

Redescription of *Botryllophilus inaequipes* Hansen, 1923 (Crustacea: Copepoda: Cyclopoida: Ascidicolidae)

Shigeko Ooishi

Friday Harbor Laboratories, University of Washington, 620 University Road, Friday Harbor,
Washington 98250-9299, U.S.A., e-mail: ooishi_fhl@hotmail.com

Abstract.—Hansen (1923) described the female of *Botryllophilus inaequipes* based on three specimens, which he designated as syntypes, collected from the Davis Strait. One syntype (with segmented metasome) on loan from the Zoological Museum, University of Copenhagen, could be identified as *B. inaequipes*; the other two syntypes (with unsegmented metasome) are a different species. The redescription, based on the specimen of *B. inaequipes*, confirms that most of the appendages of this copepod show diagnostic features of female morphotype A (subgroup 1) of the genus. The paragnaths (with free distal portion), labrum (with middistal lobe), and copulatory organs (comprising tubular copulatory pores and large seminal receptacles), studied for the first time, are thought to be unique for the species.

Hansen (1923) characterized the female of *Botryllophilus inaequipes* as possessing many appendages that he thought to be similar to those of *B. brevipes* Sars, 1921, and also a segmented metasome like that of *B. ruber* Hesse, 1864. Hansen's illustrations, however, dealt with only six appendages (right antennule, antenna, mandible, left leg 1, right and left leg 4); the body form was not shown. In addition, the host is unknown. Illg & Dudley (1980) stated that this species needs a much more detailed description and determination of its host. Through the courtesy of Dr. N. Bruce, I was able to examine Hansen's three specimens, deposited as syntypes of *B. inaequipes*, when I visited the Zoological Museum, University of Copenhagen, in August 1996. Later, Dr. Bruce arranged to have the three specimens sent to me for further study. However, only one of them was identifiable as *B. inaequipes*. In addition, the only specimen of *B. inaequipes* had previously been dissected and lacked many appendages. The present redescription is based on this specimen.

The genus *Botryllophilus* Hesse, 1864 consists of 14 established species, nine of them belonging to type A (with 5-segmented urosome) and five others belonging to type B (with more than 5-segmented urosome). Type A species have been divided, by Ooishi (2000), into two subgroups (1, 2) based on two patterns (I, II) of leg armature formulas. *Botryllophilus inaequipes* belongs to subgroup 1 (pattern I) of type A, with five congeners: (1) *B. brevipes* Sars, 1921; (2) *B. bergensis* Schellenberg, 1921; (3) *B. abbotti* Ooishi & Illg, 1989; (4) *B. koreensis* Seo & Lee, 1995; and (5) *B. bamfieldensis* Ooishi, 2000.

Because *B. inaequipes* is redescribed here and *B. brevipes* Sars (junior homonym of *B. brevipes* Brément, 1909, of subgroup 2) has been restudied (Ooishi 2002), *B. bergensis* will be left as the only species of subgroup 1 that is still in need of study. I have confirmed, however, that the type specimen of *B. bergensis* was not in the Schellenberg collection when I visited the Natural History Museum, Humboldt University, Berlin, in 1996.

Materials and Methods

Three specimens (designated as syntypes of *B. inaequipes* Hansen) contained in two vials (each with a catalog number) were sent to me, together with a data sheet, from the Zoological Museum at Copenhagen. One vial contained two specimens (CRU-2387); the other contained one specimen (CRU-2388). The data from the museum give the depths by metric system and also exact dates for the specimens, although Hansen's paper (1923) gives the depths in Danish fathoms and the years as "The Ingolf-Expedition 1895–1896." The following more exact data for the specimens are given on the basis of those from the museum and Hansen's paper; latitudes and longitudes are the same in both. I designated the three specimens as A, B, and C.

CRU-2387 . . . 2 females (A, B), Ingolf Station 32 (Davis Strait), 66°35'N, 56°38'W, 599 m (318 Danish fathoms) depth, 11 July 1895.

CRU-2388 . . . 1 female (C), Ingolf Station 36 (Davis Strait), 61°50'N, 56°21'W, 2702 m (1435 Danish fathoms) depth, 28 July 1895.

Specimens A–C were immersed in lactic acid (with a slight amount of methyl-blue) and their body forms were drawn in detail, with the aid of a camera lucida, for morphological comparison, and specimen B was selected as the holotype (as explained in the Systematics section, below).

A photomicrograph (Fig. 6a), before dissecting, was made from specimen B. Drawings for the retained appendages or other body portions were also made with the aid of a camera lucida. Other photomicrographs were made of the copulatory organs in the urosome.

In order to make it easy to understand the morphology of *B. inaequipes*, illustrations given in this paper consist of my originals plus four others that were remade from illustrations given by Hansen (1923: pl. III, 2b [right antenna], 2d [left leg 1], 2e [right leg 4], 2f [left leg 4]) for four appendages.

The remade illustrations were obtained by magnifying Hansen's illustrations to be approximately the same size as my originals. These are asterisked, as seen in Figs. 2e* (right antenna), 3c* (left leg 1), 4c* (right leg 4), and 4d* (left leg 4). Illustrations for right legs 1 and 2 are not presented in this paper, because these legs were lacking in the specimen that I examined and also were not included in Hansen's illustrations.

The dissected specimen, which was returned to the museum in September 1997, consisted of the following parts: the metasome without legs 1–4 and the urosome with caudal rami, both in a vial with ethanol, and appendages mounted singly in polyvinyl lactophenol on 11 slides. The mounted appendages are: (1) left antennule, (2) left antenna, (3) left mandible, (4) labrum, (5) paragnaths, (6) left maxillule, (7) left maxilla, (8) left maxilliped, (9) left leg 2, (10) right leg 3, and (11) left leg 3. Specimens A and C (each in a vial with ethanol) were returned to the museum at the same time.

In the armature formula for legs 1–4, the total number of spines or spiniform elements (Roman numerals) is given first and connected by a dash with the number of setae or setiform elements (Arabic numerals) in each segment. The total number (T) of these elements is given in parentheses for protopod, endopod, and exopod. This formula style was used first by Ooishi & Illg (1989) to specify the number and composition of armature elements on each leg segment of a botryllophilin (type A). In the armature formula for *B. inaequipes*, the predicted number and/or composition of missing or incorrectly illustrated elements are included in italics (see Table 1).

The abbreviations used are: A1 = antennule, A2 = antenna, L = labrum, MD = mandible, MX1 = maxillule, MX2 = maxilla, MXP = maxilliped, PG = paragnath, and P1 = leg 1. The numeric symbols used are: I = first armature element or first major element of antenna, maxilla, and leg exopod; I₁ = first seta on first segment of an-

tennule; I_2 = first seta on second segment of antennule; 1 = one independent seta (not associated with any other setae) of antennule; and +1 = one subordinate seta associated with a major seta of antennule or maxilla. These symbols were used first by Ooishi (1996) to recognize easily the location, size, and shape of each element on the appendage in botryllophilins, and to establish its homology in other species.

Systematics

Family Ascidicolidae Thorell, 1859

Subfamily Botryllophilinae Sars, 1921

Genus *Botryllophilus* Hesse, 1864

Botryllophilus inaequipes Hansen, 1923

Figs. 1–6

Selection of holotype.—Hansen's three specimens (A, B, and C) were examined with the following results: A, metasome unsegmented, body damaged on right side; B, metasome segmented, body partly dissected, lacking 6 right cephalosomal appendages and 5 legs (right legs 1, 2, and 4, left legs 1 and 4), but retaining oral area and remaining appendages of cephalosome, metasome, and urosome; and C, metasome unsegmented, body partly dissected, lacking left cephalosomal appendages except for antennule.

Specimen B was the only one which had a segmented metasome, characteristic of *Botryllophilus inaequipes*, thus obviously differing from specimens A and C, which had an unsegmented metasome. In addition, six of the 11 missing appendages mentioned above for specimen B corresponded to the right antennule (2a, designated as left, by Hansen), right antenna (2b), right mandible (2c), left legs 1 (2d) and 4 (2f), and right leg 4 (2e) illustrated by Hansen (1923: pl. III). Specimen B has therefore been designated as the holotypic female of *B. inaequipes* and selected for this redescription. Specimens A and C were not further studied by me, because they were not thought to be *B. inaequipes*.

Holotypic specimen examined.—Holo-

type ♀ (ZMUC-CRU-2387), collected at Ingolf Station 32, 66°35'N, 56°38'W, 599 m depth, in sifted bottom mud of the Davis Strait, 11 July 1895; dissected specimen deposited in Zoological Museum, University of Copenhagen.

Redescription of female.—Body (Figs. 1a, b, 6a) vermiform, 1.47 mm long, measured along body axis, based on illustrated specimen. Proportional lengths 1:2.4:2 for cephalosome, metasome, and urosome; these regions well demarcated. Ratio of length of prosome to that of urosome 1.7:1. Body surface with sparsely scattered hairlike sensilla. Color of living specimen unknown.

Cephalosome (Fig. 1a, d, e) subtriangular, with rounded anterior margin. Appendages consisting of 6 pairs through maxillipeds. Rostral area (Fig. 1d) slightly sclerotized and expanded.

Metasome (Fig. 1a, b) somewhat compressed, 5-segmented; segmentation distinct in first four segments, but weak between fourth and fifth segments. Proportional lengths 1:0.75:0.75:1:0.56 for 5 segments. Greatest width 0.40 mm in second and third segments. First to fourth segments bearing biramous asymmetrical legs (right legs 1 and 2 not shown here), without intercoxal sclerite, as seen in left legs 1–4 (Figs. 3c*, d, 4b, d*) and right legs 3 and 4 (Fig. 4a, c*). Fifth (shortest) segment narrowed toward urosome, bearing uniramous short leg 5 pair (Fig. 1a); proximal portion of leg 5 incorporated into posterolateral corners of fourth segment. Short transverse sclerite (Fig. 1c) present on midventral side, indicating boundary between fourth and fifth segments.

Urosome (Fig. 1a–c) cylindrical, consisting of 5 segments (genital, 3 abdominal, anal); anal segment slightly longer than each of anterior 4 subequal segments. In genital segment, gonopores dorsolateral, and opening of genital atrium midventral. Short caudal rami with ventrally directed terminal spines.

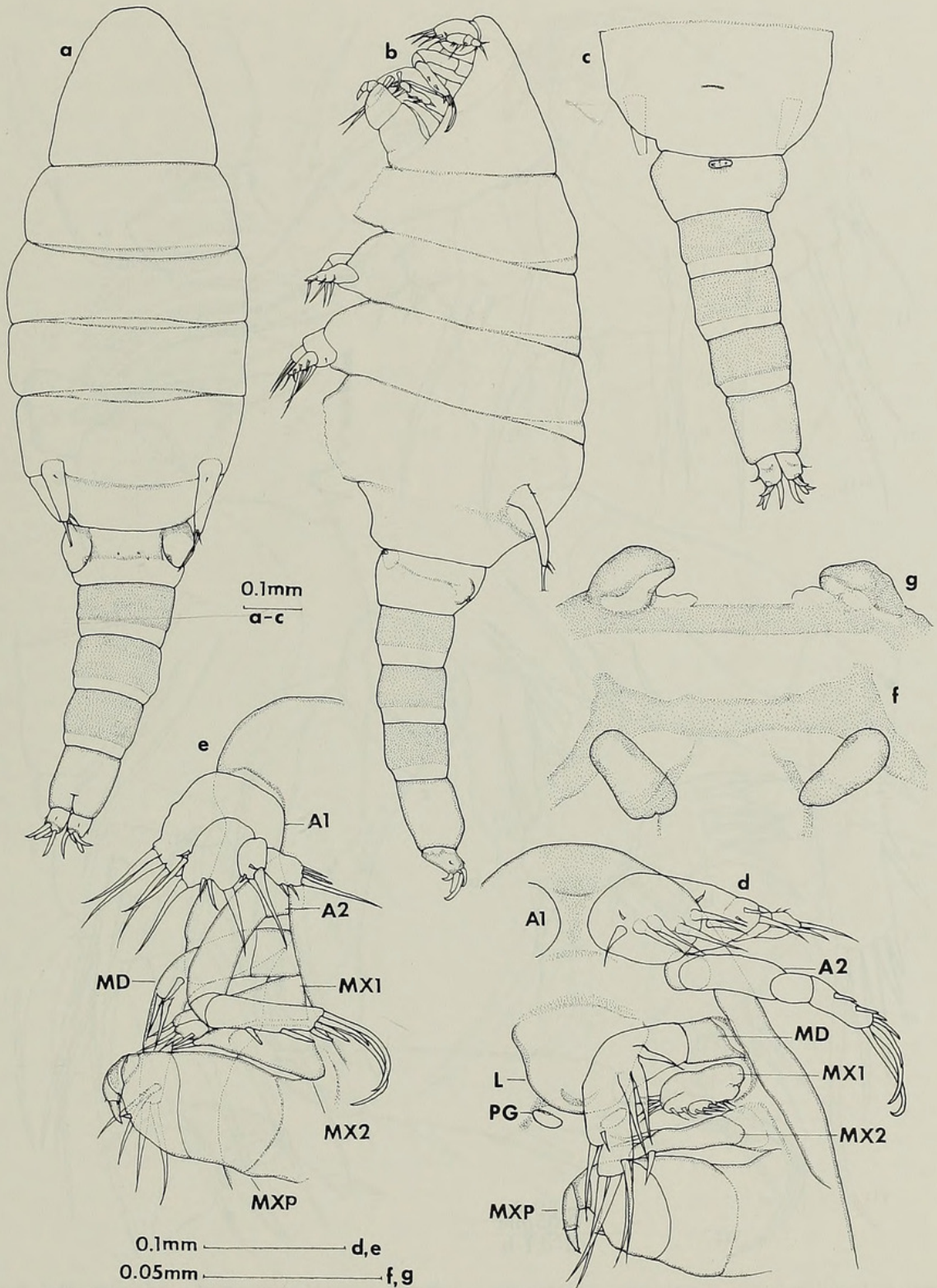


Fig. 1. *Botryllophilus inaequipus* Hansen, female. a, body form, dorsal; b, body form, lateral; c, posterior metasome with urosome, ventral; d, cephalosome, ventral (left side); e, cephalosome, lateral; f, paragnaths, ventral; g, paragnaths, posterior.

Antennule (Fig. 2a, b) 4-segmented; enlarged first segment about as long as total length of narrowed second to fourth segments. First segment with 9 setae (I_1+2 ,

II_1 , III_1+1 , IV_1 , V_1 , 1), second segment with 4 setae (I_2 , II_2+2), third segment with 3 setae (I_3+2), and fourth segment with 12 setae (I_4 , 11). Total setal number 28, in-

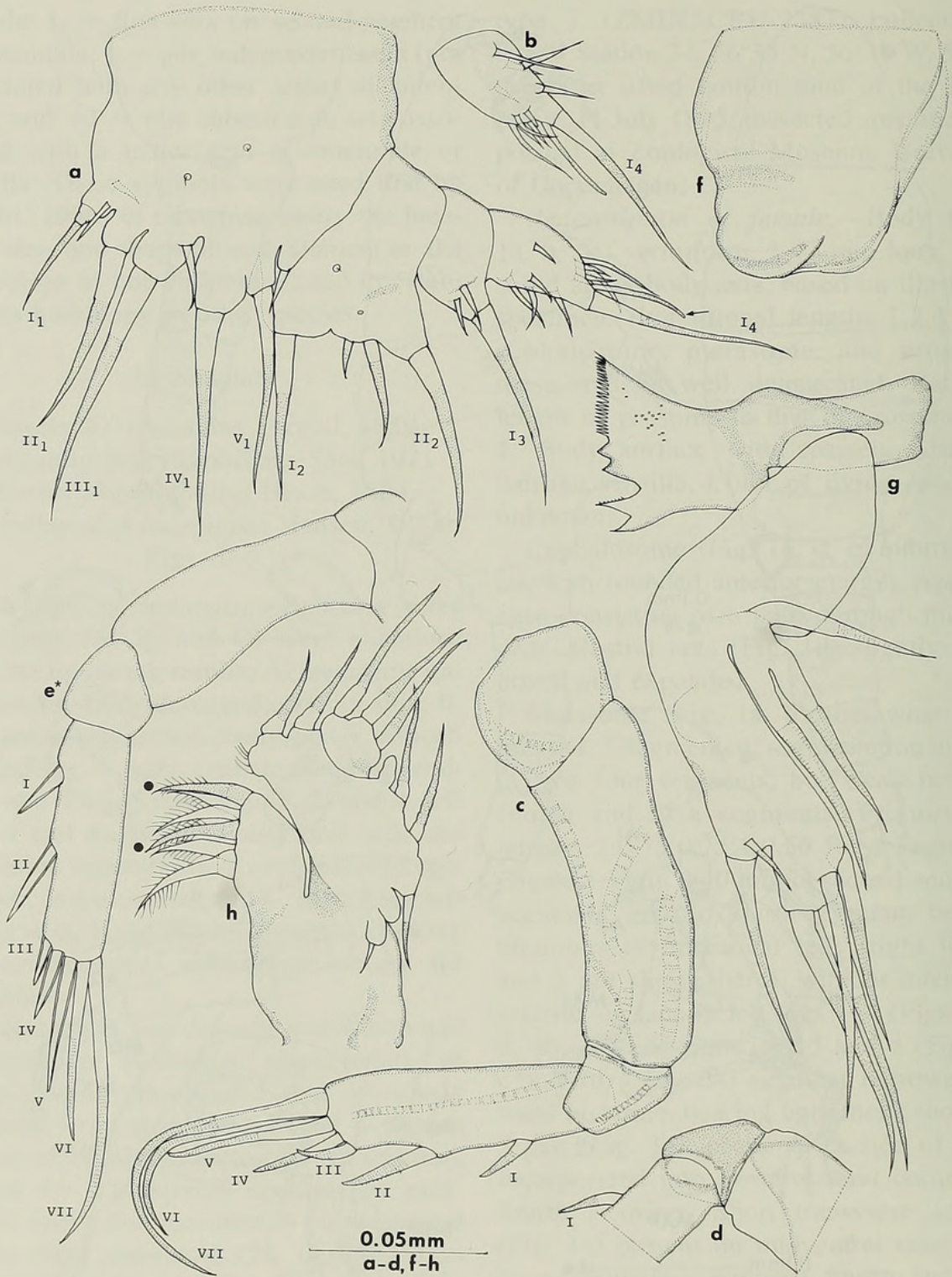


Fig. 2. *Botryllophilus inaequipes* Hansen, female. a, left antennule, anterior; b, fourth segment of antennule, posterior; c, left antenna, posterior; d, left antenna, anterior, showing short third segment; e*, right antenna, posterior; f, labrum, viewed from anterolateral side; g, left mandible, anterior; h, left maxillule, posterior.

cluding 1 aesthete-like seta (Fig. 2a, arrow) on fourth segment. In first segment, longest major seta (III₁) slightly shorter than proximal width of segment, and 1 in-

dependent seta (1) at anterodistal corner short.

Antenna (Fig. 2c, e*) 4-segmented, asymmetrical with respect to composition

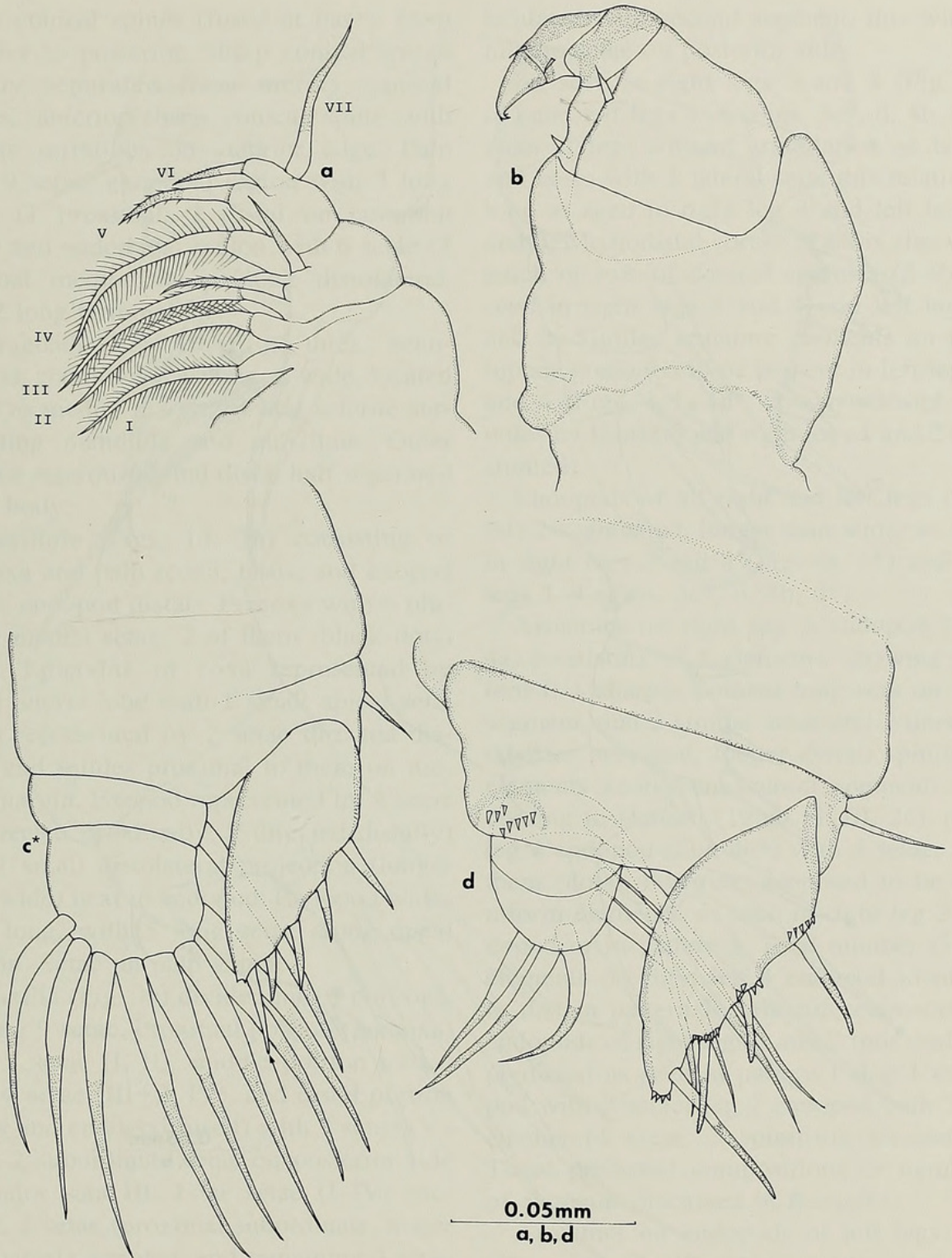


Fig. 3. *Botryllophilus inaequipes* Hansen, female. a, left maxilla, posterior; b, left maxilliped, posterior; c*, left leg 1, anterior; d, left leg 2, anterior.

of armature elements. In left antenna (Fig. 2c, d), fourth segment slightly shorter than longest second segment; third segment shortest. Fourth segment with 7 simple setae (I–VII): 2 (I, II) on medial margin and 5 (III–VII) on terminal margin.

Proportional lengths about 1:1.2:0.9:1.5:2.8:4.5:5.9 for 7 setae (I–VII); longest seta (VII) about 1.2 times as long as fourth segment (measured on anterior margin). Right antenna (Fig. 2e*) with 7 elements (I–VII): 5 spines (2 [I, II] me-

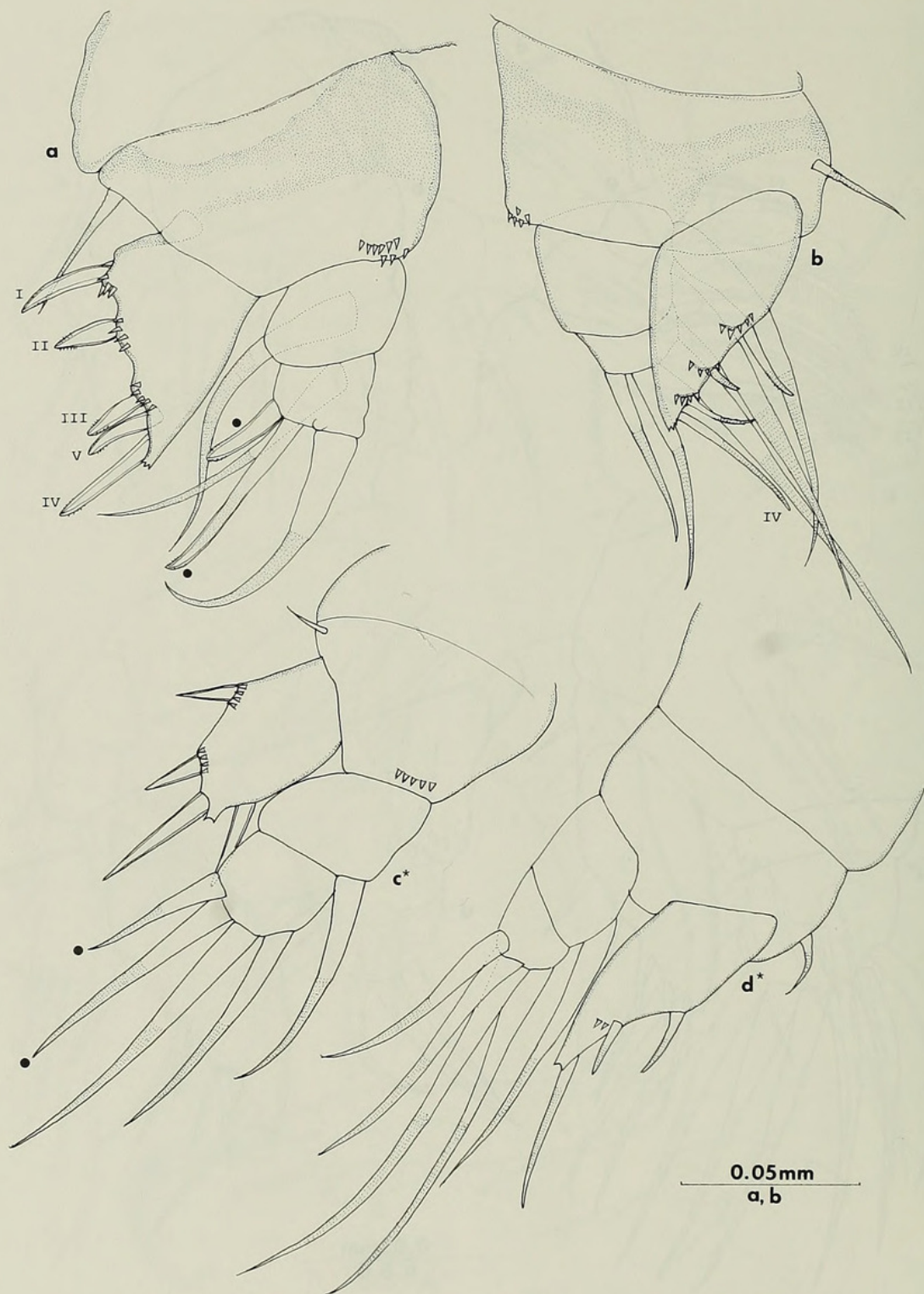


Fig. 4. *Botryllophilus inaequipes* Hansen, female. a, right leg 3, anterior; b, left leg 3, anterior; c*, right leg 4, anterior; d*, left leg 4, anterior.

dial, 3 [III–V] terminal) and 2 terminal setae (VI, VII).

Labrum (Fig. 2f) thick, with large rounded middistal lobe protruded from anterior surface.

Mandible (Fig. 2g) consisting of coxa

and elongated palp (basis, exopod, and endopod fused). Coxa with minute tubercles on anterior surface, and gnathobasic medial margin with double rows of comblike spinules (anteriorly ending in 1 longer element) and single row of 2 conical and 2

sharp conical spines (fused at base), from anterior to posterior. Sharp conical spines widely separated from merely conical spines; anterior sharp conical spine with minute serrations on anterior edge. Palp with 9 setae: exopodal region with 3 long setae (1 proximal, 2 distal on common base) and endopodal region with 6 setae (2 unequal mediolateral, 2 long distolateral, and 2 long terminal).

Paragnath (Fig. 1d, f, g) thick, bean-shaped, about twice as long as wide, located close to medial margin of oral sclerite surrounding mandible and maxillule. Outer surface sclerotized and distal half separated from body.

Maxillule (Figs. 1d, 2h) consisting of precoxa and palp (coxa, basis, and exopod fused; endopod distal). Precoxa with 6 plumose medial setae; 2 of them (black dots) stout. Epipodite of coxa represented by small lateral lobe with 1 small apical seta. Basis represented by 2 setae directed distally and setules proximal to them on medial margin. Exopod represented by 3 setae (1 directed proximally, 2 directed distally) and 1 small distolateral projection (longer than wide) next to endopod. Endopod wider than long, with 3 long setae along distal margin. Setae on palp simple.

Maxilla (Fig. 3a) divided into 3 portions, bearing 9 setae. Proximal portion (precoxa) with 2 setae (I, II), middle portion (coxa) with 4 setae (III+2, IV), and distal portion (basis and endopod fused) with 3 setae (V–VII); 2 subordinate setae on posterior side of major seta III. Four setae (I–IV) plumose, 2 setae (proximal subordinate, major V) coarsely serrated, and remaining 3 setae (1 distal subordinate, 2 major [VI, VII]) simple.

Maxilliped (Fig. 3b) consisting of coxa with 1 small medial seta proximally, basis with 2 similar setae (anterior, posterior) on medial margin, and 3-segmented endopod. In endopod, major articulation between first and second segments. Claw-shaped third segment tridentate at apex, and weakly ar-

ticulated with second segment, this with 2 minute setae on posterior side.

As seen in right legs 3 and 4 (Fig. 4a, c*) and left legs 1–4 (Figs. 3c*, d, 4b, d*), coxa of legs without articulation on body, and basis with 1 lateral seta, this relatively long as seen in right leg 3 and left legs 2 and 3. Mediodistal corner of basis also with patch or row of conical spinules (5–9), as seen in right legs 3 and 4 and left legs 2 and 3. Similar armature elements on protopods predicted to be present in left legs 1 and 4 (Figs. 3c*, 4d*, shown without spinules by Hansen) and right legs 1 and 2 (not studied).

Endopods of all right and left legs (P1–P4) 2-segmented, longer than wide, as seen in right legs 3 and 4 (Fig. 4a, c*) and left legs 1–4 (Figs. 3c*, d, 4b, d*).

Armature on right leg 3 endopod (Fig. 4a) consisting of 5 elements, showing pattern I: 1 sharply pointed long seta on first segment, and 2 similar setae and 2 unequal (shorter proximal, longer distal) spiniform elements (dots) on second segment. According to Hansen (1923: pl. III, 2e), right leg 4 endopod (Fig. 4c*) with 5 setae; 2 of them (dots), however, supposed to be spiniform elements, as seen in right leg 3 endopod or in pattern I. Total number (5) of elements on right leg 4 endopod identical to that in pattern I. Armature elements on endopods of right legs 1 and 2 (not studied) predicted as seen in pattern I (leg 1 endopod with 8 setae; leg 2 endopod with 7 elements [4 setae, 3 spiniform elements]). These predicted compositions or numbers of elements discussed in *Remarks*.

Armature on endopods of left legs 1–4 (Figs. 3c*, d, 4b, d*) consisting only of long setae. Armature formula 9, 7, 5, 5 for left legs 1–4 (1 seta on first segment; remaining setae on second segment). Armature (9) on left leg 1 endopod (Fig. 3c*) including 1 additional seta on second segment, but remaining elemental numbers for left legs 2–4 endopods corresponding to those in pattern I.

Exopod of right leg 3 (Fig. 4a) 1-seg-

mented, approximately trapezoidal. Proportional lengths 1:0.9:2:1.9 for 4 margins (basal, lateral, distal, and medial); medial margin markedly longer than lateral margin. Armature comprising 5 stout spines (I–V) with minute spinular serrations distally, representing pattern I: 4 (I–IV) protruding from truncated uneven distal margin, and remaining 1 (V) protruding from posterior side of ramus. These 5 spines directed distally; spine V between spines III and IV. Proportional lengths 1:0.68:0.68:1.21:0.78 for spines I–V; proximalmost spine (I) distinctly shorter than distalmost spine (V). Right leg 4 exopod (Fig. 4c*) longer than wide, with 4 spines (3 distal, 1 medial), showing pattern 1. Medial spine corresponding to spine V in right leg 3 exopod. Spine numbers for exopods of right legs 1 and 2 (not studied) predicted to be 6 and 5, respectively; in each leg, most spines protruding from distal margin and remaining 1 spine from posterior side of ramus, as seen in right leg 3 exopod.

Distal margin of right exopod, close to base of each spine, with spinules, as seen in exopods of right legs 3 and 4. Spinular formula: 5, 4, 5, 3 for 4 spines (I–IV) in right leg 3 (Fig. 4a); 4, 4, 2 for 3 spines (on distal margin) in right leg 4 (Fig. 4c*). Spinules (3) close to distalmost spine (IV, in case of right leg 3) basally fused and protruded distally, forming mediobasal corner of ramus. Similar spinular arrangement probably present in right legs 1 and 2 (not studied). Spinules absent around spine (V, in case of right leg 3) protruding from posterior side (legs 1–3) or medial margin (leg 4) of ramus.

Exopods of left legs 1–4 (Figs. 3c*, d, 4b, d*) 1-segmented, approximately rhomboid, 2–2.5 times as long as wide. Lateral margin corresponding to lateral and distal margins of right exopods, and bearing setiform elements corresponding to spines protruded from distal margin of right exopods. Element protruded from posterior side (legs 1–3) or medial margin (leg 4) of right leg exopods missing on left leg exo-

pods. Thus, exopods of left legs 1–4 with formula 5, 4, 4, 3, representing pattern I. Proportional lengths 1:0.4:0.8:1.8 for 4 setiform elements on left leg 3 exopod (Fig. 4b); distalmost element (IV) evidently longest. In left legs 2 and 4 (Figs. 3d, 4d*), distalmost element also longest. This element on left leg 1 (Fig. 3c*, arrow) not longest (probably inadequately illustrated by Hansen).

Spinular formula on lateral margin of left leg exopods: 5, 4, 5, 4 in leg 2 (Fig. 3d); 5, 4, 4, 4 in leg 3 (Fig. 4b). Spinules in left legs 1 and 4 (Figs. 3c*, 4d*, not fully shown by Hansen) probably present as seen in left legs 2 and 3.

Armature formula for legs 1–4, including predicted numbers and composition of elements, shown in Table 1.

Leg 5 (Fig. 5a, b) almost symmetrical, short. Length about 28% of that of urosome, twice as long as proximal width. Armature: 3 short setae (1 proximal, 2 distal) on dorsal margin and 1 long seta terminally. Proximal seta markedly short, and 2 distal setae with conspicuous gap between them. Long terminal setae on both sides lacking distal portions, so their exact lengths unknown.

Apparatus at gonopore (Fig. 5c–e) consisting of 2 closely set small conical spines (larger proximal, smaller distal, both articulated at base) externally and 7 small sclerites internally on medial margin of cuticular flap covering gonopore. Dorsal surface between gonopores with 2 hairlike sensilla posteriorly. Opening of genital atrium close to posterior margin of ventral metasome (Fig. 5d, f). Complex of copulatory organs within atrium divided into 2 portions (right, left) by medial septum; each portion with tubular copulatory pore protruding from surface and leading to corresponding large seminal receptacle internally (Fig. 6b–e). Right tubular pore (Figs. 5d, arrow, 6b, CP) apparently longer than left (Fig. 6c, CP) and protruding beyond outer edge of oblong opening of genital atrium (Fig. 6b, GA). Right and left seminal receptacles (SR)

Table 1.—Armature formula for legs 1–4 of the female of *Botryllophilus inaequipes*. Predicted numbers and compositions of armature elements on right legs 1 and 2 (not studied) and predicted composition of elements on right leg 4 endopod are given in italics; total number (T = 5) of elements on right leg 4 endopod is not predicted number, because it is identical to that in pattern I.

(Right)	Coxa; Basis	(T)	Endopod	(T)	Exopod	(T)
P1	<i>0-0; 0-1</i>	(1)	<i>0-1; 0-7</i>	(8)	<i>VI-0</i>	(6)
P2	<i>0-0; 0-1</i>	(1)	<i>0-1; III-3</i>	(7)	<i>V-0</i>	(5)
P3	0-0; 0-1	(1)	0-1; II-2	(5)	V-0	(5)
P4	0-0; 0-1	(1)	0-1; II-2	(5)	IV-0	(4)
(Left)						
P1	0-0; 0-1	(1)	0-1; 0-8	(9)	0-5	(5)
P2	0-0; 0-1	(1)	0-1; 0-6	(7)	0-4	(4)
P3	0-0; 0-1	(1)	0-1; 0-4	(5)	0-4	(4)
P4	0-0; 0-1	(1)	0-1; 0-4	(5)	0-3	(3)

close together medially, and receptacle duct (RD) leading from posterolateral corner of each seminal receptacle (Fig. 6d, e).

Anal segment (Fig. 5g, h) longer than wide, with about 10 small hairlike sensilla. Anus opening posterodorsally.

Caudal ramus (Fig. 5g, h) sclerotized, longer than wide, bearing 2 short setae (lateral, dorsal) and 4 stout claw-shaped spines with minute serrations distally: lateral spine (LS) rounded at apex; medial (MS), dorsal (DS), and ventral (VS) spines pointed at apex; ventral spine shortest.

Male.—Unknown.

Remarks.—As seen in Table 2, most of the appendages of *Botryllophilus inaequipes*, as given in the original paper, have been emended here. Most appendages, except for leg 5, adequately provide diagnostic features of type A (subgroup 1) of the genus (see Ooishi & Illg 1988; Ooishi 2002).

Left leg 1 endopod (Fig. 3c*) was shown by Hansen (1923:25, pl. III, 2d) to have nine setae, this bearing one additional element in comparison with pattern I (8). Because right leg 1 is lacking, and also because Hansen did not allude to it, it is not certain that right leg 1 endopod also has one additional seta. In *B. abbotti* (pattern I), an additional element on only left endopod has been considered as a variation in the number of elements (Ooishi 2000:585).

In formula pattern I, however, the composition of armature elements (6) on the second segment of right leg 2 endopod is somewhat varied in species of subgroup 1; the first segment always has one seta. Three kinds of compositions can be seen as follows: (a) II-4 (2 spiniform elements, 4 setae) in *B. bamfieldensis* (Ooishi 2000:578); (b) III-3 (3 spiniform elements, 3 setae) in *B. abbotti* (Ooishi & Illg 1989:456) and *B. brevipes* Sars (Ooishi 2002:829); and (c) IV-2 (4 spiniform elements, 2 setae) in *B. koreensis* (Seo & Lee 1995:84). Several unnamed *Botryllophilus* species of the same subgroup (Ooishi, unpublished) have the second type composition. It is apparent that the second type (b) occurs rather commonly in subgroup 1. The probable composition (III-3) of elements on the same segment given for *B. inaequipes* (Table 1) is based on this fact.

In the original paper by Hansen (1923: pl. III, 2e), four elements on the second segment of right leg 4 endopod were illustrated as being all setae. In all other species mentioned above, these four elements consist of two spiniform elements (II) and two setae (2). Therefore, the same composition of elements is probably present in *B. inaequipes*.

In any case, the armature formula (4) for right leg 4 exopod and that (5, 4, 4, 3) for left legs 1–4 exopod, which have been confirmed in this paper, mean that the armature

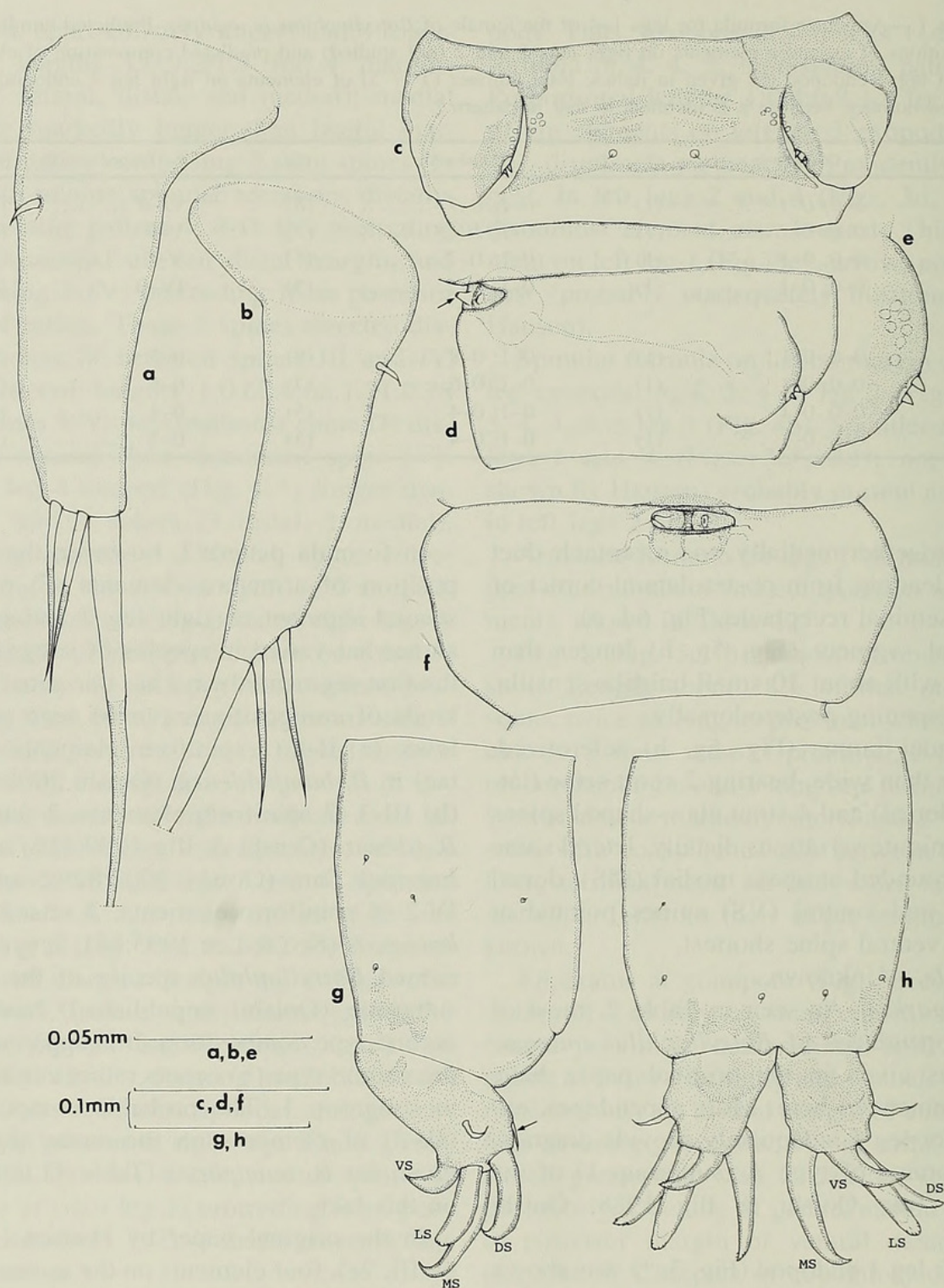


Fig. 5. *Botryllophilus inaequipes* Hansen, female. a, right leg 5, lateral (terminal seta without distal portion); b, left leg 5, lateral (terminal seta without distal portion); c, genital segment, dorsal; d, genital segment, lateral (arrow indicates right tubular copulatory pore); e, gonoporal apparatus, left; f, genital segment, ventral; g, anal segment with left caudal ramus, lateral (arrow indicates dorsal seta on caudal ramus); h, anal segment with caudal rami, ventral.

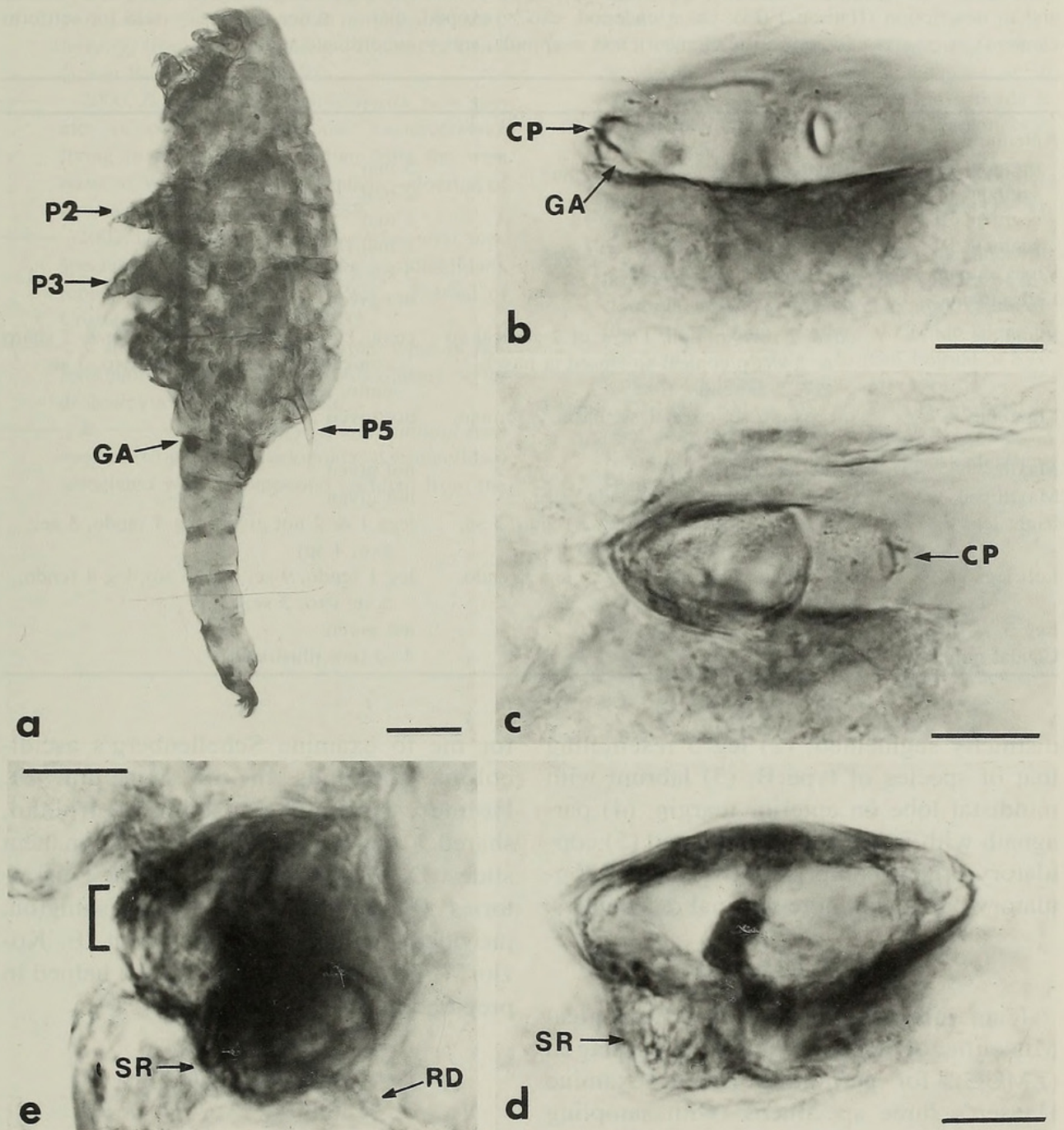


Fig. 6. *Botryllophilus inaequipes* Hansen, female, photomicrographs. a, body form, lateral; b, copulatory organs, ventral, showing right tubular copulatory pore (CP) protruding beyond outer edge of genital atrium (GA); c, copulatory organs, ventral (viewed from slight right side), showing left tubular copulatory pore (CP); d, copulatory organs, ventral, showing 2 large seminal receptacles (SR); e, copulatory organs, lateral (bracket indicates opening of genital atrium; receptacle duct [RD] leading from posterolateral corner of seminal receptacle [SR]). Scale bar = 0.147 mm in Fig. 6a; scale bar = 0.013 mm in Fig. 6b-e.

formula for the remaining legs evidently represents pattern I.

In leg 5, two short distal setae have a conspicuous gap between them, as seen in species of type B; these setae in type A spe-

cies are closely set and without a gap (Ooishi & Illg 1988).

Botryllophilus inaequipes is distinguished from five congeners of subgroup 1 by the following features: (1) metasome

Table 2.—Comparative features for appendages of *Botryllophilus inaequipes*, as given in redescription (Ooishi) and in description (Hansen 1923): en = endopod, exo = exopod, maj = major seta, se = seta (or setiform element), sp = spine (or spiniform element), spn = spinule, sub = subordinate seta.

	Redescription	Description
Antennule		
segment I	5 maj, 3 sub, 1 se	5 maj
segment II	2 maj, 2 sub	2 maj, 2 sub
segment III	1 maj, 2 sub	1 maj
segment IV	1 maj, 11 se	1 maj, 7 se
Right antenna	not studied	5 sp, 2 se
Left antenna	7 se	not given
Mandible	coxa, 2 rows of spn, 1 row of 2 conical sp & 2 sharp conical sp (fused at base); exo, 3 se; endo, 6 se	coxa, 1 row of spn, 2 conical sp & 2 sharp conical sp (fused at base); exo, 3 se; endo, 5 se
Maxillule	precoxa, 6 se; coxa, 1 se; basis, 2 se; exo, 3 se; endo, 3 se	not given
Maxilla	7 maj, 2 sub	not given
Maxilliped	coxa, 1 se; basis, 2 se; endo, 2 se	not given
Right legs	legs 1 & 2 not studied; leg 3 (endo, 3 se, 2 sp; exo, 5 sp)	legs 1 & 2 not given; leg 4 (endo, 5 se; exo, 4 sp)
Left legs	leg 2 (endo, 7 se; exo, 4 se), leg 3 (endo, 5 se; exo, 4 se)	leg 1 (endo, 9 se; exo, 5 se), leg 4 (endo, 5 se; exo, 3 se)
Leg 5	4 se	not given
Caudal ramus	2 se, 4 sp	4 sp (not illustrated)

distinctly segmented; (2) leg 5 resembling that of species of type B; (3) labrum with middistal lobe on anterior margin; (4) paragnath with free distal portion; and (5) copulatory organs comprising two tubular copulatory pores and large seminal receptacles.

Acknowledgments

I am indebted to N. Bruce, Zoological Museum, University of Copenhagen (ZMUC), for permitting me to examine Hansen's three specimens (with sampling data) and to dissect the holotypic female of *B. inaequipes*. B. Bisballe (ZMUC) helped me in reconfirming the data of the three specimens. I thank J. Bresciani, Royal Veterinary and Agricultural University (RVAU), for enabling me to work on the Hansen collection at the Zoological Museum at Copenhagen. My thanks are extended to J. Bresciani (RVAU), D. Damkaer (Monroe, Washington), and two other anonymous scientists for reviewing the manuscript. O. Coleman, Natural History Museum, Humboldt University, Berlin, arranged

for me to examine Schellenberg's ascidicolous copepods in the Museum. M. Holmes, National Museum of Ireland, shared a technique for making permanent slides. D. Willows, Friday Harbor Laboratories (FHL), University of Washington, provided facilities and equipment. E. Kozloff (FHL) and C. Staude (FHL) helped in preparation of the manuscript.

Literature Cited

- Brément, E. 1909. Contribution à l'étude des copépodes des ascidicoles du Golfe du Lion.—Archives de Zoologie Expérimentale et Générale 1 (Notes et Revue 5):61–89.
- Hansen, H. J. 1923. Crustacea Copepoda. II. Copepoda parasita and hemiparasita.—Danish Ingolf-Expedition 3(7):i–ii, 1–92.
- Hesse, M. 1864. Observations sur des crustacés rares ou nouveaux des côtes de France.—Annales des Sciences Naturelles 1:333–358.
- Illg, P. L., & P. L. Dudley. 1980. The family Ascidiocolidae and its subfamilies (Copepoda, Cyclopoida), with descriptions of new species.—Mémoires du Muséum National d'Histoire Naturelle 117:1–192.

- Ooishi, S. 1996. Two ascidicolid copepods, *Botryllophilus macropus* Canu and *B. norvegicus* Schellenberg, from British waters.—*Journal of Crustacean Biology* 16:169–191.
- . 2000. *Botryllophilus bamfieldensis*, new species (Copepoda: Cyclopoida: Ascidicolidae), living in a compound ascidian from the west coast of Vancouver Island, Canada.—*Journal of Crustacean Biology* 20:571–588.
- . 2002. Description of *Botryllophilus sarsi*, new species (Copepoda: Cyclopoida: Ascidicolidae), replacing *B. brevipes* Sars, 1921.—*Journal of Crustacean Biology* 22:819–833.
- , & P. L. Illg. 1988. Two morpho-types of *Botryllophilus* (Cyclopoida: Ascidicolidae).—*Hydrobiologia* 167/168:561–566.
- , & ———. 1989. *Botryllophilus abbotti* new species (Copepoda: Cyclopoida: Ascidicolidae) associated with a compound ascidian from the Monterey Peninsula.—*Bulletin of Marine Science* 45:447–466.
- Sars, G. O. 1921. An account of the Crustacea of Norway with short descriptions and figures of all the species, vol. 8. Copepoda, Monstrilloida & Notodelphyoida. Bergen Museum, Bergen, Norway, 91 pp.
- Schellenberg, A. 1921. Neue Norwegische Notodelphyiden.—*Kongelige Norske Videnskabers Selskabs Skrifter* 1921, 3:1–11.
- Seo, I.-S., & K.-S. Lee. 1995. Copepod associated with ascidians from Korea. II. A new species of *Botryllophilus* (Copepoda, Cyclopoida, Ascidicolidae) from simple ascidians at Chindo Island in the South Sea, Korea.—*Korean Journal of Systematic Zoology* 2:79–86.
- Thorell, T., 1859. Bidrag till kännedomen om krustaceer, som lefva i arter af släktet *Ascidia* L.—*Kongliga Svenska Vetenskaps-Akademiens Handlingar* 3(8):1–84.



Ooishi, Shigeko. 2002. "Redescription of *Botryllophilus inaequipis* Hansen, 1923 (Crustacea: Copepoda: Cyclopoida: Ascidicolidae)." *Proceedings of the Biological Society of Washington* 115, 636–649.

View This Item Online: <https://www.biodiversitylibrary.org/item/110040>

Permalink: <https://www.biodiversitylibrary.org/partpdf/85636>

Holding Institution

Smithsonian Libraries

Sponsored by

Biodiversity Heritage Library

Copyright & Reuse

Copyright Status: In copyright. Digitized with the permission of the rights holder.

Rights Holder: Biological Society of Washington

License: <http://creativecommons.org/licenses/by-nc-sa/3.0/>

Rights: <https://biodiversitylibrary.org/permissions>

This document was created from content at the **Biodiversity Heritage Library**, the world's largest open access digital library for biodiversity literature and archives. Visit BHL at <https://www.biodiversitylibrary.org>.