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New Species of Marine Harpacticoid Copepods of the Genera *Harpacticella* and *Tigriopus* from the Bonin Islands, with Reference to the Morphology of Copepodid Stages

By

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(*With 21 Text-figures*)

In the previous paper (Itô, 1975), I described a new species of interstitial isopod of the genus *Microcerberus* as the first report of my faunistic study carried out at the Bonin Islands in April 1973. In the present paper as the second report from the study, two new species of marine harpacticoid copepods (Family Harpacticidae: *Harpacticella* Sars and *Tigriopus* Norman) are described together with the knowledge on the morphology of some copepodid stages which I could find in the preserved materials, though they were not enough to follow whole the developmental stages.

Before going further, I would like to express sincere thanks to Professor Mayumi Yamada, Hokkaido University, for reading the manuscript. The present paper is based upon a part of my thesis presented to Hokkaido University. The type specimens are deposited in the Zoological Institute, Faculty of Science, Hokkaido University.

1. *Harpacticella oceanica* n. sp.

(Figs. 1~11)

1–1. *Description of adults* (Figs. 1~5).

Female. Body (Figs. 1–1, 2) fairly depressed dorso-ventrally, about 0.62 mm long, rostrum and furcal setae excluded, and 0.30 mm in greatest width measured at posterior end of cephalothorax. A nauplius eye present. A small square purple patch (following description of coloration is based upon observation of formalin-preserved material) just above nauplius eye. A transverse brown band somewhat interrupted partially on cephalothorax. Each pleurotergite of first two thoracic somites clearly tinctured with dark brown except for an oval area of dorso-anterior part and a pair of crescent areas of posterior part. Third thoracic pleurotergite laterally fringed with a dark brown band. Anterior part of fourth

thoracic somite dark brown. All abdominal somites tinctured with pale brown except for certain colorless areas of dorsal side as shown in figure (Fig. 1–1). Rostrum (Fig. 2–1) fairly bending down, shorter than wide, much sclerotized along both lateral rims, and with a pair of short sensillae apically. Cephalothorax somewhat wider than long, with some scattering hairs on dorsal surface and along lateral margin. First three thoracic somites combined shorter than cephalothorax and gradually tapering behind. A pair of leg 5 apparently visible in dorsal view.

Fig. 1. *Harpacticella oceanica* n. sp. Adult female (Holotype). 1. body, dorsal; 2. ditto, lateral; 3. abdomen, dorsal; 4. ditto, ventral; 5. antenna. Adult male (Allotype). 6. antenna.

Abdomen (Figs. 1–3, 4) shorter than cephalothorax and remarkably reduced in width rather than first four somites. Genital double-somite scarcely subdivided by a very short chitinous suture on each lateral side; dorsal part with two shallow depressions of a transversely elongated oval outline; one bare setula representing reduced leg 6 arising from each lateral end of genital area; many delicate spinules arranged in an almost longitudinal line on both lateral sides of anterior subdivision; posterior subdivision ornamented with some vertical spinular rows on lateral sides.

Antepenultimate somite more than twice as wide as long, ornamented with some spinular rows laterally and ventrally, and a hair on each lateral side near posterior end. Penultimate somite almost as in previous somite, but lateral hairs wanting; dorsal part of posterior hyaline membrane slightly expanding behind. Anal somite less shorter than preceding somite, with a pair of fine hairs dorsally, and many spinules along posterior end of ventral side. Furcal ramus somewhat wider than long, slightly tapering distally, forming itself a hyaline lappet at outer corner of ventral side; principal terminal setae well developed; a bare seta on inner distal corner; one basally geniculate setula, which is accompanied with several spinules, arising from inner dorsal side near posterior end; two setae on outer distal corner; a very fine setula arising from middle outer side. Egg sac single and fairly depressed dorso-ventrally.

Antennule (Fig. 2–1) seven-segmented, of a rather stumpy appearance; first segment somewhat shorter than diameter, and with one seta at anterior distal part and several spinules anteriorly; second one apparently longer than preceding one, with six setae anteriorly and three setae dorsally; third one somewhat shorter than preceding one, with at least six setae anteriorly; fourth one forming itself a process terminating in a well developed aesthetasc, with a setula on anterior side; apical three segments remarkably slenderized and shortened; fifth one ornamented with only one seta on anterior side; sixth one somewhat longer than preceding one, and with several setae anteriorly and posteriorly; last one terminating in a trifurcate seta, and with at least three setae on posterior distal corner. *Antenna* (Fig. 1–5). Coxa short and unornamented. Allobasis almost twice as long as basal diameter, with several spinules on proximal half of anterior side; no spine or seta present. Exopodite rather slender, two-segmented; first segment almost twice as long as second one, and ornamented with one bare seta on distal corner; second segment with two somewhat spinulose setae and a spinule apically. Endopodite gradually thickened distally, and as long as allobasis, with several spinules subdistally and subproximally; two somewhat spinulose spines arising from about two-thirds the length; distal end ornamented with one spinulose spine, four geniculate longer spines and one bare seta; of geniculate spines one with a spinule midst. *Mandible* (Figs. 2–2, 3, and Fig. 35–4 for male). Praecoxa strikingly extending inwards, much sclerotized; pars incisiva probably tridentate; pars molaris clearly differentiated; one spinulose seta on inner dorsal edge; a row of some spinules on middle edge. Coxa-basis moderate in size, terminating in two bare juxtaposed setae. Endopodite one-segmented, subcylindrical, almost as long as coxa-basis, ornamented with two juxtaposed setae on middle inner edge, and about ten juxtaposed setae on distal end. Exopodite as long as endopodite, fairly slenderized, with one seta subproximally, one longer seta midst, and five (?) juxtaposed setae terminally; several spinules on distal part. *Maxillula* (Fig. 3–1). Arthrite of praecoxa furnished with an oblique row of spinules on posterior side of proximal part; several spinules on dorsal edge; two parallel setae arising from anterior side; four spines on inner edge and two close spines on inner dorsal corner.

Coxa ornamented with four bare setae on apex of inner cylindrical process. Of basis inner process with four setae terminally and two setae on ventral side. Endopodite represented by a small segment terminating in three bare setae. Exopodite remarkably elongated, subcylindrical, and terminating in three juxtaposed setae;

Fig. 2. *Harpacticella oceanica* n. sp. Adult female (Holotype). 1. rostrum and antennule; 2. mandible. Adult female (Paratype). 3. Praecoxa of mandible. Adult male (Allotype). 4. Praecoxa of mandible.

several spinules on distal part both inwards and outwards. *Maxilla* (Fig. 3–2). Syncoxa about 1.5 times as long as wide, with three endites; proximal endite roundly swelling, ornamented with one plumose seta and a vertical row of some spinules and another spinular row dorsally; middle endite cylindrical, and ending in one plumose seta and one spinulose thick seta; distal endite as long as previous one, and with three apical setae. Basis furnished with one strong claw which is apparently serrate dorsally; two close setae arising from anterior (?) side; one seta near dorsal edge. Endopodite represented by a small segment with three bare setae. *Maxillipede* (Fig. 3–3). Coxa absent (?). Basis tapering distally, with one seta and several spinules. First endopodite segment about 1.5 times as long as basis; inner margin entirely straight and without any ledge; several spinules on

subproximal outer edge. Second endopodite segment forming itself a strong claw with at least two setulae.

Leg 1 (Figs. 3–4, 5). Coxa and basis very much inclined. Coxa with a transverse spinular row on anterior side of basal part; some longer spinules fringing slightly swollen outer edge; some shorter spinules along distal part of outer margin; a transverse row of more than ten spinules (13 in the illustrated leg and 11 in the other leg) directed distally on anterior side near distal end. A line of

Fig. 3. *Harpacticella oceanica* n. sp. Adult female (Holotype). 1. maxillula; 2. maxilla; 3. maxillipede; 4. leg 1, posterior side; 5. ditto, anterior side.

demarcation between coxa and basis rather obscure in posterior side (Fig. 3–4). Basis shorter than coxa, furnished with one strong outer spine which directs laterally (or horizontally) and is fringed with two spinular rows along dorsal side (not both sides); an oblique spinular row on anterior side near base of outer spine described above; one hairy inner seta arising from a small protuberance accompanied with

several fine spinules; anterior side ornamented with more other spinular rows, a transverse row on inner part, a short row along distal edge near inner seta, and a rather longer row near outer distal corner obliquely; inner margin and inner distal part of posterior side spinulose. Both rami three-segmented. Exopodite much longer than endopodite; first segment, including a distal membranous part covering anterior base of second segment, about 2.5 times as long as wide and ornamented with three spinular rows along outer margin, and one outer seta on a subdistal ledge (on distal corner in posterior view, since distal membranous part is invisible in this situation); second one somewhat shorter than preceding one in anterior view, and with one outer spine almost midst, and one spinulose seta on subdistal inner edge; third one fairly sclerotized, and furnished with four arched claws and one bare setula. Endopodite somewhat slenderer than exopodite; first segment more than three times as long as greatest width, with one plumose inner seta midst, some rather flexible spinules along proximal half of inner margin, a transverse spinular row on anterior side near distal end, and some rigid spinules along outer margin; second one as long as wide, and several spinules on outer edge; third one slightly longer than preceding one, and furnished with one strong claw terminally and a setula on subdistal inner edge, and several delicate spinules along inner margin. *Leg 2* (Fig. 4–1). Coxa ornamented with some rigid spinules along outer margin; anterior side with an outcurved spinular row near outer edge, a transverse row of a few spinules subproximally and a row of very delicate spinules on inner part along distal end. Basis with one spinulose outer seta accompanied with several spinules near base anteriorly. Both rami three-segmented. Exopodite longer than endopodite, without any spinule on posterior side; first segment ornamented with five oblique spinular rows, including one row around base of outer spine, on anterior side of outer part, and fringed with some spinules (more than ten) outwards; one outer spine and three outer spines on each second and third segment, respectively, all spines apparently pectinate outwards; distal end of third segment furnished with one elongate spine, which is spinulose outwards and hairy inwards, and one plumose seta; each segment with one, one and two plumose inner setae, counting distally. Endopodite; spinular row fringing first segment slightly interrupted midst; each outer margin of distal two segments spinulose; one spinulose outer spine arising from a subdistal ledge of third segment; of two terminal setae on last one, outer one somewhat rigid, rather spiniform and spinulose outwards; each segment with one, one and two plumose inner setae, counting distally. *Leg 3* (Fig. 4–2). Coxa, basis fairly bigger than those in leg 2. Basis furnished with one bare outer seta. Exopodite ornamented with three plumose inner setae, otherwise as in previous leg. First endopodite segment somewhat shortened. Third endopodite segment furnished with one spinulose outer seta on subdistal ledge, two plumose setae terminally, and three plumose inner setae. *Leg 4* (Fig. 4–3) somewhat smaller than leg 3. Of exopodite segments each posterior side ornamented with many delicate spinules particularly on outer half. Spine and setal ornamentation of exopodite as in previous leg except for minor difference in

their sizes. Endopodite fairly reduced in size, three segments combined almost as long as first two exopodite segments combined; third segment with three inner setae, otherwise as in leg 3. *Leg 5* (Fig. 5–1). Inner expansion of baseoendopodite extremely produced, nearly extending to distal end of exopodite segment, and clearly demarcated by a small notch at outer base, furnished with three rather

Fig. 4. *Harpacticella oceanica* n. sp. Adult female (Holotype). 1. leg 2; 2. leg 3; 3. leg 4.

shorter setae, which arise from distal end or outer subdistal edge and terminate in a hair on each apex, and one elongate seta, which is more than three times as long as exopodite segment and sparsely spinulose, on subdistal inner edge and one spinulose seta, which is almost as long as exopodite segment, close to previous one; both margins fairly spinulose. Exopodite about 2.5 times as long as basal width, slightly tapering apically, furnished with five setae distally or subdistally in all; outermost one almost as long as this segment and spinulose on full length; next one almost twice as long as previous one, and scarcely spinulose; next one narrow and bare; next seta arising from distal end, considerably elongate, more than twice as long as this segment, and bare; innermost one arising from a subdistal ledge, and of same length as previous seta; both margins spinulose, and a longitudinal spinular row on anterior distal part near margin; several spinules on anterior side near distal end.

Male. Body (Fig. 5–2) 0.56 mm long, somewhat thinner than female in dorsal aspect. Rostrum (Fig. 5–3) furnished with a pair of sensillae; both lateral edges fringed with a thin hyaline membrane. Fourth free thoracic somite with a transverse spinular row on ventral side near posterior end. A pair of spermatophores present through first two metasomal somites. A shallow depression of an oval

Fig. 5. *Harpacticella oceanica* n. sp. Adult female (Holotype). 1. leg 5. Adult male (Allotype). 2. body, lateral; 3. rostrum; 4. antennule; 5. leg 5; 6. leg 6 and abdomen, ventral.

outline clearly visible on dorsal side of first abdominal somite with leg 6 and also succeeding somite. All abdominal somites more or less spinulose, particularly second, third and fourth ones ornamented with three or four remarkable transverse rows of many spinules on each ventral side. Furcal rami almost as in female. *Antennule* (Fig.5–4) subchirocer. Apical segment fairly sclerotized and rather complicated. Of swollen segment aesthetasc arising from a much developed cylindrical process. *Antenna* (Fig. 1–6) and oral appendages as in female.

Leg 1, *leg 2*, *leg 3* and *leg 4* same as in female. *Leg 5* (Fig. 5–5). Baseoendopodite represented by a very small segment, with one bare outer seta. Exopodite

fairly longer than wide, with four setae in all, innermost and outermost setae somewhat spinulose, and other two entirely bare; terminal seta longest and reaching fourth abdominal somite. *Leg 6* (Fig. 5–6). Both legs clearly separable by a deep depression from each other. Each leg with three setae in all on lateral corner; innermost seta thick and somewhat spinulose, other two very slender and bare.

Variability. Besides the holotype and the allotype, another one female and one male were dissected. No remarkable difference was found among them.

1–2. *Remarks.* Up to the present, four species have been known in the genus as follows (localities and records, see Itô and Kikuchi, 1977); *H. paradoxa* (Brehm, 1924), *H. inopinata* Sars, 1908, *H. lacustris* Sewell, 1924 and *H. amurensis* Borutsky, 1952. This is the first record of genuine marine species for the genus.

The present new species is easily discernible from the other three species, except for *H. amurensis* whose male is still unknown, in the armature of leg 5 in male. The exopodite of leg 5 in male is furnished with four setae in the present species, but three in the other three species. The shape of the fifth leg in female of the present species is alike to that of *H. paradoxa* particularly in the appearance of the elongate exopodite.

On the other hand, the robust appearance of the leg 1 in *H. oceanica* approaches to that of *H. lacustris* rather than *H. inopinata.* In the last mentioned species the first leg consists of fairly selnderized rami, and the first endopodite segment is fairly shorter than the first exopodite segment. The first segments of both rami in the leg 1 are subequal in length to each other in *H. oceanica* and *H. lacustris. H. amurensis* is clearly discernible from the present new species in the shape and ornamentation of the fifth pair of legs in female.

Specimens examined. Holotype; female (7–IV–'73). Allotype; male (7–IV–'73). Paratypes; a female (7–IV–'73) and a male (19–IV–'73). All the type specimens were collected by rinsings of subtidal sand and pebbles together with some molluscan shells at Miyanohama, Chichijima Isl. (1∼4 m depths. Itô leg.).

Besides these types, I found two adult females in the sample from which the holotype was selected. These two females have been preserved without dissection for a future study.

1–3. *Description of developmental stages* (Figs. 6∼11).

Since culture of this species was entirely unable, the following description of copepodid stages was made based upon the specimens selected from the formalin-preserved sample (7-IV-'73).

The first copepodid stage. Body (Fig. 6–1) consisting of five somites, about 0.21 mm long, 0.10 mm wide measured at a posterior portion of cephalothorax, moderately depressed dorso-ventrally. Rostrum directed almost horizontally. Cephalothorax almost as long as wide, occupying half of whole body. Succeeding somites gradually tapering behind. Pleurotergite of second somite differentiated. Fourth somite unornamented. Fifth somite (Fig. 7–4) slightly widened posteriorly and longer than preceding somite, and with two transverse rows of some spinules

on ventral side near posterior end. Furcal ramus about 1.4 times as long as basal width, ornamented with one fine setula on middle outer edge and one slender, relatively longer seta on outer distal corner; principal terminal setae arising from a common base, and accompanied with one delicate, but fairly long, seta dorsally; several spinules on ventral side near distal end and inner edge. *Antennule* (Fig. 7–1) four-segmented, without any spinulose seta; first segment somewhat shorter than diameter, with one seta on anterior distal edge; second one ornamented with a slender aesthetasc; apical two segments slenderer than proximal two; third segment with several setae both anteriorly and posteriorly; apical one somewhat longer than preceding one, terminating in an aesthetasc and other setae.

Fig. 6. *Harpacticella oceanica* n. sp. Dorsal view of copepodid stages. 1. first cop.; 2. second cop.; 3. third cop.; 4. fourth cop. male; 5. ditto; 6. fifth cop. male.

Leg 1 (Fig. 7–2). Coxa and basis not differentiated from each other. Coxal area ornamented with some spinules on outer edge. Outer spine of basis differentiated, but inner seta not differentiated. Both rami one-segmented, shorter than protopodite. Exopodite more than twice as long as greatest width, terminating in two arched claws; three separate spines arising from outer edge; a few spinules on subproximal outer edge. Endopodite a little shorter than exopodite segment furnished with one short spine on subdistal outer corner, two terminal setae, outer one of which is somewhat spinulose and the other one is elongate and hairy; one hairy seta on subdistal inner edge and one rather short hairy seta arising from a point one-third the length of inner margin; outer margin spinulose, and a slight depression of middle part indicating a sign of segmentation in next stage. *Leg 2* (Fig. 7–3). Demarcation between coxa and basis obscure. Basis with one bare outer seta accompanied with several spinules basally. Both rami one-segmented and of an equal length. Exopodite about three times as long as greatest width, furnished with two widely separate bare spines on outer margin, one somewhat spinulose spine on outer distal corner, and two elongate terminal setae, outer one spinulose outwards and inner one hairy; one slender hairy seta arising from inner subdistal edge. Endopodite rather slenderized, with one bare outer spine (or rather rigid seta) near distal end, two elongate terminal setae, and three relatively

shorter setae along inner margin; outer side fringed with at least four groups of several spinules. *Leg 3* (Fig. 7–4) represented by a protuberance at lateral end of third somite, furnished with one thick bare seta on distal end, one remarkably dwarfed seta inwards and one slender setula outwards.

The second copepodid stage. Body (Fig. 6–2) consisting of six somites, 0.25 mm long, and about 0.12 mm in greatest width. Cephalothorax slightly longer than three succeeding somites combined. Pleurotergites of second and third somites well differentiated. Fourth somite (Fig. 8–5) shortest, and unornamented. Last somite more than 1.5 times as long as preceding somite, widened posteriorly, and furnished with two spinular rows on ventral side as in preceding stage. Furcal ramus elongate, almost as long as last somite; four spinules arranged in a transverse row on ventral side near proximal edge; principal terminal setae completely separated from each other, outer one fairly slenderized (abnormal ?); one fine setula arising from middle outer side; one bare seta on outer distal corner, accompanied with several spinules near base; one basally geniculate seta on dorso-inner side; one slender seta on inner distal edge close to inner principal seta; several spinules on ventral side near distal end; one short seta arising from dorsal side rather outwards. *Antennule* (Fig. 8–1) five-segmented; several spinules added to anterior side of first segment near seta; second segment apparently protruded at anterior end, and terminating in an aesthetasc; third and fourth ones derived from third segment in previous stage; third one shortest, with two setulae on anterior side; fourth one with two setae, one of which is much

Fig. 7. *Harpacticella oceanica* n. sp. The first copepodid stage. 1. antennule; 2. leg 1; 3. leg 2; 4. leg 3 and abdomen, ventral.

Fig. 8. *Harpacticella oceanica* n. sp. The second copepodid stage. 1. antennule; 2. leg 1; 3. leg 2; 4. leg 3; 5. leg 4 and abdomen, ventral.

elongate, on anterior distal end and two setulae posteriorly; last one somewhat tapering apically.

Leg 1 (Fig. 8–2). Coxa and basis clearly demarcated from each other by a rather rough suture, and fairly inclined. Distal part of outer margin of coxa fringed with some longer spinules and shorter ones. Basis much wider than long; outer spine dorsally spinulose and accompanied with some delicate spinules near anterior base; an oblique row of many spinules on anterior side near outer distal corner; one bare inner seta differentiated; inner margin less spinulose. Both rami two-segmented. Exopodite somewhat longer than endopodite; first segment almost twice as long as greatest width, and furnished with some spinules along outer margin, and one bare outer spine subdistally; second one shorter than first, and with two smaller outer spines well separate from each other, and two claws on distal end. First endopodite segment about 1.5 times as long as second one, and furnished with one hairy inner seta midst and an oblique spinular row on anterior side near distal end; second one rather tapering apically, ornamented with one arched claw terminally, and two rows of very delicate spinules on outer margin. *Leg 2* (Fig. 8–3). Coxa and basis apparently demarcated by a suture. Outer seta of basis somewhat thickened and spinulose on both sides. Both rami two-segmented. Exopodite somewhat longer than endopodite; first segment spinulose outwards, and with one outer spine; second one slightly longer than first, furnished with two outer spines subdistally, one elongate spine and one seta on distal end, and two inner setae, each midst and subdistally. First endopodite segment ornamented with one hairy inner seta near distal end; second one much longer than first, one outer spine, two terminal and two inner marginal hairy setae; inner one of terminal setae spinulose outwards; outer margin of each segment with some spinules. *Leg 3* (Fig. 8–4). Coxa and basis differentiated. Both rami one-segmented. Exopodite ornamented as in leg 2 in preceding stage, but with two inner setae instead of one. Endopodite fairly slenderized, with one outer seta, two terminal setae, and three inner marginal setae, distal one of which is hairy and other two are entirely bare. *Leg 4* (Fig. 8–5) represented by a conspicuous protuberance terminating in two close bare setae, inner one slightly shorter than other; one slender seta arising from outer edge.

The third copepodid stage. Body (Fig. 6–3) consisting of seven somites, 0.3 mm long and about 0.14 mm in greatest width. Metasome and urosome clearly discernible in appearance from each other. Cephalothorax somewhat shorter than wide, and almost as long as four succeeding somites combined. Pleurotergite of second, third and fourth somites well differentiated. Sixth somite shortest and unornamented. Both principal terminal setae of furcal ramus well developed. *Antennule* (Fig. 9–1) five-segmented; second segment relatively elongated and some setae added to anterior side and dorsal side; third one furnished with two long setae anteriorly.

Leg 1 (Fig. 9–2) almost same as in preceding stage. *Leg 2* (Fig. 9–3). Several spinules added to outer edge of coxa. Basis as in preceding stage. One short seta

added to inner subdistal edge of first exopodite segment. In second exopodite segment, one bare spine added to almost middle outer edge and one short seta added to a point about one-third the length of inner margin. First endopodite segment as in preceding stage; second segment with one additional inner seta, then, inner margin with three setae in all. *Leg 3* (Fig. 9–4). Coxa and basis as in preceding

Fig. 9. *Harpacticella oceanica* n. sp. The third copepodid stage. 1. antennule; 2. leg 1; 3. leg 2; 4. leg 3; 5. leg 4; 6. leg 5 and abdomen, ventral.

stage. Both rami two-segmented. Exopodite slightly longer than endopodite; first segment widened distally, with one outer spine and some delicate spinules around base of outer spine and along outer margin, lacking in inner seta; second one 1.2 times as long as first, elongate oval in outline, furnished with two outer spines subdistally, one elongate spine and one hairy seta terminally, and three inner setae. Endopodite rather slender; first segment with one hairy inner seta; second one with one outer spine on subdistal edge, two terminal setae, and three inner marginal setae. *Leg. 4* (Fig. 9–5). Coxa fairly lowered. Both rami one-segmented, ornamented as in leg 3 in preceding stage. *Leg 5* (Fig. 9–6) represented by a slight protuberance with one spinelike bare seta and one bare seta outwards.

The fourth copepodid stage. Male. Body (Figs. 9–4, 5) consisting of eight somites, about 0.35 mm long, 0.18 mm in greatest width measured in posterior portion of cephalothorax. Fifth somite (Fig. 10–6) ornamented with some delicate spinules on ventral side near posterior end. Seventh somite shortest and unornamented. *Antennule* (Fig. 10–1) six-segmented, much thickened and stumpy

in appearance; second and third segments derived from second segment in preceding stage; several spinules on anterior side of first segment; second one furnished with at least four setae on anterior side and three setae on dorsal side; third one terminating in an aesthetasc; apical three segments tapering distally.

Fig. 10. *Harpacticella oceanica* n. sp. The fourth copepodid stage. Male. 1. antennule; 2. leg 1; 3. leg 2; 4. leg 3; 5. leg 4; 6. leg 5 and abdomen, ventro-lateral. Female. 7. antennule; 8. leg 5 and abdomen, lateral.

Leg 1 (Fig. 10–2). Basal two segments fairly inclined. Coxa ornamented with some longer spinules on a slight swelling at middle part of outer side, and several short spinules along subdistal outer margin, and one transverse spinular row on anterior side near middle of distal end. A transverse row of many delicate spinules added onto middle anterior side of inner half. Both rami ornamented as in preceding stage except for size and number of spinules. *Leg 2* (Fig. 10–3). Coxa and basis as in preceding stage. Exopodite somewhat thickened; interspace between first two outer spines of second segment fairly widened. Second endopodite segment more elongate rather than first, and proximal inner seta well

developed. *Leg 3* (Fig. 10–4). Coxa and basis as in preceding stage. Of first exopodite segment one inner seta differentiated. Second exopodite segment about 1.5 times as long as first; one outer spine and one inner seta added. Endopodite shorter than exopodite; one inner seta added to a point about one-third the length. *Leg 4* (Fig. 10–5). Both rami two-segmented. Exopodite fairly longer and thicker than endopodite; first segment lacking in inner seta, and with one outer spine; second one about 1.3 times as long as first, elongate oval in appearance, and furnished with three outer spines, interspace between first two much widened, and one elongate spine and one seta on distal end, and with four inner marginal setae. Endopodite; first segment with one inner seta; second one about 1.5 times as long as first, and furnished with one outer spine on subdistal edge, two terminal setae, and three inner marginal setae. *Leg 5* (Fig. 10–6). Baseoendopodite rudimental, with one outer spine accompanied with several delicate spinules around base. Exopodite somewhat wider than long, furnished with four bare setae in all, of two terminal setae outer one longest and far exceeding posterior end of sixth somite. *Leg 6* (Fig. 10–6) represented by a small protuberance with one spiniform seta and one bare seta.

Female. Body consisting of eight somites as in male. Fifth somite (Fig. 10–8) without spinular row. Genital double-somite not yet formed. *Antennule* (Fig. 10–7) seven-segmented, slender; second, third and fourth segments derived from second segment in preceding stage (In a specimen of the third cop. stage, three segments were clearly detected inside the integument of the second segment.); an aesthetasc arising from fourth segment.

Leg 1, leg 2, leg 3 and *leg 4* same as in male. *Leg 5* (Fig. 10–8) represented by a plate. Inner expansion area ornamented with two bare close setae. Exopodite area with two terminal and two outer marginal setae.

The fifth copepodid stage. Male. Body (Fig. 6–6) consisting of nine somites, 0.52 mm long, about 0.22 mm wide. Rostrum as shown in figure (Fig. 11–2). Cephalothorax much wider than long, almost as long as three succeeding somites combined. Seventh and eighth somites short, and unornamented. Last somite ornamented with a transverse spinular row near posterior end on both ventro-lateral sides. While another several spinular rows are also recognized on (or in) the last somite, they are maybe ones for the next stage formed under the integument. *Antennule* (Fig. 11–1) four-segmented, much thickened; third segment as long as first two segments combined, and with an aesthetasc; fourth one corresponding with apical three segments in preceding stage, tapering distally. *Antenna* as shown in figure (Fig. 11–3).

Leg 1 (Fig. 11–4). Some spinules added onto posterior side of basis. Both rami three-segmented, fairly approaching to those in adult. *Leg 2* (Fig. 11–5), *leg 3* (Fig. 11–6) and *leg 4* (Fig. 11–7). Setal and spinal number of each segment as in adult. *Leg 5* and *leg 6* (Fig. 11–8) well differentiated and almost same as in adult.

Female unknown.

1–4. *Discussion.* Before entering into the discussion about this interesting

material of developmental stages, I must admit it is not sure that all the specimens here described are certainly of a single species *Harpacticella oceanica*, because they are not the cultivated specimens but the ones selected from a field sample. The developmental stages, therefore, want yet to be confirmed based upon another material obtained by cultivation.

Fig. 11. *Harpacticella oceanica* n. sp. The fifth copepodid stage. Male. 1. antennule; 2. rostrum, ventral; 3. antenna; 4. leg 1; 5. leg 2; 6. leg 3; 7. leg 4; 8. leg 5 and abdomen, ventral.

The most prominent characteristic in the development of this species would be antennular differentiation process. In the third molt of female copepodid, the second antennular segment is subdivided into three segments, then, the antennular proximal part in the fourth copepodid female consists of four segments, though the

corresponding part is represented by three segments in the male. Such the antennular proximal part consisting of four segments in the fourth copepodid female has already been known in *Paratigriopus hoshidei* Itô (Itô, 1976 a).

On the other hand, the differentiation process of the first two segments of antennular distal part in the female shows a good accordance with that already found in some species of the genera, *Tigriopus*, *Harpacticus* and *Zaus* (see Ito, 1970, 1971, 1976 a, 1976 b). These two segments in question are represented by a single segment in the first copepodid stage, and the segment is subdivided into two segments in the first molt for the second copepodid stage.

The differentiation of the endopodite outer spine of leg 2, leg 3 and leg 4 is of the non-retarded formation type (terminology, see Itô, 1976 b, p. 467). The presence of a pair of buds of leg 6 in the fourth copepodid male is quite unique, because this leg is formed in the final molting in all the Harpacticidae-species of which the developmental stages are well examined (*Tigriopus fulvus*; Fraser, 1936. *T. japonicus*; Itô, 1970. *Harpacticus uniremis*; Itô, 1971. *H. nipponicus*; Itô, 1976 b. *H. littoralis*; Castel, 1976. *Paratigriopus hoshidei*; Itô, 1976 a. *Zaus robustus*; Itô, 1976 a).

2. ***Tigriopus igai*** **n. sp.**

(Figs. 12~21)

2–1. *Description of adults* (Figs. 12~15).

Female. Body (Figs. 12–1, 2) 0.57 mm long, rostrum and furcal setae excluded, and slightly depressed dorso-ventrally. Body color pale reddish brown. Nauplius eye present. Rostrum (Fig. 13–1) defined at base, attenuate in front; a pair of sensillae on anterior edge much longer than another pair on dorsal side. Cephalothorax almost as long as wide, with some scattering hairs; hyaline frill of lateral edge scarcely developed, but of posterior edge moderately developed. Thorax gradually tapering behind. Fourth free thoracic somite half as wide as greatest width of cephalothorax, ornamented with a vertical row of more than ten rigid spinules on each lateral side. Genital double-somite (Figs. 12–3, 4. Figs. 12–5, 6, a paratype) subdivided by a chitinous suture at each lateral side and by an obscure chitinous stripe ventrally; some hairs arising from dorsal surface and lateral side as shown in figure; an arched row of considerable number of spinules on each lateral side near posterior end. Antepenultimate somite ornamented with two hairs dorsally, and a vertical spinular row together with two hairs on each lateral side near posterior end. Penultimate somite with a vertical spinular row on both sides as in preceding somite, but without any hair; dorsal part of hyaline frill somewhat extending posteriorly. Anal somite short, furnished with a long hair on dorsal side near each furcal ramus, and some minute spinules on lateral side of posterior edge; anal operculum somewhat rounded, bare. Furcal ramus almost as long as wide.

Antennule (Fig. 13–1) nine-segmented, gradually tapering apically except for

first segment; first segment thickened distally, with some spinules on anterior side; apical five segments combined almost as long as proximal two combined. *Antenna* (Fig. 13–2). Coxa short and unornamented. Allobasis twice as long as greatest diameter, with one seta on middle anterior edge, and some spinules on

Fig. 12. *Tigriopus igai* n. sp. Adult female (Holotype). 1. body, dorsal; 2. ditto, lateral; 3. abdomen, dorsal; 4. abdomen, lateral. Adult female (Paratype). 5. ditto, dorsal; 6. ditto, ventral.

proximal half of anterior side. Exopodite (Fig. 13–3) three-segmented; first segment longest, about 1.7 times as long as distal diameter, somewhat thickened distally, and furnished with two setae, each located distally and subdistally and spinulose along one side; second one small and furnished with one spinulose seta as those of preceding segment; third one tapering apically and ending in a dwarfed

seta without clear articulation at base, and furnished with one seta which is spinulose along both sides and arises from middle edge of this segment. Endopodite somewhat shorter than allobasis, furnished with two spines, accompanied with several spinules basally, on anterior edge and one spine, four geniculate elongate spines and a setula on distal end; a transverse row of many delicate spinules (or a serrate

Fig. 13. *Tigriopus igai* n. sp. Adult female (Holotype). 1. rostrum and antennule; 2. antenna; 3. antennal exopodite; 4. mandible; 5. maxillula; 6. maxilla; 7. maxillipede.

plate) near distal end. *Mandible* (Fig. 13–4). Praecoxa well sclerotized; pars incisiva tridentate. Coxa-basis simple, rounded at apex, with two bare setulae subdistally. Both rami one-segmented, cylindrical, and of an equal length. Endopodite furnished with three close setae arising from a ledge at middle inner part, and five juxtaposed setae on distal end. Exopodite furnished with one inner seta at a point one-fourth the length, one outer seta rather midst, and terminating in four juxtaposed setae; several spinules on outer middle edge and near distal end. *Maxillula* (Fig. 13–5). Arthrite of praecoxa fairly developed, ornamented with an arched row of some rigid

spinules on posterior side, two parallel spiniform setae on anterior side near ventral edge, some groups of delicate spinules on dorsal edge; inner edge furnished with six claws and one spinulose thick seta. Coxa not so protruded inwards, reaching midway of arthrite of praecoxa, furnished with five setae in all. Inner process of basis not exceeding beyond inner extremity of arthrite of praecoxa, ornamented with four setae apically and two close setae ventrally. Endopodite represented by a short cylindrical segment terminating in three setae. Exopodite well developed, much inclined outwards, more than twice as long as endopodite segment, and furnished with four juxtaposed setae terminally. *Maxilla* (Fig. 13–6). Syncoxa longer than wide, ornamented with many minute spinules on posterior side, and with three endites; first endite far separated from other two, represented by a discoid lobe ornamented with three short setae and some spinules arranged as shown in figure; second and third endites cylindrical and with three bare or delicately spinulose setae on each apex. Basis forming itself a strong claw which is somewhat serrate along dorsal edge and accompanied with one bare setula on subproximal posterior edge and two close setae on anterior side near ventral proximal edge. Endopodite represented by a rudimental minute segment terminating in two bare setae. *Maxillipede* (Fig. 13–7). Coxa absent (?). Basis with one seta on a small protruding apex at inner side. First endopodite segment without particular ledge inwards, and about twice as long as greatest diameter, furnished with one bare seta on inner edge midst accompanied with two spinular rows each subproximally and subdistally. Second endopodite segment forming itself a strong, but short, claw with one bare seta.

Leg 1 (Fig. 14–1). Coxa remarkably inclined inwards, ornamented with many taller spinules along outer margin, a row of spinules directing outwards on anterior side of proximal part, another row of spinules directing rather vertically on posterior side of proximal part, and a transverse row of small rigid spinules at middle of distal extremity of anterior side. Basis smaller than coxa, ornamented with a row of many rigid spinules near anterior base of exopodite, and another row on middle part of distal end; some rather flexible spinules on inner edge and posterior side near inner edge; a transverse short row of delicate spinules on anterior side of inner part; outer spine spinulose along both sides; inner seta not reaching inner seta of first endopodite segment, and accompanied with some rigid spinules around base. Both rami three-segmented. Exopodite much longer than endopodite; first segment including a membranous distal part almost three times as long as wide, ornamented with three groups of a few spinules along outer margin, and with one bare outer seta subdistally; second one somewhat thickened distally, a little shorter than preceding segment, and with one relatively short outer seta at a point two-thirds the length, and one spinulose setula on distal inner corner; third one furnished with four delicately spinulose claws and one geniculate spine. The third exopodite segment is apparently movable and retractile into the second segment by a thick muscle connecting a middle part of proximal edge of this segment with a proximal portion of the second segment (cf. Figs. 14–1 and 14–7).

First endopodite segment about 2.2 times as long as greatest width, ornamented with two groups of several rigid spinules along outer margin, a transverse spinular row on anterior side near distal end, some rather flexible spinules along inner margin between base and one plumose inner seta; second one with a few spinules outwards; third one longer than preceding segment, ornamented with some rigid

Fig. 14. *Tigriopus igai* n. sp. Adult female (Holotype). 1. leg 1; 2. leg 2; 3. leg 3; 4. leg 4; 5. leg 5. Adult female (Paratype). 6. abnormal third exopodite segment of leg 3. Adult male (Allotype). 7. apical part of exopodite of leg 1.

spinules along outer margin, and one arched claw and one geniculate spine on distal end. *Leg 2* (Fig. 14–2). Coxa considerably expanding outwards, ornamented with an arched row of many minute spinules parallel with outer margin on posterior side, a transverse row of some longer spinules on proximal portion of anterior side, and some spinules along outer margin of distal half. Outer seta of basis rather

spiniform and finely spinulose at both sides. Setal and spinal ornamentation of both rami as shown in figure. First endopodite segment fairly longer than succeeding segment. *Leg 3* (Fig. 14–3). Outer seta of basis elongate and bare. Exopodite somewhat robustly built. Otherwise as in leg 2. *Leg 4* (Fig. 14–4). Outer seta of basis somewhat shortened. Inner margin of third exopodite segment furnished with three setae in all, in which middle one is somewhat rigid and serrate at distal half inwards. Endopodite remarkably reduced in size, not reaching third exopodite segment. *Leg 5* (Fig. 14–5). Inner expansion of baseo-endopodite segment fairly protruded triangularly, extending beyond exopodite segment, furnished with four slender and finely hairy setae in all; terminal seta longest, more than four times as long as exopodite segment; several spinular groups on both edges of inner expansion; outer seta entirely bare and arising from a short cylindrical process, accompanied with some rigid spinules near base. Exopodite about 1.5 times as long as greatest width, almost rectangular, and furnished with five setae in all; innermost seta arising from subdistal ledge and somewhat spiniform; terminal one longest, more than three times as long as exopodite segment, and finely hairy; outer three setae subequal in length and somewhat hairy; two pits on anterior side arranged as shown in figure.

Male. Body (Fig. 15–1) about 0.53 mm long. Rostrum (Fig. 15–5) narrow, with two pairs of sensillae. Cephalothorax ornamented with some hairs on dorsal surface and along lateral margin (Fig. 15–4). Abdomen (Figs. 15–2, 3) scarcely tapering behind. Second and third abdominal somites each ornamented with a vertical row of some spinules together with a hair on each lateral side near posterior end, and a long transverse row of many spinules on ventral side. Fourth abdominal somite ornamented with two short rows of spinules on ventral side along posterior end. Ventral side of anal somite with many conspicuous spinules near both furcal rami. Inner one of principal terminal setae of furcal ramus very much elongated, about as long as body. *Antennule* (Fig. 15–5) subchilocer. *Antenna* (Fig. 15–6). Allobasis without anterior seta and any spinule. Otherwise as in female. Oral appendages as in female.

Leg 1 as in female. *Leg 2* (Fig. 15–7). Coxa, basis and exopodite almost as in female. Spiniform process of second endopodite segment strong, reaching a midway of third exopodite segment. Inner seta of second endopodite segment clearly demarcated at base. Third endopodite segment reduced in size; outer one of terminal setae and inner seta fairy dwarfed. *Leg 4* as in female. *Leg 5* (Fig. 15–8). Both baseoendopodites confluent, represented by a narrow plate without inner expansion; outer seta bare and arising from a short cylindrical process. Exopodite furnished with four setae in all; innermost one longest, about twice as long as others. *Leg 6* (Fig. 15–3) represented by three bare setae accompanied with several spinules.

Variability. Besides the holotype and the allotype, two females and one male were dissected. Among them, one female specimen had an abnormal leg. The endopodite of the right leg 4 (Fig. 15–9) was represented by a small segment

with two bifurcate setae. In the other female specimen, the last exopodite segment of the left leg 3 (Fig. 15–6) was lacking in two outer spines, but was of an aberrant spine arising from posterior side.

Fig. 15. *Tigriopus igai* n. sp. Adult male (Allotype). 1. body, lateral; 2. leg 5 and abdomen, lateral; 3. abdomen, ventral; 4. lateral part of cephalothoracic integument; 5. rostrum and antennule; 6. antenna; 7. leg 2; 8. leg 5. Adult female (Paratype). 9. leg 4 with abnormal endopodite.

2–2. *Remarks.* The present new species is closely allied to *T. minutus* Bozic, 1960 reported from Gorée, Senegal, in the general appearance of the baseoendopodite of leg 5 (♀) with four setae, the exopodite of leg 5 (♂) with four setae and further the third exopodite segment of leg 4 with three inner setae (♀ and ♂). The baseoendopodite of leg 5 in male is furnished with one inner seta in *T. minutus*,

while the corresponding area of the new species is entirely bare. In this respect *T. minutus* and the new species are easily distinguishable from each other. Of *T. raki* Bradford, 1967 reported from Leigh, New Zealand, the baseoendopodite of male leg 5 has no inner seta. In this respect and, furthermore, the setal ornamentation of the baseoendopodite of female leg 5 as well as the last exopodite segment of leg 4, *T. raki* fairly approaches to the present new species, though they are easily discernible from each other in the shape of the baseoendopodite segment of female leg 5 and the setal number of male leg 6.

On the other hand, *T. brachydactylus* Candeias, 1959 reported from Angola is also alike to the present new species, while the male of the former species is still unknown. According to the figures by Candeias (1959), the ratios of endopodites of the second and fourth legs to the corresponding exopodite are much bigger in *T. brachydactylus* rather than those in the new species. Further, the shape of the maxillipede of *T. brachydactylus* is somewhat different from that of the new species.

Specimens examined. Holotype; female. Allotype; male. Paratypes; two females and one male. All the type specimens were collected in a small rock pool somewhat above the high water mark at Ototojima Isl., the Bonins (18–IV–'73, Itô leg.; water temp. 33.5°C).

The other 13 adult females, of which seven are ovigerous, and 11 adult males collected from the same pool are kept intact for a future study.

The trivial name is in honor of Mr. Mikio Iga, Ogasawara Fruit Fly Laboratory, Ogasawara-Tokyo.

2–3. *Description of developmental stages* (Figs. 16~21).

The following description is based upon the specimens found in the field sample, from which the type material was selected. Some nauplii were also found in the same sample, though they are not described here. No specimen of the first copepodid stage and the fourth copepodid female was collected.

Fig. 16. *Tigriopus igai* n. sp. Lateral view of copepodid stages. 1. second cop.; 2. third cop.; 3. fourth cop. male; 4. ditto; 5. fifth cop. females; 6. fifth cop. male.

The second copepodid stage. Body (Fig. 16–1) consisting of six somites, about 0.27 mm long. Rostrum (Fig. 17–1) furnished with a pair of sensillae anteriorly. Cephalothorax almost as long as five succeeding somites combined. Pleurotergite of second and third somites well differentiated. Fifth somite unornamented. Last somite as long as preceding one, ornamented with two transverse spinular rows on

ventral side near posterior end. Furcal ramus as long as basal width. *Antennule* (Fig. 17–1) seven-segmented; fist two segments much thicker than others; second segment longest and furnished with an aesthetasc; apical one with a very narrow aesthetasc.

Leg 1 (Fig. 17–2). Coxa ornamented with a transverse row of some taller spinules on anterior side of proximal part, and many spinules along outer margin of distal half. Basis ornamented with some delicate spinules on middle portion of distal end; inner seta and outer one differentiated as in adult. Both rami two-segmented. Exopodite somewhat longer than endopodite; first segment thickened distally, ornamented with at least three short rows of some delicate spinules near outer edge and one outer seta subdistally; second one shorter than preceding one, furnished with one short seta at a point a third the length of outer margin, and three arched claws and one geniculate spine on and near distal end. First endopodite segment thick, about three times as long as second one, and ornamented with some spinules along outer margin, an oblique row of some spinules on anterior side near distal end, and one somewhat spinulose inner seta subdistally; second one tapering distally, terminating in one arched claw and one spine. *Leg 2* (Fig. 17–3). Anterior side of coxa ornamented with a transverse row of some conspicuous spinules subproximally and an oblique spinular row near outer distal corner. Basis furnished with one thick spinulose outer seta. Both rami two-segmented. Exopodite longer than endopodite; first segment with one outer spine, but lacking in inner seta; second one of an oval outline, longer than preceding one, furnished with two outer pines, one elongate spine and one hairy seta on distal end, and two inner setae. The endopodite segments subequal in length; first segment furnished with one setula on inner subdistal edge; second one furnished with one outer spiniform seta subdistally, two terminal setae, and one inner seta. *Leg 3* (Fig. 17–4). Coxa unornamented. Basis with one bare outer seta and some spinules anteriorly. Both rami one-segmented. Exopodite about 1.3 times as long as endopodite segment, furnished with three widely separate outer spines accompanied with several minute spinules around each base, one elongate spine and one hairy seta on distal end, and one setula on subdistal inner edge. Endopodite somewhat swelling inwards, furnished with one short outer seta subdistally, two terminal setae, and one setula on inner subdistal edge. *Leg 4* (Fig. 17–5) represented by a low protuberance bearing one spiniform seta

Fig. 17. *Tigriopus igai* n. sp. The second copepodid stage. 1. rostrum and antennule; 2. leg 1; 3. leg 2; 4. leg 3; 5. leg 4 and abdomen, ventral.

accompanied with one bare seta on each lateral side (in the illustrated specimen, a seta of the left leg was absent).

The third copepodid stage. In the two specimens of this stage exmained, the one (not illustrated) was apparently female, because two segments for the next stage were recognized inside the third antennular segment.

Body (Fig. 16–2) consisting of seven somites, about 0.3 mm long. Cephalothorax almost as long as succeeding six somites combined. Pleurotergite of second, third and fourth somites well differentiated. Sixth somite (Fig. 18–6) unornamented. Last somite as wide as preceding one, ornamented as in previous stage. Outer one of principal terminal setae of furcal ramus somewhat thickened. *Antennule* (Fig. 18–1) eight-segmented; second and third segments derived from second segment in preceding stage; second segment with two setae dorsally and one seta on anterior side; third one much longer than preceding one, furnished with an aesthetasc.

Fig. 18. *Tigriopus igai* n. sp. The third copepodid stage. 1. antennule; 2. leg 1; 3. leg 2; 4. leg 3; 5. leg 4; 6. leg 5 and abdomen, ventral.

Leg 1 (Fig. 18–2). Posterior side of basis ornamented with a row of some spinules near inner edge. Both rami almost as in preceding stage, except for relative lengths of segments. *Leg 2* (Fig. 18–3). Coxa and basis as in preceding stage. Exopodite more robustly built; some rigid spinules added to first segment; one outer spine and one small inner seta added to second segment. Endopodite reaching middle of second exopodite segment; second segment slightly longer than first. *Leg 3* (Fig. 18–4). Anterior side of coxa ornamented with a transverse spinular row on proximal part and an oblique spinular row on outer distal corner. Both rami two-segmented and furnished almost as in leg 2 in preceding stage. *Leg 4* (Fig. 18–5). Coxa unornamented. Basis with one short outer seta accompanied with several spinules near base. Both rami one-segmented, furnished as in leg 3 in preceding stage. *Leg 5* (Fig. 18–6) represented by a slight protuberance furnished with one bare spiniform seta and one slender seta.

The fourth copepodid stage. No female copepodid was collected.

Male. Body (Figs. 16–3, 4) consisting of eight somites, about 0.38 mm long in a fully expanded specimen. Cephalothorax almost as long as six succeeding somites combined. Sixth and eighth somites (Fig. 19–6) unornamented. Spinular rows of last somite consisting of great number of close spinules. Inner one of principal terminal setae of furcal ramus fairly longer than 0.2 mm. *Antennule* (Fig. 19–1) eight-segmented; first three segments thickened; third segment somewhat

swollen and with an aesthetasc.

Leg 1 (Fig. 19–2). Outer margin of coxa fringed with a great number of taller spinules. Outer side of second endopodite segment ornamented with two rows of several delicate spinules. *Leg 2* (Fig. 19–3). Distal segment of each ramus somewhat longer than proximal one. Of first exopodite segment inner seta differentiated. Interspace between first two outer spines somewhat widened. One setula added to a point a third the length of inner margin of second endopodite segment. *Leg 3* (Fig. 19–4). Of first exopodite segment inner seta differentiated. One outer spine and one inner seta added to second exopodite segment. Distal end

Fig. 19. *Tigriopus igai* n. sp. The fourth copepodid stage. Male. 1. antennule; 2. leg 1; 3. leg 2; 4. leg 3; 5. leg 4; 6. leg 5 and abdomen, ventral; 7. ditto in another specimen.

of endopodite reaching middle of exopodite segment. Second endopodite segment elongated, with one additional inner seta at a point a third the length. *Leg 4* (Fig. 19–5). Both rami two-segmented. First exopodite segment furnished with one outer spine accompanied with many spinules near base, lacking in inner seta; second one about 1.5 times as long as preceding segment, furnished with three outer spines, one elongate spine and one hairy seta terminally, and four inner marginal setae. Distal end of endopodite segment not reaching middle of second exopodite segment; first segment with one small inner seta; second one somewhat longer than preceding one, furnished with one spiniform outer seta on subdistal edge, two hairy setae terminally and one inner seta arising from a point three-fourths the length. *Leg 5* (Figs. 19–6, 7) represented by a moderately expanded lobe furnished with three (four ?) setae terminally or outwards, and one slender outer seta arising from a small protuberance.

The firfth copepodid stage. Female. Body (Fig. 16–5) consisting of nine somites, about 0.46 mm long. Rostrum as shown in figure (Fig. 20–1).

Cephalothorax almost as long as six succeeding somites combined. Sixth somite (Fig. 21–1) unornamented. Genital double-somite not yet formed. Seventh and eighth somites ornamented with a vertical row of some spinules on each lateral side near posterior end. Last somite and furcal ramus almost as in preceding stage. Of principal terminal setae inner one about 0.2 mm long. *Antennule* (Fig. 20–1) nine-segmented; third and fourth segments probably derived from third segment in preceding stage; first segment with some spinules on anterior side; second one with some setae anteriorly, dorsally and posteriorly; fourth one furnished with an aesthetasc. *Antenna* (Fig. 20–2) as shown in figure.

Fig. 20. *Tigriopus igai* n. sp. The fifth copepodid stage. Female. 1. rostrum and antennule; 2. antenna; 3. leg 1; 4. leg 2; 5. leg 3; 6. leg 4. Male. 7. antennule.

Leg 1 (Fig. 20–3), *leg 2* (Fig. 20–4), *leg 3* (Fig. 20–5) and *leg 4* (Fig. 20–6). Both rami of four pairs of legs three-segmented and ornamented almost as in adult, but somewhat stumpy in appearance. Each coxa of second, third and fourth legs lacking in a posterior spinular row. Of each coxa outline not so inclined. Of basis in leg 3 outer seta fairly elongated as in adult. Of third exopodite segment in leg 4 middle inner seta not serrate, but smooth and short. *Leg 5* (Fig. 21–1). Inner expansion of baseoendopodite furnished with four setae. Exopodite not extending beyond distal extremity of inner expansion, furnished with five setae.

Male. Body (Fig. 16–6) almost as long as female. Rostrum (Fig. 20–7) somewhat narrow. Abdomen slender rather than in female. Of principal terminal setae of furcal ramus inner one much elongated, about 0.3 mm long. *Antennule* (Fig. 20–7) eight-segmented as in preceding stage, much more thickened; sixth segment fairly elongated.

Fig. 21. *Tigriopus igai* n. sp. The fifth copepodid stage. Female. 1. leg 5 and abdomen, ventral. Male. 2. leg 2; 3. leg 5 and abdomen, ventral.

Leg 1, leg 3, leg 4 as in female. *Leg 2* (Fig. 21–2). Spiniform process of second endopodite segment differentiated, its distal end not extending beyond last endopodite segment. Of third endopodite segment ornamentation not reduced any way, as in female. *Leg 5* (Fig. 21–3). Baseoendopodite not clearly defined at base. Exopodite somewhat longer than wide, furnished with four setae.

2–4. *Discussion.* The antennular segmentation process of this species is clearly different from those so far known in the most Harpacticidae-species. In the present species, the antennular proximal part of female consists of two segments in the first two copepodid stages (of the first copepodid stage is presumptive), three in the third and four in the fourth stage (two segments were detected in the third antennular segment of the third copepodid stage; cf. p. 86). Such the antennular proximal part of three segments in the third copepodid stage is quite rare within the family Harpacticidae, and has been known only in *Harpacticus gracilis* Claus reported by Pugliesi (1914). The four-segmented antennular proximal part in the fourth copepodid stage has so far been found only in two species, *Harpacticella oceanica* (the present paper) and *Paratigriopus hoshidei* reported by Itô (1976).

The difference in the setal number of the third exopodite segment of leg 4 between the adults of *T. igai* and *T. japonicus* (Itô, 1970) is recognizable also in the fifth copepodid stage. Between these two *Tigriopus*-species, the setal ornamenta-

tion of the fifth pair of legs in the female is clearly different even in the fifth copepodid stage. The differentiation process of the inner seta of the first endopodite segment of leg 2, leg 3 and leg 4, further, is entirely distinct between them, because the seta in question is apparent even in the one-segmented ramus in *T. japonicus*, though it's not present in *T. igai*, whose one in question becomes apparent in the two-segmented ramus.

Summary

1. *Harpacticella oceanica* n. sp. was reported from bottom sands of Chichijima Isl., the Bonins. This is the first record of genuine marine species for the genus.

2. The copepodid stages, except for the fifth copepodid female, of *H. oceanica* were described, based upon the specimens selected from a field sample.

3. *Tigriopus igai* n. sp. was reported from a rock pool in Ototojima Isl., the Bonins.

4. The copepodid stages, except for the first one and the fourth copepodid female, of *T. igai* were described, based upon the specimens collected from the type locality.

References

Borutskii, E. V. 1952. Fresh-water Harpacticoida. Fauna U.S.S.R., Crustacea III, **4**: 3–424. (In Russian)

Bozic, Br. 1960. Le genre *Tigriopus* Norman (Copépodes Harpacticoides) et ses formes Européennes recherches morphologiques et expérimentales. Arch. Zool. exp. gén. **93**(3): 169–269.

Bradford, J. M. 1967. The genus *Tigriopus* Norman (Copepoda: Harpacticoida) in New Zealand with a description of a new species. Trans. roy. Soc. New Zealand. Zool. **10**(6): 51–59.

Brehm, V. 1924. Diagnosen neuer Entomostraken. IV. Teil. Akad. Anz. Wien **1924**(13): 99–100.

Candeias, A. 1959. Contribution to the knowledge of the harpacticoid (Crustacea, Copepoda) from the littoral of Angola. Publ. cult. Cia Diamant. Angola **45**: 77–104.

Castel, J. 1976. Développement larvaire et biologie de *Harpacticus littoralis* Sars, 1910 (Copépode, Harpacticoide) dans les étangs saumâtres de la région d'Arcachon. Cah. Biol. Mar. **17**: 195–212.

Fraser, J. H. 1936. The occurrence, ecology and life history of *Tigriopus fulvus* (Fischer). J. mar. biol. Ass. U.K. **20**: 523–536.

Itô, T. 1970. The biology of a harpacticoid copepod, *Tigriopus japonicus* Mori. J. Fac. Sci. Hokkaido Univ. Ser. VI, Zool. **17**: 474–500, pls. 7–8.

——— 1971. The biology of a harpacticoid copepod, *Harpacticus uniremis* Kröyer. *Ibid.* **18**: 235–255, pl. 11.

——— 1975. A new species of marine interstitial isopod of the genus *Microcerberus* from the Bonin Islands. Annot. Zool. Japon. **48**: 119–128.

——— 1976 a. Morphology of the copepodid stages of *Zaus robustus* Itô and *Paratigriopus*

hoshidei Itô from Japan, with reference to some biological observations (Harpacticoida: Harpacticidae). J. Fac. Sci. Hokkaido Univ. Ser. VI, Zool. **20**: 211–229.

——— 1976 b. Descriptions and records of marine harpacticoid copepods from Hokkaido, VI. *Ibid.* **20**: 448–567.

——— and Y. Kikuchi 1977. On the occurrence of *Harpacticella paradoxa* (Brehm) in Japan; a fresh-water harpacticoid copepod originally described from a Chinese lake. Annot. Zool. Japon. **50**: 40–56.

Pugliesi, E. 1914. Sullo sviluppo larvale di *Harpacticus gracilis* Cls. Atti Acc. Ven. Trent. **7**: 81–95.

Sars, G. O. 1908. On the occurrence of a genuine harpacticid in the Lake Baikal. Arch. Mathem. Naturvidenskab., Kristiania **29**(4): 3–13, 1 pl.

Sewell, R. B. S. 1924. Fauna of the Chilka Lake. Crustacea Copepoda. Mem. Ind. Mus. **5**: 773–851, pls. 44–59.