DESCRIPTION OF EARLY STAGE ZOEAE OF *SPIRONTOCARIS MURDOCHI* (DECAPODA, HIPPOLYTIDAE) REARED IN THE LABORATORY

Larvae of *Spirontocaris murdochi* Rathbun have not been described in the literature. During studies on rearing larvae in the laboratory for descriptive purposes, I succeeded in rearing zoeae of *S. murdochi* through Stage III. The first three zoeal stages of *S. murdochi* are described, illustrated, and compared with descriptions of morphologically similar hippolytid zoeae.

Methods and Rearing Results

I obtained an ovigerous female *Spirontocaris murdochi* carrying late-stage embryos while sampling pandalid shrimp in Auke Bay, Alaska, for toxicity studies. The female was caught 2 April 1979 at a depth of 18 m at lat. 58°21.6′ N, long. 134°39.3′ W. Stage I zoeae released from the female were reared in 250 ml jars containing about 200 ml of filtered seawater. The jars were checked daily for exuviae, and a few zoeae were preserved every other day. The zoeae were offered live plankton strained through a 0.333 mm mesh, but there was no evidence that the zoeae ate the plankton. (For a more complete description of the methods, see Haynes 1982.) Most of the zoeae molted to Stage II, but only two zoeae molted to Stage III.

Techniques of measurement and illustration are those of Haynes (1976, 1979). At least five zoeae of Stages I and II were used to verify segmentation and setation.

Description

The terms used in the descriptions and nomenclature of appendages are from Haynes (1976, 1979). Only those morphological characteristics useful for readily identifying each stage are given. Setation formulae are the number of setae per segment from the distal to the proximal segment. The telsonic setae are numbered as pairs beginning with the inner (medial) pair. For clarity, setules on setae are usually omitted, but spinulose setae are shown.

The following characteristics apply to zoeal Stages I, II, and III. The rostrum is slender, spiniform, without teeth, about one-fourth the length of the carapace, and projects horizontally. The ventral and posterior margins of the carapace are smooth except for pterygostomian spines. Mandibles are without palps; there is no proximal setose seta on the maxillule; and the maxillipeds are without epipodites. Abdominal somites 4 and 5 have posterolateral spines (the fifth pair is slightly longer than the fourth pair in Stage I, but both pairs are nearly the same length in Stages II and III). An anal spine is present.

Stage I Zoea

Mean total length of Stage I zoea (Fig. 1A), 3.4 mm (range 3.2-3.6 mm; six specimens). Eyes sessile. Carapace with two minute rounded prominences: One at posterior edge, other at base of rostrum.

ANTENNULE (Fig. 1B).—Protopodite of first antenna, or antennule, simple, unsegmented, tubular, with heavily plumose seta terminally. Conical projection tipped with four aesthetascs: Three long, one of intermediate length.

ANTENNA (Fig. 1C).—Second antenna, or antenna, with inner flagellum (endopodite) and outer antennal scale (exopodite). Flagellum unsegmented, slightly shorter than scale, styliform, tipped by plumose seta and shorter spine. Antennal scale distally divided into five joints (distal joint incomplete) and fringed with 10 heavily plumose setae along terminal and inner margins. Tip of antennal scale curved toward outer margin. Protopodite with spine only at base of flagellum.

MANDIBLES (Fig. 1D).—Incisor process of left mandible has four teeth in contrast to triserrate incisor process of right mandible. Both left and right mandibles with movable premolar denticle (lacinia mobilis). Left mandible with subterminal tooth.

MAXILLULE (Fig. 1E).—First maxilla, or maxillule, with coxopodite, basipodite, and endopodite. Coxopodite (proximal lobe) with seven spines: Five spinulose, two simple. Basipodite (median lobe) with 10 short, smooth spines terminally. Two-segmented endopodite originates from lateral margin of basipodite: Proximal segment with two spinulose spines, distal segment with three spinulose spines.

MAXILLA (Fig. 1F).—Second maxilla, or maxilla, has platelike exopodite (scaphognathite) with five plumose setae along outer margin and

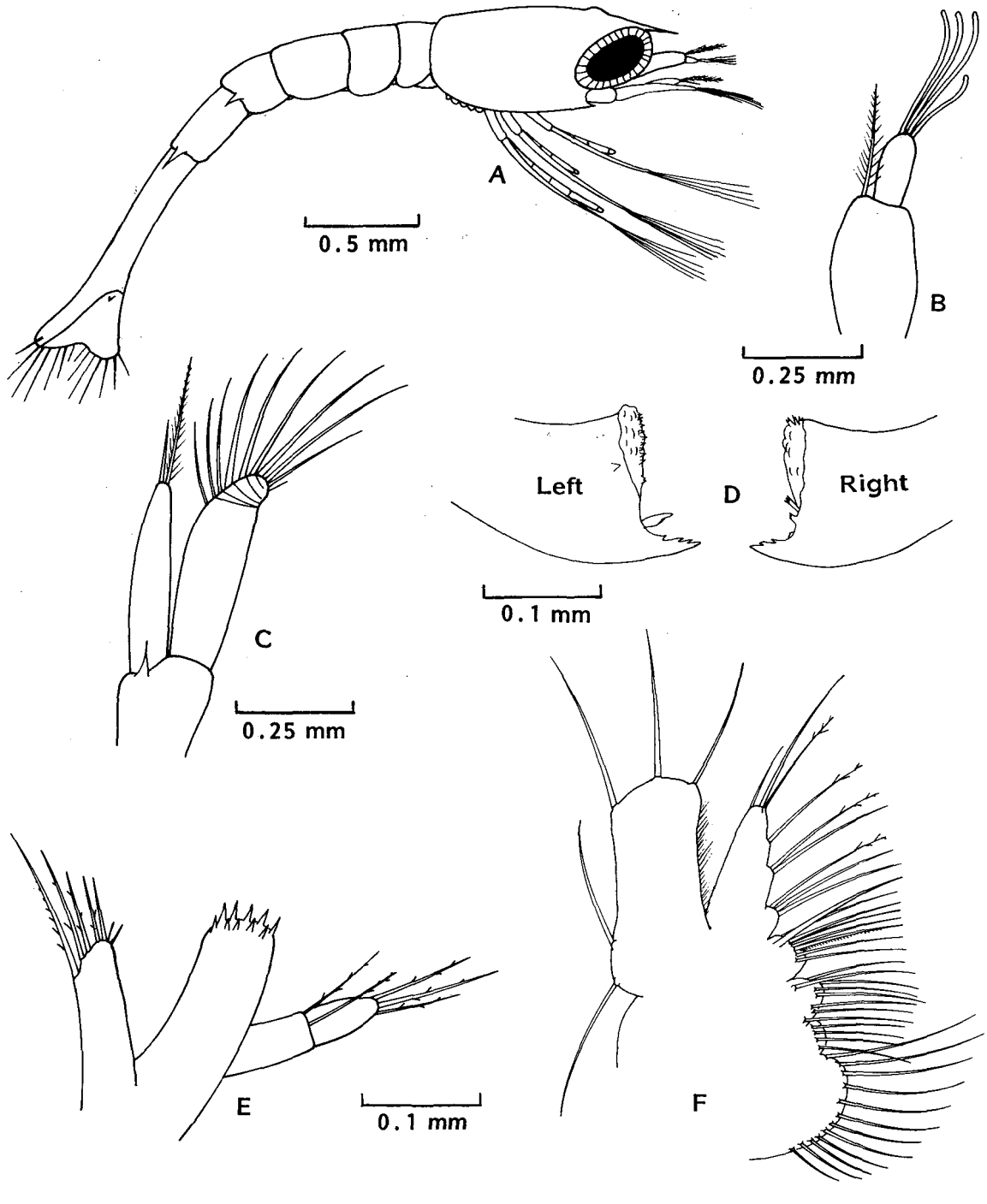

FIGURE 1.—Stage I zoea of *Spirontocaris murdochi*: A, whole animal, right side; B, antennule, dorsal; C, antenna, ventral; D, mandibles (left and right), posterior; E, maxillule, ventral; F, maxilla, dorsal.

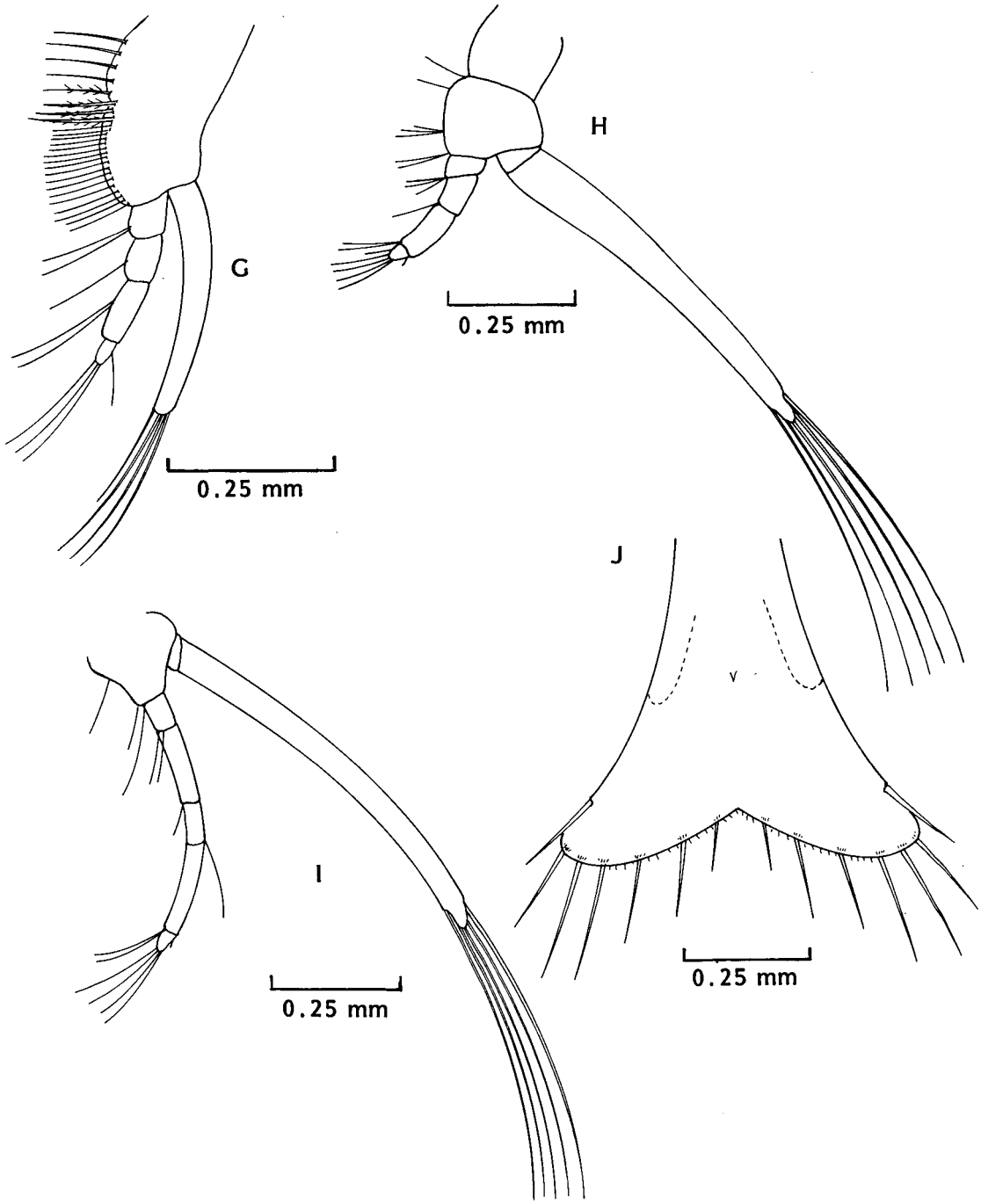

FIGURE 1.—*Continued*—G, first maxilliped, lateral; H, second maxilliped, lateral; I, third maxilliped, lateral; J, telson, ventral.

hairs along medial margin. Unsegmented endopodite with nine setae (four setae slightly spinulose). Coxopodite and basipodite bilobed. Coxopodite with eight setae on each lobe. Basipodite with 16 setae: 4 on distal lobe, 12 on proximal lobe.

FIRST MAXILLIPED (Fig. 1G).—Most setose of natatory appendages. Bilobed protopodite with 5 setae on proximal lobe, 20 setae on distal lobe (three of setae on distal lobe spinulose). Endopodite four-segmented; setation formula 4, 2, 1, 2. Exopodite (a long, slender ramus jointed at base) has four natatory setae.

SECOND MAXILLIPED (Fig. 1H).—Protopodite bisegmented: Distal segment with seven setae, proximal segment without setae. Endopodite four-segmented; setation formula 6, 2, 1, 3. Exopodite with five natatory setae.

THIRD MAXILLIPED (Fig. 1I).—Unsegmented protopodite with three setae. Five-segmented endopodite about two-thirds length of exopodite; setation formula 5, 2, 1, 1, 2. Exopodite with five natatory setae.

PEREOPODS.—Poorly developed, anteriorly directed under body.

PLEOPODS.—Absent.

ABDOMEN AND TELSON (Fig. 1A, J).—Abdomen with pair of posterolateral spines on somites 4 and 5, pair on somite 4 somewhat shorter than pair on somite 5. Telson emarginate posteriorly, fused with abdominal somite 6. Telson with 7 + 7 densely plumose setae, minute spinules at base of each seta except outermost pair, larger spinules along terminal margin of telson between bases of four inner pairs of setae. Uropods visible and enclosed.

Stage II Zoea

Mean total length of Stage II zoea, 3.7 mm (range 3.5-4.0 mm; three specimens). Eyes stalked. Carapace identical to Stage I carapace.

ANTENNULE (Fig. 2A).—Two-segmented, with large outer flagellum and smaller inner flagellum on terminal margin. Flagella not segmented; inner flagellum conical, with long spine terminally; outer flagellum with four aesthetascs terminally. Proximal segment with large spine projecting slightly downward from ventral surface. Both proximal and distal segments have two plumose setae each.

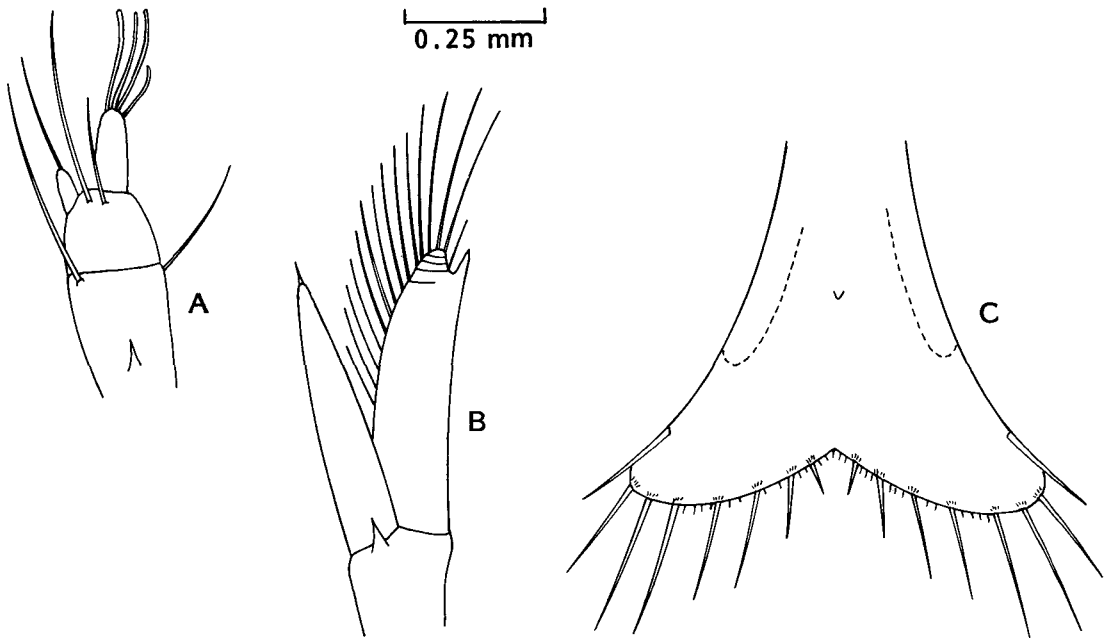

FIGURE 2.—Stage II zoea of *Spirontocaris murdochi*: A, antennule, ventral; B, antenna, ventral; C, telson, ventral.

ANTENNA (Fig. 2B).—Flagellum styliform, about same length as antennal scale, tipped by short spine. Antennal scale about 3.5 times as long as wide, fringed with 15 plumose setae along terminal and medial margins. Antennal scale with four joints distally (proximal joint incomplete), lateral projection on distal portion. Tip of antennal scale not curved laterally as in Stage I. Protopodite with spine at base of flagellum.

MANDIBLES.—Same as in Stage I except have slightly developed molar lip.

MAXILLULE, MAXILLA, AND MAXILLIPEDS.—Similar to Stage I except scaphognathite of maxilla has six setae; exopodites of maxillipeds 1-3 have 5, 8, and 10 natatory setae, respectively.

PEREOPODS.—Slightly larger than in Stage I, extend somewhat vertically, have naked exopodites on pereopods 1 and 2.

PLEOPODS.—Absent.

ABDOMEN AND TELSON.—Posterolateral spines on abdominal somites 4 and 5 nearly same length. Telson (Fig. 2C) still fused with abdominal somite 6, has 8 + 8 densely plumose setae. Enclosed uropods somewhat longer than in Stage I.

Stage III Zoea

Mean total length of Stage III zoea, 4.1 mm (range 3.9-4.3 mm; two specimens). Carapace identical to Stage II carapace, except has supraorbital spine.

ANTENNULE.—Similar to Stage II antennule except outer flagellum has subterminal seta, proximal segment with four setae around distal joint and three plumose setae laterally, distal segment with four large plumose setae.

ANTENNA, MANDIBLES, MAXILLULE, AND MAXILLA.—Similar to Stage II but with following differences. Antennal scale, without joints terminally, has 20 plumose setae along terminal and medial margins; subterminal spine extends just beyond tip of scale. Mandibles with a few additional teeth between incisor and molar processes. Maxillule with 9 spinulose spines on coxopodite and 12 short smooth spines on basipodite. Scaphognathite of maxilla has 9-12 plumose setae.

MAXILLIPEDS.—Exopodites of maxillipeds 1-3 have 5, 10, and 10 natatory setae, respectively.

PEREOPODS (Fig. 3A, B).—Exopodites only on pereopods 1 and 2; chelae present but undeveloped; endopodites of pereopods 1 and 2 with terminal seta.

PLEOPODS.—Present as buds.

ABDOMEN AND TELSON.—Telson (Fig. 3C),

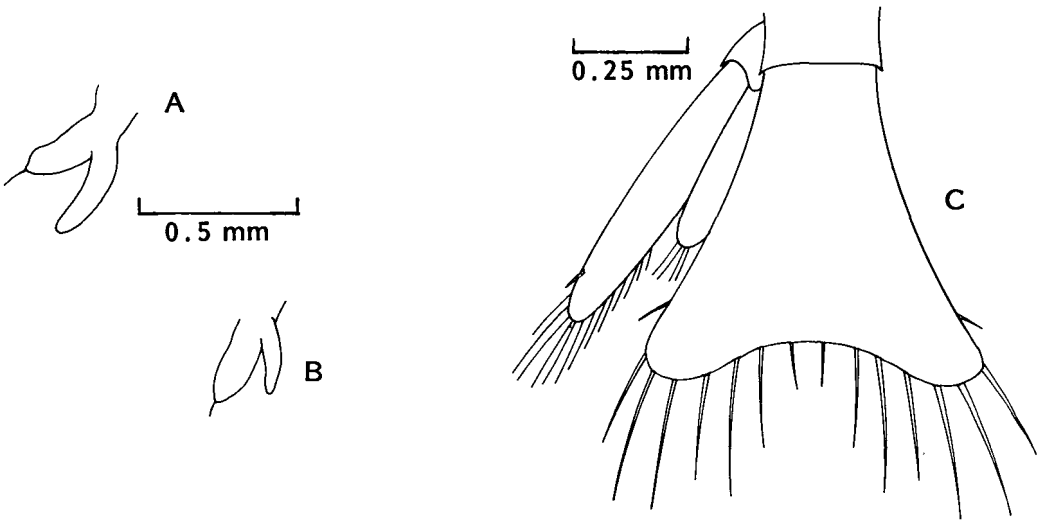

FIGURE 3.—Stage III zoea of *Spirontocaris murdochi*: A, pereopod 1, lateral; B, pereopod 2, lateral; C, telson, dorsal.

jointed with abdominal somite 6, has 8 + 8 densely plumose setae. Most of spinules at setal bases and along terminal margin absent. Uropods free. Endopodite of uropod about one-half length of exopodite, has four setae along terminal margin. Exopodite usually with 13 distal marginal setae and an outer subterminal spine.

Comparison of Zoeal Stages with Descriptions by Other Authors

Of the described *Spirontocaris* zoeae, those of *S. murdochi* are most similar to zoeae of *S. spinus* (Sowerby), *S. spinus intermedia* Makarov, and *S. phippsii* (Krøyer): all have relatively long, spiniform rostrums; exopodites on pereopods 1 and 2; and posterolateral spines on abdominal somites 4 and 5. However, larvae of *S. spinus* (described by Pike and Williamson 1961) and *S. spinus intermedia* (described by Ivanov 1971) are distinguishable from larvae of *S. murdochi*: *S. spinus* and *S. spinus intermedia* have a tuft of setae on the dorsal surface of abdominal somite 4; *S. murdochi* does not. Furthermore, in Stage I zoeae of *S. spinus* and *S. spinus intermedia*, the posterolateral spine on abdominal somite 5 is as short as, or shorter than, the spine on abdominal somite 4; whereas, in Stage I zoeae of *S. murdochi*, the posterolateral spine on abdominal somite 5 is noticeably longer than the posterolateral spine on abdominal somite 4.

Pike and Williamson (1961) described a Stage II specimen of *S. phippsii* whose identity is assumed from the distribution of adults in the northwestern Atlantic Ocean. The specimen is described as being nearly the same as Stage II *S. spinus* except somewhat larger (6.0 mm). Also, the posterolateral spines on abdominal somites 4 and 5 of *S. phippsii* are "more prominent", the dorsal tuft of setae on abdominal somite 4 is absent, the telson is "broader", and the second pair of telsonic spines are about three-fourths the length of the third pair. This description is inadequate to distinguish between Stage II *S. phippsii* and Stage II *S. murdochi*, except for total length: Stage II *S. murdochi* average 3.7 mm total length compared with 6.0 mm for *S. phippsii*.

The Stage III zoeae described as "*Spirontocaris* larva Nr. 2" by Stephensen (1916) from Greenland waters are assumed to be *S. phippsii* (Pike and Williamson 1961). When the figures and description of Stephensen's Stage III zoeae are compared with my description of Stage III *S. murdochi*, *S. murdochi* are smaller and noticeably less developed. Stephensen's zoeae are 6.5 mm long, the carapace has an antennal spine, the pleopods and the chelae of pereopods 1 and 2 are clefted, and telsonic setal pairs 3 and 4 are the same length. My Stage III zoeae average 4.1 mm long, the carapace does not have antennal spines, the pleopods and chelae of pereopods 1 and 2 are not clefted, and the third pair of telsonic setae are noticeably shorter than the fourth pair of telsonic setae.

It should be noted, however, that this comparison of zoeae of *S. murdochi* and *S. phippsii* is based on specimens from different geographical areas as well as specimens of *S. phippsii* that are of unproven identity. Confirmation of morphological development of *S. phippsii* larvae from the North Pacific Ocean is desirable.

Acknowledgment

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