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# Redescription of *Lepeophtheirus marginatus* Bere, 1936 (Copepoda: Caligidae) and relegation of *L. christianensis* Wilson, 1944 and *L. orbicularis* Shiino, 1960 as its synonyms

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*Abstract.*—*Lepeophtheirus marginatus* Bere, 1936 is redescribed based on examination of type specimens. Studying the type materials of *L. christianensis* Wilson, 1944 and *L. orbicularis* Shiino, 1965 from sea catfish (*Galeichthyes* sp.) collected in the Gulf of Mexico and Peru, respectively, led us to recommend relegating both of them as synonyms of *L. marginatus* Bere.

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In their report on a new species of *Lepeophtheirus* parasitic on the bullseye puffer (*Sphoeroides annulatus* Jenyns) taken off Sinaloa, Mexico, Ho et al. (in press) suspected that *L. christianensis* reported by Wilson (1944) may be synonymous with *L. marginatus* Bere, 1936, because these nominal species resemble one another and probably were reported from the same species of sea catfish (*Galeichthys* sp.) caught at the same locality (off Pass Christian, Mississippi). Therefore, type specimens of both species deposited at the National Museum of Natural History, Smithsonian Institution in Washington, D.C. were examined. Unexpectedly, in the process of reviewing the species of *Lepeophtheirus* reported from the sea catfish, it was discovered that not only is *L. christianensis* synonymous with *L. marginatus,* but also is *L. orbicularis* Shiino, 1965.

Based on these studies we herein redescribe *L. marginatus* and then discuss the establishment of *L. christianensis* and *L. orbicularis* as junior synonyms of *L. marginatus.*

## Materials and Methods

The specimens kept in 70% ethanol in the collections of National Museum of Natural History, Smithsonian Institution in Washington, D.C. and Faculty of Bioresources, Mie University in Tsu, Japan were cleared in lactic acid for 1 hr before examination. Two specimens (one female and one male) of *L. marginatus* from USNM 79163 were dissected in a drop of glycerin and the removed body parts and appendages were mounted on slides using glycerin as mounting medium and examined using a compound microscope. All drawings were made with the aid of a camera lucida. In this report a full description is given of the female and only those parts and appendages showing sexual dimorphism are given of the male.

## *Lepeophtheirus marginatus* Bere, 1936
Figs. 1–6

*Material examined.*—Type-material 1 ♀ and 1 ♂ (USNM 69860) from "outside skin" of *Arius felis* (Linnaeus) (= *Galeichthys felis*) collected at Englewood, Florida and another collection containing 3 ♀ ♀, 2 ♂ ♂, and 1 young ♀ (USNM 79163) from Lemon Bay, Florida (no host designated on label).

*Female.*—Body (Fig. 1A) 3.12 (2.94–3.44) mm long, excluding setae on caudal

rami. Cephalothoracic shield nearly as long (1.59 mm) as wide (1.43 mm), excluding marginal hyaline membranes. Fourth pediger distinctly wider (373 μm) than long (193 μm). Genital complex (Fig. 1B) slightly longer than wide (942 × 878 μm) and scattered with setules in central part of dorsal surface and posteroventral surface near leg 5; median portion of anterior margin protruded to form a short stem that connects to 4th pediger, posteroventral portion between 5th legs with or without shield-like cement plate (originating from a male with whom female mated) holding spermatophores. Abdomen (Fig. 1B) not clearly separated from genital complex, distinctly wider than long (210 × 388 μm) and with convex sides. Caudal ramus (Fig. 1A, B) small, wider than long (51 × 70 μm), carrying 3 short (mediodorsal seta broken off on both rami in dissected specimen) and 3 long plumose setae (broken off on both rami in dissected specimen). Egg sacs (not shown in Fig. 1A) longer than half body length.

Frontal plate (Fig. 1A) with 1 setule on anterior margin near midline. Antennule (Fig. 2A) 2-segmented; proximal segment with 27 plumose setae on anterodistal surface, distal segment 2.69 times longer than wide, with isolated seta about midway on posterior margin and 11 setae plus 2 aesthetascs on distal margin. Antenna (Fig. 2B) 3-segmented; proximal segment smallest, with bluntly pointed postero-medial process; 2nd segment robust, with ventral corrugated pad near tip; distal segment with sharply pointed, bent tip, with small seta in proximal region and slender seta in middle region. Postantennal process (Fig. 2B) comprising massive, globular base with 2 setule-bearing papillae and broadly rounded shaft. A spherical outgrowth located between bases of antenna and postantennal process. Mandible (Fig. 2C) with 4 sections, bearing 12 teeth on medial margin of distal blade. Maxillule (Fig. 2B) consisting of long, slender, pointed process and papilla with 3 unequal setae. Maxilla (Fig. 2D) 2-segmented; proximal segment (lacertus) large, with transverse ridge across middle region and cuneiform process on medial surface; slender, distal segment (brachium) carrying small subterminal process on outer edge and 2 unequal elements (calamus and canna) terminally and subterminally. Maxilliped (Fig. 2E) 2-segmented; proximal segment (corpus) largest, with basal flange on medial surface; distal segments sharply pointed claw carrying small knob in proximal region and simple, medial seta in middle region. Sternal furca on dissected specimen (Fig. 2F) with bluntly tipped tines bearing marginal hyaline membranes, but tines of other specimens appears spatula-like as shown in Fig. 6C.

Armature on rami of legs 1–4 as follows (Roman numerals indicating spines and Arabic numerals, setae):

| | Exopod | Endopod |
|---|---|---|
| Leg 1 | I-0; III, I, 3 | (vestigial) |
| Leg 2 | I-1; I-1; II, 5 | 0-1; 0-2; 6 |
| Leg 3 | I-1; I, II, 5 | 0-1; 6 |
| Leg 4 | I-0; I-0; III | (absent) |

Leg 1 (Fig. 3A) protopod with plumose outer seta and another plumose inner seta; endopod short, bluntly tipped pinnate process; first segment of exopod with row of setules on posterior edge and short spiniform seta at anterior-distal corner; middle 2 of 4 terminal elements on last segment of exopod with accessory process, 3 terminal elements bearing crescent membrane terminally on both sides assuming spoon-like structure, and 3 posterior plumose setae short. Leg 2 (Fig. 3B) coxa small, with large plumose seta on posterior edge; basis with small, naked outer seta; both lateral and medial edge of protopod with large marginal membranous fringe, proximal lateral spines on third segment of exopod semipinnate with naked anterior side, next spine pinnate and appearing setiform. Leg 3 (Fig. 4A) protopod with large lateral and posterior marginal membranous fringe in addition to lateral and medial plumose setae. Both rami 2-segmented; proximal seg-

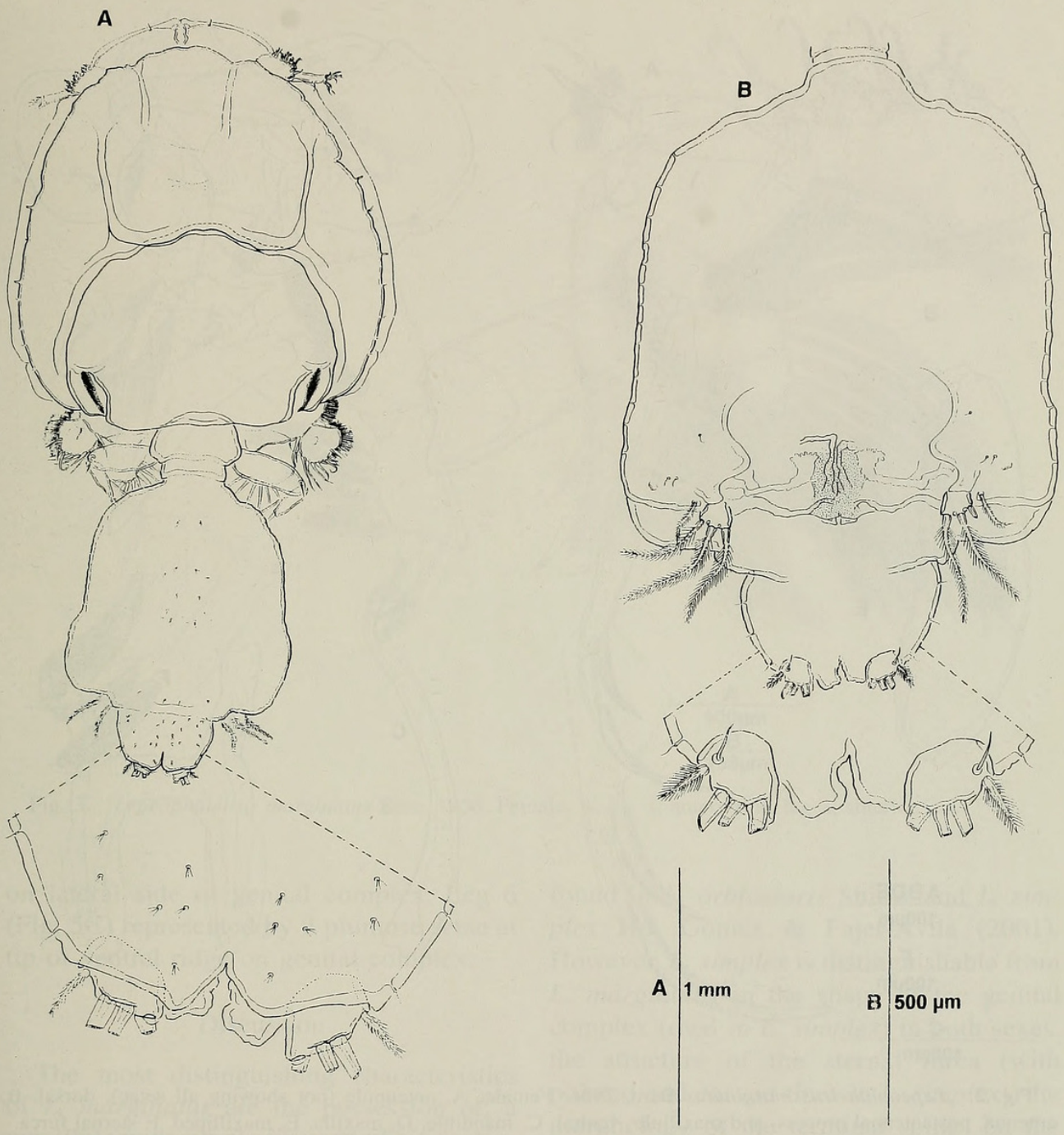


Fig. 1. *Lepeophtheirus marginatus* Bere, 1936. Female. A, habitus, dorsal. B, genital complex and abdomen, ventral.

ment of exopod round, with marginal membranous fringe membrane and slender setiform process; second and terminal segments incompletely fused, with 2 setules proximal to lateral spines on terminal segment. Leg 4 (Fig. 4B) protopod with short, naked distal-lateral seta; pectens on exopod segments at insertion of each lateral spine (Fig. 4C).

Leg 5 (Fig. 4D) represented by pinnate seta and small process tipped with 3 plumose setae.

*Male.*—Body (Fig. 5A) 2.27 (1.90–2.48) mm long, excluding setae on caudal rami. Cephalothoracic shield about as long (1.19 mm) as wide (1.13 mm), excluding marginal hyaline membranes. Genital complex (Fig. 5C) longer than wide, 916 × 786 µm, sparsely covered with setules on dorsal surface and lateral margins; ventral surface

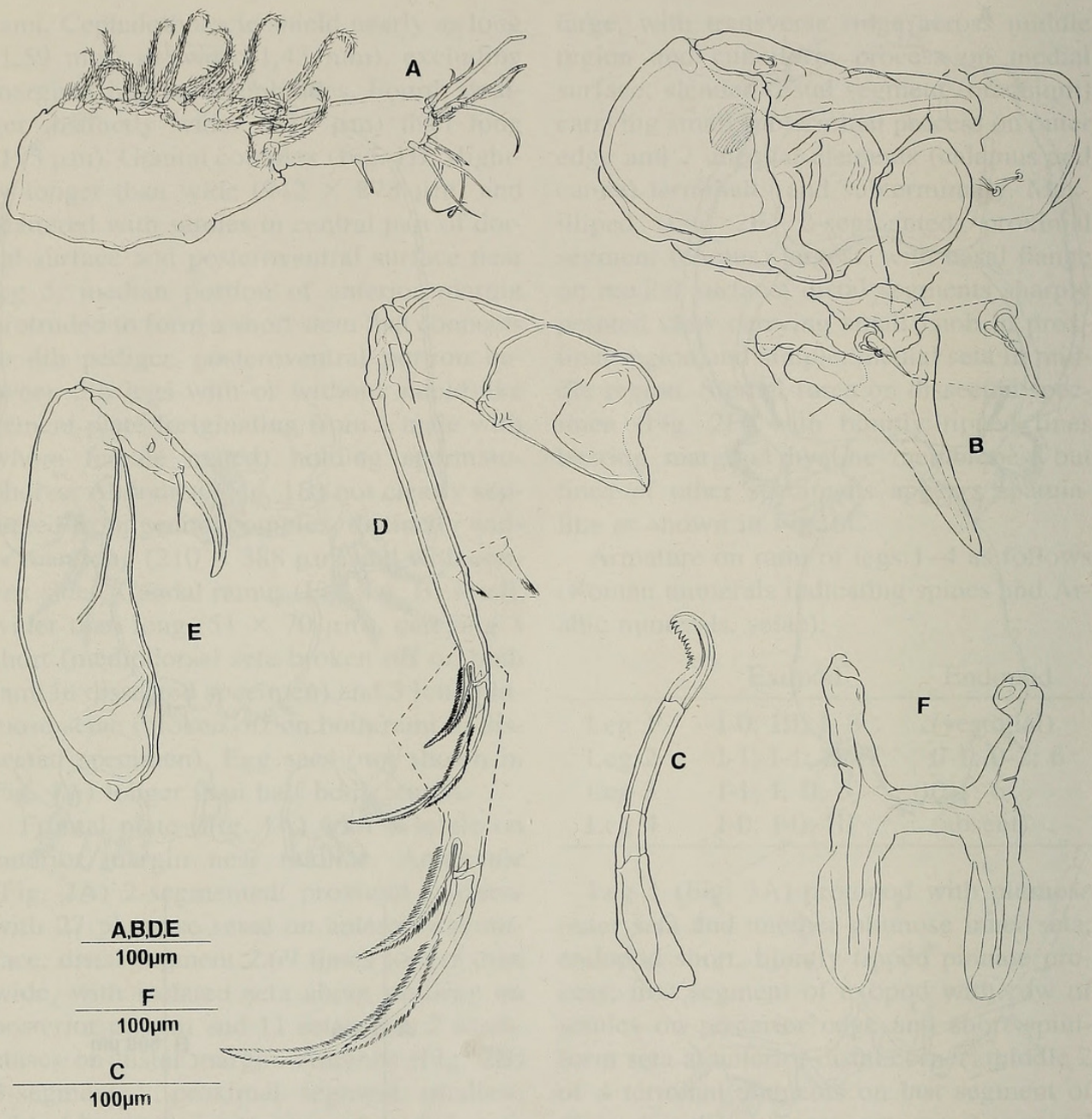


Fig. 2. *Lepeophtheirus marginatus* Bere, 1936. Female. A, antennule (not showing all setae), dorsal. B, antenna, postantennal process, and maxillule; ventral. C, mandible. D, maxilla. E, maxilliped. F, sternal furca.

showing two posterolateral lobes bearing leg 6 at their tip. Abdomen (Fig. 5C) short and slightly wider (488 µm) than long (461 µm). Caudal ramus (Fig. 5B) wider (68 µm) than long (50 µm). Antenna (A1 in Fig. 6A) 3-segmented; proximal segment with large corrugated pad; middle segment largest, robust and armed with 2 corrugated pads (Fig. 6B); terminal segment prehensile, quadrifurcate distally and armed with 2 spiniform setae. Corrugated pad on sternum (A3 in Fig. 6A) posterior and medial to maxillule (A2 in Fig. 6A). Dentiform process of maxillule with small protuberance near base (A2 in Fig. 6A). Corpus of maxilliped (Fig. 6D) with 2 transverse ridges near base; shaft bearing subspherical protuberance basally and spiniform seta distally; claw with denticulate medial protrusion near base (see insert drawing in Fig. 6D). Sternal furca (Fig. 6C) with broad, spatula-like tines. Leg 5 (Fig. 5C) consisting of small plumose seta and papilla tipped with 1 simple and 2 plumose setae located


Fig. 3. *Lepeophtheirus marginatus* Bere, 1936. Female. A, leg 1, anterior. B, leg 2, anterior.

on lateral side of genital complex. Leg 6 (Fig. 5C) represented by 3 plumose setae at tip of ventral ridge on genital complex.

## Discussion

The most distinguishing characteristics of *L. marginatus* are the possession of: a maxillule with simple (instead of bifid) dentiform process (see Figs. 2B and 6A); a 2-segmented (instead of 3-segmented) exopod of leg 3 with slender setiform element (instead of robust, claw-like spine) on proximal segment (see Fig. 4A); and a 3-segmented exopod of leg 4 with long (instead of minute), proximal, outer spine (see Fig. 4B). Due to an incomplete original description of *L. marginatus* and the lack of supplemental information in Causey (1955), the first two of these three unusual features of *L. marginatus* were unknown until now. Interestingly, these three features are also found in *L. orbicularis* Shiino and *L. simplex* Ho, Gómez & Fajer-Avila (2001). However, *L. simplex* is distinguishable from *L. marginatus* in the shape of the genital complex (oval in *L. simplex*) in both sexes, the structure of the sternal furca (with pointed and curved tines in *L. simplex*), the morphology of the terminal spines on the exopod of leg 1 (lacking crescent membrane in *L. simplex*), and the structure of the terminal claw of male antenna (bipartite and equipped with a tridentate medial protuberance in *L. simplex*).

One hundred and eight species of caligid copepods are currently classified in the genus *Lepeophtheirus*. Among them, six species were reported from the sea catfishes (Ariidae). They are *L. dissimulatus* Wilson, 1905; *L. monacanthus* Heller, 1865; *L. unispinosus* Pearse, 1952, *L. christianensis, L. marginatus* and *L. orbicularis*. *Lepeo-*

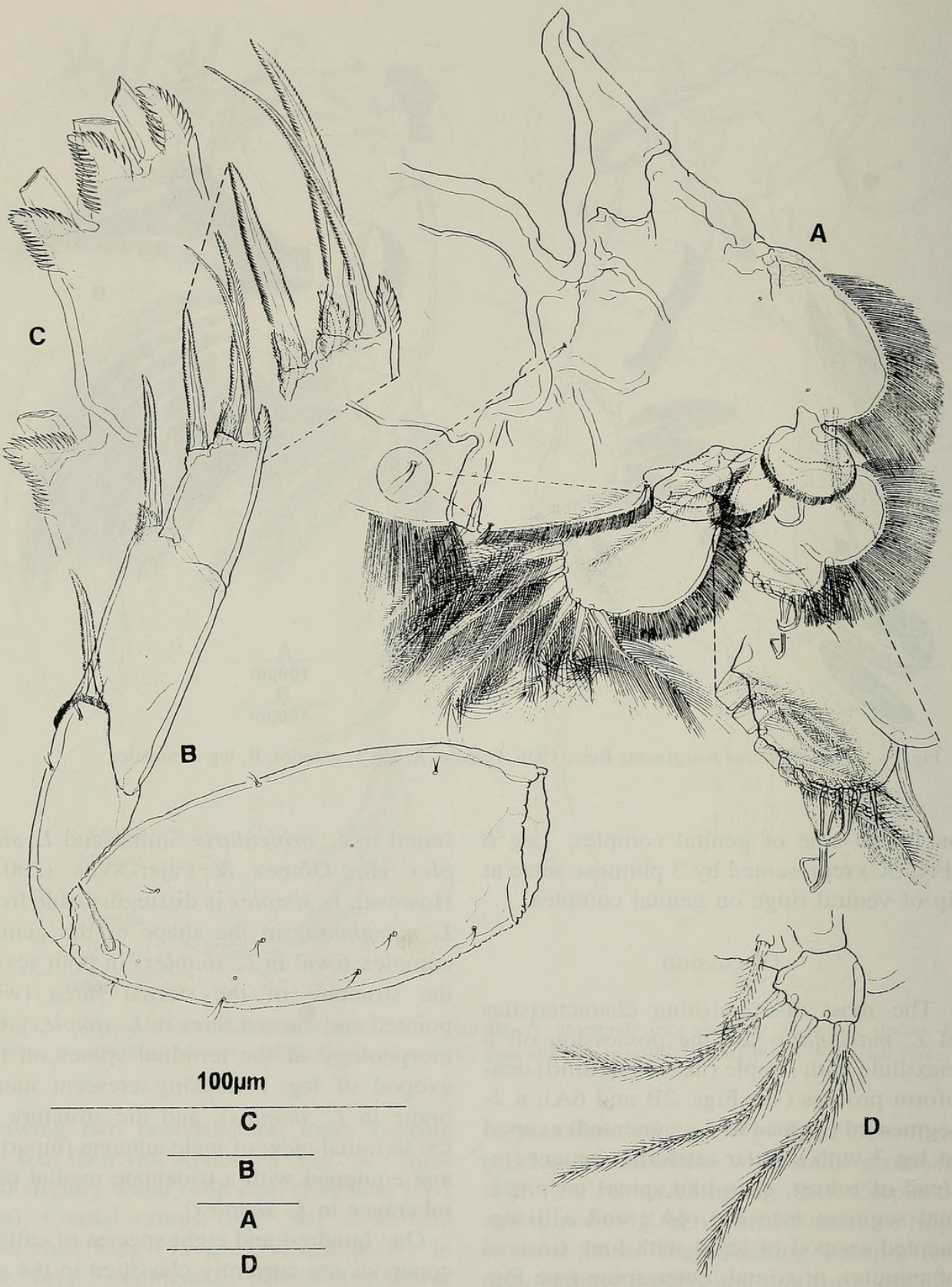


Fig. 4. *Lepeophtheirus marginatus* Bere, 1936. Female. A, leg 3, ventral. B, leg 4, anterior. C, terminal part of leg 4 exopod. D, leg 5.

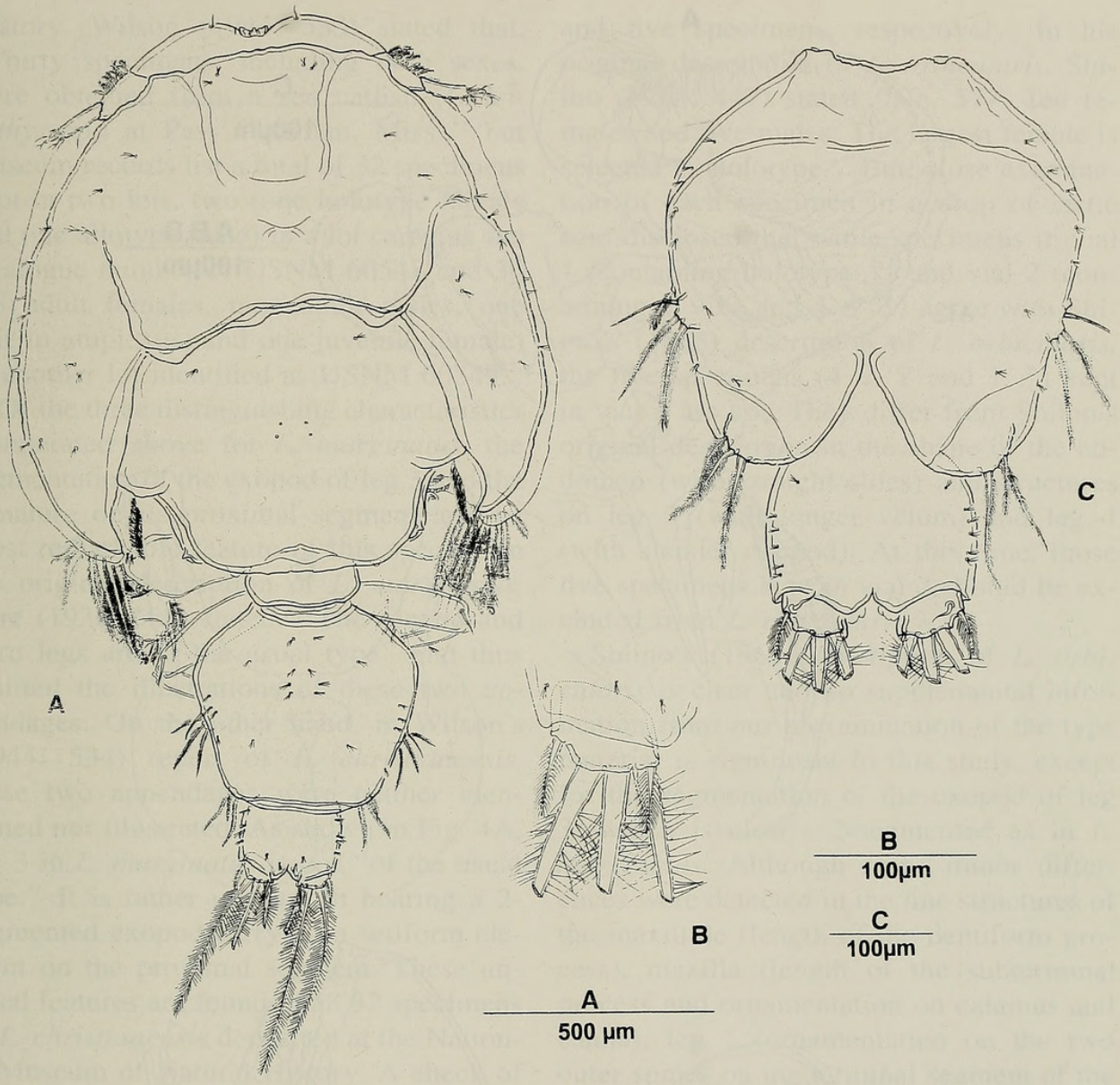


Fig. 5. *Lepeophtheirus marginatus* Bere, 1936. Male. A, habitus, dorsal. B, caudal ramus, dorsal. C, genital complex and abdomen, ventral.

*phtheirus dissimulatus* differs from *L. marginatus* in the structure of leg 3, and *L. monacanthus* and *L. unispinosus* are distinguishable easily from *L. marginatus* by the terminal armature on the exopod of leg 1. Thus, only *L. christianensis* and *L. orbicularis* remain to be scrutinized further.

In her original report of *L. marginatus,* Bere (1936: 587) stated: "A single male and female have been selected for the types of the new species with U.S.N.M. No. 60548." Curiously, Wilson (1944) listed the same catalogue number for his type material of *L. christianensis.* He (Wilson 1944: 533) stated: "The female holotype and male allotype are U.S.N.M. No. 60548." The type collections kept at Smithsonian Institution show that the catalogue number of USNM 60548 is for the type lot of *L. christianensis* and that of *L. marginatus* is USNM 69860. Strangely, although *L. christianensis* was published eight years later than *L. marginatus* it is assigned a smaller (i.e., earlier) catalogue number.

Another curiosity about Wilson's report of *L. christianensis* concerns the number of specimens he collected, examined, and deposited in the National Museum of Natural

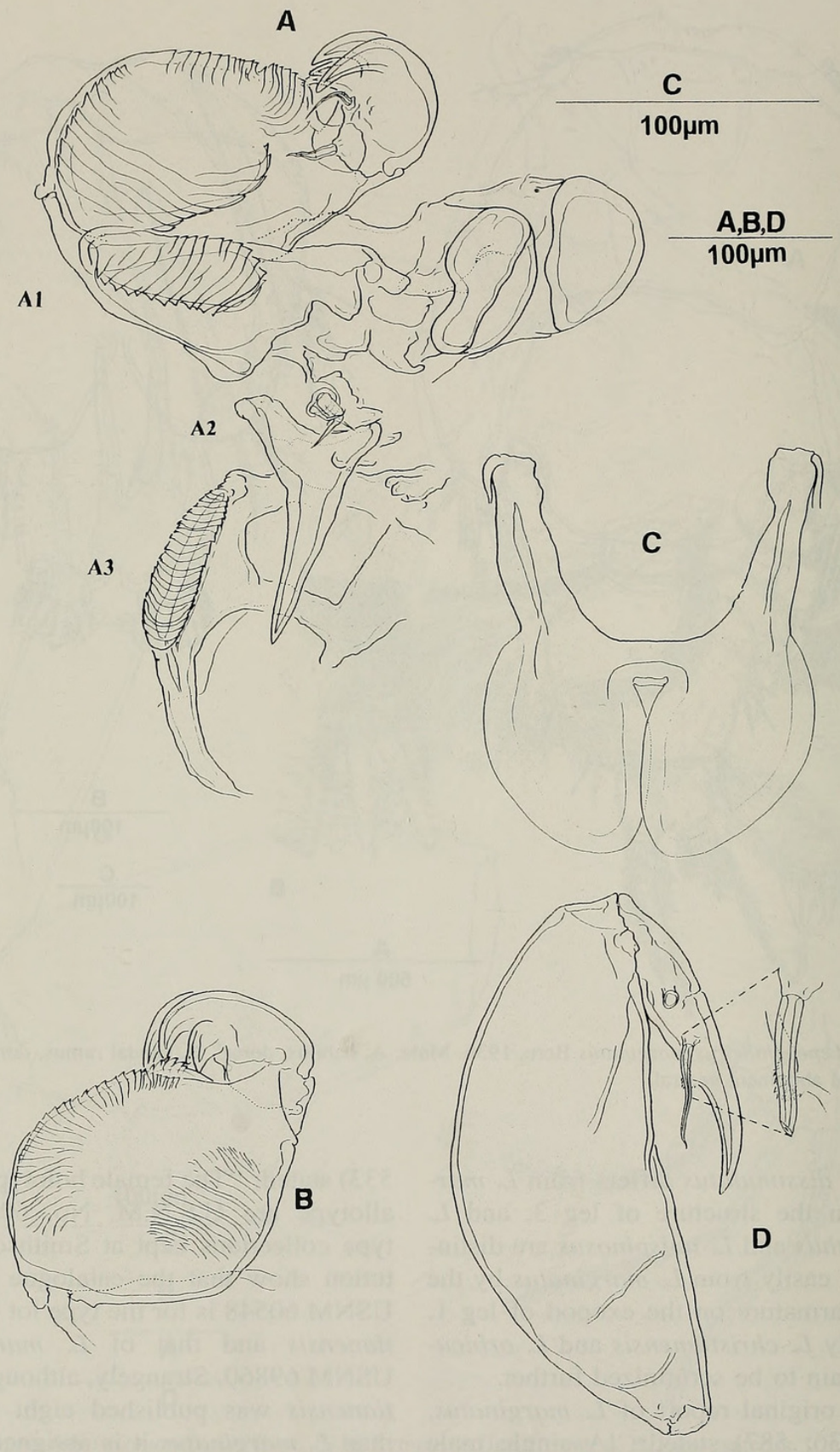


Fig. 6. *Lepeophtheirus marginatus* Bere, 1936. Male. A, antenna (A1), maxillule (A2), and corrugated pad (A3), ventral. B, middle and terminal segments of antenna, anterior. C, sternal furca. D, maxilliped, anterior.

History. Wilson (1944: 533) stated that, "Thirty specimens, including both sexes, were obtained from a sea catfish (*Galeichthys* sp.) at Pass Christian, Miss.," but museum records list a total of 32 specimens kept in two lots, two (one holotype female and one allotype male) in a lot carrying the catalogue number of USNM 60548 and 30 (18 adult females, nine adult males, one pair in amplexus, and one juvenile female) in another lot identified as USNM 60549.

Of the three distinguishing characteristics enumerated above for *L. marginatus,* the segmentation of the exopod of leg 3 and the armature on its proximal segment are the most remarkable feature of this species. In the original description of *L. marginatus,* Bere (1936: 588) stated: "The second and third legs are of the usual type" and thus omitted the illustrations of these two appendages. On the other hand, in Wilson's (1944: 534) report of *L. christianensis,* these two appendages were neither mentioned nor illustrated. As shown in Fig. 4A, leg 3 in *L. marginatus* is not "of the usual type." It is rather unusual in bearing a 2-segmented exopod carrying a setiform element on the proximal segment. These unusual features are found in all 32 specimens of *L. christianensis* deposited at the National Museum of Natural History. A check of their other features revealed that, indeed, all 32 specimens are compatible with our redescription of *L. marginatus.* Accordingly, we recommend relegating *L. christianensis* Wilson, 1944 as a junior synonym of *L. marginatus* Bere, 1936.

When Shiino (1965) reported *L. orbicularis,* no comments on or comparison with *L. marginatus* were made. However, after observing the morphology of *L. marginatus* and noting its close resemblance to *L. orbicularis,* we felt it was necessary to examine the type material of the latter, which was kept in the Faculty of Bioresources at Mie University in Tsu, Japan.

The type material of *L. orbicularis* (S-577) is kept in three vials marked 1, 2, and 3, with each of them containing one, nine, and five specimens, respectively. In his original description of *L. orbicularis,* Shiino (1965: 447) stated "No. 577. Ten females and five males. The largest female is selected as holotype." But, close examination of each specimen in a drop of lactic acid disclosed that while specimens in vial 1 (containing holotype ♀) and vial 2 (containing 5 ♀ ♀ and 4 ♂ ♂) agree with Shiino's (1965) description of *L. orbicularis,* the five specimens (4 ♀ ♀ and 1 ♂) kept in vial 3 are not. They differ from Shiino's original description in the shape of the abdomen (with straight sides) and structures on leg 3 (with longer velum) and leg 4 (with slender exopod). At this time, those five specimens kept in vial 3 should be excluded from *L. orbicularis.*

Shiino's (1965) description of *L. orbicularis* is clear and no supplemental information from our reexamination of the type material is significant to this study, except for the segmentation of the exopod of leg 3, which is clearly 2-segmented as in *L. marginatus.* Although some minor differences were detected in the fine structures of the maxillule (length of the dentiform process), maxilla (length of the subterminal process and ornamentation on calamus and canna), leg 2 (ornamentation on the two outer spines on the terminal segment of the exopod), and leg 4 (relative length of the lateral spine on the proximal segment of the exopod), these differences are considered geographical variation, because Shiino's (1965) material came from Peru, a different locality from Bere's (1936). Hence, we recommend that the name *L. orbicularis* Shiino, 1960 be relegated as junior synonym of *L. marginatus* Bere, 1936.

## Acknowledgments

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sity in Tsu, Japan to examine the type-material of *L. orbicularis* at that institution. Z. Kabata and two other reviewers are acknowledged for their comments and suggestions for the improvement of this paper. The completion of this manuscript was aided by a fellowship from the JISTEC (Japan International Science and Technology Exchange Center) and a grant from the Paramitas Foundation to the senior author (JSH).

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