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OSTRINCOLA AND *PSEUDOMYICOLA* (CRUSTACEA: COPEPODA: POECILOSTOMATOIDA) ASSOCIATED WITH MARINE BIVALVE MOLLUSKS ON THE PACIFIC COAST OF PANAMA

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Abstract.—Two myicolid copepods occur in the mantle cavity of Bivalvia on the Pacific coast of Panama. *Ostrincola falcatus,* new species, is described from *Protothaca asperrima, Mytella guyanensis,* and *Anadara obesa.* The species is distinguished by the falciform seta on the third segment of the maxilliped of the male. A key to the species of *Ostrincola* is given. The widespread *Pseudomyicola spinosus* is recorded from a new host, *Anadara obesa.*

The genus *Ostrincola* Wilson, 1944, contains several species, all of which live in the mantle cavity of bivalve mollusks in intertidal or shallow-water areas of tropical and subtemperate regions. More than 20 species of bivalves serve as hosts.

Pseudomyicola spinosus (Raffaele and Monticelli, 1885) is known from the Mediterranean, the North and South Atlantic, and the Indo-Pacific, where it is associated with numerous bivalve hosts (Humes 1968).

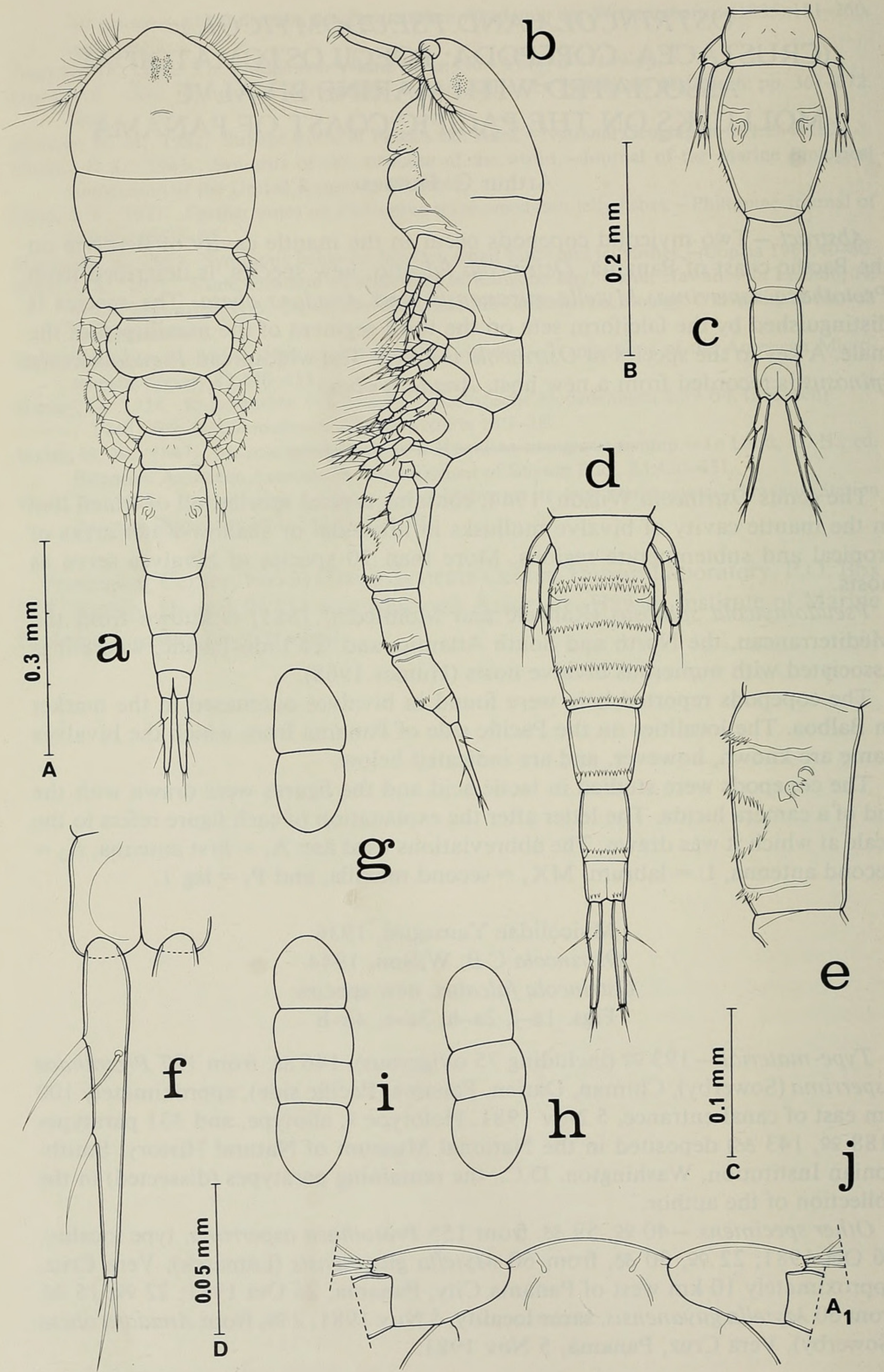
The copepods reported here were found in bivalves purchased in the market in Balboa. The localities on the Pacific side of Panama from which the bivalves came are known, however, and are indicated below.

The copepods were studied in lactic acid and the figures were drawn with the aid of a camera lucida. The letter after the explanation of each figure refers to the scale at which it was drawn. The abbreviations used are: A_1 = first antenna, A_2 = second antenna, L = labrum, MX_2 = second maxilla, and P_1 = leg 1.

Myicolidae Yamaguti, 1936
Ostrincola C.B. Wilson, 1944
Ostrincola falcatus, new species
Figs. 1a–j, 2a–h, 3a–e, 4a–h

Type-material.—193 ♀♀ (including 75 ovigerous), 146 ♂♂, from 127 *Protothaca asperrima* (Sowerby), Chiman, Darien, Panama (Pacific side), approximately 100 km east of canal entrance, 5 Nov 1981. Holotype ♀, allotype, and 331 paratypes (188 ♀♀, 143 ♂♂) deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C.; the remaining paratypes (dissected) in the collection of the author.

Other specimens.—40 ♀♀, 59 ♂♂, from 155 *Protothaca asperrima,* type locality, 26 Oct 1981; 22 ♀♀, 30 ♂♂, from 60 *Mytella guyanensis* (Lamarck), Vera Cruz, approximately 10 km west of Panama City, Panama, 26 Oct 1981; 22 ♀♀, 15 ♂♂, from 60 *Mytella guyanensis,* same locality, 5 Nov 1981; 2 ♀♀, from *Anadara obesa* (Sowerby), Vera Cruz, Panama, 5 Nov 1981.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Female.—Body (Fig. 1a, b) elongate, widest in cephalosome. Length (not including setae on caudal rami) 0.99 mm (0.91–1.11 mm) and greatest width 0.26 mm (0.24–0.29 mm), based on 10 specimens from *Protothaca* in lactic acid. Ratio of length to width of prosome 2.2:1. Ratio of length of prosome to that of urosome 1.21:1. Segment of leg 1 weakly separated dorsally from cephalosome. Epimera of segments bearing second and third legs broadly rounded and projecting slightly in dorsal view. Small median sclerotized bar dorsally on head behind eye. Segment of leg 5 (Fig. 1c) 44 × 86 μm. Genital segment elongate, 140 × 96 μm, with slightly expanded lateral margins. Genital areas located dorsally just anterior to middle of segment and bearing 2 minute setae about 3 μm long (Fig. 1c, e). Dorsal surface of genital segment smooth, but ventral surface ornamented with anterior and posterior transverse rows of spines joining laterally (Fig. 1d, e), thus forming circlet. Three postgenital segments from anterior to posterior 68 × 65, 65 × 52, and 38 × 42 μm, each segment ventrally with posterior transverse row of spines.

Caudal ramus (Fig. 1f) elongate, 94 μm long, 14 μm wide proximally, 10 μm wide medially, and 4.5 μm wide distally. Ratio of length to greatest width 6.7:1. Armature consisting of proximal outer seta 34μm, distal outer seta 33 μm, dorsal seta 14 μm, and 3 terminal setae from outer to inner 11, 33, and 14 μm. All setae smooth.

Body surface unornamented except for 4 minute hairs (setules ?) on dorsal surface of segment bearing fifth legs.

Egg sac (in females from *Protothaca*) with seriate eggs, 2 eggs in sac measuring 218 × 96 μm (Fig. 1g), 3 eggs in sac 286 × 110 μm (Fig. 1h), and 4 eggs in sac 330 × 110 μm (Fig. 1i). Most females with 3 eggs in each sac.

Rostrum (Fig. 1j) broad and not well defined.

First antenna (Fig. 2a) 151 μm long, 7-segmented. Lengths of segments (measured along posterior margin): 16.5 (45 μm along anterior margin), 22, 11, 14, 26, 17, and 20 μm, respectively. Formula for armature: 4, 14, 5, 3, 4 + 1 aesthete, 2 + 1 aesthete, and 7 + 1 aesthete. All setae smooth.

Second antenna (Fig. 2b) 160 μm long, 3-segmented. First segment with diagonal row of spinules. Small second segment with minute seta. Elongate third segment slightly recurved, 96 × 16 μm, ratio 6:1, bearing 1 minute seta near middle of concave edge, 3 small subterminal setae, and terminal claw 37 μm. Segment ornamented along proximal half of convex side with small spinules.

Labrum (Fig. 2c) with 2 hyaline posteroventral lobes and bearing prominent spines on outer lateral angles. Mandible (Fig. 2d) with 4 elements. Convex side having small process followed by unilaterally haired seta. Another longer unilaterally haired seta nearby on dorsal surface. Distally mandible extended as long setiform element haired along one side and having bilaterally haired seta near its base. Paragnath not seen. First maxilla (Fig. 2e) with 4 setae. Second maxilla (Fig. 2f) 2-segmented. First segment large, ornamented with 3 groups of spinules. Second segment small, with minute proximal seta, smooth subterminal seta, and 2 unequal unilaterally haired terminal setae.

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Fig. 1. *Ostrincola falcatus,* new species, female. a, Dorsal (scale A); b, Lateral (A); c, Urosome, dorsal (B); d, Urosome, ventral (B); e, Genital segment, lateral (C); f, Caudal ramus, dorsal (D); g, Egg sac, dorsal (A); h, Egg sac, dorsal (A); i, Egg sac, dorsal (A); j, Rostral area, ventral (D).

Maxillipeds absent. Arrangement of appendages of cephalosome as in Fig. 2g. Legs 1–4 (Figs. 2h, 3b, c, d) with 3-segmented rami. Armature as follows (Roman numerals indicating spines, Arabic numerals representing setae):

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

Coxa in all 4 legs with finely barbed inner spine. Basis in leg 1 with stout barbed spine and adjacent outer row of spinules, but in legs 2–4 this area without spine or spinules. Contour of margin of basis medial to endopod slightly indented in legs 3 and 4. Outer margins of segments of both rami bearing rows of spines, spines on endopods more prominent than those on exopods. Row of hairs in addition to spines on segments of endopods. In one female third segment of right exopod of leg 1 with IV, 3 (Fig. 3a), but left exopod with usual IV, 4.

Leg 5 (Fig. 3e) 2-segmented. First segment 28 × 23 μm, bearing 1 dorsal seta and ornamented with 3 small spines. Second segment broad, 65 × 39 μm, ratio 1.67:1, bearing 2 smooth setae and 2 finely barbed spines, lengths of these elements from dorsal to ventral 54, 20, 22, and 43 μm. This segment ornamented only with few small spinules distally on ventral edge.

Leg 6 represented by 2 minute setae on genital area (Fig. 1e).

Color in living specimens in transmitted light opaque gray, eye dark blue, egg sacs dark gray.

Male.—Body (Fig. 4a, b) resembling that of female. Length (excluding setae on caudal rami) 0.86 mm (0.83–0.89 mm) and greatest width 0.21 mm (0.19–0.22 mm), based on 10 specimens from *Protothaca* in lactic acid. Ratio of length to width of prosome 2.2:1. Ratio of length of prosome to that of urosome 1.08:1.

Segment of leg 5 21 × 75 μm (Fig. 4c). Genital segment 120 × 96 μm, smooth dorsally but ventrally with band of spines in anterior half and row of spines on

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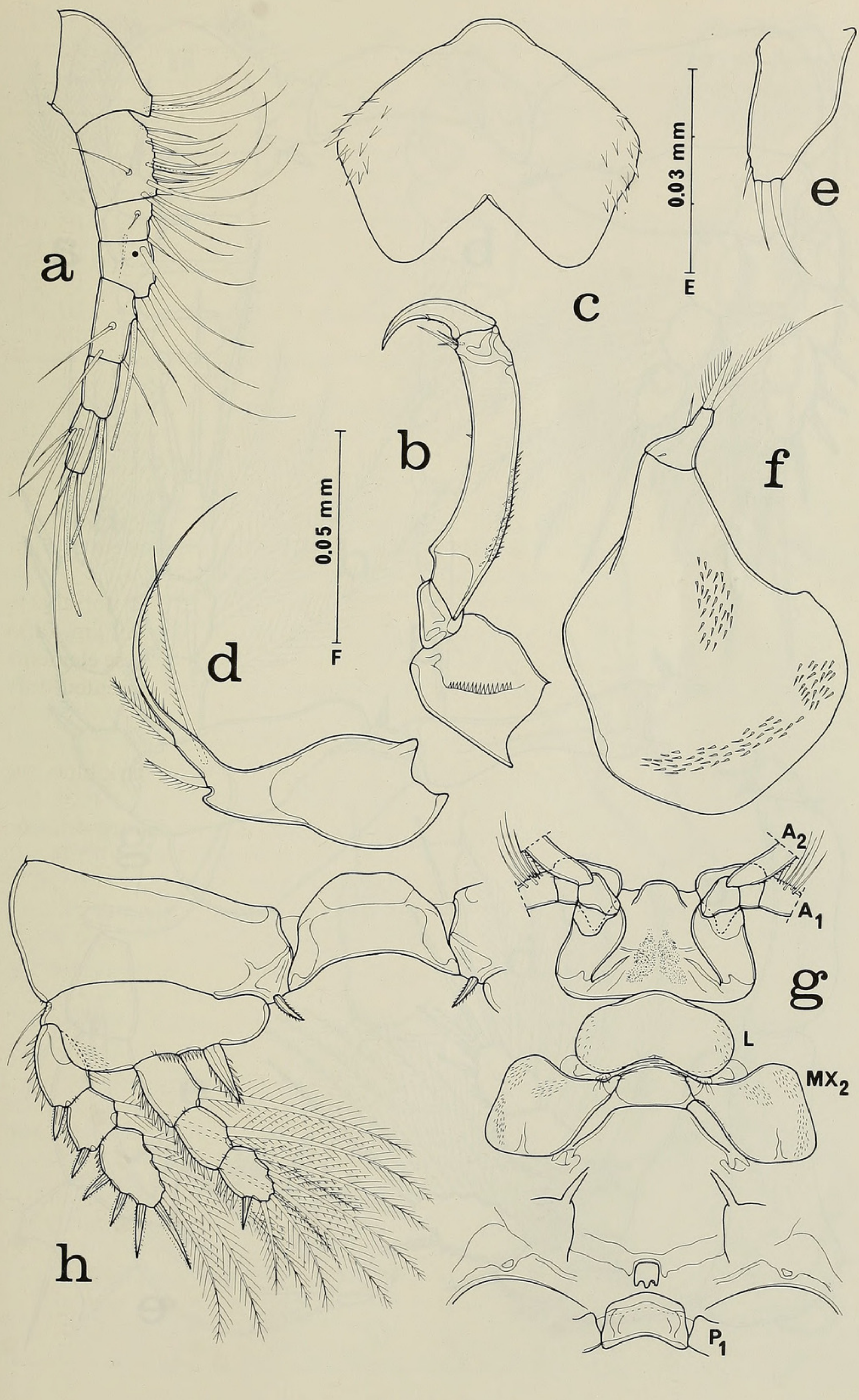
Fig. 2. *Ostrincola falcatus,* new species, female. a, First antenna, ventral (scale D); b, Second antenna, antero-outer (D); c, Labrum, ventral (D); d, Mandible, ventral (E); e, First maxilla, ventral (E); f, Second maxilla, ventral (F); g, Midregion of cephalosome showing arrangement of appendages, ventral (C); h, Leg 1 and intercoxal plate, anterior (D).

Fig. 3. *Ostrincola falcatus,* new species, female. A, Abnormal third segment of left exopod of leg 1, anterior (scale D); b, Leg 2 and intercoxal plate, anterior (D); c, Leg 3 and intercoxal plate, anterior (D); d, Leg 4 and intercoxal plate, anterior (D); e, Leg 5, lateral (D).

Fig. 4. *Ostrincola falcatus,* new species, male. a, Dorsal (scale A); b, Lateral (A); c, Urosome, ventral (C); d, Genital segment, lateral (A); e, Maxilliped, anterior (F); f, Maxilliped, posterior (F); g, Seta on third segment of maxilliped, posterior (E); h, Leg 5, lateral (F).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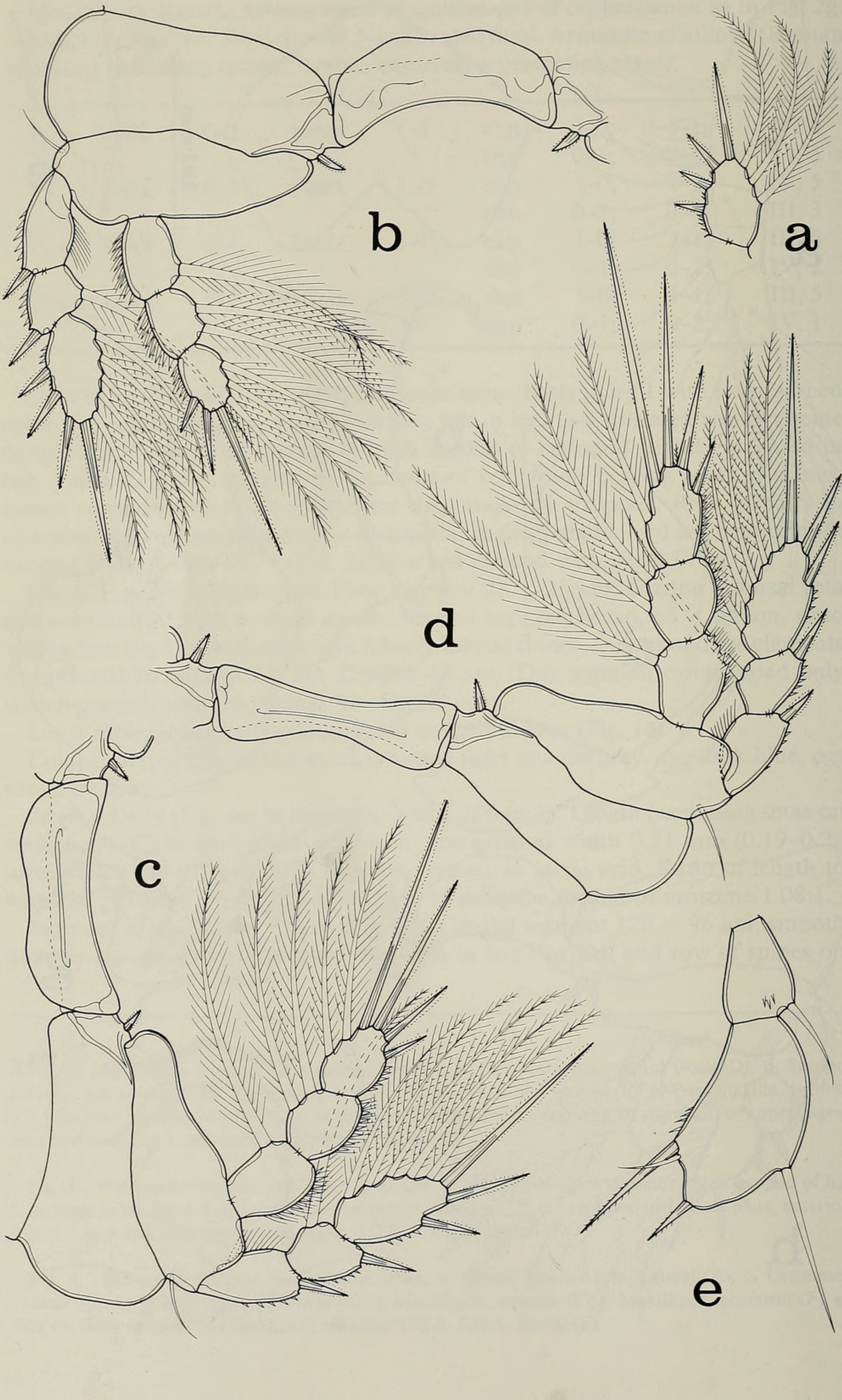
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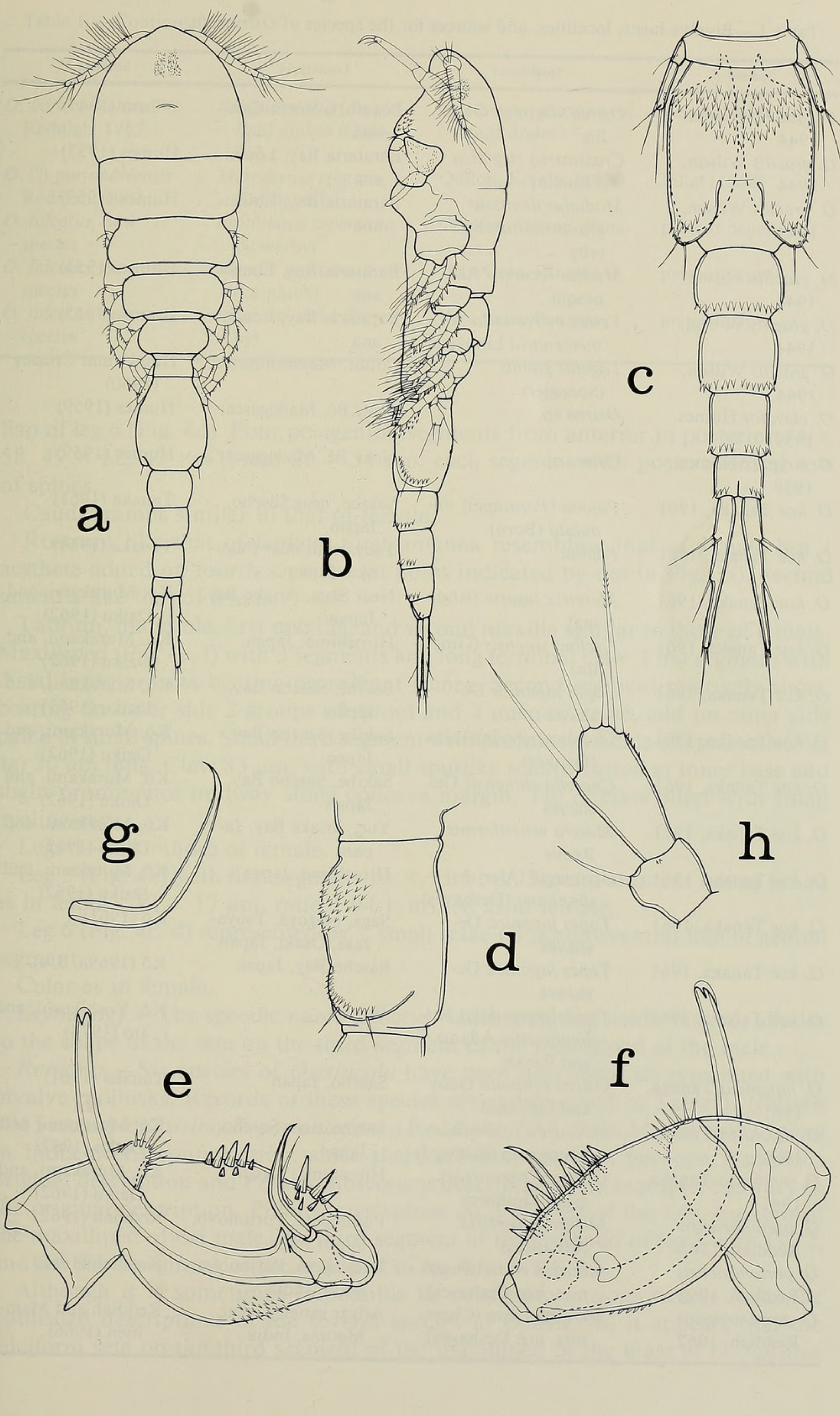
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Table 1.—Bivalve hosts, localities, and sources for the species of *Ostrincola*.

Species	Host	Locality	Source
O. gracilis Wilson, 1944	*Ostrea virginica* Gmelin	Beaufort, North Carolina	Wilson (1944)
O. gracilis Wilson, 1944	*Crassostrea virginica* (Gmelin)	Barataria Bay, Louisiana	Humes (1953)
O. gracilis Wilson, 1944	*Modiolus demissus granosissimus* Sowerby	Barataria Bay, Louisiana	Humes (1953)
O. gracilis Wilson, 1944	*Mytilus recurvus* Rafinesque	Barataria Bay, Louisiana	Humes (1953)
O. gracilis Wilson, 1944	*Venus mercenaria mercenaria* Linnaeus	Barataria Bay, Louisiana	Humes (1953)
O. gracilis Wilson, 1944	*Tagelus gibbus* (Spengler)	Cotuit, Massachusetts	Humes and Cressey (1960)
O. clavator Humes, 1959	*Ostrea* sp.	Nosy Bé, Madagascar	Humes (1959)
O. simplex Humes, 1959	*Ostrea* sp.	Nosy Bé, Madagascar	Humes (1959)
O. koe Tanaka, 1961	*Paphia* (*Paratapes*) *undulata* (Born)	Sakibe, near Sasebo, Japan	Tanaka (1961)
O. koe Tanaka, 1961	*Paphia*	Tsuyazaki, near Fukuoka, Japan	Tanaka (1961)
O. koe Tanaka, 1961	*Meretrix lusoria* (Röding)	Near Saga, Ariake Bay, Japan	Kô, Murakami, and Daiku (1962)
O. koe Tanaka, 1961	*Cyclina sinensis* (Gmelin)	Hiroshima, Japan	Kô, Murakami, and Daiku (1962)
O. koe Tanaka, 1961	*Tapes japonica* Deshayes	Sakibe, Sasebo Bay, Japan	Kô, Murakami, and Daiku (1962)
O. koe Tanaka, 1961	Claudiconcha japonica (Dunker)	Sakibe, Sasebo Bay, Japan	Kô, Murakami, and Daiku (1962)
O. koe Tanaka, 1961	*Caecella chinensis* Deshayes	Sakibe, Sasebo Bay, Japan	Kô, Murakami, and Daiku (1962)
O. koe Tanaka, 1961	*Mactra veneriformis* Reeve	Yue, Ariake Bay, Japan	Kô, Murakami, and Daiku (1962)
O. koe Tanaka, 1961	*Arcopagia* (*Merisca*) *diaphana* (Deshayes)	Hiroshima, Japan	Kô, Murakami, and Daiku (1962)
O. koe Tanaka, 1961	*Tapes japonica* Deshayes	Saga, Nagoya, Tsuyazaki, Ôsaki, Japan	Kô (1961)
O. koe Tanaka, 1961	*Tapes japonica* Deshayes	Sasebo Bay, Japan	Kô (1969a, b, c)
O. koe Tanaka, 1961	*Tapes* (*Amygdala*) *philippinarum* Adams and Reeve	Japan	Kô, Yoshikoshi, and Ito (1974)
O. japonicus Tanaka, 1961	*Ostrea echinata* Quoy and Gaimard	Sasebo, Japan	Tanaka (1961)
O. japonicus Tanaka, 1961	*Saxostrea echinata* (Quoy and Gaimard)	Sakibe, near Sasebo, Japan	Kô, Murakami, and Daiku (1962)
O. japonicus Tanaka, 1961	*Ostrea* (*Crassostrea*) *gigas* Thunberg	Hiroshima, Japan	Kô, Murakami, and Daiku (1962)
O. portonoviensis Reddiah, 1962	*Meretrix meretrix* (Linnaeus)	Puddupeta, Portonovo, South India	Reddiah (1962)
O. portonoviensis Reddiah, 1962	*Meretrix casta* (Chemnitz, nec Deshayes)	Puddapeta, Portonovo, South India	Reddiah (1962)
O. portonoviensis Reddiah, 1962	*Meretrix casta* (Chemnitz, nec Deshayes)	Adyar estuary, near Madras, India	Reddiah and Mammen (1966)

Table 1.—(Continued).

Species	Host	Locality	Source
O. portonoviensis Reddiah, 1962	*Sanguinolaria* (*Soletellina*) *diphos* (Gmelin)	Puddupeta, Portonovo, South India	Reddiah (1962)
O. (?) *portonoviensis* Reddiah, 1962	*Mesodesma trigona* (Deshayes)	Quilon, Kerala, India	Pillai (1968)
O. falcatus, new species	*Protothaca asperrima* (Sowerby)	Chiman, Darien, Panama	present paper
O. falcatus, new species	*Mytella guyanensis* (Lamarck)	Vera Cruz, Panama	present paper
O. falcatus, new species	*Anadara obesa* (Sowerby)	Vera Cruz, Panama	present paper

flap of leg 6 (Fig. 4d). Four postgenital segments from anterior to posterior 44 × 58, 49 × 52, 42 × 41, and 26 × 35 μm, each segment with posteroventral row of spines.

Caudal ramus similar to that of female.

Rostrum like that of female. First antenna resembling that of female but 1 aesthete added on fourth segment (at point indicated by dot in Fig. 2a). Second antenna like that of female.

Labrum, mandible, first maxilla, and second maxilla similar to those of female. Maxilliped (Fig. 4e, f) with 3 segments and long terminal claw. First segment with distal inner process bearing prominent spines. Second segment relatively short, bearing on inner side 2 groups of spines and 2 unequal setae, and on outer side patch of small spines. Small third segment with prominent sickle-shaped seta (Fig. 4g) 30 μm long. Claw 83 μm, with small spurlike sclerotization at inner base and slight prominence midway along concave margin. Tip of claw blunt with small hyaline cap.

Legs 1–4 like those of female.

Leg 5 (Fig. 4h) with first segment 13 × 15.5 μm. Second segment not as broad as in female, 33 × 17 μm, ratio 1.94:1, armed as in female.

Leg 6 (Fig. 4c, d) represented by 2 small setae on posteroventral flap of genital segment.

Color as in female.

Etymology.—The specific name *falcatus,* Latin meaning sickle-shaped, alludes to the shape of the seta on the third segment of the maxilliped of the male.

Remarks.—Six species of *Ostrincola* have been described, all associated with bivalve mollusks. Records of these species are summarized in Table 1. (Pillai's 1963 record of *Ostrincola portonoviensis* Reddiah, 1962, from *Mesodesma trigona* in India needs confirmation, since there are discrepancies between Reddiah's original description and Pillai's subsequent description. For example, contrary to the original description, Pillai shows spines on a process of the first segment of the maxilliped of the male, the third segment of the endopod of leg 3 with IV, 2, and the same segment of the endopod of leg 4 with IV, 2.)

Although it is sometimes impossible to determine various details from the published descriptions of the several species of *Ostrincola,* it appears that the falciform seta on the third segment of the maxilliped of the male of *O. falcatus*

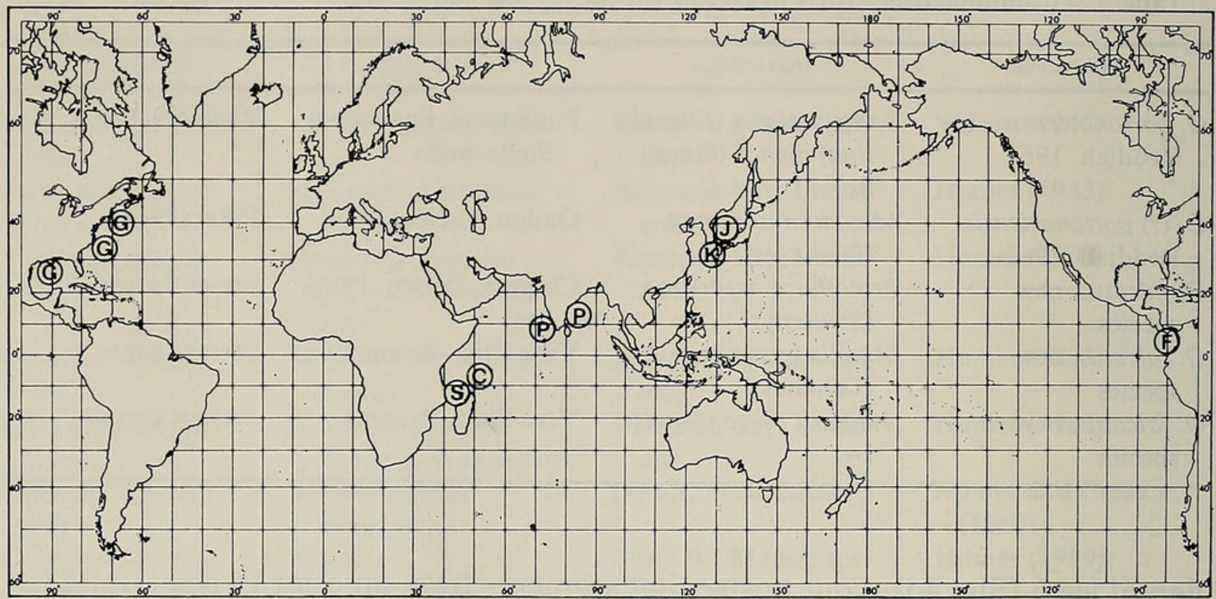

Fig. 5. Distribution of *Ostrincola.* C = *clavator,* F = *falcatus,* G = *gracilis,* J = *japonicus,* K = *koe,* P = *portonoviensis,* and S = *simplex.*

is diagnostic. In other species of the genus this seta is straight or only slightly recurved (this seta not described in *O. japonicus*). The spurlike sclerotization at the base of the claw of the maxilliped of the male also seems characteristic of the new species.

Specimens from *Mytella guyanensis* are often somewhat larger than those from *Protothaca asperrima.* Twenty females from *Mytella* had a length of 1.15 mm (1.01–1.35 mm) and greatest width of 0.32 mm (0.29–0.38 mm) and 20 males a length of 0.93 mm (0.75–1.01 mm) and greatest width of 0.24 mm (0.22–0.26 mm). Their size ranges overlap with specimens from *Protothaca.* A combination of the specimens from *Protothaca* with those from *Mytella* shows a length of 1.09 mm (0.91–1.35 mm) and greatest width of 0.30 mm (0.26–0.38 mm) for females and a length of 0.91 mm (0.75–1.01 mm) and greatest width of 0.23 mm (0.19–0.26 mm) for males.

Only two females from *Mytella* were ovigerous, but both of these had elongate egg sacs with the eggs arranged in a cluster rather than seriate. In one female the sac contained 11 eggs and measured 485 × 215 μm.

The ranges of the bivalve hosts are of interest since presumably *Ostrincola falcatus* may occur over part or all of their ranges. *Protothaca asperrima* is found from the Gulf of California to Peru, *Mytella guyanensis* occurs from Lower California to northern Peru and on the coast of Venezuela southward to Brazil, and *Anadara obesa* ranges from Mexico to northern Peru (Olsson 1961).

The various species of *Ostrincola,* whose geographical distribution is shown on the accompanying map (Fig. 5), may be distinguished by the use of the following key:

Key to the species of *Ostrincola*

1. Endopod of leg 1 with third segment armed with II,4 2
– Endopod of leg 1 with third segment armed with I,5 3

2. Endopod of leg 3 with third segment armed with IV,1 .... *O. clavator*
– Endopod of leg 3 with third segment armed with III,3 .... *O. simplex*
3. Endopod of leg 3 with third segment armed with II,4 and that of leg 4 with II,3 .... *O. portonoviensis*
– Endopod of leg 3 with third segment armed with IV,2 and that of leg 4 with IV,1 4
4. Leg 5 in female with second segment round, flattened, ratio 1:1 . *O. gracilis*
– Leg 5 in female with second segment longer than wide, at least 1.36:1 . 5
5. Leg 5 in female with second segment having several spinules on both sides 6
– Leg 5 in female with second segment with few spinules only on one side .... *O. falcatus*
6. Second antenna with third segment long and slender, ratio approximately 7:1 .... *O. japonicus*
– Second antenna with third segment relatively short, ratio approximately 4:1 .... *O. koe*

Pseudomyicola Yamaguti, 1936
Pseudomyicola spinosus (Raffaele and Monticelli, 1885)

Material studied.—1 ♀, 1 ♂, from 60 *Anadara obesa* (Sowerby), Vera Cruz, Panama, 5 Nov 1981.

Remarks.—Humes (1968) listed 39 hosts for this copepod. Since then the copepod has been reported in Japan from *Mytilus edulis* (Linnaeus) and *Septifer virgatus* (Wiegmann) by Ho (1980), who regarded *Pseudomyicola ostreae* Yamaguti, 1936, as a synonym. On the southern Californian coast *P. spinosus* is common in *Mytilus edulis* and *Mytilus californianus* Conrad (Ho 1980). In New Zealand it is abundant in *Crassostrea glomerata* Gould (Dinamani and Gordon 1974). Furthermore, I have seen specimens of *P. spinosus* from *Chione* (*Austrovenus*) *stutchburyi* (Gray) from Cox's Creek, Westmere, Auckland, New Zealand (collected by Dr. Philippa M. Black in 1971 in the upper reaches of Waitemata Harbor, within the city).

The addition of these four new hosts increases the number of bivalves serving as hosts for *P. spinosus* to 44.

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