W. D. WILLIAMS

A Revision of North American Epigean Species of Asellus (Crustacea: Isopoda)

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ABSTRACT

Williams, W. D. A Revision of North American Epigean Species of *Asellus* (Crustacea: Isopoda). *Smithsonian Contributions to Zoology,* 49: 1–80, 1970.—A taxonomic revision of North America epigean species of *Asellus* is given based almost entirely upon a study of male material. Descriptions are given of *A. communis* Say, *A. brevicauda brevicauda* Forbes, *A. brevicauda bivittatus* Walker, new combination, *A. intermedius* Forbes, *A. attenuatus* Richardson, *A. dentadactylus* Mackin and Hubricht, *A. montanus* Mackin and Hubricht, *A. kenki* Bowman, *A. racovitzai racovitzai,* new species, *A. racovitzai australis,* new subspecies, *A. forbesi,* new species, *A. obtusus,* new species, *A. laticaudatus,* new species, *A. scrupulosus,* new species, *A. nodulus,* new species, and *A. occidentalis,* new species. *Asellus militaris* Hay is synonymized with *A. intermedius,* and *A. tomalensis* Harford is regarded as a questionable name. It is suggested that *A. aquaticus* is absent from the North American continent. A key for the identification of males is given, and phylogenetic relationships are discussed, taking into consideration the ideas of Hennig (1950).

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W. D. Williams

A Revision of North American Epigean Species of *Asellus* (Crustacea: Isopoda)

Introduction

Ten epigean species of *Asellus* have hitherto been described from North America: *A. communis* Say, *A. brevicauda* Forbes, *A. intermedius* Forbes, *A. tomalensis* Harford, *A. militaris* Hay, *A. attenuatus* Richardson, *A. dentadactylus* Mackin and Hubricht, *A. montanus* Mackin and Hubricht, *A. bivittatus* Walker, and *A. kenki* Bowman. Of these only *A. dentadactylus, A. montanus,* and *A. kenki* have been described in sufficient detail in their original description to allow reasonable certainty of identification. The remainder, which includes most of the widespread species, has been inadequately known. This lack of knowledge is perhaps excusable because many of the specific descriptions were prepared before it was realized fully to what extent crustacean taxa should be described, and before it was appreciated that certain parts of the anatomy of *Asellus,* namely the male genital pleopods, were of particular taxonomic importance. As species of *Asellus* are frequent members of the fauna of North American freshwaters, sometimes forming a considerable proportion of the biomass, and as there is a continuing need for greater precision in ecological and pollutional studies dealing with freshwater, the present paper sets out to place our knowledge of the North American surface-living species of *Asellus* on a more precise footing.

Since this paper represents a revision and extension of knowledge of epigean forms, it may be regarded as complementing the papers of Steeves (1963a,b, 1964a,b, 1965, 1966) which deal with North American hypogean species on a more or less comprehensive basis. It is not possible, however, to draw an absolutely distinct line between species occurring in surface waters and those in underground waters. Thus, three species which typically occur in hygopean situations have been reported from surface waters: *A. tridentatus* (Hungerford) (Leonard and Ponder, 1949; Dexter, 1954); *A. conestogensis* Levi (Levi, 1949); and *A. stygius* (Packard) (Minckley, 1961). These species are not discussed in this paper; only those species which *typically* occur in surface waters are considered. Such surface species always have eyes.

During this investigation females were treated only cursorily, since as far as known they do not possess specific characters as precise as do males. This paper, therefore, is based almost entirely upon a study of male specimens only. Females differ from males principally in the structure of their first peraeopod and second pleopod (the first pleopod is always absent), and only these appendages are mentioned when reference is made to female material. To avoid confusion, the second pleopod of females is herein referred to as the "first" pleopod. Females are referred to only when type material (allotype or paralectotype) is available.

Within males, the most important systematic characters are associated with the genital pleopods, particularly with the tip of the endopodite of the second pleopod. The terminology here used for the various structures of the endopodite tip follows Steeves (1963a). Thus, a maximum of four terminal elements are associated with the ventral terminal groove: a mesial process arising from the medial edge of the ventral groove; a cannula, essentially a tubular prolongation of the ventral groove; a lateral process arising

W. D. Williams, Department of Zoology, Monash University, Clayton, Victoria 3168, Australia.

from the lateral edge of the ventral groove; and a terminal caudal process. To aid interpretation and comparison on the part of the reader, all drawings of the endopodite tip in this paper are similarly oriented and are from the right pleopod.

With regard to the actual examination of the morphology of the endopodite tip, it should be noted that variations from the descriptions given in this paper may appear to occur according to the position of the appendage when mounted for microscopical examination. It is important that endopodites are in undistorted positions when examined. Furthermore, the morphology may be altered by clearing or by mounting in a medium that includes a clearing agent; if the clearing is too severe it may cause contraction and distortion, particularly of the more delicate and unsclerotized parts, e.g., the cannula. The best media, though temporary, appear to be water or 70 percent alcohol. For the most part in the present study, material other than type material was examined after mounting and clearing in "Euparal" (George Gurr Ltd.). Type specimens were examined in 70 percent alcohol, and their various appendages and remains are preserved in 70 percent alcohol in microvials.

All drawings were made with a camera lucida.

Although the most important systematic characters, that is morphological features associated with the male second pleopod and particularly with the distal part of the endopodite, remain relatively constant in males of different sizes and from different localities, dissimilarities from a type description may occur with regard to both these and other morphological characters. An indication of the extent of such variation follows the type description of each species and is based upon all available male material of the species in question. In comparisons of unknown material with type descriptions, all segmental appendages from the first antennae to the uropoda were usually examined.

Apart from that applying to *A. communis,* in the type descriptions, details are omitted when these refer to parts of the body that are similar in morphology to *A. communis* (neotype). It should also be noted that: (1) body length refers to the distance between the anterior margin of the head and the posterior margin of the telson, i.e., exclusive of the uropoda; (2) the length of the second pleopod of males is always regarded as the distance between the proximal end of the sympod and the distal tip of the *endopodite* (note that in many species the exopodite extends beyond the endopodite).

Abbreviations used in this paper referring to the institutions from which material was borrowed are as follows:

GLI	Great Lakes Institute, Toronto
INHS	Illinois Natural History Survey, Urbana
MCZ	Museum of Comparative Zoology, Harvard University
NMC	National Museum of Canada, Ottawa
ROM	Royal Ontario Museum, Toronto
USNM	Smithsonian Institution, United States National Museum

In the synonymies for each species, no attempt is made to provide complete references to each name because of the largely uncritical application of names that has taken place; only the more important descriptive papers or papers otherwise of some importance are listed.

Generic and Subgeneric Characters

All species examined during the present study were clearly covered by the generic diagnosis of *Asellus* as given by Birstein (1951, p. 51); the only other freshwater isopods encountered were referable to the genus *Lirceus.* However, clear division of North American species into the subgenera of *Asellus* reported from North America—*Conasellus* Stammer, *Mesasellus* Birstein, and *Baicaloasellus* Stammer—seems not possible. The simple concept indicated by Birstein (1951, p. 22) that central and eastern species belong to the subgenus *Conasellus,* while western species belong to one or two other subgenera no longer seems tenable. Thus, comparison of the diagnosis of the subgenus *Conasellus* as given by Stammer (1932, p. 130) with the redescriptions and original descriptions of species given herein and by Steeves (1963a, b, 1964a, b, 1965, 1966) reveals that none of the subgeneric characters is unique for all central and eastern species other than those which, according to Bresson (1955), apparently belong to *Baicaloasellus.* The only character with some constancy is the development of one or more median processes on the posterior margin of the propodus of the male first peraeopod. But even this, while considerably developed in most epigean species, is definitely absent in several hypogean species. In view of this situation I, like Bowman (1967), am inclined in this paper to the ideas of Chappuis (1955, p. 168) who advised against the creation of subgenera in the genus *Asellus.* At the same time, although no subgeneric divisions are now attempted, I do not wish to deny that meaningful species groupings of subgeneric status are possible for North American species of *Asellus*. Such groupings, however, will need to follow a further extension of our systematic knowledge of epigean forms, especially perhaps those in the west, and an integration of this with our knowledge of hypogean species groups.

Key to Males of Known North American Epigean Species of *Asellus*

(The terms mesial, lateral, and caudal process, ventral groove, and cannula, refer to structures at the tip of the endopod of the second pleopod.)

1. Palm of propodus of first peraeopod lacking triangular process near midpoint; mesial and caudal process not developed, but lateral process large, projecting beyond cannula, and distally recurved (Figures 53D,E, 56) .... ***A. occidentalis***, new species
   Palm of propodus of first peraeopod usually with a triangular process (often large) near midpoint; lateral process either absent, or developed in conjunction with mesial process 2
2. First pleopod usually distinctly longer than second, and distal segment usually subovate, often curved outward, and with few to several long plumose spines on distal margin 3
   First pleopod usually subequal in length to second or distinctly shorter, and distal segment subovate to subrectangular, without long plumose spines on distal margin 8
3. Endopod of second pleopod subject to torsion so that ventral groove is not visible in ventral aspect 4
   Endopod of second pleopod not subject to torsion; ventral groove clearly visible in ventral aspect 5
4. Endopodial armature of second pleopod forming a terminal spiral structure (Figures 24D,E). ***A. montanus*** Mackin and Hubricht
   Endopodial armature of second pleopod consisting of two large, heavily sclerotized structures showing only mild torsion (Figures 51E,F) .... ***A. nodulus***, new species
5. Lateral process not developed, but mesial process large and bifid, and caudal process wide and dentate (Figures 23D,E) .... ***A. dentadactylus*** Mackin and Hubricht
   Lateral process well developed, caudal process either absent or broadly rounded 6
6. Uropoda about half length of telson (never more than 0.7 telson length); endopodial armature consisting of a rounded mesial process (not dentate), and a nonsclerotized rounded lateral process (Figures 12C,D, 15) .... ***A. brevicauda*** Forbes
   (for separation of the two subspecies, see Table 3.)
   Uropoda subequal in length to telson; endopodial armature not as described for *A. brevicauda* 7
7. Mesial process dentate, lateral process sclerotized and pointed, caudal process not developed (Figures 49D,E, 50) .... ***A. scrupulosus***, new species
   Mesial process not dentate, lateral process rounded, caudal process developed and broadly rounded with a few rugosities (Figures 25D,E) .... ***A. kenki*** Bowman
8. Mesial process absent 9
   Mesial process present 11
9. Caudal process absent (Figures 46D,E, 48) .... ***A. laticaudatus***, new species
   Caudal process present 10
10. Caudal process often with acutely pointed apex; cannula short and wide (Figures 16C, 17D,E, 20) .... ***A. intermedius*** Forbes
    Caudal process usually broadly rounded; cannula long and narrow (Figures 5D,E, 10). ***A. communis*** Say
11. Cannula relatively long and narrow 12
    Cannula relatively short and wide 13
12. Caudal process usually with an acute apex (Figures 29D,E, 32, 33D,E, 36); first pleopod subequal in length to second .... ***A. racovitzai***, new species
    (for separation of the two subspecies, see Table 4.)
    Caudal process rounded (Figures 21D,E); first pleopod distinctly shorter than second. ***A. attenuatus*** Richardson
13. Mesial process usually short and wide, and cannula very wide with a recurved outer lip (Figures 44C,D, 45) .... ***A. obtusus***, new species
    Mesial process usually long and not very wide, and cannula of moderate width (Figures 37D,E, 41) .... ***A. forbesi***, new species
    (further differences between these two species are given in Table 5.)

Asellus communis Say

FIGURES 1–6, 8–10

Asellus communis Say, 1818, pp. 427–428.
Not *Asellus militaris* Hay, 1878, p. 90.
Not *Asellus communis* Say.—Racovitza, 1920, pp. 79–95, figs. 52–73.

Asellus communis was the first species of North American *Asellus* to be described. The description was extremely brief and no details were given of the male sexual pleopods; furthermore, no drawings were included. In view of the inadequacy of the original description, it is uncertain if any of the several subsequent redescriptions, none of which referred to original type material, in fact applied to *A. communis* (cf. Smith, 1874; Richardson, 1905; Racovitza, 1920; Van Name, 1936).

The description by Racovitza (1920) is of some importance since it was original in the sense that it was not based on previous descriptions and was very detailed. It also provided an extensive bibliography up to 1920 for the species. The description, however, was based on two male specimens and one ovigerous female sent to Racovitza by the United States National Museum from a collection made by W. P. Hay from the edge of the Potomac River in Virginia, a locality some 125 miles from the region where *A. communis* had apparently been collected by Say for the original description. The decision to regard these specimens as conspecific with *A. communis* appears to have been quite arbitrary on the part of Racovitza; indeed it seems that Racovitza did not even sight Say's description, as indicated by his remarks (p. 79) under the heading "Type de l'espèce."

Unfortunately, no specimens identified by Say appear now to exist. Say did not mention in the original description that types had been set aside, but there is a brief note following a comment on the habitat of the species (p. 427, "Cabinet of the Academy"), from which we may reasonably conclude that identified material had been placed in the collections of the Academy of Natural Sciences of Philadelphia. None of this material can now be found, according to information received from Mr. C. W. Hart, Jr., the Academy of Natural Sciences of Philadelphia (personal communication, January 1966), who made a search on my behalf.

In the absence of material named by Say, it is therefore impossible to determine with absolute certainty the identity of *A. communis* or its conspecificity or otherwise with the species described by Racovitza. Despite this uncertainty, however, it is clear that the name *A. communis* has been the most frequently used of all specific names when referring to epigean freshwater isopods in North America. Van Name (1936, p. 456), for example, states that it is "by far the most abundant and widely distributed isopod in the eastern half of the United States, also in southern Canada."

In order to provide a solution to the identity of *A. communis,* and as rather precise details were given by Say of the area from which we may conclude he obtained his specimens, the decision was taken to create a neotype. This decision, it is felt, is in accord with the provisions of Article 75, Neotypes, of the International Code of Zoological Nomenclature Adopted by the XV International Congress of Zoology (1961) in that the neotype is designated in connection with revisory work and is essential for the identification of one of a number of closely similar species. Confirmation has been received from four colleagues who work on or are interested in the taxonomy of North American *Asellus* species that this procedure is not one they object to (Drs. E. L. Bousfield, T. E. Bowman, R. Prins, and H. R. Steeves III).

With reference to the distribution of *A. communis,* Say noted (p. 427) that it inhabits "small streams of fresh water, under stones," and (pp. 427–428) is "a very common species in our fresh water, particularly in rivulets under stones. It is frequently introduced with the Schuylkill water into Philadelphia." Bearing this information in mind, a collection was made at Valley Forge, about 20 miles northwest of Philadelphia, on 14 April 1967 from Valley Forge Creek, a small, moderately fast-flowing, stony-bottomed tributary of the Schuylkill River. This locality is proposed as the restricted type locality. Of the three male specimens collected, the largest was selected and designated the neotype.

Comparison of Racovitza's (1920) description with the description given herein of the neotype of *A. communis* indicates that two species are involved, that is the species described by Racovitza is different from *A. communis.* The material from which Racovitza received three specimens in 1920 and upon which specimens he based his description is fortunately still in existence and has been used as the type collection for a new species *A. racovitzai* (see under this species).

Asellus militaris was described by Hay in 1878. In a later publication, however, he noted (1882, p. 241) that the species should be synonymized with *A. communis.* Probable syntype material of *A. militaris* still exists and this, on examination, proved to be conspecific with *A. intermedius* (see discussion under this species).

TYPE MATERIAL.—Neotype: adult ♂, catalog number 7300, labeled "*Asellus communis* Say Neotype (♂)." Topotypes: two adults ♂♂, catalog number 7301, labeled "*Asellus communis* Say topotypes (2♂)." All specimens in the collection of the Academy of Natural Sciences of Philadelphia and in jar labeled "*Asellus communis* Say neotype and topotypic material collected from Valley Forge Creek, near Philadelphia, Pa., 14 April 1967 by W. D. Williams."

DESCRIPTION OF NEOTYPE.—Body: Length, 11.0 mm; maximum width, 4.0 mm. Color of live specimens mottled pale and dark brown. Surface smooth.

Head (Figure 1A): About twice as wide as long. Front margin distinctly concave. Eyes moderately large and quite distinct. Lateral margins of head with numerous simple spines of various lengths.

Thoracic terga: Roughly rectangular, posterior ones slightly larger than anterior ones, all with short to long spines on lateral and posterior margins. Second to seventh terga with anterior angles forming small lobes increasing in size posteriorly. First tergum (Figure 1B) without such lobes but coxa of first peraeopod prominent.

First antenna (Figure 1C): Flagellum 16-merous and tip not quite reaching to distal end of last segment of peduncle of second antenna; penultimate 3 segments bearing aesthetascs. Flagellum and peduncle subequal in length. All segments of peduncle more or less subequal in length. First peduncle segment about twice as long as wide; second and third segments respectively 3 and 4 times as long as wide.

Second antenna (Figure 1D): Length (6.0 mm) just over half (0.55) that of body. Flagellum 53-merous and about twice length of peduncle. First, second, and third segments of peduncle stout, each with several strong simple spines, and about as wide as long; fourth segment as long as first three combined, 3 times as long as wide; fifth segment about 1.5 times length of fourth, about 6 times as long as wide.

Lips: Upper lip (Figure 1E) subquadrate with dense fringe of fine setae distally. Lower lip (Figure 1F) bilobed, each lobe more or less triangular and fringed with long fine setae distally and marginally.

Mandibles: Each with a large, well-developed 3-segmented palp, the last 2 segments of which form a weak claw with its inner margins bearing many spines each with a fine setose 'comb' distally. Left mandible (Figure 2A) with 4-toothed incisor process and lacinia; spine row beneath lacinia of 15 unilaterally plumose spines. Right mandible of neotype missing, but that of a topotype (Figure 2B) with a 4-toothed incisor and a spine row beneath incisor of 16 finely pectinate to unilaterally plumose spines.

First maxilla (Figures 2C, D): Inner plate with 5 large plumose spines terminally and numerous fine, small, simple spines laterally. Outer plate with 11 variously dentate stout spines on distal margin, one long, fine, plumose spine near lateral distal angle, some small spines on outer proximal margin, and a fringe of fine setae on proximal part of inner margin.

Second maxilla (Figure 2E): Outer plate of 2 subequal laminae; outer lamina with about 22 long to short, pectinate or dentate spines on distal margin; inner lamina with 15 such spines on distal margin. Inner plate bearing a number of simple, plumose or pectinate spines on distal edge and with a medial dorsal row of about 36 long, simple spines.

Maxilliped (Figure 2F): Palp large with many slender spines on inner margins of segments and a few strong spines on outer margins. Masticatory lobe with several simple or plumose spines distally and 5 coupling hooks medially. Epipodite subquadrate, outer basal angle almost a right angle.

First peraeopod (Figures 3A, B): Relatively short and stout, subchelate. Dactylus as long as palm of propodus, with numerous teethlike spines on inner margin and ending in a distinct claw. Propodus almost as long as wide, subquadrate; palm with a single large triangular projection as tall as width of opposing part of dactylus and situated near midpoint, a smaller projection between larger projection and point of attachment of dactylus, 2 very strong teethlike spines proximally, and a submarginal row of spines on inner and outer surfaces. Carpus small, as long as wide, triangular. Merus larger than carpus, slightly wider than long, subtriangular. Ischium about twice as long as merus, length about 1.5 times width. Basis subrectangular,

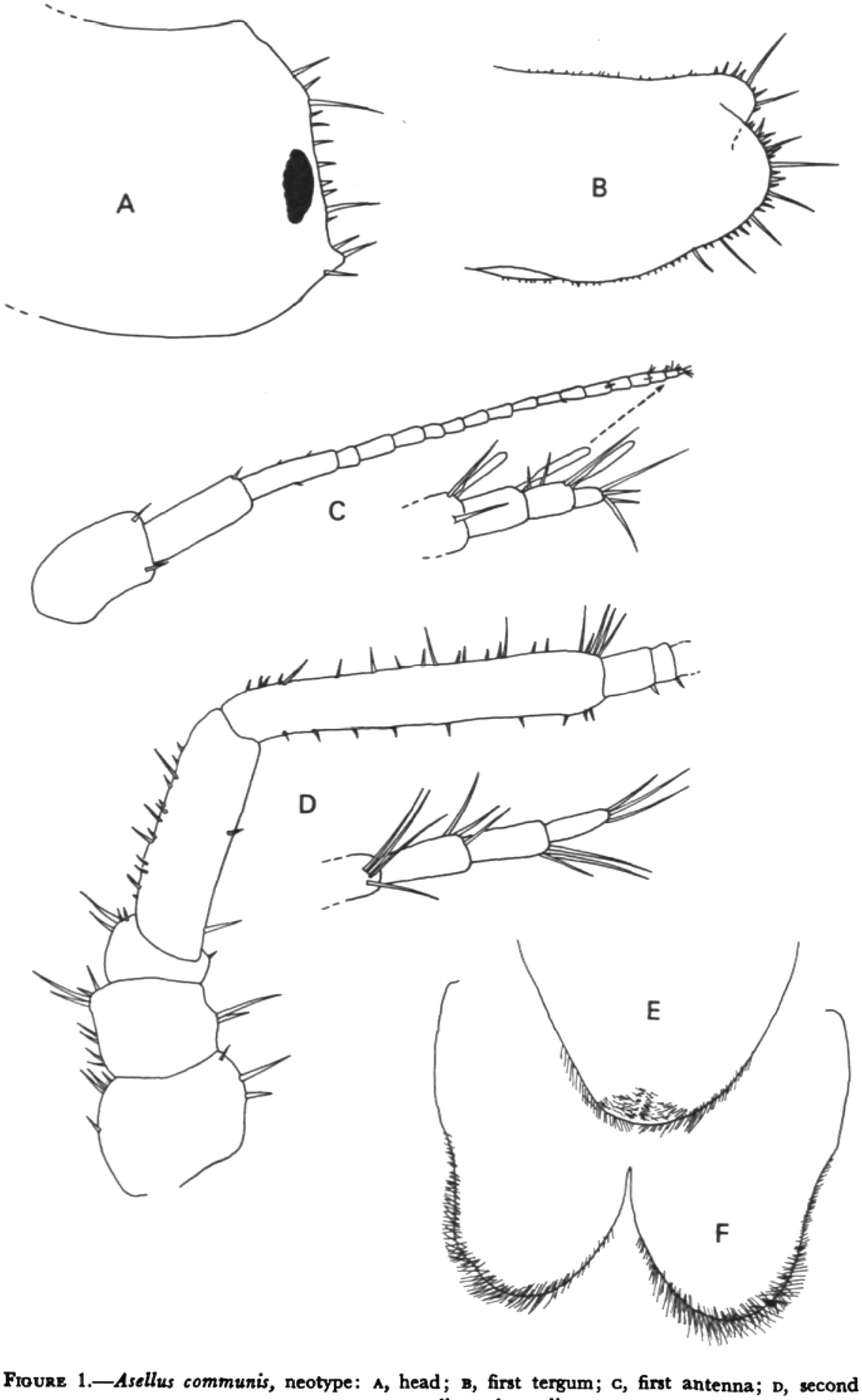

FIGURE 1.—*Asellus communis,* neotype: A, head; B, first tergum; C, first antenna; D, second antenna; E, upper lip; F, lower lip.

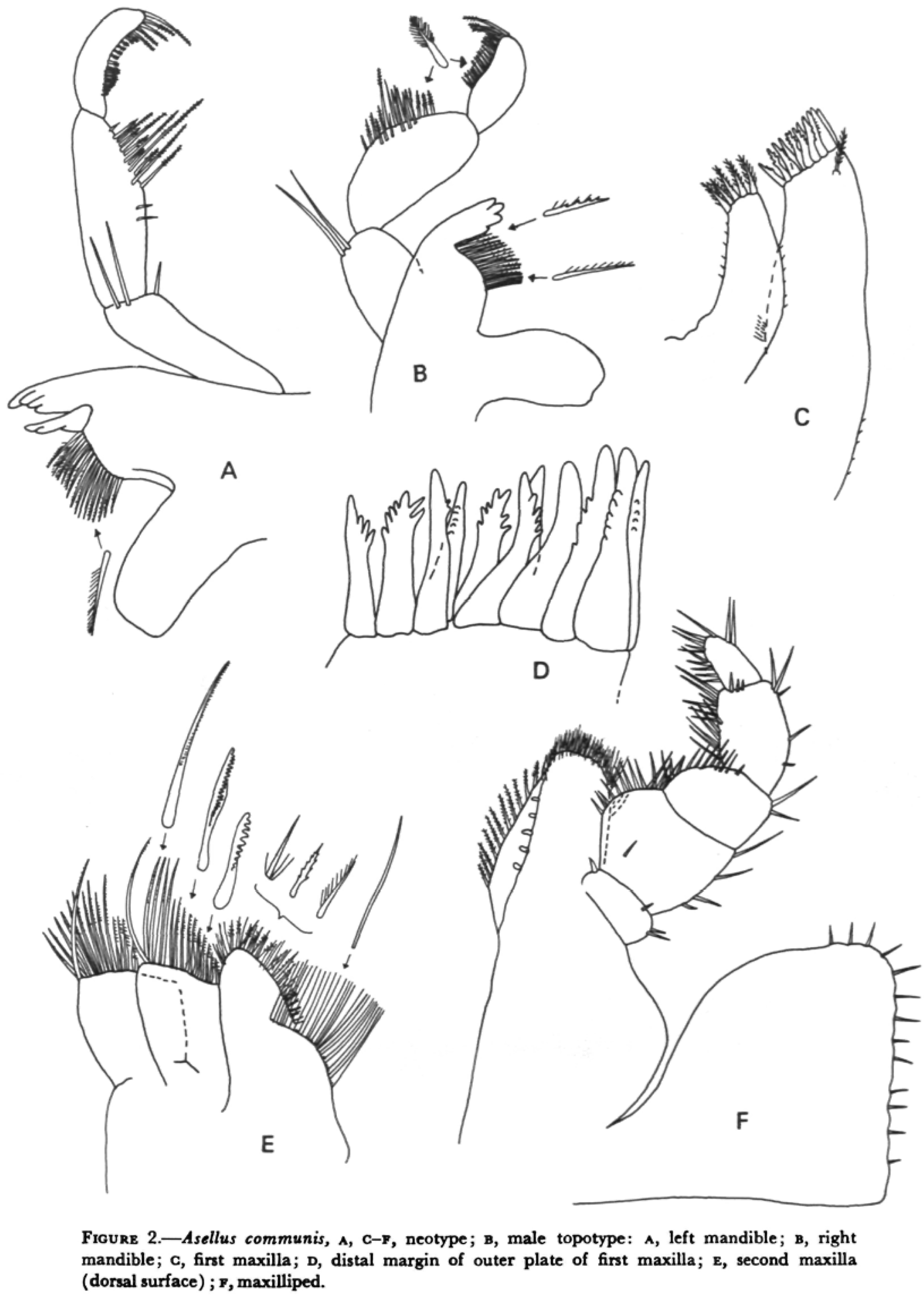

FIGURE 2.—*Asellus communis*, A, C–F, neotype; B, male topotype: A, left mandible; B, right mandible; C, first maxilla; D, distal margin of outer plate of first maxilla; E, second maxilla (dorsal surface); F, maxilliped.

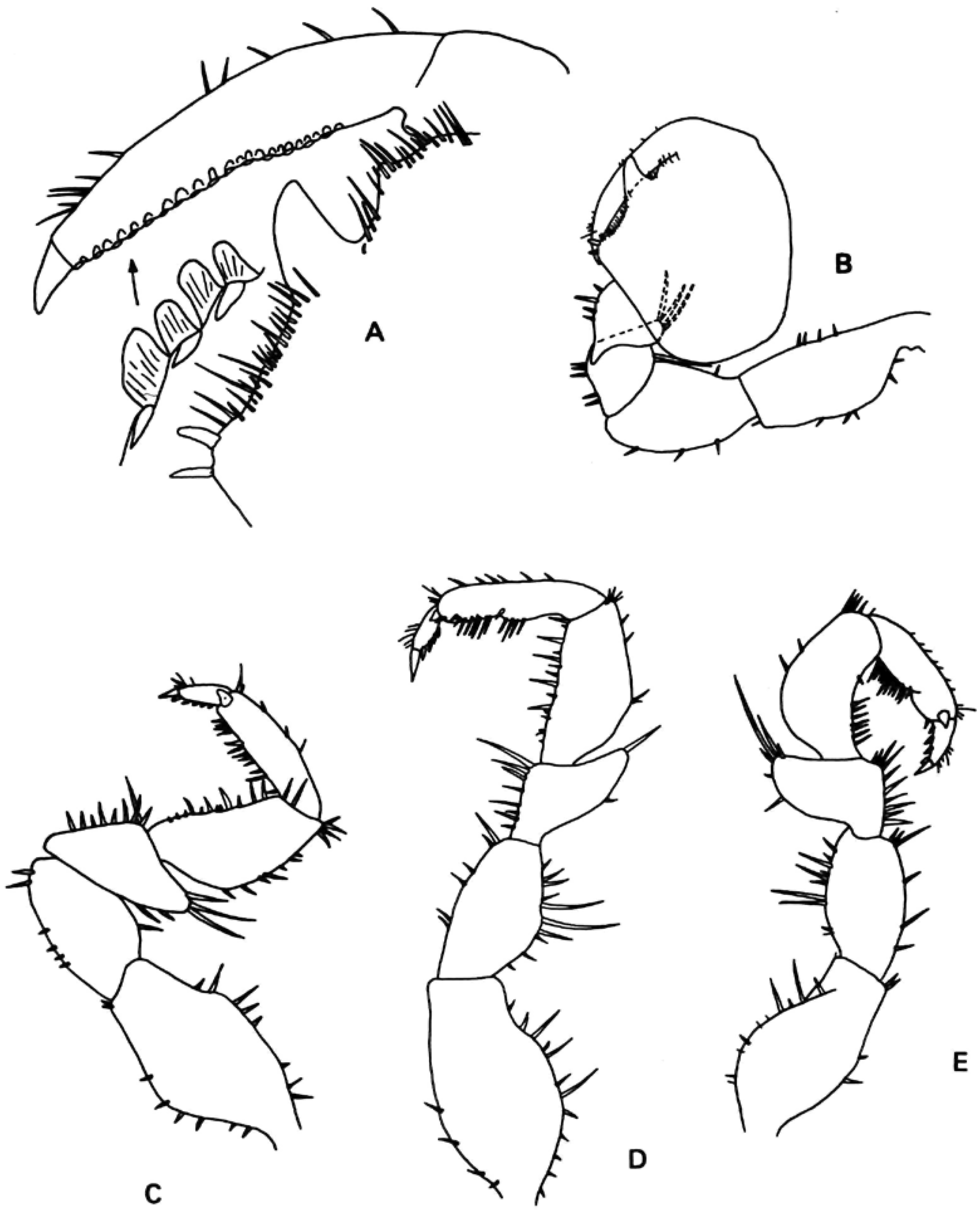

FIGURE 3.—*Asellus communis*, neotype: A, dactylus and palm of first peraeopod; B, first peraeopod; C, second peraeopod; D, third peraeopod; E, fourth paraeopod.

about 1.5 times as long as ischium, and twice as long as wide.

Second peraeopod (Figure 3C): Longer than but not as robust as first peraeopod; not subchelate. Dactylus about half as long as propodus with 5 teethlike spines on inner margin and a similar terminal spine. Propodus about 4 times as long as wide, and bearing distally a sclerotized triangular process. Carpus trapezoidal, twice as long as greatest width. Merus subtriangular, almost as long as wide, with some very long and strong spines at anterodistal angle. Ischium subrectangular, twice as long as merus and two-thirds as wide as long. Basis subrectangular, 1.5 times as long as ischium, about twice as long as wide.

Third peraeopod (Figure 3D): Similar to second peraeopod.

Fourth peraeopod (Figure 3E): Slightly shorter than second or third peraeopod. Dactylus half as long as propodus and with 4 teethlike spines on inner margin. Propodus 3 times as long as wide, notched at point one-third of length from distal end on inner margin with several long spines proximal to notch and a single triangular projection on distal margin. Carpus bent in long axis and forming with dactylus and propodus an almost subchelate structure. Otherwise rather similar to second peraeopod.

Fifth peraeopod (Figure 4A): Longer than fourth peraeopod. Dactylus about two-fifths as long as propodus and with 4 teethlike spines on inner margin. Propodus about 5 times as long as wide; anterior margin not notched but with several long spines; distal margin with triangular projection and anterodistal angle with a strong spine. Carpus more or less straight along long axis, about twice as long as wide, and three-quarters length of propodus. Merus slightly longer than wide, with a few robust spines at posterodistal angle. Ischium three-fourths as wide as long, and as long as carpus; posterior margin with several long spines. Otherwise rather similar to second peraeopod.

Sixth peraeopod (Figure 4B): Slightly longer than fifth peraeopod. Propodus about 4 times as long as wide. Carpus 2.5 times as long as greatest width. Otherwise similar to fifth peraeopod.

Seventh peraeopod (Figure 4C): Slightly longer than sixth peraeopod. Carpus about twice as long as wide. Otherwise rather similar to sixth peraeopod.

First pleopod (Figure 5A): Total length of appendage 1.26 times as long as second pleopod. Sympod subrectangular, about three-fourths as wide as long, inner margin with 5 hooklike protuberances for coupling. Distal segment also subrectangular, but outer margin very slightly concave; twice as long as wide, and about 1.33 as long as sympod; distal margin and distal half of outer margin bearing numerous short and simple spines; inner proximal angle with single spine.

Second pleopod (Figures 5B–E): Sympod subsquare with single spine near inner distal angle. Proximal segment of exopod with 3 setose and 1 simple spine on outer margin. Distal segment of exopod ovate with 23 long setose spines marginally and also many very fine setae arranged in groups of about 3 to 5 on surface of segment near inner margin. Endopod narrow, slightly curved medially, about as long as both segments of exopod, two-thirds length of sympod, and about 3 times as long as greatest width; prominent inner and outer apophyses occur basally. Cannula of endopod long and simple, extending beyond caudal process. Caudal process prominent, rounded, sclerotized, without associated hooks. Mesial process not evident.

Third pleopod (Figure 6A): Sympod small. Exopod forming large operculum for remaining pleopods, ovate; suture between proximal and distal segments running obliquely and proximally; outer and distal margins of distal segment with many relatively long plumose spines, inner submargin with several short simple spines; outer margin of proximal segment with many simple spines, and short simple spines also present along suture with distal segment. Endopod small and ovate.

Fourth pleopod (Figure 6B): Sympod small. Exopod ovate and with a row of relatively long simple spines and very short fine setae along outer proximal margin. Endopod ovate, smaller than exopod.

Fifth pleopod (Figure 6C): Exopod subrectangular, about 1.5 times as long as wide, and with several long simple spines (but no fine setae) along outer proximal margin.

Uropod (Figures 4D, 6D): Slightly shorter (0.89) than telson. Peduncle about twice as long as greatest width, with many marginal spines. Exopod two-thirds (0.69) length of peduncle; endopod about as long as (0.92) peduncle and 3 times as long as greatest width.

Telson (Figure 6D): Subcircular, as long as wide; apex obtusely pointed, and lateral and posterior margin with numerous simple and relatively short spines.

MATERIAL EXAMINED.—Apart from the neotype and the two topotypes (in part), the following material

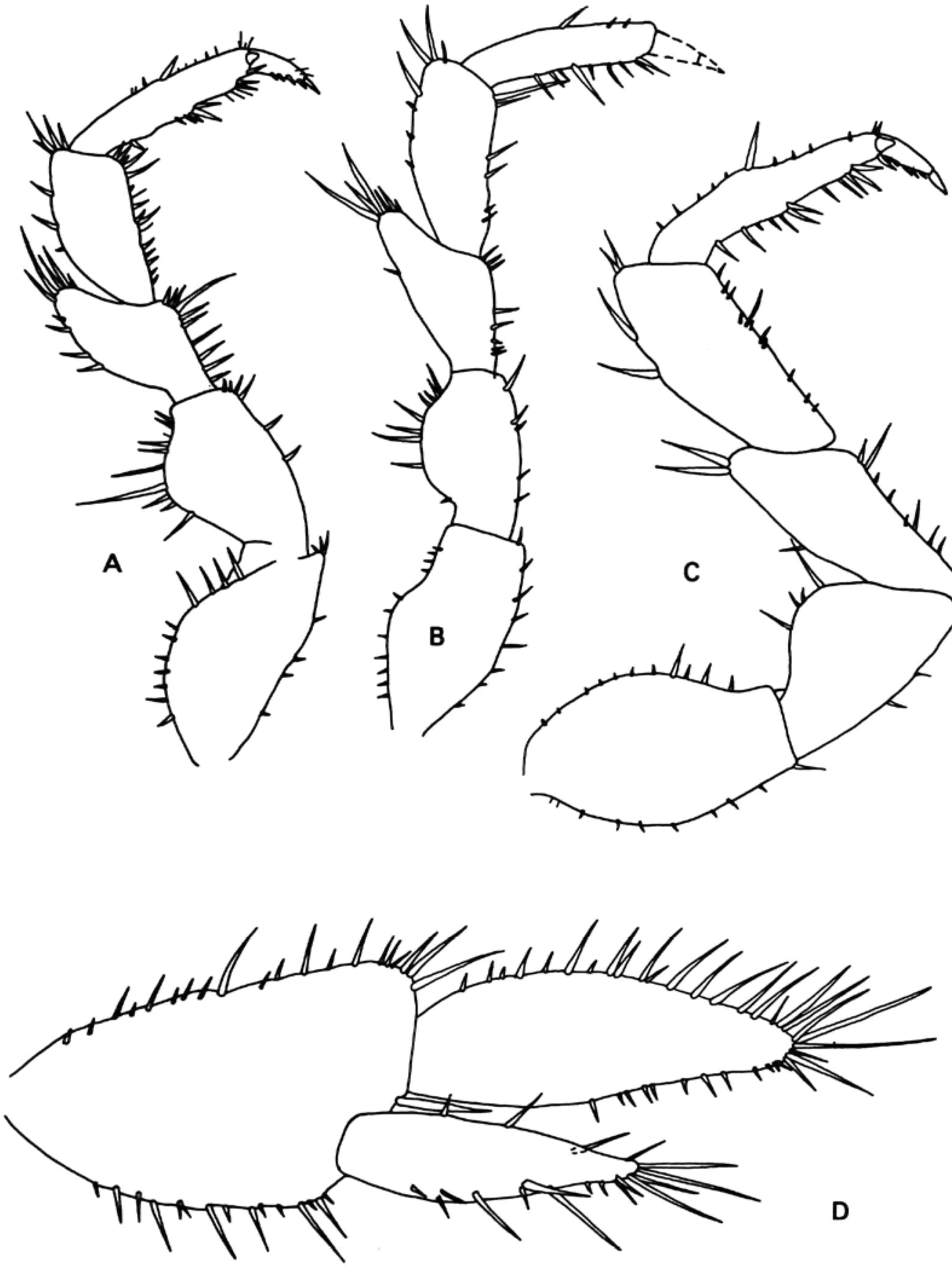

FIGURE 4.—*Asellus communis*, neotype: A, fifth peraeopod; B, sixth peraeopod; C, seventh peraeopod; D, uropod.

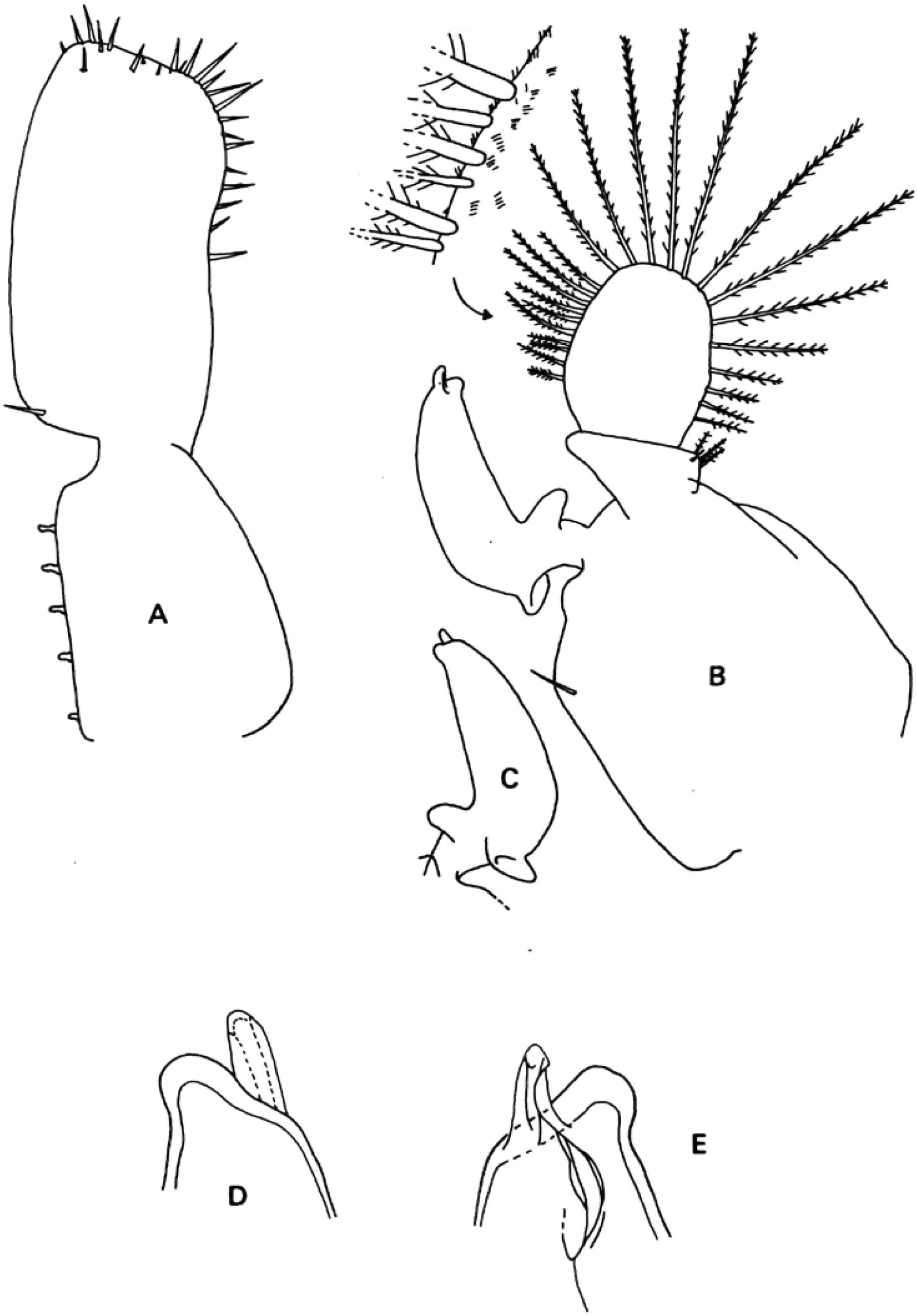

FIGURE 5.—*Asellus communis*, neotype: A, first pleopod; B, second pleopod; C, dorsal surface of endopodite of second pleopod; D, E, respectively dorsal and ventral surfaces of tip of endopodite of second pleopod.

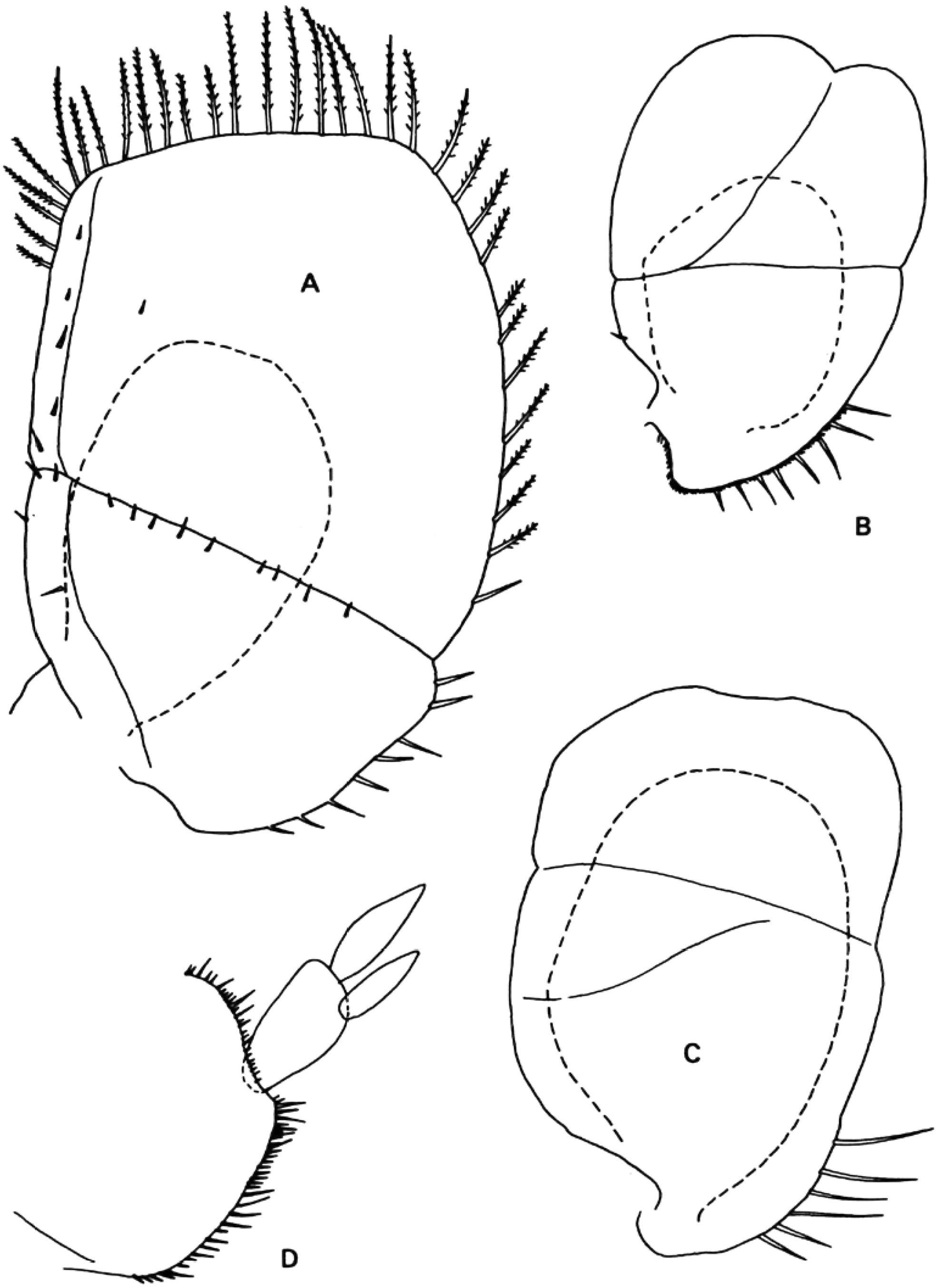

FIGURE 6.—*Asellus communis*, neotype: A, third pleopod; B, fourth pleopod; C, fifth pleopod; D, uropod and telson.

was examined and considered to be *A. communis;* such differences as occurred from the neotype were considered to be insignificant at the species level.

NOVA SCOTIA: Argyle stream, Yarmouth County, 3♂♂, coll. E. L. Bousfield, 28.vi.1958 (NMC); stream near Doctor's Cove, Shelbourne County, 1 ♂, coll. E. L. Bousfield, 28.vi.1950 (NMC); Pubnico Lake, Yarmouth County, 5♂♂, coll. E. L. Bousfield, 21.vi.1956 (NMC).

ONTARIO: Lynn River, 1♂, coll. Ontario Dept. P. & D., 10.vi.1955 (NMC); Chaffey's Locks, Leeds County, 1♂, coll. I. M. Smith, 4.ix.1965 (ROM).

COLORADO: Independent Reservoir, Boulder County, 4♂♂, coll. S. J. Herrmann, 18.iv.1967; Longmount Power Station Lake, Boulder County, 7 ♂♂, coll. S. J. Herrmann, 18.iv.1967; Mirror Lake, Larimore County, ∞ ♂♂, coll. S. J. Herrmann, 26.iv. 1967; Kid's Lake, Larimore County, 30♂♂, coll. S. J. Herrmann, 26.iv.1967; Meadow Lake, Larimore County, ∞ ♂♂, coll. S. J. Herrmann, 26.iv.1967; Rainbow Lake, Larimore County, ∞ ♂♂, coll. S. J. Herrmann, 26.iv.1967; Sunset Lake, Boulder County, ∞ ♂♂, coll. S. J. Herrmann, 26.iv.1967; Willow Lake, Larimore, ∞ ♂♂, coll. S. J. Herrmann, 26.iv.1967.

MAINE: Bangor, 2♂♂, coll. J. Brower, 21.iv.1962.

MARYLAND: Hall's Creek, Dunkirk, Calvert County, 2 ♂♂, coll. R. H. Greenfield and W. H. Ball, 25.vi.1934 (USNM).

MASSACHUSETTS: Cambridge, 1♂, coll. Wheatland, April 1860 (MCZ); Cambridge, 8♂♂, coll. Wheatland, 21.iv.1860 (MCZ); (?) Cambridge, 2♂♂, collector and date not marked (MCZ); Salem, 11♂♂, coll. Boston Society of Natural History, date not marked (MCZ); Beaver Brook, Danvers, ∞ ♂♂, coll. H. W. Winkley, date not marked (USNM); Red Brook Pond, 3♂♂, coll. E. L. Bousfield, 11.ix.1963 (NMC); Witch Brook and Crocker Pond, 8♂♂, coll. E. L. Bousfield, 24.ix.1965 (NMC).

NEW JERSEY: Swamp back of Orange Mountains, ∞ ♂♂, coll. E. G. Mitchell, 1906 (USNM); Lakehurst, 1♂, coll. D. Barr, 16.v.1962 (ROM); New Lisbon, 3♂♂, coll. D. Barr, 16.v.1962 (ROM); Lakehurst, 2♂♂, coll. D. Barr, 17.v.1962 (ROM).

PENNSYLVANIA: Conestoga River Lancaster County, 6♂♂, coll. H. W. Levi, June 1948 (MCZ).

VERMONT: Lake Champlain,* 2♂♂, coll. E. L. Bousfield, 19.vi.1956 (NMC).

WASHINGTON: Echo Lake,* King County, 2♂♂, coll. E. L. Bousfield, 20.vii.1955 (NMC).

WEST VIRGINIA: Halltown, 6♂♂, coll. B. Bryan, date not marked (USNM).

Collections marked by an asterisk contained more than one species. Many of the collections in addition to males included juveniles and nonovigerous and ovigerous females, but since it is at present not possible to identify such material, no note of their occurrence is made. These two comments apply generally to all collections referred to in subsequent pages of this paper.

Geographical distribution.—Figure 7 shows the geographical distribution of all localities detailed above (except those of uncertain position) as well as the position of the restricted type locality. It indicates that the species mainly occurs in the northeastern part of the United States and the southeastern part of Canada. There are two disjunct regions, however, where the species has also been recorded: Colorado, where it was recorded from eight different localities in the Denver area; and the State of Washington, where the species was recorded together with *A. racovitzai* in Echo Lake, King County. Material from both regions was examined with particular care, but as far as the present author could discern all specimens appeared clearly to be conspecific with material of *A. communis* from the eastern part of North America.

The material from Echo Lake was collected by Dr. E. L. Bousfield, and his notes upon the locality are of considerable interest; he wrote (personal communication, 1 September 1967):

> Echo Lake is the type locality of *Crangonyx richmondensis occidentalis* H. & H., one of a species complex that is usually found together with *A. communis* in the east. . . . *Crangonyx pseudogracilis* Bousf., formerly thought to be endemic to eastern North America, has also turned up in material from Oregon and Washington [cf. Bousfield, 1961], and indicates that fresh-water peracaridans may have much wider distributions than formerly believed.

In this connection, the records of "*A. communis*" by Hatch (1947) are also of some interest; while no certainty can be attached to his specific determinations, the mention of material from the Lake Washington drainage basin (p. 171) with a single prominent tooth on the inner margin of the posterior surface of the propodus of the male first peraeopod suggests that he too might have been dealing with a "typically" eastern species, for males of *A. occidentalis,* the only widespread western species known, lack such a tooth.

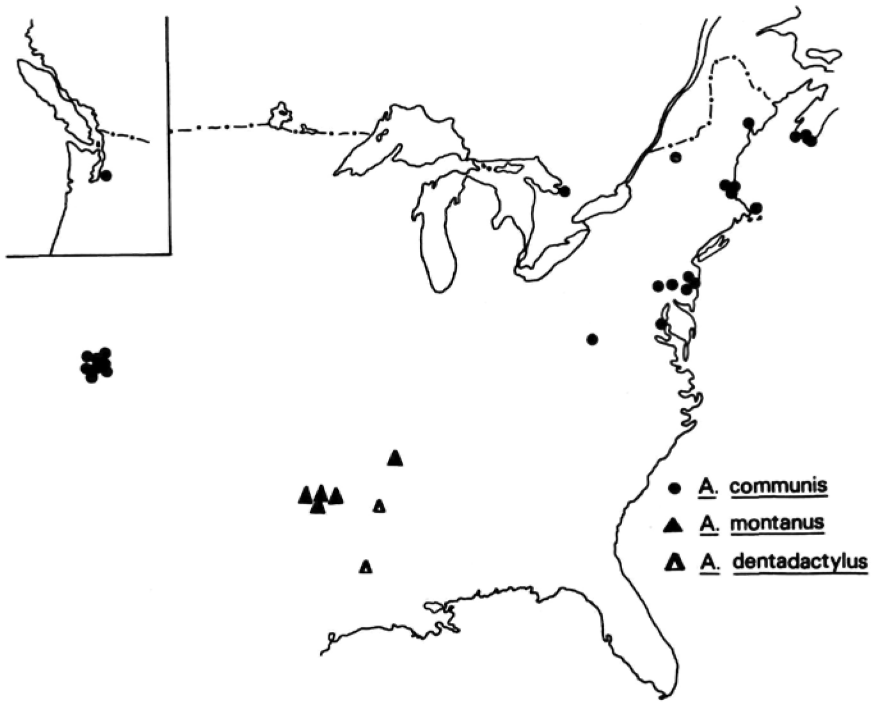

FIGURE 7.—Geographical distribution.

One cannot rule out in the case of the Washington material missorting of labels (the material was not sorted by Bousfield personally); but this eventuality could hardly have occurred in the case of the material from Colorado, which was collected only a short time before my receipt of it. Artificial transference from the eastern States cannot perhaps be ruled out for the Colorado localities, since all are situated in a region with extensive numbers of artificial water bodies and reservoirs, and such waters are frequently recipients of food stocking (invertebrates) on the part of angling associations. *Asellus* is well known to be a nutritive fish food, but appears naturally to be rare or absent in most of the region to the north of Colorado. Thus, Dr. W. N. Rosine of Augustana College, South Dakota, wrote (personal communication, 11 May 1967):

> I have collected amphipods rather extensively in South Dakota, Nebraska and Minnesota and have come across isopods only once. . . . I must say that over the years I have been rather surprised by the lack of isopods in this part of the county. . . . it seems to me that if they were even occasionally present around here then I would have found them at some time or another. Collecting in Colorado produced the same experience. Visits in that State to literally hundreds of lakes, springs and streams yielded only two collections in the early 1950s.

ECOLOGY.—From the limited locality data upon labels in the collections of material examined, it seems that *A. communis* may occur in a wide variety of inland waters: from creeks, rivers, ponds, lakes, reservoirs, and, in one instance, from a swamp. At least with regard to choice of macrohabitat the species appears to be wide ranging. It does not, however, seem to be present in any of the Great Lakes, as it was never recorded in any of the numerous collections that I have examined from these waters. Hatchett (1947) commented upon the ecology of "*A. communis*" in Michigan at length, but as the characters he used to identify Michigan species of *Asellus* (number of segments in flagellum of first antenna, head shape) are variable and show no well-defined specific differences, the identity of his species remains uncertain. For the same basic reason, several other reports containing ecological data on "*A. communis*" must also be ignored.

FURTHER DESCRIPTION (♂).—This account, unless specifically noted otherwise, is based only upon mate-

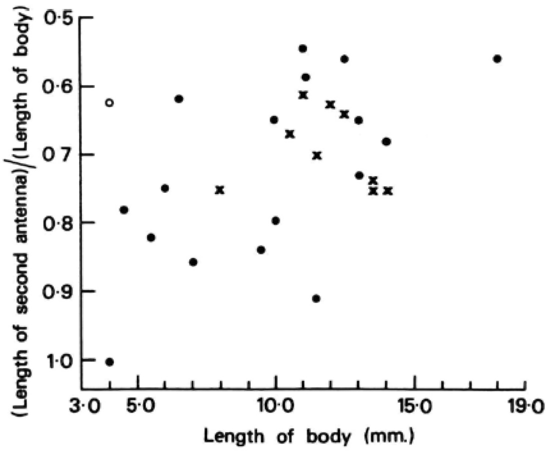

FIGURE 8.—*Asellus communis.* Relationship between length of second antenna and length of body: (●) eastern specimens; (x) Colorado specimens; (o) specimens from Washington State.

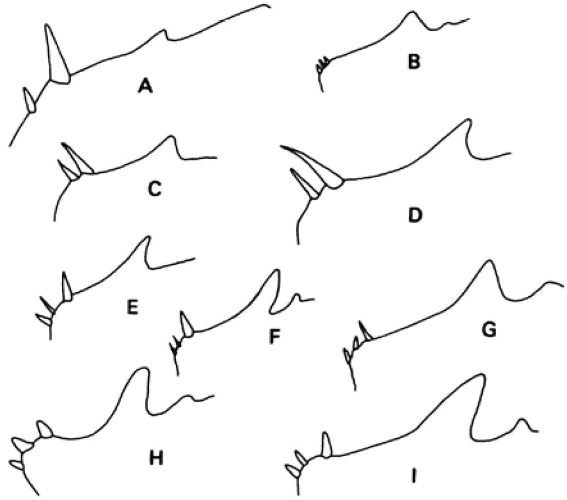

FIGURE 9.—*Asellus communis,* extent of variation in palm shape of male first peraeopod: A, Leeds County, Ontario; B, Lake Champlain, Vermont; C, Witch Brook and Crocker Pond; D, Echo Lake, Washington; E, Yarmouth County, Nova Scotia; F, Bangor, Maine; G, Meadow Lake, Larimore County, Colorado; H, Kid's Lake, Larimore County, Colorado; I, Salem, Massachusetts.

rial from the eastern part of North America, but the variation recorded is nevertheless inclusive for western material.

Body: The smallest male with well-developed secondary sexual characters was 4.0 mm long; the largest male examined was 18.0 mm.

First antenna: Flagellum 6- to 17-merous, the number of articles depending to some extent upon the size of the specimen; flagellum tip reaching to midpoint of last peduncle segment of second antenna or almost to distal end of this segment.

Second antenna: Length from just over half to same length as body, the fraction showing a rough inverse correlation with absolute body size. This relation is indicated in Figure 8 in which are plotted the appropriate values for the largest male in each of 27 collections, including those from Colorado and Washington (indicated differently). Flagellum 36- to 82-merous, the number of segments generally increasing with the length of the specimen.

Mouthparts: See Table 1.

First peraeopod: 2 to 4 (usually 3) very strong teeth-like spines at proximal end of palm. Some variation occurs in the shape of the palm and its triangular process (cf. Figure 9).

First pleopod: Total length of appendage 1.0 to 1.47 (usually 1.1) times as long as second pleopod. Inner margin of sympod with 3 to 6 coupling hooks. Outer margin of distal segment straight to slightly concave.

Second pleopod: One to a few simple spines near inner distal angle of sympod. Proximal segment of exopod with 2 to 4 spines on outer margin, and distal segment with 19 to 24 marginal spines. Although no gross variations in the morphology of the tip of the endopodite occur, there are nevertheless minor morphological variations occurring between specimens from the same locality and also from different localities; Figure 10 illustrates the range of such variation. As indicated, the cannula may vary in length and may not extend beyond the caudal process or may distinctly do so. The caudal process itself may be no more than a slightly rounded distal protuberance, or may be quite prominent and even in some cases obtusely pointed. The typical morphology is as illustrated in Figures 5D,E for the neotype. For purposes of comparison, Figure 10 also indicates the structure of the endopoite tip of a specimen from Echo Lake, Washington, and Independent Reservoir, Colorado.

Uropod: See Table 2.

TABLE 1.—*Variation in certain features of the mouthparts of North American epigean* Asellus *species*

[Except *A. kenki*, males only; except where indicated, data from examination of all material available—details in text]

	A. communis	*A. brevicauda brevicauda*	*A. brevicauda bivittatus*	*A. intermedius*	*A. attenuatus* [a]	*A. dentadactylus* [a]	*A. montanus* [a]	*A. kenki* [c]	*A. racovitzai racovitzai*	*A. racovitzai australis*	*A. forbesi*	*A. obtusus*	*A. laticaudatus*	*A. scrupulosus*	*A. nodulus*	*A. occidentalis*
LEFT MANDIBLE:																
teeth in incisor	4	4	4	4[b]	4	4	4	4	4	4	4	4	4	4	4	4
teeth in lacinia	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
spines in row beneath lacinia	8–17	14–25	8–9	9–22	12	11	10	10–12	10–19	10–11	10–18	10–18	11–13	11–15	10–16	9–12
RIGHT MANDIBLE:																
teeth in incisor	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
spines in row beneath incisor	9–20	16–27	12	9–24	15	?	15	13	12–21	10–11	11–19	12–19	12–15	13–17	13–17	11–14
FIRST MAXILLA:																
terminal spines on inner plate	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5[d]
terminal spines on outer plate [e]	11	11	11	11	11?	?	10	11	11	11–13	11–12	10–12	11	11–13	11–12	10–13
SECOND MAXILLA (outer plate):																
distal spines on outer lamina	15–23	18–28	15–18	16–26	22	13	13	?	13–19	16–18	15–22	16–18	17–19	14–18	17–19	16–22
distal spines on inner lamina	11–15	15–18	12–14	10–19	11	12	12	?	10–15	11–14	11–15	11–13	11–13	10–13	11–13	10–13
MAXILLIPED:																
Coupling hooks on medial margin of masticatory lobe.	5–7	6–8	4–5	3–8	6	?	?	4–5	4–6	4–5	4–7	4–5	5–6	3–6	5	4–7

[a] Lectotype only.
[b] Minor teeth also present in one specimen.
[c] From Bowman (1967).
[d] Six in one specimen.
[e] Usually difficult to discern accurately.

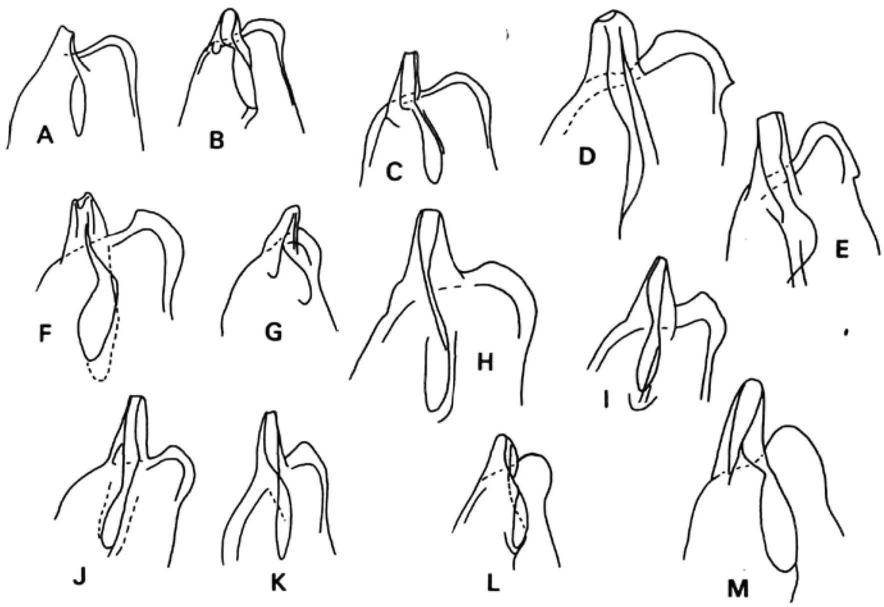

FIGURE 10.—*Asellus communis,* extent of variation in morphology of endopodite tip of male second pleopod: A, Lynn River, Ontario; B, Orange Mountains, New Jersey; C, Toronto, Ontario; D, New Lisbon, New Jersey; E, F, Lakehurst, New Jersey; G, Hall's Creek, Maryland; H, Bangor, Maine; I, K, Cambridge, Massachusetts; J, Pubnico Lake, Nova Scotia; L, Echo Lake, Washington; M, Independent Reservoir, Colorado.

TABLE 2.—*Variation in certain features of uropod of North American epigean* Asellus *species*
[Except where indicated, males only, and data from examination of all available material]

	uropod length / telson length			exopod length / peduncle length			endopod length / peduncle length		
	Range	*M*	±*S.D.*	*Range*	*M*	±*S.D.*	*Range*	*M*	±*S.D.*
A. communis	0. 86–1. 20	1. 01	0. 08	0. 55–1. 20	0. 75	0. 18	0. 82–1. 60	1. 08	0. 19
A. brevicauda brevicauda	0. 48–0. 68	0. 52	0. 07	0. 68–1. 07	0. 86	0. 13	0. 90–1. 21	1. 05	0. 14
A. brevicauda bivittatus	0. 36–0. 44	0. 41	0. 03	0. 64–0. 91	0. 76	0. 09	0. 85–1. 00	0. 92	0. 07
A. intermedius	0. 6 –1. 1	0. 87	0. 14	0. 62–1. 23	0. 84	0. 16	1. 0 –1. 6	1. 20	0. 15
A. attenuatus [a]	1. 0	–	–	1. 2	–	–	1. 3	–	–
A. dentadactylus [b]	0. 95–1. 3	–	–	0. 63–0. 75	–	–	0. 91–1. 0	–	–
A. montanus [b]	1. 0 –1. 5	–	–	0. 39–0. 65	–	–	0. 80–0. 86	–	–
A. kenki [c]	1. 1 –1. 2	–	–	0. 54–1. 1	–	–	1. 0 –1. 26	–	–
A. racovitzai racovitzai	0. 70–1. 00	0. 90	0. 11	0. 58–1. 22	0. 84	0. 17	0. 90–1. 58	1. 15	0. 16
A. racovitzai australis	0. 80–1. 50	1. 12	0. 19	0. 57–1. 16	0. 73	0. 15	0. 89–1. 32	1. 03	0. 10
A. forbesi	0. 67–1. 5	1. 16	0. 20	0. 45–0. 95	0. 69	0. 10	0. 72–1. 23	1. 01	0. 13
A. obtusus	1. 0 –2. 0	1. 48	0. 32	0. 71–1. 31	0. 91	0. 15	0. 91–1. 52	1. 13	0. 15
A. laticaudatus	1. 0 –1. 2	1. 08	0. 06	0. 62–0. 68	0. 66	0. 02	0. 95–1. 06	1. 00	0. 04
A. scrupulosus	0. 95–1. 28	1. 04	0. 12	0. 64–0. 85	0. 75	0. 04	0. 85–1. 03	0. 96	0. 11
A. nodulus	0. 88–1. 21	1. 03	0. 12	0. 67–1. 07	0. 90	0. 15	1. 35–1. 87	1. 52	0. 23
A. occidentalis	0. 67–1. 25	0. 88	0. 16	1. 00–1. 50	1. 27	0. 19	1. 21–2. 00	1. 52	0. 25

[a] From paralectotype (♂).

[b] From text and drawing of Mackin and Hubricht (1938) and lectotype (apparently applies to both sexes).

[c] From text and drawings of Bowman (1967) and original (applies to both sexes).

Asellus brevicauda Forbes

Asellus brevicauda Forbes, 1876, pp. 8–10.—Richardson, 1905, pp. 423–425, figs. 477–479.—Van Name, 1936, pp. 462–463, fig. 290.
Asellus brevicaudus Mackin and Hubricht, 1938, pp. 631–632.
Asellus bivittatus Walker, 1961, pp. 385–390, figs. 1–5.

Asellus brevicauda was described by Forbes in 1876, but the description though rather lengthy did not include details of those parts of the body of most taxonomic significance; it did not, moreover, include drawings despite Richardson's indication (1905, fig. 477) that it did, and it was obviously a composite description based on several specimens. A later description by Richardson (1905) seems to be original in that it was not based entirely on Forbes' description and contained additional (but relatively unimportant) descriptive material. It was based upon a single specimen, but Richardson made no comment as to where this came from, and neither her description nor the original one of Forbes' mentions deposition of type material. In Richardson's redescription of *A. intermedius* in the same paper (pp. 422–423), however, she mentions that she had been sent "types" [sic] of *A. intermedius* from the Museum of Comparative Zoology of Harvard University, and since this species was described by Forbes at the same time he described *A. brevicauda,* it seems possible that Richardson was sent similar material for *A. brevicauda*, although she does not say so. At all events, inquiries to the curator at the Museum of Comparative Zoology, Dr. H. W. Levi, revealed the presence in the collections of that institution of a single male specimen of *Asellus* in a tube with the label: "MCZ Illinois; Union Co., July 30, 1876; S. A. Forbes coll. *Asellus brevicauda* Forbes." Bearing in mind Forbes' only statement (1876, p. 10) about the distribution of the species, namely that it is found in Jackson and Union counties in southern Illinois, and the fact that other crustaceans collected on 30 July (*Gammarus fasciatus* Say, p. 6) and in 1876 (*Eubranchipus serratus* Forbes, pp. 13–14) were referred to in the same paper, the circumstantial evidence is very strong that this specimen is a syntype.

According to Dr. H. W. Levi (personal communication, 13 September 1967), the specimen was originally deposited in the Peabody Academy of Science and later transferred. It could have been so deposited by Forbes as a result of his contact with S. I. Smith of Yale College (cf. Forbes, 1876, p. 3), although in view of Forbes' position as curator of the Illinois Museum of Natural History deposition in his own institution would have been normal. The Illinois Natural History Survey, although possessing syntype material of *A. intermedius,* did not possess syntype material for *A. brevicauda* (Dr. J. D. Unzicker, personal communication, 5 June 1967). The specimen from the Museum of Comparative Zoology is accordingly now designated as the lectotype of *A. brevicauda.* It is not certain that this is the actual specimen examined in 1905 by Richardson, but because its dimensions correspond to those given by Richardson this seems likely.

Apparently under the impression that the specific name *brevicauda* was adjectival, Mackin and Hubricht (1938) altered it to *brevicaudus* to seem to agree in gender with the genus name. It is, however, a noun, and the original spelling is correct.

Asellus bivittatus was described by Walker (1961) from a stream, Doe Run, in Meade County, Kentucky. Unfortunately, although her description was very detailed in most respects, she omitted critical details concerning the morphology of the tip of the endopodite of the male second pleopod, stating only (p. 388), "pore at distal end giving appearance of bifurcation." She provided a figure of the second pleopod of the male, but it was at too small a scale to provide clarification. Her type material is deposited in the United States National Museum, and reexamination of the sexual pleopods of the holotype as well as male topotypic material kindly given me by Prof. H. B. N. Hynes and Dr. L. A. Krumholz revealed that the morphology of the tip of the endopodite of the second pleopod was almost identical with that of the lectotype of *A. brevicauda*. Her taxon is therefore regarded as conspecific with *A. brevicauda.* There seem to be, nevertheless, differences between other parts of the morphology of her taxon and the lectotype of *A. brevicauda,* and these are such that it is appropriate at present to accord her taxon subspecific status.

It should be noted that both Walker's taxon and what she regarded as "somewhat differentiated" *A. brevicauda* occur in the same stream, although spatially separated (see also Minckley, 1963, who regarded such material as aberrant *A. bivittatus*). It is perhaps possible that the differences displayed by her taxon are no more than phenotypic variations of typical *A. brevicauda* brought about by the physical nature of the environment (upper reaches of Doe Run, associated with the moss *Fissidens*). Some of the significant distinguishing criteria of Walker's taxon, according to