

## Marine pelagic calanoid copepods from some portion in Mindanao waters, Southern Philippines: Families Pontillidae and Calanidae

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**Abstract.** Some marine pelagic calanoid copepods of the families Pontillidae and Calanidae were described morphologically from specimens found in plankton net samples collected off the coast of Mindanao waters. Taxonomic characters for identification of copepod species were based on the quantitative and qualitative characters. Differences between female and male were based on the antennules, morphology and structure of the fifth legs and the number of segments of the urosome. Under family Pontillidae, three copepod species were identified namely, *Labidocera acuta*, *L. minuta*, and *Calanopia aurivilli*. For family Calanidae, three species were described such as *Undinula vulgaris*, *Cosmocalanus darwinii*, and *Canthocalanus pauper*. Female and male were described for each species except for *C. pauper* in which only male species was presented. The detailed description together with the drawings and measurements are presented.

**Key Words:** Tropical copepods, morphological description, Mindanao waters, Southern Philippines.

**Introduction.** Copepods are aquatic crustaceans which are the diminutive relatives of the crabs and shrimps. They are among the smallest (mostly < 1 mm) and most abundant of crustaceans and are usually the dominant member of the marine zooplankton (Niesen 1982). According to Al-Yamani et al (1997a, 1997b), copepods comprise about 70 % of the zooplankton community and have a variable distribution both spatially and temporally. There are about 2,000 known marine pelagic species of copepods (Razouls & Bovee 1998) and because of their high diversity and abundance they can be regarded as the insects of the seas (Huys & Boxshall 1991). In an ecological point of view, they are the principal link between phytoplankton and higher tropic levels in many marine food chains since many marine animals' major diet is composed of copepods. Since zooplankton (*i.e.* copepods) occupy a key position in the pelagic foodweb, as they transfer organic energy produced by phytoplankton to higher trophic levels, including pelagic fish, their importance in the pelagic realm therefore could not be ignored.

Although copepod taxonomic studies are quite popular and extensive in other parts of the world, copepod fauna information in the Philippine waters are old and are limited to those reported by Wilson (1950) during his cruise in the Pacific Ocean on board the United States fisheries steamer "Albatross" from 1887 to 1909. To address this gap, an attempt was made to describe in detail, with accompanying drawings and measurements, each of the species encountered and to provide information on their geographic distribution in some portion in Mindanao waters. The data generated will serve as baseline information for future copepod taxonomic research and will add valuable information in zooplankton community structure. Such knowledge is essential to

understand and be able to predict the impact of environmental changes on fish stock fluctuations.

**Material and Method.** The plankton samples were obtained from the offshore waters of the established stations in four bays, namely Iligan, Gingoog, Butuan and Sarangani, all are located in Mindanao waters (Figure 1). Iligan Bay is found at the northern part of Mindanao islands. It is separated in the south by Gingoog and Macajalar Bay from the coast of Northern Mindanao, and in north by the Mindanao Sea from Bohol. It is "U" shaped and is approximately 8°30'31" North latitude, 123°43'15" East longitude. It has a mouth of approximately 351 mi (560 km) and an area of about 2000 km<sup>2</sup> (Camarao 1983). The bay serves as a source of food, fish and other potential food resources such as shells and algae to the fisher folks in the nearby areas and has been identified by the Philippine Bureau of Fisheries and Aquatic Resources (BFAR) as a major fishing ground for various sea products. Gingoog Bay, which is an inlet of Bohol or Mindanao Sea, is located on the northeastern coast of Misamis Oriental approximately 122 km east of Cagayan de Oro City and 74 km west of Butuan City. Butuan Bay is located along the northeastern coast of Mindanao and is part of the Bohol Sea. It is bounded by the Visayan Sea in the North, the Gingoog Bay & Macajalar Bay in the West, the province of Agusan Del Norte & Butuan City in the South, and the province of Surigao Del Norte in the East. Sarangani Bay is a bay located on the southern tip of Mindanao in the Philippines. It opens up to the Celebes Sea on the Pacific Ocean. Sarangani Bay is situated at 6° 07' North latitude and 125° 06' East longitude. The bay encloses an area of 449.22 km<sup>2</sup> from Tampuan Pt. in Maasim to Sumbang Pt. in Glan and opens into the Mindanao and Celebes Sea. The coastline length of Sarangani Bay from Glan extending to Maasim is about 79 km having an average depth of 350 m. It is recognized as the richest tuna fishing ground in the country and known for its abundant catch of tunas, scads and flying fishes including small fishes (frigate, mackerels, roundscads) and demersal fishes (snappers, breems, groupers and moonfishes) (Portugal 2000). The bay is fringed with mangrove and coral reefs that serves as shelter and refuge for resident and transient adult and juvenile fishes of commercial and recreational importance, invertebrates and various epiflora and epifauna (De Jesus et al 2001). Within these bays, sampling was done by horizontal (towing of net for 5 minutes) and vertical (50 m depth) tows and hauls using conical plankton net (length: 1.8 m, mouth diameter: 0.45 m, mesh size opening: 300 mm). All samples collected were preserved with 5 % buffered formalin/seawater solution. Taxonomic characters for copepod identification were based on the body segmentation, number of segments, setae and spines on the antennule, antenna, maxilla, maxillipeds and paired legs. For each mounted part, the number of segments and setae were counted and the details of the urosome were noted. The number of spines of the caudal ramus was also recorded. All copepod samples were identified to species by dissection and examination following the dissection procedures and techniques of Huys & Boxshall (1991). The dissected parts as well as the whole specimen were mounted on separate glass slides using Hoyer's medium as mountant and were examined and measured using a dissecting stereomicroscope. The parts projected from the microprojector were drawn in detailed. Lengths of prosome was taken dorsally starting from the anterior margin of the cephalon to the posterior tip of the last metasomal somite while urosome was made from the anterior margin of the genital somite to the posterior tip of the caudal rami not including the setae.

The specimens were identified using the descriptions and taxonomic keys of Farran (1936), Dakin & Colefax (1940), Wilson (1950), Kasturirangan (1963), Owre & Foyo (1967), Bradford-Grieve (1994, 1999), Mulyadi (2002, 2004), and Al-Yamani et al (2011).



Figure 1. Map of Mindanao Island showing the established stations in the four chosen bays. Inset is the map of the Philippines with Mindanao Island enclosed in a diamond. Legend: ● Iligan Bay, ● Gingoog Bay, ● Butuan Bay, ● Sarangani Bay.

**Results and Discussion.** Six species of copepods were collected and identified in the designated sampling areas of Mindanao waters. Under family Pontillidae, three copepod species were identified namely, *Labidocera acuta*, *L. minuta* and *Calanopia aurivilli*. For family Calanidae, three species were described such as *Undinula vulgaris*, *Cosmocalanus darwinii* and *Canthocalanus pauper*. Although the study areas are teeming with different copepod species, these six copepods were chosen for detailed description of their morphology because they occur frequently in both the vertical and horizontal waters. Further, female and male were described for each species except for *C. pauper* in which only male species was presented.

## TAXONOMIC DESCRIPTION

### Family PONTILLIDAE

#### *Labidocera acuta* Dana, 1849 (Figures 2-7)

**Synonym:** *Pontella acuta* Dana, 1849; *Labidocera acutum* Giesbrecht, 1892 (Dakin & Colefax 1940).

**Occurrence.** This species was encountered only in the horizontal waters of Kamanga station in Sarangani Bay. The female species were commonly encountered than the male.

Description of adult female and male. Body length: females 2.30 mm, males 2.91 mm. Both sexes have elongated body and light orange coloration in live specimens. The prosome of both sexes is comprised of a cephalosome and 5 metasomal segments or pedigerous somites (Figures 2a and 2b). The female and male measures 1.45 mm and 2.16 mm, respectively. Head with an anterior margin and a pointed hook curved to the ventral aspect. Cuticular eye-lenses are present dorsally, with the male's eyes bigger than that of the female. The end corners of the prosome are pointed, which is symmetrical in female and asymmetrical in male (Kasturirangan 1963).

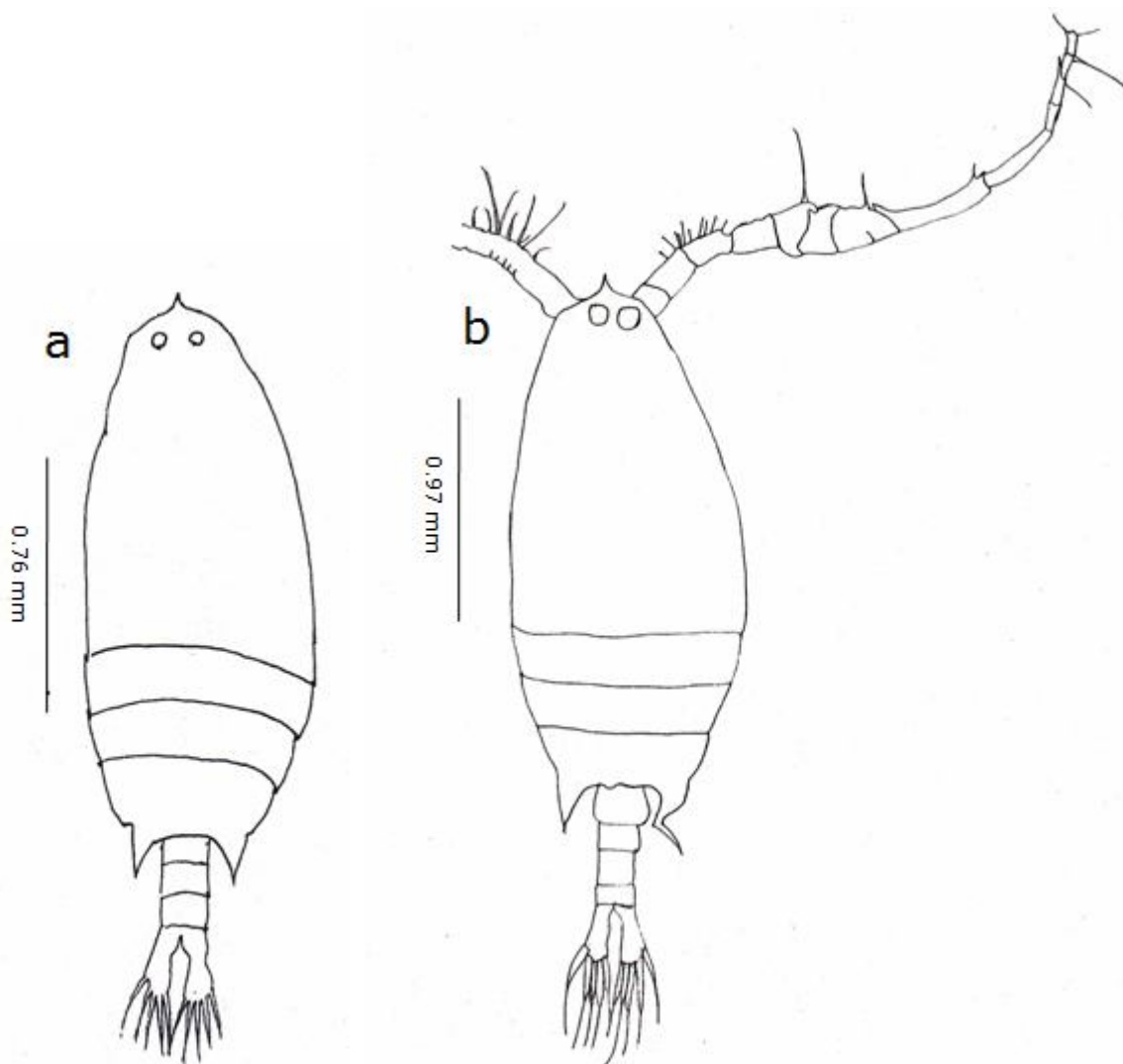


Figure 2. Dorsal view of (a) female and (b) male *Labidocera acuta* Dana.

The urosome in female is 3-segmented (Figure 3a) while it is 4-segmented in the male (Figure 3b). The caudal ramus of both sexes is moderately long and bears 5 thick setae of equal length and positioned on the distal portion of the caudal ramus.

Both the left (Figure 4a) and right (Figure 4b) antennules of the female are 24-segmented and symmetrical and measures 2.16 mm and 2.41 mm, respectively. The male antennule is 22-segmented and asymmetrical. The left antennule (Figure 5a) resembles that of the female while the right antennule (Figure 5b), which is geniculate, has fusions between segments 15 and 16. Presence of row of denticles extends between these two fused segments.

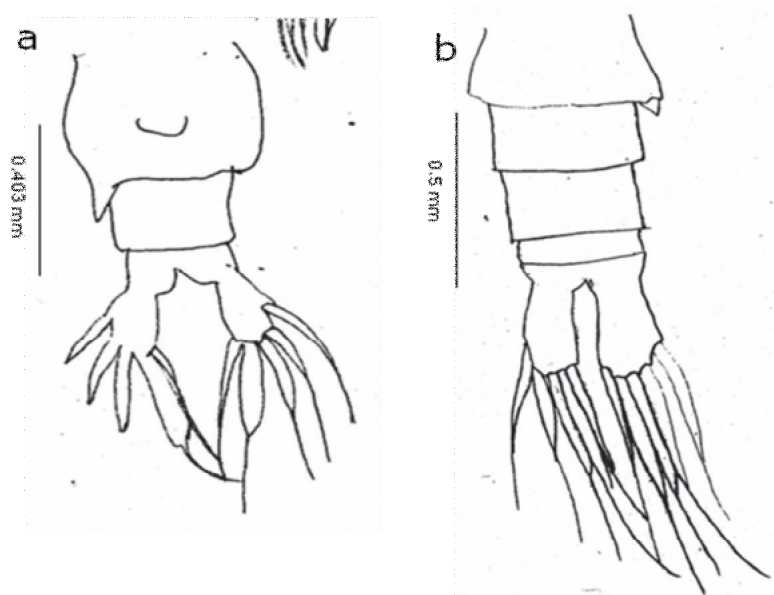


Figure 3. (a) Ventral view of female urosome and (b) dorsal view of male urosome of *Labidocera acuta* Dana.

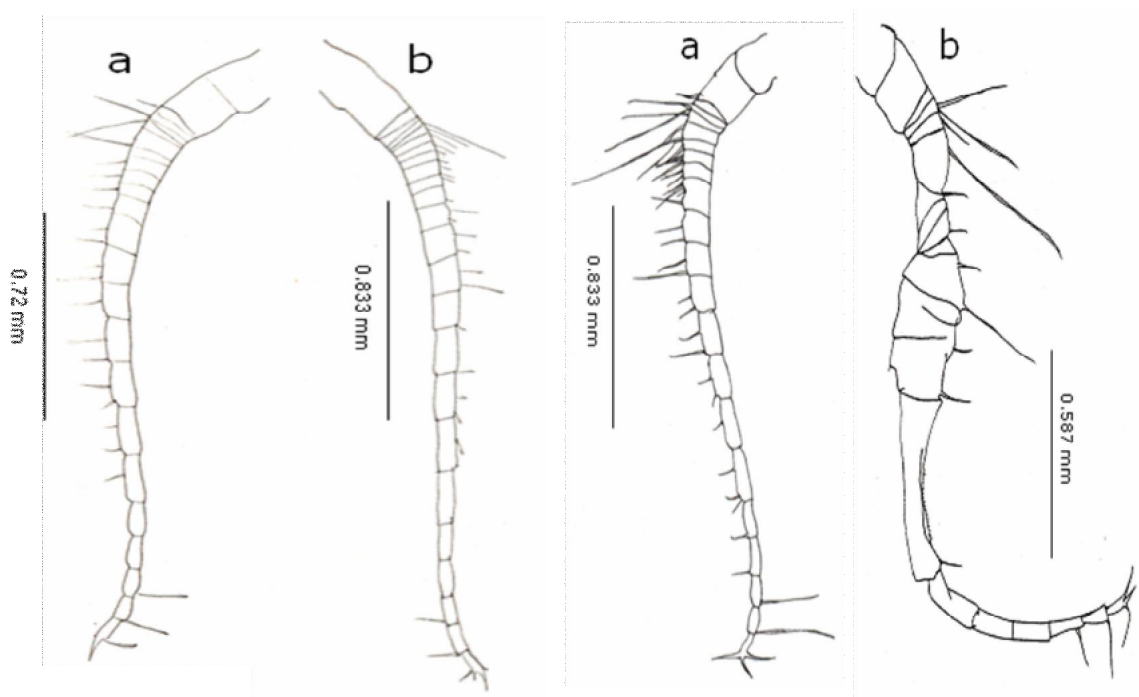


Figure 4. (a) left and (b) right antennule of female *Labidocera acuta* Dana.

Figure 5. (a) left and (b) right antennule of male *Labidocera acuta* Dana.

Swimming legs 1 to 4 of both sexes (Figures 6 a-d and 7 a-d) are biramous with all of the legs having 3-segmented exopodites and 2 segmented endopodites (Kasturirangan 1963). The swimming leg 5 of the female is also biramous, however, the exopod has an unsmooth outer margin. It measures 0.29 mm. The endopod are rudimentary and characterized by a two-pointed spine (Figure 6e) and measures 0.13 mm. For the male, swimming leg 5 is uniramous with the outer margins being smooth bearing a spine on the distal portion. The right section is longer than the left and measures 1 mm with the distal end being twisted assuming a ball-like formation (Figure 7e).

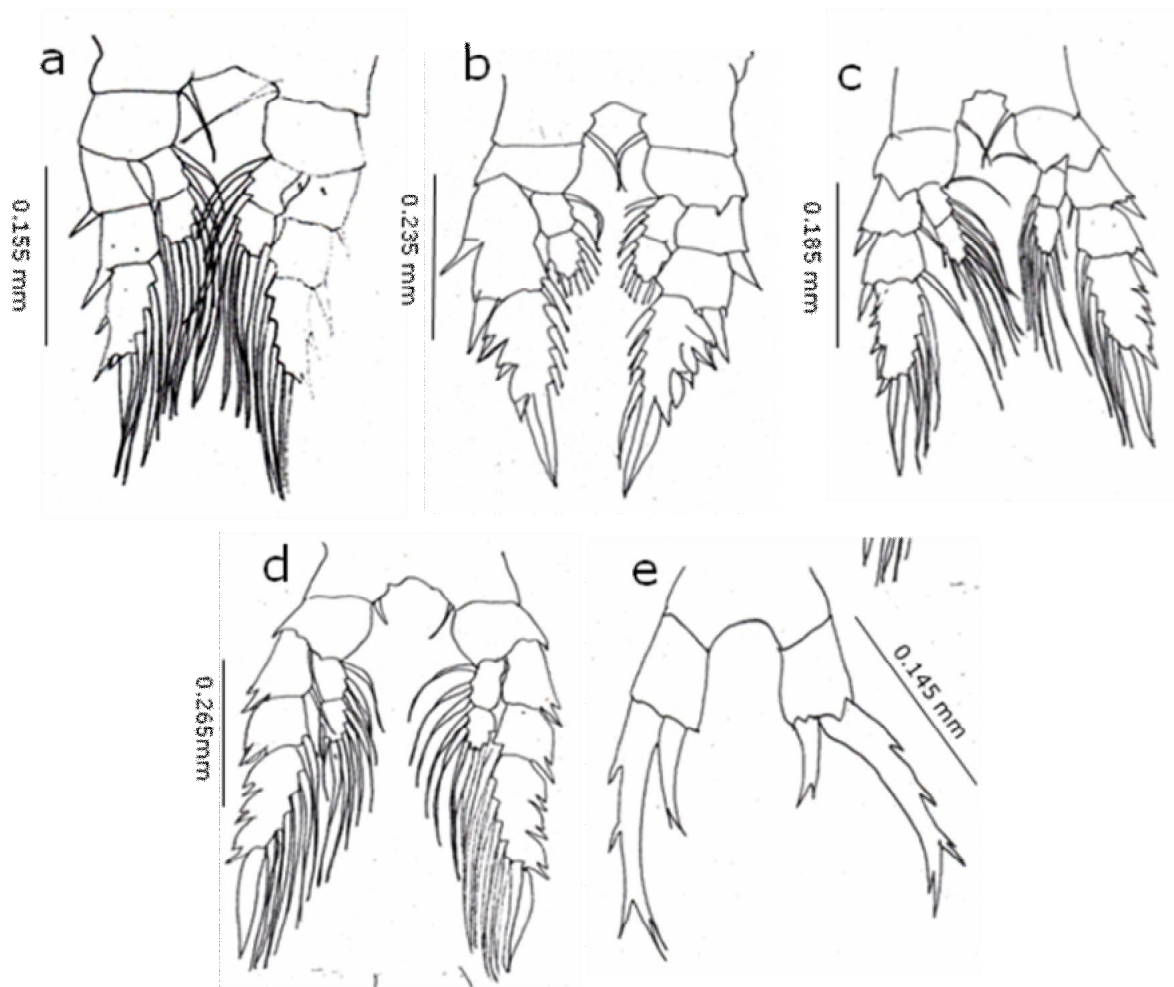


Figure 6. Female swimming (a) leg 1, (b) leg 2, (c) leg 3, (d) leg 4, and (e) leg 5 of *Labidocera acuta* Dana.

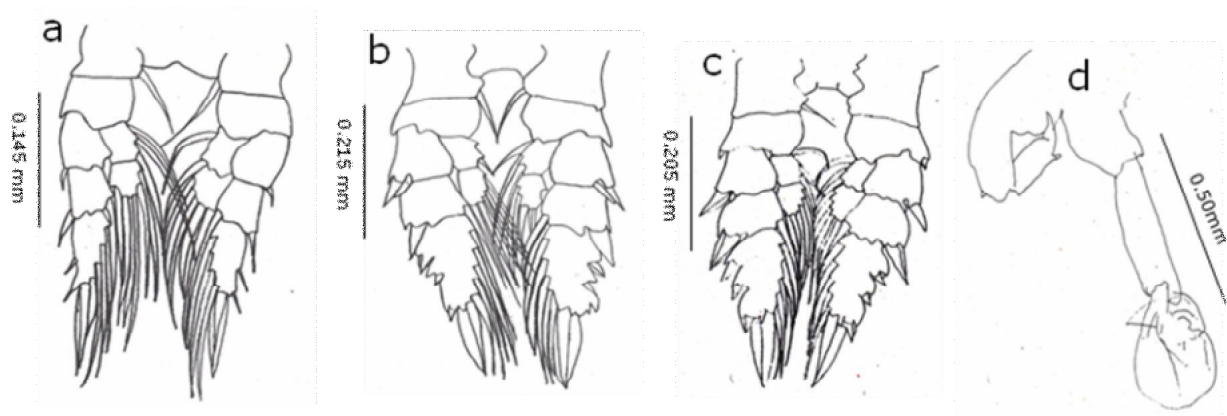


Figure 7. Male swimming (a) leg 1, (b) leg 2, (c) leg 3, and (d) leg 5 of *Labidocera acuta* Dana.

Present descriptions are similar with those described and figured by Giesbrecht (1892), Mori (1937), Kasturirangan (1963), Silas & Parameswaran (1969), Bradford-Grieve (1999), Mulyadi (2002), Othman & Toda (2006), Phukham (2008), and Al-Yamani et al (2011).



**Remarks.** Wilson (1950) also reported this species in the Philippines such as Iloilo Straits, Nasugbu Bay, Port Binanga, Luzon, and Caldera Bay anchorage in west coast of Mindanao.

**Pacific Ocean records:** Farran (1936), Mori (1937), Kasturirangan (1963), Chen & Zhang (1965), Greenwood (1979), Bradford-Grieve (1999), Mulyadi (2002), Othman & Toda (2006), Phukham (2008).

***Labidocera minuta* Giesbrecht, 1889**

(Figures 8-12)

**Synonym:** *Labidocera minutum* Giesbrecht, 1889 (Dakin & Colefax 1940).

**Occurrence.** This species was encountered only in the waters of Consuelo and Magsaysay stations in Gingoog Bay. Both sexes were frequently collected in the horizontal and vertical waters with males being more numerous than the females.

**Description of adult female and male.** Body length: females 1.73 mm, males 1.60 mm. Head end not truncated for both sexes and body with light orange coloration in live specimens. The prosome comprises of a cephalosome and a 4 free pedigerous somites for both female (Figure 8a) and male (Figure 8b). The cephalon of the female is narrow with lateral hooks and has small dorsal eye lenses. The male cephalon is the same with the cephalon of the female, however the only difference is the dorsal eye lenses in males are large and in contact with each other (Kasturirangan 1963). The posterior corners of the prosome in females are rounded with a very small projection present on the left side. Kasturirangan (1963) reported presence of this small projection located on the right side of the posterior margin of the metasome. For the male, the corners of the prosome are drawn out into spines, with the right side ending in short pointed process while the left side bearing longer and somewhat spatulate spine.

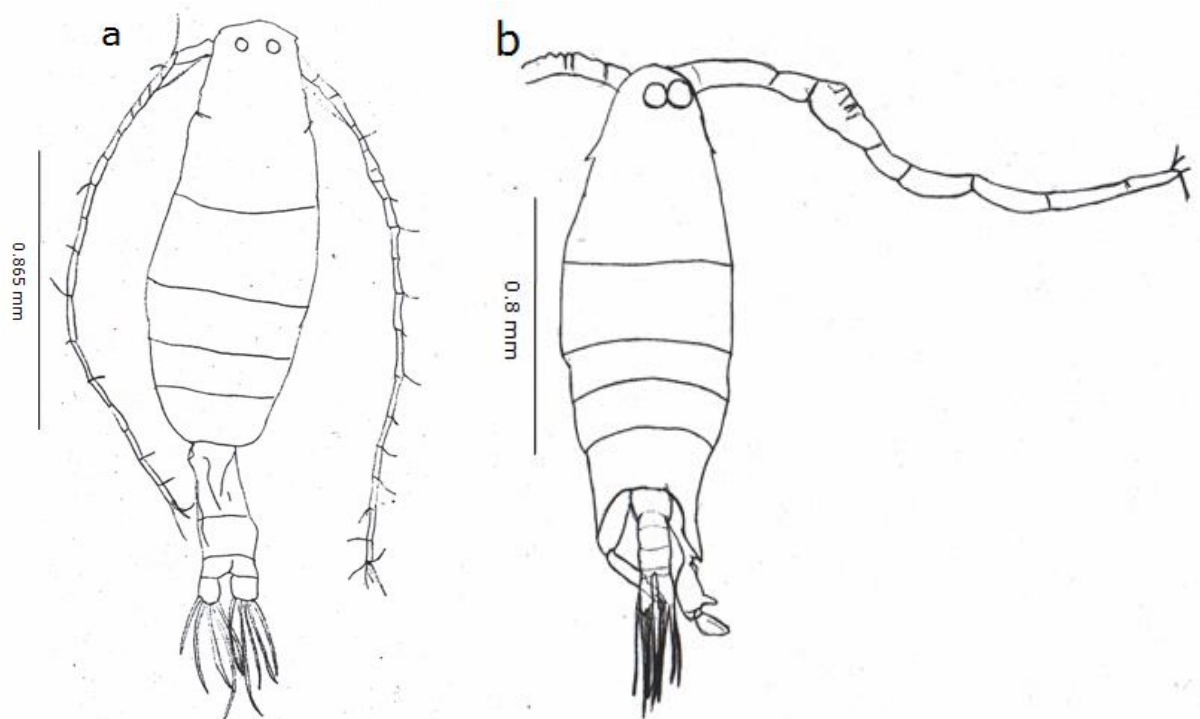


Figure 8. Dorsal view of (a) female and (b) male *Labidocera minuta* Giesbrecht.

The female urosome is 3-segmented (Figure 9a), with the genital segment being asymmetrical. It measures 0.51 mm. The first segment in the urosome is elongated and as long as the second and third segments combined. The right posterior corner is modified into 1 short lobular projection partly overlapping the second segment laterally. The anal segment is asymmetrical, right lateral outwardly produced. The urosome of the male is 5-segmented and measures 0.39 mm (Figure 9b). Each caudal ramus has 5 setae. The length of the urosome including the caudal ramus is 0.51 mm for female and 0.39 mm for male.

Both antennules of the female are 19-segmented (Figures 10 a,b) and measures 2.08 mm for the right and 2.10 mm for the left antennule. For the male, the left antennule is 21-segmented (Figure 10c) and measures 1.30 mm, while the right side, where geniculation occurs, is 14-segmented and measures 1.27 mm (Figure 10d).

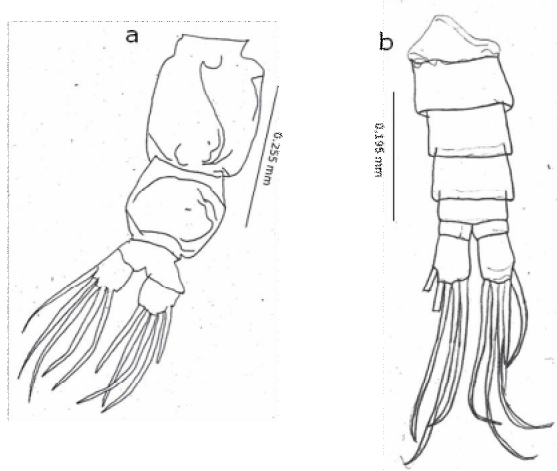


Figure 9. Ventral view of (a) female urosome and dorsal view of (b) male urosome.

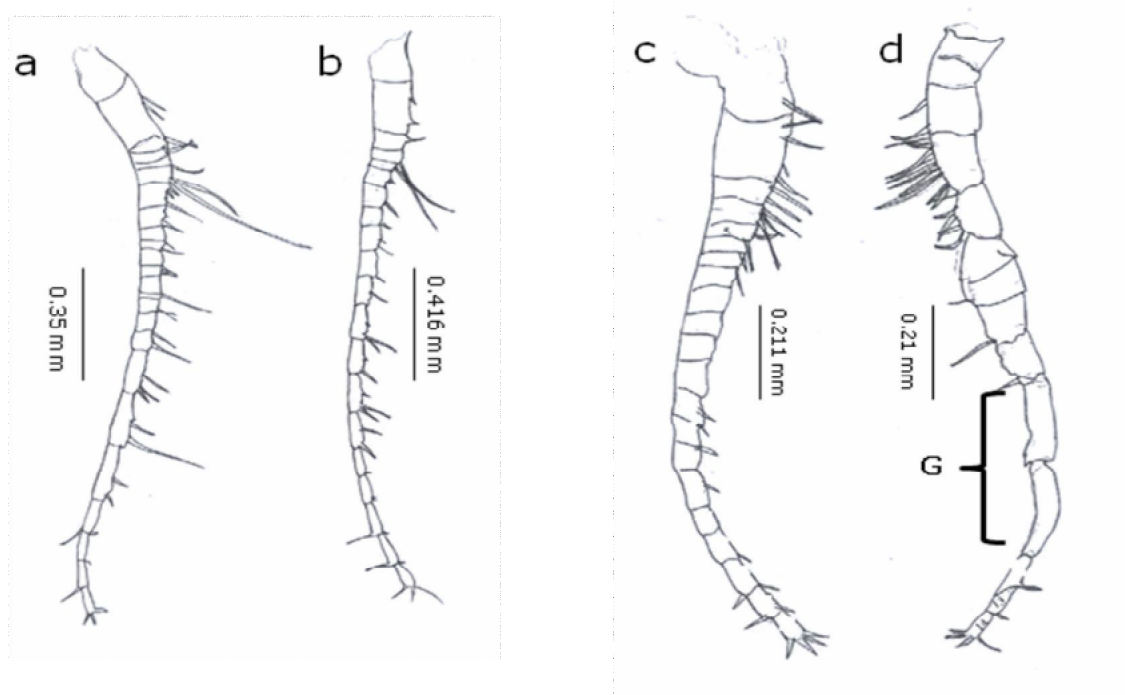


Figure 10. Female (a) right and (b) left antennules; male (c) left and (d) right antennules of *Labidocera minuta* Giesbrecht. G - geniculation.



Swimming legs 1 to 4 of both sexes are biramous (Figures 11 a-d and 12 a-d) with all of the legs having 3-segmented exopodites and 2-segmented endopodites (Kasturirangan 1963). The swimming leg 5 for female is biramous (Figure 11e) with the left leg having slightly longer exopodal segment ending in 2 subequal spine and 2 outer marginal spines, while the endopodal segments are somewhat bifurcated at the apex. In male, leg 5 is uniramous (Figure 12e) with the terminal segment of the left leg having at least 3-lobe like projections. In the right leg the second segment is bent inwards at distal half, the inner margin with 1 transparent flap, right thumb of chela short, broader toward tip with 1 process, and truncate (Mulyadi 2002).

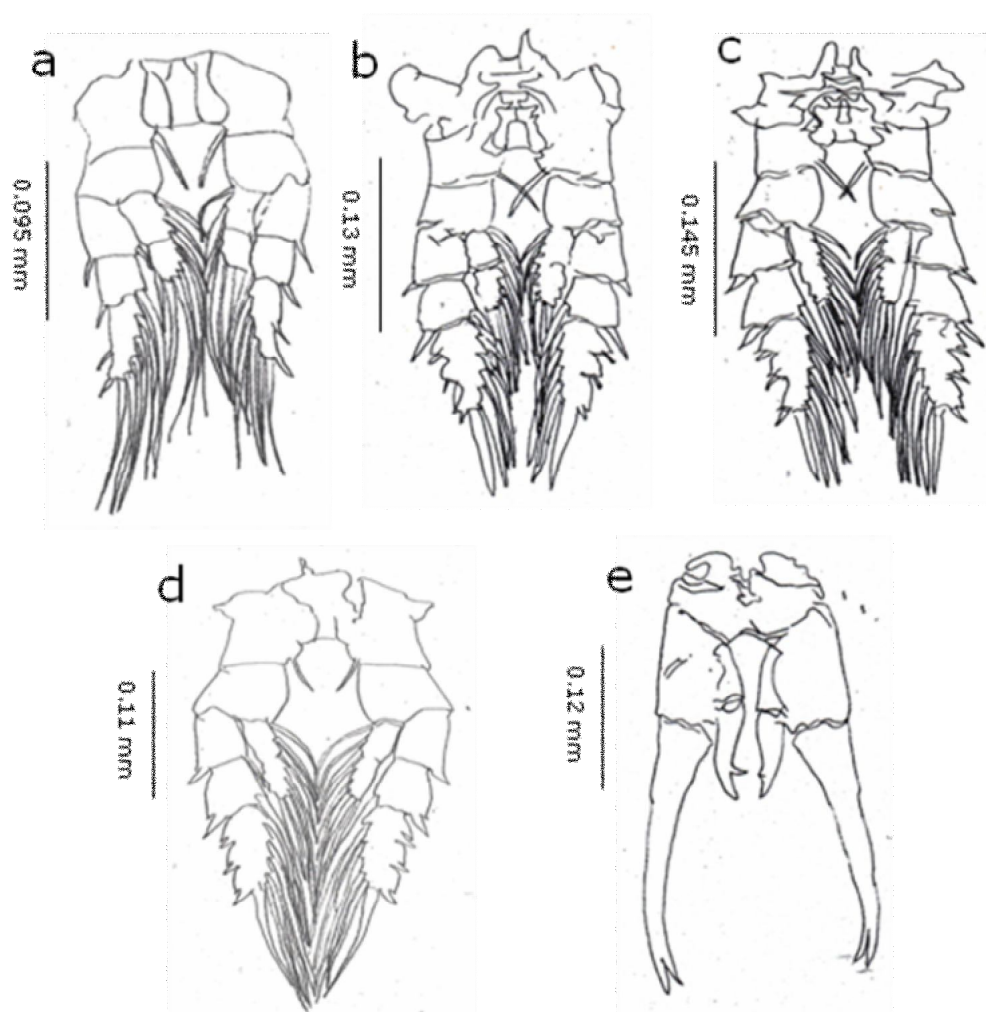


Figure 11. Female swimming (a) leg 1, (b) leg 2, (c) leg 3, (d) leg 4, and (e) leg 5 of *Labidocera minuta* Giesbrecht.

The present records are similar with those described and figured by Giesbrecht (1889), Wilson (1950), Kasturirangan (1963), Chen & Zhang (1965), Tanaka (1964), Bradford-Grieve (1999), Mulyadi (2002), Othman & Toda (2006), Phukham (2008), and Al-Yamani et al (2011).

Pacific Ocean records: Farran (1936), Kasturirangan (1963), Tanaka (1964), Chen & Zhang (1965), Greenwood (1979), Bradford-Grieve (1999), Mulyadi (2002), Othman & Toda (2006), Phukham (2008).

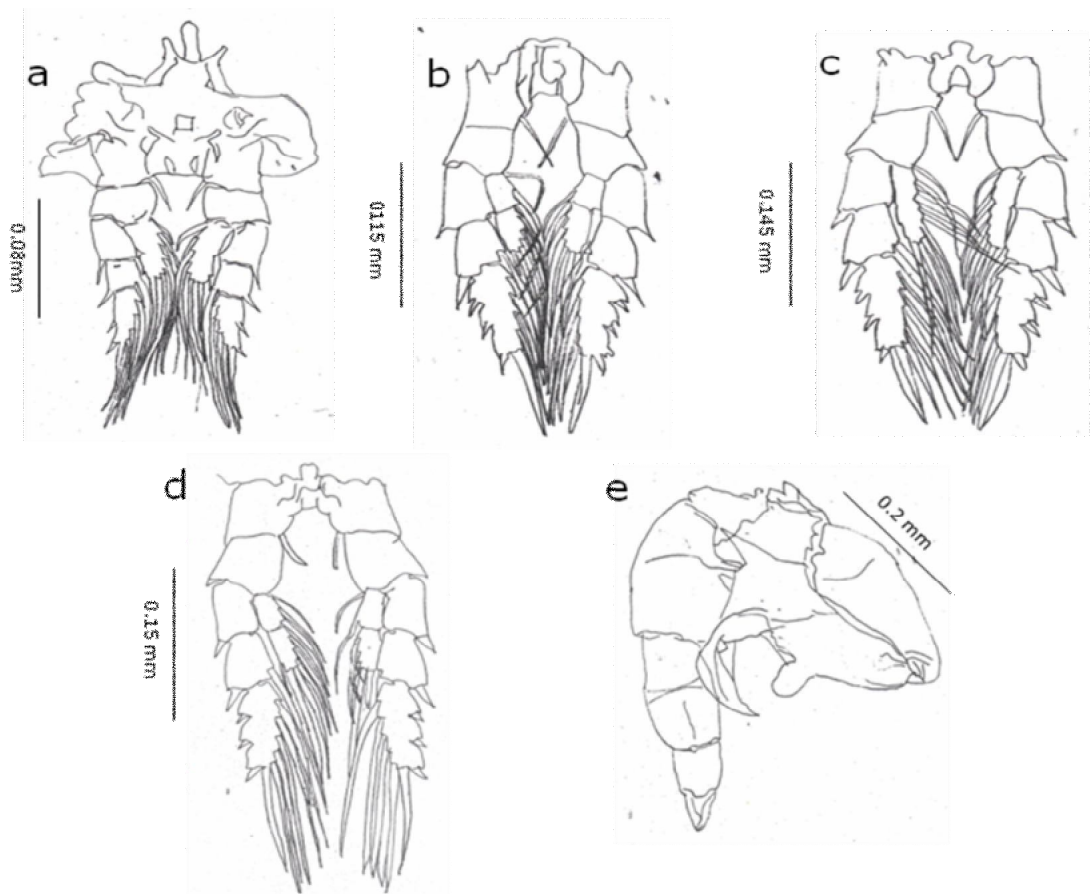


Figure 12. Male swimming (a) leg 1, (b) leg 2, (c) leg 3, (d) leg 4, and (e) leg 5 of *Labidocera minuta* Giesbrecht.

***Calanopia aurivilli* Cleve, 1901**  
(Figures 13-18)

**Occurrence.** This species was encountered only in the waters of Aloran station in Iligan Bay. Both sexes were frequently collected in the horizontal and vertical waters with males being dominant in numbers than the females.

**Description of adult female and male.** Body length: females 1.560 mm, males 1.500 mm. Typical copepodan part is possessed by both sexes. The prosome, which is comprised of the cephalosome and 5 metasomal segments, is differently shaped in both sexes. The female is oblongately shaped (Figure 13a), while male is elongate (Figure 13b). Cephalon has no lateral hooks and no cuticular eyes. The posterior corner of the last metasomal segment for both sexes is drawn out into spines. Rostrum tapers posteriorly and bulged proximally (Figure 13 c,d) (Mulyadi 2002).

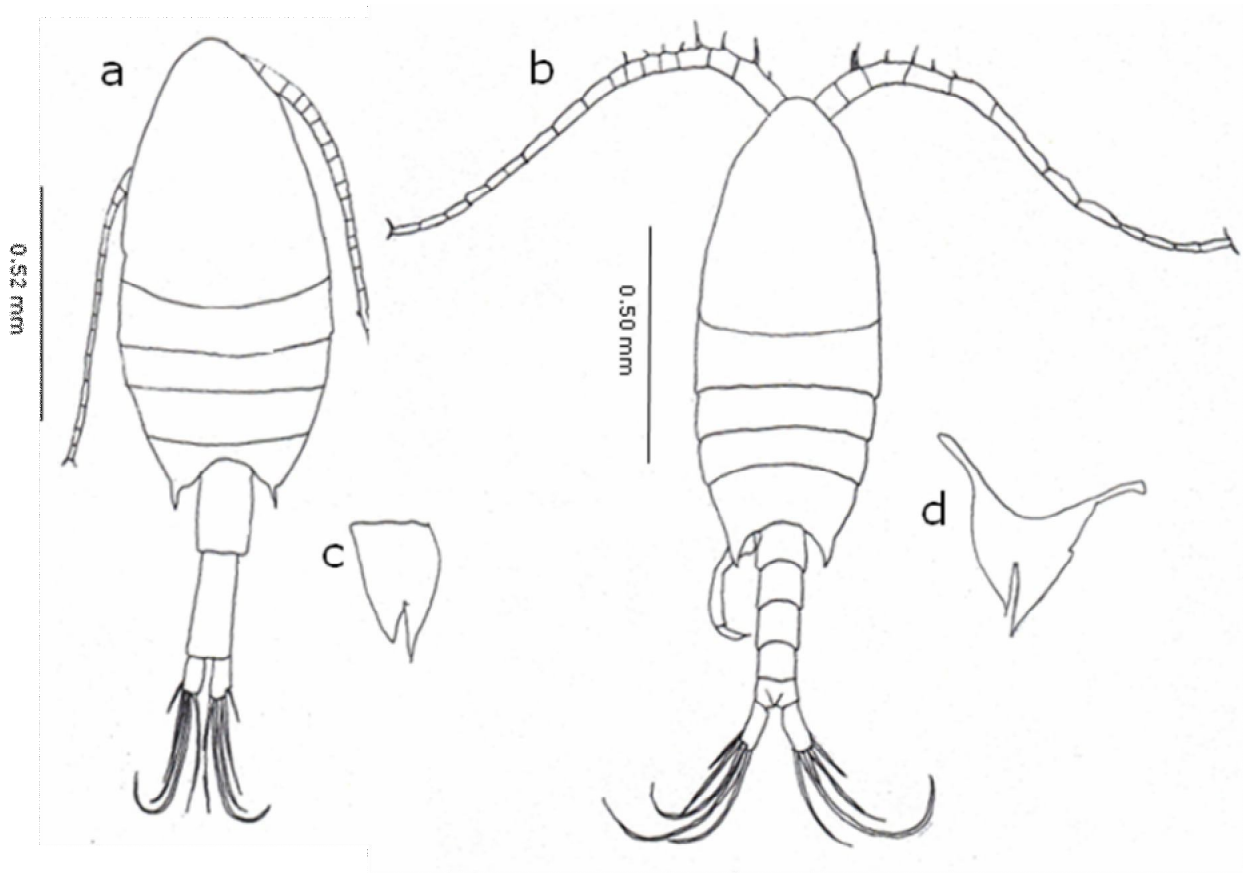


Figure 13. Dorsal view of (a) female and (b) male *Calanopia aurivilli* Cleve. Anterior view of rostrum in (c) female and (d) male.

The female urosome is 2-segmented (Figure 14a), with the genital aperture located ventrally and is seen as a slit with two small circles. The urosome of the male is 5-segmented (Figure 14b). The caudal ramus of both sexes bears 6 setae with the second seta distinctly longer than the rest. The length of the urosome including the caudal ramus is 0.510 mm for female and 0.450 mm for male.

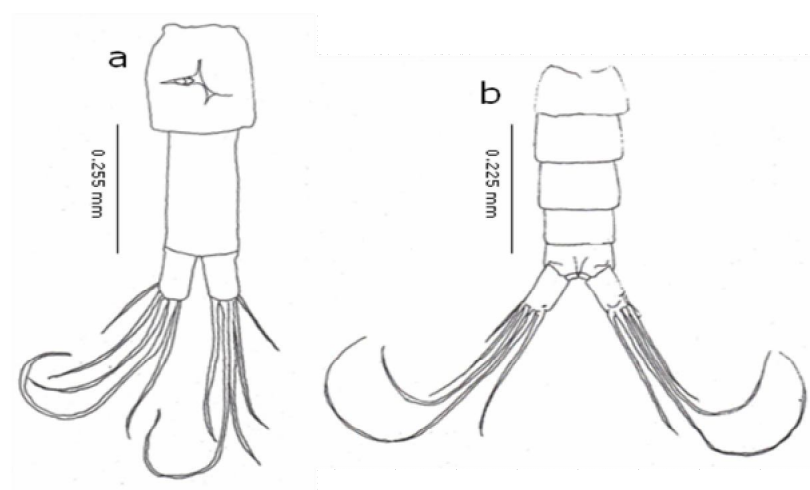


Figure 14. (a) Ventral view of female urosome and (b) dorsal view of male urosome of *Calanopia aurivilli* Cleve.

Both antennules of the female are 17-segmented (Figures 15 a,b) and measures 0.8790 mm for the right and 0.900 mm for the left antennule. For the male, the left antennule is 17-segmented (Figure 16a) and measures 0.930 mm, while the right side is 12-segmented, measuring 0.900 mm and geniculates at segments seven and eight (Figure 16b). The antennules of both sexes are terminated with two setae, each being distributed at the inner and outer margins.

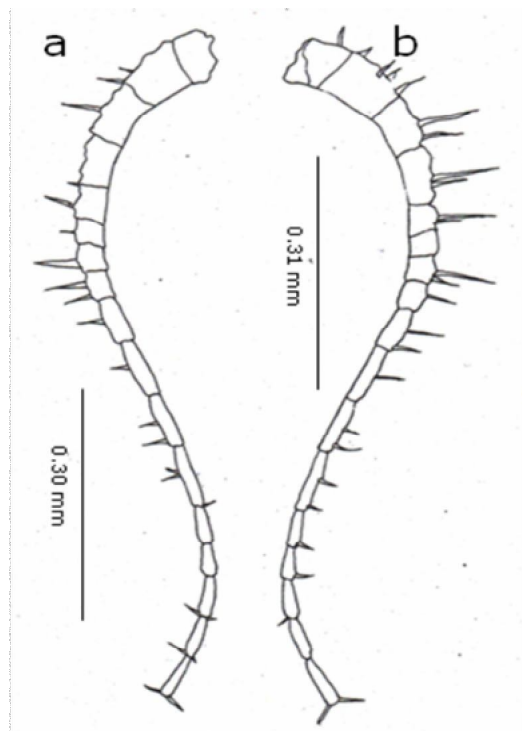


Figure 15. (a) Left and (b) right antennule of female *Calanopia aurivilli* Cleve.

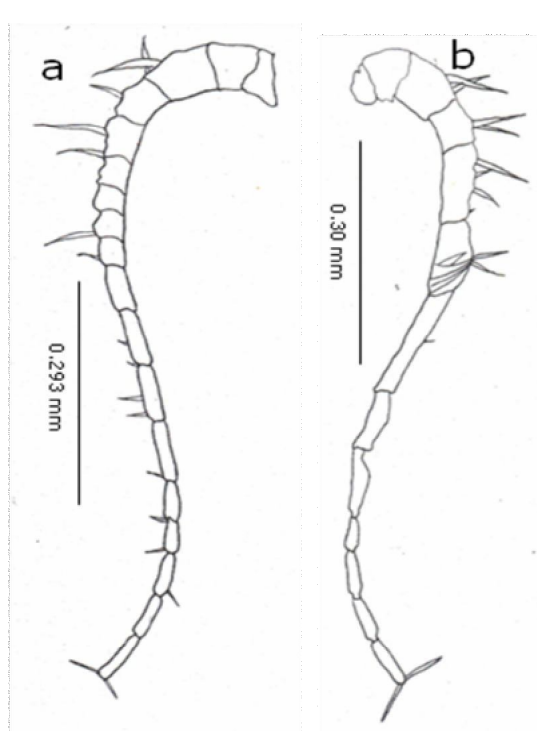


Figure 16. (a) Left and (b) right antennule of male *Calanopia aurivilli* Cleve.

Swimming legs 1 to 4 of both sexes are biramous (Figures 17 a-d and 18 a-d) with all of the legs having 3-segmented exopodites and 2-segmented endopodites. Both the swimming legs 5 for female are biramous, symmetrical, measures 0.330 mm and are 4-segmented (Figure 17e). The terminal segment has long slender seta and two pointed teeth located at the outer margin. In male, leg 5 is uniramous with the left leg being 3-segmented and measures 0.300 mm (Figure 18e). Its third segment is raised into a claw which has a small flat plate in the middle and two sharp hooks at both ends. The right leg measures 0.330 mm and is 4-segmented. The fourth segment is developed into a pointed elongate structure.

The above descriptions are similar with those described and figured by Kasturirangan (1963), Bradford-Grieve (1999), Mulyadi (2002), Othman & Toda (2006) and Phukham (2008). Except for the difference in the number of segments in female antennule and swimming leg 5 where Mulyadi (2002) observed 18 segments for the female antennule, while the present study described only 17, female swimming leg 5 reported as 3-segmented, however we observed 4-segmented for leg 5.

**Remarks.** Wilson (1950) also reported this species in Sabtan Island, Philippines.

**Pacific Ocean records:** Scott (1909), Farran (1936), Kasturirangan (1963), Silas & Pillai (1973), Bradford-Grieve (1999), Mulyadi (2002), Othman & Toda (2006), Phukham (2008).

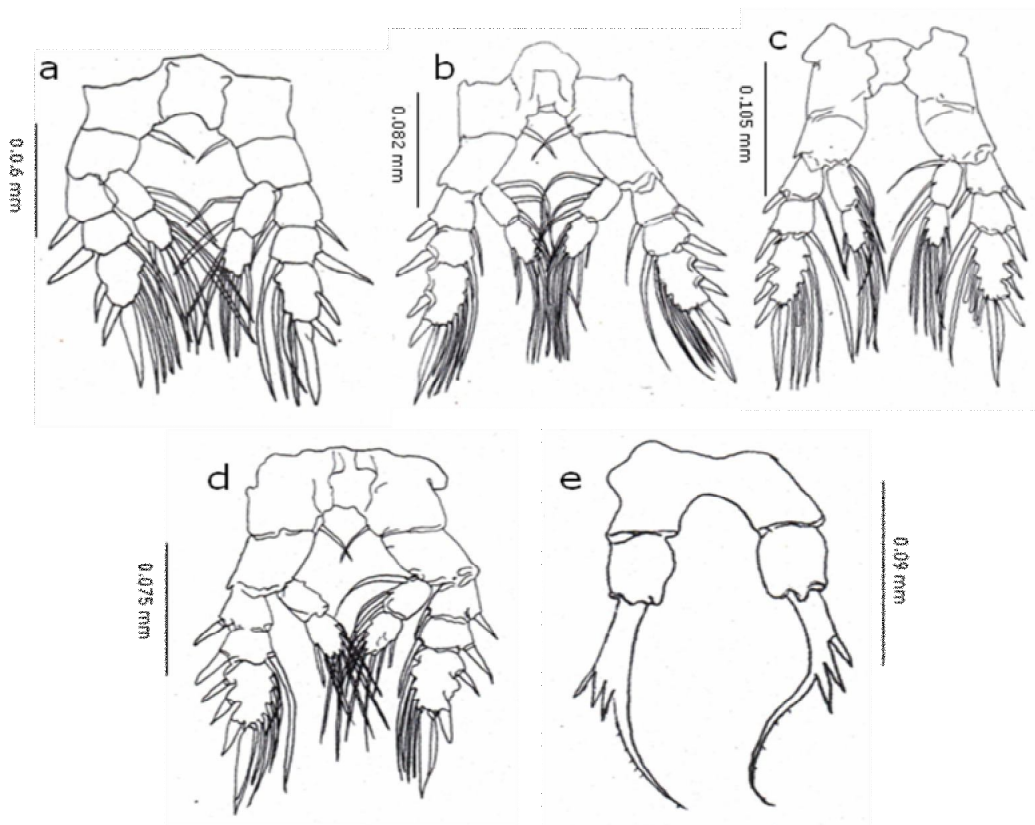


Figure 17. Female swimming (a) leg 1, (b) leg 2, (c) leg 3, (d) leg 4, and (e) leg 5 of *Calanopia aurivilli* Cleve.

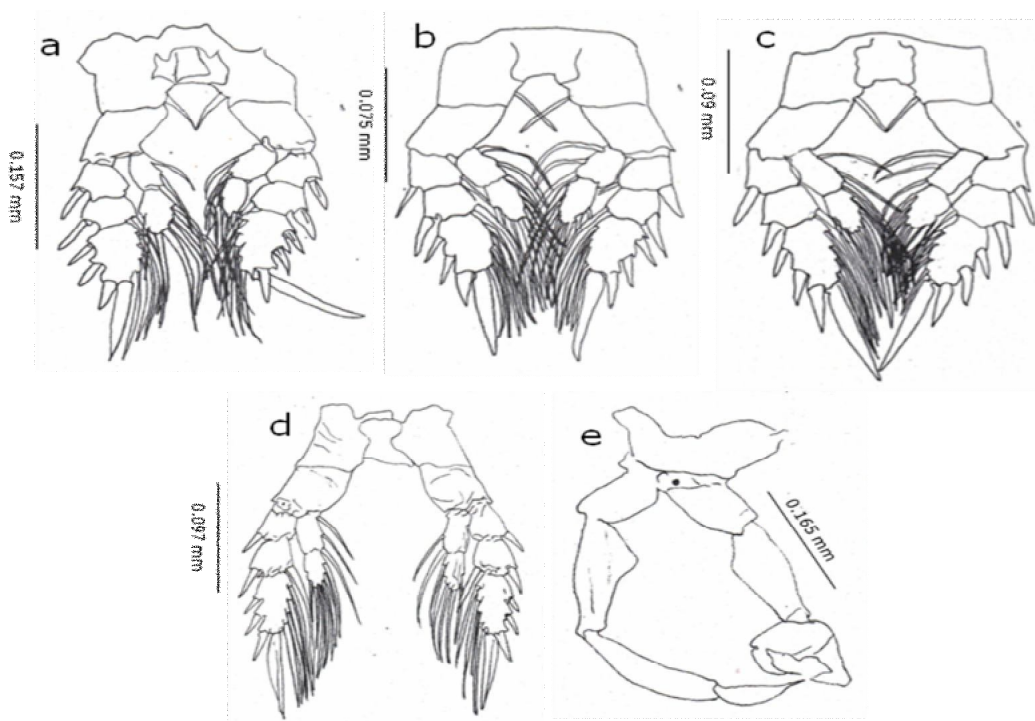


Figure 18. Male swimming (a) leg 1, (b) leg 2, (c) leg 3, (d) leg 4, and (e) leg 5 of *Calanopia aurivilli* Cleve.



## Family CALANIDAE

### *Canthocalanus pauper* Giesbrecht, 1888

(Figures 19-22)

Synonym: *Calanus pauper* Giesbrecht, 1888.

Occurrence. The male species were frequently encountered only in the horizontal and vertical waters in all stations in Sarangani Bay. No females were observed.

Description of adult male. Body length is 1.75 mm. The species have slender body and brown coloration in live specimens. The prosome comprises of cephalosome and 5 metasomal segments (Figure 19). It measures 1.36 mm and is 4.5 times longer than the urosome. The posterolateral ends of the last metasomal segment and is narrowly rounded (Mulyadi 2004).

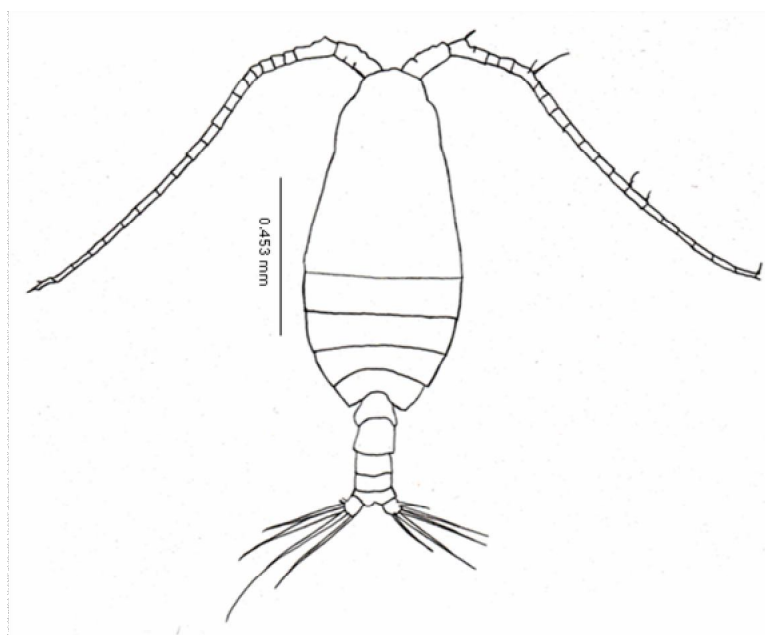


Figure 19. Dorsal view of male *Canthocalanus pauper* Giesbrecht.

The urosome is 5-segmented (Figure 20) and measures 0.40 mm. The prosome-urosome articulation is between the last metasomal segment and genital somite. Each of the caudal ramus has 5 setae and is noticeably spread apart. The first seta is the shortest, the second, third and fifth setae are of the same length while the fourth seta is the longest.

The antennule is uniramous and comprise of 23 segments. The right antennule (Figure 21a) bears 1 seta on the outer margins of segments 1, 2, 4, 8, 10, 11, 13, 17, 20, and 1 seta on the outer margin of segment 21, while segment 23 bears 1, 1, 2 setae on the outer margin, on the inner margin and on its distal end, respectively. The left (Figure 21b) and right antennule measures 1.13 mm and 1.20 mm, respectively. No geniculation was observed.



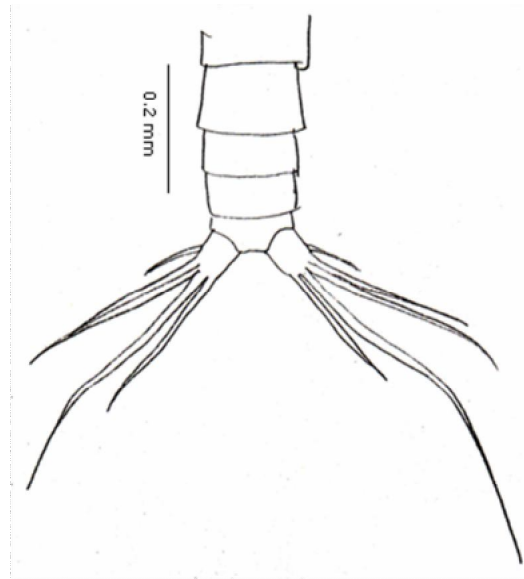


Figure 20. Urosome of male *Canthocalanus pauper* Giesbrecht.

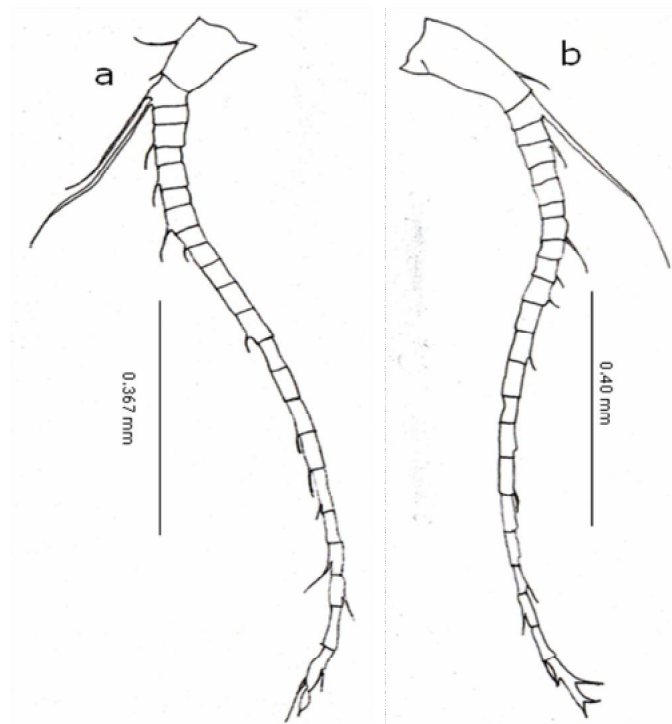


Figure 21. Male (a) left and (b) right antennules of *Canthocalanus pauper* Giesbrecht.

Swimming legs 1 to 4 (Figure 22 a-d) are biramous bearing 3-segmented exopod and endopod. Leg 5 is asymmetrical (Figure 22e). Left leg is 3-segmented, prehensile and flexed outward. The endopod of the left leg ends with two terminal setae, while the exopod bears a seta on the outer region of the second segment and two apical setae on the third segment. Right leg is also 3-segmented, with the exopod devoid of inner marginal setae.

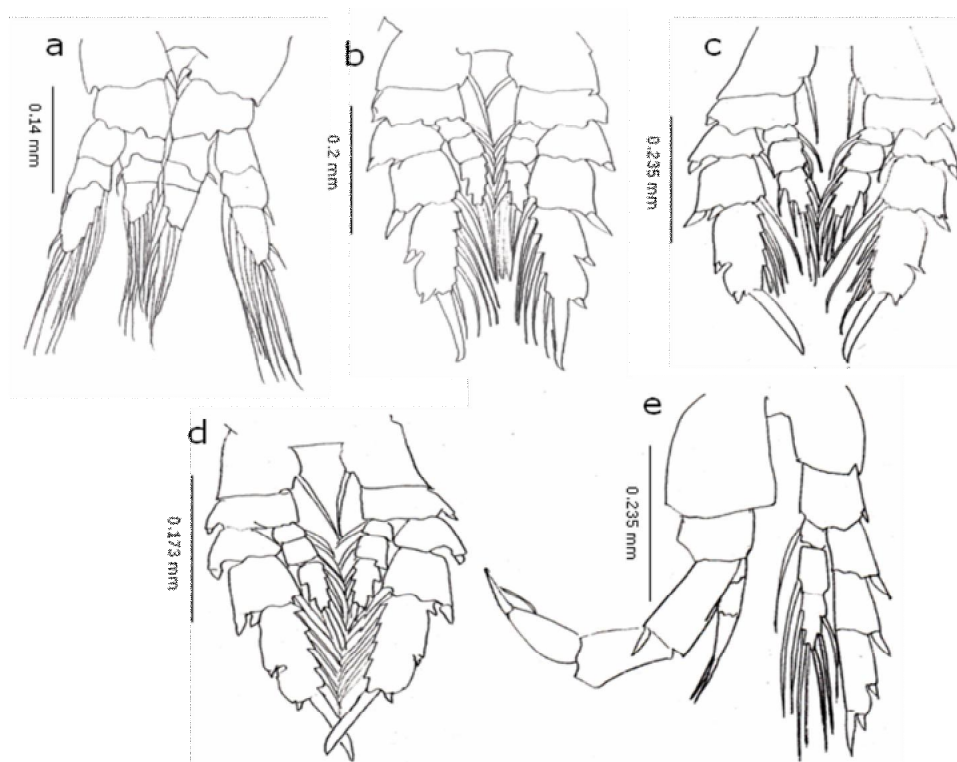


Figure 22. Male swimming (a) leg 1, (b) leg 2, (c) leg 3, (d) leg 4, and (e) leg 5 of *Canthocalanus pauper* Giesbrecht.

The above descriptions are similar with those described and figured by Kasturirangan (1963), Bradford-Grieve (1994), Mulyadi (2004), and Al-Yamani et al (2011).

**Remarks.** Wilson (1950) also reported this species in the Iloilo Straits of the Island of the Philippines.

**Pacific Ocean records:** Farran (1936), Dakin & Colefax (1940), Kasturirangan (1963), Bradford-Grieve (1994), Mulyadi (2004).

### ***Undinula vulgaris* Dana, 1849** (Figures 23-28)

**Synonym:** *Calanus vulgaris* Giesbrecht, 1888; Giesbrecht & Schmeil, 1898; Farran (1929); Dakin and Colefax (1940); *Calanus vulgaris plumosus* Wolfende (1905); *Calanus orientalis* Marukawa (1908); *Stephos perplexus* Wilson (1950).

**Occurrence.** Both sexes were commonly encountered only in the vertical and horizontal waters of all stations in Butuan Bay. However, females were observed to be quite numerous compared to the males

**Description of adult female and male.** Body length: female is 2.574 mm, male is 2.223 mm. Both sexes are semi-transparent in coloration in live specimens. The body is oblongated with the head rounded anteriorly for female but narrower in male (Mulyadi 2004). Both sexes have prosome that comprises of cephalosome and 5 metasomal segments (Figure 23a,b). The posterior margins of the metasome in female are drawn out into a spine (Figure 24a), which is quite shorter compared to those shown by Kasturirangan (1963), Bradford-Grieve (1994) and Mulyadi (2004). In the male, the posterior margin of the metasome is symmetrically rounded (Figure 23b).

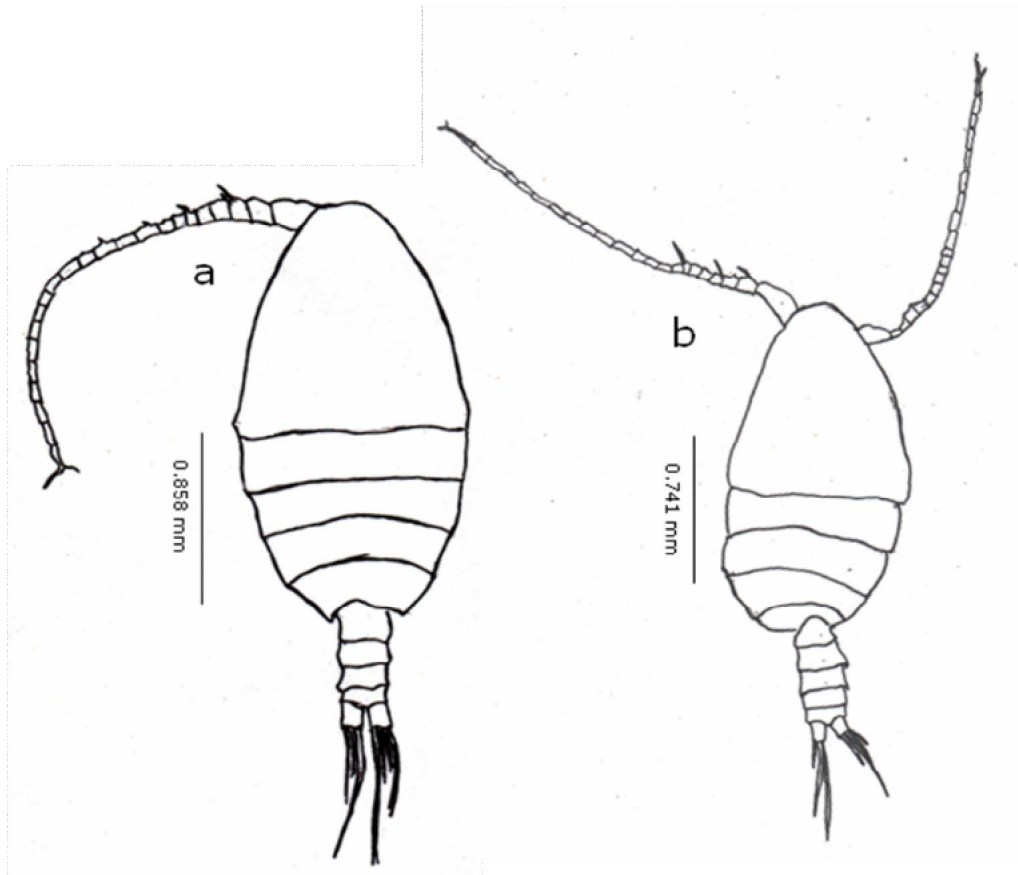


Figure 23. Dorsal view of (a) female and (b) male *Undinula vulgaris* Dana.

The female urosome (Figure 24a) is 4-segmented with the genital segment being the longest while the anal segment being the shortest (Mulyadi 2004). Its caudal rami are wider compared to the male, with each ramus harboring 5 setae. The second seta is the longest, while the fifth is the shortest among the other setae. The male urosome (Figure 24b) is 5-segmented with each caudal ramus having 5 setae. The urosome together with the caudal ramus measures 0.884 mm in female and 0.936 mm in male.

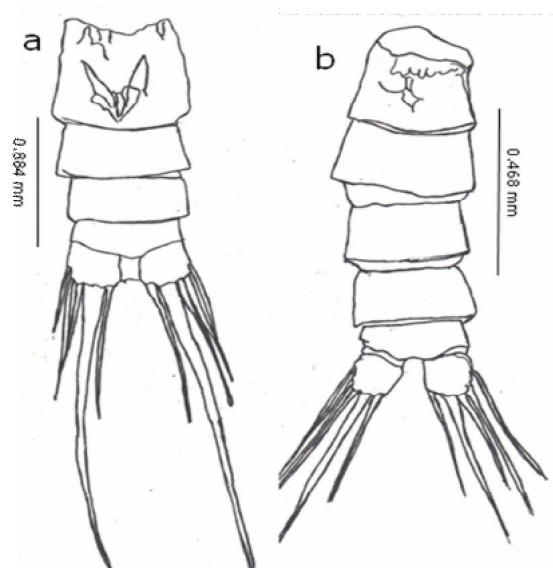


Figure 24. (a) Ventral view of female and (b) dorsal view of urosome of male *Undinula vulgaris* Dana.

The antennules of both sexes are uniramous (Figures 25-26). For the female, the left antennule (Figure 25a) is 23-segmented and measures 3.081 mm. The sixth, and eighth to fifteenth segments bear fine hairs. In the right antennule (Figure 25b), it is 24-segmented and measures 2.964 mm. For the male, the left antennule is 23-segmented (Figure 26a) and measures 1.300 mm. The right antennule (Figure 26b), where geniculation occurs, is much shorter than the left, measuring 1.235 mm and is 21-segmented. The segments that is associated with the geniculation occurred from second to the sixth segments.

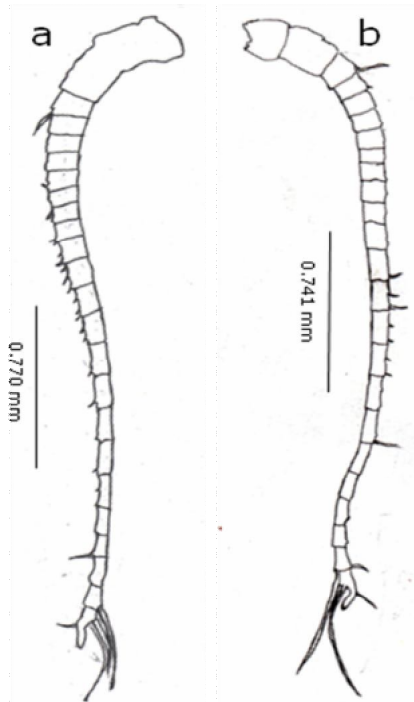


Figure 25. (a) Left and (b) right antennule of female *Undinula vulgaris* Dana.

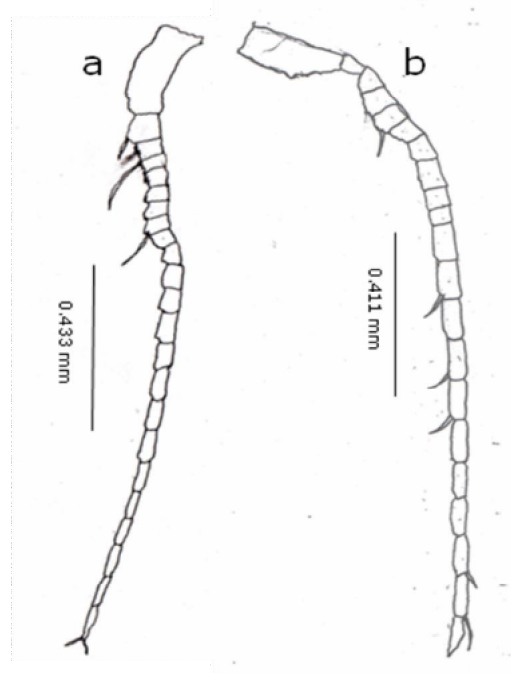


Figure 26. (a) Left and (b) right antennule of male *Undinula vulgaris* Dana.

Swimming legs 1 to 4 of both sexes are biramous (Figures 27 a-d and 28 a-d) with all of the legs having 3-segmented exopodites and endopodites. Swimming legs 1 to 5 in female are the same and fully setose, except that the terminal spine on the last exopod segments in leg 5 (Figure 27e) did not point inward (Kasturirangan 1963). For both sexes, the outer margins of the second exopodal segment in leg 2 (Figures 27b and 28b) have a deep notched (as noted by red arrow) (Kasturirangan 1963) or invagination (Mulyadi 2004). In male, leg 5 is highly modified in structure (Figure 28e) and asymmetrical. The right leg, which is shorter, is biramous having 3-segmented exopods and endopods. The exopodites are much longer than the endopods. The left leg is uniramous, with 2-segmented exopods but no endopods (Mulyadi 2004). The exopodites are very long (Mulyadi 2004) that folds like a "Z" (Kasturirangan 1963).

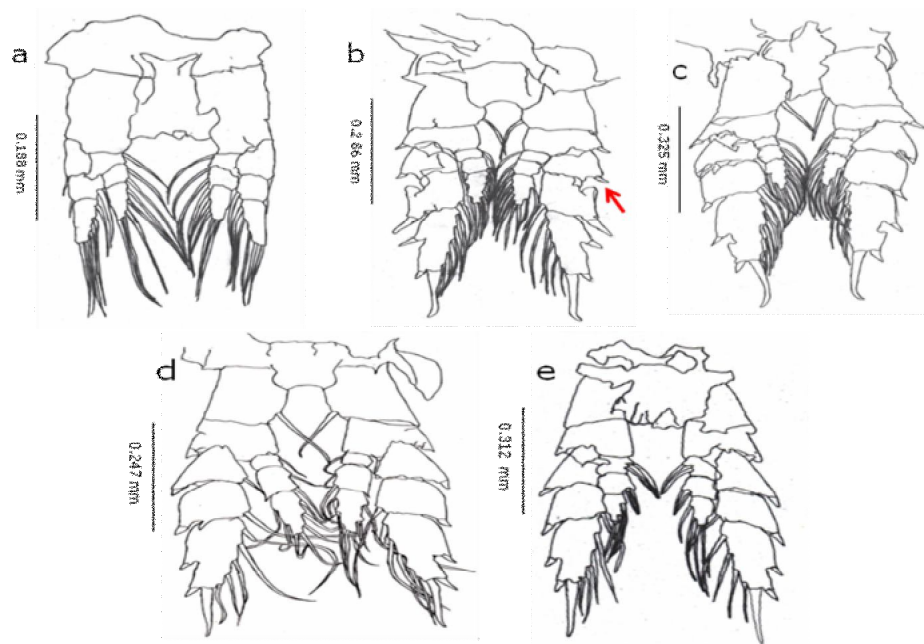


Figure 27. Female swimming (a) leg 1, (b) leg 2, (c) leg 3, (d) leg 4, and (e) leg 5 of *Undinula vulgaris* Dana.

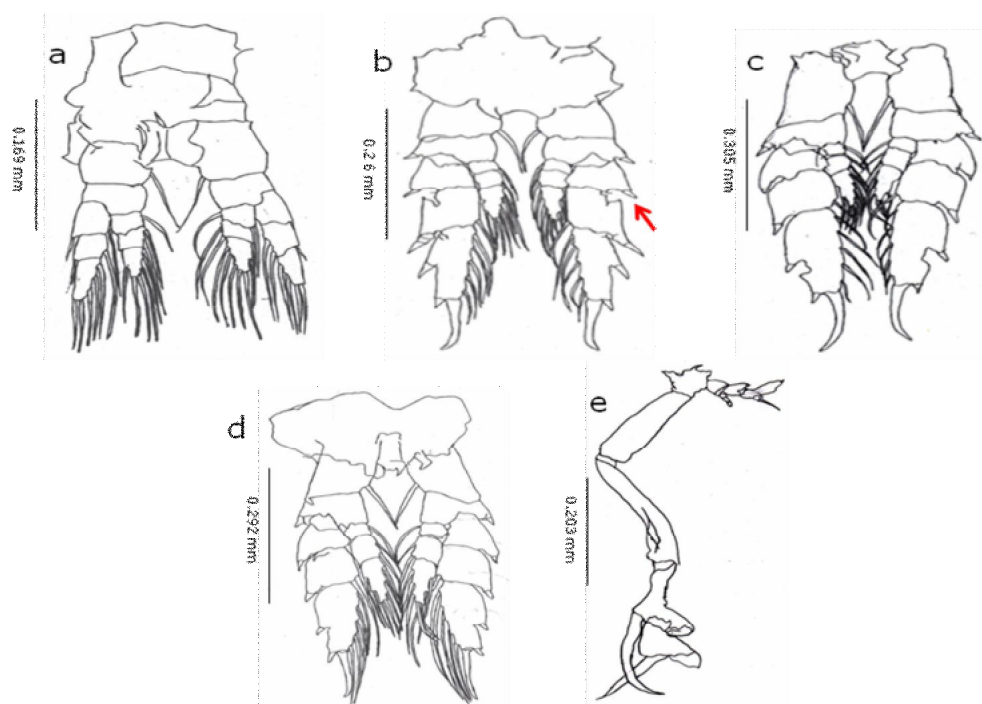


Figure 28. Male swimming (a) leg 1, (b) leg 2, (c) leg 3, (d) leg 4, and (e) leg 5 of *Undinula vulgaris* Dana.

The above descriptions are similar with those described and figured by Mori (1937), Kasturirangan (1963), Chen & Zhang (1965), Owre & Foyo (1967), Bradford-Grieve (1994), Bradford-Grieve et al (1999), Mulyadi (2004), and Phukham (2008).

**Remarks.** Wilson (1950) also reported this species in different islands in the Philippines, namely the Iloilo Straits, Caldera Bay anchorage in west coast of Mindanao, and Sabtan Island.

Pacific Ocean records: Mori (1937), Dakin & Colefax (1940), Kasturirangan (1963), Chen & Zhang (1965), Bradford & Jillett (1974), Bradford-Grieve (1994), Bradford-Grieve et al (1999), Mulyadi (2004), Phukham (2008).

***Cosmocalanus darwinii* Lubbock, 1860**  
(Figures 29-34)

Synonym: *Undinula darwinii* Lubbock, 1860

Occurrence. Both sexes were frequently encountered only in the horizontal and vertical waters of Iligan City proper, Tag-ibo, Biga, Manticao, Initao, Libertad and Gitagum, Misamis Oriental stations in Iligan Bay. Males were numerous than the females.

Description of adult female and male. Body length: female is 1.70 mm, male is 1.60 mm. The species have oblongated body and dark brown coloration in live specimens. Both sexes have prosome that comprises of cephalosome and 5 metasomal segments, with the posterior corners of the last metasomal segment being symmetrical and rounded (Figure 29 a,b).

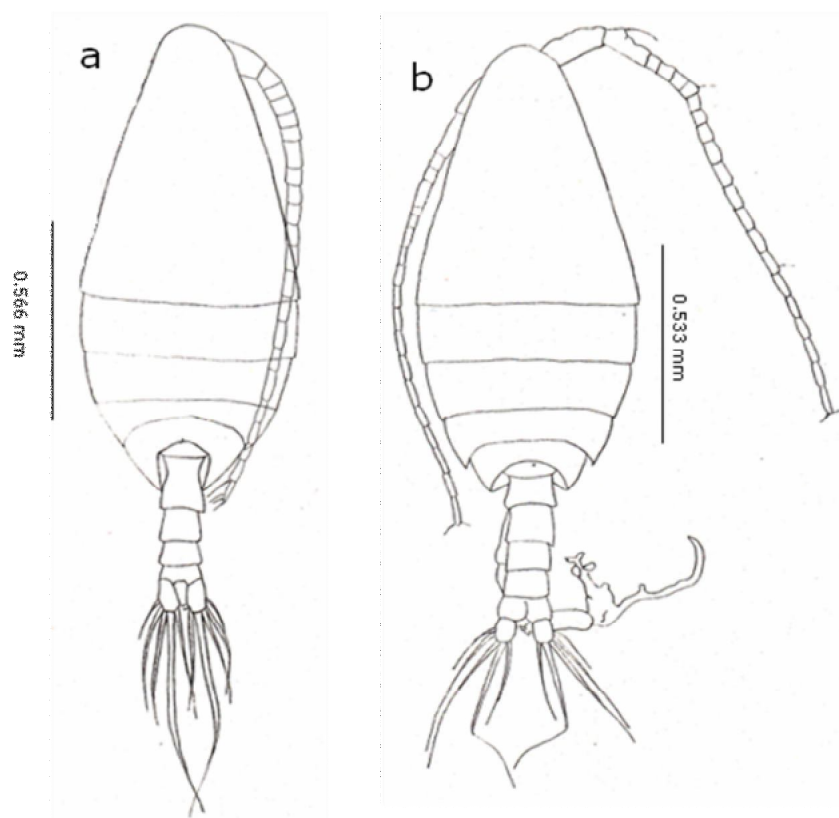


Figure 29. Dorsal view of (a) female and (b) male *Cosmocalanus darwinii* Lubbock.

The urosome in female is 4-segmented (Figure 30a), with the genital aperture located ventrally in the middle of the genital double somite/segment. The urosome of the male is 5-segmented (Figure 30b). Each caudal ramus for both sexes has 6 setae with the second seta much longer than the rest. The length of the urosome including the caudal ramus is 0.32 mm for female and 0.48 mm for the male.



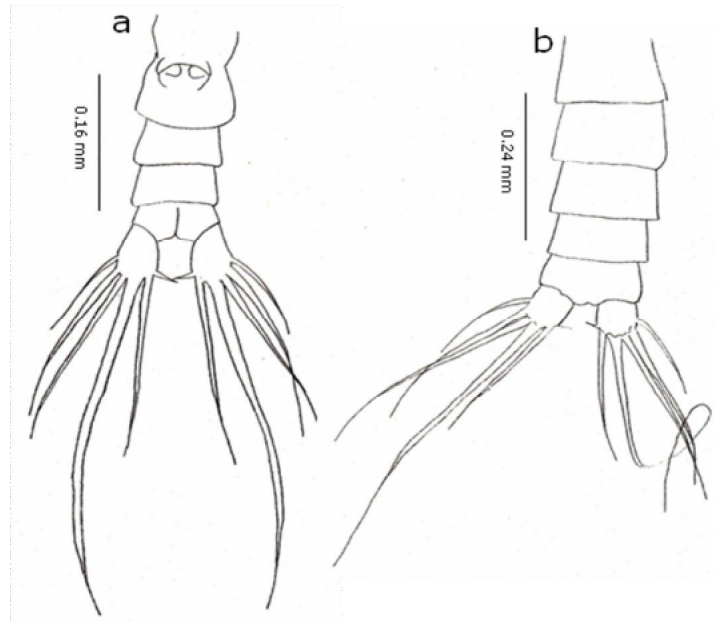


Figure 30. (a) Ventral view of female and (b) dorsal view of urosome of male *Cosmocalanus darwinii* Lubbock.

Both antennules of female are 25-segmented (Figure 31 a,b) and measures 1.8 mm for the right and 2.0 mm for the left antennule. In the right antennule (Figure 31a) one seta can only be found on the outer margin of the eighteenth, twenty-third up to twenty-fifth segments, while in the left antennule (Figure 31b) 1 seta is present on segments nineteenth, twenty-fourth and twenty-fifth on the outer margin.

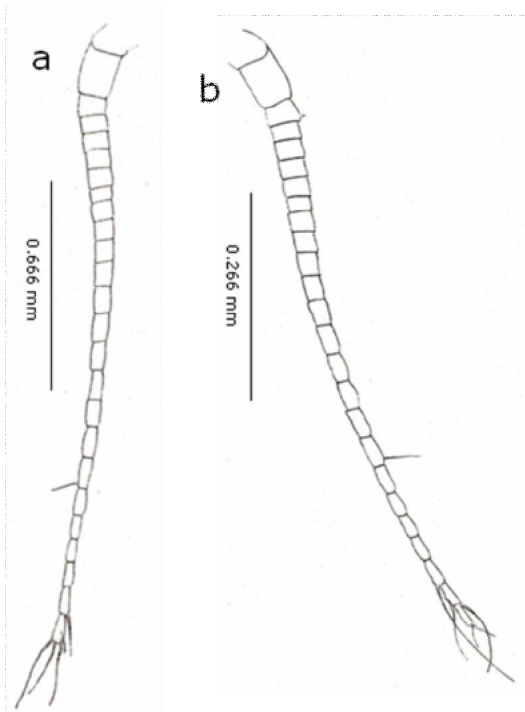


Figure 31. (a) Left and (b) right antennule of female *Cosmocalanus darwinii* Lubbock.

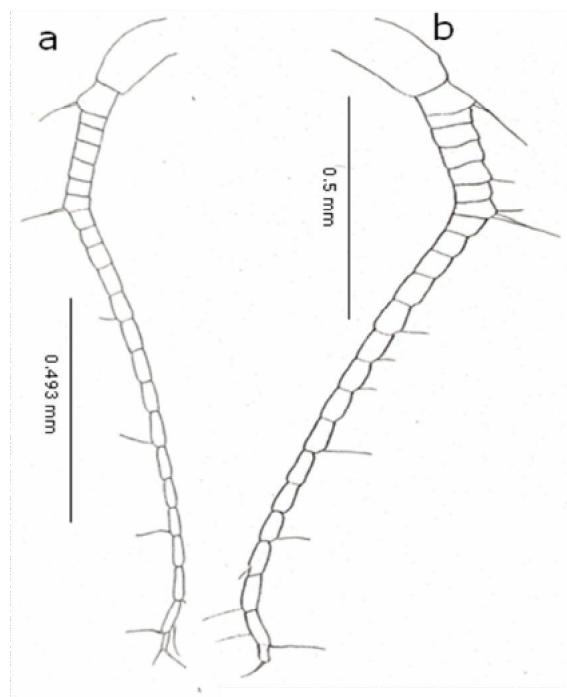


Figure 32. (a) Left and (b) right antennule of male *Cosmocalanus darwinii* Lubbock.

In male, the antennule is 24-segmented (Figure 32 a,b) and measures 1.5 mm on the right and 1.48 on the left antennule. On the right antennule (Figure 32a), second, sixth, eighth, thirteenth, fourteenth, fifteenth, seventeenth, and twenty to twenty-fifth segments bear a seta on the outer margin. On the left antennule (Figure 32b), the second, eighth, thirteenth, seventeenth, twenty, and twenty-second to twenty-fifth segments have 1 seta on the outer margin.

Swimming legs 1 to 4 in both sexes are biramous (Figures 33 a-d and 34 a-c) with all of the legs having 3-segmented exopodites and endopodites. For female, swimming legs 1 to 5 are the same and fully setose. For leg 2 (Figure 33b) and leg 3 (Figure 33c), the lateral margin of the third exopodal segment bear 2 outer spines with denticles between them (Mulyadi 2004). Leg 5 (Figure 33e) is the same with leg 4 (Figure 33d).

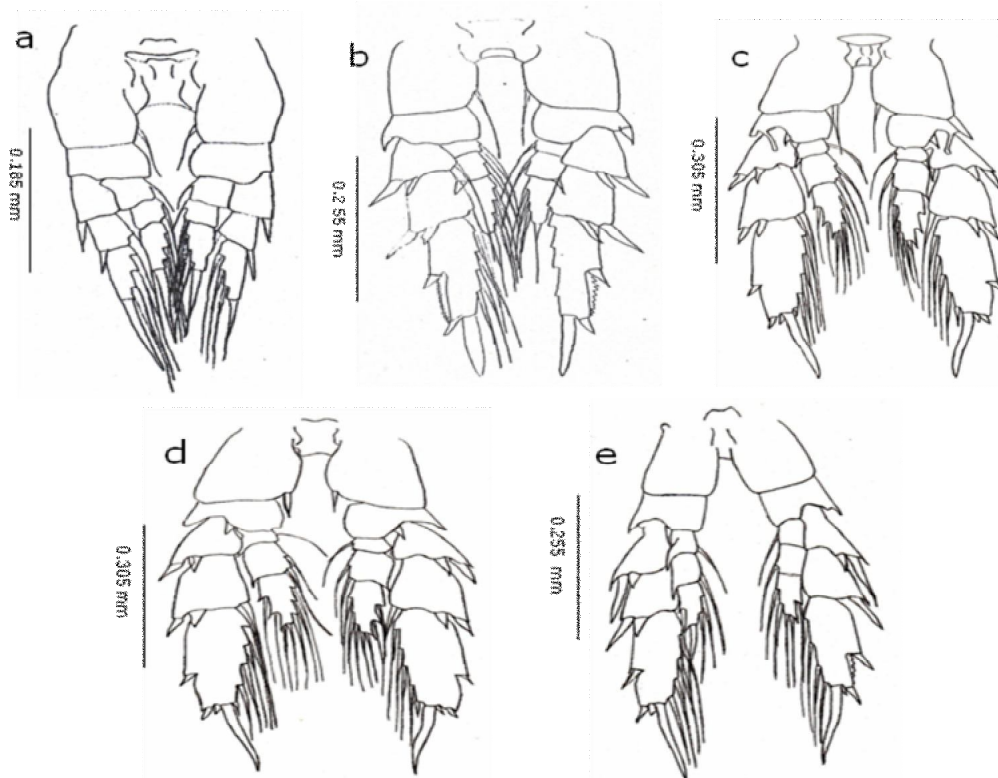


Figure 33. Female swimming (a) leg 1, (b) leg 2, (c) leg 3, (d) leg 4, and (e) leg 5 of *Cosmocalanus darwinii* Lubbock.

For male, leg 3 (Figure 34c) is the same with those of the female. For leg 5 (Figure 34e), the right leg, which is much smaller, is biramous having 3-segmented exopods and endopods. The inner margin of basipodal segment is serrated. For the left leg, it is uniramous having 3-segmented highly modified exopods and rudimentary endopods. The inner margin of basipodal segment has spinules. The second exopodal segment bears an elongated external spine with an inner-like projection (Mulyadi 2004), while the third segment is widened and armed with a stout bifurcate process. The tooth on the inner margin of the outer arm is at or near the center (Wilson 1950).

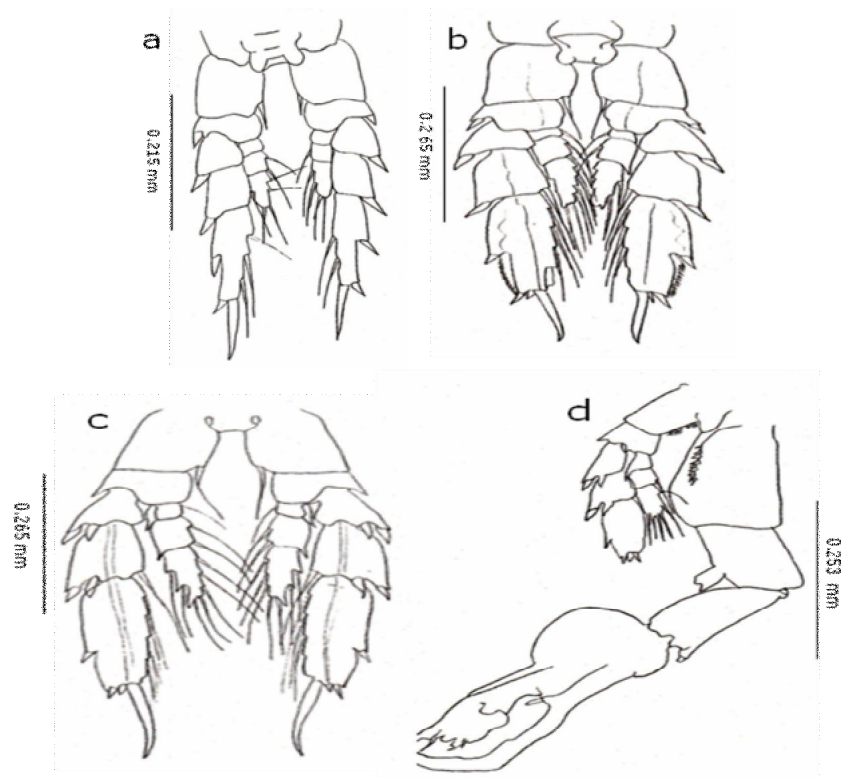


Figure 34. Male swimming (a) leg 2, (b) leg 3, (c) leg 4, and (d) leg 5 of *Cosmocalanus darwinii* Lubbock.

The above descriptions are similar with those described and figured by Kasturirangan (1963), Bradford-Grieve (1994), and Mulyadi (2004).

Pacific Ocean records: Dakin & Colefax (1940), Wilson (1950), Kasturirangan (1963), Bradford-Grieve (1994), and Mulyadi (2004).

**Conclusions.** Copepods of the same species may vary morphologically depending on the place or area. In the case of *Calanopia aurivilli*, our figures on leg 5 of both sexes showed absence of setules on the inner and outer margins, however these attributes were seen on the same organism from the Indian waters. Further, difference on *C. aurivilli* can also be observed between our results and those in Indonesian waters. For instance, in Indonesian waters 18 segments for the female antennule were observed but our study described only 17, female swimming leg 5 reported as 3-segmented in Indonesian waters, however we observed 4-segmented only. These variations exhibited between the same calanoid species from different places may be interpreted as an evidence of some kind of genetic switch mechanism (Huys & Boxshall 1991) which may allow control in the reversal of either asymmetric or symmetric structures that may result to their successful survival, reproduction and existence.

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