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A NEW SPECIES OF *PONTELLA* (COPEPODA: CALANOIDA)  
FROM THE INLAND SEA OF JAPAN WITH  
NOTES ON ITS FEEDING HABITS AND  
RELATED SPECIES

*Susumu Ohtsuka, Abraham Fleminger, and Takashi Onbé*

A B S T R A C T

A new species of calanoid copepod *Pontella rostraticauda* (family Pontellidae) is described based on specimens collected in surface waters of the Inland Sea of Japan. Due to its neustonic character, this species may have been overlooked by previous investigators. The gut content analysis revealed that this species feeds on a wide variety of foods, including both zooplankters and phytoplankters, and can be classified as an omnivorous copepod. The new species is closely allied to *P. surrecta* Wilson and *P. alata* Scott and is distinguished from them by the shape of the female urosome and the fifth legs of both sexes. Several derived characters shared by the three species and their geographical distributions provide the basis for proposing the *Pontella alata* species group as a unique radiation within the genus. Species of this lineage tend to occur in coastal waters around those oceanic islands comprising the western rim of the tropical Pacific. The group occurs north to southern Japan and south to the Great Barrier Reef.

Until now, only four species of the family Pontellidae have been recorded from the central part of the Inland Sea of Japan (Setonaikai): *Calanopia thompsoni* Scott, *Labidocera rotunda* Mori, *Pontellopsis tenuicauda* (Giesbrecht), and *Pontellopsis yamadae* Mori (Hirota, 1961, 1964, 1968a, b, 1979; Kado, 1954, 1957; Ohtsuka, unpublished). In contrast to such a low species diversity in the Inland Sea, 21 species of the family Pontellidae have been collected in summer in the Kuroshio Current region, south of Shikoku, Japan (Matsuo and Marumo, 1982). During the course of our investigation on the neuston of the Inland Sea of Japan in the summer of 1985, a new species of the genus *Pontella* (family Pontellidae) was found. As far as we know, the present species appears to be the first new calanoid copepod from the Inland Sea of Japan. The new species feeds on a variety of organisms, and is apparently omnivorous.

The present paper deals with the description of the new species of *Pontella*, its feeding habits, and its phylogenetic as well as biogeographic relationships.

MATERIALS AND METHODS

Neuston samples were collected at Station A-1 and Stations B-1 to B-5, respectively, on 21 June and 8, 9 August 1985, in Hiuchi-Nada, the central part of the Inland Sea of Japan (Fig. 1). The Ocean Research Institute (ORI) neuston net with a mesh size of 0.33 mm (Matsuo *et al.*, 1976) was towed for 10 min at a speed of about 2 knots on board T/RV *Toyoshio-maru*, Hiroshima University. The samples were fixed with 10% neutralized Formalin-sea water immediately after capture. Prosome length was measured for intact specimens collected in August. Gut contents dissected out were examined with a scanning electron microscope (JSM T-20 SEM).

Twenty intact specimens of each sex were randomly selected from the samples collected at Stations B-1, B-2, and B-3 to examine the frequency of occurrence of food items in the guts. The gut was removed from the body and immersed in gum-chloral medium on a thin glass slide, dissected, and, after adding a cover slip, examined under a differential interference microscope. Intact food organisms in the guts of the pontellids were measured with an ocular micrometer.

We used the criterion of morphological similarity in derived sexual characters (synapomorphies) in both sexes to shed light on the phylogenetic relationships of the new species.

Zooplankton sampling outside of the Inland Sea of Japan that yielded new geographic records of species closely related to the new species was based mostly on surface tows with standard conical nets

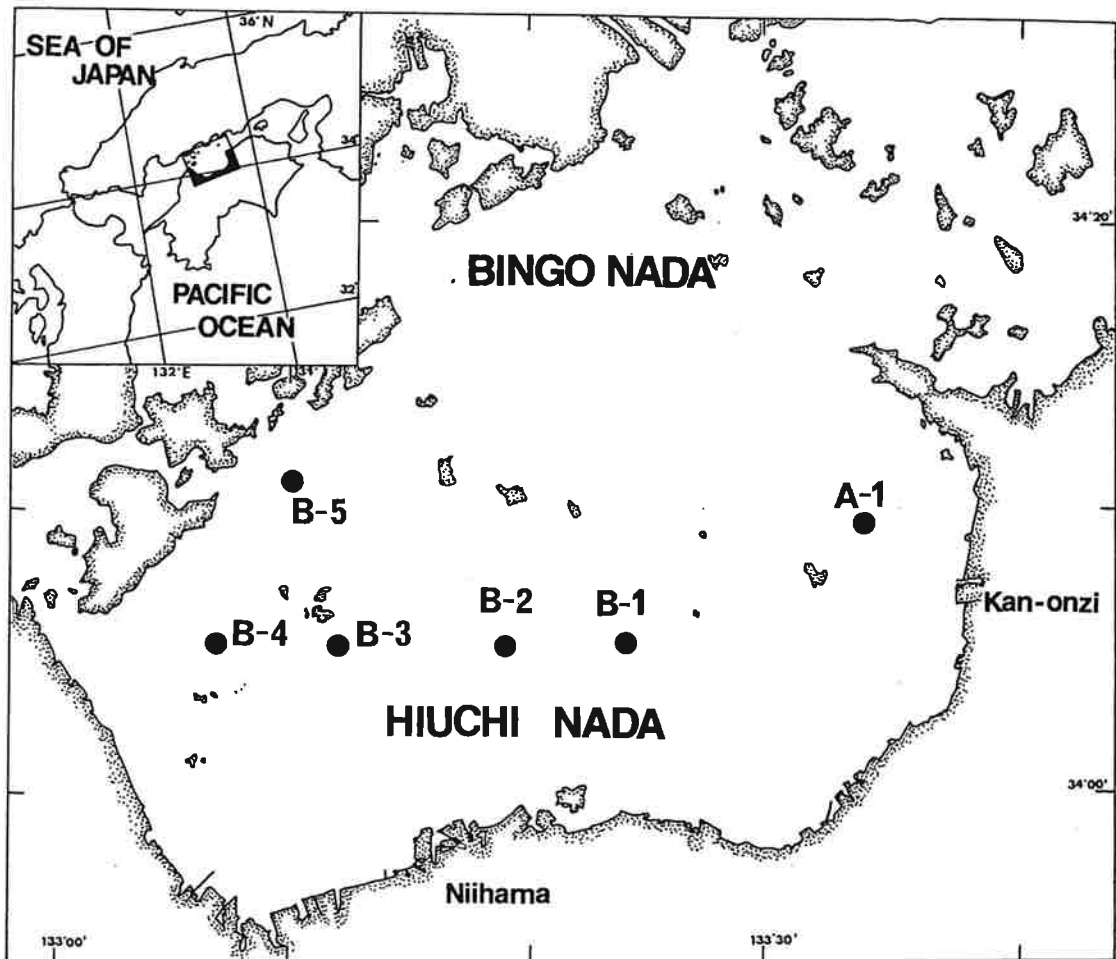


Fig. 1. Location of sampling stations in Hiuchi-Nada, the Inland Sea of Japan.

0.7 and 1 m in diameter. A small number of neuston tows are also represented. Most of this sampling was carried out at stations occupied by the Moro Expedition, R/V *Alpha Helix*, 31 May–24 July 1979. A brief summary of this cruise is presented elsewhere (Fleminger, in press). Zooplankton surface samples were taken in very shallow waters ( $\leq 20$  m depth) during the Moro Expedition from an outboard motor-powered sea skiff launched routinely at inshore stations from R/V *Alpha Helix*.

#### DESCRIPTION

##### *Pontella rostraticauda*, new species

Figs. 2–5, 7A

*Types*.—One dissected adult ♀ was designated as the holotype and 1 dissected adult ♂ as the allotype; 2 dissected adult ♀♀ and 2 dissected adult ♂♂ as paratypes, and 1 intact adult ♀ and 2 intact adult ♂♂ were also designated as additional paratypes. The holotype and allotype have been deposited with the Faculty of Applied Biological Science of Hiroshima University, Japan. Paratype specimens have also been deposited in the National Museum of Natural History, Smithsonian Institution, Washington (USNM 232023).

*Type Locality*.—Hiuchi-Nada, the Inland Sea of Japan (Station B-2, 34°05.17'N, 133°19.10'E).

*Female*.—Body (Fig. 2A) robust, 2.38 mm in prosome length and 2.96 mm in total length. Cephalosome separated from first metasome segment, with pair of lateral hooks and pair of lenses located anteriorly. Rostrum without lens, basal portion extended ventrally roughly to level of ventral eye (Fig. 2B) and divided

distally into two short spiniform processes. Fourth and fifth metasomal segments separated from each other; latter segment produced posterolaterally on both sides, left side a little more prominent than right side. Urosome 2-segmented. Genital complex much larger than anal segment; asymmetrical with small anterolateral swelling and very large posterodorsal beaklike elevation (Fig. 2C–E), latter elevation arising halfway along length of genital complex, directed dorsocaudally and tapering into blunt tip reaching as far as two-thirds length of left caudal ramus. Genital operculum (Fig. 2F) produced into blunt process on right side. Caudal rami asymmetrical, right caudal ramus broader and longer than left; inner margin of each ramus fringed with fine hairs; right ramus with small prominence on outer middle margin.

Antennule (Fig. 2G) 25-segmented, symmetrical; posterior margin of second to thirteenth segments fringed with fine hairs. Antenna (Fig. 2H) with basipod 1 having plumose seta anteriorly; basipod 2 with 2 anterodistal setae; endopod 2-segmented, proximal segment much elongated, bearing 2 setae of unequal length distally, apical segment lamellar, produced into proximal and terminal lobe, former with 6 long and 3 minute setae, latter with setula, 6 setae, and posterior fine spinules; exopod 5-segmented, second segment cylindrical, with seta at one-sixth of its length, medial seta, and 3 distal setae; terminal segment globular, equipped with 2 setulae and seta.

Mandibular blade (Fig. 2I) heavily chitinized bearing 7 teeth and spinulose seta on cutting edge; both third and fourth dorsalmost teeth bicuspidate; "dagger-like" spines (Turner, 1978) present at base of third to seventh teeth. Mandibular palpus (Fig. 2J) with 2-segmented endopod and 5-segmented exopod; basipod bearing 4 inner marginal setae. Maxillula (Fig. 3A) with gnathobase having 16 stout setae, minute spinules and fine hairs near base of stout setae; second inner lobe with 3 setae of unequal length; third inner lobe with 1 long and 3 short setae of subequal length; first outer lobe equipped with 9 setae; second outer lobe rudimentary with single seta; basipod 2 with long hairs on inner basal half, 4 medial setae, 4 subapical setae, and 5 apical setae; endopod completely fused with basipod 2; exopod with 10 setae and small setula. Maxilla (Fig. 3B) with 6 inner lobes on basal segment; fourth to sixth lobes carrying 2, 1, and 1 strong setae, respectively, each with row of setulae arranged at right angles to its inner margin and distal end serrated (setulae and serrations not shown in Fig. 3B); endopod of 3 segments, first segment with only single strong seta, second with setula and strong seta, third segment with 3 strong setae, 1 being serrate along inner margin (Fig. 7A is a SEM micrograph of the male maxilla viewed from inside showing the arrangement of setulae, which are in general similar to those of female). Maxilliped (Fig. 3C) reduced in size; basipod 1 with 3 groups of setae, consisting of 2, 3, and 3 setae, respectively, distal part produced distally covering basal part of basipod 2; anterior margin of basipod 2 fringed with row of small teeth and small setula subdistally and 2 plumose setae distally; endopod of 5 free segments, first segment with 2 distal setae, second to fourth each bearing distal seta, last with 3 setae of unequal length.

Legs except for leg 1 with 2-segmented endopod and 3-segmented exopod. Leg 1 (Fig. 3D) with both endopod and exopod 3-segmented; terminal exopod segment ending in acute process, first and second exopod segments with 4 or 5 minute spinules at base of outer spines. Legs 2 and 3 (Fig. 3E, F) similar in structure and armature to each other, but leg 3 much larger than leg 2; each proximal endopod segment with small protuberance at point one-third length of outer margin. Leg 4 (Fig. 3G) with basipod 2 having minute denticular process at base of large plumose seta. Leg 5 (Fig. 3H) asymmetrical; each basipod 2 with plumose seta

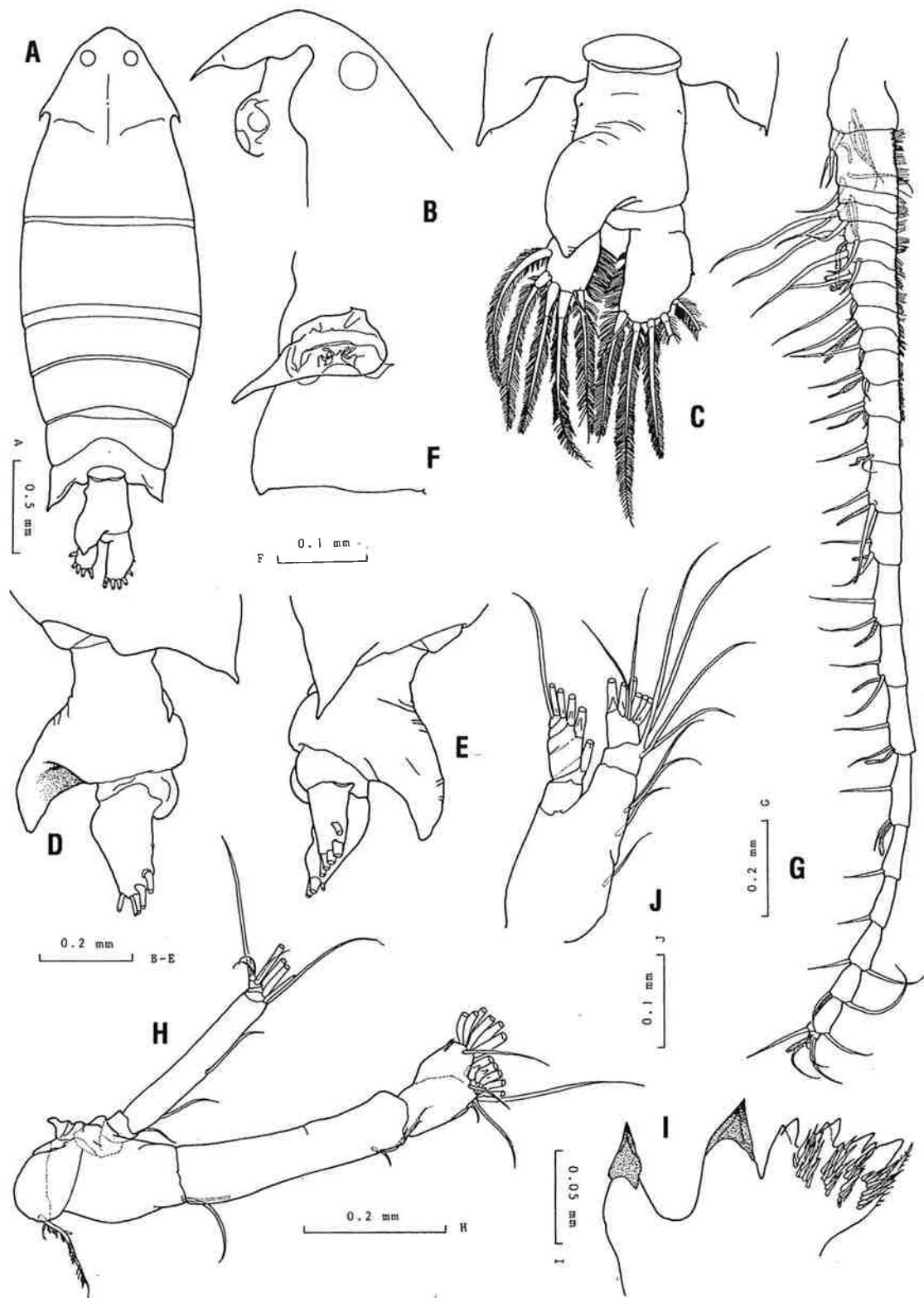


Fig. 2. *Pontella rostraticauda*, new species. Female (holotype). A, habitus, dorsal view; B, rostrum, lateral view; C, urosome, dorsal view; D, urosome, lateral view (right); E, urosome, lateral view (left); F, genital opening; G, antennule; H, antenna; I, mandibular cutting edge; J, mandibular palpus.

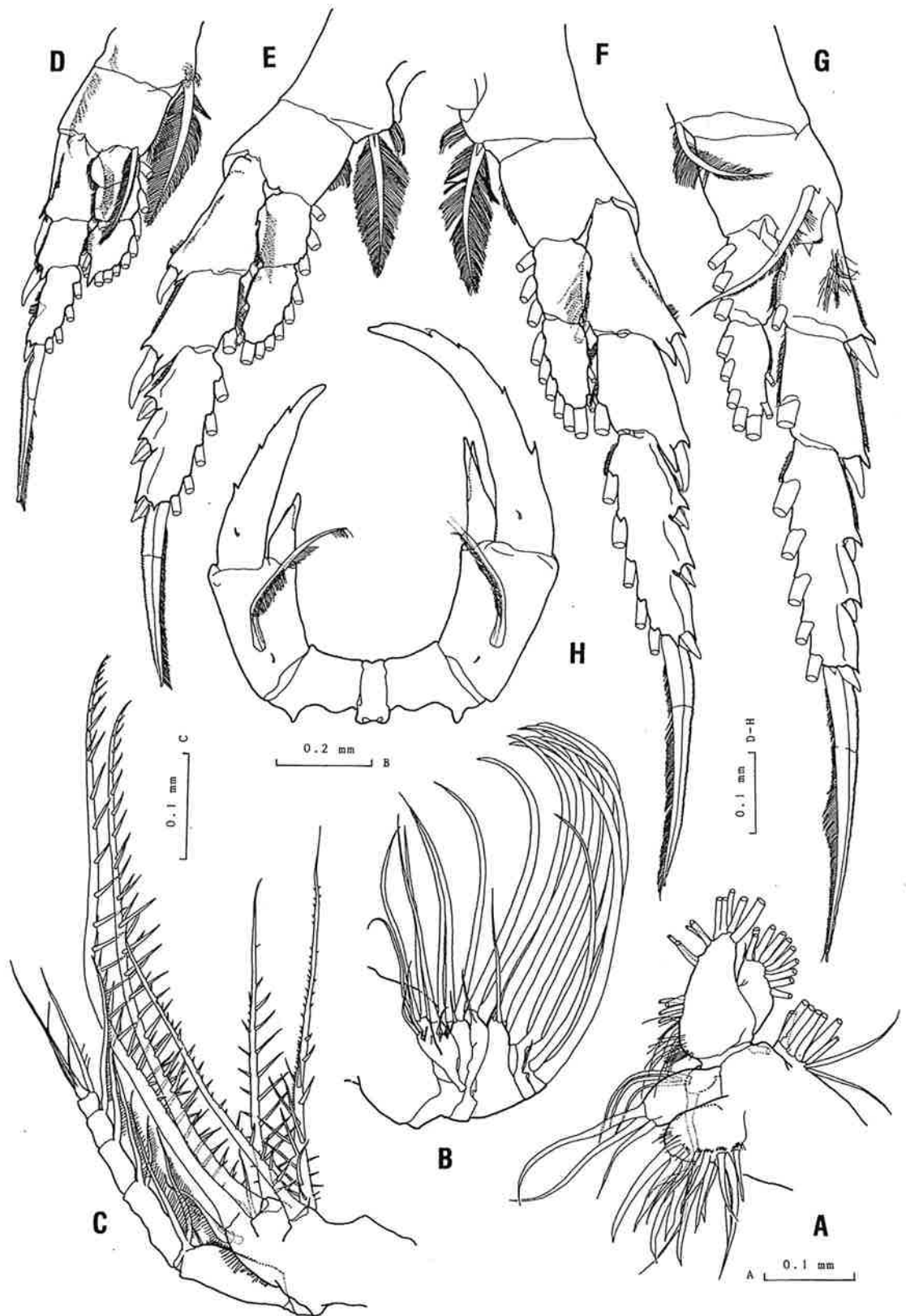


Fig. 3. *Pontella rostraticauda*, new species. Female (holotype). A, maxillula; B, maxilla (setules on setae omitted); C, maxilliped; D, leg 1, anterior face; E, leg 2, anterior face; F, leg 3, anterior face; G, leg 4, posterior face; H, leg 5, posterior face.

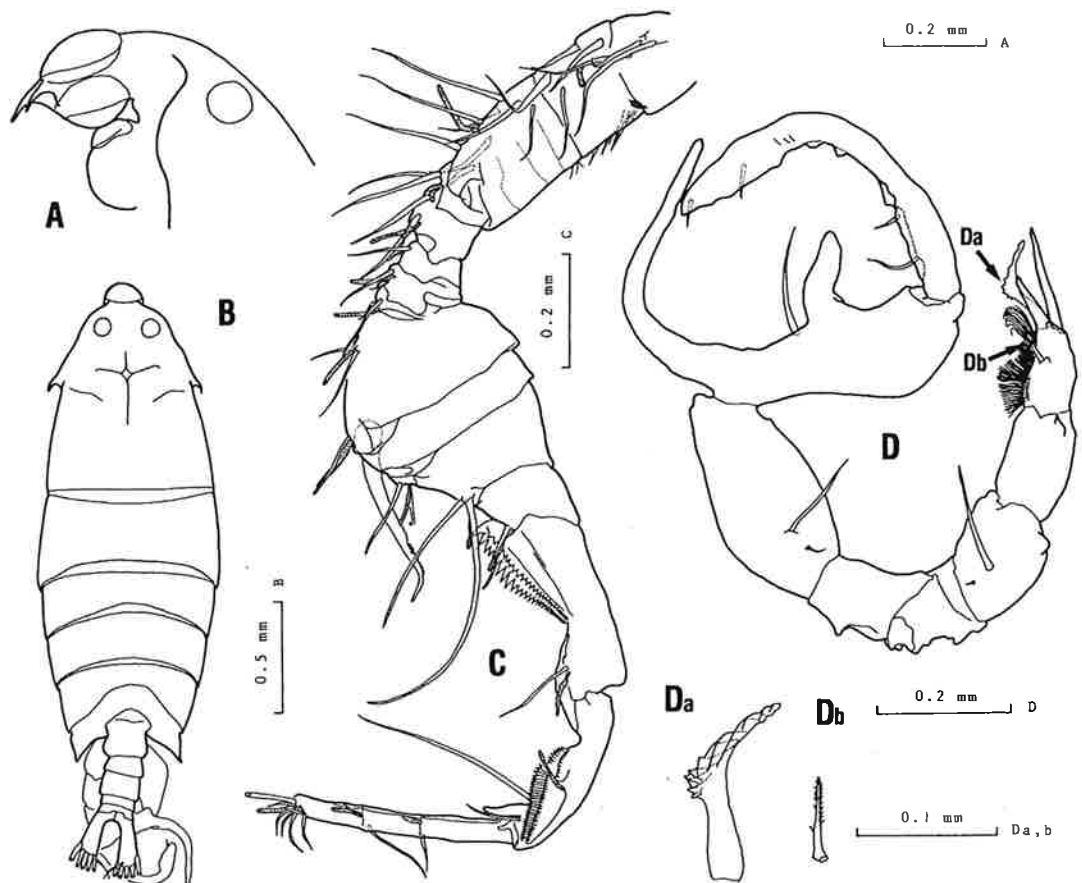


Fig. 4. *Pontella rostraticauda*, new species. Male (allotype). A, rostrum, lateral view; B, habitus, dorsal view; C, right antennule; D, leg 5, posterior face; Da, aesthete-like seta on terminal segment of left leg 5; Db, lateral spinulose seta on terminal segment of left leg 5.

and very fine setula near base of posterior face; right exopod shorter than left, smoothly curved inward, tapering to distal point, with 4 minute processes along outer margin; right endopod also shorter than left, bifurcated, and two-fifths of length of right exopod; left exopod and endopod larger than right ones, but similar in structure.

*Male*.—Body (Fig. 4B) more compact than in female, 1.95 mm in prosome length and 2.60 mm in total length. Cephalosome and first metasomal segment separated from each other; fourth and fifth metasomal segments also not fused. Pair of cephalic hooks present as in female. Rostrum (Fig. 4A), anterior and posterior sides with 2 well-developed lenses which are absent in female. Last metasomal segment slightly asymmetrical. Urosome 5-segmented; genital segment slightly asymmetrical, left side weakly produced; caudal rami symmetrical, rather elongated.

Right antennule (Fig. 4C) geniculate, 25-segmented, first to twelfth segments proximal to expanded 4 (thirteenth to sixteenth) segments incompletely fused; last 4 segments fused. Left antennule with 25 segments; eleventh and twelfth segments partially fused. All other appendages except for leg 5 similar in structure to those of female.

Leg 5 (Fig. 4D) asymmetrical; endopod wanting; chela formed by penultimate and terminal segments in right leg; thumb of chela ending in slender process

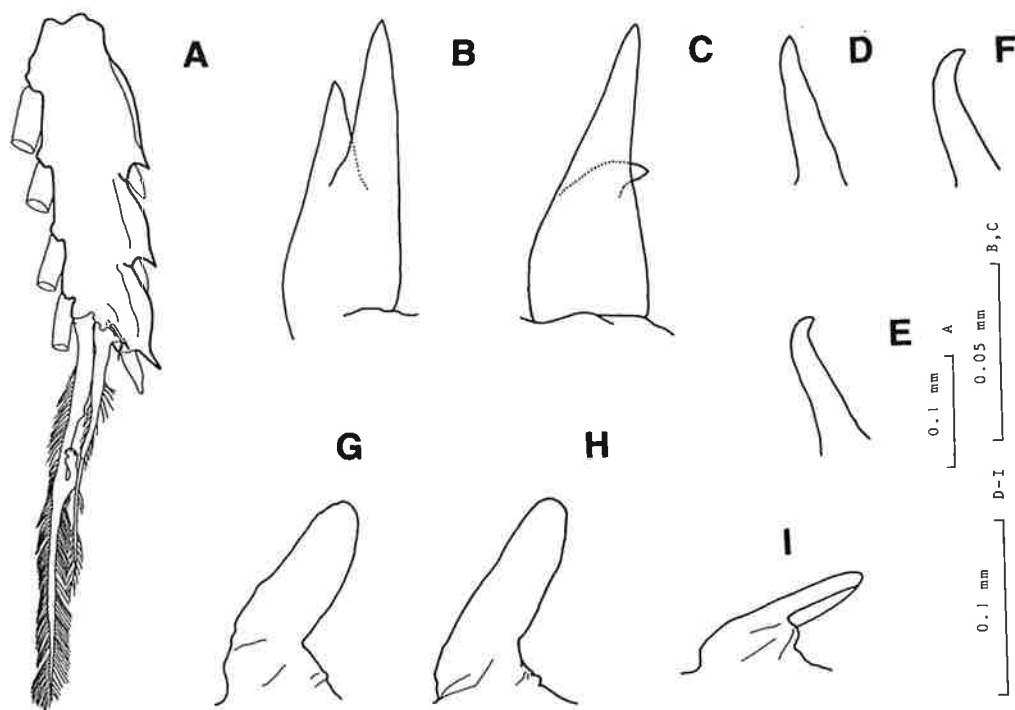


Fig. 5. *Pontella rostraticauda*, new species. Variations. A, abnormal terminal exopod segment of leg 4; B, C, right endopods of leg 5 (paratypes); D-F, spinelike processes on terminal segment of leg 5 (D, allotype; E, F, paratypes); G-I, perpendicular digitiform processes (G, allotype; H, I, paratypes).

curving inward, large digitiform process arising perpendicular to concave surface, with naked seta at base; finger of chela elongated almost as long as left leg, curved outward at middle point, tip slightly expanded, lamelliform, 4 short setae present along concave face; left leg penultimate segment with minute process distally, terminal segment carrying hirsute patch, minute seta, and spinulose seta laterally, and spine, aesthete-like seta, and spinelike process terminally.

*Variation.*—Prosoma length (mean  $\pm$  SD) of intact specimens of both sexes collected on 8, 9 August 1985: females,  $2.42 \pm 0.16$  mm ( $N = 18$ ); males,  $2.02 \pm 0.07$  mm ( $N = 32$ ). The terminal exopodal segment of left leg 4 of a paratype female (Fig. 5A) is abnormal: in place of the terminal spine, a plumose seta is present, near whose base a bifurcated setula is located; the inner distalmost seta is also abnormal in that it bears medially a small papillate projection. The tip of the short process of the female right endopod of leg 5 may be straight (Fig. 5B) or curved inwards (Fig. 5C). The male leg 5 also may vary: the tip of the terminal spinelike process of the left leg 5 is straight (Fig. 5D) or curved slightly outwards (Fig. 5E, F); the perpendicular digitiform process of a paratype male is abnormally slender and curved inwards (Fig. 5I), although that of another paratype male (Fig. 5H) is the same as in the allotype (Fig. 5G).

*Etymology.*—The specific name “*rostraticauda*” derives from the posterolateral beaklike process on the female genital complex.

*Remarks.*—The female most closely resembles that of *P. surrecta* Wilson, 1950. For comparison of the new species with *P. surrecta*, three specimens of each sex collected around New Guinea were examined. Female appendages of both species are almost the same except for leg 5. The most conspicuous difference is in the



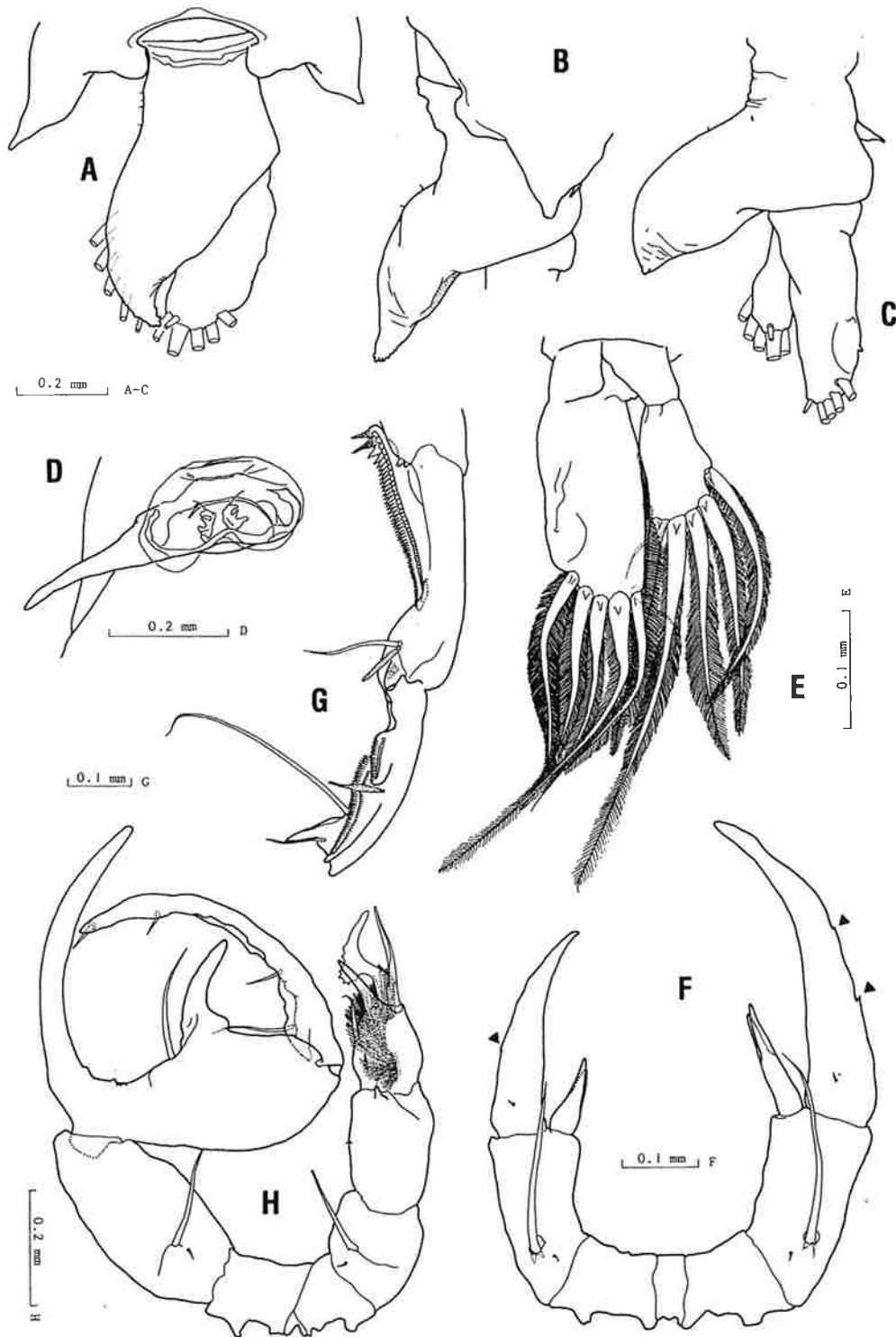


Fig. 6. *Pontella surrecta* Wilson collected from Wewak Harbor, Papua New Guinea (24 VI 1979). A-F, female. A, urosome, dorsal view; B, urosome, lateral view; C, urosome, lateral view, another specimen; D, genital operculum; E, caudal rami, ventral view; F, leg 5, posterior face. G, H, male. G, segments proximal and distal to articulation of right antennule; H, leg 5, posterior face. Arrowheads indicating minute prominences.

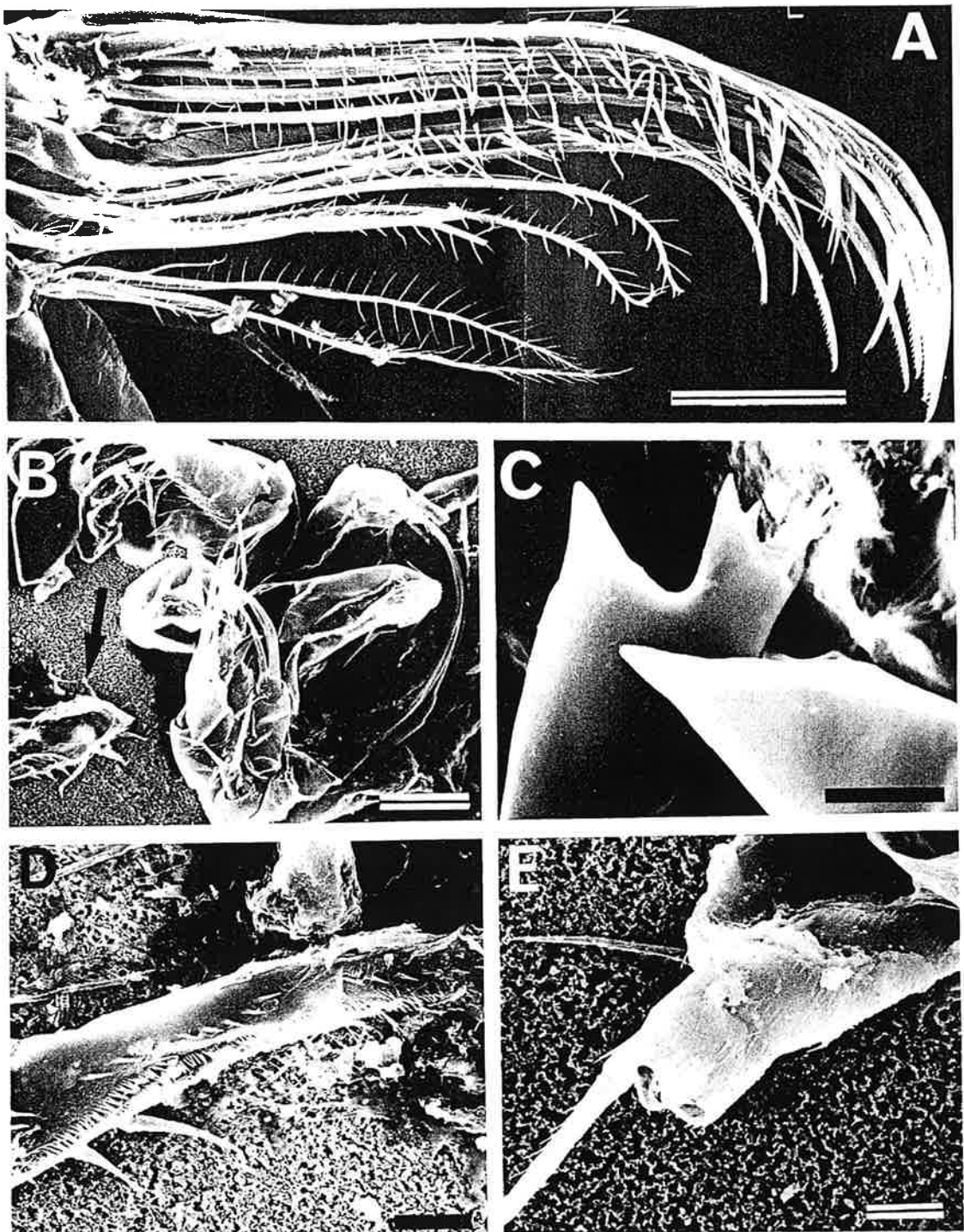


Fig. 7. *Pontella rostraticauda*, new species. A, maxilla of male, medial view, scale bar = 100  $\mu\text{m}$ ; B-E, food organisms; B, *Evadne tergestina* and *Penilia avirostris* (carapace of *P. avirostris* indicated by arrow), scale bar = 50  $\mu\text{m}$ ; C, mandibular blade of *E. tergestina*, scale bar = 10  $\mu\text{m}$ ; D, furcal claw of *P. avirostris*, scale bar = 10  $\mu\text{m}$ ; E, copepod nauplius, scale bar = 10  $\mu\text{m}$ .

morphology of the urosome. In *P. rostraticauda*, the beaklike posterodorsal process never reaches the end of the left caudal ramus, whereas in *P. surrecta* (Fig. 6A-C) the size of the process is variable, so that in one specimen it completely covers the left caudal ramus and in another the process does not reach the end.

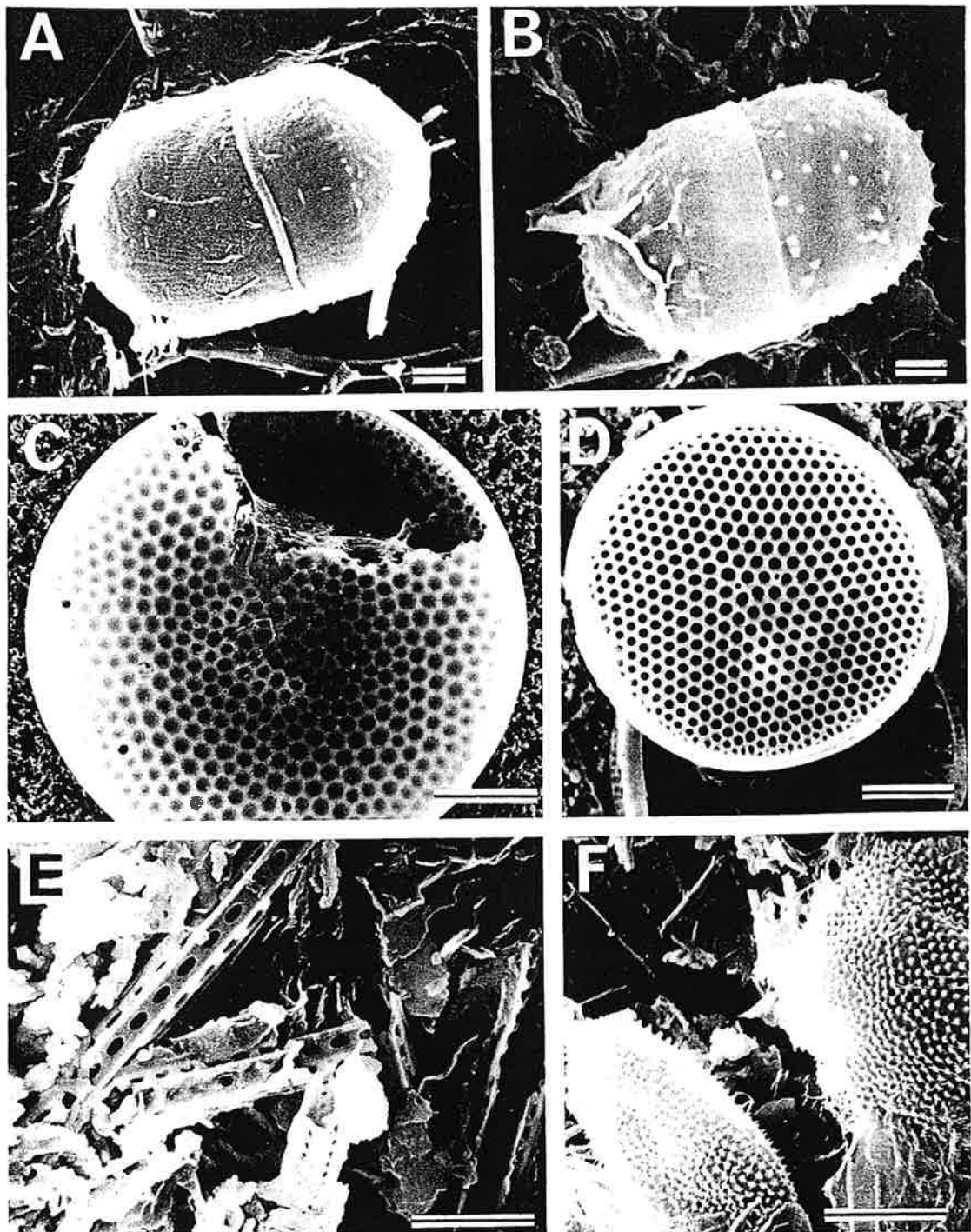


Fig. 8. *Pontella rostraticauda*, new species. A–F, food organisms; A, B, resting spores of diatom, scale bar = 1  $\mu\text{m}$ ; C, *Coscinodiscus radiatus*, scale bar = 10  $\mu\text{m}$ ; D, *Thalassiosira oestruppi* var. *venrickae*, scale bar = 5  $\mu\text{m}$ ; E, spines of *Chaetoceros*, scale bar = 5  $\mu\text{m}$ ; F, *Prorocentrum balticum*, scale bar = 1  $\mu\text{m}$ .

The shape of the process is also different. In lateral view, the tip of the process is directed downward or horizontally in the former species, but in the latter it is directed upward. The genital operculum of the latter species (Fig. 6D) is produced farther toward the right side than in the former species. The difference in the

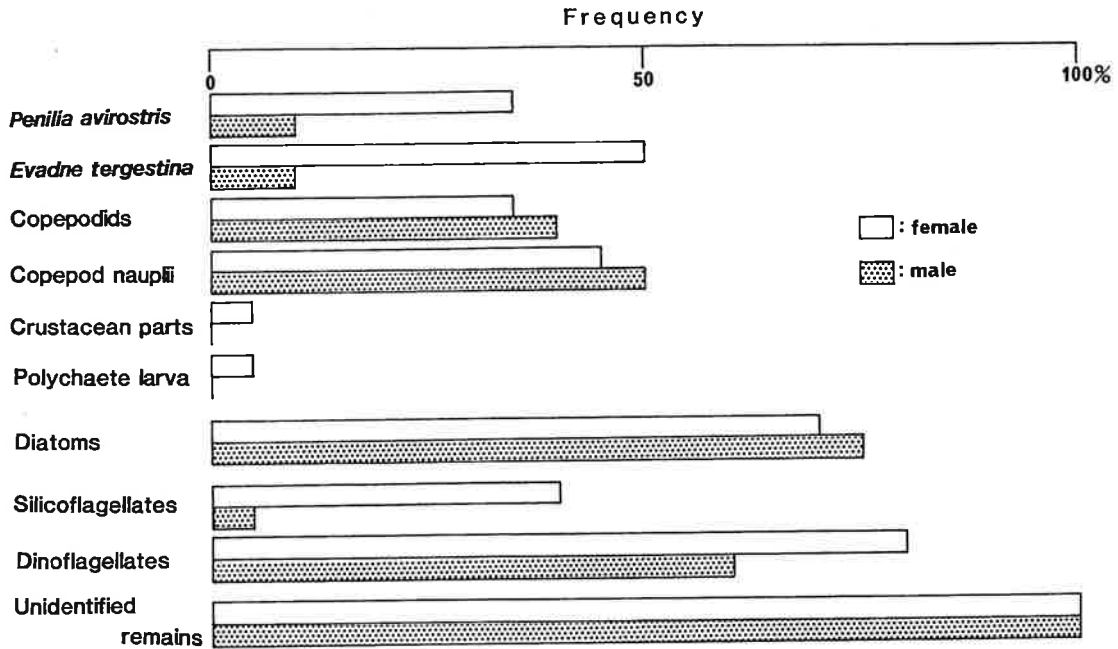


Fig. 9. *Pontella rostraticauda*, new species. Frequency of occurrence of food items in the guts.

caudal rami is marked. The caudal rami of *P. surrecta* (Fig. 6E) are more asymmetrical: the right is much larger than the left. The female leg 5 is a little different: in *P. rostraticauda*, the external margins of both left and right legs have four conspicuous minute processes, whereas in *P. surrecta* (Fig. 6F) there are only two minute prominences on the left leg and one or two very fine prominences on the right. The males of both species are not easy to distinguish. The segments proximal and distal to the articulation of the right antennule are different from each other (Figs. 4C, 6G). The chelae in leg 5 differ in length and shape, although the number and position of setae are the same.

Wilson (1950) misidentified the male he described as *P. surrecta*; an examination of the type specimens confirmed that this male should be referred to *P. elephas* Brady (Brady, 1883).

Although numerous samplings of zooplankton have been made in the Inland Sea of Japan, neither endemic nor new species of zooplankton have so far been recorded from the Sea (cf. Madhupratap and Onbé, 1986). The present records mark the first Inland Sea calanoid copepod species new to science. Owing to its characteristic neustonic distribution, this species may have been taken rarely and probably was overlooked by previous investigators. Considering the distribution of its closest relatives discussed below, and its absence from all previous studies off eastern Asia, the new species cannot be considered an expatriate from the oceanic environment carried into the Inland Sea by an incursion of the Kuroshio Current. Some females had spermatophores on the genital complex, indicating that the species breeds in the Inland Sea. Moreover, on 21 June 1985 (Station A-1), early copepodid stages were collected. This fact, and the absence of adults on this date, indicates that the population in the central part of the Sea may fluctuate seasonally. It may be that this species occurs only during the warmer season and survives as resting eggs during the colder season as in *P. meadi* Wheeler (Grice and Gibson, 1977) and *P. mediterranea* (Claus) (Grice and Gibson, 1981).

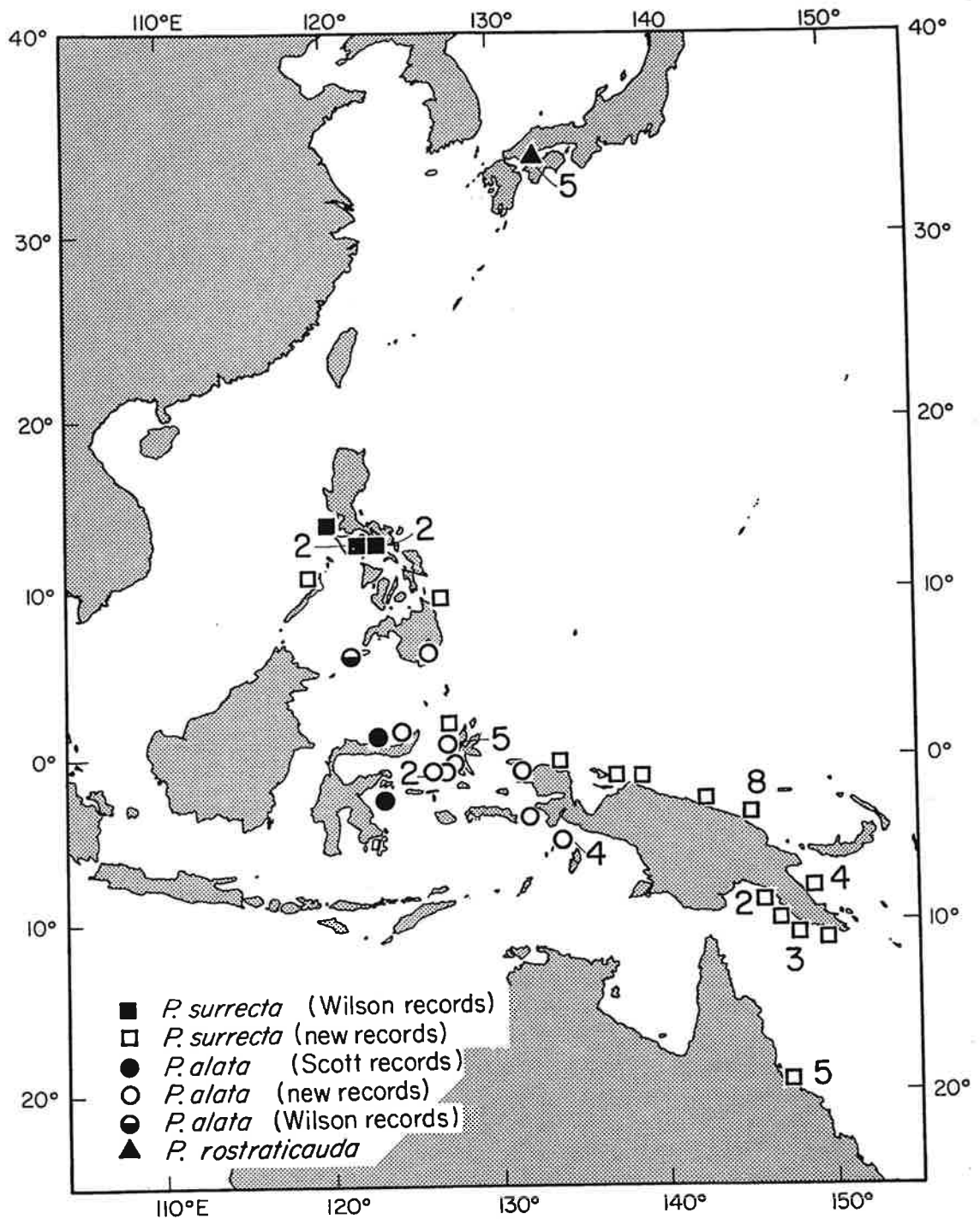


Fig. 10. Distribution of new and published records of the *Pontella alata* species group: *Pontella surrecta* Wilson, *P. alata* Scott, and *P. rostraticauda*, new species. Arabic numerals show the number of individual tows containing one or more individuals of the species taken in the vicinity of the new record indicated by the symbol.

#### In Situ Feeding Habits

The organisms found in the guts of *Pontella rostraticauda* are listed in Table 1 and SEM photomicrographs of some of these are shown in Figs. 7B-E and 8A-F. The frequency of occurrence of food items is also illustrated in Fig. 9. The



Table 1. Food items of *Pontella rostricauda*, new species.

Food items	Largest dimension ( $\mu\text{m}$ )
Cladocerans	
<i>Penilia avirostris</i>	—
<i>Evadne tergestina</i>	—
Copepod nauplii	
<i>Pseudodiaptomus marinus</i>	—
Pontellids	—
<i>Microsetella</i>	—
Copepodids	
<i>Paracalanus</i>	—
Pontellids	—
<i>Acartia</i>	—
<i>Corycaeus</i>	—
Unidentified crustacean	—
Polychaete larva	—
Diatoms	
<i>Thalassiosira</i> spp.	18–21
<i>Coscinodiscus radiatus</i>	48
<i>Cyclotella</i> sp.	14
<i>Asteromphalus heptactis</i>	44
<i>Chaetoceros</i> spp.	—
<i>Rhizosolenia</i> spp.	—
<i>Nitzschia</i> sp.	91–97
<i>Cocconeis scutellum</i>	31
Unidentified centric diatoms	4–6
Unidentified pennate diatoms	12–13
Diatom resting spores	6–20
Dinoflagellates	
<i>Prorocentrum balticum</i>	13–16
<i>P. compressum</i>	34–35
<i>P. triestinum</i>	27–32
<i>P. dentatum</i>	13–21
Silicoflagellates	
<i>Ebria tripartita</i>	27–30
<i>Distephanus speculum octonaris</i>	35–41
Others	
Insects	—
Eggs or cysts	—
Unidentified materials	—

sexual difference in the frequency of occurrence is not statistically significant ( $\chi^2$  test,  $0.1 < P < 0.2$ ). Both naupliar and copepodid stages of several species of copepods were frequently found in the gut, followed by two species of cladocerans, *Penilia avirostris* and *Evadne tergestina*. Other zooplankters represented by small crustaceans and a polychaete larva were observed, but less frequently. Most of the individuals ingested solitary and chain-forming diatoms of varying sizes (4–97  $\mu\text{m}$  in largest dimension) and a similar number of individuals contained thecate dinoflagellates, *Prorocentrum* spp. (13–35  $\mu\text{m}$ ), in the guts. Two species of silicoflagellates of 30–41  $\mu\text{m}$  in largest dimension were also detected. In all 40 guts examined we found unidentified remains composed of minute particles and amorphous sticky substances. Contrary to the general previous contention that pontellid

copepods are carnivorous, Turner (1978) first demonstrated direct evidence that some of them are omnivores, ingesting both phyto- and zooplankters. Our observations essentially agree with his conclusion.

Almost all the prey crustaceans found were crushed into pieces, apparently being macerated by the action of the mandibular cutting edges of this copepod. A few individuals remained intact and were easily identified to species. There were many broken frustules of diatoms (Fig. 8C, E), whereas some diatom cells, for example, *Nitzschia* sp., were found intact in the guts. These facts suggest that while this pontellid feeds raptorially by grasping food organisms, it sometimes swallows food particles without maceration. There were diatom resting spores whose frustules remained unchanged and showed no sign of having been macerated (Fig. 8A, B). In the case of *Prorocentrum* spp., the situation was similar. These cells most likely resist digestion and survive passage through the guts of some zooplankton grazers (Hargraves and French, 1983; Silver and Bruland, 1981).

Copepod species found in the guts appear to be those which dominated in the plankton community at the time of collection (Hirota, 1961). The incidence of predation on two species of marine cladocerans might be a rare record for marine copepods, although cladocerans have been reported to be a favored food of freshwater copepods (cf. Kerfoot, 1977). *Penilia avirostris* and *E. tergestina* are distributed more densely in the upper layer of the water column in summer than in the layer below the thermocline (Onbé, 1974). In addition, dinoflagellates, *Prorocentrum* spp., which occurred frequently in the guts, have often been found to be abundant in the surface film at the air-sea interface (Harvey, 1966; Hattori et al., 1983). If this pontellid is truly neustonic, then the possibility of the prey-predator encounter increases and the chance that these organisms are eaten by *P. rostraticauda* may increase. The origin of the unidentified amorphous substances always found in the guts is obscure. Amorphous substances may be derived from a variety of sources, e.g., detrital materials or larvaceans whose bodies are soft enough to break down immediately after ingestion. The latter possibility is supported by the fact that in the guts of the congeneric species *P. securifer* collected near Shirahama, on the Pacific coast, some feeding filters of pelagic tunicates were found together with unidentified materials (Ohtsuka, unpublished).

As in some other pontellid species (Turner, 1978; Ohtsuka, unpublished), the maxillae of *P. rostraticauda* bear many long stout setae with setules which are oriented at right angles to the setae (Fig. 7A). The maxillipeds, located in between the maxillae, are less developed and are similar in structure to those of the common neritic calanoid *Acartia clausi* (Ohtsuka, unpublished). From this we may surmise that *P. rostraticauda* has a feeding mode similar to that found in *A. clausi* (Rosenberg, 1980). Judging from its food assemblages in the guts as well as its characteristic feeding appendage structure, *P. rostraticauda* can be regarded as an "opportunistic omnivore" which feeds on almost anything available in its environment (Mullin, 1966; Turner, 1978, 1984a, b).

#### THE *PONTELLA ALATA* SPECIES GROUP

*Definition.* — Adult females of *Pontella* with genital segment bearing large process extending posteriorly over part to all of furca. Operculum over genital opening extended to right in spiniform process. Right furcal ramus considerably larger than left ramus. Rostrum large but lacking distinctive lens. Fifth legs asymmetrical; right rami shorter than left rami; exopods virtually naked, lateral processes when present minute. Adult males with rostrum bearing large double convex lens. Chela

of right fifth leg large, overall width roughly equal to length of urosome less furca; proximal segment with slender elongated thumb and proximally slender digitiform process straight or bent and paralleling thumb. Distal segment of chela slender and elongate. Terminal segment of left fifth leg with robust spiniform process and one large aesthete-like seta, denticulated or ribbed. Group defined by above combination of characters, since individually one or more of these characters sometimes occurring in species outside of group.

Besides the new species, *Pontella rostraticauda*, described above, two additional species comprise the *P. alata* group.

#### *Pontella alata* Scott

*Pontella alata* Scott, 1909, Siboga Expeditie, 29a: 160, pl. 51, figs. 11–15 (♀ only), original description, holotype not designated, sampling locality 01°15.0'N, 123°37.0'E.

*Pontella cerami* Scott, 1909, Siboga Expeditie, 29a: 163, pl. 53, figs. 8–15 (♂ only); Wilson, 1950, U.S.N.M. Bull. 100, 14: 291, pl. 27, figs. 402–403. New synonymy.

*Remarks.*—During the Moro Expedition (Fleminger, in press) males and females of *P. alata* were taken together frequently in surface tows and usually in the absence of other species of *Pontella*. Occurrences were distributed between western New Guinea and southern Mindanao in the Banda and Ceram seas and in the Moluccan Passage (Table 2, Fig. 10). In most instances samples containing the species were taken nearshore and usually inshore of the 20-m isobath. Voucher specimens have been deposited in the National Museum of Natural History, Smithsonian Institution, Washington (USNM 232024) and with the Faculty of Applied Biological Science of Hiroshima University, Japan. Diagnostic characters were examined and confirmed in specimens listed in Table 2.

#### *Pontella surrecta* Wilson

Fig. 6

*Pontella surrecta* Wilson, 1950, U.S.N.M. Bull. 100, 14: 299, pl. 29, figs. 426, 427, 429, original description of ♀ (not ♂), sampling locality, Romblon I., Luzon, Philippine Is., type series locality, National Museum of Natural History (USNM 074134, 074085). Male described by Wilson in this 1950 citation, p. 300, figs. 428, 430, not *P. surrecta* but assignable to *Pontella elephas* Brady (Brady, 1883). New synonymy.

*Remarks.*—Examination of Wilson's (1950) type series of *P. surrecta* revealed that the male that he attributed to *P. surrecta* is misidentified; it is in all details a male of *P. elephas* Brady. The Moro Expedition collected small numbers of both sexes of *P. surrecta* frequently in nearshore surface tows off eastern and northern New Guinea and northeastern Mindanao. Other field activities provided records from the Great Barrier Reef between latitudes 17° and 19°S and off northern Palawan (Table 2, Fig. 10). In most instances the tows were taken inshore of the 20-m isobath. Voucher specimens have been deposited in the National Museum of Natural History (USNM 232025) and with the Faculty of Applied Biological Science of Hiroshima University, Japan. Diagnostic characters were examined and confirmed in specimens listed in Table 2.

#### ZOOGEOGRAPHY OF THE *PONTELLA ALATA* GROUP

Collectively the records of the three species comprising this group form a narrow but distinctive band crossing the broadly tropical latitudes from eastern Australia to southern Japan. Most of the records occur at those oceanic islands forming the westernmost rim of the Pacific Ocean (Fig. 10). *Pontella surrecta* tends to occur in coastal waters on the Pacific Ocean side of these islands, whereas *P. alata*



Table 2. Zooplankton net surface tows sampling representatives of the *Pontella alata* group. Records from the Inland Sea of Japan taken by T/RV *Toyoshio-maru* and marked by T-m. Records from the Moro Expedition (R/V *Alpha Helix*) marked by ME. Other records marked by \*. Cruise track and stations for the Moro Expedition shown in Fleminger (in press). The numbers of females and males represent the number of adult specimens in which the diagnostic characters were examined and confirmed.

Locality	Station	Latitude	Longitude E	Date	Local time	♀	♂
<i>Pontella rostricauda</i>							
Hiuchi-Nada	T-m A-1	34°09.5'N	133°34.5'	21 VI	'85	?	Copepods only
Hiuchi-Nada	T-m B-1	34°05.7'N	133°24.7'	8 VIII	'85	1440	4 1
Hiuchi-Nada	T-m B-2	34°05.2'N	133°19.1'	8 VIII	'85	1535	24 21
Hiuchi-Nada	T-m B-3	34°05.2'N	133°13.6'	8 VIII	'85	1618	5 0
Hiuchi-Nada	T-m B-4	34°05.3'N	133°09.4'	8 VIII	'85	1713	10 36
Hiuchi-Nada	T-m B-5	34°11.9'N	133°10.8'	9 VIII	'85	0830	2 2
<i>Pontella alata</i>							
Sorong Island	ME 39-1	00°48.2'S	130°54.0'	2 VII	'79	1200	1 1
Samei Island	ME 45	03°05.6'S	132°28.1'	4 VII	'79	1808	1 1
Aru Archipelago	ME 51A	05°25.6'S	134°24.5'	6 VII	'79	1747	8 7
Aru Archipelago	ME 51-1	05°25.7'S	134°25.5'	6 VII	'79	1300	0 5
Aru Archipelago	ME 51-2	05°25.7'S	134°25.5'	6 VII	'79	1400	0 11
Makian Island	ME 65	00°09.5'N	127°18.5'	13 VII	'79	0500	1 0
Makian Island	ME 66-1	00°21.7'N	127°22.0'	13 VII	'79	0700	1 1
Moti Island	ME 67	00°29.6'N	127°25.3'	14 VII	'79	0540	11 5
Dodinga Bay	ME 68	00°49.8'N	127°36.6'	14 VII	'79	1604	11 7
Dodinga Bay	ME 68-1	00°49.8'N	127°36.6'	14 VII	'79	0937	8 4
Dodinga Bay	ME 68-2	00°49.8'N	127°36.6'	14 VII	'79	1005	3 0
Dodinga Bay	ME 68-3	00°49.8'N	127°36.6'	14 VII	'79	1038	2 0
Dodinga Bay	ME 68-4	00°49.8'N	127°36.6'	14 VII	'79	1341	5 8
Tandjoeng							
Liguamadehe	ME 69	01°33.1'N	127°28.9'	15 VII	'79	0500	1 0
Manado	ME 74	01°32.5'N	124°45.0'	17 VII	'79	0725	1 0
Davao Gulf	ME 81	06°52.5'N	125°38.4'	20 VII	'79	0600	3 2
<i>Pontella surrecta</i>							
*Townsville, Australia (at various inshore localities over reef)	—	—	—	6 VII	'78	?	0 1
*Townsville, Australia (at various inshore localities over reef)	—	—	—	3 XI	'78	?	4 3
*Townsville, Australia (at various inshore localities over reef)	—	—	—	17 XI	'78	?	2 5
*Townsville, Australia (at various inshore localities over reef)	—	—	—	9 I	'79	?	8 4
Hall Sound	ME 11-1	08°52.5'S	146°31.6'	8 VI	'79	0739	1 3
Hall Sound	ME 11-2	08°52.5'S	146°31.6'	8 VI	'79	0820	1 1
Port Moresby	ME 14-2	09°35.5'S	147°04.0'	10 VI	'79	0828	1 0
Keaboro Bay	ME 17	10°09.6'S	148°06.6'	13 VI	'79	1706	1 0
Keaboro Bay	ME 17-2	10°09.6'S	148°06.6'	13 VI	'79	0918	7 4
Keaboro Bay	ME 17-4	10°09.6'S	148°06.6'	13 VI	'79	1053	4 8
Brummer Island	ME 18-6	10°45.7'S	150°21.9'	14 VI	'79	1510	1 0
Cape Ward Hunt	ME 22	07°59.4'S	148°05.5'	17 VI	'79	0805	7 5
Cape Ward Hunt	ME 22-3	07°59.4'S	148°05.5'	17 VI	'79	1442	1 0
Cape Ward Hunt	ME 22-4	07°59.4'S	148°05.5'	17 VI	'79	1515	4 4
Cape Ward Hunt	ME 22A	07°59.4'S	148°05.5'	17 VI	'79	1945	1 1
<sup>1</sup> Wewak Harbor	ME 28A	03°30.5'S	143°35.0'	22 VI	'79	2300	35 38
<sup>1</sup> Wewak Harbor	ME 29	03°30.5'S	143°35.0'	24 VI	'79	2400	6 11

Table 2. *Continued.*

Locality	Station	Latitude	Longitude E	Date	Local time	♀	♂
Wewak Harbor	ME 29-1	03°30.5'S	143°35.0'	24 VI '79	?	13	13
Wewak Harbor	ME 30	03°06.2'S	142°18.2'	26 VI '79	1930	3	5
Wewak Harbor	ME 32	01°35.1'S	138°15.8'	29 VI '79	0537	3	5
Wewak Harbor	ME 33-4	01°36.0'S	137°25.0'	29 VI '79	1452	1	2
Wewak Harbor	ME 36-5	00°40.5'S	133°20.0'	1 VII '79	1312	0	1
Lolata Bay	ME 70-2	01°40.1'N	127°29.2'	15 VII '79	1018	1	0
Lolata Bay	ME 88	09°40.0'N	124°36.1'	23 VII '79	0600	3	0
*Lolata Bay	—	11°29.5'N	123°45.3'	27 XI '79	1810	12	2

<sup>1</sup> Sampling with aid of electric light directed onto sea surface.

predominates west of these same islands along the coasts facing the eastern seas of the Indo-Malayan region. *Pontella rostraticauda* is known at present only from the Inland Sea of Japan. It may also occur south in the Ryukyus and possibly as far as Taiwan. All three species have been found in or very near the sea surface in nearshore coastal waters, i.e., typically inshore of the 100-m isobath, where they commonly appear in relatively small numbers. The abundance of adults of *P. alata* in samples in which the species was tallied during quantitative analysis is:  $\bar{x} = 0.23$  individuals/m<sup>3</sup>, SD = 0.2828,  $N = 10$  samples, range 0.054–0.307/m<sup>3</sup>. One sample, ME 66-1, containing an unusually high number of this species (6/m<sup>3</sup>), was omitted from the estimated mean. The abundance of adults of *P. surrecta* in samples in which the species was tallied during quantitative analysis is:  $\bar{x} = 0.086$  individuals/m<sup>3</sup>, SD = 0.1071,  $N = 11$  samples, range 0.018–0.334/m<sup>3</sup>.

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