



Siphonostomatoid copepods from deep-sea hydrothermal sites on the Mid-Atlantic Ridge west of the Azores.

Arthur G. HUMES

Boston University Marine Program, Marine Biological Laboratory, Woods Hole, Massachusetts, 02543, U. S. A.

Abstract: Two new siphonostomatoid copepods are described from a depth of 1688 m at a hydrothermal area on the Mid-Atlantic Ridge (37°N, 32°W). *Aphotopontius temperatus* n. sp. is characterized by the rectangular shape of the female genital double-somite. In legs 1-4 of copepodid V, the female has 2-segmented rami, but in the male these rami are segmented as in the adult (3-segmented except for a 2-segmented endopod in leg 4). The number of postgenital somites in copepodid V is reduced to 2 in the female and 3 in the male. *Aphotopontius atlanteus* is reported from very close to its type locality on Lucky Strike. *Stygiopontius rimivagus* n. sp., known only from the male, has 3 setae on the free segment of leg 5 and the third segment of the endopod of leg 2 has the formula IV,2.

Résumé : Deux copépodes siphonostomatoïdes nouveaux sont décrits d'une zone hydrothermale sur la Ride Médio-Atlantique (37°N, 32°W) à une profondeur de 1688 m. *Aphotopontius temperatus* n. sp. est caractérisé par la forme rectangulaire du somite génital double de la femelle. Chez la femelle, les pattes 1-4 du copépodite V ont des rames à 2 segments mais chez le mâle les rames sont segmentées comme chez l'adulte (3 segments sauf dans la quatrième patte qui a 2 segments). Le nombre de somites postgénétaux est réduit à 2 chez la femelle et à 3 chez le mâle. *Aphotopontius atlanteus* est signalé d'un site proche de sa localité type à Lucky Strike. *Stygiopontius rimivagus*, n. sp., dont on ne connaît que le mâle, a 3 soies sur le segment libre de la cinquième patte et l'endopodite de la deuxième patte a la formule IV,2.

Keywords : *Aphotopontius*, *Stygiopontius*, Siphonostomatoida, Copepoda, Mid-Atlantic Ridge, hydrothermal sites.

Introduction

Numerous species of siphonostomatoid copepods have been found, often in large numbers, at deep-sea hydrothermal vents and cold seeps (Humes & Dojiri, 1980; Humes, 1984, 1987, 1988a, b, 1989a, b, c, 1990a, b, 1991; Humes & Huys, 1992; Humes & Lutz, 1994; Humes, 1996). In a few cases, these siphonostomatoids are known to be associated with invertebrate hosts, for example, *Stygiopontius pectinatus* Humes, 1987, in the branchial chamber of the shrimp *Rimicaris exoculata* Williams & Rona (see Humes, 1987; Galkin & Moskalev, 1990), and

Aphotopontius acanthinus Humes & Lutz, 1994, on the carapaces of brachyuran crabs and on limpets (Humes & Lutz, 1994). Members of the genus *Aphotopontius* are known from the eastern Pacific (East Pacific Rise, Galapagos Rift, Guaymas Basin), northeastern Pacific (Explorer Ridge, Gorda Ridge, Juan de Fuca Ridge), and the Mid-Atlantic Ridge. The 10 species are: *A. acanthinus* Humes & Lutz, 1994, *A. arcuatus* Humes, 1987, *A. atlanteus* Humes, 1996, *A. baculigerus* Humes, 1987, *A. flexispina* Humes, 1987, *A. forcipatus* Humes, 1987, *A. hydronauticus* Humes, 1989, *A. limatulus* Humes, 1987, *A. mammillatus* Humes, 1987, and *A. probolus* Humes, 1990. Two species of *Aphotopontius* have been reported from the Mid-Atlantic Ridge, *A. forcipatus* Humes, 1987,

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from 23°23'N, 44°56'W (Humes, 1996), and *A. atlanteus* Humes, 1996, 37°20'N, 32°17'W (Humes, 1996), both sites on the Mid-Atlantic Ridge. Twenty-one species of *Stygiopontius* are known from the eastern Pacific, northeastern Pacific, the Lau Basin, the Mariana Back-Arc Basin, and the Mid-Atlantic Ridge. These include: *S. appositus* Humes, 1989, *S. brevispina* Humes, 1991, *S. bulbisetiger* Humes, 1996, *S. cinctiger* Humes, 1987, *S. cladarus* Humes, 1991, *S. flexus* Humes, 1987, *S. hispidulus* Humes, 1987, *S. latulus* Humes, 1996, *S. lauensis* Humes, 1991, *S. lumiger* Humes, 1989, *S. mirus* Humes, 1996, *S. mucroniferus* Humes, 1987, *S. paxillifer* Humes, 1989, *S. pectinatus* Humes, 1987, *S. quadrispinosus* Humes, 1987, *S. regius* Humes, 1996, *S. sentifer* Humes, 1987, *S. serratus* Humes, 1996, *S. stabilitus* Humes, 1989, *S. teres* Humes, 1996, and *S. verruculatus* Humes, 1987. Of these, eight species are known from the Mid-Atlantic Ridge: *S. bulbisetiger*, *S. cladarus*, *S. latulus*, *S. mirus*, *S. pectinatus*, *S. regius*, *S. serratus*, and *S. teres*.

During the preparation of this paper more than 3400 siphonostomatoid copepods were examined. A new species of *Aphotopontius* is described, including both adults and copepodid V. With the addition of this new species, *Aphotopontius* now contains 11 species, all from deep-sea hydrothermal sites and all probably associated to some degree with invertebrates living there (vestimentiferans, bivalves, and decapods). Including the new species described below, the genus *Stygiopontius* now contains 22 species, all, like species of *Aphotopontius*, from hydrothermal sites and all probably associated with invertebrates.

Materials and methods

The copepods were found in washings of bathymodiolid mussels collected in individual closed containers, and were preserved in 70% ethyl alcohol. The copepods were measured and studied in lactic acid, using the wooden slide method described by Humes & Gooding (1964). The length of the body does not include the setae on the caudal rami. In the formula for the armature of the legs, Roman numerals indicate spines and Arabic numerals setae. The letters CV refer to Copepodid V. Segments of the antennules were measured along their posterior nonsetiferous margins. The drawings were made with the aid of a camera lucida.

Siphonostomatoida Thorell, 1859
Dirivultidae Humes & Dojiri, 1980
Aphotopontius Humes, 1987
Aphotopontius temperatus n. sp.
(Figs. 1-3)

Type material: 76 ♀♀, 338 ♂♂ from Jason mussel samples (from Sintra 1-6: 73 ♀♀, 243 ♂♂, 125 CV ♀♀, and

51 CV ♂♂) (from Eiffel Tower 2, 4, and 5: 3 ♀♀, 95 ♂♂, 15 CV ♀♀, and 3 CV ♂♂), Lucky Strike, 37°17'N, 32°16'W, west of the Azores (location shown on map in Van Dover *et al.*, 1996), depth 1688 m, 28 and 30 July 1996. Cindy Lee Van Dover collector. Holotype ♀ (USNM 285469), allotype ♂ (USNM 285470), and 120 paratypes (60 ♀♀, 60 ♂♂) (UNSM 285471) deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (All type specimens from Sintra 6). Remaining specimens in the collection of the author.

Female: body (Fig. 1a) with length 0.77 mm (0.69-0.83 mm) and greatest width 0.37 mm (0.35-0.41 mm), based on 10 specimens. Greatest dorsoventral thickness 0.25 mm. Somite bearing leg 1 fused with cephalosome. Epimera of somites bearing legs 1-4 rounded posterolaterally, particularly those of somite bearing leg 4. Ratio of length to width of prosome 1.37:1. Ratio of length of prosome to that of urosome 1.86:1.

Somite bearing leg 5 (Fig. 1b) rectangular in dorsal view, 70 x 94 µm, but slightly swollen ventrally in lateral view (Fig. 1c). Genital double-somite in dorsal view shorter than wide, 70 µm long, 101 µm wide at level of small anterior lateral expansions and 91 µm wide posteriorly at level of genital areas. Sides of genital double-somite subparallel in posterior two-thirds. Genital areas located laterally near midregion of somite, bearing seta 27 µm long (Fig. 1c). Three postgenital somites from anterior to posterior 36 x 74, 29 x 68, and 52 x 61 µm. Anal somite with few minute posterolateral and ventral spinules (Fig. 1c).

Caudal ramus (Fig. 1d) moderately elongate, 52 x 26 µm, ratio 2:1. Outer lateral seta 78 µm, dorsal seta 94 µm, outermost terminal seta 49 µm, innermost terminal seta 70 µm, all smooth. Two long median terminal setae 117 µm (outer) and 285 µm (inner), both with lateral setules.

Body surface without visible sensilla.

Egg sac not seen.

Rostral area (Fig. 1e) undeveloped. Antennule (Fig. 1f) 273 µm long. Lengths of its 10 segments: 44 (78 µm along anterior margin), 19, 9, 28, 18, 18, 18, 18, 21, and 44 µm, respectively. Armature: 12, 8, 2, 4, 2, 2, 2, 2, 2 + 1 aesthetasc, and 12. All setae smooth. Antenna (Fig. 2a) with elongated basis bearing 1-segmented exopod with 3 setae and 2-segmented exopod, first segment unarmed, second segment with 3 terminal setae, middle seta by far longest, and few small setules.

Oral cone in ventral view short (Fig. 1e), oval, consisting of elongated labrum and semilunar labium. Mandible (Fig. 2b) slender blade 100 µm long, narrowed distally with few small subterminal spinules. Maxillule (Fig. 2c), maxilla (Fig. 2d), and maxilliped (Fig. 2e) resembling those of congeners, for example, *Aphotopontius acanthinus* Humes & Lutz, 1994.

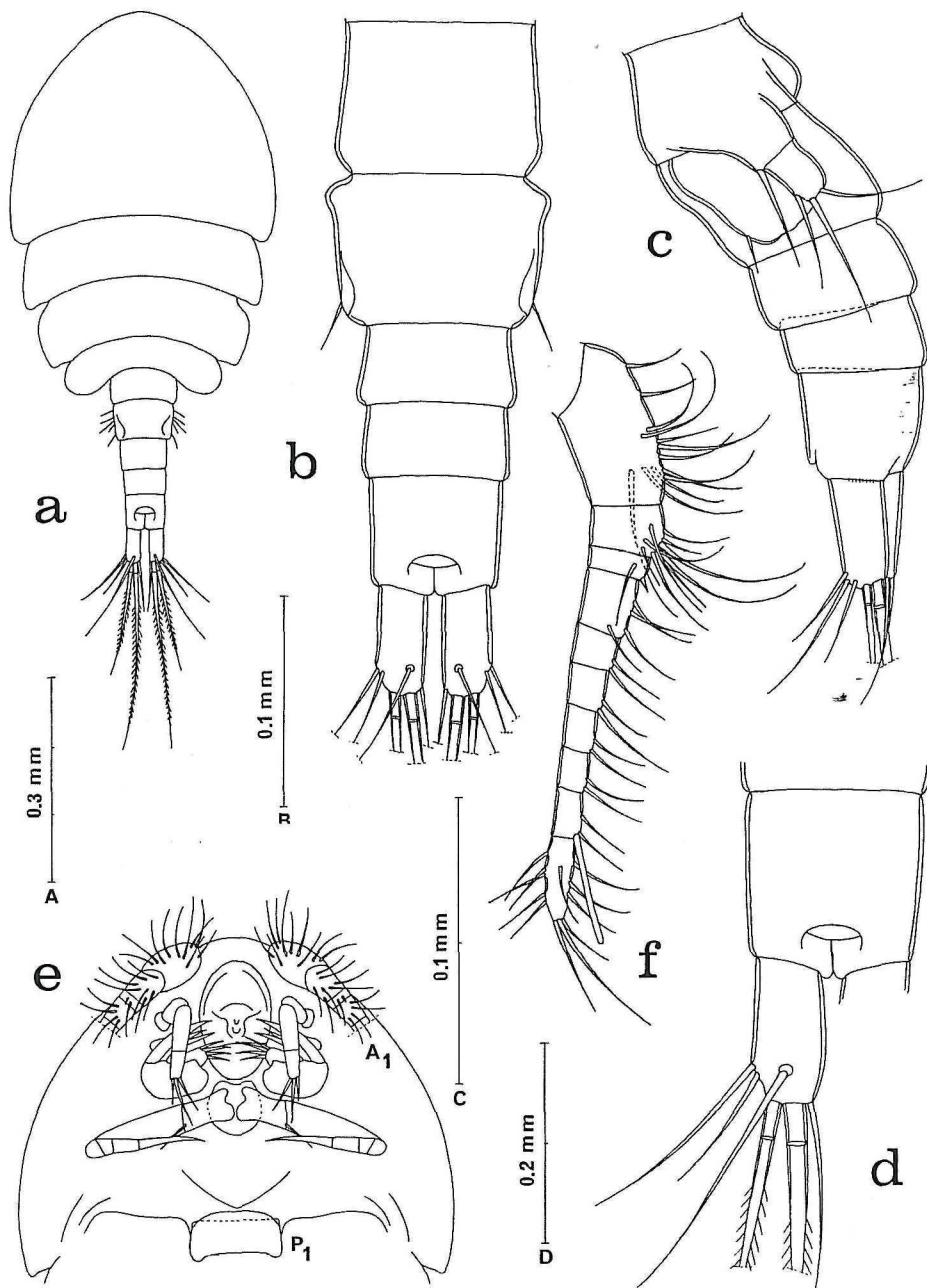


Figure 1. *Aphotopontius temperatus* n. sp. Adult female: a, body, dorsal view (scale A); b, urosome, dorsal (B); c, urosome, lateral (B); d, anal somite and caudal ramus, dorsal (C); e, cephalosoma, ventral (D); f, antennule, anterodorsal (B). A₁ = antennule, P₁ = leg 1.

Figure 1. *Aphotopontius temperatus* n. sp. Femelle adulte : a, corps, vue dorsale (échelle A) ; b, urosome, vue dorsale (B) ; c, urosome, vue latérale (B) ; d, somite anal et rame caudale, vue dorsale (C) ; e, céphalosome, vue ventrale (D) ; f, antennule, vue antéro-dorsale (B). A₁ = antennule, P₁ = leg 1.

Ventral area between maxillipeds and first pair of legs not protuberant.

Legs 1-4 (Fig. 2f,h-j) segmented and armed as in congeners. Formula for armature as follows:

P₁ coxa 0-1 basis I-I exp I-I; I-I; II,I,4
 enp 0-1; 0-2; 1,2,3

P ₂	coxa 0-1	basis 1-0	exp I-1;	I-1;	III,I,4
			enp 0-1;	0-2;	1,2,3
P ₃	coxa 0-1	basis 1-0	exp I-1;	I-1;	III,I,5
			enp 0-1;	0-2;	1,I,1,2
P ₄	coxa 0-0	basis 1-0	exp I-1;	I-1;	III,I,4
			enp 0-1;	I,1	

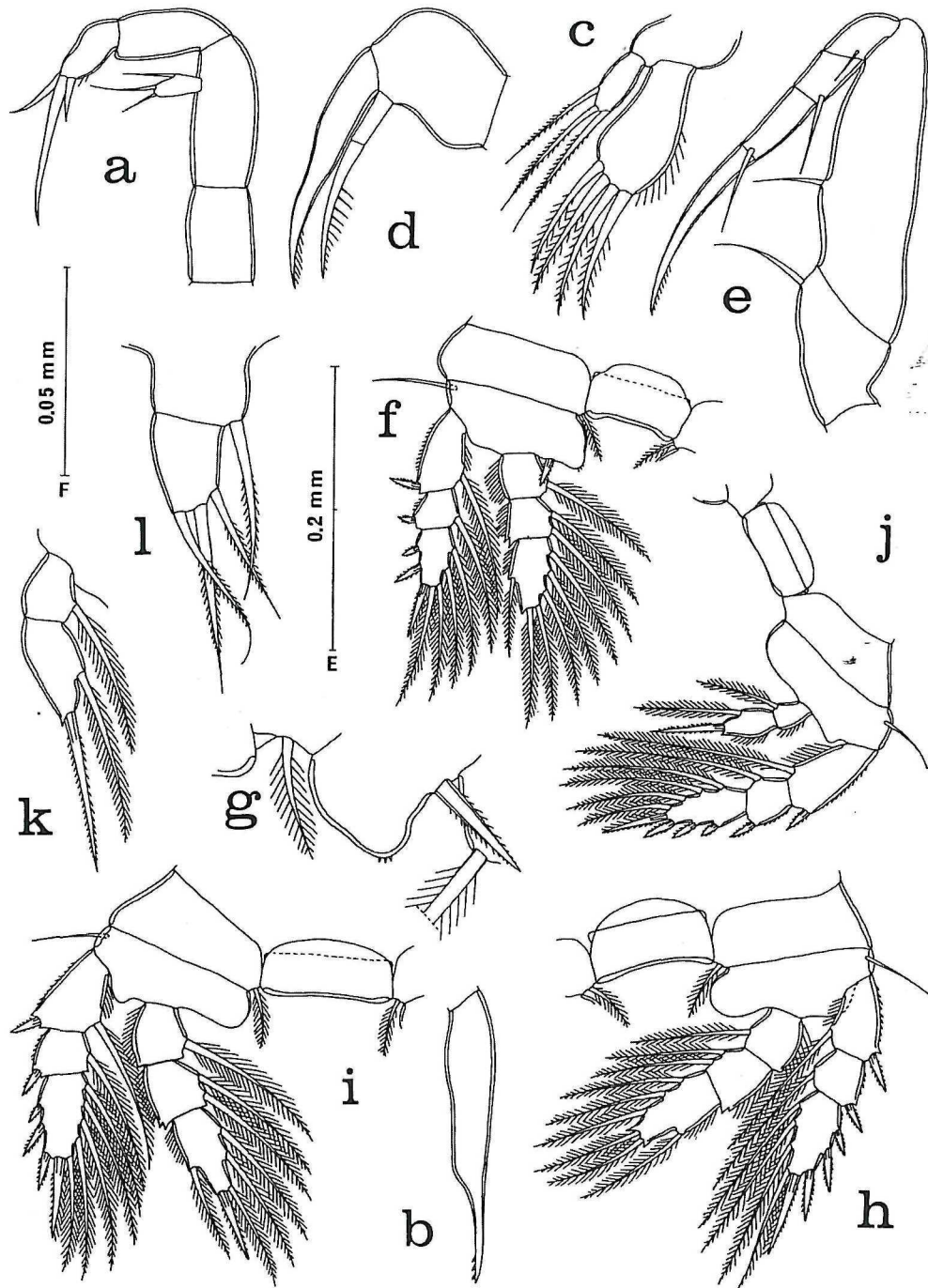


Figure 2. *Aphotopontius temperatus* n. sp. Adult female: a, antenna, antero-inner (scale C); b, mandible, posterior (C); c, maxillule, posterior (C); d, maxilla, posterior (C); e, maxilliped, posterior (C); f, leg 1 and intercoxal plate, anterior (E); g, detail of basis of leg 1, anterior (F); h, leg 2 and intercoxal plate, posterior (E); i, leg 3 and intercoxal plate, anterior (E); j, leg 4 and intercoxal plate, posterior (E); k, endopod of leg 4, posterior (C); l, leg 5, ventral (F).

Figure 2. *Aphotopontius temperatus* n. sp. Femelle adulte : a, antenne, vue antéro-interne (échelle C) ; b, mandibule, vue postérieure (C) ; c, maxillule, vue postérieure (C) ; d, maxille, vue postérieure (C) ; e, maxillipède, vue postérieure (C) ; f, patte 1 et plaque intercoxale, vue antérieure (E) ; g, détail de la base de la première patte, vue antérieure (F) ; h, patte 2 et plaque intercoxale, vue postérieure (E) ; i, patte 3 et plaque intercoxale, vue antérieure (E) ; j, patte 4 et plaque intercoxale, vue postérieure (E) ; k, endopodite de la quatrième patte, vue postérieure (C) ; l, patte 5, vue ventrale (F).

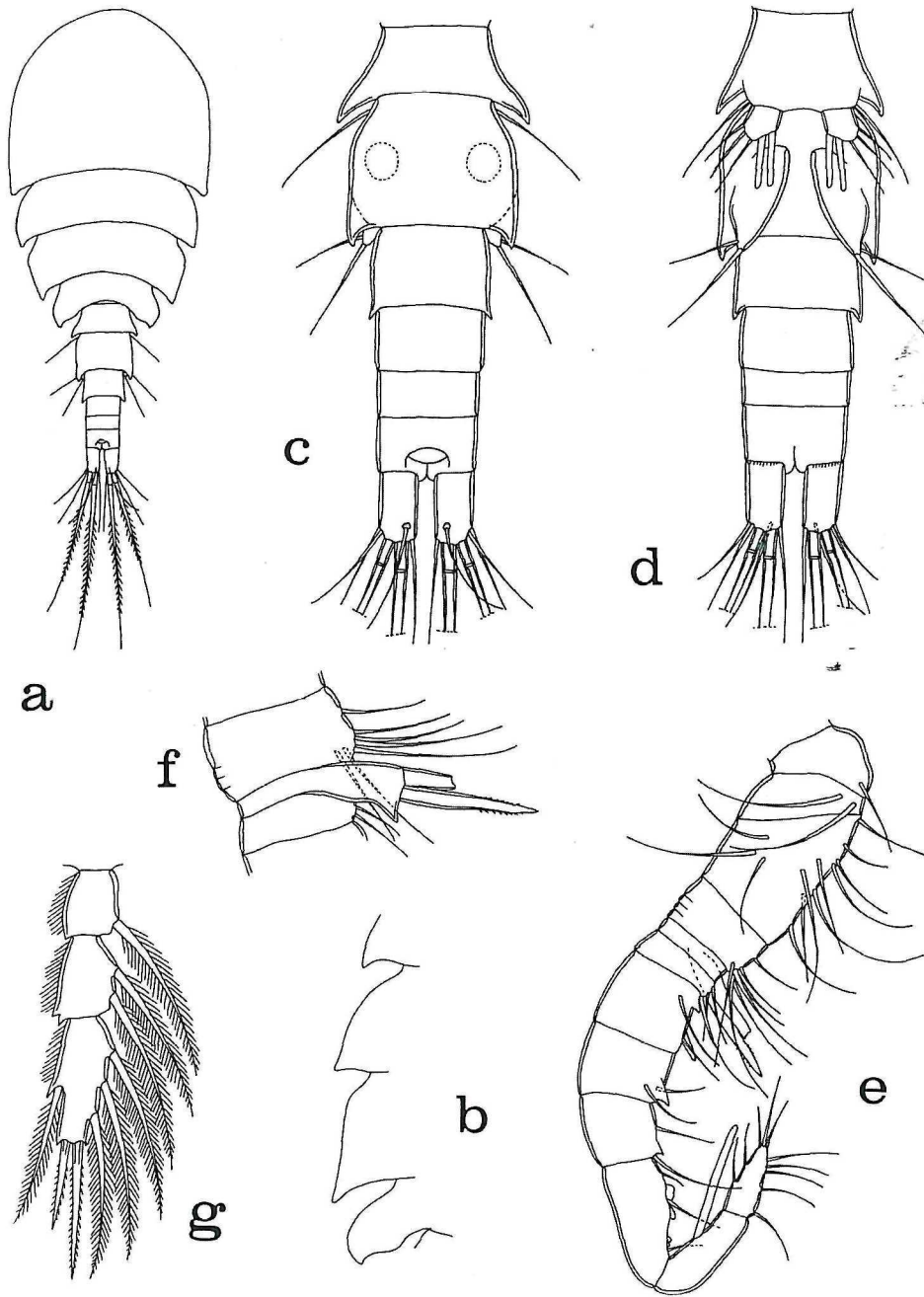


Figure 3. *Aphotopontius temperatus* n. sp. Male: a, body, dorsal (scale A); b, epimera of metasomal somites, dorsal (E); c, urosome, dorsal (B); d, urosome, ventral (B); e, antennule, anterodorsal (C); f, segments 4, 5, and 6 of antennule, showing armature of segment 5, posteroventral (F); g, endopod of leg 2, anterior (B).

Figure 3. *Aphotopontius temperatus* n. sp. Mâle : a, corps, vue dorsale (échelle A) ; b, épimères des somites métagomaires, vue dorsale (E) ; c, urosome, vue dorsale (B) ; d, urosome, vue ventrale (B) ; e, antenneule, vue antérodorsale (C) ; f, segments 4, 5, et 6 de l'antenneule, montrant l'armature du segment 5, vue postéroventrale (F) ; g, endopodite de la deuxième patte, vue antérieure (B).

Leg 1 with inner barbed spine on basis 25 μm ; expanded inner margin of basis with few minute spinules (Fig. 2g). Leg 4 with exopod 148 μm long; endopod (Fig. 2k) with first segment 22 x 18 μm , its inner seta 53 μm ; second segment

33 x 19 μm , its inner seta 55 μm and terminal barbed spine 55 μm

Leg 5 (Fig. 21) 2-segmented, in ventral view first segment incompletely set off from body somite, its outer

seta 57 μm ; second segment 31 x 17 μm , its 3 setae from outer to inner 47, 51, and 52 μm . All setae with short lateral setules.

Leg 6 probably represented by seta on genital area (Fig. 1c).

Color of living specimens red.

Male: body (Fig. 3a) with length 0.63 mm (0.59-0.65 mm) and greatest width 0.28 mm (0.27-0.29 mm), based on 6 specimens. Greatest dorsoventral thickness 0.21 mm. Epimera of somites bearing legs 1-4 pointed posterolaterally, especially those of somites bearing legs 3 and 4 (Fig. 3b). Ratio of length to width of prosome 1.46:1. Ratio of length of prosome to that of urosome 1.74:1.

Somite bearing leg 5 (Fig. 3c, d) in dorsal view 36 x 81 μm , sharply pointed posterolaterally. Genital somite subquadrangular, 57 x 75 μm , slightly wider than long, sides subparallel, drawn out in points posterolaterally. First postgenital somite with pair of posterolateral spiniform processes. Four postgenital somites from anterior to posterior 39 x 60, 29 x 55, 18 x 49, and 27 x 47 μm . Anal somite with row of minute posterolateral and ventral spinules (Fig. 3d).

Caudal ramus (Fig. 3c, d) similar to that of female, slightly smaller, 32 x 20 μm , ratio 1.6:1.

Body surface without sensilla.

Rostral area as in female. Antennule (Fig. 3e) geniculate, 12-segmented. Lengths of segments: 5.5 (24 μm along anterior margin), 16.5, 21, 17, 5.5, 9, 26.5, 24, 23, 43, 36, and 23 μm , respectively. Armature: 1, 2, 12, 7, 2, 2, 4, 2, 2, 3, 1 aesthetasc, and 10. Fifth segment (Fig. 3f) extended anteriorly, having spiniform process and 2 terminal elements, one spiniform and finely barbed, 30 μm , other truncated with irregular tip, 13 μm .

Antenna, oral cone, mandible, maxillule, maxilliped, and ventral area between maxillipeds and first pair of legs as in female.

Legs 1-4 resembling those of female, except sexual dimorphism in third segment of endopod of leg 2 (Fig. 3g) with formula I,II,3.

Leg 5 (Fig. 3d) situated ventrally. Free segment 18 x 13 μm , with 5 setae, 3 outer slender, 2 inner stout and hyaline.

Leg 6 (Fig. 3d) posteroventral flap on genital somite, bearing 2 long setae 45 and 52 μm .

Spermatophore not seen.

Color as in female.

Etymology: the specific name *temperatus*, Latin meaning having proper limits, temperate, alludes to the relatively slight modification in the shape of the genital double-somite of the female, as compared with congeners.

Remarks: *Aphotopontius temperatus* may be distinguished from its 10 congeners by the form of the

rectangular genital double-somite in the female, possessing only a pair of small anterolateral rounded expansions.

Copepodid V (Figs. 4-6)

Material studied: 140 ♀♀, 55 ♂♂ (from Sintra 1-6: 125 ♀♀, 51 ♂♂; from Eiffel Tower 2, 3, and 5: 15 ♀♀, 3 ♂♂). Other collection data same as that for adults. Specimens of Copepodid V have been deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C.

Female: body (Fig. 4a) resembling that of adult. Length 0.61 mm (0.59-0.64 mm) and greatest width 0.29 mm (0.28-0.30 mm), based on 10 specimens. Greatest dorsoventral thickness 0.20 mm. Ratio of length to width of prosome 1.21:1. Ratio of length of prosome to that of urosome 1.83:1.

Somite bearing leg 5 (Fig. 4b, c) subquadrate in dorsal view, 73 x 78 μm , in lateral view (Fig. 4d) subtrapezoidal. Presumptive genital somite 49 x 62 μm , with pair of small posterolateral spines (Fig. 4b-d), both 7.5 μm . Two postgenital somites 29 x 56 and 52 x 52 μm , respectively.

Caudal ramus (Fig. 4e) 43 x 23 μm . Outer lateral seta 78 μm , dorsal seta 88 μm , outermost terminal seta 39 μm , innermost terminal seta 44 μm , and 2 median terminal setae 78 μm (outer) and 263 μm (inner).

Body surface without visible sensilla.

Rostral area as in adult. Antennule (Fig. 4f), 195 μm long, 10-segmented, but segments 5 and 6 weakly separated. Length of its segments: 29 (60 μm along anterior margin), 13, 5, 15, 12, 11, 13, 15, 21, and 36 μm , respectively. Armature: 8, 4, 2, 4, 2, 2, 2, 2 + 1 aesthetasc, and 12. All setae smooth.

Antenna, oral cone, mandible, maxillule, maxilla, and maxilliped (Fig. 4g) resembling those of adult.

Legs 1-4 (Figs. 4h, 5a-c) with 2-segmented rami. Formula for armature as follows:

P ₁	coxa 0-1	basis 1-I	exp I-1;	II,I,5
			enp 0-1;	1,2,5
P ₂	coxa 0-1	basis 1-0	exp I-1;	II,I,6
			enp 0-1;	1,2,5
P ₃	coxa 0-0	basis 1-0	exp I-1;	III,I,5
			enp 0-1;	1,I,4
P ₄	coxa 0-0	basis 1-0	exp I-0;	III,I,5
			enp 0-1;	I,1

Leg 4 with exopod 104 μm long; endopod (Fig. 5d) with first segment 16 x 14 μm , its inner seta 29 μm ; second segment 23 x 17 μm , its inner seta 26 μm , its terminal spine 52 μm .

Leg 5 (Fig. 4c) similar to that of adult, but outermost seta on second segment relatively shorter.

Leg 6 probably represented by pair of small posterolateral spines on presumptive genital somite.

Color as in adult.

Male: body (Fig. 5e) similar to that of adult. Length 0.60 mm (0.57-0.64 mm) and greatest width 0.27 mm (0.25-0.28 mm), based on 10 specimens. Greatest dorsoventral

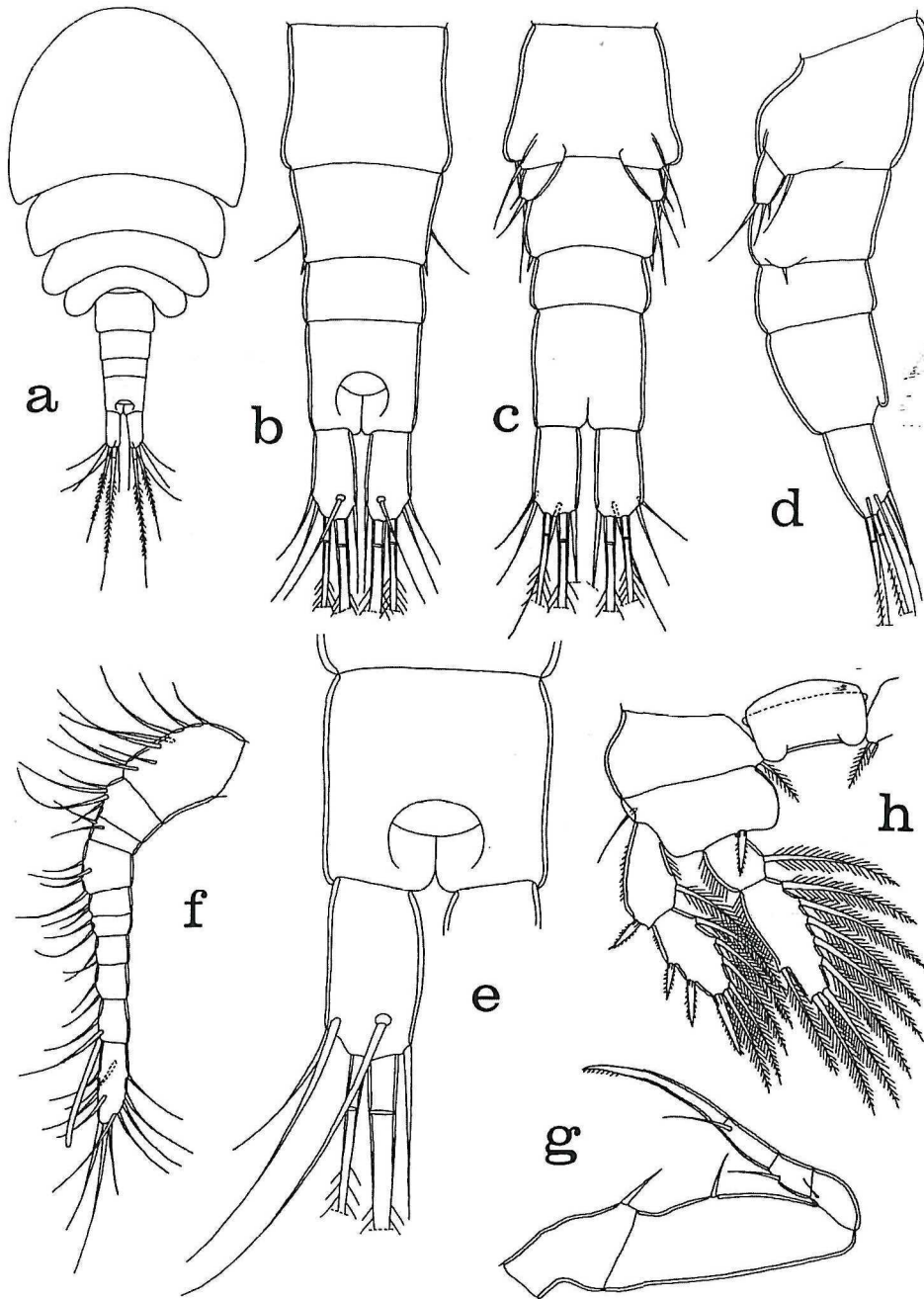


Figure 4. *Aphotopontius temperatus* n. sp. Copepodid V, female: a, body, dorsal (scale A); b, urosome, dorsal (B); c, urosome, ventral (B); d, urosome, lateral (B); e, anal somite and caudal ramus, dorsal (F); f, antennule, posteroventral (B); g, maxilliped, posterior (C); h, leg 1 and intercoxal plate, anterior (B).

Figure 4. *Aphotopontius temperatus* n. sp. Copépodite V, femelle ; a, corps, vue dorsale (échelle A) ; b, urosome, vue dorsale (B) ; c, urosome, vue ventrale (B) ; d, urosome, vue latérale (B) ; e, somite anal et rame caudale, vue dorsale (F) ; f, antennule, vue postéroventrale (B) ; g, maxillipède, vue postérieure (C) ; h, patte 1 et plaque intercoxale, vue antérieure (H).

thickness 0.19 mm. Epimera of somites bearing legs 1-4 pointed as in adult. Ratio of length to width of prosome 1.3:1. Ratio of length of prosome to that of urosome 1.54:1.

Somite bearing leg 5 (Fig. 5f) 44 x 75 μ m. Genital somite 52 x 68 μ m with pair of prominent posterolateral spiniform processes. First postgenital somite with pair of small

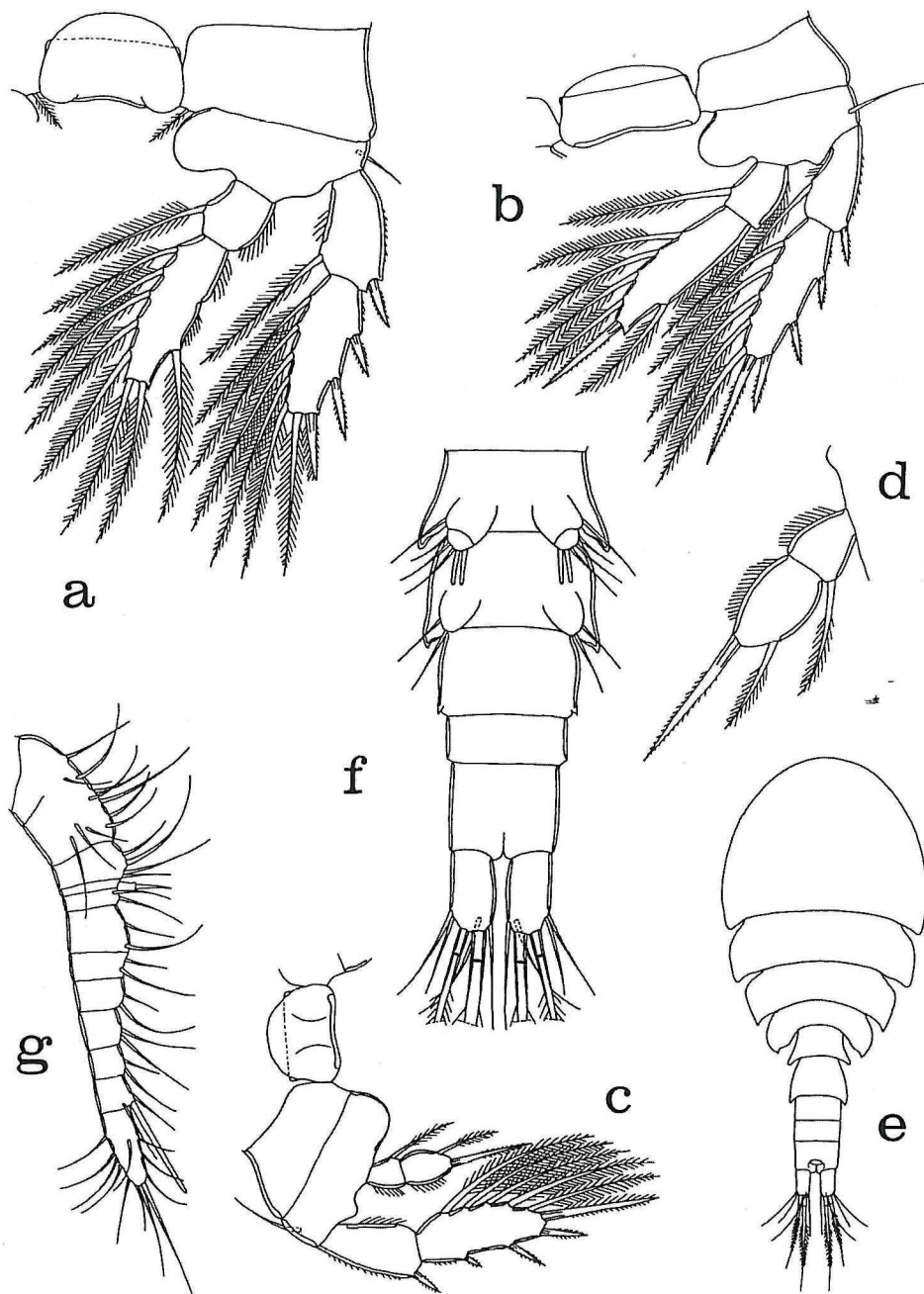


Figure 5. *Aphotopontius temperatus* n. sp. Copepodid V, female: a, leg 2 and intercoxal plate, anterior (scale B); b, leg 3 and intercoxal plate, posterior (B); c, leg 4 and intercoxal plate, anterior (B); d, endopod of leg 4, anterior (F). Copepodid V, male: e, dorsal (A); f, urosome, ventral (B); g, antennule, ventral (B).

Figure 5. *Aphotopontius temperatus* n. sp. Copépodite V, femelle : a, patte 2 et plaque intercoxale, vue antérieure (échelle B) ; b, patte 3 et plaque intercoxale, vue postérieure (B) ; c, patte 4 et plaque intercoxale, vue antérieure ; d, endopodite de la quatrième patte, vue antérieure (F). Copépodite V, mâle : e, corps, vue dorsale (A) ; f, urosome, vue ventrale (B) ; g, antennule, vue ventrale (B).

posterolateral spiniform processes. Three postgenital somites from anterior to posterior 36×57 , 23×52 , and $42 \times 49 \mu\text{m}$.

Caudal ramus (Fig. 5f) $39 \times 20 \mu\text{m}$, ratio 1.95:1, resembling that of female.

Body surface without visible sensilla.

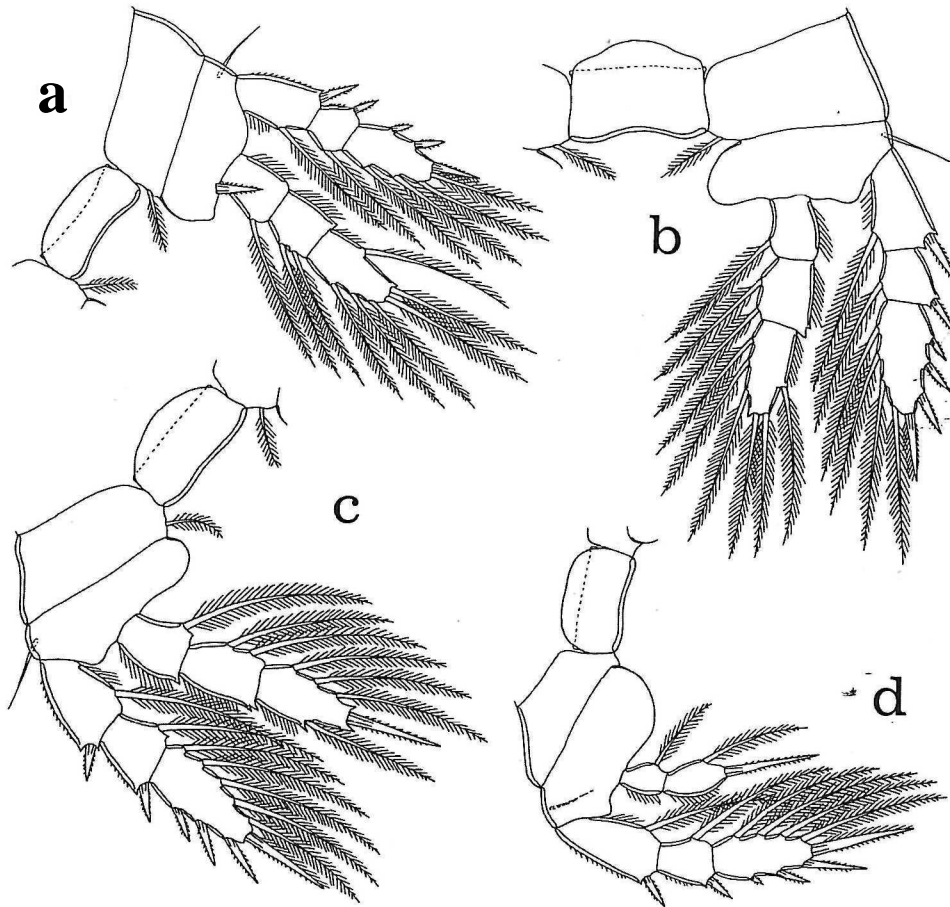


Figure 6. *Aphotopontius temperatus* n. sp. Copepodid V, male: a, leg 1 and intercoxal plate, anterior (scale B); b, leg 2 and intercoxal plate, anterior (B); c, leg 3 and intercoxal plate, anterior (B); d, leg 4 and intercoxal plate, anterior (B).

Figure 6. *Aphotopontius temperatus* n. sp. Copépodite V, mâle : a, patte 1 et plaque intercoxale, vue antérieure (échelle B) ; b, patte 2 et plaque intercoxale, vue antérieure (B) ; c, patte 3 et plaque intercoxale, vue antérieure (B) ; d, patte 4 et plaque intercoxale, vue antérieure (B).

Rostral area like that of adult. Antennule (Fig. 5g) 220 μ m long, 11-segmented, but segments 1 and 2 only partially separated and 5 and 6 weakly separated. Armature: 10, 4, 1, 2, 2, 2, 2, 2, 2 + 1 aesthetasc, and 12. Antenna as in adult.

Oral cone, mandible, maxillula, maxilla, and maxilliped like those in adult.

Legs 1-4 (Fig. 6a-d) with 3-segmented exopods and endopods, except 2-segmented endopod in leg 4. Armature:

P_1	coxa 0-1	basis 1-1	exp 1-1; I-1;	II,I,4
			enp 0-1; 0-2;	1,2,3
P_2	coxa 0-1	basis 1-0	exp I-1; I-1;	III,I,4
			enp 0-1; 0-2;	1,2,3
P_3	coxa 0-1	basis 1-0	exp I-1; I-1;	III,I,5
			enp 0-1; 0-2;	1,1,3
P_4	coxa 0-0	basis 1-0	exp I-1; I-1;	III,I,4
			enp 0-1; I,1	

Leg 5 (Fig. 5f) similar to that of adult.

Leg 6 incomplete flap on genital somite bearing 2 setae as in adult.

Color as in adult.

Remarks: the most notable features of copepodid V, when compared with the adult, are the reduction in the number of postgenital somites to 2 in the female and 3 in the male, the incompletely separated segments in the antennule of both sexes, the 2-segmented rami on legs 1-4 in the female, and the nongeniculate nature of the antennule in the male.

While the specimens described here as copepodid V were obviously not obtained by rearing, they are considered as copepodid V of *Aphotopontius temperatus* on the basis of (1) their similarities in external anatomy to the adults, (2) their occurrence in large numbers along with adults of the new species, and (3) their size range falling just below but not overlapping that of the adult. (A few younger

copepodids were also present in the samples, but are not described here because of their uncertain linkage to *A. temperatus*.

Information on the copepodid stages of siphonostomatoid copepods is scarce. Although developmental stages are known for certain siphonostomatoids living on fishes, for example, *Caligus* (see Kabata, 1972), *Lepeophtheirus* (see Boxshall, 1974), the larval development of those siphonostomatoids associated with hosts other than fishes is very incomplete (Ferrari, 1988). Nothing is known of the copepodid development of the Dirivultidae.

The sexual difference in segmentation of the rami of legs 1-3, such as that seen in the fifth copepodid of *Aphotopontius temperatus*, with the endopod of the female 2-segmented but that of the male 3-segmented, is remarkable. A sexual difference in segmentation occurs in the fifth copepodid of the notodelphyid copepod *Pygodelphys aquilonaris* Illg, where the endopod of leg 4 is 2-segmented but in the male 3-segmented (Dudley, 1966, fig. 28h, j). However, in certain poecilostomatoid copepods where the fifth copepodid is known, for example, *Lichomolgus canui* G. O. Sars, in Costanzo (1968); *Leptinogaster major* (Williams), in Humes (1986); and *Pseudanthessius gracilis* Claus, in Costanzo *et al.* (1996), the endopod is 3-segmented in both sexes.

Aphotopontius atlanteus Humes, 1996

Material studied: 2391 ♀♀, 1 ♂, from Jason mussel samples (from Sintra 1-6: 902 ♀♀; 1 ♂, from Eiffel Tower 1-5: 1489 ♀♀), Lucky Strike, 37°17'N, 32°16'W, west of the Azores, depth 1688 m, 28 and 30 July 1996. Cindy Van Dover collector. Specimens have been deposited in the National Museum of Natural History (USNM 285472), Smithsonian Institution, Washington, D. C.

The type specimens of this species were obtained at 37°20'N, 32°17'W in 1636 m (Humes, 1996).

Identification of the three species of *Aphotopontius* known from the Mid-Atlantic Ridge. Identification of copepods of the genus *Aphotopontius* involves a detailed study of the external body parts, as in the description of *A. temperatus*, above. However, in some cases, a few easily observed features will provide preliminary determination. Females of the three species from the Mid-Atlantic Ridge may be recognized as follows: *A. atlanteus* by its moderately large size (length 0.98 mm, range 0.88-1.08 mm) and by its genital double-somite being expanded in the anterior half with rounded margins; *A. forcipatus* its genital double-somite having rounded margins and by its elongate caudal ramus with a ratio of 5.64:1; and *A. temperatus* by its subrectangular genital double-somite with slight anterior expansions. Members of *Aphotopontius* may be distinguished from two other genera found on the

Table 1. Siphonostomatoid copepods at hydrothermal vent sites on the Mid-Atlantic Ridge.

Tableau 1. Copépodes siphonostomatoides des sites hydrothermaux de la Ride Médio-Atlantique.

23°22.160'N, 44°57.072'W in 3620-3650 m	26°08.8'N, 44°49.6'W in 3522 m	23°23'N, 44°56'W in 3400-3520 m	37°17-20'W, 32°16-17'W in 1636-1688 m
<i>Stygiopontius pectinatus</i> Humes, 1987	<i>Stygiopontius pectinatus</i> Humes, 1987	<i>Rimipontius mediospinifer</i> Humes, 1996	<i>Aphotopontius atlanteus</i> Humes, 1996
		<i>Stygiopontius bulbisetiger</i> Humes, 1996	
		<i>Stygiopontius cladarus</i> Humes, 1996	
		<i>Stygiopontius forcipatus</i> Humes, 1987	
		(see Humes, 1996)	
		<i>Stygiopontius latulus</i> Humes, 1996	
		<i>Stygiopontius mirus</i> Humes, 1996	
		<i>Stygiopontius pectinatus</i> Humes, 1987	
		<i>Stygiopontius regius</i> Humes, 1996	
		<i>Stygiopontius serratus</i> Humes, 1996	
		<i>Stygiopontius teres</i> Humes, 1996	

Mid-Atlantic Ridge by examining the formula for the endopod of leg 4, which is 0-0; I in *Rimipontius* Humes, 1996, and 0-0; I,1 in *Stygiopontius* Humes, 1987.

Thirteen siphonostomatoid copepods occur at hydrothermal sites on the Mid-Atlantic Ridge (Table 1). Ten species live at 23° and 26°N in depths of 3490-3650 m. The remaining three species are found at 37°N in depths of 1635-1688 m. Van Dover *et al.* (1996) considered the Lucky Strike fauna, at 37° in a depth of approximately 1636 m, to be a biogeographic hydrothermal province, with a characteristic hydrothermal community. However, explanations for the distribution of the siphonostomatoid copepods known from the Mid-Atlantic Ridge, and for whether a barrier truly exists between 23°-26°N and 37°, remain unknown.

Stygiopontius Humes, 1987

Stygiopontius rimivagus, new species
(Figs. 7-9)

Type material: 7 ♂♂ from Jason mussel samples (Sintra 2), Lucky Strike, 37°17'N, 32°16'W, west of the Azores (location shown on map in Van Dover *et al.*, 1996), 1688 m, 28 July 1996. Cindy Lee Van Dover collector. Holotype (USNM 285473) and 4 paratypes (USNM 285474) deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C. Remaining paratypes (dissected) in the collection of the author.

Male: body (Fig. 7a) with prosome moderately broadened, rostral region denoted by pair of slight indentations in contour. Length 0.79 mm (0.72-0.87 mm) and greatest width 0.43 mm (0.42-0.45 mm), based on 7 specimens. Greatest dorsoventral thickness 0.28 mm. Somite bearing leg 1 fused with cephalosome. Epimera of somites bearing legs 3 and 4 pointed posteriorly (Fig. 7b). Ratio of length to width of prosome 1.28:1. Ratio of length of prosome to that of urosome 1.54:1.

Somite bearing leg 5 (Fig. 7c) 52 x 125 µm. Genital somite in dorsal view 68 x 127 µm, wider than long with gently rounded lateral margins. Four postgenital somites from anterior to posterior 52 x 101, 52 x 94, 34 x 83, and 34 x 83 µm.

Caudal ramus (Fig. 7d) 47 x 34 µm, slightly longer than wide, ratio 1.38:1. Outer lateral seta 52 µm, dorsal seta 50 µm, and outermost terminal seta 52 µm, all smooth. Innermost terminal seta 156 µm, and 2 median terminal setae 242 (outer) and 418 µm (inner), all with lateral setules (innermost seta with setules on medial side only).

Body surface with few sensilla (Fig. 7a, c).

Rostral area (Fig. 7e) not developed. Antennule (Fig. 7f) 210 µm long in geniculate condition as in figure. Approximate lengths of its 12 segments: 39, 10, 31, 15, 13, 13, 34, 23, 26, 50, 42, and 18 µm, respectively. All setae smooth, except modified stout sclerotized element on

segment 5 with subterminal setule and tip with minute knobs (Fig. 7g). Antenna (Fig. 8a) with short smooth coxa, elongated basis with inner and outer marginal setules. Exopod 1-segmented, 8 x 5 µm, bearing 3 setae, middle seta very long. Endopod 2-segmented, first segment unarmed, second segment with 1 inner marginal seta (few minute setules near base), 1 subterminal outer seta 18 µm (few minute setules near base), and 2 long terminal finely barbed setae 78 µm and 39 µm.

Oral cone short resembling that of *Stygiopontius cladarus* Humes, 1996. Mandible (Fig. 8b) slender blade 100 µm long with few minute subterminal teeth. Maxillule (Fig. 8c) and maxilla (Fig. 8d) as illustrated. Maxilliped (Fig. 8e) similar to that of *S. cladarus*, but second segment with few outer marginal setules.

Ventral area between maxillipeds and first pair of legs resembling that in *S. cladarus*.

Legs 1-4 (Figs. 8f-h, 9a) segmented and armed as in congeners. Formula for armature as follows:

P ₁	coxa 0-1	basis 1-1	exp I-1; I-1;	II,I,4
			enp 0-1; 0-2;	1,2,3
P ₂	coxa 0-0	basis 1-0	exp I-1; I-1;	III,I,4
			enp 0-1; 0-2;	I,II,I,2
P ₃	coxa 0-0	basis 1-0	exp I-1; I-1;	III,I,5
			enp 0-1; 0-2;	1,I,3
P ₄	coxa 0-0	basis 1-0	exp I-1; I-1;	II,I,4
			enp 0-0; I,1	

Leg 1 (Fig. 8f) with coxa having inner plumose seta and basis bearing inner setiform spine 27 µm. Third segment of endopod of leg 2 (Fig. 8g) with 4 stout finely barbed spines and 2 plumose setae. Endopod of leg 4 (Fig. 9b) with small unarmed first segment 16 x 13 µm. Elongate second segment 47 x 15.5 µm, bearing terminal barbed spine 60 µm and subterminal plumose seta 90 µm.

Leg 5 (Fig. 9c-e) located ventrally, with free segment oval, 17 x 13 µm, bearing 3 setae 52, 23, and 44 µm; seta on body adjacent to free segment 60 µm, with swollen base. All setae smooth.

Leg 6 (Fig. 9c) posteroventral flap on genital somite bearing 2 smooth setae 65 µm and 47 µm.

Spermatophore seen only inside genital somite, as in Figs. 7a, c, 9e.

Color uncertain but presumably red as in *Aphotopontius temperatus*, above.

Female unknown.

Etymology: the name *rimivagus* is a combination of the Latin words *rima*, meaning a fissure or cleft, and *vagus*, wandering, alluding to the habitat near vents.

Remarks: at present the genus *Stygiopontius* contains 22 species, including the new species described here. In 10 species only females are known. *Stygiopontius rimivagus* can be compared with 11 congeners in which males are known. Seven of these species differ from the new species

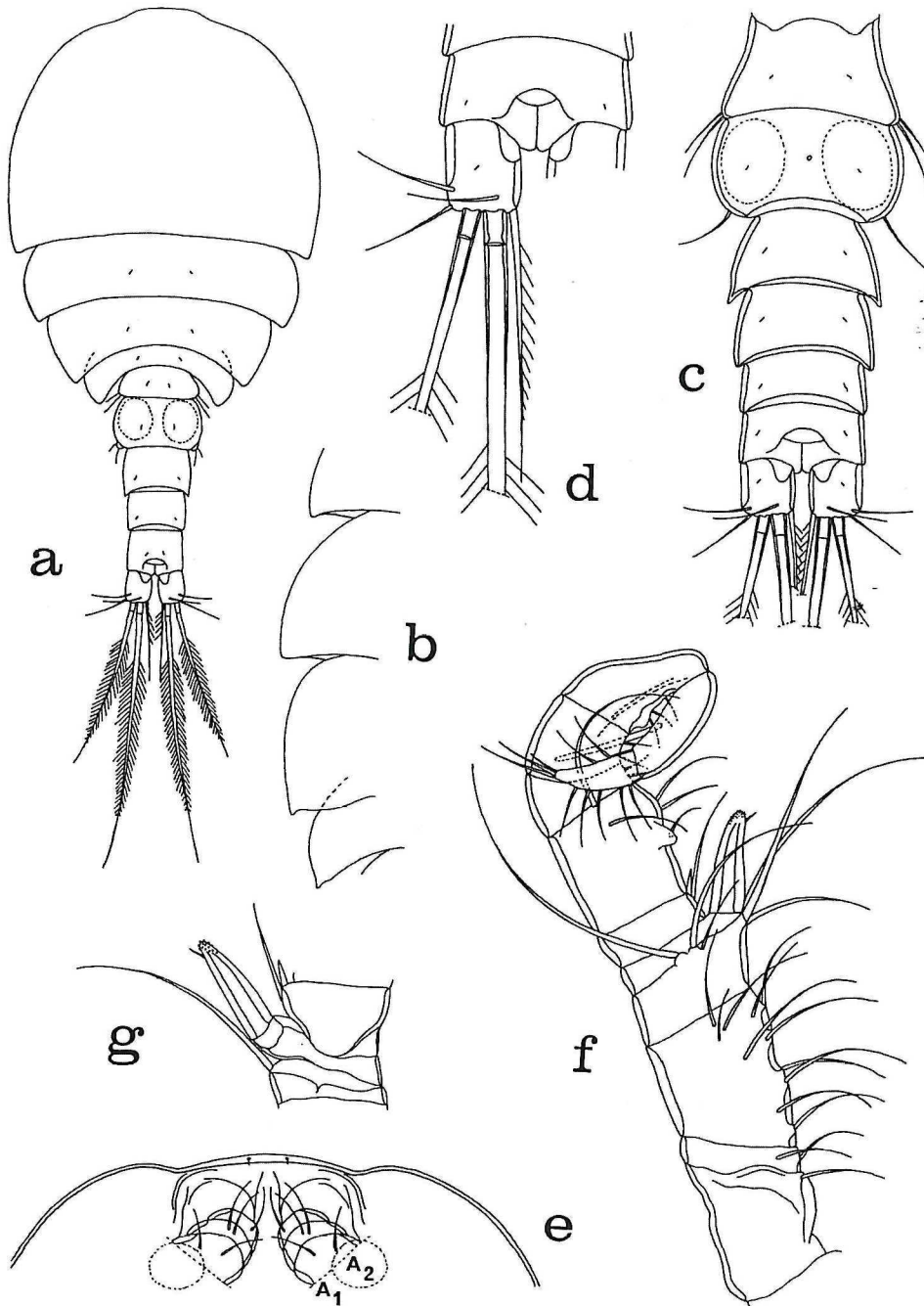


Figure 7. *Stygiopontius rimivagus* n. sp. Male: a, body, dorsal (scale A); b, outline of epimera of metasomal somites, dorsal (B); c, urosome, dorsal (B); d, anal somite and caudal ramus, dorsal (B); e, rostral area, ventral (E); f, antennule, anterodorsal (C); g, segment 5 of antennule, posteroventral (F).

Figure 7. *Stygiopontius rimivagus* n. sp. Mâle : a, corps, vue dorsale (échelle A) ; b, contour des epimères des somites métasomaux, vue dorsale (B) ; c, urosome, vue dorsale (B) ; d, somite anal et rame caudale, vue dorsale (B) ; e, région du rostre, vue ventrale (E) ; f, antennule, vue antérodorsale (C) ; g, cinquième segment de l'antennule, vue postéroventrale (F).

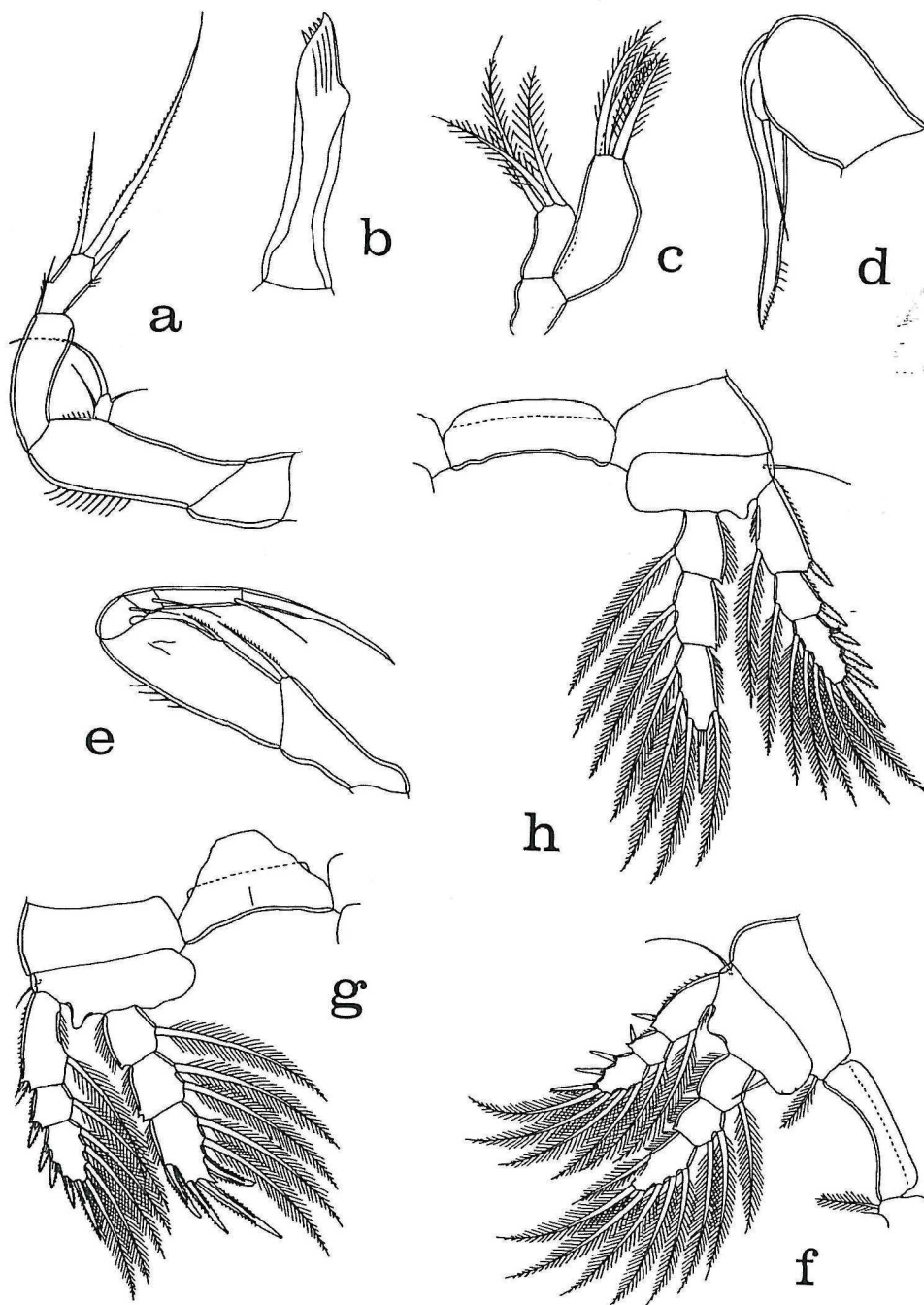


Figure 8. *Stygiopontius rimivagus* n. sp. Male: a, antenna, postero-outer (scale C); b, mandible, flat view (C); c, maxillule, posterior (C); d, maxilla, posterior (C); e, maxilliped, posterior (B); f, leg 1 and intercoxal plate, anterior (C); g, leg 2 and intercoxal plate, anterior (E); h, leg 3 and intercoxal plate, anterior (E).

Figure 8. *Stygiopontius rimivagus* n. sp. Mâle : a, antenne, vue postérieure externe (échelle C) ; b, mandibule, vue à plat (C) ; c, maxillule, vue postérieure (C) ; d, maxilla, vue postérieure ; e, maxillipède, vue postérieure (B) ; f, patte 1 et plaque intercoxale, vue antérieure (C) ; g, patte 2 et plaque intercoxale, vue antérieure (E) ; h, patte 3 et plaque intercoxale, vue antérieure (E).

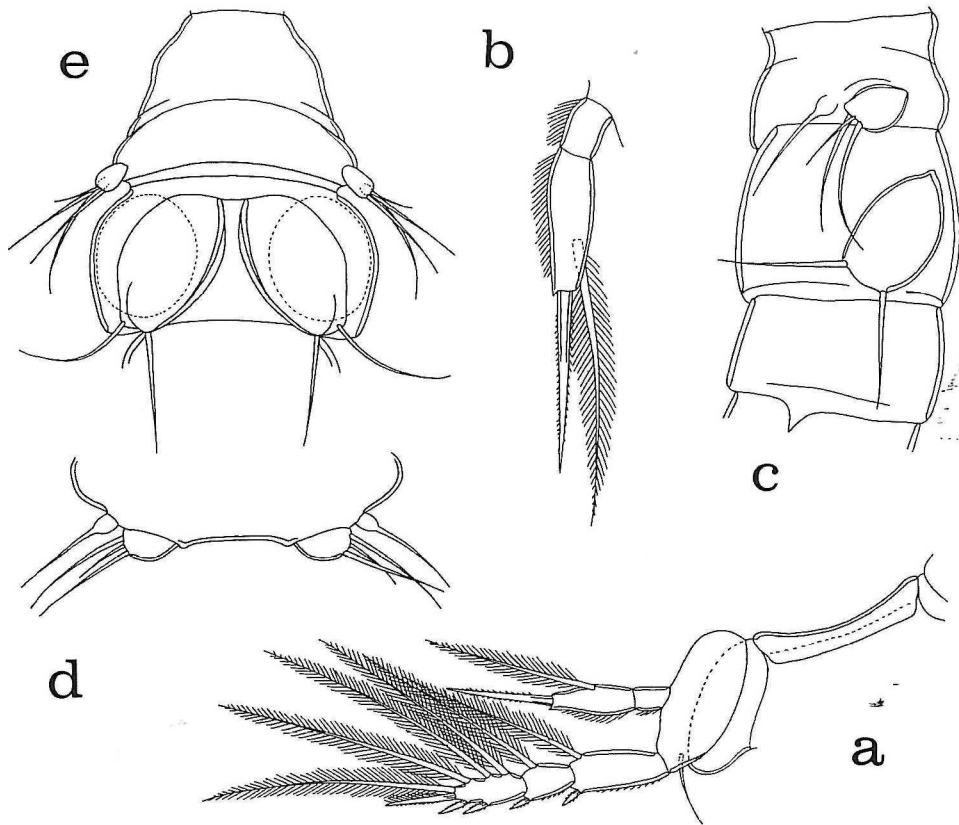


Figure 9. *Stygiopontius rimivagus* n. sp. Male: a, leg 4 and intercoxal plate, anterior (scale E); b, endopod of leg 4, posterior (C); c, somite bearing leg 5, genital somite, and first postgenital somite, showing legs 5 and 6, lateral (B); d, fifth pair of legs, posterior, in dissection (B); e, somite bearing leg 5 and genital somite, ventral (B).

Figure 9. *Stygiopontius rimivagus* n. sp. Mâle : a, patte 4 et plaque intercoxale, vue antérieure (échelle E) ; b, endopodite de la quatrième patte, vue postérieure (C) ; c, somite portant la cinquième patte, somite génital, et premier somite postgénital, montrant pattes 5 et 6, vue latérale (B) ; d, cinquième paire de pattes, vue postérieure dans une dissection (B) ; e, somite portant la cinquième patte et le somite génital, vue ventrale (B).

in having the free segment of leg 5 armed with five elements (instead of three as in *S. rimivagus*): *S. appositus*, *S. cladarus*, *S. paxillifer*, *S. quadrispinosus*, *S. regius*, *S. serratus*, and *S. verruculatus*. Of the remaining four species, two may be distinguished from the new species by the formula for the third segment of the endopod of leg 2, with *S. brevispina* having 1,II,3 and *S. lauensis* having 1,III,2. The other two species, *S. mirus* and *S. latulus*, have the formula IV,2, as in the new species, but the four spines are very unequal in length, with one being much longer than the others.

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