Description of a New Subspecies of *Angursa biscupis* Pollock (Heterotardigrada, Halechiniscidae) from Tanabe Bay, Japan

By

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With Text-figure 1 and Table 1

Although the Tardigrada are one of the permanent components of the coastal meiobenthos and a number of species have already been reported from the Atlantic Ocean and the Mediterranean Sea including their marginal seas, our knowledge on the tardigrade fauna of Japan is still very poor. The marine Tardigrada so far recorded from Japan are only the following two: *Echiniscoides sigismundi* (Schultze) from the Seto Inland Sea (Morikawa, 1951, 1965, 1967) and *Hypsibius* (*Isohypsibius*) *itoi* Tsurusaki from Hokkaido (Tsurusaki, 1980; see also Itô, 1984, for microdistribution). In addition to these, preliminary reports are given for *Actinarctus* sp. from the Ryukyu Archipelago by Sudzuki (1979) and for a species of Stygarctidae from Hokkaido by Hiruta (1983). As can be seen in these records, only a few species of Arthrotardigrada from Japan have hitherto been reported though a variety of species would be expected to occur. Keeping such circumstances in mind, I have carried out a faunistic study of marine Tardigrada in Tanabe Bay on the Pacific coast of southern Honshu, the main island of Japan, and have found at least seventeen species of Arthrotardigrada. In the present paper, as the first report from this study, I describe a new subspecies of *Angursa biscupis* Pollock, 1979 (Heterotardigrada, Arthrotardigrada, Halechiniscidae, Styraconyxinae). Other species collected from Tanabe Bay will be reported elsewhere.

The sampling station was established on a beach on Hatake-jima Island in Tanabe Bay (33° 42′N, 135° 21′E) on the Pacific coast of Honshu, Japan. The beach sand was coarse and its median grain size was 0.735 mm at the lower intertidal zone. The entire sand sample was fixed in 4% formalin and, then, animals were extracted by decantation through a 40 μm mesh net. Each specimen was mounted in anhydrous glycerin on slide glass and was examined with the differential interference microscope.

Angursa biscupis clavifera subsp. nov.

Holotype, a female, from a sandy beach on Hatake-jima Island, Tanabe Bay, Japan, on 7, June,

1982; allotype, a male, from the same locality as holotype, on 15, May, 1984; three paratypes: a male from the same sample as holotype, and a male and a sexually undefinable specimen from the same sample as allotype. Another specimen (female) from the same sample as allotype, which was badly damaged during the examination. Type materials will be deposited in the Seto Marine Biological Laboratory.

Holotype. (Fig. 1. A) Sexually matured female in phase 3 of molting cycle of Tardigrada (see Kristensen, 1976).

Outer structure of the old cuticle: Body slender, 176 μm in length. Insertions of legs at the height of 24 percent (leg I), 41 percent (II), 62 percent (III) and 97 percent (IV) of body length. Distance between the insertions of legs III and IV much greater than those between legs I and II or II and III. Most of all surface of the body punctulate. A pair of small unpunctulate areas present on the ventral surface of the trunk at the height between legs III and IV. Muscles attaching to the areas. Coxa of each leg punctulate; femur more finely punctulate than the other surface of the body or the coxa. Cuticular folds of body surface between legs I and II and between II and III.

Cephalic appendages as the follows: median cirrus 6 μm, consisting of scapus and flagellum, situated middorsally and 7.5 μm posteriorly to the anterior margin of the head; a pair of internal cirri 8.5 μm, each consisting of scapus and flagellum, situated laterodorsally to the mouth cone; a pair of external cirri 7 μm, each consisting of scapus and flagellum, situated laterally to the mouth cone and a little posteriorly to the internal cirri; a pair of lateral cirri 8.5 μm, each consisting of scapus and flagellum, situated slightly dorsally to each lateral margin of the head; a pair of primary clavae large, 19 μm, club-shaped, with round transverse sections, stretched laterally from thin bases and bending somewhat dorsally at about 70 percent of their length, ventrally adjacent to the lateral cirri, cirrophores not observed; a pair of secondary clavae 7 μm in length, 10 μm in width, situated dorsally and posteriorly to the internal cirri, appearing as unpunctulate thin cuticular domes slightly elevated; a pair of ventral dome-shaped areas with similar appearances to those of secondary clavae, 6.5 μm in length, 11.5 μm in width, situated posteriomesially to the external cirri, appearing as unpunctulate thin cuticular areas slightly elevated.

A pair of cirri E 16.5 μm, each not separated into scapus and flagellum, standing on a small funnel-shaped cirrophore situated just dorsally to the coxa of leg IV.

Appendages of legs spine-shaped in legs I, II and III, papilla-shaped in legs IV. Each of legs I's appendages 11.5 μm, separated into scapus and flagellum, inserted in the outer side of the femur. Each of legs II's and III's appendages very short, 2 μm, rudimentary, not separated into scapus and flagellum, situated in the outer side of the femur, directed posteriolaterally. Each of legs IV's appendages spherical papilla, 4 μm in length, 3.5 μm in diameter, enveloped in a semispherical cuticular sheath, with short apical spine (1 μm).

Each leg separated into four parts: coxa, femur, tibia and tarsus (Fig. 1. E). Coxa punctulate like other surface of the trunk; femur finely punctulate; tibia and tarsus smooth. Each tarsus bearing four digits. Internal digits (12 μm in leg IV)

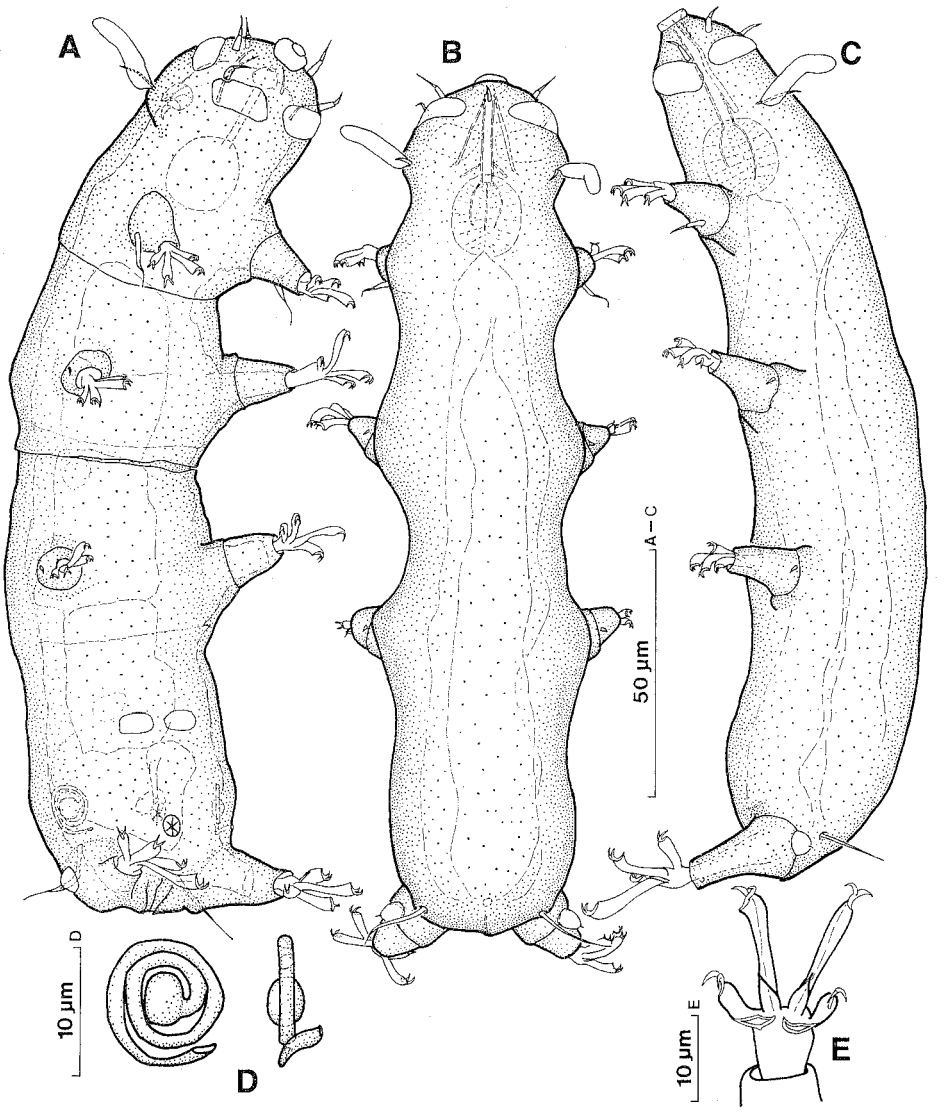

Fig. 1. *Angursa biscupis clavifera* subsp. nov. A, Holotypic female; B–C, Allotypic male; D, Seminal receptacles of the holotype; E, Tarsus, digits, and claws, showing proximal pads of the internal digits and peduncles of the external digits.

much longer than external digits (7.5 µm). Ventral peduncle like that of *Styraconyx hallasi* Kristensen, 1977 (see Kristensen & Higgins, 1984), not attached to the claw, present only on each external digit, absent on each internal digit. Ventral proximal pad leaf-shaped with distal point, not heart-shaped with distal notch as known in most of *Styraconyx* species, persent only on the base of each internal digit, absent on each external digit. Each claw with two hooks: internal hook and external hook. External hook stronger than internal hook. Internal hook (ventral) and external

hook (dorsal) opposed vertically each other near the parting point of the hooks.

Mouth cone 3 μm in length, 7.5 μm in diameter, situated subterminally. Mouth opening on top of the mouth cone. Two small lateral spherules present under the cuticle of both sides of the mouth cone. Anus appearing as a longitudinal groove, situated ventrally at the posterior margin of the trunk. Papillae beside the anus such as those described in *Angursa biscupis biscupis* absent.

Gonopore normal halechiniscid-type, 4 μm in diameter, situated midventrally and 17.5 μm anteriorly to the posterior margin of the trunk.

Outer structure and inner structure of the new animal: Animal shrinking inside the old cuticle. Cuticular folds of body surface visible between legs II and III and between legs III and IV, not visible between legs I and II.

Median cirrus inserted inside the old median cirrus. Internal cirri and external cirri stretched between the old cuticle and the new cuticle. Lateral cirri not observed. Primary clavae flattened dorsoventrally, folded into two, lying between the old cuticle and the new cuticle. Secondary clavae and ventral thin cuticular dome-shaped areas of the head not visible. Cirri E inserted inside the old cirri E. Appendages of legs not visible.

Each tibia and tarsus telescopically retracted into each femur or coxa. Digits and claws visible inside the femur.

Buccal tube, placoids, stylets and stylet supports unvisible or lacking. Pharyngeal bulb oval, 16.5 μm in length, 13.5 μm in width, situated slightly ventrally at the height between legs I and lateral cirri. Stomach or gut not visible.

Gonopore visible somewhat anteriorly to the gonopore of the old cuticle. Gonad or ovary lying dorsally, extending anteriorly from the near end of the trunk to the height just posterior to the insertions of legs I, containing five well-developed eggs.

Spherical seminal receptacles (Fig. 1. D), 4 μm in diameter, present between the old cuticle and the new cuticle, somewhat anterior to the height of the gonopore. Duct starting from the internoventral side of each vesicle, surrounding the vesicle about twice in the same plane, opening on top of a small papilla situated on latero-ventral surface of the old cuticle of the height just anterior to the insertion of leg IV.

Eye pigment spots absent.

Allotype. (Fig. 1. B-C) Sexually matured male in phase 0 of molting cycle of Tardigrada (see Kristensen, 1976). Measurements shown in Table 1.

Remarkable sexual dimorphism absent. Cuticular folds of body surface absent. Cephalic appendages and appendages of legs as those of holotype.

Buccal tube 19.5 μm in length, 2 μm in diameter. Placoids very thin, consisting of two lateral branches and an indistinct center branch, with ventral excrescence at the anterior part of each lateral branch. Stylets 19 μm, the thickest at the half of their length, tapering anteriorly, with sharp anterior points, with very thin appendix in the posterior end. Two stylets making an angle about 40°. Stylet supports 4.5 μm, thin, in the same diameter through their length, attached to the buccal tube at the height 2.5 μm anterior to the anterior margin of the pharyngeal bulb.

Table 1. Measurements of *Angursa biscupis clavifera* subsp. nov. No. 1: holotypic female, 2: female, 3: allotypic male, 4–5: paratypic males, 6: paratypic specimen which is sexually undefinable. Sex (F: female; M: male; ?: undefinable); Phase, of molting cycle (see Kristensen, 1976); BL: body length; CE: cirri E; EC: external cirri; HW: width of head (between the insertions of lateral cirri); IC: internal cirri; LC: lateral cirri; MC: median cirrus; Pa IV (l; d): papillae of legs IV (length; diameter); PC: primary clavae; SC (l; w): secondary clavae (length; width); Sp I-III: spines of legs I–III; Sp/Pa: papillal spines of legs IV; VD (l; w): ventral thin cuticular dome-shaped areas of the head (length; width); n.d.: no data. (All measurements in μm).

No.	1	2	3	4	5	6
Sex	F	F	M	M	M	?
Phase	3	0	0	0	3	0
BL	176.0	206.0	172.0	124.0	144.0	171.0
HW	n.d.	39.0	34.0	25.0	32.5	34.5
MC	6.0	6.5	6.0	2.5	4.5	4.0
IC	8.5	10.5	6.5	7.0	7.0	7.0
EC	7.0	12.0	9.0	6.0	7.0	6.0
LC	8.5	11.0	11.0	7.0	7.5	6.0
PC	19.0	19.0	20.5	17.5	16.5	19.0
SC (l)	7.0	6.0	4.5	n.d.	6.0	5.5
SC (w)	n.d.	11.0	10.0	n.d.	4.5	8.5
VD (l)	6.5	7.0	6.0	n.d.	6.0	6.0
VD (w)	11.5	13.5	11.0	n.d.	12.0	10.0
CE	16.5	13.5	14.0	12.0	13.5	13.0
Sp I	11.5	10.0	11.5	7.5	8.5	7.5
Sp II	2.0	2.0	2.5	n.d.	2.0	n.d.
Sp III	2.0	2.0	3.0	n.d.	2.0	n.d.
Pa IV (l)	4.0	4.0	4.5	4.5	4.5	4.5
Pa IV (d)	3.5	3.5	3.0	3.0	3.5	3.5
Sp/Pa	1.0	1.5	1.0	1.0	1.0	1.0

Two stylet supports making an angle about 100°. Outer terminal of each stylet support not attached to the stylet. Pharyngeal bulb oval, 16.5 μm in length, 14 μm in width.

Gonopore oval, small 1.5 μm in diameter, situated 10 μm anteriorly to the posterior margin of the trunk, more posteriorly than that of holotypic female. Gonad or testis lying dorsally, extending anteriorly from the near end of the trunk to the height just anterior to the insertions of legs II. Stomach or gut containing amorphous materials.

Paratypes. Two males and a sexually undefinable specimen. Measurements shown in Table 1.

One male and the sexually undefinable specimen are in phase 0 of molting cycle of Tardigrada (Kristensen, 1976), and another male in phase 3. Cuticular folds of body surface of paratypes are between legs I and II and between legs II and III in the two males, and absent in the sexually undefinable specimen.

In the sexually undefinable specimen the gonopore is unvisible or lacking. But

this specimen has a gonad which extends anteriorly from the near end of the trunk to the height of legs II and which seems immature.

Remarks. In the genus *Angursa*, two species, *Angursa biscupis* Pollock, 1979 and *Angursa lanceolata* Renaud-Mornant, 1981, have been known. *Angursa* from Tanabe Bay can be identified with *Angursa biscupis* because it has large primary clavae, distinct spines only on legs I and simple cirri E. *Angursa biscupis* has had two subspecies, namely, *A. b. biscupis* Pollock, 1979 (the nominotypical subspecies) and *A. b. abyssalis* Renaud-Mornant, 1981. *Angursa biscupis biscupis* does not have a median cirrus or papillae of legs IV and has papillae beside the anus, while *A. b. abyssalis* has a median cirrus and papillae of legs IV but not papillae beside the anus. In these respects the specimens from Tanabe Bay accord with *A. b. abyssalis*, though they differ from the latter in the size and the shape of the primary clavae, the shape of the peduncles, the presence of the secondary clavae and the presence of the sensory spines of legs II and III. Hence, *Angursa biscupis* from Tanabe Bay is separated from both *A. b. biscupis* and *A. b. abyssalis*, and is designated as a new subspecies of *Angursa biscupis*.

Primary clavae are much longer in *A. b. clavifera* subsp. nov. than in other two subspecies. The primary clavae of the new subspecies are 16.6–20.5 μm, 9.2–14 percent of body length as opposed to 9.5–12 μm, 7.4–7.5 percent of body length in *A. b. biscupis* (Pollock, 1979) and to 10 μm, 8.2 percent of body length in *A. b. abyssalis* (Renaud-Mornant, 1981). The shape of the primary clavae of the new subspecies is not "strap-like" as described in other two subspecies, but "club-shaped" with round transverse section.

Peduncles were not described in *A. b. biscupis* by Pollock (1979). Renaud-Mornant (1981) drew those of *A. b. abyssalis* which, according to her drawings, have rather simple structures. Those of the new subspecies are more complex than those of *A. b. abyssalis*, and similar to those of *Styraconyx hallasi* (see Kristensen & Higgins, 1984).

Secondary clavae have previously been unknown in *Angursa*. The presence of the secondary clavae in the new subspecies indicates that *Angursa* may have secondary clavae as some other genera of Styraconyxinae. The ventral thin cuticular dome-shaped areas of the head found in the new subspecies, which seem to be a kind of reduced clavae, have previously been unknown in the genus, too. They may be the ventral rudimentary parts of secondary clavae which was separated from the dorsal main parts of secondary clavae as the secondary clavae reduced.

It is well known that the hooks of each claw of *Angursa* species are laterally opposed and that the external hook is somewhat stronger than the internal hook as Pollock (1979) and Renaud-Mornant (1981) indicated. As shown in the description of the holotype of the new subspecies, it is found that the internal hook forks ventrally from the claw crescent at first, and then bends internally. This observation shows that the external hook of *Angursa* species is homologous with the primary hook of other styraconyxid species, and that the internal hook with the secondary hook. The accessory hook of the claw has never been known in any *Angursa* species.

Although I have used the names "external hook" and "internal hook" in the description, "primary hook" and "secondary hook" should be used even in *Angursa* species instead of the former two in order to unify the terminology for the hooks of the claws in halechiniscids or Arthrotardigrada.

The number of cuticlar folds of body surface is 0 in the holotype and in a paratype and 2 in the allotype and in two paratypes of the new subspecies. This character may not be specific in this new subspecies.

Details of the seminal receptacle of *Angursa* were first described here. Pollock (1979) found the "large irregular refractile bodies" in *A. b. biscupis* and mentioned that the structures were possibly related to "lateral vesicles" described in *Florarctus hulingsi* by Renaud-Mornant (1976), which turned out to be seminal receptacles later. The structures found by him are undoubtedly seminal receptacles, and his supposition is just correct.

Diagnosis: *Angursa biscupis* with median cirrus, with secondary clavae, with spines of legs I, II and III, with papillae of legs IV, without papillae beside the anus. Spines of leg II and III very short. Primary clavae club-shaped, stretched laterally, larger than those of *A. b. biscupis* and *A. b. abyssalis*. Cirri E simple.

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