

HYPHALION SAGAMIENSE, A NEW SPECIES OF
CLAUSIDIIDAE (COPEPODA: POECILOSTOMATOIDA)
ASSOCIATED WITH A VESICOMYID BIVALVE
FROM THE HATSUSHIMA COLD-SEEP SITE
IN SAGAMI BAY, JAPAN

Tatsuki Toda, Tomoyuki Miura, and Takahisa Nemoto

Abstract.—A new clausidiid copepod, *Hyphalion sagamiense*, found in association with a vesicomylid bivalve, *Calyptogena soyoae* Okutani, 1957, at a depth of 1170 m from the Hatsushima cold-seep site in Sagami Bay, Japan, is described. The species is morphologically very close to its only congener *Hyphalion captans* Humes, 1987 from Guaymas Basin, Gulf of California. The new copepod is distinguished from *H. captans* by the presence of 7-segmented first antenna, spinose paragnath, 5th leg with 2 broad segments, and in the male by a delicate seta on the long terminal claw of the 3-segmented maxilliped. Discovery of the present new species requires an amendment of the generic definition.

In recent years, a large number of new copepods have been described from deep-sea hydrothermal vents and cold-seep sites in the eastern Pacific and the Atlantic (Humes & Dojiri 1980a, 1980b; Fleminger 1983; Humes 1984, 1987, 1988a, 1988b, 1988c, 1988d, 1989a, 1989b, 1989c, 1989d). On the other hand, little is known of the copepods living at vents and/or seep sites in the western Pacific. The only work is one by Humes (1990) who described two new species from a deep-sea hydrothermal vent at the Mariana Back-Arc Basin.

A series of dives by the deep-sea submersible *Shinkai 2000* of the Japan Marine Science and Technology Center (JAMSTEC) have been made for multiple purposes at the Hatsushima cold-seep site which is characterized by the dominant occurrence of *Calyptogena soyoae* Okutani, 1957, since 1984 (Okutani & Egawa 1985). During Dive 315 of 1987, more than 40 specimens of this vesicomylid bivalve were collected and the animals associated with this mollusk were examined. A polychaete and a cope-

pod species were found in the mantle cavity (Miura 1988), and the former was recently described (Miura & Laubier 1990). The purpose of this paper is to describe the parasitic copepod. The new copepod species is morphologically very close to *Hyphalion captans* Humes, 1987 collected from Guaymas Basin, Gulf of California; however, some unique characters in the new copepod support the establishment of a new taxon and require a minor emendation of the original diagnosis of the genus.

Materials and Methods

Calyptogena soyoae, hosts of the copepods, were collected during *Shinkai 2000* Dive 315 from the Hatsushima cold-seep site (depth 1170 m, 35°00.0'N and 139°13.8'E) in Sagami Bay, Japan, on 19 November 1987. Copepods were found on the gills of the bivalves and were collected using a small pipette with a tip diameter of 2.0–2.5 mm. Specimens were fixed in 10% formalin and preserved in 80% ethanol.

Copepods were dissected and examined in lactic acid under a stereo- and a compound microscope. Body length was measured from the anterior border of the prosome to the posterior edge of the caudal rami. Segment lengths were measured along the dorsal midline; widths were given as maxima unless otherwise stated. The segments of the first antenna were measured along their posterior, non-setose margins. All drawings were made with the aid of a camera lucida. The text abbreviations are: l = length, w = width, P1–P4 = leg 1–leg 4, exp = exopod, and enp = endopod. In the armature formulae of legs 1–4, Roman and Arabic numerals caps represent spines and setae, respectively.

Family Clausidiidae Embleton, 1901

Genus *Hyphalion* Humes, 1987

Hyphalion sagamiense, new species

Figs. 1–4

Material examined.—40 ovigerous females, 2 males, 1 copepodite. Types deposited in National Science Museum (NSMT), Tokyo, Japan. Holotype female, NSMT-Cr 10159; allotype male, NSMT-Cr 10160; paratype 34 females, NSMT-Cr 10161. Additional materials deposited in Plankton Division, Ocean Research Institute, University of Tokyo and Faculty of Fisheries, Kagoshima University.

Habitat.—Gills of *Calyptogena soyoae* Okutani, 1957.

Locality.—Hatsushima cold-seep site, Sagami Bay, Japan.

Description—Female.—Body (Fig. 1a, b) elongate, flattened; body surface smooth. Total length 2.01 mm, greatest width 0.63 mm. Greatest dorsoventral thickness 0.28 mm. Length ratio of prosome to urosome 1.21:1.

Prosome consisting of 4 somites. Ratio of length to width of prosome 1.69:1. Somite bearing leg 1 fused with cephalosome; cephalothorax $532 \times 628 \mu\text{m}$ (l \times w). So-

mites bearing legs 2, 3, and 4 decreasing in width posteriorly: 161×544 , 188×466 , $140 \times 388 \mu\text{m}$ (l \times w). Epimeral areas of pedigerous somites rounded.

Urosome with 4 somites. Somite bearing leg 5 (Fig. 1c) $112 \times 321 \mu\text{m}$ (l \times w). Genital somite, much broader than long in dorsal view $180 \times 312 \mu\text{m}$ (l \times w); its lateral margins expanded. Genital areas located dorsolaterally on expanded portions of somite (Fig. 1d); each area with 2 small smooth setae, $24 \mu\text{m}$ and $26 \mu\text{m}$. Four abdominal somites: 154×231 , 112×199 , 96×157 , and $81 \times 151 \mu\text{m}$ (l \times w). Anal somite (Fig. 1e) with 4 broad anteroventral striated scales from right to left 15×10 , 15×13 , 16×12 , $17 \times 15 \mu\text{m}$ (l \times w); each posteroventral corner (Fig. 1f) with a single row of spinules.

Caudal ramus (Fig. 1c) longer than wide, $184 \times 65 \mu\text{m}$ (l \times w), ratio of length to width 2.83:1. Ramus armed with 6 setae: outer lateral seta $43 \mu\text{m}$; dorsal seta $67 \mu\text{m}$; innermost terminal seta $82 \mu\text{m}$; two long median terminal setae $207 \mu\text{m}$ (outer) and $395 \mu\text{m}$ (inner); all these setae smooth. Outermost terminal seta minutely barbed and $111 \mu\text{m}$.

Egg sac containing 2 eggs (Fig. 1g). Egg approximately $280 \times 250 \mu\text{m}$ (4 eggs measured).

Rostrum (Fig. 2a) broad, posterior margin rounded without ornamentation. First antenna (Fig. 2b) 7-segmented. Length of each segment: 57, 74, 31, 43, 26, 29, and $43 \mu\text{m}$, with formula for armature: 5, 15, 6, 3, 5, 2 + 1 aesthete, and 7 + 1 aesthete, respectively. All setae smooth except some of those on segments 4–7 with minute barbules. Second antenna (Fig. 2c) 3-segmented. First and second segments with single seta. Third segment recurved, with 3 inner subterminal setae, 1 inner terminal seta, 1 outer terminal seta and 3 very long, recurved, sickle-shaped, terminal claws, longest $228 \mu\text{m}$. All setae and claws smooth. Claws of both sides forming a strong prehensile structure.

Labrum (Fig. 2d) broad, $59 \times 106 \mu\text{m}$ (l

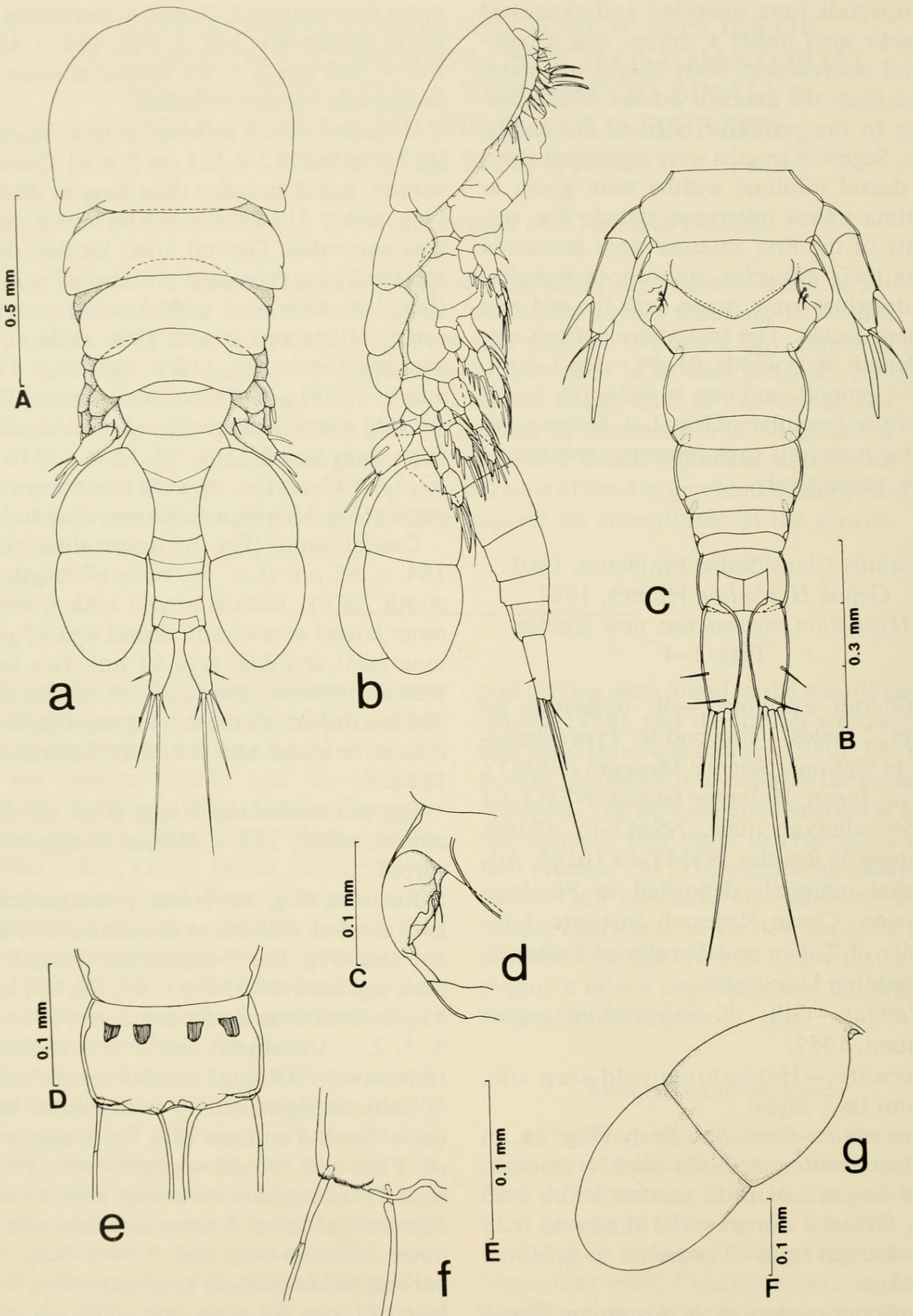


Fig. 1. *Hyphalion sagamiense*, new species. Female: a, dorsal (scale A); b, lateral (A); c, urosome, dorsal (B); d, genital area, dorsal (C); e, anal segment, ventral (D); f, right side of anal segment, ventral (E); g, egg sac, dorsal (F).

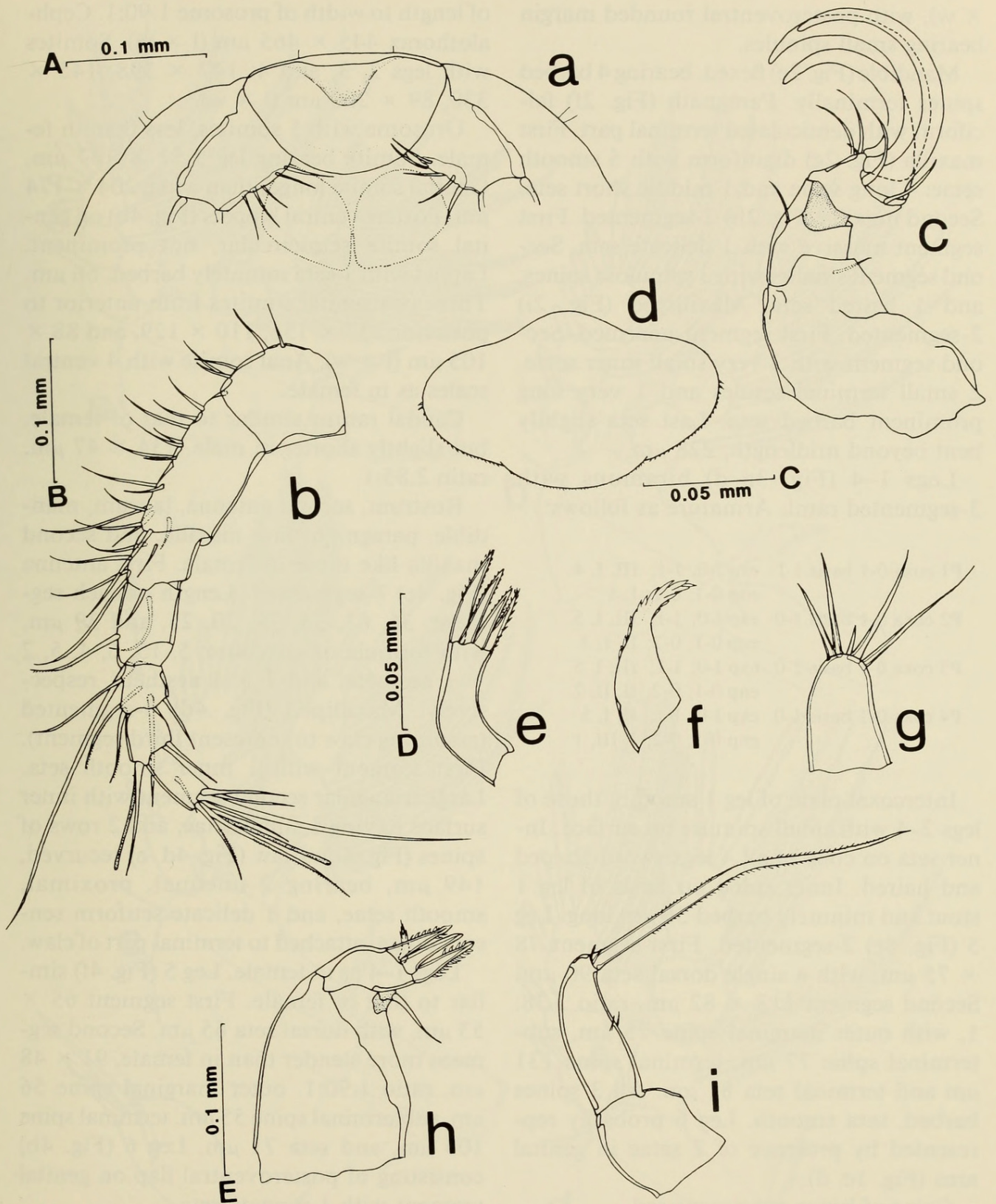


Fig. 2. *Hyphalion sagamiense*, new species. Female: a, rostral area, ventral (scale A); b, first antenna, dorsal (B); c, second antenna (B); d, labrum, ventral (C); e, mandible (D); f, paragnath (D); g, first maxilla (D); h, second maxilla (E); i, maxilliped (E).

× w), with posteroventral rounded margin bearing small spinules.

Mandible (Fig. 2e) flexed, bearing 4 barbed spines terminally. Paragnath (Fig. 2f) falciform with denticulated terminal part. First maxilla (Fig. 2g) digitiform with 5 smooth setae: 4 long setae and 1 middle short seta. Second maxilla (Fig. 2h) 2-segmented. First segment massive with 1 delicate seta. Second segment smaller with 3 spinulose spines, and 1 haired seta. Maxilliped (Fig. 2i) 2-segmented. First segment unarmed. Second segment with 2 very small inner setae, 2 small terminal setules and 1 very long prominent barbed seta. Last seta slightly bent beyond midlength, 228 μm .

Legs 1–4 (Fig. 3a–d) biramous with 3-segmented rami. Armature as follows:

P1 coxa 0-1 basis 1-1	exp I-0; I-1; III, I, 4 enp 0-1; 0-1; I, 5
P2 coxa 0-1 basis 1-0	exp I-0; I-1; III, I, 5 enp 0-1; 0-2; II, I, 3
P3 coxa 0-1 basis 1-0	exp I-0; I-1; III, I, 5 enp 0-1; 0-2; II, II, 2
P4 coxa 0-1 basis 1-0	exp I-0; I-1; II, I, 5 enp 0-1; 0-2; I, III, 1

Intercoxal plate of leg 1 smooth, those of legs 2–4 with small spinules on surface. Inner seta on coxa of all 4 legs sword-shaped and haired. Inner spine on basis of leg 1 stout and minutely barbed 56 μm long. Leg 5 (Fig. 3e) 2-segmented. First segment 78 × 75 μm , with a single dorsal seta 90 μm . Second segment 113 × 82 μm , ratio 1.38:1, with outer marginal spine 75 μm , subterminal spine 77 μm , terminal spine 131 μm and terminal seta 81 μm . All 3 spines barbed, seta smooth. Leg 6 probably represented by presence of 2 setae in genital area (Fig. 1c, d).

Color of living specimens red.

Male.—General form (Fig. 4a) similar to that of female. Total length 1.42 mm, greatest width 0.47 mm, and greatest dorsoventral thickness 0.23 mm. Length ratio of prosome to urosome 1.30:1.

Prosome consisting of 4 somites. Ratio

of length to width of prosome 1.90:1. Cephalothorax 445 × 465 μm (l × w). Somites with legs 2, 3, and 4: 147 × 398, 145 × 330, 89 × 260 μm (l × w).

Urosome with 5 somites, less than in female. Somite bearing leg 5 51 × 167 μm . Genital somite longer than wide, 204 × 174 μm . Posteroventral lappets (Fig. 4b) on genital somite semicircular, not prominent. Lappet with 1 seta minutely barbed, 66 μm . Three postgenital somites from anterior to posterior 137 × 156, 110 × 129, and 88 × 105 μm (l × w). Anal somite with 4 ventral scales as in female.

Caudal ramus similar to that of female, but slightly shorter in male, 134 × 47 μm , ratio 2.85:1.

Rostrum, second antenna, labrum, mandible, paragnath, first maxilla, and second maxilla like those of female. First antenna (Fig. 4c) 7-segmented. Length of each segment: 36, 63, 33, 38, 20, 25, and 39 μm , with formula or armature: 5, 15, 6, 4, 5, 2 + 1 aesthete, and 7 + 1 aesthete, respectively. Maxilliped (Fig. 4d) 3-segmented (assuming claw to represent third segment). First segment with 1 inner smooth seta. Large triangular second segment with inner surface having 1 small setae, and 2 rows of spines (Fig. 4e). Claw (Fig. 4d, e) recurved, 149 μm , bearing 2 unequal, proximal, smooth setae, and 1 delicate setiform sensory organ, attached to terminal part of claw.

Legs 1–4 as in female. Leg 5 (Fig. 4f) similar to that of female. First segment 65 × 53 μm , with dorsal seta 65 μm . Second segment more slender than in female, 91 × 48 μm , ratio 1.90:1, outer marginal spine 56 μm , subterminal spine 55 μm , terminal spine 105 μm , and seta 71 μm . Leg 6 (Fig. 4b) consisting of posteroventral flap on genital segment with 1 pinnate seta.

Color of living specimens red.

Etymology.—This species has been named after its sampling site, Sagami Bay.

Remarks.—Several features of the new species conform to the genus *Hyphalion* Humes, 1987: the habitus, the urosome with

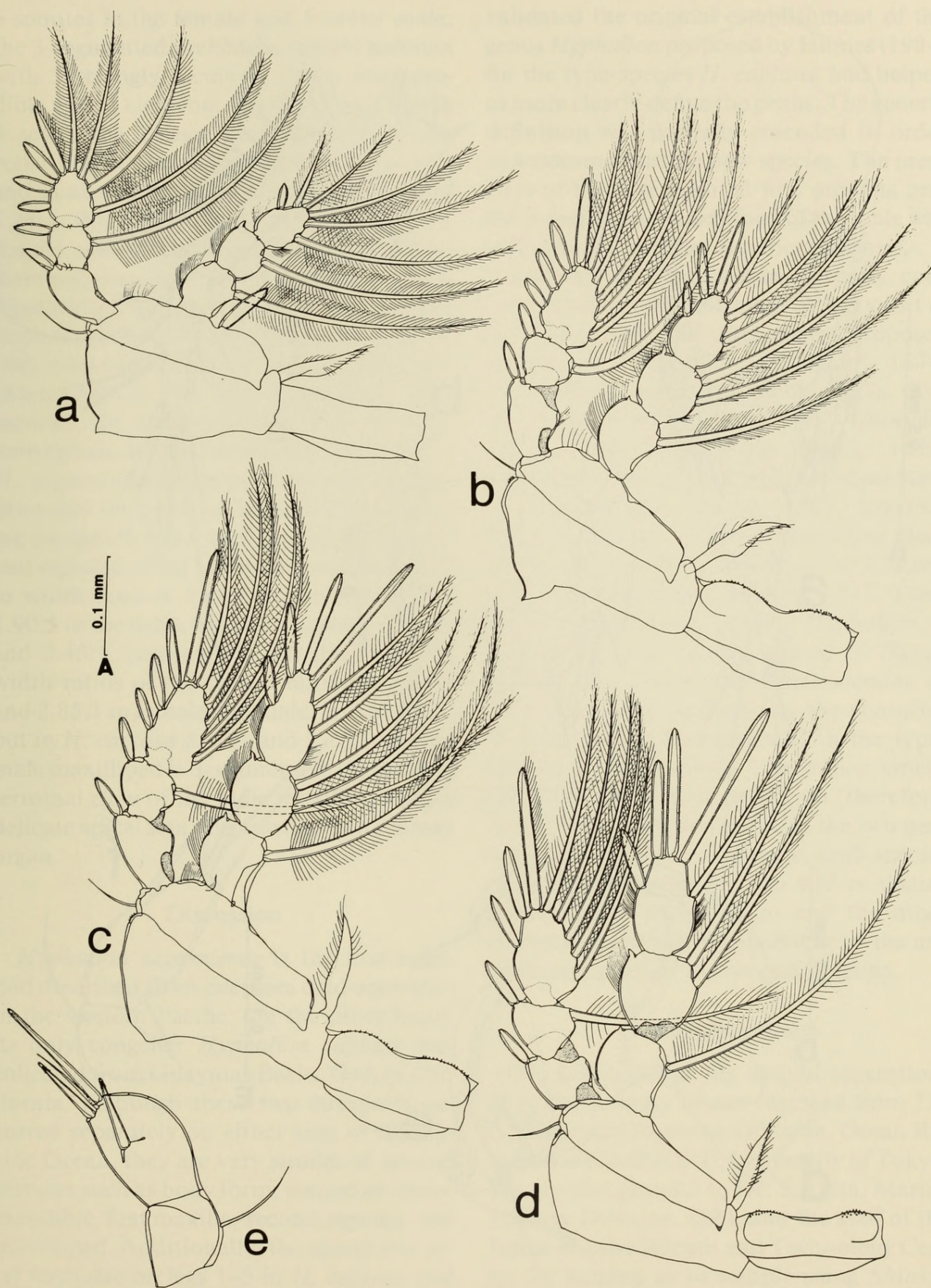


Fig. 3. *Hyphalion sagamiense*, new species. Female: a, leg 1 and intercoxal plate, anterior (scale A); b, leg 2 and intercoxal plate, anterior (A); c, leg 3 and intercoxal plate, anterior (A); d, leg 4 and intercoxal plate, anterior; e, leg 5, left, anterior (A).

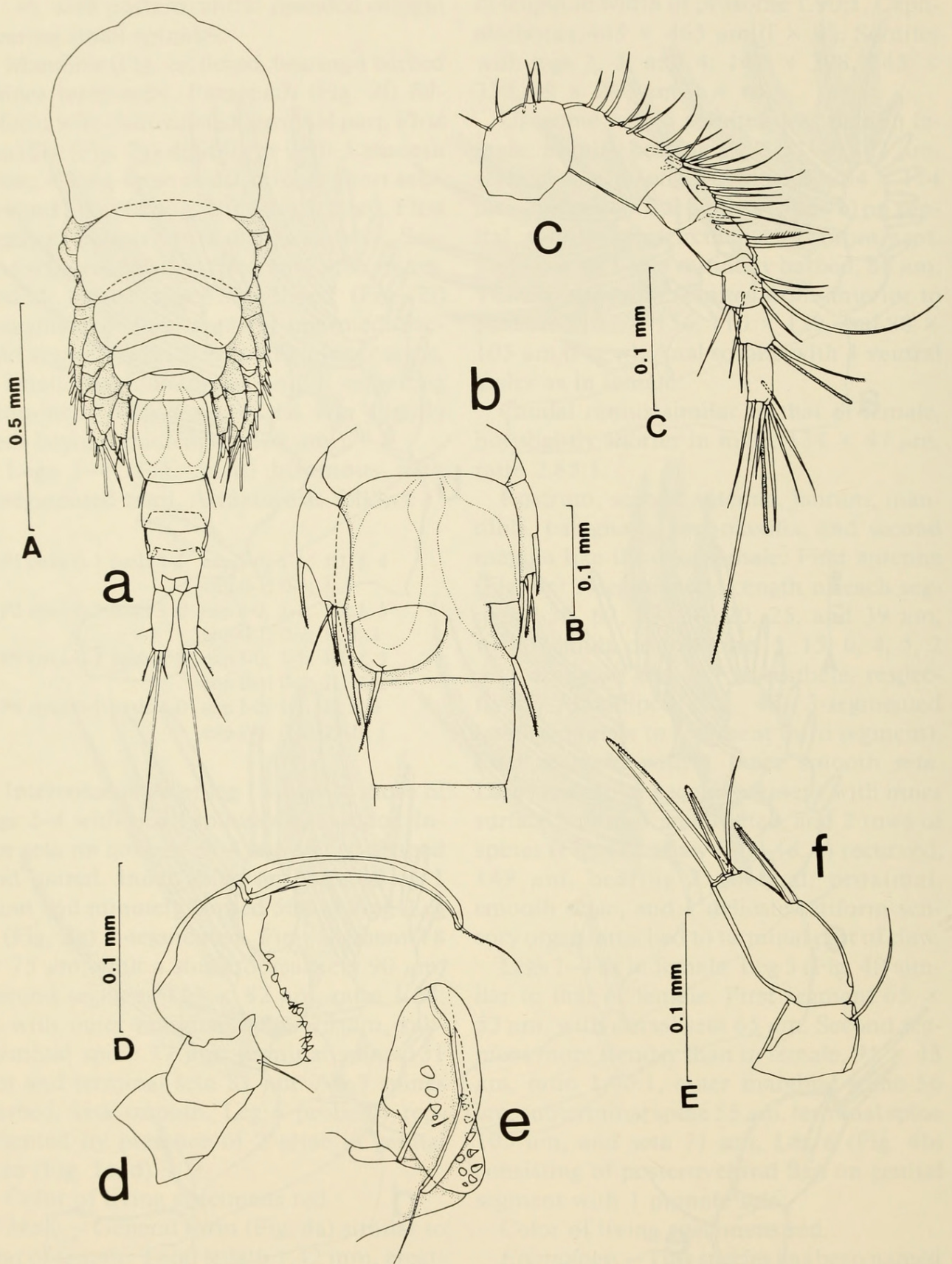


Fig. 4. *Hyphalion sagamiense*, new species. Male: a, dorsal (scale A); b, genital segment, legs 5 and 6, ventrolateral (B); c, first antenna (C); d and e, maxilliped (D); f, leg 5, dorsal (E).

6 somites in the female and 5 in the male, the 3-segmented prehensile second antenna with 3 strongly recurved claws, the mandible with 4 elements, the first maxilla with 5 setae, the 2-segmented second maxilla consisting of a large first segment with 1 seta and small second segment with 3 spines and 1 seta, the 2-segmented maxilliped of the female with the second segment having an extremely long seta, and the spinal and setal formulae on legs 1–5. However, *Hyphalion sagamiense* may be distinguished from its only congener, *H. captans* by the following characters: (1) The first antenna is 7-segmented; the third segment of *H. captans* corresponds to third and fourth segments of *H. sagamiense*, judging from the proportions and the ornamentation; (2) the tapering paragnath has a spinose tip; (3) the second segment of leg 5 is broad, and the length to width ratio is 1.38:1 in the female and 1.90:1 in the male, but in *H. captans*, 2.23:1 and 2.43:1, respectively; (4) the length to width ratios of the caudal rami are 2.83:1 and 2.85:1 in female and male, respectively, but in *H. captans* 3.17:1 and 3.15:1; (5) the male maxilliped is 3-segmented; (6) the long terminal claw of the male maxilliped has a delicate apical seta presumed to be a sensory organ.

Discussion

Hyphalion sagamiense is the first copepod described from deep-sea cold-seep sites in the western Pacific. On the other hand, its only congener *Hyphalion captans* was collected from Guaymas Basin, Gulf of California. Although these two copepods occurred separately on either side of the Pacific Ocean, they are very similar in several features such as body form, second antenna, mandible, first maxilla, second maxilla, and maxilliped. Additionally, the spinal and setal formulae on legs 1–5 in *H. captans* and *H. sagamiense* are the same; consequently, these two species are considered to be closely allied. The discovery of the new species

validated the original establishment of the genus *Hyphalion* proposed by Humes (1984) for the type-species *H. captans*, and helped to more clearly define the genus. The generic definition was partially emended in order to accommodate the new species. The presence of the 7-segmented first antenna and the 4-segmented maxilliped of the male was added to the original generic diagnosis.

The family Clausidiidae currently consists of nine genera included by Vervoort & Ramirez (1966) and three genera proposed afterwards: *Clausidium* Kossmann, 1874, *Conchylurus* Bocquet & Stock, 1957a, *Cotylomolgus* Humes & Ho, 1967, *Giardella* Canu, 1888, *Hemicyclops* Boeck, 1873, *Hersiliodes* Canu, 1888, *Hippomolgus* Sars, 1917, *Hyphalion* Humes, 1987, *Leptinogaster* Pelsener, 1929, *Myzomolgus* Bocquet & Stock, 1957b, *Pseudopsyllus* T. Scott, 1902, and *Tychidion* Humes, 1973. Presently, among these genera, *Hyphalion* is considered most closely related to *Hemicyclops*. The 7-segmented first antenna of the new species conforms to the character of *Hemicyclops* (6-segmented in the type-species of *Hyphalion*). The minor emendation of the generic definition, therefore, makes the distinction between the two genera a little obscure. However, both species of the genus *Hyphalion* can still be distinguished from *Hemicyclops* and the other genera in the family Clausidiidae by the unusual armature of the second antenna.

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(TT) Plankton Division, Ocean Research Institute, University of Tokyo, Minamidai, Nakano-ku, Tokyo 164, Japan; (Present address) Department of Bioengineering, Faculty of Engineering, Soka University, Tangicho, Hachioji-shi, Tokyo 192, Japan; (TM) Faculty of Fisheries, Kagoshima University, Shimoarata, Kagoshima 890, Japan; (TN*) Plankton Division, Ocean Research Institute, University of Tokyo, Minamidai, Nakano-ku, Tokyo 164, Japan.

* Professor Takahisa Nemoto died on 22 August 1990 after several months of illness.



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