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JAPANESE CHORDEUMATID MILLIPEDS. II. THE NEW GENUS *NIPPONOTHRIX* (DIPLOPODA, CHORDEUMATIDA, METOPIDIOTRICHIDAE)[1]

by William A. Shear and Tsutomu Tanabe

ABSTRACT

Nipponothrix aculeus and *N. yuwandake*, gen. et spp. nov., are the first members of the milliped family Metopidiotrichidae to be reported from Japan, and provide evidence for synonymy of the milliped families Metopiditrichidae, Neocambrisomatidae, Reginaterreumatidae, and Schedotrigonidae.

The second author of this paper, together with Nobuo Tsurusaki, Tottori University, has revealed a wealth of new chordeumatid milliped taxa by careful collecting in Japan at various seasons of the year. The first author has had extensive experience with this difficult group and, together with Japanese and Australian colleagues, is attempting to construct an accurate taxonomy for chordeumatids in North America and around the Pacific Rim. To this end, a series of papers is being produced on the Japanese fauna (Shear, Tsurusaki, & Tanabe, 1994) and the Australian fauna (Shear & Mesibov, in press).

Finding interesting new species, distinct at the generic level, is always exciting and important. Far more so when those species provide new biogeographical data and permit the synonymy of family-level taxa.

Recently, Mauriès (1978, 1987, 1988) has published an important series of papers on millipeds of the families Metopidiotrichidae Attems, Neocambrisomatidae Mauriès (*nom. corr.* from "Neocambrisomidae"), Schedotrigonidae Mauriès, and Reginaterreumatidae Mauriès (*nom. corr.* from "Reginaterreumidae").

These families have a common feature that is unique in chordeumatids: the tenth leg coxal glands are enlarged and at least partly sclerotized. The tenth leg telopodites are reduced (not in itself unique to this group) and the sternum of the tenth legpair may be strongly modified. Mauriès (1987) has demonstrated that these glands function to form large, species-specific spermatophores, which the male gonopods then insert into receptacles of the female cyphopods. The families, except for Neocambrisomatidae with two genera, are mono-

[1]Part 1: Shear, Tsurusaki, & Tanabe, 1994, Myriapodologica, 3: 13-17.

basic. They are most easily separated by the distribution of gonopod flagella: none present in Metopidotrichidae and Reginaterreumatidae, only on the anterior gonopods in Neocambrisomatidae, and only on the posterior gonopods in Schedotrigonidae. In metopidiotrichids, the tenth sternum is largely unmodified, while in the other four families, various kinds of projections occur. Reginaterreumatids are distinguished by the extreme reduction of the anterior gonopod telopodites and the presence of a large, shield-like anterior gonopod coxosternum.

These families share a common anterior and posterior gonopod plan as well as the unique tenth legpair modifications. It seems to us (and perhaps now to Mauriès as well: ". . . la découverte de ce nouveau genre doit [*Nipponothrix*], d'une maniére ou d'autre, nous conduire à réunir les Neocambrisomidae et les Metopidiothricidae . . . [*in litt.* to Shear, 31 May 1989]") that to maintain them as separate families conceals their close relationship and adds redundant taxa to the system. Therefore, we propose synomymizing these families under the oldest name, Metopidiotrichidae Attems.

SYSTEMATIC TREATMENT

Superfamily Heterochordeumatoidea Pocock
Family Metopidotrichidae Attems

Metopidiothrichinae Attems, 1907, p. 123 (type genus *Metopidiothrix* Attems 1907).
Metopidiotrichidae, Verhoeff, 1929, p. 1478; Mauriès, 1987, p. 21.
Schedotrigonidae Mauriès 1978, p. 63 (type genus, *Schedotrigona* Silvestri 1903). **New Synonymy.**
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Reginaterreumidae (*recte:* Reginaterreumatidae) Mauriès 1988, p. 22 (type genus *Reginaterreuma* Mauriès 1987). **New Synonymy.**

New Diagnosis: Chordeumatid millipeds with 32 trunk segments in both sexes. Pregonopodal legs of males modified in various ways. Anterior gonopods a coxosternum with erect telopodites (vestigial in *Reginaterreuma*), with or without a flagellum. Posterior gonopods free from sternum, with prominent coxites (bearing a flagellum in *Schedotrigona*); telopodites 2-articled, the proximal (prefemur) erect, cylindrical, the distal (femur) swollen, pyriform, reflexed. Tenth legpair with sternum essentially normal or with processes; coxae enlarged, coxal glands enlarged and sclerotized, extending deep into body cavity, used in formèing characteristic, large spermatophores; telopodites variously reduced, ranging from 5-articled to small vestigial single article. Eleventh coxae without glands.

Included genera: *Metopidiothrix* Attems 1907 (= *Malayothrix* Verhoeff 1929), *Schedotrigona* Silvestri 1903 (=*Huttoniella* Pocock 1903), *Reginaterreuma* Mauriès 1987, *Neocambrisoma* Mauriès 1987, *Australeuma* Golovatch 1986, *Nipponothrix* Shear & Tanabe, new.

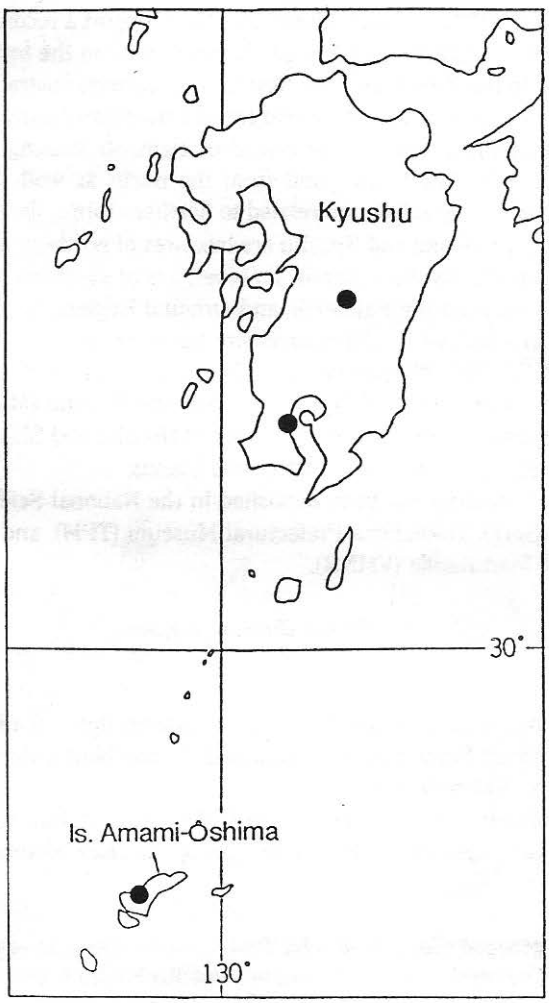
Distribution: Japan, Palawan (Shear, 1993), Viet Nam, Java, Sumbawa (Mauriès, 1988), New Guinea, Queensland, Tasmania, New Zealand.

Discussion: The family as newly defined is equivalent to Mauriès' superfamily Metopidiothricoidea (*recte:* Metopidiotrichoidea), but without the families Megalotylidae Golovatch & Mikhalova 1978 and Adritylidae Shear 1977. Megalotylids, known from the Himalaya and eastern Siberia, are enigmatic, with some characters suggesting a placement in Heterochordeumatoidea, and others Conotyloidea. Some species have very large tenth leg coxal glands, but these glands are not sclerotized. Since glands are also present on coxae 11 of

males, they may represent descendents of an ancestral stock of the latter superfamily. Adritylids also require re-evaluation, but their strongly modified tenth leg coxae do not include spermatophore-forming glands, in fact, the glands are much reduced in size.

The synonymies are based on the discovery of the new Japanese genus *Nipponothrix*, which could easily be placed in *Metopidiothrix* were it not for posterior flagella on the anterior gonopods (Fig. 1), the characteristic feature of neocambrisomatids. This discovery forces the realization that overall gonopod plan, not the presence or absence of certain elements, should determine the contents of the family. There is no doubt that the genera included are a compact, monophyletic unit with their defining synapomorphy the enlarged, sclerotized coxal glands of the tenth legpair.

Metopidothrix, Neocambrisoma, Nipponothrix, Australeuma and *Reginaterreuma* form a fairly compact group, while *Schedotrigona* is distinct enough by virtue of the much larger size of its species and its numerous and peculiar pregonopodal leg specializations to be recognized as forming a subfamily Schedotrigoninae.



Map 1. Southern Japan, showing distribution of *Nipponothrix*. Localities are, from north to south, Mt. Ichifusa-yama, Jigenji-kôen Park, and Mt. Yuwan-dake.

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The superfamily Heterochordeumatoidea contains at least three other families: Heterochordeumatidae Pocock, Eudigonidae Verhoeff (Shear, 1988), and Peterjohnsiidae Mauriès (Shear & Mesibov, in press). In neither of these families, nor in the (possible) next immediate outgroups, the superfamilies Diplomaragnoidea and Conotyloidea, do we find gonopod flagella widespread[2] or associated with recognizably plesiomorphic characters. This suggests that their presence is apomorphic for genera or species groups, and their distribution through the superfamilies mentioned also suggests that they are convergent developments that have emerged many times. Indeed the structure of "flagella," which may be basally jointed and movable, or not, thick or thin, with elaborations or smooth, derived from whole gonopods or parts of gonopods, seems to establish that the function served is met by a wide variety of adaptations, all subsumed under the term "flagellum."Clearly, if use of this term is to continue, a more restrictive definition must be constructed.

While the inclusion of genera from Japan, southeast Asia, Indonesia and Australia in one family may seem biogeographically anomalous (suggesting a relationship of parts of Asia to Gondwana,[3] and not to Laurasia), just such distributions of other milliped families are reviewed by Simonsen (1992), who concludes that they support a reconstruction of the region for Permo-Triassic time suggested by Audley-Charles (1983) on the basis of stratigraphy and invertebrate fossils. In this reconstruction, New Guinea, eastern Australia, and Indonesia were adjacent in the late Triassic at the active margin of a northward-moving continent.

The Japanese milliped fauna is composed of elements coming from more southerly regions (Southeast Asia, China, etc.) and from the north as well (Korea, Siberia). Most millipeds on Hokkaido, for example, are related to northern forms also found in Siberia, while the faunas of Honshu, Shikoku and Kyushu are mixtures of northern and southern elements. All the millipeds from the Ryukyu Islands, however, are of southern origin.

The boundary between the Palearctic and Oriental Regions is often set in the Tokara Islands, the northern part of the Ryukyu chain; however, many millipeds have dispersed northward beyond this line. *Nipponothrix* is likely a descendant of metopidiotrichids from Southeast Asia and is found on the Ryukyu Islands and Kyushu (Map 1). However, as the milliped fauna of Kyushu is roughly similar to that of Honshu and Shikoku, it is possible that *Nipponothrix* will also be found on the latter two islands.

Type and other material has been deposited in the National Science Museum (Natural History), Tokyo (NSMT), Tokushima Prefectural Museum (TPM), and the Virginia Museum of Natural History, Martinsville (VMNH).

Nipponothrix, new genus

Type species: *Nipponothrix aculeus* Shear & Tanabe, described below as new.

Derivation of name: From Nippon, Japan, and the combining stem -thrix, indicating the close relationship to *Metopidiothrix*.

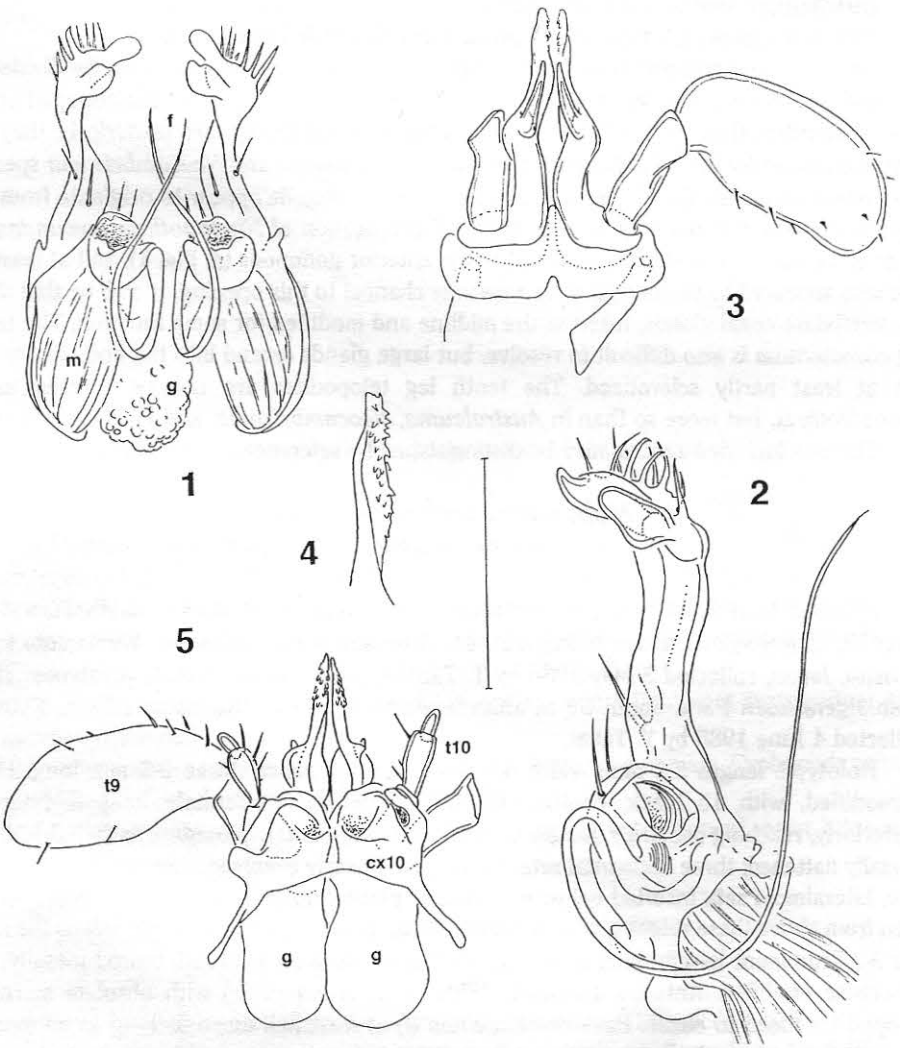
Diagnosis: similar in nearly all respects to *Metopidiothrix*, but distinct from that genus in having a posterior flagellum on the anterior gonopods; *Australeuma* and *Neocambrisoma*

[2]The entire anterior gonopod telopodite of some *Diplomaragna* species is long, thin, and "flagelliform." However, this cannot be considered homologous to a flagellar branch developed from, or as part of, a coxite.

[3]As has been repeatedly pointed out (without much effect), the name "Gondwanaland" is not properly formed, since "Gondwana" means "land of the gonds."

also have anterior gonopod flagella, but differ in that their tenth leg sterna bear medial projections. Females of *Nipponothrix* may be distinguished from both related genera by not having the median valves of the cyphopods fused, and by the presence of a thinly sclerotized median plate posterior to the cyphopod valves.

Description: Small (5-6 mm long) chordeumatid millipeds, about ten times as long as wide. Head not covered by collum, not modified in males. Thirty-two segments in both sexes. Diplosegments cylindrical, high-arched, with low lateral shoulders just below midline bearing lateralmost segmental setae, sides of segments below shoulders with 5-7 prominent longitudinal striations. Segmental setae short, less than one-fifth as long as diplosegment



Figs. 1-5. *Nipponothrix aculeus*. Fig. 1. Anterior gonopods, posterior view, 200X. Fig. 2. Right anterior gonopod, mesal view, 400X. Fig. 3. Posterior gonopods, posterior view, 200X. Fig. 4. Posterior gonopod coxite tip, anterior view, 400X. Fig. 5. Posterior gonopods and tenth legs, posterior view, 200X. Scale line: 0.3 mm for figs. 1, 3, 5, 0.15 mm for figs. 2, 4.

diameter, thick, blunt to slightly spatulate. Pregonopodal legs of males enlarged, femora curved mesally, otherwise unmodified. Anterior gonopods with sternum obselete; coxal region with posterior, long, coiled flagellum arising from probable coxal gland margin; telopodite erect, robust, bearing few setae, curving laterally around coxites of posterior gonopods, with complex tips. Posterior gonopods with robust sternum bearing irregular median projections. Coxites erect, appressed. Telopodites with cylindrical prefemur, swollen, pyriform femur. Tenth legpair of males with coxosternum bearing openings of enlarged, partly sclerotized coxal glands; telopodites reduced to two small segments. Eleventh coxae of males without glands. Cyphopods of females normal, not fused, inner and outer valves distinct, inner valves with strong transverse ribs.

Distribution: southern Kyushu, Japan.

Included species: the type and *N. yuwandake* Shear & Tanabe, n. sp.

Remarks: The anterior gonopod sternum appears reduced and may even be divided in the midline, its remnant fusing with the gonopod coxae. The flagella of the gonopod coxae arise posteriorly, then coil back between the gonopods and finally turn posteriorly; they are significantly longer than the gonopod flagella of *Australeuma* and *Neocambrisoma* species. The region where the flagella arise is complex, and the flagella appear to originate from the margin of a rimmed opening. In one gonopod preparation of *Nipponothrix yuwandase*, a large glandular mass was present dorsal to the anterior gonopods (g, Fig. 1), and at least on one side appeared to be connected by a definite channel to this opening. It may be that these are persistant coxal glands, fused in the midline and modified for some function. The tenth leg coxosternum is also difficult to resolve, but large glands extend into the body cavity and are at least partly sclerotized. The tenth leg telopodites are not as reduced as in *Metopidothrix*, but more so than in *Australeuma*, *Neocambrisoma*, and *Reginaterreuma*.

The two included species may be distinguished by reference to the figures.

Nipponothrix aculeus, new species
Figures 1-6, Map 1

Material: Male holotype (TPM), 5 male and two female paratypes (TPM, NSMT, VMNH) from Mt. Ichifusu-yama, about 800 m altitude, Mizukami-mura, Kuma-gun, Kumamoto Pref., Kyushu, Japan, collected 3 May 1986 by T. Tanabe; male and two female paratypes (TPM) from Jigenji-koen Park, about 50 m altitude, Kagoshima City, Kagoshima Pref., Kyushu, collected 4 June 1985 by Y. Takai.

Holotype: length 5.2 mm, width 0.6 mm, antennal article three 0.3 mm long. Head unmodified, with 15 black, contiguous ocelli. Antennae moderately long, if extended posteriorly, reaching posterior margin of third trunk segment. Diplosegments cylindrical, not dorsally flattened; three segmental setae of each side nearly evenly spaced, in almost straight row, lateralmost seta inserted below midpoint of pleurotergum, on prominent ridge. When seen from above these ridges give a slightly serrated appearance to the trunk. Below the ridge are 5-7 prominent longitudinal striations. Pregonopodal legs enlarged, bowed mesally, not otherwise modified. Anterior gonopods (Figs. 1, 2; m = muscle) with obsolete sternum; telopodites fused to coxae. Posterior flagellum (f) at least half again as long as telopodite, arising from rim of pore or depression posterior on coxa, curving anteriorly, then dorsoposteriorly; anterior rim of pore with two small setae. Telopodite robust, slightly curved posteriorly and mesally, tip sharply bent mesally, with two blunt lobes and series of spines; large lateral and posterior setae present. Posterior gonopods (Figs. 3-5) with transverse, band-like sternum. Coxites erect, appressed in midline, two-branched; shorter posterior branch sharply elbowed, hook-like, longer anterior branch tipped with numerous retrorse prickles

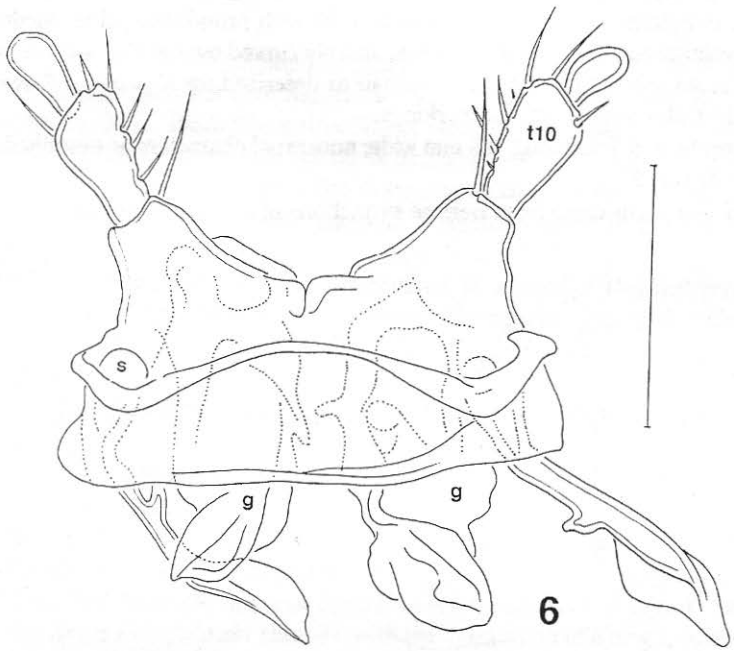


Fig. 6. *Nipponothrix aculeus,* tenth legs, posterior view, 400X. Scale line: 0.15 mm.

(Fig. 4). Prefemur cylindrical, about three times as long as wide; femur (t9) swollen, pyriform. Tenth legpair (Figs. 5, 6) with robust coxosternum (cx10) bearing openings of large, partially sclerotized coxal glands (g; s = spiracle); coxal part of coxosternum with single seta. Telopodite (t10) two-articled, distal article minute. Eleventh coxae without glands, not modified.

Color light tan mottled dusky purplish-brown, prominent light spot surrounding each lateralmost segmental seta.

Female paratype: Length, 5.5 mm, width 0.6 mm. Otherwise as male. Cyphopods as in fig 9; not distinguishable from those of *N. yuwandake.*

Notes: All specimens were obtained by Berlese funnel extraction of moist litter from broad-leaf evergreen forests.

Nipponothrix yuwandake, new species
Figures 7-9

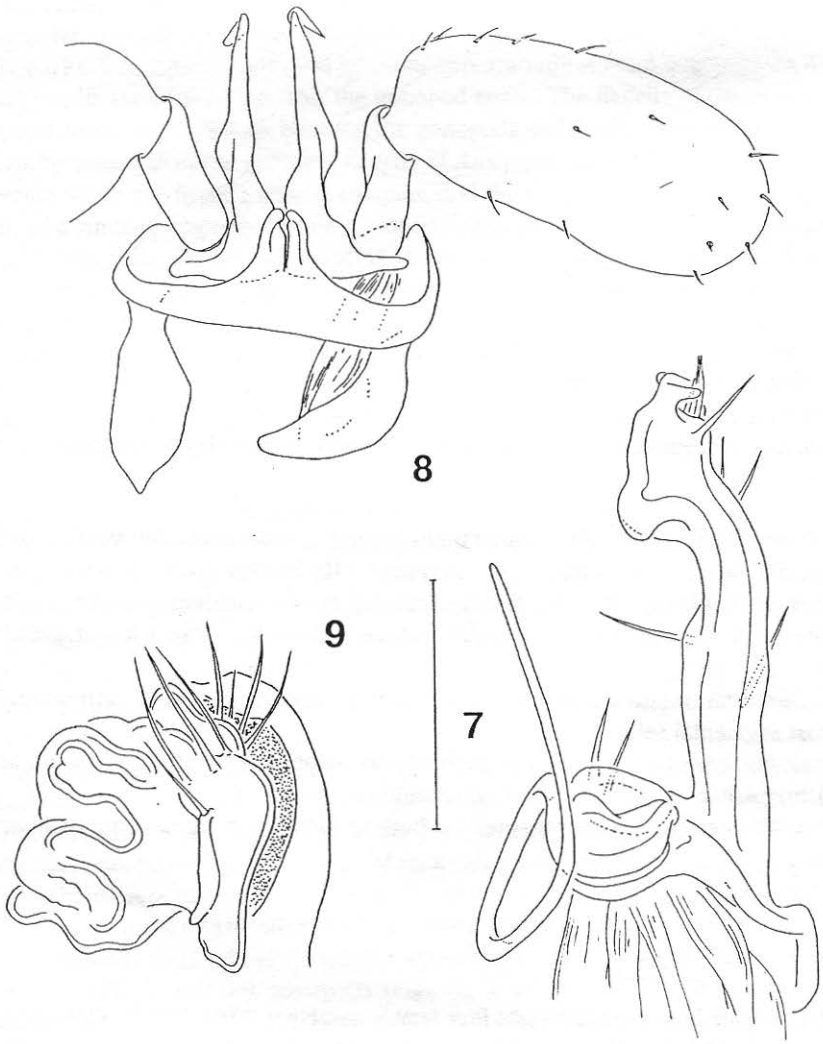
Material: Male holotype (TPM) and four female paratypes (TPM, NSMT, VMNH) from Mt. Yuwan-dake, about 450 m elevation, Uken-san, Is. Amami-ôshima, Kagoshima Pref. (Ryukyu Islands), Japan, collected 17 February 1993 by T. Tanabe.

Holotype: Length, 5.8 mm, width 0.6 mm, third antennal article 0.2 mm long. Head unmodified, with seven black, contiguous ocelli. Antennae shorter than in *N. aculeus,* reaching back only to posterior margin of collum. Metazonites of segments with much less prominent lateral ridge than in *N. aculeus.* Segmental setae short, blunt, less than 0.1 mm

long. Anterior gonopods (Fig.7) similar to those of foregoing species, differing in details of tip, as shown in figures. Posterior gonopods (Fig. 8) with prominent paired median knobs anterior on sternum; coxites without branches, sharply curved over at tips, with possible pore at distal end. Telopodite articles and tenth legpair as described for *N. aculeus*. Eleventh coxae without glands. Color white, without markings.

Female paratype: 5.5 mm long, 0.6 mm wide; nonsexual characters as described for male. Cyphopods as in Fig. 9.

Notes: All specimens came from Berlese extractions of evergreen, broad-leaf forest litter.



Figs. 7-9. *Nipponothrix yuwandake*. Fig. 7. Right anterior gonopod, anterior view, 400X. Fig. 8. Posterior gonopods, anterior view, 200X. Fig. 9. Right cyphopod, posteror view. Scale line: 0.3 mm for figs. 8, 9, 0.15 mm for fig. 7.