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## JAPANESE CHORDEUMATID MILLIPEDES. IV. THE NEW GENUS JAPANOPARVUS (DIPLOPODA, CHORDEUMATIDA, HOFFMANEUMATIDAE).

by William A. Shear, Tsutomu Tanabe and Nobuo Tsurusaki

### ABSTRACT

*Japanoparvus okai*, *hiroshimaensis* and *tsurugiensis*, gen. et spp. nov., are described from Honshu and Shikoku, Japan. The new genus is the second to be discovered of the family Hoffmaneumatidae, heretofore known only from *Hoffmaneuma exiguum* Golovatch, from the Maritime Province of the Russian Far East. The relationships of the hoffmaneumatids are obscure, but may lie with the eastern European Mastigophorophyllidae.

This paper is the fourth in a series<sup>1</sup> on the chordeumatid millipeds of Japan, based largely on the collections of the second and third authors.

The milliped family Hoffmaneumatidae was proposed by Golovatch (1978) for his new species *Hoffmaneuma exiguum*, a tiny chordeumatid from the Maritime Province of the Russian Far East. Golovatch recognized the unusual nature of the new family and was unable to suggest any definitive relationships, but mentioned the eastern European mastigophorophyllids as possible allies. Part of Golovatch's uncertainty was due to a misinterpretation of the gonopods, clarified later by Shear (1992). New illustrations of the gonopods of *Hoffmaneuma exiguum* are provided here for comparative purposes.

Shear (1992) considered Hoffmaneumatidae the sister group of Mastigophorophyllidae because of the long flagella on both pairs of gonopods. Examination of examples of species of *Mastigophorophyllum* and *Mastigona*, however, now cast some doubt on that idea, especially in light of the new genus described below. All we can do at this point is to exclude Hoffmaneumatidae from two lineages of chordeumatids: the heterochordeumatoids, which have lost the eleventh coxal glands and have a distinctive posterior gonopod telopodite, and the distinctive European family Chordeumatidae, with their extensive leg modifications both anterior and posterior to the gonopods. The seemingly incessant stream of newly discovered supraspecific taxa in the Chordeumatida suggests that we may be far from understanding the internal relationships and evolution of this large and complex order.

Type and other material has been deposited in the Tokushima Prefectural Museum (TKPM), the National Science Museum (Natural History), Tokyo (NSMT) and the Virginia Museum of Natural History (VMNH). We thank Dr. Y. Touyama (Hiroshima University),

<sup>1</sup> Part 3: Shear & Tsurusaki, 1995, *Myriapodologica* 3: 97-106.

for sending the specimens of the new species from Hiroshima Prefecture, Dr. S. I. Golovatch (Sverdlov Institute, Moscow) for material of *Hoffmaneuma exiguum*, and Dr. H. W. Levi (Museum of Comparative Zoology) for the loan of material of *Mastigophorophyllon saxonicum* and *Mastigona bosniense*. Mr. E. Oka discovered the type species of the new genus in the course of an ecological study of the soil fauna; we are indebted to him for providing abundant specimens for study.

## SYSTEMATIC TREATMENT

### Family Hoffmaneumatidae Golovatch

Hoffmaneumatidae Golovatch 1974, p. 1008 (type genus *Hoffmaneuma* Golovatch 1978); Shear, 1992, p. 68.

Diagnosis: Chordeumatid millipeds with 28 trunk segments in both sexes. Promentum absent from gnathochilarium. Trunk segments cylindrical in outline, without pronounced shoulders or paranota; metatergal setae short, acute. Pregonopodal legs of males either somewhat enlarged or entirely unmodified. Anterior gonopods with two coxites, a flagelliform branch on the anterior side sheathed by the inner coxite, and a posterior fimbriate process. Posterior gonopods with complex coxites and a small, single-articled, flaplike telopodite. Tenth legs much reduced, without coxal glands; eleventh legs with coxal glands, otherwise unmodified.

Included genera: *Hoffmaneuma* Golovatch 1974, *Japanoparvus* Shear, Tanabe, & Tsurusaki, new.

Distribution: Northeast Asia: Maritime Province of the Russian Far East, Japanese islands of Honshu and Shikoku.

### Key to genera and species of Hoffmaneumatidae

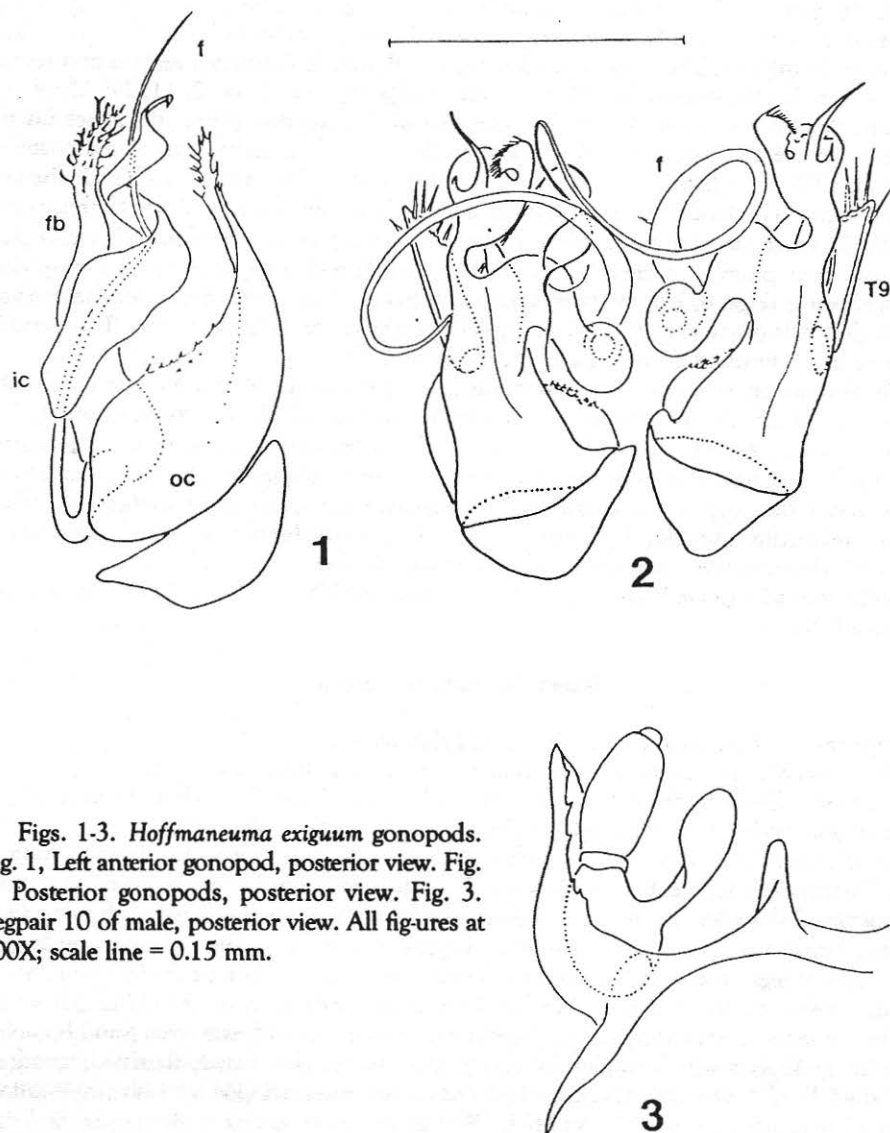
- 1a. Posterior gonopods with a long flagelliform branch.....*Hoffmaneuma exiguum* Golovatch.  
.....2  
1b. No such branch.....2
- 2a. Six ocelli in both sexes.....*Japanoparvus hirosimaensis*, new species.  
2b. Three to 5 ocelli.....3
- 3a. Tenth legs with coxosternum relatively narrow, legs closely appressed to posterior gonopods.....*Japanoparvus okai*, new species.  
3b. Tenth legs with coxosternum very broad, legs widely separated from posterior gonopods.....*Japanoparvus tsunugiensis*, new species.

### Genus *Hoffmaneuma* Golovatch

*Hoffmaneuma* Golovatch 1974, p. 1009; Shear, 1992, p. 68.

Type species: *Hoffmaneuma exiguum* Golovatch.

Probably because of the extremely small size of the animals, the complexity of the gonopods, and the unexpected involvement of three, rather than two, pairs of legs in the gonopod complex, Golovatch (1978) incorrectly interpreted their anatomy. A correct interpretation was given by Shear (1992), referring to Golovatch's drawings. Figs. 1-3 are new illustrations prepared from material kindly donated by Dr. Golovatch, digested in trypsin,



Figs. 1-3. *Hoffmaneuma exiguum* gonopods. Fig. 1, Left anterior gonopod, posterior view. Fig. 2. Posterior gonopods, posterior view. Fig. 3. Legpair 10 of male, posterior view. All figures at 400X; scale line = 0.15 mm.

mounted on a microscope slide and examined with Nomarski interference contrast illumination.

The general plan of hoffmaneumatid gonopods appears to be as follows. The anterior gonopods (Fig. 1) consist of a relatively unmodified sternum and two separate articulated coxae, which give rise to inner and outer coxites on each side. The inner coxite (*ic*) sheaths a long flagelliform branch (*f*) which originates on the posterior surface of the coxa but passes between the coxae to the sheathing groove on the anterior face of the inner coxite. The outer coxite (*oc*) is shorter and less complex than the inner. Near the base of the flagelliform branch on the posterior side of the gonopod, a heavily fimbriated process (*fb*) originates. It is

doubtful if any of the branches and processes of the coxae are telopodite remnants; the fimbriate branch may be homologous to an everted coxal gland. The posterior gonopods (Fig. 2) consist of a sternum which appears to be reduced, partially fused to the coxae, and divided in the midline. The coxae are complicated and include fimbriated regions and several processes. In *Hoffmaneuma*, but evidently not in *Japanoparvus* (Figs. 7, 11, 12), there is a very long flagelliform branch (*f*), which, like that of the anterior gonopods, arises on the posterior surface and passes anteriorly between the coxae. The telopodites of the posterior gonopods (T9) are reduced to a single articulated podomere that is flattened lengthwise and apically setose. The tenth legs are modified differently in the two genera. In *Hoffmaneuma* (Fig. 3), the broad sternum has a median lobe and a strong ventral extension on either side. The coxae have prominent mesal processes, and there is a distinct, three-articled telopodite. In *Japanoparvus* (Figs. 8, 13), the coxal process projects anteriorly and the telopodite consists of a single article (there may be a minute apical article) with or without setation. The eleventh leg coxae bear a functional coxal gland, and the twelfth coxae a pair of posterior hooks.

No obvious apomorphies are shared with Mastigophorophyllidae. In that family, the second legs of females are very much reduced (of normal size in hoffmaneumatids). The anterior gonopods are superficially similar, but the supposed homolog of the flagelliform branch in hoffmaneumatids is probably another coxite in mastigophorophyllids; it remains on the posterior side and is not sheathed. The posterior gonopods are complicated, but an obvious telopodite homolog is missing, and a flagelliform branch arises on the anterior surface of what must be a coxosternum, close to the midline.

*Hoffmaneuma exiguum* is characterized by Mikhajlova (1993, p. 29) as "widespread in the Maritime Province."

#### *Japanoparvus*, new genus

Type species: *Japanoparvus okai*, described below as new.

Derivation of name: From Japan, and Latin *parvus*, small; masculine gender.

Diagnosis: Differing from *Hoffmaneuma* in lacking a long, flagelliform branch on the posterior gonopods and in the single-articled telopodites of the male tenth legs.

Description: Small (4-5 mm long) chordeumatid millipeds, about ten times as long as wide. Twenty-eight segments in both sexes. Diplosegments nearly circular in cross-section, without lateral shoulders or paranota; segmental setae short, acute, unmodified. Pigmentation lacking, ocelli black, 3-6 in single row. Legpairs three and four of males enlarged, pregonopodal legs otherwise unmodified. Anterior gonopods with four distinct branches: a lateral, lobelike coxite, a mesal, more complex coxite with anterior sheathing groove for flagelliform branch; posteriorly arising flagelliform branch and fimbriate coxal gland homolog. Posterior gonopods with complex lobular coxite and single-articled, flattened, quadrate telopodite. Tenth legs reduced, coxae with anterior processes, telopodites with single article. Coxae 11 with glands; coxae 12 with hooks. Female genitalia complex, with unusual fimbriate regions posterior on valves.

Distribution: Hiroshima Prefecture, Honshu, and Tokushima Prefecture, Shikoku, Japan.

Included species: the type, *Japanoparvus tsurugiensis* n. sp., and *Japanoparvus hirosimaensis* n. sp.

Remarks: Fig. 4 shows a sketch plan of the gonopod complex in an undissected male of *Japanoparvus hirosimaensis*. The flagelliform branch of the anterior gonopod (*ag*) arises posteriorly, passes between the coxae, and then extends back over the coxites of the posterior gonopod (*pg*). In *J. hirosimaensis* and *J. okai*, the reduced tenth legs (L10) are appressed to the posterior surfaces of the posterior gonopods, but *J. tsurugiensis* differs in that there is a large space between the two, due to long anterior extensions of the tenth leg sterna.

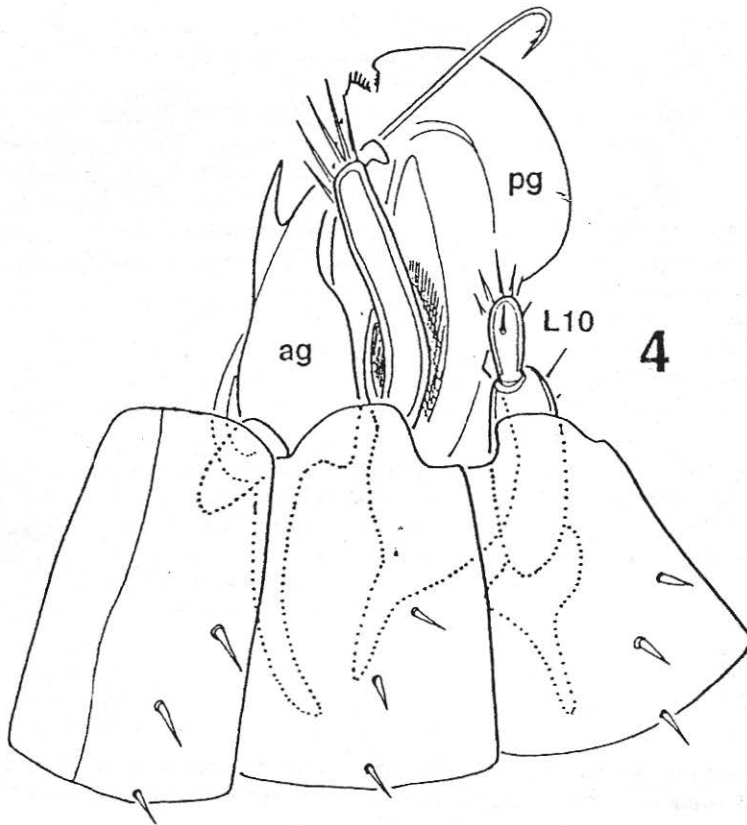
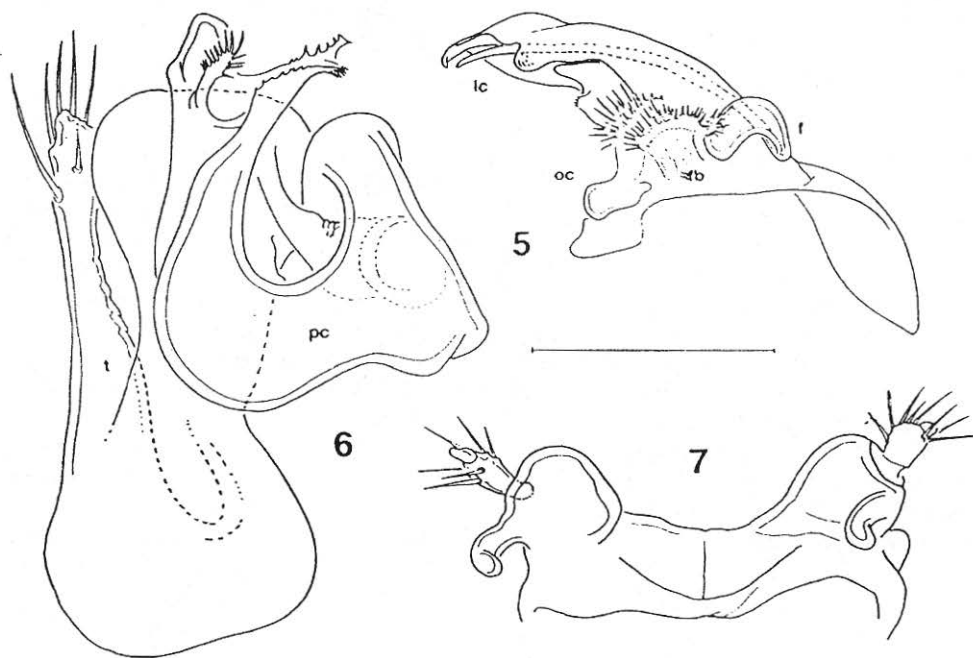


Fig. 4. Sketch plan of gonopods of *Japanoparvus hirosimaensis*. Anterior to the left.

*Japanoparvus okai*, new species  
Figs.6-7, Map 1

Material: Male holotype and female paratype (NSMT), 2 male and 2 female paratypes (VMNH) from bamboo (*Phyllostachys pubescens*) forest, 30-40m elevation, Hamasaka Shrine, Hamasaka, Tottori city, Tottori Pref., 21 April 1994, Eiji Oka leg.

Other specimens examined: All are from evergreen broad-leaf forests in Tottori city, Tottori Prefecture, less than 30 m in elevation, and all collections are by Eiji Oka, unless otherwise noted. Iwami-gun: Iwami-cho, Kumano Shrine, 29-April 1994, 1 female; Fukube-son, Sakadani Shrine, 60 m, 14 March 1992, N. Tsurusaki leg., 1 female (misidentified as *Speophilosoma tottoriense* in Shear, Tsurusaki, & Tanabe, 1994). Momodani, Momodani Shrine, 60 m, 14 March 1992, N. Tsurusaki, 2 females (misidentified as *S. tottoriense* in Shear, Tsurusaki, & Tanabe, 1994); Oochidani, 6 May 1994, 1 male. Mt. Kyūshō, 50-60 m, 19 April 1994, 1 male, 1 female (NSMT); 1994-11-14, 1 male; 24 November 1994, 1 male; 12 December 1994, 1 male, 1 female. Kakuji, Shiidani Shrine, 30 m, 2 May 1994, 1 female; Ōro, Mt. Ōro, *Cryptomeria japonica* forest, 30 m, 16 April 1994, 3 males, 3 females. Kokōge, Nakatomi-takatake Shrine, 10 May 1994, 1 male, 2 females; 15



Figs. 5-7. *Japanoparvus okai*. Fig. 5. Right anterior gonopod, mesal view. Fig. 6. Left posterior gonopod, mesal view. Fig. 7. Legpair 10 of male, anterior view. All figures at 400X; scale line = 0.15 mm.

October 1994, 13 juveniles (preadult stage), 8 December 1994, 2 males, 2 females (VMNH). Fuse, Sannō-san: 30 April 1994, 1 male, 3 females; 2 December 1994, 3 males, 1 female (TKPM). Koyama: Mt. Urayama, 28 March 1994, 4 males, 4 females (VMNH); Mt. Tariyama, 5 May 1994, 1 male. Koyama, Mt. Ishiba: 13 April 1994, 4 males, 2 females (VMNH); 8 November 1994, 1 male, 1 female; 4 December 1994, 1 male. Iwayoshi, Mt. Yoshiyama: 30 March 1994, 1 male, 3 females; 15 December 1994, 1 female. Mitsu, Mitsu Shrine, 7 May 1994, 2 males; Fushino, Fushino Shrine, 28 April 1994, 2 males. Hakuto, Hakuto Shrine, *Pinus thunbergii* forest: 28 April 1994, 1 male, 18 October 1994, 1 female. Katsurami, Katsurao Shrine, *Cryptomeria japonica* forest, 10 May 1994, 1 male; Takazumi, Kitano Shrine, 9 May 1994, 2 males, 2 females; Is. Aoshima, Lake Koyama, *Pinus densiflora* - *Eurya japonica* forest, 28 February 1994, 3 females. Tōhaku-gun, Misasa-cho, Misasa Spa, *Quercus serrata* forest, 120 m, 20 March 1994, N. Tsurusaki leg., 1 male (VMNH).

Male: length 4.5 mm, width 0.4 mm, antennal article three 0.2 mm long. Head not modified, with four black ocelli in curved line. Seen from above, trunk segment seven distinctly swollen. Legpairs three and four enlarged, pregonopodal legs otherwise unmodified. Anterior gonopod (Fig. 6) with flagellum originating mesally, sheathed in inner coxite (ic); outer coxite (oc) small, blunt, fimbriate process (fb) low. Posterior gonopod (Fig. 7) with divided coxosternum, coxae subglobose, with large, complex coxites (pc); telopodite (t) slender, well sclerotized, apically setose. Legs 10 (Fig. 8) with coxosternum narrow, coxal part with anteriorly projecting hooked processes; telopodites 2-articled, the apical article minute.

Female: Length, 5.3 mm, width, 0.5 mm, antennal segment three 0.20 mm long. Cyphopod as in *J. hirosimaensis* (Fig. 12).

Notes: The number of ocelli within an ocular field, which sometimes differs between the right and left ocular fields of an individual, varies from 3 to 5. Among 63 adults (34 males and 29 females) counted, the mode is 4 ocelli shared by 79% of males and 59% of females, followed by 3 (15% of males and 34% of females) and 5 (6% of males and 7% of females). Some degree of interpopulational variation in the number of ocelli seems to occur, though no consistent geographical trend can be detected.

This species seems to be very common in the forest leaf-litter of various woodlands, fragments of which remain in the Tottori plain. Specimens mature in late October. In some localities (Sakadani Shrine, Mt. Kyūshō, Oochidani, Tariyama) this species is sympatric with *Speophilosoma tottoriense* or *S. koyama* of the family Speophilosomatidae, another group of Chordeumatida, which are of similar size (ca. 5 mm) and hence presumably have a similar niche (Shear, Tsurusaki and Tanabe, 1994). However, they have rarely been found together (by extraction with Tullgren funnel) in a single litter-sample collected from a woodland site. This might suggest the occurrence of competitive exclusion between *J. okai* and *Speophilosoma* spp.

*Japanoparvus okai* can easily distinguished from the species of *Speophilosoma* by having (1) conspicuously enlarged gonopod-complex and unmodified legpair 7 in males, (2) shorter segmental setae (ca. 0.07 mm: ca. 0.2 mm in *Speophilosoma*) in both males and females, and (3) a pair of long (ca. 0.15 mm) spinnerets on the preanal segment in both males and females; the spinnerets of *Speophilosoma* are much shorter.

Distribution: So far known from the eastern and the middle part (westernmost record is Misasa Spa) of Tottori Prefecture, Honshu, Japan (Map 1).

Name: The specific name honors Mr. Eiji Oka, who collected most of the present material of this species during his research work on milliped fauna for his graduate thesis submitted to Tottori University.

#### *Japanoparvus hirosimaensis*, new species

Figs. 8-12, Map 1

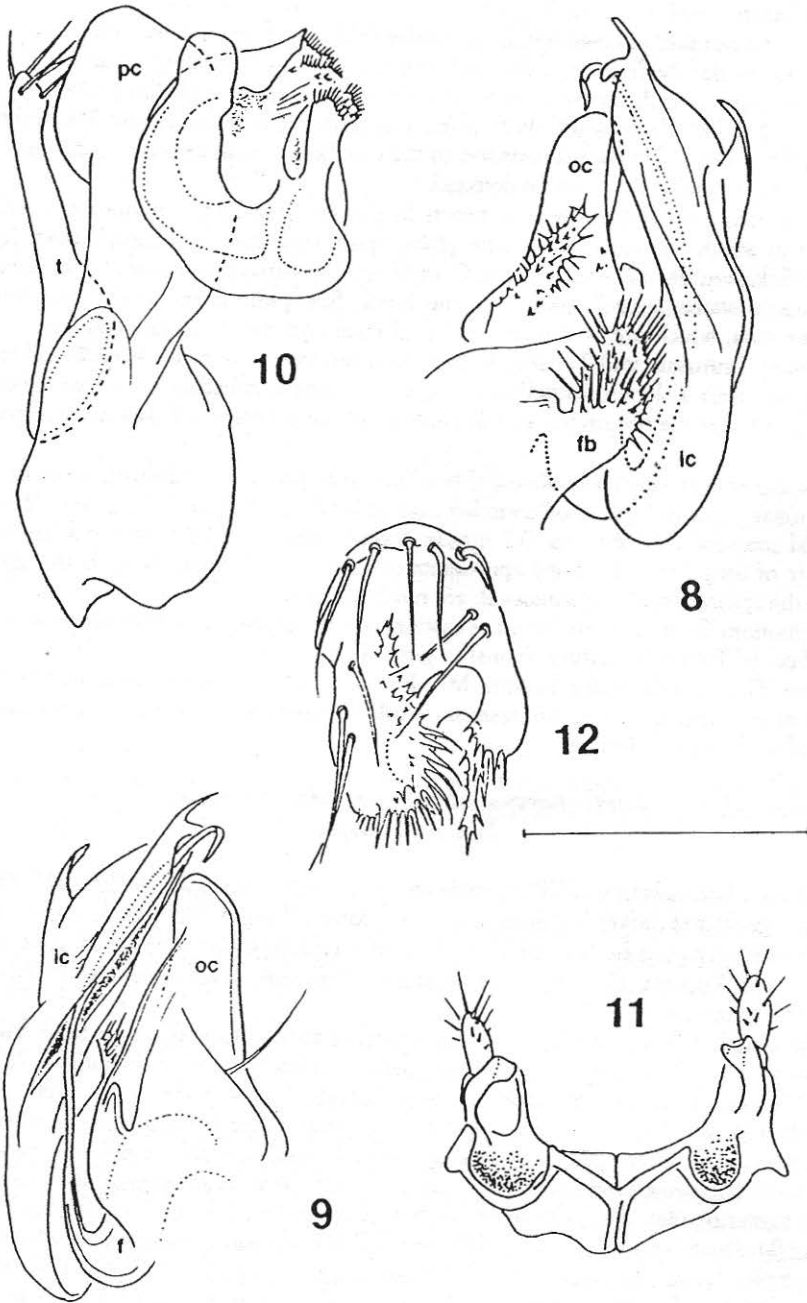
Material: Male holotype (TKPM), male and two female paratypes (TKPM, NSMT) from naturally regenerated cedar (*Cryptomeria japonica*) forest, Yoshiwa-mura, Saiki-gun, Hiroshima Pref., Honshu, Japan, collected "1989" by Y. Touyama; four male paratypes (TKPM, NSMT, VMNH) from Koyama, Kake-chō, Yamagata-gun, Hiroshima Pref., collected 15 November 1989 by Y. Touyama.

Male: length 4.5 mm, width 0.4 mm, antennal article three 0.2 mm long. Head not modified, with six black ocelli in curved line. Seen from above, trunk segment seven distinctly swollen. Legpairs three and four enlarged, pregonopodal legs otherwise unmodified. Anterior gonopods (Figs. 8, 9) with two prominent coxites; inner coxite (*ic*) with deep cleft setting off smaller mesal and larger lateral branches, lateral branch sheaths flagelliform process (*f*), terminates in two acute process. Outer coxite (*oc*) blunt, thick, quadrangular, with single lateal seta. In posterior view (fig.5) flagelliform branch (*f*) originates close to base of fimbriate process (*fb*). Posterior gonopod (Fig. 10) with divided coxosternum, coxae subglobose, with large, complex coxites (*pc*); telopodite (*t*) slender, apically setose. Legs 10 (Fig. 11) with broad coxosternum; coxal portion with apical, anteriorly projecting blunt process; telopodite single-articled, spindle-shaped, setose. Coxae 11 with glands, coxae 12 with posterior hooks.

Female: Length, 4.8 mm, width 0.4 mm, antennal segment three 0.18 mm long. Cyphopod as in Fig. 12.

Notes: All specimens were obtained by hand sorting of litter.

Name: The species name refers to Hiroshima Prefecture.

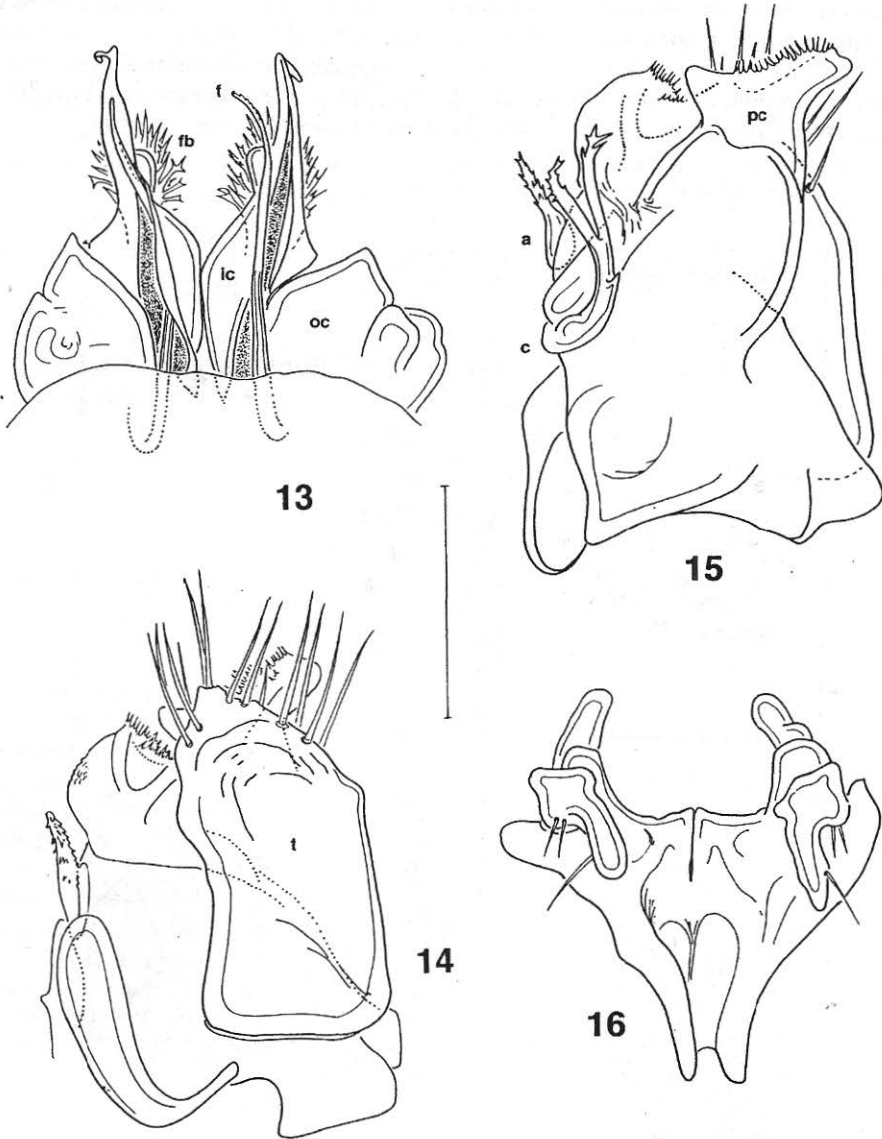


Figs. 8-12. *Japanoparvus hirosimaensis*. Fig. 8. Anterior gonopods, posterior view. Fig. 9. Right anterior gonopod, view slightly lateral of anterior. Fig. 10. Left posterior gonopod, mesal view. Fig. 11. Legpair 10 of male, posterior view. Fig. 12. Left cyphopod of female, ventral view. All figures at 400X; scale line = 0.15 mm.



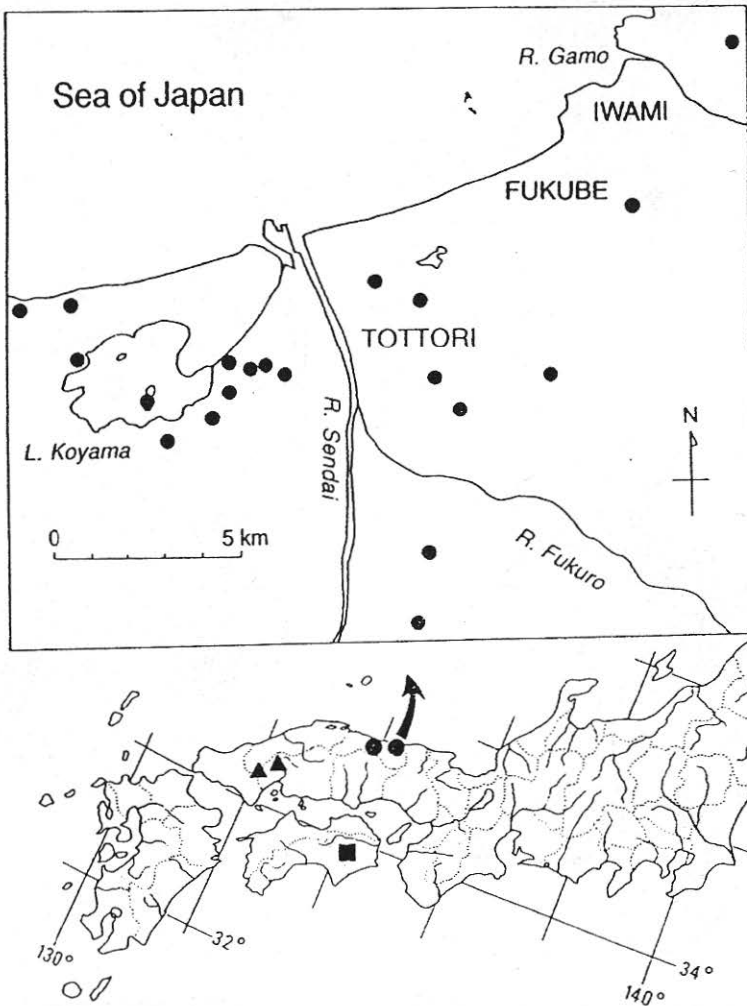
*Japanoparvus tsurugiensis*, new species  
Figs. 13-16, Map 1

Material: Male holotype (TKPM), two male and two female paratypes (TKPM, NSMT, VMNH) from near Tsurugi-jinja Shrine,  $\pm 1450\text{m}$  elevation, Minokoshi, Mt. Tsurugi-san, Higashiyayama-son, Miyoshi-gun, Tokushima Prefecture, Shikoku, Japan, collected 29 October 1992 by T. Tanabe.



Figs. 13-16. *Japanoparvus tsurugiensis*. Fig. 13. Anterior gonopods, anterior view. Fig. 14. Right posterior gonopod, lateral view. Fig. 15. Left posterior gonopod, mesal view. Fig. 16. Legpair 10 of male, ventral view. All figures at 400X; scale line = 0.15 mm.

Male: length 5.0 mm, width 0.4 mm, antennal article three 0.2 mm long. Head not modified, with four black ocelli in curved line. Seen from above, trunk segment seven distinctly swollen. Legpairs three and four enlarged, pregonopodal legs otherwise unmodified. Anterior gonopods (Fig.13) with two coxites; inner coxite (*ic*) triangular-acuminate, tip curved posteriorly, anterior surface with sheathing groove for flagelliform branch (*f*). Outer coxite (*oc*) low, bluntly pointed, lacking setae. Large fimbriate branch (*fb*) originates posteriorly near base of flagelliform branch. Posterior gonopods (Figs.14, 15) with divided coxosternum, coxae subglobose, with large, complex coxites (*pc*) bearing on anterior face small, articulated process (*a*) and bifurcate, curved branch (*c*); telopodite (Fig. 14; *t*) subquadrate, flattened, with numerous setae. Legs 10 (Fig. 16) with broad coxosternum (*cx*) extending anteriorly; coxal portions each with anteriorly directed processes bearing few setae; telopodite single-articled, cylindrical, asetose, directed posteriorly. Coxae 11 with glands, coxae 12 with posterior hooks.



Distribution of *Japanoparvus*. Filled circles, *J. okai*. Triangles, *J. hirosimaensis*. Square, *J. tsurugiensis*.

Female: Length, 5.0 mm, width 0.4 mm, antennal segment three 0.22 mm long. Cyphopod similar to those of the preceding species.

Notes: All specimens were obtained by Berlese funnel extraction of moist litter from a deciduous broad-leaved forest. Bamboo-grass, *Sasamorpha borealis*, dominates on the forest floor.

Name: The species name refers to the Tsurugi-jinja Shrine.

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#### Addresses of the authors:

William A. Shear  
Department of Biology  
Hampden-Sydney College  
Hampden-Sydney VA 23943 USA

Tsutomu Tanabe  
Tokushima Prefectural Museum  
Bunka-no-Mori Park  
Hachiman-cho  
Tokushima 770  
JAPAN

Nobuo Tsurusaki  
Department of Biology  
Faculty of Education  
Tottori University  
Tottori 680  
JAPAN