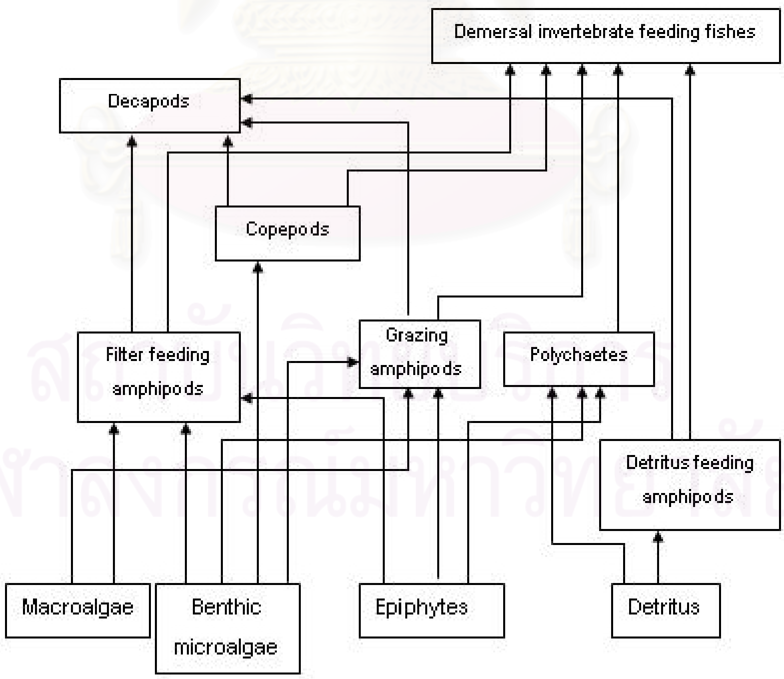


Figure 47 Role of amphipods in marine food chain in seagrass beds

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. Mophology and feeding ecology of gammarid amphipods in coral reefs and seagrass communities were compared from amphipods collected from coral reefs in Kang Kao Island, Chonburi Province during April, 2001 and from seagrass bed in Libong Island, Trang Province during December, 2003. There were four feeding modes in gammarid amphipods in the coral reef and seagrass communities namely filter feeders, grazers, filter feeder-predators and detritus feeders. Two genera of common amphipods found in both habitats were *Ampelisca* spp., filter feeding amphipods and *Urothoe* spp., detritus feeding amphipods.

2. Amphipods of 14 species from 10 families were found in the Kang Kao Island reefs with *Ampelisca brevicornis,* the benthic filter feeder, as the most dominant species. Other filter feeding amphipods were *Ampithoe* sp. A, *Paracorophium* sp. A, *Elasmopus* sp. A, *Leucothoe furina* and *Listriella* sp. A. Demersal plankton, *Ampelisca brevicornis,* feed mainly on phytoplankton while the benthic species, *Paracorophium* sp. A feed mainly on benthic microalgae and macroalgae. Diatoms and organic matter were the major food items for *Listriella* sp. A. There was only one species of grazers, *Eriopisa* sp. A. There were three species of filter feeder-predators amphipods, namely *Ceradocus* sp. A, *Gammaropsis* sp. A and *Melita appendiculata.* Filter feeder-predators amphipods food items are similar to filter feeders but they additionally had animal fragments in their stomachs. The animal fragments in *Melita appendiculata* included polychaete setae and crustacean fragments. Animal fragments in *Ceradocus* sp. A stomach were crustacean fragments and nematocysts of cnidarian, whereas animal fragments of *Gammaropsis* sp. A consisted only crustacean fragments. *Urothoe simplingnathia*, detritus feeding amphipod, were next in term of abundance to *Ampelisca brevicornis. Leucothoe alcyone, Idunella janisae* were the two other detritus feeding amphipods found. Habitat heterogeneity, available food sources and

specific adaptation contributed to the difference in amphipod diversity and abundances in Kang Kao Island reefs. Predation also was another factor to be further investigated.

3. Six amphipods in 5 families were found in the seagrass beds in Libong Island. *Kamaka* sp. A, grazing amphipod, was the dominant species. They feed on benthic micro- and macroalgae. This amphipod species was widely distributed in the sediment and on the seagrass leaves. The filter feeding amphipod, *Ampelisca cyclop,* was next in term of abundance. Other filter feeding amphipod, *Ampelisca* sp. A was also recorded. Two detritus feeders were also observed namely, *Synchelidium* sp. A and *Urothoe spinidigitus.* High density of amphipods were noted at station BL where *Halophila ovalis* dominated. Station AL consisted mainly bare sand with deposited debris bear the highest diversity of amphipods. Local amphipod distribution patterns were related to vegetation area, seagrass form and biomass and predation pressures.

4. Gammarid amphipods displayed array of feeding structures, in particular mouthparts, mandibles, maxillipeds and two pairs of maxilla, according to different feeding modes. Their associated feeding appendages, antennae and gnathopods also varied accordingly. Various adaptations on their antennae and gnathopods were found in order to serve function in searching and collecting food respectively. Filter feeding amphipods use antennae with long setae for creating feeding currents while feeding. They also use their gnathopods with setae on posterior margin like sieving basket for collecting their food particles and sent to the mouthparts. *Listriella* sp. A was the filter feeding amphipod that create feeding currents by their second maxilla together with their maxilliped. Grazing and filter feeder-predator amphipods use their antennae with the small setae for searching food and use their subchelate gnathopods to collect their food before sending them to the mouthparts .*Kamaka* sp. A was the exceptional that graze on algae directly. Filter feeder-predator amphipods have strong sharp subchelate gnathopods in addition for killing their preys. Detritus feeding amphipods have long antennae for seatching food and use their subchelate or chelate gnathopods for collecting food.

The mouthparts also showed adaptations by their feeding modes including their maxilliped, first and second maxilla and their mandible. Filter feeding amphipods have long fine setae along the medial edge of their second maxilla and maxilliped. Their mandible have trituative mandibular molar and numerous fine rakers below their incisor.Grazing amphipods have similar mouthparts to filter feeding amphipods but they have setae only on their terminal ends of second maxilla and maxilliped. Filter feeder-predator amphipods have similar mouthparts to filter feeding but with sharp lacinia mobilis and accessory spine on their mandibular molar for cutting food. Detritus feeders are characterized by their small mouthparts in particular small mandibular molar.

5. Gammarid amphipods in coral and seagrass communities play role in both the pelagic and benthic food chains. Filter feeders, grazer and filter feeder-predator amphipods play the ecological roles as the linkage of primary producers to other consumer in the higher trophic levels. Dominant filter feeding amphipods in both habitats controlled the phytoplankton communities and suspended organic materials. Grazing amphipods feed on benthic microalgae and macroalgae. They also contributed finer materials for bacterial decomposition. Detritus feeding amphipods that could be found in both the coral and seagrass communities, feed on organic materials attaching on sand grains. Their activities enhanced the bacterial decomposition in the system.

Recommendations

1. Feeding experiments in amphipods both in the laboratory and in the field should be carried out to understand the behavior, perception and food preference in amphipods in different habitats.

2. Predation pressure and interactions with other animals such as competition should be further investigated as the controlling factors in amphipod diversity and distribution.

3. Stomach content analysis of other taxa of benthic small crustaceans such as isopods and tanaidaceans should be carried out for the understanding of the ecological roles of these small crustacean groups in coral reefs and seagrass beds.

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