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THREE NEW SPECIES OF THE GENUS *PHYLLOPODOPSYLLUS*
(COPEPODA, HARPACTICOIDA)
FROM THE INLAND SEA OF JAPAN¹⁾

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With Text-figures 1-21, Tables 1-2 and Plate I

The present paper deals with three new *Phyllopodopsyllus* species found on the sandy beach of Mukaishima Island in the Inland Sea of Japan. There are currently 35 valid species and subspecies in this genus. Since the last review (Coull, 1973), the following four species have been added: *P. laspalmensis* Marinov, 1973, *P. langi* Kunz, 1975, *P. paraborutzkyi* Kunz, 1975 and *P. curtus* Marcus, 1976. The description of the present new species means the first record of the family Tetragnopitidae Lang (1948) from Japan.

The beach has a slope of about eight degrees. The horizontal extent of the intertidal part (from M.L.W.S. to M.H.W.S.) is about 26 m and the vertical is about 3.4 m. Sampling was carried out at three points at various levels as shown in Table 1. The beach is composed of relatively coarse, granitic sands; the mean diameter of the sand grains decreases seawards.

Table 1. Sampling data for each station.

Station	A	B	C
Shore level (meters above *D.L.)	3.3	2.4	1.6
Mean grain size (mm)	2.45	1.46	1.19

* D.L. refers to datum line.

All of the specimens were obtained by the so-called decanting-sieving method, in which the sediments were washed through the sieve of aperture size of 63 μ square. Dissected somites and appendages were mounted on slides using Sasa's gum-chloral medium. The following description is mostly based on a pair of adult specimens. Slide preparations used for the description are indicated by each number in parentheses. The type-series are deposited in the Mukaishima Marine Biological Station, Hiroshima University.

1) Contribution from the Mukaishima Marine Biological Station No. 185

The surface structure of the integument was examined with a scanning electron microscope, JSM-25 (Japanese Electron Optics Lab.), at an accelerating voltage of 15 kv.

Before going further, I express my sincere gratitude to Dr. Akihiko Inaba, Professor and Director of the Mukaishima Marine Biological Station, Hiroshima University, for his support and guidance to the present study. Sincere thanks are also due to Dr. F.E. Round, Professor of the Department of Botany, University of Bristol, who read the manuscript. I am grateful to Dr. T. Itô of the Seto Marine Biological Laboratory, Kyoto University, for giving beneficial advices.

Phyllopodopsyllus simplex n. sp.

(Figs. 1-7)

Female. Body (Fig. 1, 1-2) cylindrical, about 0.56 mm long, rostrum and furcal setae excluded, and about 0.09 mm in greatest width measured at the cephalothoracic somite. Colorless and semitransparent. Extremely delicate punctures visible in antennule and abdomen. A pigmented spot, not (?) a nauplian eye, visible at the front part of cephalothorax, though it is decolorized by fixation. Hind edge of each somite smooth, except for the anal somite. *Genital double-somite* (Fig. 2, 1-3) subdivided dorsally only by a row of short fine hairs and ventrally by a chitinous suture; ventrolateral rim of posterior subdivision ornamented with several hairs; genital area situated in anterior subdivision as shown in Fig. 4, 1. *Leg 6* cylindrical in shape, with three setae, of which the two inner, bare setae are much shorter, and the outermost plumose one reaching to the chitinous suture. Anal somite with two fine sensillae dorsally, and fringed with delicate hairs both laterally and ventrally; anal operculum prominent, with numerous marginal hairs. *Furcal ramus* elongated, about 6.1 times as long as wide, slightly tapering behind; dorsal and lateral face of proximal part feebly punctured; a basally geniculate seta arising from about three-fifths the length of the dorsal surface, near the middle; two naked setae occurring on the outer side, the anterior one accompanied by a hairlike setula; principal terminal seta almost equal to furcal ramus in length, and swollen at base which is inclined slightly inwards. *Rostrum* (Fig. 3, 1) defined at base, a little longer than wide, and furnished with a pair of sensillae.

Antennule (Fig. 3, 1) eight-segmented; first segment almost as long as the three succeeding segments combined; second one with a well-developed unguiform projection which is almost as long as this segment; fourth one furnished with an aesthetasc; last one longer than the two preceding segments combined; minute punctures distinct at second and third segments; indistinctly hairy seta visible on each of the first two segments. *Antenna* (Fig. 3, 2). Basis ornamented with a longitudinal row of seven hairlike spinules on the anterior surface. Exopodite one-segmented, with three hairy setae. Endopodite composed of two segments; proximal with some spinules on anterior surface of proximal part; second about 1.5 times as long as preceding one, orna-

mented with an oblique row of filmy strips on the outer surface, a spinulose cupuliferous projection near the apical end of the posterior edge, and two spines and one seta located about three quarters along the length of the antero-inner face; terminal end armed with one short narrow seta and six stout setae, four of which are geniculate. *Mandible* (Fig. 4, 2-3). Praecoxa with bidentate pars incisiva, bidentate lacinia mobilis, two or three serrate spines, three rather blunt spines and two setae, one of which is spinulose. Coxa-basis widened distally, with two arched rows composed of several longer spinules, and terminating in three setae, of which at least two are hairy. Exopodite about five times as long as wide, with two slender and one short, hairy setae terminally and halfway, respectively. Endopodite shorter than coxa-basis, with two juxtaposed setae at about two-fifths the length of inner (or ventral) edge, and

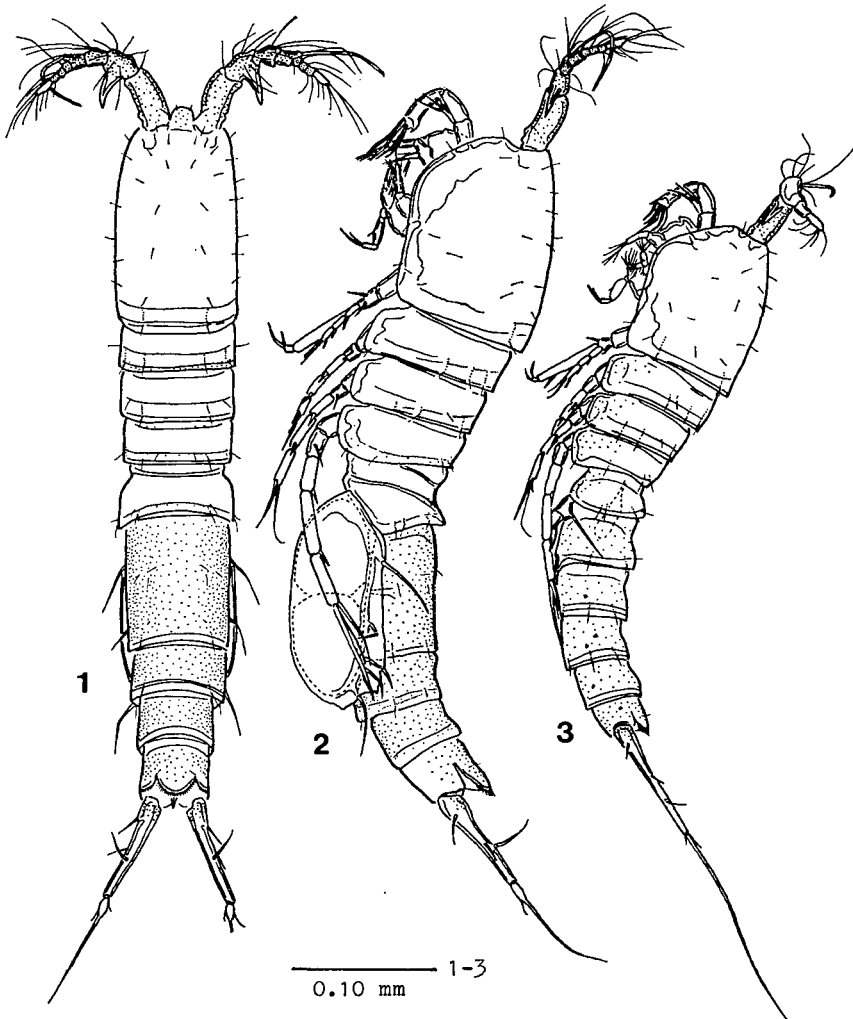


Fig. 1. *Phyllopodopsyllus simplex* n. sp. Female (holotype).—1, habitus, dorsal; 2, ditto, lateral. Male (allotype).—3, habitus, lateral.

seven apical setae. *Maxillula* (Fig. 4, 4). Arthrite of praecoxa furnished with eight, more or less claw-like setae on inner edge, of which the most dorsal has hairs along one-side; one hairy seta on the dorsal inner corner, and two slender setae arising from the posterior side near the dorsal edge; two parallel setae on the anterior surface. Inner process of coxa bearing four apical setae, three of which are hairy, and an epipodite represented by one plumose seta; several spinules forming a line on the subapical anterior surface. Basis armed with eight setae, of which at least two are hairy and two are somewhat geniculate. Both rami one-segmented; exopodite ornamented with many hairs along inner edge, and three plumose setae terminally; endopodite fringed with a number of hairs along outer edge, and furnished with four setae, the apical two being bare. *Maxilla* (Fig. 4, 5). Syncoxa with four well-developed endites which from the proximal point are bearing two, one, three and three spinulose

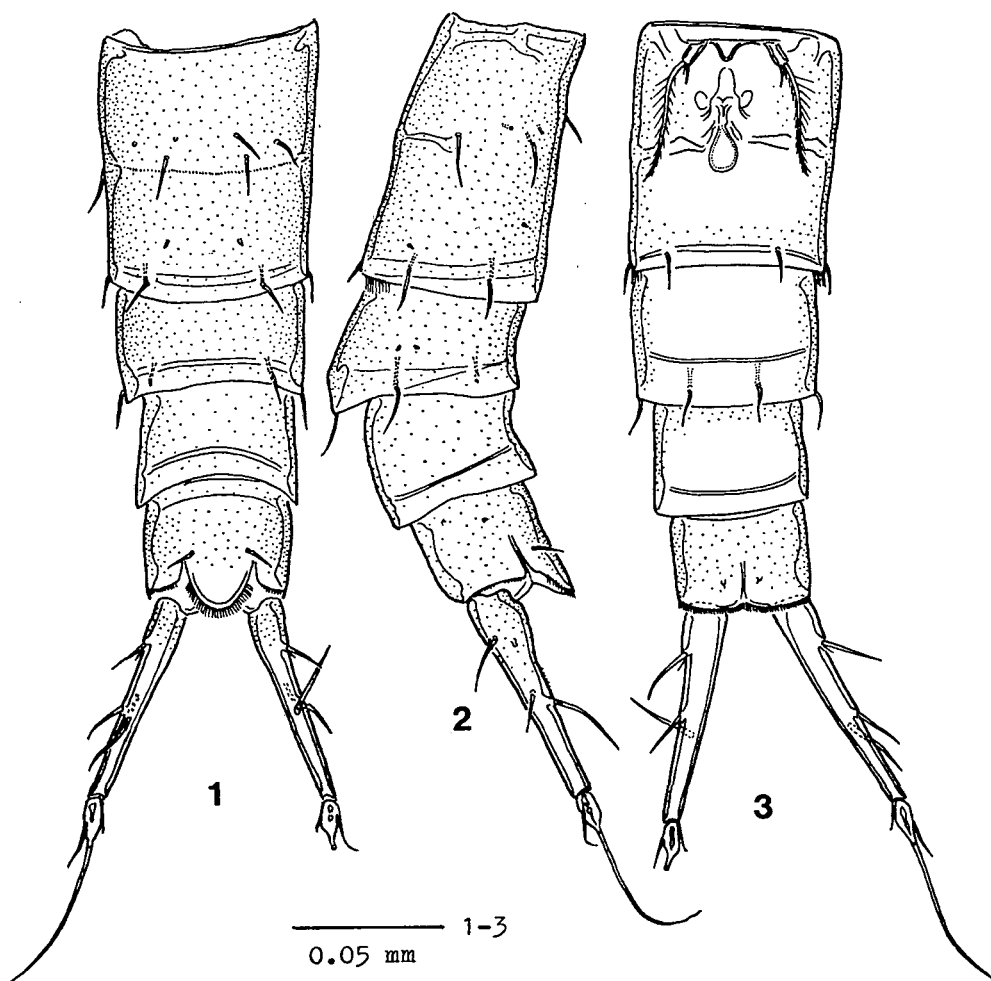


Fig. 2. *Phyllopodopsyllus simplex* n. sp. Female (holotype).—1, abdomen, dorsal (MKC-36); 2, ditto, lateral; 3, ditto, ventral.

setae on respective apices, and each of which, except for the second one, is ornamented with a subapical row of spinules on the anterior surface. Basis forming into a cylindrical process inwards, and apically armed with two claw-like, spinulose setae and one slender bare seta; one bare seta occurring subapically near dorsal edge. Endopodite three-segmented; first segment armed with three setae, one of which is geniculate, and with one hairlike setula on anterior surface; second one with one elongate geniculate seta distally; third one with two bare and one hairy setae. *Maxillipede* (Fig. 4, 6). Coxa short and unornamented. Basis almost cylindrical, with three rows of several delicate spinules, and terminating in two spinulose setae and one spiniform pectinate seta. First endopodite segment ornamented with one seta and two rows of several hairs, of which one row is composed of extremely short hairs, on inner surface; second one small and slightly widened toward distal part, with one terminal claw accompanied by a hairy seta on the inner side.

Leg 1 (Fig. 5, 1). Coxa widened proximally, somewhat swollen in outer part, and ornamented with one spinular row on the outer distal corner of the anterior surface, and with a number of delicate punctures. Inner half of basis produced distally, with one bare outer seta and one plumose inner spine, the latter arising half-way along the basis. Exopodite three-segmented; first segment longest; second one

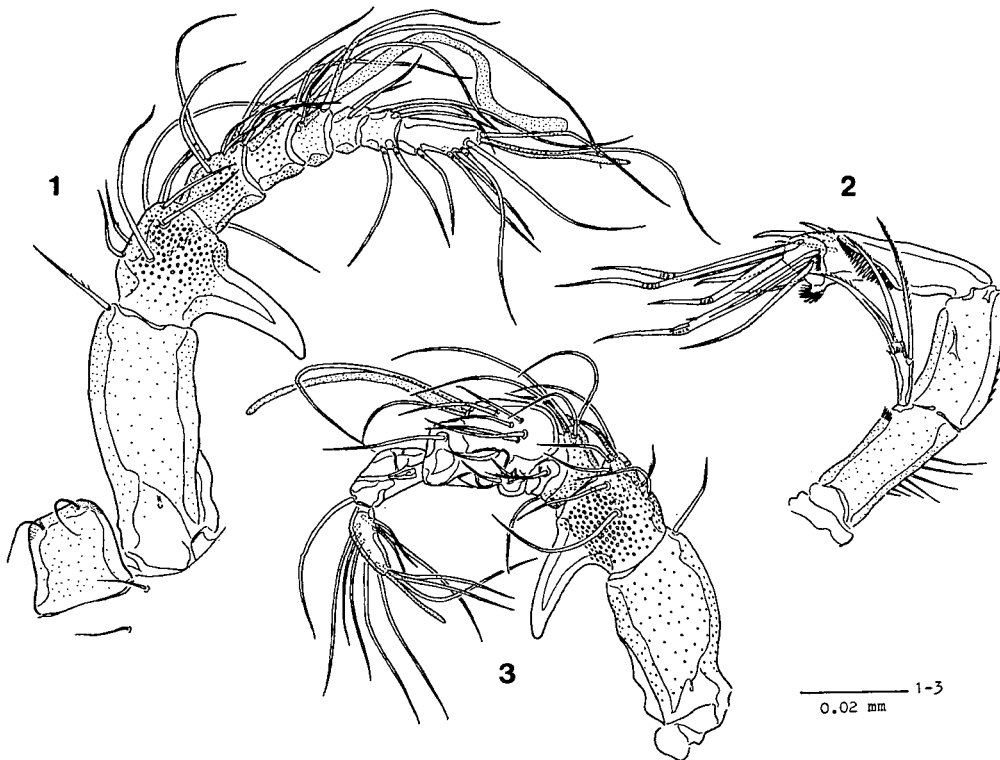


Fig. 3. *Phyllopodopsyllus simplex* n. sp. Female (holotype).—1, antennule (MKC-33); 2, antenna (MKC-35). Male (paratype).—3, antennule (MKC-25).

as long as the succeeding one, with only a few spinules on the inner edge; third one furnished with two outer spines on the distal corner and two slender geniculate setae on the distal end. Endopodite two-segmented; first segment about 1.5 times as long as exopodite, with one spinulose thick seta at about two-thirds the length of posterior margin; second one small, about twice as long as broad, with several delicate spinules on inner distal corner of anterior surface, and two terminal claws, of which the longer is almost as long as the exopodite. Leg 2 (Fig. 5, 2). Coxa ornamented with two spinular rows on the inner part of the anterior surface, and bare at the outer distal corner. Basis forming into two small triangular plates, of which one is between both rami and the other is on the inner distal corner, and with one slender outer seta and a few long hairs on the mid inner edge. Exopodite three-segmented; first segment longer and wider than succeeding segments, non-spinulose along the inner margin of

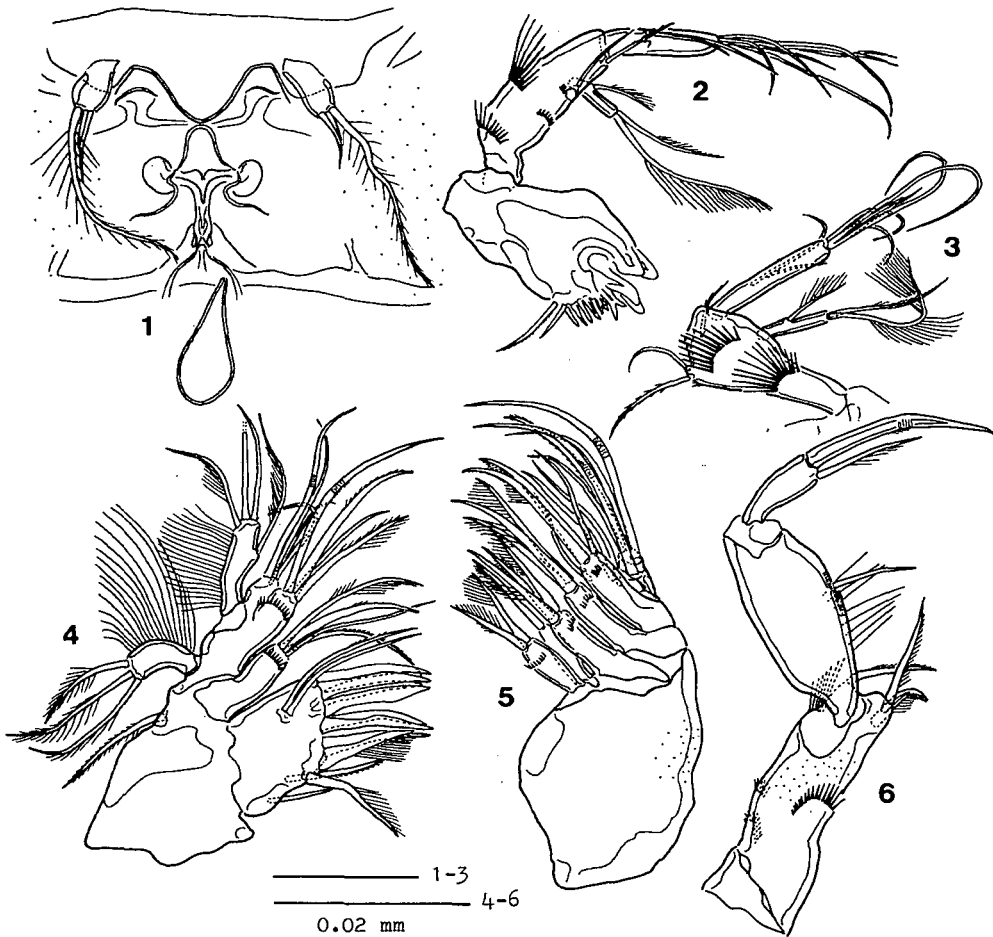


Fig. 4. *Phyllopodopsyllus simplex* n. sp. Female (1, paratype; 2-6, holotype).—1, genital area and leg 6 (MKC-11); 2, mandible (MKC-35); 3, ditto (MKC-35); 4, maxillula (MKC-35); 5, maxilla (MKC-34); 6, maxillipede (MKC-34).

the proximal half, and armed with hairy inner seta which reaches to the distal end of the second segment; second one almost equal to third one in length, ornamented with several hairs along the inner margin; distal segment non-spinulose along inner edge, and armed with two outer spines, and one spine and one seta on the terminal end. Endopodite two-segmented, reaching to one-third the length of the second exopodite-segment; proximal segment a little longer than distal one, ornamented only with many hairs along both sides, and forming into a small protuberance at the outer distal corner; the other segment approximately twice as long as wide, ornamented with numerous hairs or hairlike spinules on the posterior surface, and bearing one stout outer spine

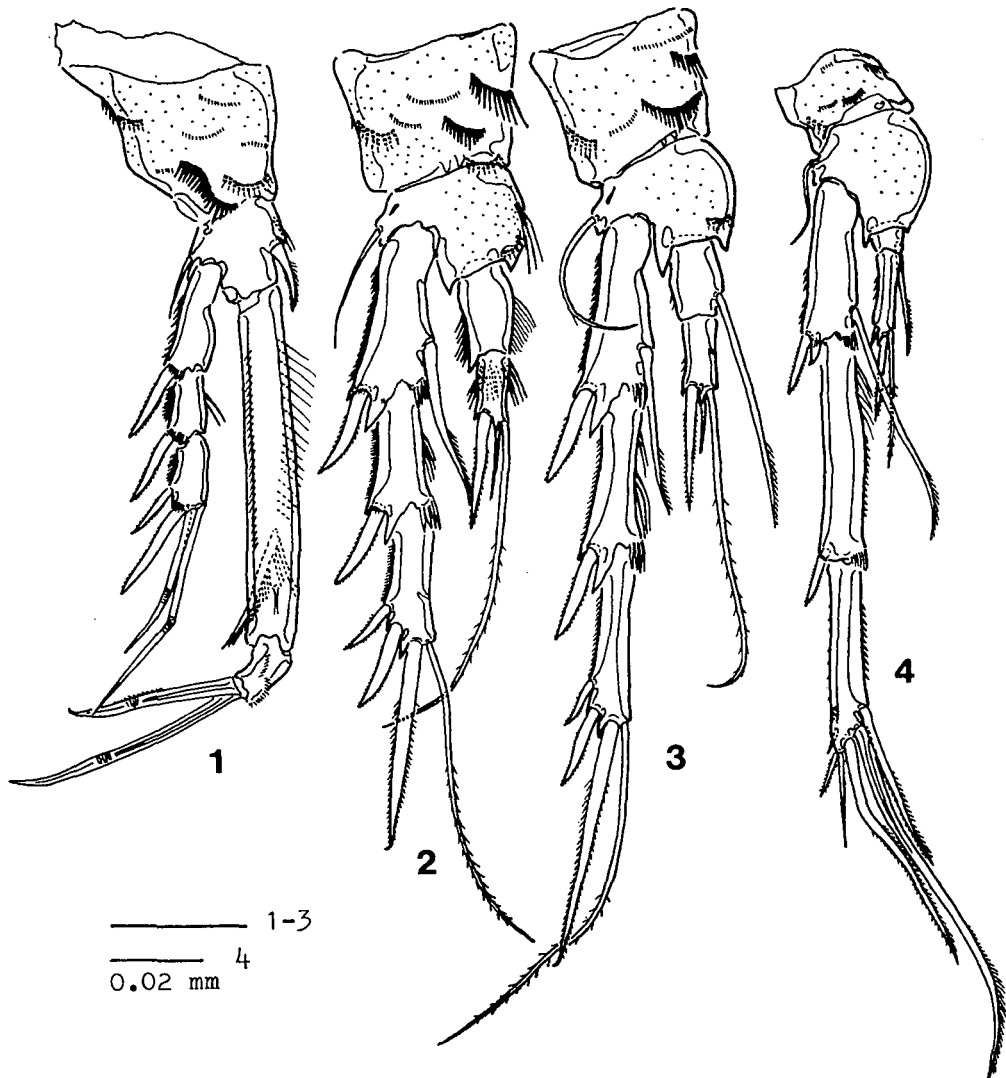


Fig. 5. *Phyllopodopsyllus simplex* n. sp. Female (holotype).—1, leg 1 (MKC-32); 2, leg 2 (MKC-31); 3, leg 3 (MKC-30); 4, leg 4 (MKC-29).

subterminally, and one bare setula and one sparsely hairy, slender seta on the distal end. *Leg 3* (Fig. 5, 3). Coxa almost same as in leg 2. Basis with one slender outer seta; triangular protuberance between both rami remarkably sharpened. Exopodite three-segmented; each segment more slender, and almost equal in length; ornamentation as in preceding leg. Endopodite two-segmented, almost as long as the first exopodite-segment; first segment as long as second, and armed with one relatively elongate, hairy seta on subdistal inner margin; second one approximately twice as long as wide, bare at inner margin, ornamented with a few spinules on the outer edge of the distal half, and distally armed as in leg 2. *Leg 4* (Fig. 5, 4). Coxa smaller than basis, and ornamented with two spinular rows on the anterior surface. Basis almost as long as wide, forming into a small projection between the rami and into a minute process at the inner distal corner, and with one thin outer seta. Exopodite remarkably elongate, three-segmented, reaching to the anterior part of the posterior subdivision of the genital double-somite; first segment ornamented with some rigid spinules along the outer margin of the distal half, and with one slender inner seta; second segment longest, about six times as long as wide, without inner seta, ornamented with a number of hairs and somewhat rigid spinules along inner edge, and non-spinulose along outer edge; distal segment fringed with some minute spinules along the outer edge and several rigid spinules along the inner margin, and armed with three spines and four setae, of which the terminal bare seta is considerably shorter and thinner than the three inner setae. Endopodite two-segmented, reaching to the distal end of the first exopodite-segment; first segment shorter than wide, and armed with a hairy inner seta which extends beyond the end of the next segment; second segment about three times as long as wide, ornamented with a few minute spinules on the middle part of the outer margin, one remarkably short spine on the outer distal corner, and one spine and one seta on the terminal end, of which the latter reaches to the middle part of the second exopodite-segment. *Leg 5* (Fig. 6, 1) large and foliaceous; baseoendopodite and exopodite fused into a single leaf-shaped plate, furnished with one slender and three short bare setae on outer distal corner, of which the proximal one is bent down near the base; only one dentiform projection visible at the outer distal corner; inner margin furnished with four, very short setae, of which the proximal is faintly hairy.

Male. Body (Fig. 1, 3) about 0.46 mm in length. Ornamentation of somites almost as in female. *Leg 6* (Fig. 6, 3) forming a common plate, each leg with an inner strong spine which is finely ciliated along the outer edge, and one elongate bare seta; a triangular projection occurs at the inner distal corner. *Furcal ramus* (Fig. 6, 2-3) more slender than that of female, approximately 6.8 times as long as greatest width, and ornamented with several minute spinules along the inner edge of the middle part; basally geniculate seta arising from about three-fifths the length of inner edge; principal terminal seta non-bulbous at base. *Rostrum* as in female.

Antennule (Fig. 3, 3) haplocer; second segment with a large unguiform projection; first three segments ornamented with minute punctures, the second with distinctly firm punctures; one short depressed seta visible on the penultimate segment. *Antenna*,

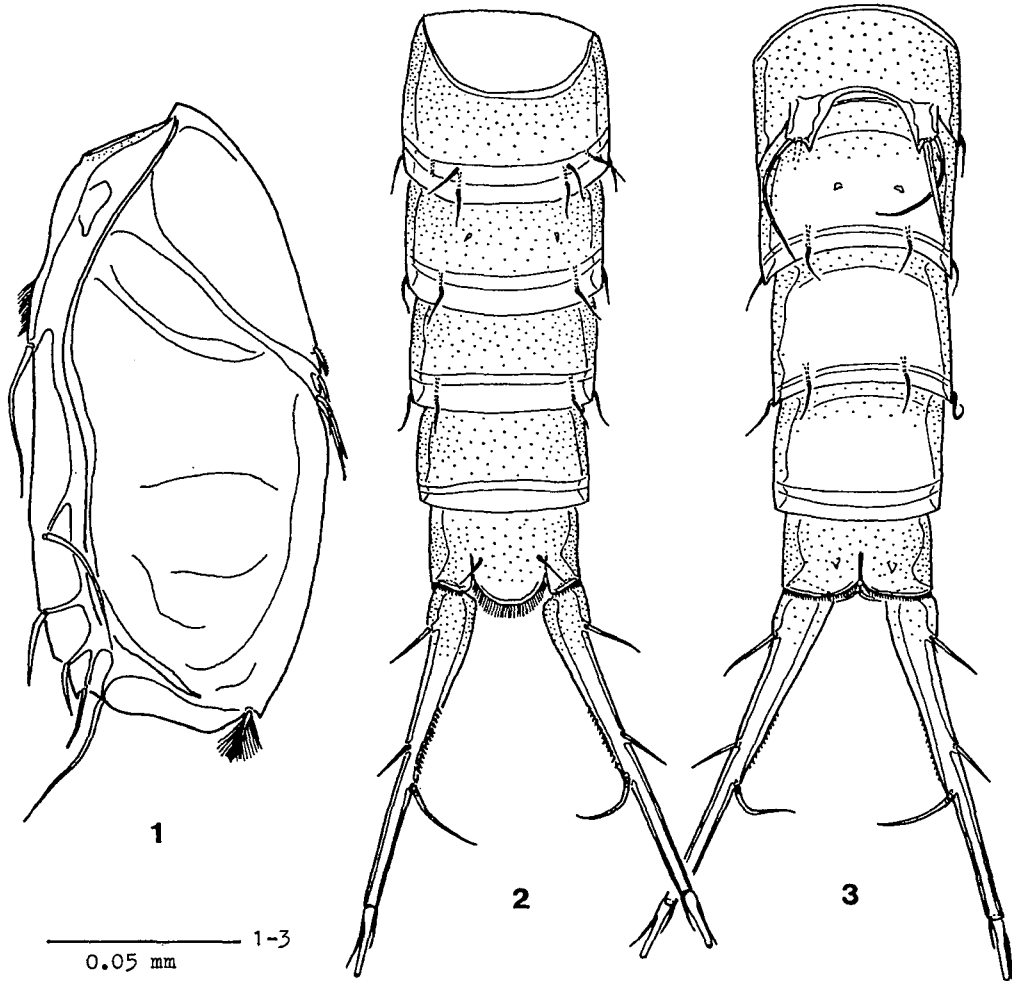


Fig. 6. *Phyllopodopsyllus simplex* n. sp. Female (holotype).—1, leg 5 (MKC-28). Male (allotype).—2, abdomen, dorsal (MKC-34); 3, ditto, ventral.

oral parts and first leg almost the same as in female.

Leg 2 (Fig. 7, 1). Coxa and basis almost as in female. Terminal seta of the third exopodite-segment more sparsely hairy than in the female. Endopodite two-segmented, reaching to distal part of the second exopodite-segment; first segment as in female; distal one transformed into an elongate process at the outer distal corner, and armed with two bare terminal setae. *Leg 3* (Fig. 7, 3). Coxa, basis and exopodite almost as in female, except for a sparsely hairy seta on the last exopodite-segment. Endopodite two-segmented; first segment as in female; second one conspicuously transformed, slightly curved outwards, forming into small triangular protuberances at both distal corners, and terminating in three setae, of which the outermost one is peculiar in appearance as shown in the figure. *Leg 4* (Fig. 7, 4). Coxa and basis as in female. Second exopodite-segment furnished with a triangular plate on the

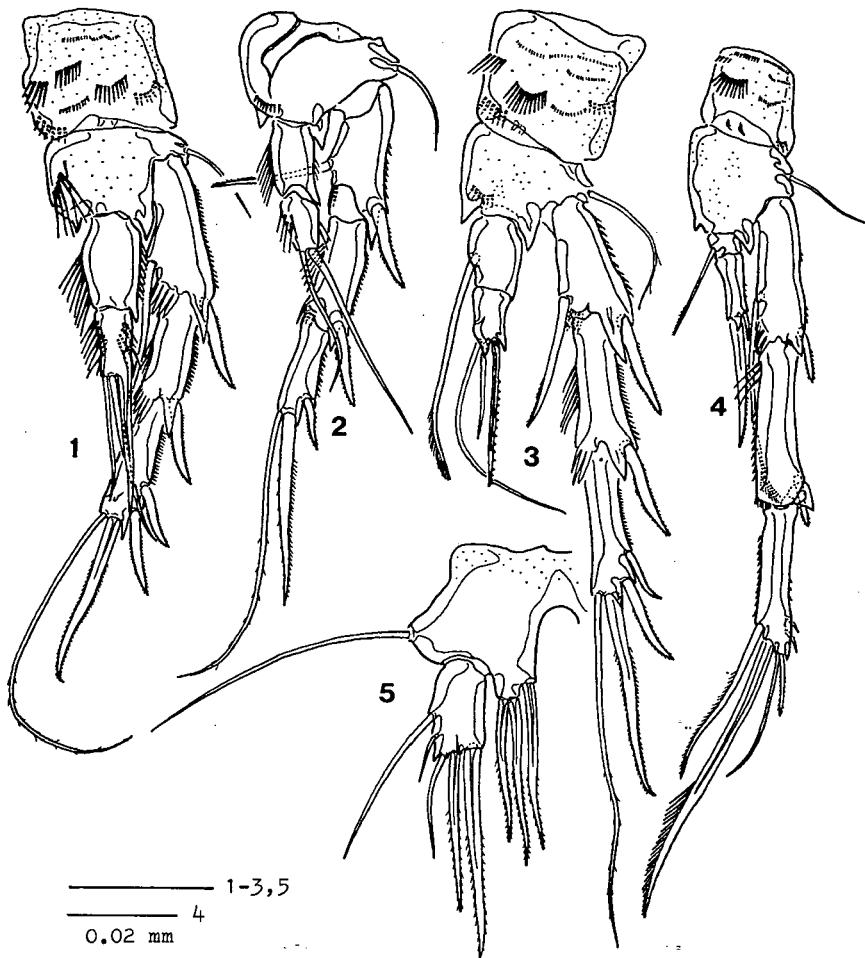


Fig. 7. *Phyllopodopsyllus simplex* n. sp. Male (1, 3-5, allotype; 2, paratype).—1, leg 2 (MKc-30); 2, ditto, posterior view (MKc-14); 3, leg 3 (MKc-29); 4, leg 4 (MKc-28); 5, leg 5 (MKc-27).

outer distal corner, and inner seta absent; third segment with two small outer spines, two terminal setae, of which the inner one is bare, and two inner setae. Endopodite two-segmented; first segment as in female; second one with one short outer spine subdistally, and one stout, faintly arched terminal spine which reaches to the middle part of the second exopodite-segment. *Leg 5* (Fig. 7, 5). Baseopodites confluent, with one inner and two distal, hairy setae, of which the middle is about 1.5 times as long as the exopodite. Exopodite forming into a small spiniform protuberance at the outer distal corner, with two hairy inner setae, and one terminal and two outer, bare setae; outer margin of the proximal half without any ornamentation; short vallecule visible near the base of subterminal inner seta.

Variation and abnormality. In the ten adult females, their body lengths varied from 0.49 mm to 0.56 mm, and from 0.43 mm to 0.46 mm in the five adult males.

No marked variation was noticed in the ornamentation of any female appendages. Among the males, however, some differences were detected. In one male, the exopodite of the left leg 5 is lacking in one outer seta. Another male has an extremely abnormal right leg 2 (Fig. 7, 2), in which both rami are somewhat diminished in size: the third exopodite-segment is armed with merely one outer spine instead of two, and the second endopodite-segment is lacking in an elongate process at the outer distal corner. This specimen is also abnormal in the ornamentation of the right leg 3: the first exopodite-segment is armed with two outer spines. The second one is dwarf, and the distal is furnished with one short and two slender spines, and one seta. Furthermore, in a different specimen, the first endopodite-segment of the left leg 3 is bare, without inner seta.

Remarks. The present species somewhat resembles two previously known species in the segmentation of the antennule and the proportion of the furcal ramus, i.e. *Phyllopodopsyllus bermudae* Lang, 1948 from Harrington Sound in Bermuda and *P. curtus* Marcus, 1976 from the Lybian shore of the Mediterranean. The present specimens, however, are easily distinguishable from these species by the thoracic legs, as is evident from Table 2 (p. 423). Both previously described species have the inner setae at the third exopodite-segments of leg 2 and leg 3, and also at the second exopodite-segment of leg 4. By contrast, the new species is lacking in all these inner setae.

Type-series. Holotype: ovigerous female. Allotype: adult male. Paratypes: five adult females and five adult males. Type-locality: Station C, intertidal zone of the sandy beach at Mukaishima Island, the Inland Sea of Japan. (29-V-1980; Kitazima leg.).

The specific name, *simplex*, is chosen to indicate how simple and smooth the surface structure of each somite is.

Phyllopodopsyllus punctatus n. sp.

(Figs. 8-14)

Female. Body (Fig. 8, 1-2) cylindrical, about 0.54 mm long and about 0.09 mm broad. Colorless and semitransparent. Integument surface strikingly ornamented with numerous minute punctures throughout the body, except for the furcal ramus (Pl. I, Figs. 2-3). Hind edge of each somite, exclusive of anal somite, smooth. *Genital double-somite* (Fig. 9, 1-3) subdivided by a chitinous suture ventro-laterally and ventrally, while dorsally there is a fine line; posterior subdivision ornamented with several hairs along ventro-lateral hind edge; genital area (Fig. 11, 1) longer than the preceding species, and extending mostly over posterior subdivision. *Leg 6* cylindrical in shape, with three setae, of which the outermost one is plumose and reaches to the hind margin of the genital double-somite. Antepenultimate somite ornamented with many hairs along the ventral hind edge. Anal somite serrated or spinulose along dorso-lateral and lateral hind margin, and spinulose or hairy along ventral hind edge; anal operculum less prominent, with numerous delicate hairs marginally; anal area ornamented with innumerable hairs. *Furcal ramus* onionlike in shape, about 1.4

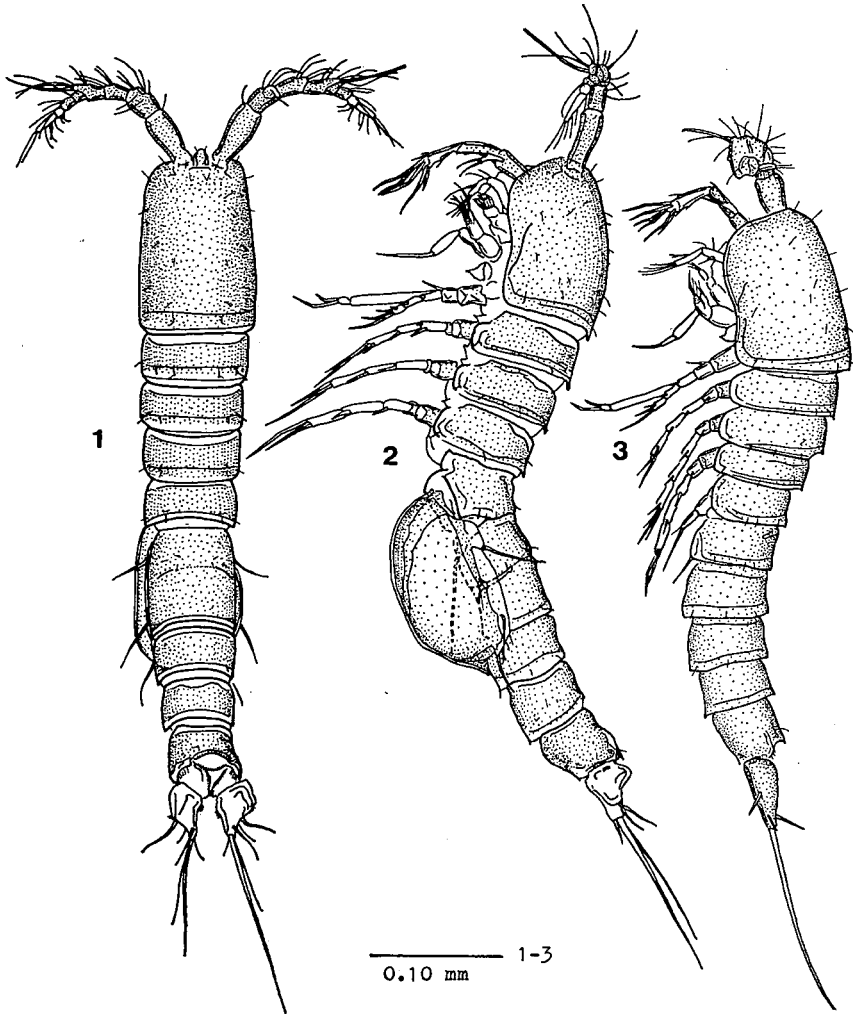


Fig. 8. *Phyllopodopsyllus punctatus* n. sp. Female (holotype).—1, habitus, dorsal; 2, ditto, lateral. Male (allotype).—3, habitus, lateral.

times as long as wide; one slender hairy seta arising from the middle of the outer face, accompanied by a setula; one basally geniculate seta occurring about three quarters of the length along the dorsal surface near the distal end; principal terminal seta non-bulbous at base, and bifurcating proximally into one outer seta which is at least 1.5 times as long as furcal ramus. *Rostrum* (Fig. 10, 1) defined at base, pentagonoid in shape, with a pair of sensillae.

Antennule (Fig. 10, 1) eight-segmented; first segment almost as long as the following two segments combined; second one without any projection; distal one about as long as the two preceding segments combined; indistinctly hairy seta visible on each first two segments. *Antenna* (Fig. 10, 2). *Basis* as long as first endopodite-segment, with delicate hairs along the anterior margin of the distal part. *Exopodite* one-seg-

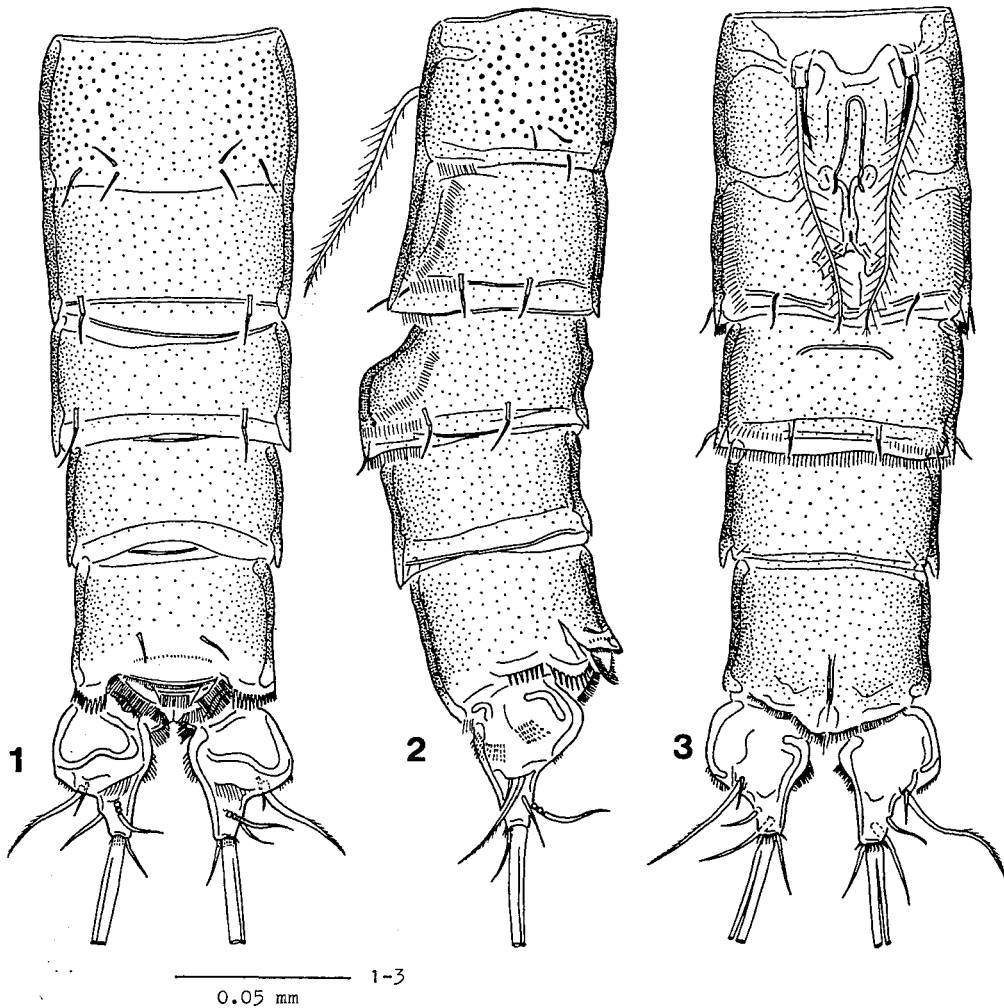


Fig. 9. *Phyllopodopsyllus punctatus* n. sp. Female (holotype).—1, abdomen, dorsal (MKA-1); 2, ditto, lateral; 3, ditto, ventral.

mented, with three hairy setae, one of which arises subterminally. First endopodite-segment with some fine hairs on the proximal part of anterior face; second one about 1.3 times as long as preceding one, spinulose along anterior edge, and furnished with two spinulose cupuliferous projections on the postero-inner face, and two spines and one seta placed about two-thirds along the length of the antero-inner face; distal end armed as in preceding species. *Mandible* (Fig. 10, 3). *Praecoxa* with bidentate pars incisiva, bidentate lacinia mobilis, two? serrate spines, seven? slender spines and one spinulose seta. *Coxa-basis* widened distally and terminating in three plumose setae. *Exopodite* small, about twice as long as wide, and furnished with two setae, the terminal seta is hairy and slender reaching nearby to the distal end of the endopodite. The subapical seta is bare and about 1.5 times as long as the exopodite. *Endopodite*



Fig. 10. *Phyllopodopsyllus punctatus* n. sp. Female (1-3, holotype; 4-6, paratype).—1, antennule (MKA-7); 2, antenna (MKA-8); 3, mandible (MKA-8); 4, maxillula (MKA-10); 5, maxilla (MKA-10); 6, maxillipede (MKA-10).

almost as long as coxa-basis, with two juxtaposed setae at about three-fifths the length of the inner edge, and provided with seven apical setae. *Maxillula* (Fig. 10, 4). Arthrite of praecoxa armed with at least ten thick setae along the inner margin, one? of which has lateral hairs, and six setae along the dorso-inner margin, three of which are hairy or spinulose; two parallel setae on anterior surface, of which the ventral one is plumose. Inner process of coxa bearing three apical setae, of which at least one is plumose. Basis furnished with eight setae, of which the dorsal two are plumose and the ventral one is somewhat geniculate. Both rami almost as in the preceding species. *Maxilla* (Fig. 10, 5). Syncoxa with four endites which from the proximal point are furnished with two, one, three and three spinulose setae respectively. Basis armed apically with two strong, pectinate setae and one narrow bare seta; one plumose seta arising from the posterior side. Endopodite composed of three short segments; first segment armed with three setae, of which one is geniculate and another is hairy, and with one setula on anterior face; second one with only one long geniculate seta; distal one bearing two slender bare and one thick geniculate setae. *Maxillipede* (Fig. 10, 6). Coxa rudimentary. Basis somewhat arched, with several rows of spinules, and armed with two thick setae which are fringed with long fine spinules, and one hairy, relatively narrow seta. First endopodite-segment almost as long as the basis, hairy along inner edge, and furnished with one bare seta at about three-fifths the length of inner edge; second segment almost cylindrical, about three times as long as wide, and armed with one terminal claw and one hairy seta.

Leg 1 (Fig. 11, 2). Coxa forming into a small protuberance on the middle outer edge, with several spinular rows. Basis furnished with one thin outer and one thick inner spine, the latter occurring in a median position. Exopodite three-segmented; first two segments equal in length; second ornamented with several spinules along the inner edge; third a little shorter than preceding, and armed with two outer spines and two terminal, geniculate setae. Endopodite two-segmented; first segment about 1.5 times as long as the exopodite, without inner seta; second one about 1.5 times as long as wide, with two terminal claws. *Leg 2* (Fig. 11, 4). Coxa ornamented with two transversal rows of spinules on the middle part of the anterior surface, several hairlike spinules or hairs on the outer distal corner, and one longitudinal spinular row along the outer margin. Basis not formed into a triangular plate between the rami, but with a minute projection on the inner distal corner, and armed with one outer spine. Exopodite three-segmented; first segment a little longer than the succeeding two segments, armed with one inner hairy seta which reaches to the middle part of the following segment; second one ornamented with some hairs and minute spinules along inner edge; distal segment spinulose along inner margin, with two outer spines, and one spine and one seta at apex. Endopodite two-segmented; first segment about 1.5 times as long as wide, without inner seta; second a little longer than preceding, about 2.5 times as long as wide, and armed terminally with one hairy spine, one setula and one hairy, slender seta which extends beyond the distal end of the exopodite. *Leg 3* (Fig. 12, 1). Coxa almost identical to that in the preceding leg. Basis with one plumose outer seta, and a minute projection on the inner

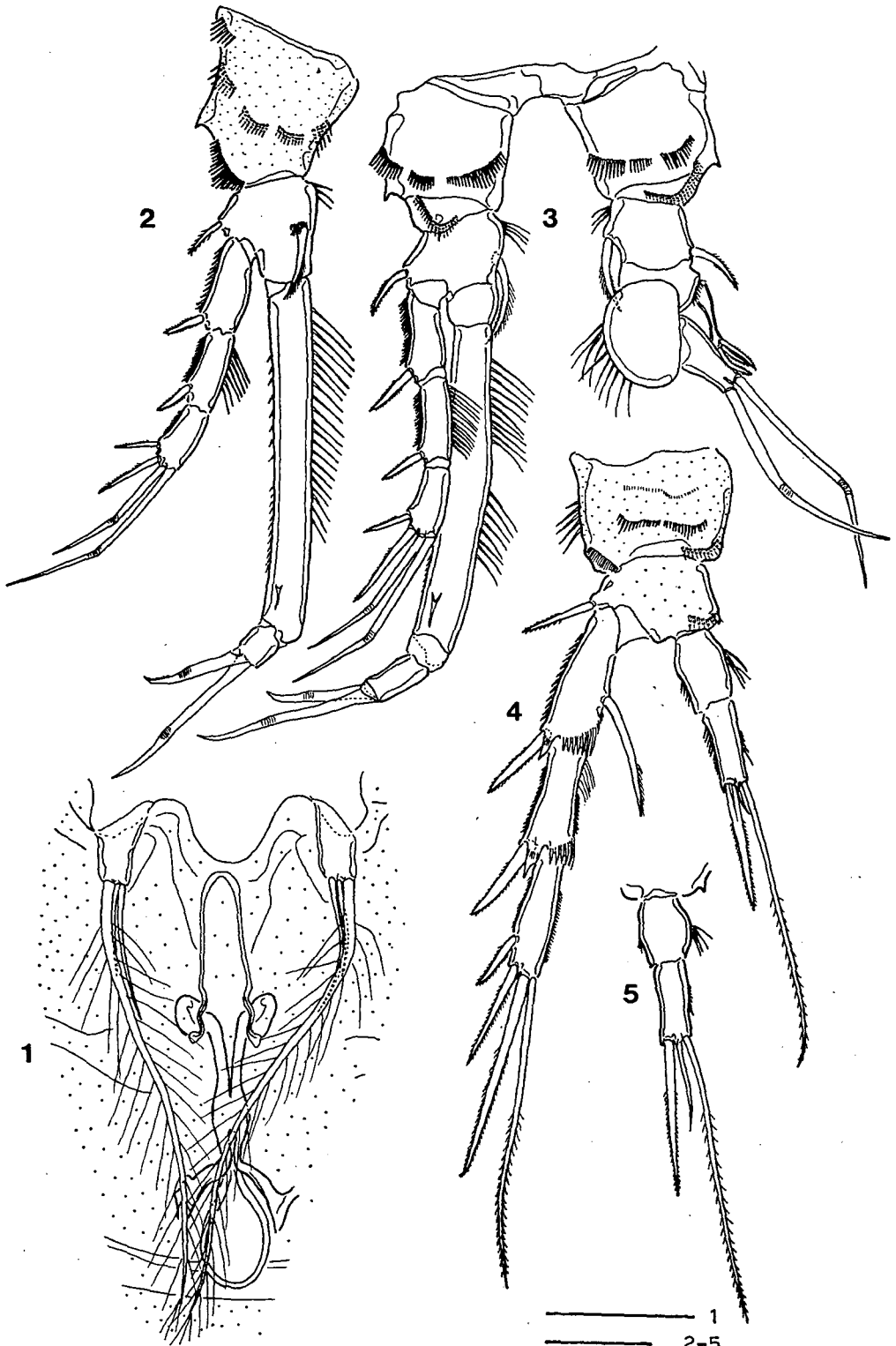


Fig. 11

0.02 mm 1
2-5

distal corner. Exopodite three-segmented; distal segment more slender than two preceding; ornamentation almost as in leg 2. Endopodite two-segmented, as long as the first exopodite-segment; first segment a little longer than wide, forming into a small protrusion at the outer distal corner, without inner seta; distal segment almost as in leg 2. Leg 4 (Fig. 12, 2). Coxa ornamented with one delicate spinular row on anterior

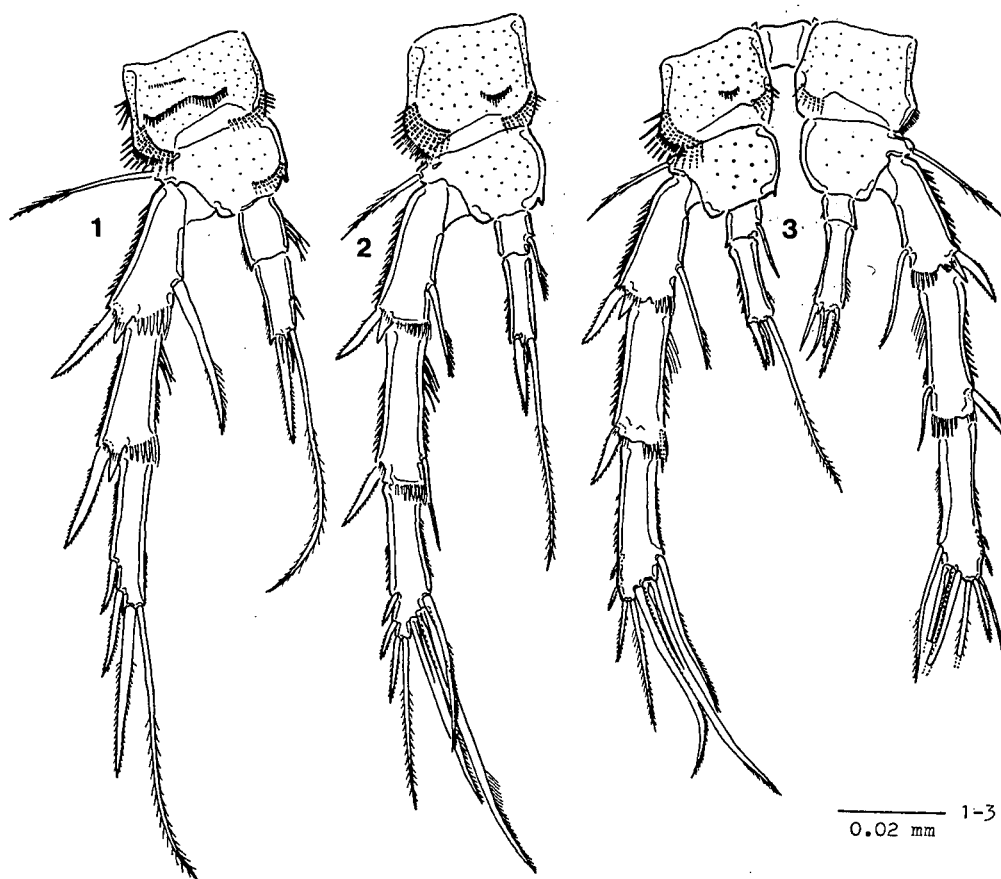


Fig. 12. *Phyllopodopsyllus punctatus* n. sp. Female (1, 2, holotype; 3, paratype).—1, leg 3 (MKA-5); 2, leg 4 (MKA-3); 3, ditto (MKA-13).

face, several hairs or hairlike spinules on the outer distal corner, and with two spinular rows near both distal corners of the posterior side. Basis almost the same as in the preceding leg, except for the lack of some spinules near the inner distal corner of the posterior side. Exopodite composed of three segments which are equal in length; first two segments each with one inner seta which, however, is comparatively shorter

Fig. 11. *Phyllopodopsyllus punctatus* n. sp. Female (2, 4, holotype; 1, 3, 5, paratype).—1, genital area and leg 6 (MKA-45); 2, leg 1 (MKA-6); 3, ditto, posterior view (MKA-43); 4, leg 2 (MKA-4); 5, ditto, endopodite (MKA-14).

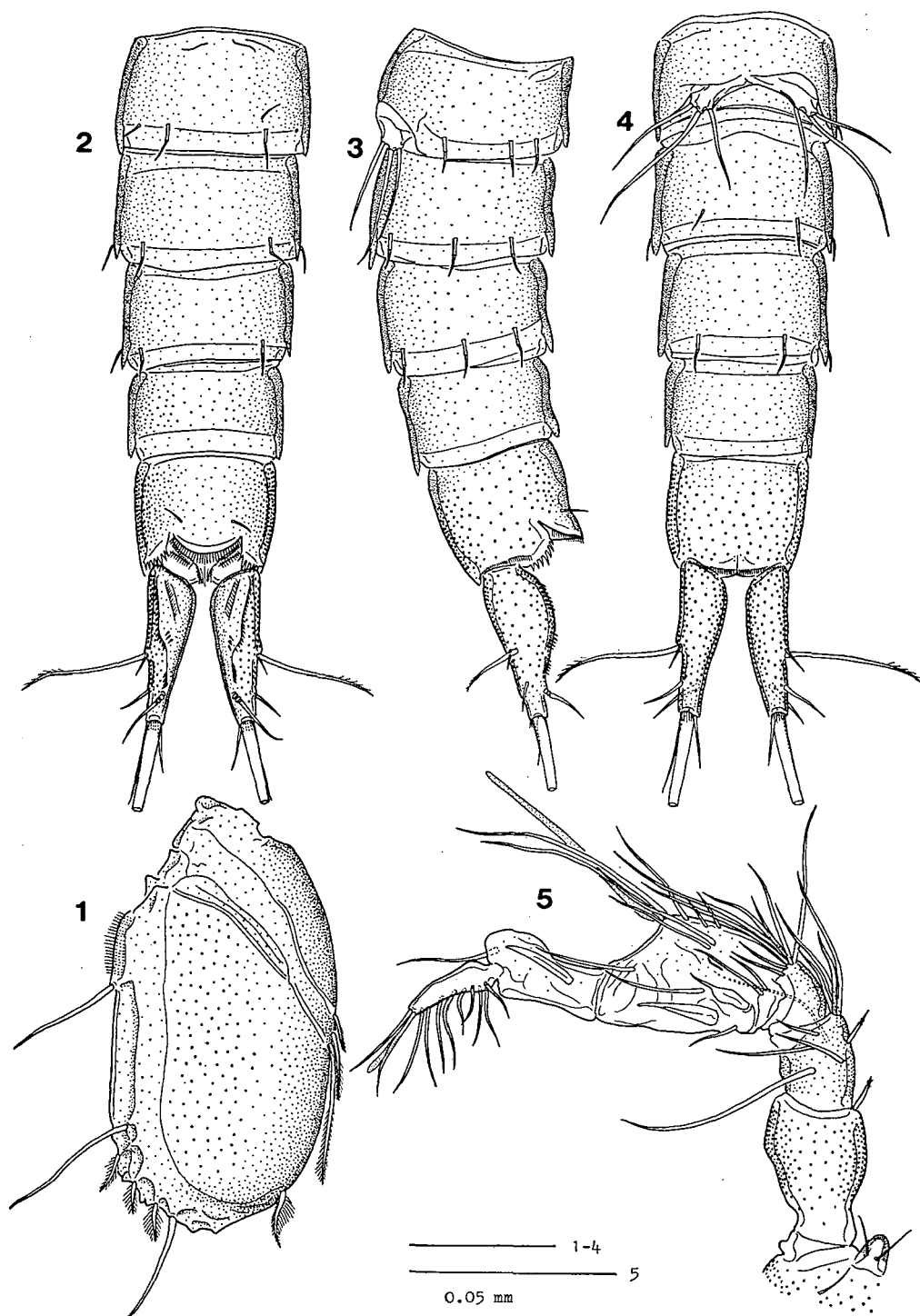


Fig. 13. *Phyllopodopsyllus punctatus* n. sp. Female (paratype).—1, leg 5 (MKA-2). Male (allotype).—2, abdomen, dorsal (MKa-22); 3, ditto, lateral; 4, ditto, ventral; 5, antennule (MKa-27).

than in the species described later (Fig. 19, 1), and moreover, the second inner seta is bare; third segment armed with three spines and four setae, of which the three inner setae are thick and spinulose. Endopodite two-segmented, somewhat shorter than the first exopodite-segment; first segment a little longer than wide, with short hairy, inner seta which reaches to the mid part of the next segment; distal one about three times as long as wide, and armed as in the preceding two legs, except that the outermost spine is shorter than the second endopodite-segment. *Leg 5* (Fig. 13, 1) large and foliaceous; baseopodite and exopodite fused into a single leaf-shaped plate, strikingly ornamented with a number of minute punctures; three plumose setae arising from the outer distal corner, where two or three small projections are visible; inner margin furnished with one setula and three hairy setae, of which the distal one is elongate (about 0.05 mm).

Male. Body (Fig. 8, 3) about 0.47 mm long. Ornamentation of each somite almost identical to that in female, except that antepenultimate somite is not fringed with hairs along the ventral hind edge (Fig. 13, 4). *Leg 6* (Fig. 13, 4) forming a common plate, and each leg with three bare setae, of which the middle is longest. *Furcal ramus* (Fig. 13, 2-4) about three times as long as greatest width, becoming thinner toward the distal end, and noticeably ornamented with a number of punctures; dorsal keel distinctly visible on the proximal half, with several fine spinules; one slender hairy seta arising from middle of the outer margin, accompanied by a setula; outermost terminal seta about half as long as furcal ramus. *Rostrum* (Fig. 13, 5) much smaller and triangular in shape.

Antennule (Fig. 13, 5) haplocer; fourth and fifth segments with two and one dorsal depressed setae, respectively. *Antenna, oral appendages* and *first leg* almost the same as in female.

Leg 2 (Fig. 14, 1). Coxa, basis and exopodite as in female. First endopodite-segment about 1.8 times as long as wide, longer than distal which is about twice as long as wide, formed into an elongate process at the outer corner, and armed with two bare setae, of which the outer one is tapering halfway and shorter than the outermost process. *Leg 3* (Fig. 14, 2). Second endopodite-segment markedly transformed, produced into a small protuberance at the outer distal corner, and at the inner distal corner, forming into two branches, the anterior which is spiniform and the posterior which is cylindrical, somewhat inclined outwards and furnished with one short spine and one slender bare seta, of which the latter extends beyond the distal end of the exopodite. *Leg 4* (Fig. 14, 3). Third exopodite-segment armed with three spines and three setae, of which the two inner setae are spinulose. Second endopodite-segment with one short outer and one long inner, scimitar-shaped terminal spine; the latter extending beyond the distal end of the second exopodite-segment. *Leg 5* (Fig. 14, 4). Baseopodite furnished with three hairy setae, of which the middle one is about 2.3 times as long as the exopodite. Exopodite about 2.2 times as long as wide, spinulose along the outer margin of the proximal half, and bearing one inner and one terminal hairy seta, one subterminal short seta which is sparsely hairy, and one outer bare seta.

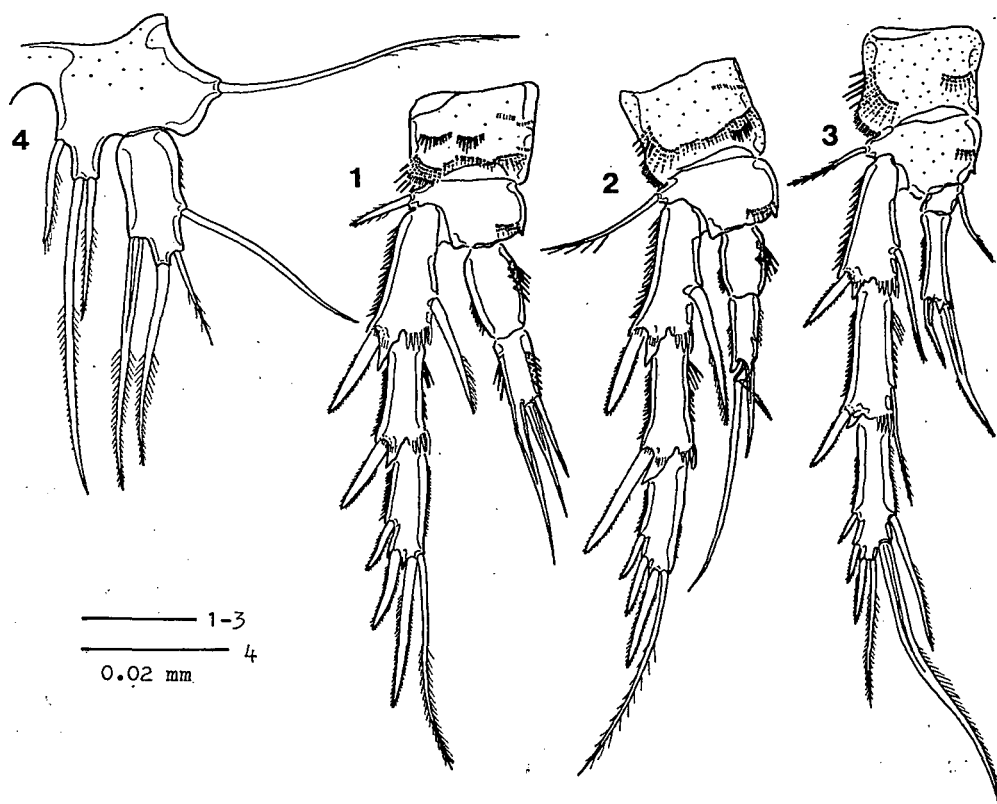


Fig. 14. *Phyllopodopsyllus punctatus* n. sp. Male (allotype).—1, leg 2 (MKa-25); 2, leg 3 (MKa-24); 3, leg 4 (MKa-23); 4, leg 5 (MKa-22).

Variation and abnormality. In the six adult females the largest is the holotypic specimen and the smallest is 0.46 mm long. In a female specimen, the endopodite of the right leg 2 (Fig. 11, 5) terminates in one spine, one narrow bare seta instead of a setula, and one hairy seta. The same specimen has abnormal legs 4 (Fig. 12, 3). The second exopodite-segment of the right leg is furnished with an abortive inner seta. The outer terminal spine of the endopodite of the same leg is as short as the adjacent setula. The first endopodite-segment of the left leg is lacking in an inner seta, and the last segment is furnished distally with four short spines and setae. Furthermore, the third exopodite-segment is armed with three spines and five setae instead of four setae, of which the outermost bare seta is additional. Another female shows extreme abnormality of the right leg 1 as in Fig. 11, 3. In the six adult males, the body lengths varied from 0.47 mm to 0.49 mm. In one male, the distal exopodite-segment of the right leg 3 lacks one outer spine. The same specimen has also an aberrant exopodite of the left leg 5, which bears five setae instead of four. In another male, the second exopodite-segment of the right leg 3 is furnished with one inner seta.

Remarks. The present species is most nearly allied to *Phyllopodopsyllus longipalpatus*

(Chappuis, 1953) from the Italian shore of the Mediterranean. It is similar, in the shape of the furcal ramus, the segmentation of the antennule, and the ornamentation of the exopodites of legs 2 and 3. The Mediterranean species, however, is distinct from the present one in the following structures (the corresponding characters of the two species are indicated in parentheses): mandibular exopodite with only one seta which is shorter than half the length of the endopodite (with two setae, of which the terminal one is almost as long as the endopodite); mandibular endopodite with one and six setae on inner edge and distal end, respectively (with two and seven setae); second endopodite-segment of maxillipede with only one terminal claw (with one terminal claw and one hairy seta); first endopodite-segment of leg 1 almost twice as long as exopodite (about 1.5 times); each terminal endopodite-segment of legs 2-4 with one spine and one seta (with one spine, one setula and one seta); third exopodite-segment of leg 4 with four spines and two setae (with three spines and four setae).

Chappuis (1954) also described the male of *P. longipalpatus* from Madagascar, which differs somewhat from the present species: the second endopodite-segment of leg 2 has two narrow setae on both distal corners, and between them, one thick spine which is nodulous near its distal end; the endopodite of leg 3 is three-segmented, distally with one spine and one seta which does not reach to the distal end of the exopodite; the third exopodite-segment of leg 4 is furnished with five spines and setae instead of six, although Chappuis (1954, p. 53) stated that "exopodites P₂, P₃ et P₄ comme chez la femelle"; the exopodite of leg 5 oval in shape, about 1.5 times as long as wide, while in the present species, narrower and about 2.2 times as long as wide.

Type-series. Holotype: adult female. Allotype: adult male. Paratypes: ten adult females and six adult males. Type-locality: Station A, intertidal zone of the sandy beach at Mukaishima Island, the Inland Sea of Japan. (9-IV-1980; Kitazima leg.).

The specific name, *punctatus*, alludes to the punctured surface of the integument.

Phyllopodopsyllus setouchiensis n. sp.

(Figs. 15-21)

Female. Body (Fig. 15, 1-2) cylindrical, about 0.63 mm long, colorless and semi-transparent; innumerable punctures distinctly visible in antennule, cephalothorax, anal somite and furcal ramus. Each somite, except for anal somite, serrated along the dorsal hind rim. *Genital double-somite* (Fig. 16, 1-3) subdivided; marginal serration of anterior subdivision indistinct on dorsal and lateral side, but prominent on dorso-lateral side; ventral side subdivided by a chitinous suture. Posterior subdivision ornamented with several hairs along the latero-ventral hind edge and delicate hairs on the latero-ventral surface. Genital area situated in anterior subdivision, as shown in Fig. 16, 4. *Leg 6* more rudimentary than the preceding two species, with three setae, of which innermost and outermost setae are plumose, the latter extending to the middle part of the posterior subdivision. Antepenultimate somite ornamented in almost the same way as the preceding somite. Penultimate somite

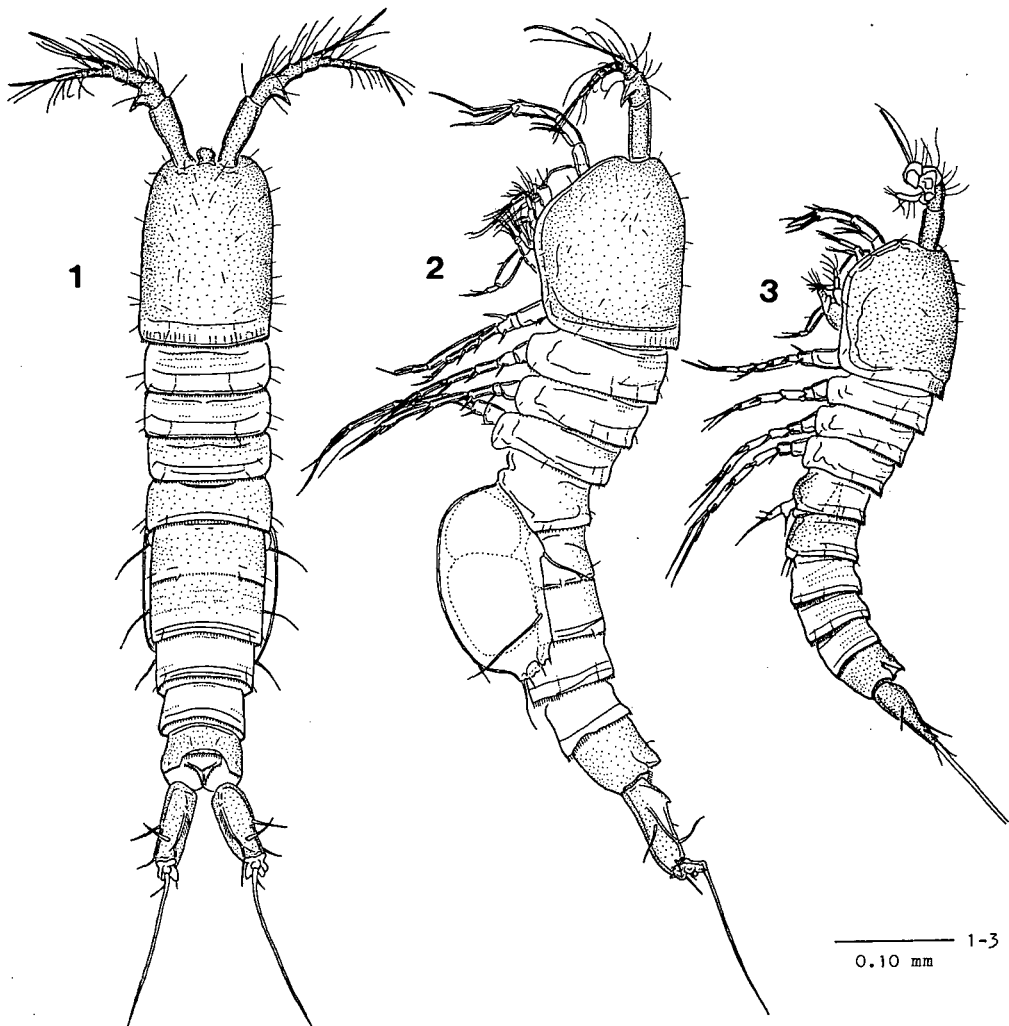


Fig. 15. *Phyllopodopsyllus setouchiensis* n. sp. Female (holotype).—1, habitus, dorsal; 2, ditto, lateral. Male (allotype).—3, habitus, lateral.

ornamented with hairs along the ventral hind edge. Anal somite hairy along the hind edge, except for the ventral hind edge between furcal rami; anal operculum less prominent with marginal hairs, and dorsally ornamented with minute scale-like projections. *Furcal ramus* more or less cylindrical, about 2.5 times as long as wide, and hairy at dorso-inner side and ventral hind edge; dorsal keel indistinct; a basally geniculate seta arising about four-fifths along the length of dorsal surface; two naked setae occurring on the outer face, of which the anterior is about one-third the length of the furcal ramus and accompanied by a hairlike setula; principal terminal seta well-developed, and conspicuously aberrant at base which is ventrally furnished with a

Fig. 16. *Phyllopodopsyllus setouchiensis* n. sp. Female (holotype).—1, abdomen, dorsal (MKB-29); 2, ditto, lateral; 3, ditto, ventral; 4, genital area and leg 6 (MKB-29); 5, antenna (MKB-35).

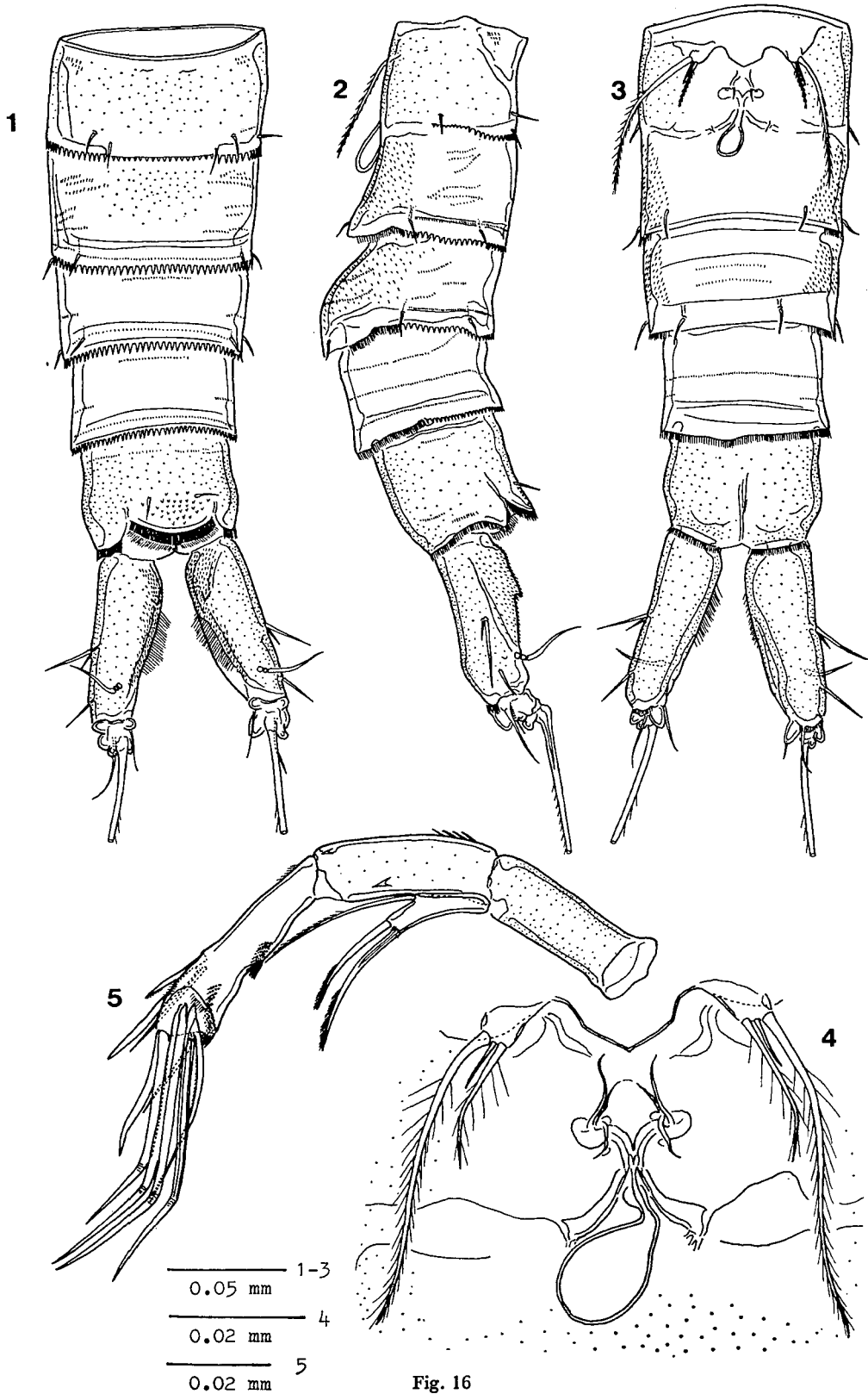


Fig. 16



Fig. 17. *Phyllopodopsyllus setouchiensis* n. sp. Female (1, 2, 4, holotype; 3, 5, paratype).—1, antennule (MKB-35); 2, mandible (MKB-35); 3, maxillula (MKB-16); 4, maxilla (MKB-36); 5, maxillipede (MKB-16). Male (6, allotype; 7, paratype).—6, mandible (MKb-32); 7, ditto, both rami (MKb-20).

narrow seta. *Rostrum* (Fig. 17, 1) defined at base, squarelike in shape.

Antennule (Fig. 17, 1) nine-segmented; first segment almost as long as the succeeding three segments combined; second with a dentiform projection which is about half the length of this segment; distal segment almost as long as the preceding three segments combined. *Antenna* (Fig. 16, 5). Basis almost as long as the first endopodite-segment, without any hairs or spinules. Exopodite one-segmented, with three hairy setae, one of which arises about two-thirds along the length of the anterior edge. First endopodite-segment with some spinules along the anterior edge of the proximal part; distal segment about 1.3 times as long as preceding one, hairy or spinulose in the proximal part of anterior side, and ornamented with two spinulose cupuliferous projections on the postero-inner face, and furthermore with two spines and one seta on about two-thirds the length of the antero-inner face; distal end armed with one short, narrow and six, more or less stout setae. *Mandible* (Fig. 17, 2; Male Fig. 17, 6). Praecoxa with bidentate pars incisiva, bidentate lacinia mobilis, three? serrate spines, three ordinary spines and one spinulose seta. Coxa-basis terminating in three sparsely hairy setae. Exopodite about four times as long as wide, and furnished with one hairy seta halfway along, one short bare seta subapically and three slender, sparsely hairy setae at the apex. Endopodite with two juxtaposed setae just below the middle of the inner edge, and seven setae terminally. *Maxillula* (Fig. 17, 3). Arthrite of praecoxa spinulose along the dorsal edge, with two parallel setae on the anterior surface, twelve, more or less claw-like setae along the inner edge, of which the dorsalmost two are one-sided spinulose, and with two spinulose setae near the dorsal inner corner. Inner process of the coxa bears five apical setae, three of which are hairy. Basis armed with eight setae, of which the innermost three are hairy. Exopodite almost the same as in the preceding two species. Endopodite with four setae, three of which are plumose. *Maxilla* (Fig. 17, 4). Syncoxa with four endites and ornamented as in the preceding two species. Basis furnished with two stout pectinate and one narrow, bare setae apically, and one bare seta on the posterior face. Endopodite three-segmented; first segment with three setae, of which one is rather geniculate and one is hairy, and with one setula; second segment with one somewhat geniculate seta; terminal segment with two bare and one hairy setae. *Maxillipede* (Fig. 17, 5). Basis tapering a little, with five spinular rows, and armed with two spinulose and one spini-form pectinate setae. First endopodite-segment almost the same as in the preceding two species; second segment cylindrical, about twice as long as wide, and furnished with one terminal claw, accompanied by two setae, one of which is hairy.

Leg 1 (Fig. 18, 1). Coxa swelling into a small protuberance at the middle outer edge, with three spinular rows on the anterior surface. Basis armed with one outer and one inner spine, of which the latter arises proximally. Exopodite three-segmented; first two segments equal in length; second one ornamented with several spinules along the inner edge; third one shorter than the preceding segments, and ornamented as in the preceding two species. Endopodite two-segmented; first segment about 1.2 times as long as the exopodite, with one spinulose seta at about two-thirds the length of inner or postero-inner edge, and fringed with a number of long spinules along both

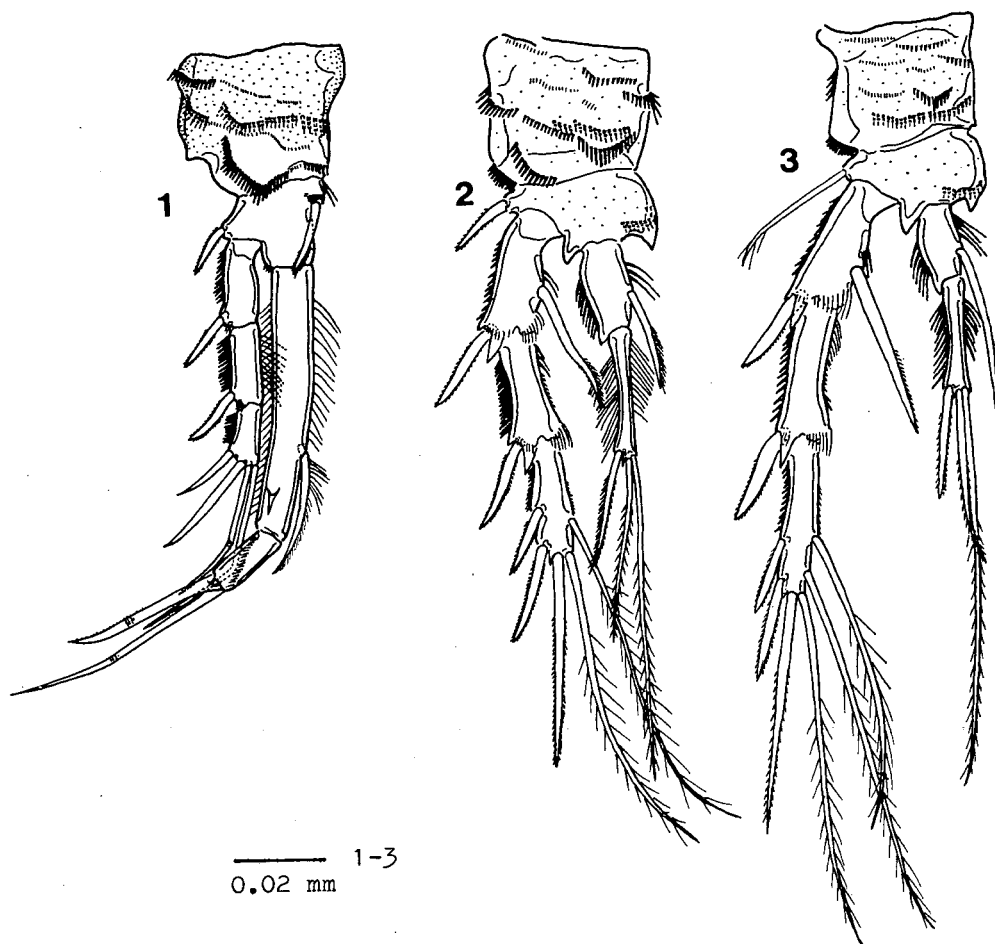


Fig. 18. *Phyllopodopsyllus setouchiensis* n. sp. Female (holotype).—1, leg 1 (MKB-34); 2, leg 2 (MKB-33); 3, leg 3 (MKB-32).

margins; second one about 2.5 times as long as wide, with a diagonal row of delicate spinules on the anterior surface. *Leg 2* (Fig. 18, 2). Coxa ornamented with at least six spinular rows on the anterior surface, and several delicate spinules on the outer distal corner. Basis formed into two triangular plates, of which one is positioned between the rami and the other is on the inner distal corner, and armed with one outer spine. Exopodite three-segmented; first segment ornamented with a few spinules on the middle of the inner edge, and with hairy inner seta; second segment with some hairs and minute spinules along the inner edge; distal segment with two outer spines, one spine and one seta on distal end, and one inner seta. Endopodite two-segmented, extending beyond distal end of the second exopodite-segment; proximal segment about twice as long as wide, spinulose along outer and proximal inner edges, formed into a small protuberance at the outer distal corner, and bearing a hairy inner seta which reaches to the mid part of the succeeding segment; second one much slenderer, becom-

ing thinner halfway, approximately six times as long as wide, and ornamented with a number of hairlike spinules or hairs along both edges, one slender spine on the outer distal corner, and two hairy setae on the distal end, of which the inner one is much elongated. Leg 3 (Fig. 18, 3). Basis formed into two triangular protuberances as in the preceding leg, with outer slender, hairy seta. Exopodite three-segmented; first segment spinulose at the middle inner edge; terminal segment with two outer spines, one spine and one seta on the distal end, and two inner setae. Endopodite two-segmented, reaching to about two-thirds the length of the second exopodite-segment; first segment as in leg 2, except for the slender inner seta which extends beyond the distal end of the endopodite; second segment is slender, about four times as long as wide,

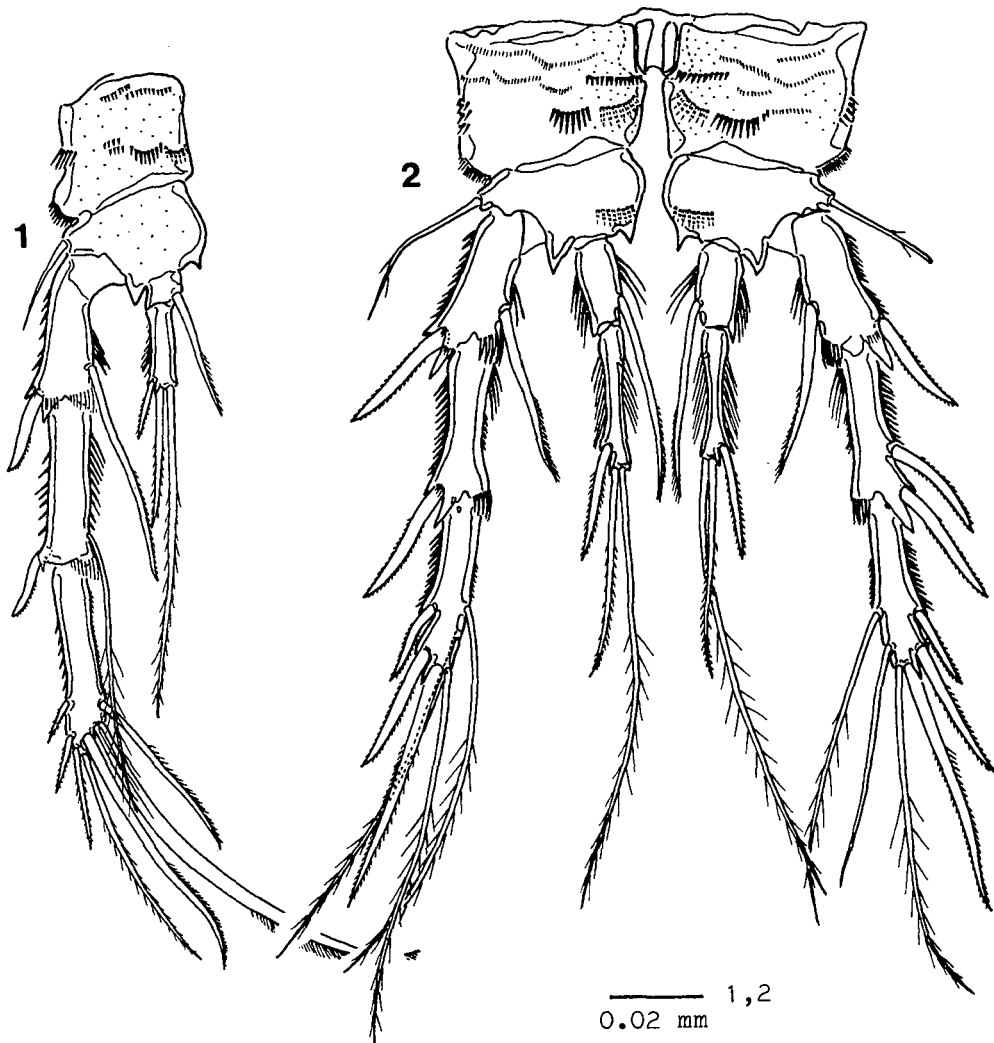


Fig. 19. *Phyllopodopsyllus setouchiensis* n. sp. Female (1, holotype; 2, paratype).—1, leg 4 (MKB-31); 2, leg 3 (MKB-14).

spinulose along both sides; and armed with one subterminal outer spine and two terminal setae, of which the innermost seta is extremely long. *Leg 4* (Fig. 19, 1). Basis formed into a triangular projection and a small process, between rami and at inner distal corner, respectively, and armed with one bare outer seta. Exopodite consisting of three segments; first segment spinulose along the middle inner edge, with an inner slender, hairy seta; second segment spinulose, sparsely and moderately along outer and inner edges, respectively, forming into a beaklike protuberance at the outer distal corner, and armed with an inner slender, hairy seta; last segment to some degree longer than the preceding two, and bearing three spines and four setae. Endopodite small, shorter than the first exopodite-segment, two-segmented; first segment somewhat shorter than wide, and furnished with one hairy inner seta which extends beyond the distal end of the next segment; second segment about three times as long as wide, hairy along the outer margin, and armed with a short subterminal outer spine and two terminal setae, of which the innermost is so long as to reach almost to the distal end of the exopodite. *Leg 5* (Fig. 20, 1) large, foliaceous, formed into an egg pouch under the abdomen together with both legs as in the preceding two species, and ornamented with delicate punctures on the proximal part; three short bare setae occurring at the outer distal corner, the proximal being shortest and bent down and, moreover, four dentiform projections visible on this part; the inner margin furnished with one setula and three hairy setae, the distal of which is extremely elongated (about 0.07 mm).

Male. Body (Fig. 15, 3) about 0.46 mm long; second abdominal and antepenultimate somites fringed with hairs along the ventral hind edge; other ornamentation almost the same as in female. *Leg 6* (Fig. 20, 4) with one hairy spine and two slender bare setae. *Furcal ramus* about 3.4 times as long as greatest width, tapering toward the distal end, and markedly ornamented with a number of punctures; dorsal keel indistinct; two naked setae occurring on the outer side, of which the proximal one is about one-third the length of the furcal ramus and arising about two-fifths the way along the length of the outer edge; two bare setae, which are almost equal in length, occurring on either side of principal terminal seta which is non-bulbous at base. *Rostrum* (Fig. 20, 5) as in female.

Antennule (Fig. 20, 5) subchirocer (?); second segment with a small protuberance; fourth one with one conspicuously transformed seta and one small depressed seta; penultimate segment anteriorly swelling into a hyaline expansion, with one short depressed seta. *Antenna, oral parts* and *first leg* almost as in female.

Leg 2 (Fig. 21, 1). *Coxa, basis* and *exopodite* almost the same as female. Endopodite two-segmented, reaching to the middle part of the third exopodite-segment; first segment slender, approximately 2.4 times as long as wide, spinulose along the inner edge of the proximal half and outer edge, formed into a small projection at the outer distal corner, and furnished with a short inner seta; second segment elongated, about five times as long as wide, densely spinulose along the outer edge and sparsely along the inner edge, and terminally armed with two bare spines and one bare seta, of which the outermost spine is a little longer than this segment. *Leg 3* (Fig. 21, 2). *Coxa,*

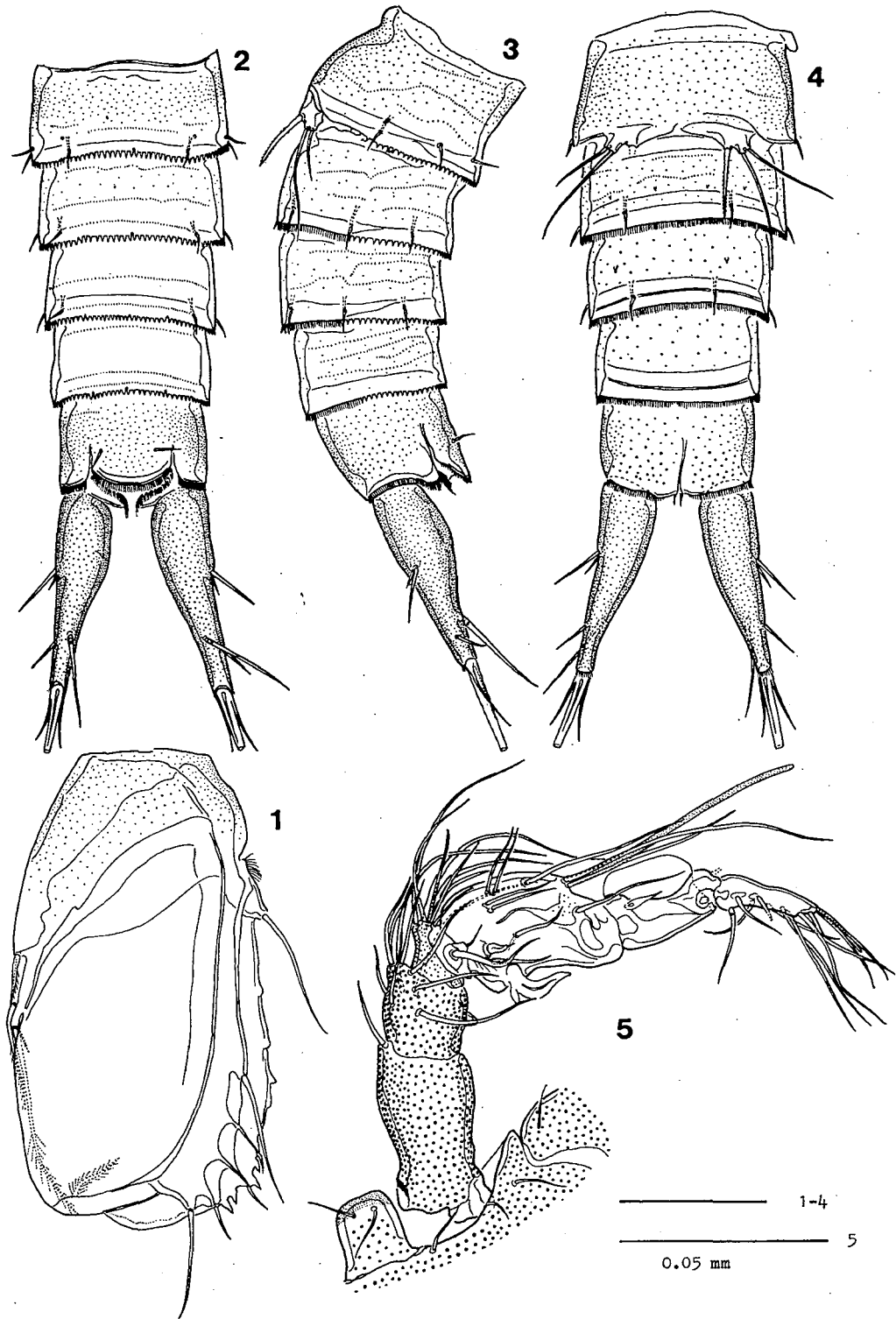


Fig. 20. *Phyllopodopsyllus setouchiensis* n. sp. Female (holotype).—1, leg 5 (MKb-30). Male (2-4, allotype; 5, paratype).—2, abdomen, dorsal (MKb-34); 3, ditto, lateral; 4, ditto, ventral; 5, antennule (MKb-35).

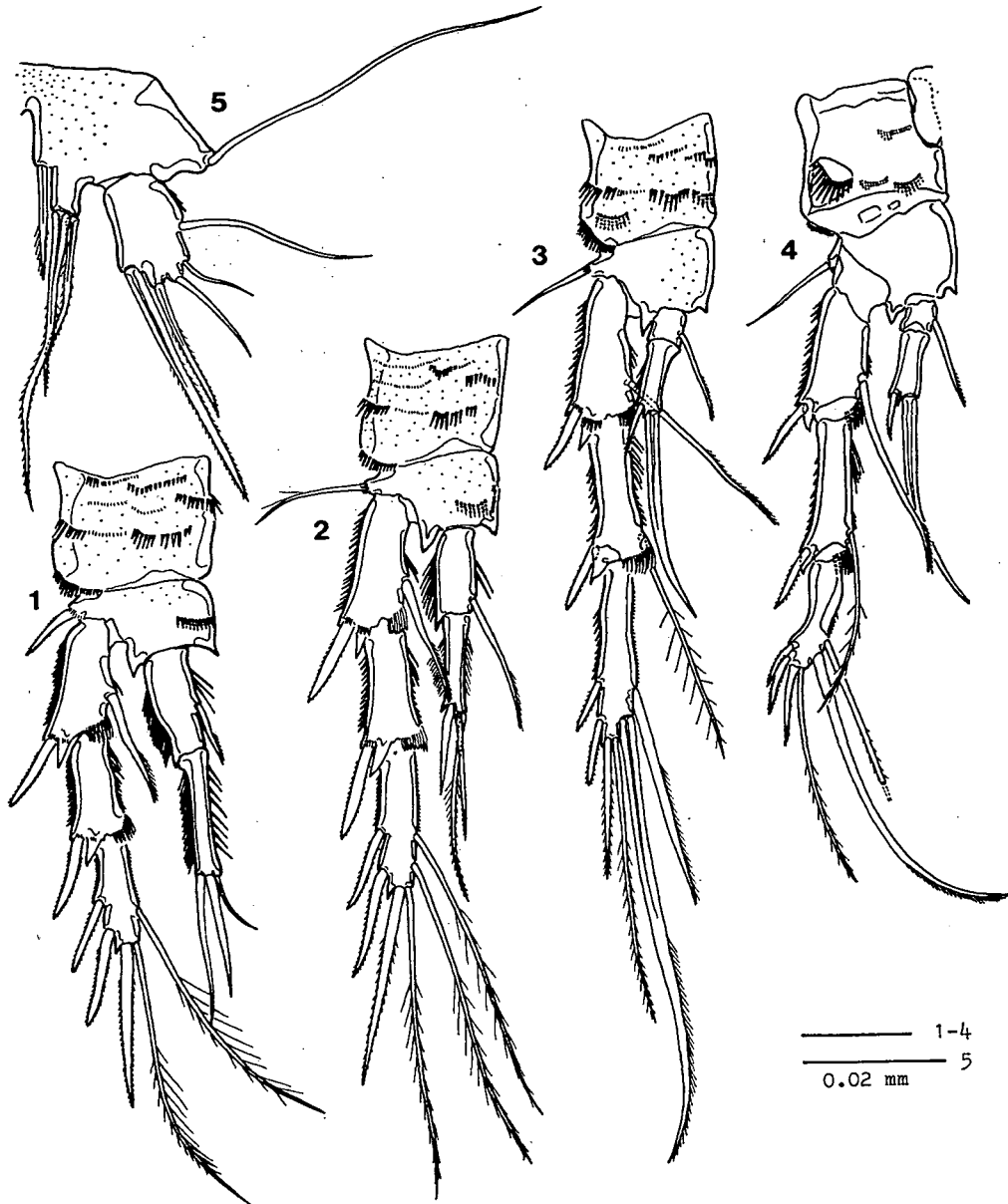


Fig. 21. *Phyllopodopsyllus setouchiensis* n. sp. Male (1-3, 5, allotype; 4, paratype).—1, leg 2 (MKb-29); 2, leg 3 (MKb-28); 3, leg 4 (MKb-27); 4, ditto, posterior view (MKb-8); 5, leg 5 (MKb-26).

basis and exopodite as in female. Endopodite two-segmented, reaching to the distal part of the second exopodite-segment; second segment a little longer than preceding one, about four times as long as wide, with one outer spine subterminally, and one narrow spine and one hairy seta on the terminal end, the latter reaching to the distal end of the exopodite. *Leg 4* (Fig. 21, 3). Second exopodite-segment formed into a

triangular plate at the outer distal corner, with one slender, plumose inner seta; the distal segment is armed with three spines and three setae. First endopodite-segment as long as wide, with a hairy inner seta; distal segment spinulose along the outer margin, with one short outer subterminal spine and one scimitar-shaped terminal spine which is so elongate as to reach to the proximal part of the third exopodite-segment. *Leg 5* (Fig. 21, 5). Baseoendopodite with three hairy setae, of which the middle one is extremely elongated, about 2.8 times as long as the exopodite. Exopodite about 1.6 times as long as wide, spinulose along the outer margin of the proximal half, and armed with two hairy inner, one bare terminal and two bare outer setae.

Variation and abnormality. In the ten adult females, their body lengths varied from 0.57 mm to 0.66 mm. Among females dissected, one specimen is abnormal in the ornamentation of the left leg 3, in which the second exopodite-segment is armed with two outer spines instead of one. Furthermore, in the same leg, the subdistal inner seta of the distal exopodite-segment is bare (Fig. 19, 2). In the five adult males, the largest one is 0.52 mm long and the smallest is 0.45 mm long. In one male, the third exopodite-segment of the left leg 4 is, to some degree, stunted, curving outwards, and though ornamented with three spines and three setae, arrested in development as in Fig. 21, 4. In another male, the subterminal seta of the mandibular exopodite is much lengthened, and one sparsely hairy seta arises from about one-third the length of the inner margin instead of from the middle (Fig. 17, 7).

Remarks. The present species is remarkably close to *Phyllopodopsyllus briani* Petkovski, 1955 from the Adriatic coast of Yugoslavia in the setal structure of the thoracic legs (Table 2), but it is significantly different from the latter in several other structures. First, in *P. briani* the furcal ramus of female is more slender, about four times

Table 2. Setal formulae of three new species and the most closely related forms.

	P2		P3		P4	
	Exo.	End.	Exo.	End.	Exo.	End.
<i>P. bermudae</i> Lang	1.0.122	0.3	1.0.222	0.3	1.1.322	1.3
<i>P. curtus</i> Marcus	1.0.122	0.3	1.0.222	1.3	1.1.322	1.3
<i>P. simplex</i> n. sp.	1.0.022	0.3	1.0.022	1.3	1.0.322	1.3
<i>P. longipalpatus</i> (Chappuis)	1.0.022	0.2	1.0.022	0.2	? ? 321	1.2
<i>P. punctatus</i> n. sp.	1.0.022	0.3	1.0.022	0.3	1.1.322	1.3
<i>P. briani</i> Petkovski	1.0.122	1.3	1.0.222	1.3	1.1.322	1.3
<i>P. setouchiensis</i> n. sp.	1.0.122	1.3	1.0.222	1.3	1.1.322	1.3

as long as wide, and the terminal seta is not transformed at the base. In addition to that, the furcal ramus of the male is much the same as the female (Petkovski, 1955, p. 128), although the genus *Phyllopodopsyllus* generally exhibits sexual dimorphism of the furcal ramus. Secondly, in the female of *P. briani*, the second segment of the antennule is not formed into a dentiform projection at its outer margin, but into a

small protuberance. Thirdly, the anal operculum is well-developed, whereas in the present species it is not so rounded as to be visible from the ventral side. Lastly, in the already described species the first endopodite-segment of leg 1 is equal to or less than the exopodite in length, and armed with a slender inner seta which extends beyond the distal end of the second segment.

Type-series. Holotype: ovigerous female. Allotype: adult male. Paratypes: six adult females and six adult males. Type-locality: Station B, intertidal zone of the sandy beach at Mukaishima Island, the Inland Sea of Japan. (28-V-1980; Kitazima leg.).

The Inland Sea of Japan is often referred to as Setouchi which is the stem of the specific name.

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EXPLANATION OF PLATE I

Scanning electron photomicrographs. Each scale represents 0.02 mm.

- Fig. 1. Rostrum and cephalothoracic somite (*Phyllopodopsyllus simplex* n. sp., female).
- Fig. 2. Rostrum and cephalothoracic somite (*Phyllopodopsyllus punctatus* n. sp., female).
- Fig. 3. Genital double-somite and leg 5 (ditto).
- Fig. 4. Rostrum and cephalothoracic somite (*Phyllopodopsyllus setouchiensis* n. sp., female).

