W. D. WILLIAMS

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

SMITHSONIAN CONTRIBUTIONS TO ZOOLOGY • 1970 NUMBER 49

SERIAL PUBLICATIONS OF THE SMITHSONIAN INSTITUTION

The emphasis upon publications as a means of diffusing knowledge was expressed by the first Secretary of the Smithsonian Institution. In his formal plan for the Institution, Joseph Henry articulated a program that included the following statement: "It is proposed to publish a series of reports, giving an account of the new discoveries in science, and of the changes made from year to year in all branches of knowledge not strictly professional." This keynote of basic research has been adhered to over the years in the issuance of thousands of titles in serial publications under the Smithsonian imprint, commencing with *Smithsonian Contributions to Knowledge* in 1848 and continuing with the following active series:

Smithsonian Annals of Flight
Smithsonian Contributions to Anthropology
Smithsonian Contributions to Astrophysics
Smithsonian Contributions to Botany
Smithsonian Contributions to the Earth Sciences
Smithsonian Contributions to Paleobiology
Smithsonian Contributions to Zoology
Smithsonian Studies in History and Technology

In these series, the Institution publishes original articles and monographs dealing with the research and collections of its several museums and offices and of professional colleagues at other institutions of learning. These papers report newly acquired facts, synoptic interpretations of data, or original theory in specialized fields. Each publication is distributed by mailing lists to libraries, laboratories, institutes, and interested specialists throughout the world. Individual copies may be obtained from the Smithsonian Institution Press as long as stocks are available.

S. Dillon Ripley
Secretary
Smithsonian Institution

SMITHSONIAN CONTRIBUTIONS TO
ZOOLOGY

NUMBER 49

W. D. Williams

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

SMITHSONIAN INSTITUTION PRESS
CITY OF WASHINGTON
1970

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).

Official publication date is handstamped in a limited number of initial copies and is recorded in the Institution's annual report, Smithsonian Year.

UNITED STATES GOVERNMENT PRINTING OFFICE
WASHINGTON : 1970

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 - Price $1.25

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,

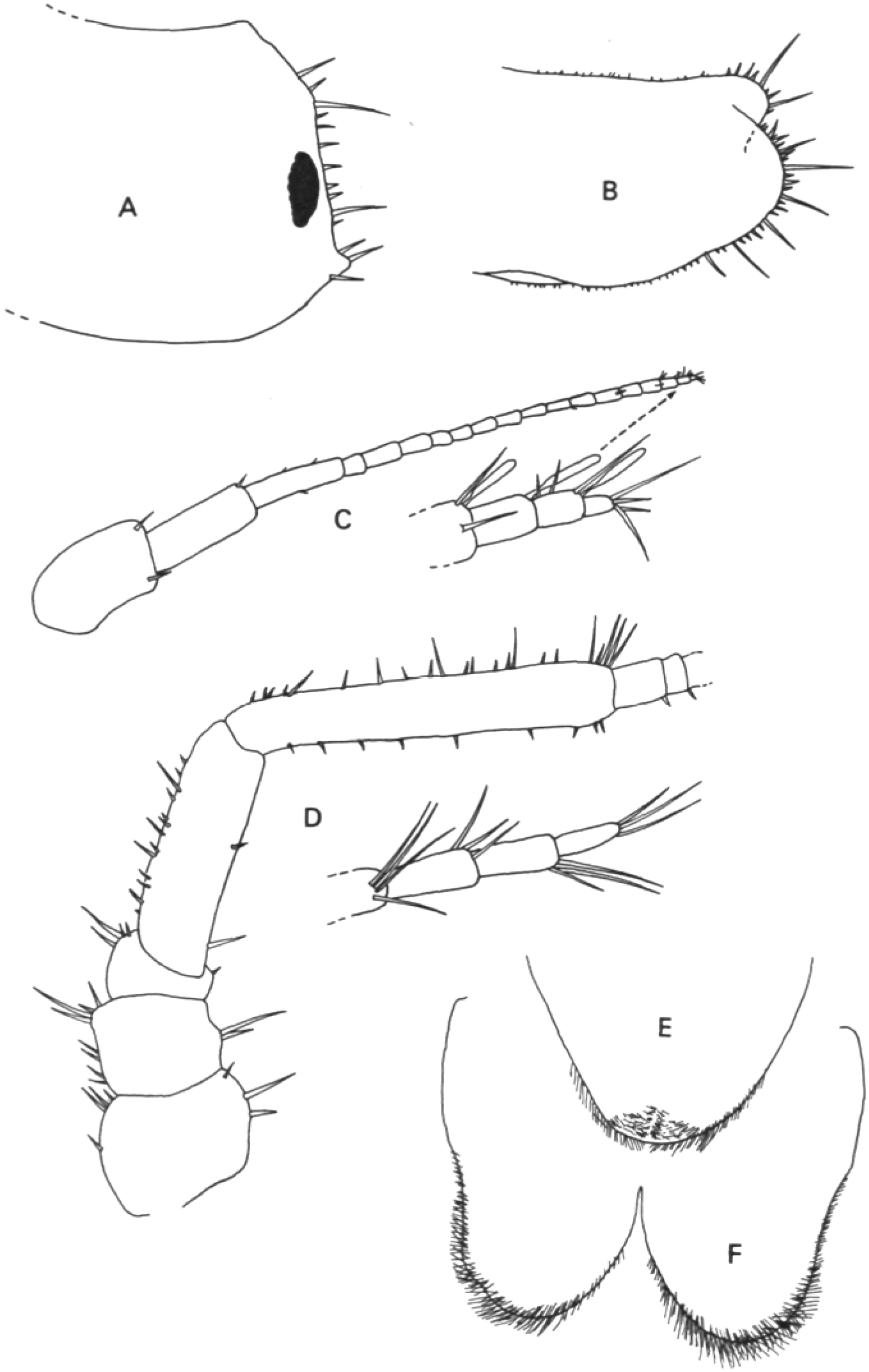

FIGURE 1.—*Asellus communis,* neotype: A, head; B, first tergum; C, first antenna; D, second antenna; E, upper lip; F, lower lip.

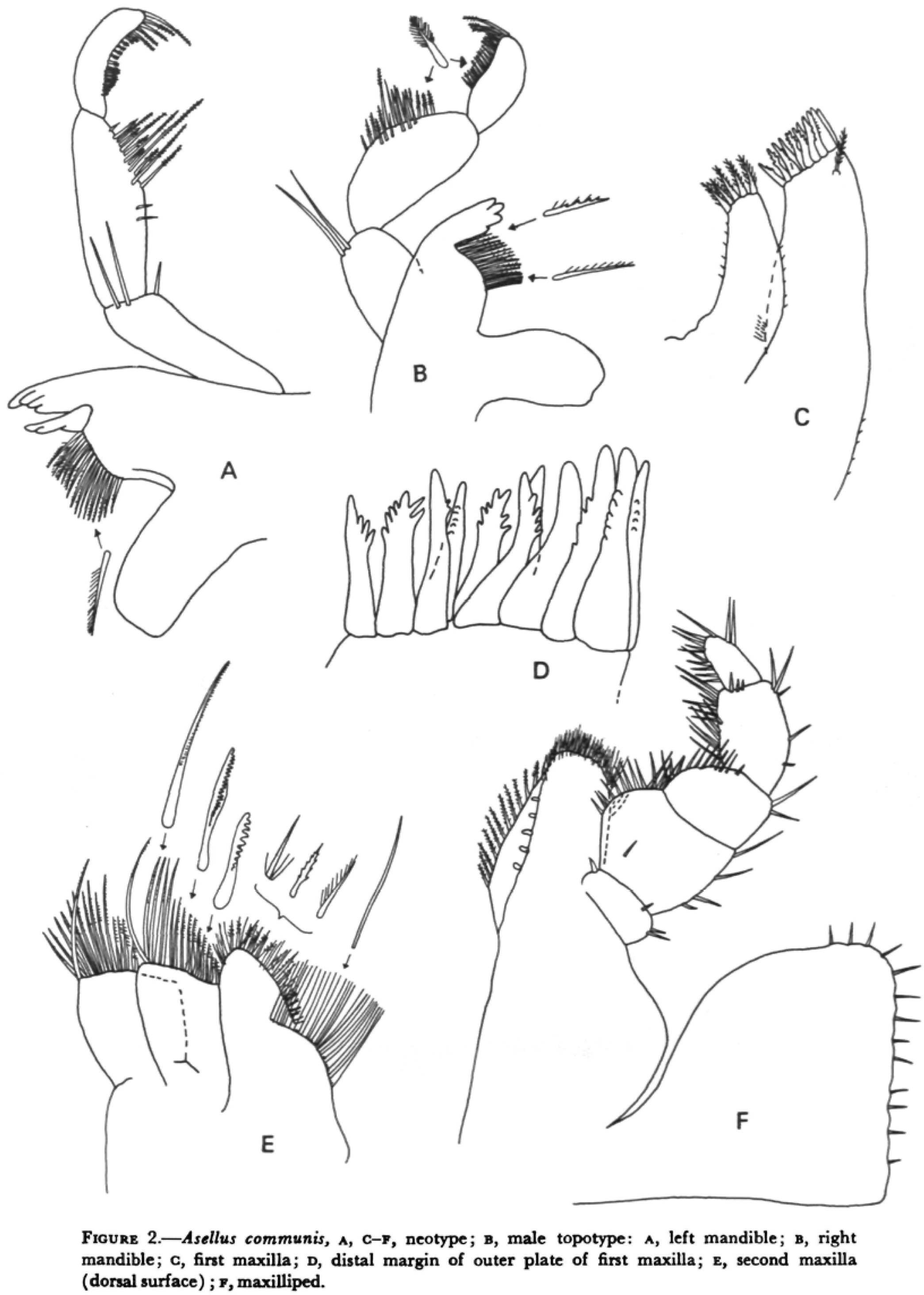

FIGURE 2.—*Asellus communis*, A, C–F, neotype; B, male topotype: A, left mandible; B, right mandible; C, first maxilla; D, distal margin of outer plate of first maxilla; E, second maxilla (dorsal surface); F, maxilliped.

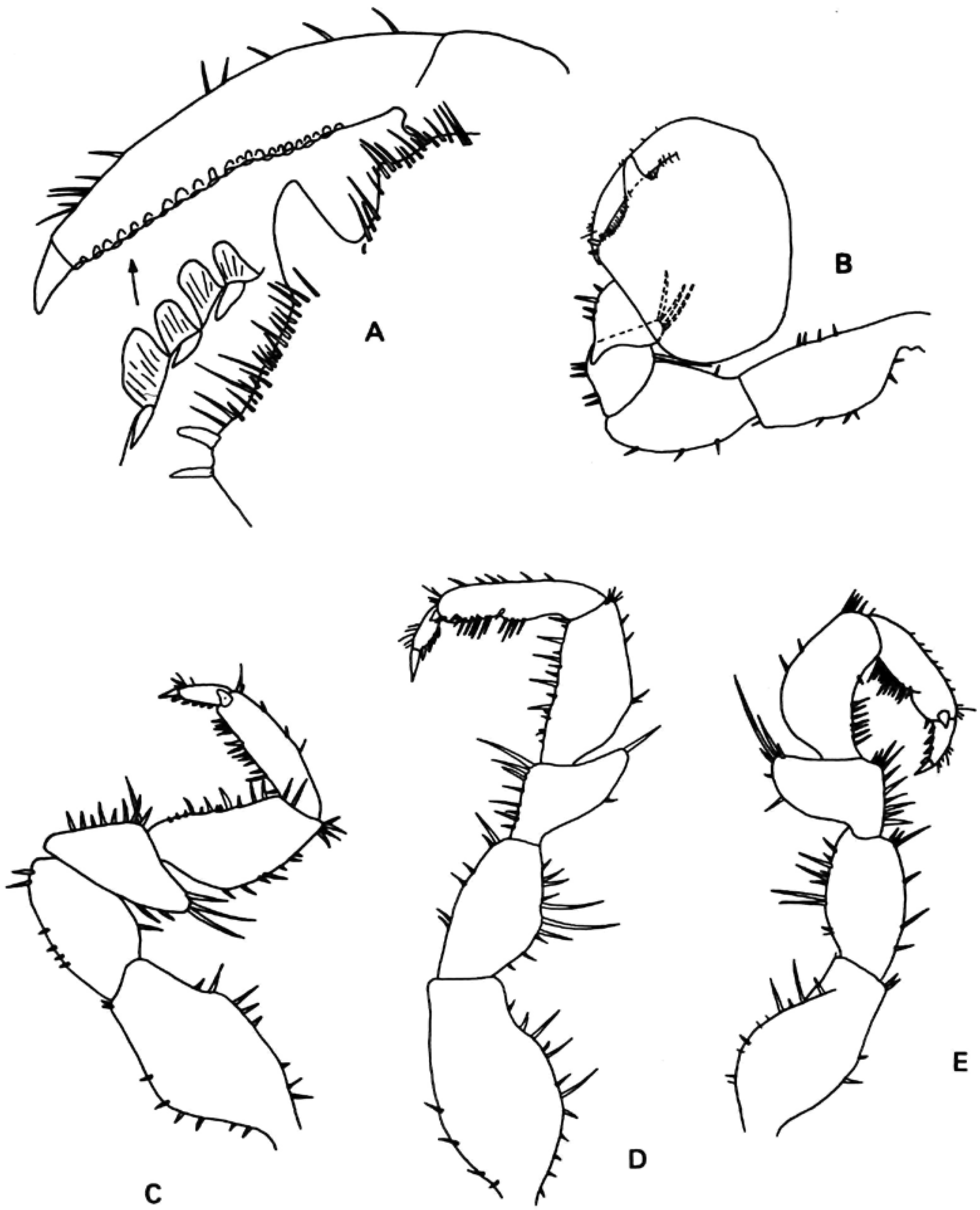

FIGURE 3.—*Asellus communis,* neotype: A, dactylus and palm of first peraeopod; B, first peraeopod; C, second peraeopod; D, third peraeopod; E, fourth paraeopod.

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

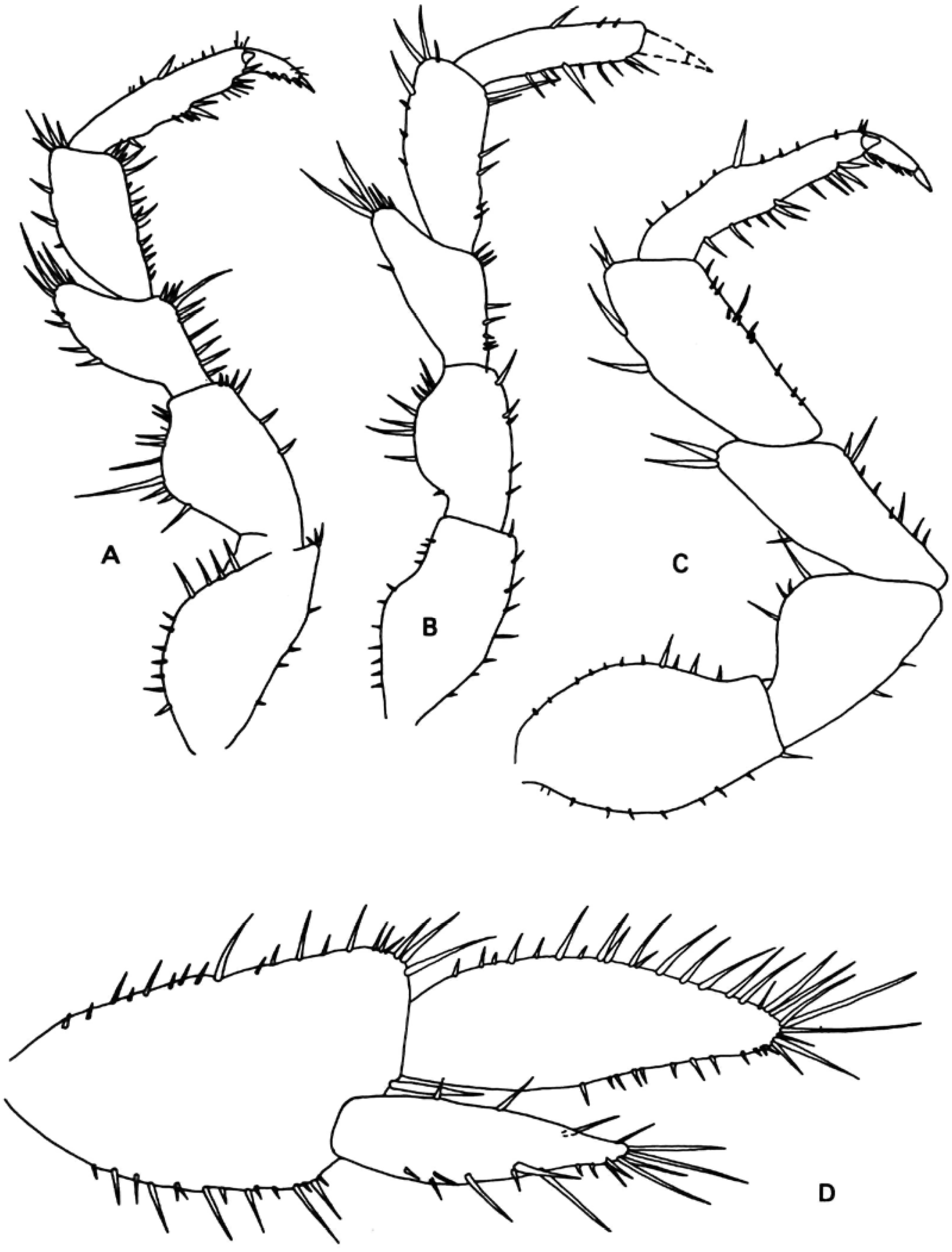

FIGURE 4.—*Asellus communis*, neotype: A, fifth peraeopod; B, sixth peraeopod; C, seventh peraeopod; D, uropod.

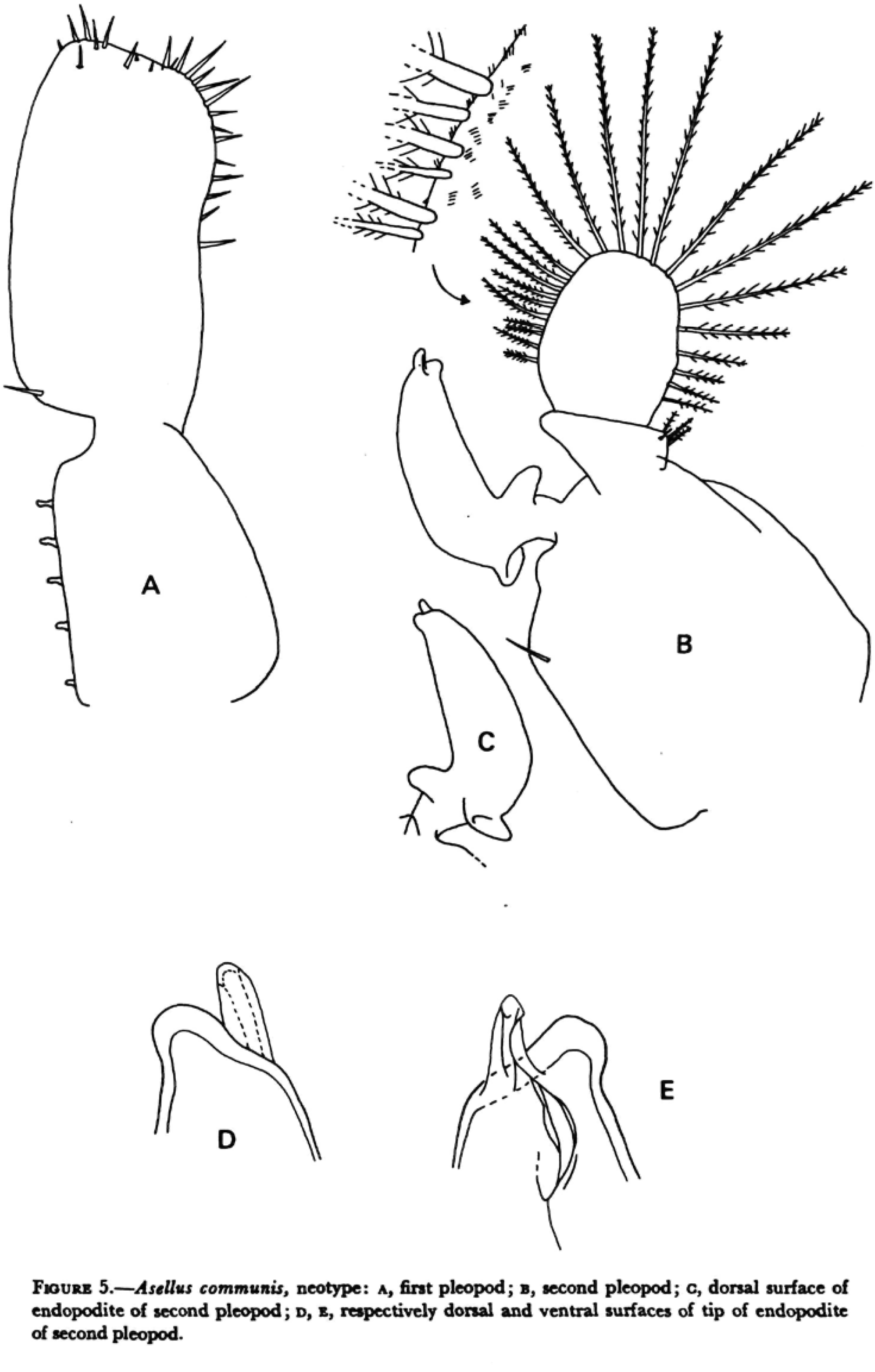

FIGURE 5.—*Asellus communis*, neotype: A, first pleopod; B, second pleopod; C, dorsal surface of endopodite of second pleopod; D, E, respectively dorsal and ventral surfaces of tip of endopodite of second pleopod.

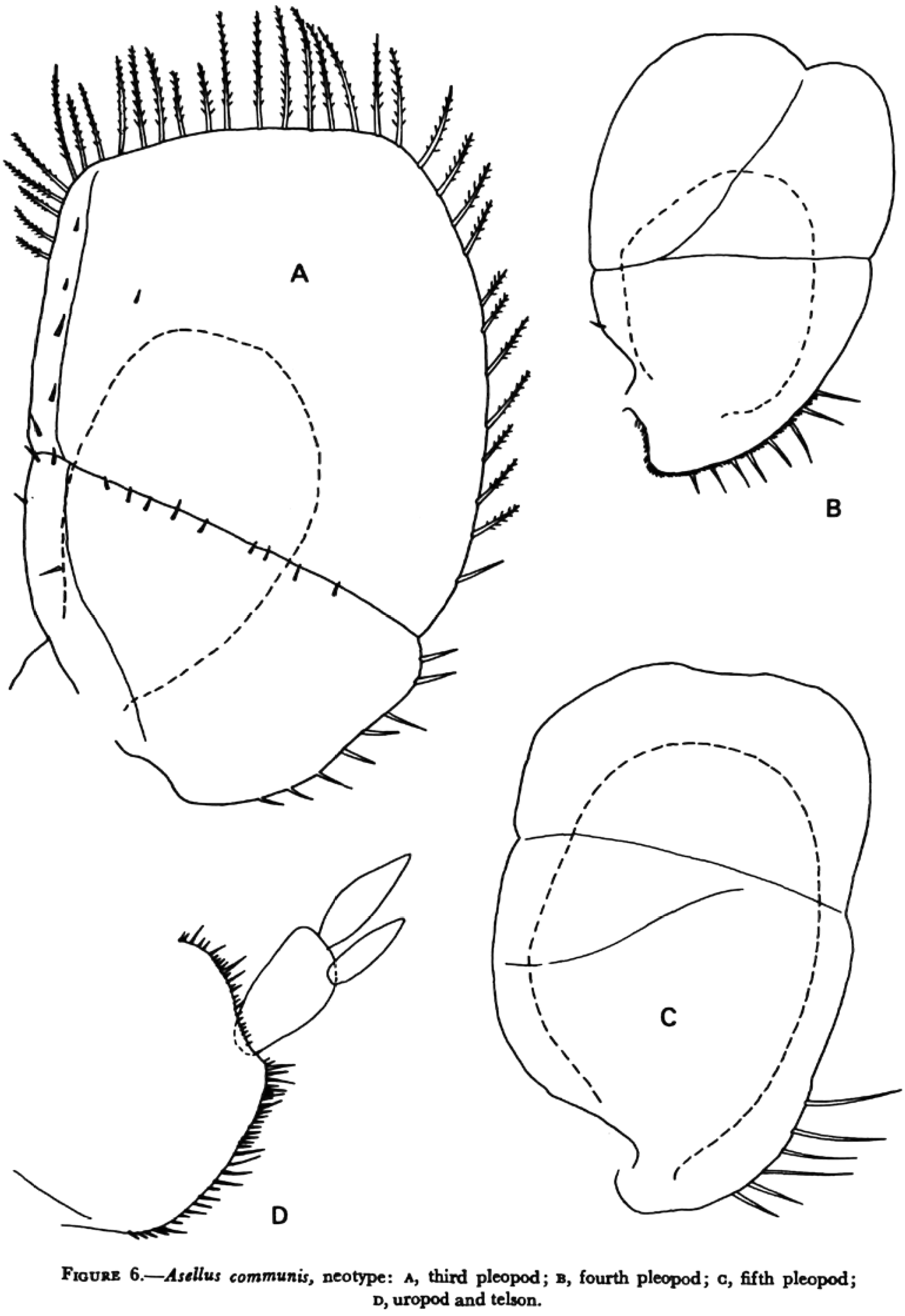

FIGURE 6.—*Asellus communis,* neotype: A, third pleopod; B, fourth pleopod; C, fifth pleopod; D, uropod and telson.

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.

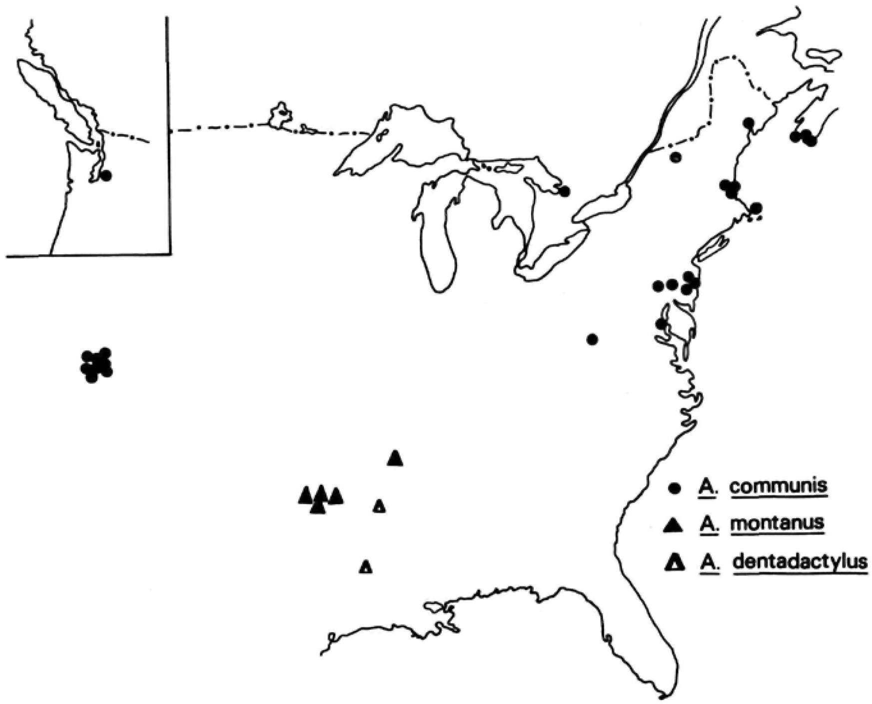

FIGURE 7.—Geographical distribution.

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-

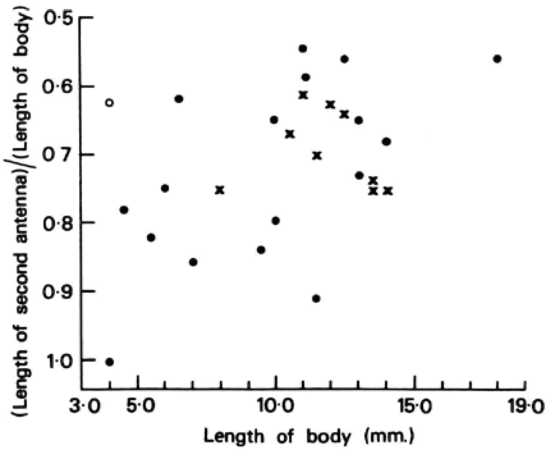

FIGURE 8.—*Asellus communis.* Relationship between length of second antenna and length of body: (●) eastern specimens; (x) Colorado specimens; (o) specimens from Washington State.

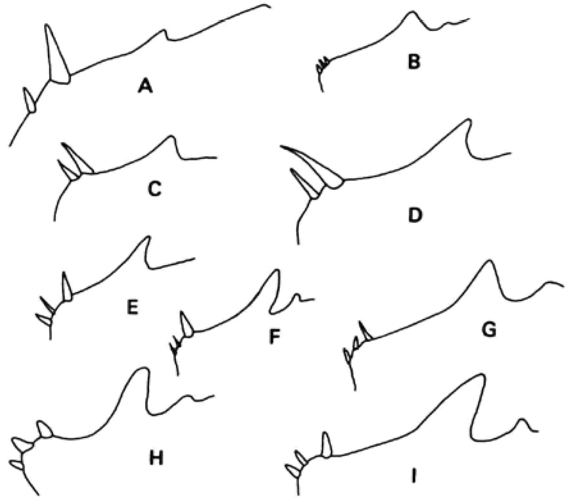

FIGURE 9.—*Asellus communis,* extent of variation in palm shape of male first peraeopod: A, Leeds County, Ontario; B, Lake Champlain, Vermont; C, Witch Brook and Crocker Pond; D, Echo Lake, Washington; E, Yarmouth County, Nova Scotia; F, Bangor, Maine; G, Meadow Lake, Larimore County, Colorado; H, Kid's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

378-615 O - 70 - 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.

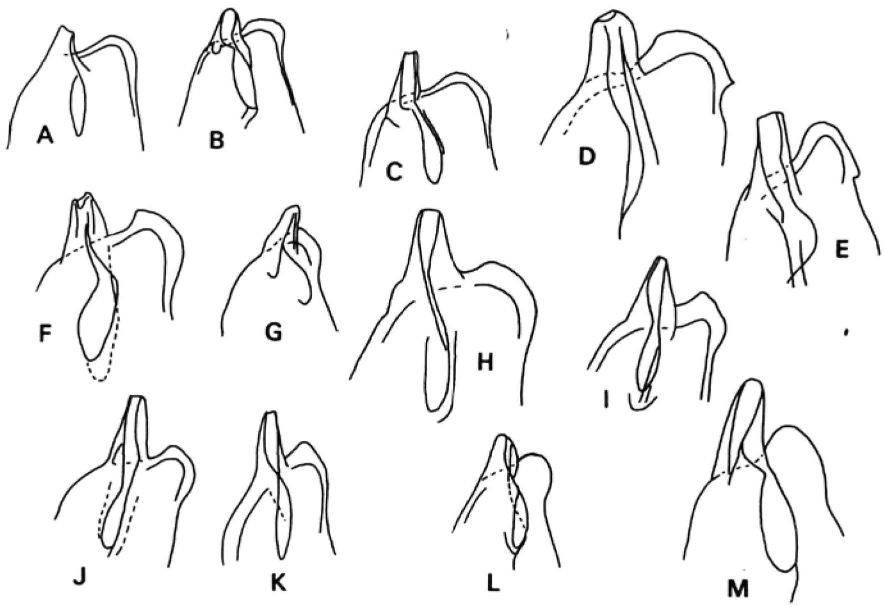

FIGURE 10.—*Asellus communis,* extent of variation in morphology of endopodite tip of male second pleopod: A, Lynn River, Ontario; B, Orange Mountains, New Jersey; C, Toronto, Ontario; D, New Lisbon, New Jersey; E, F, Lakehurst, New Jersey; G, Hall's Creek, Maryland; H, Bangor, Maine; I, K, Cambridge, 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

Walker, are small size and body color pattern. The present author has been unable to examine a collection of small males of *A. brevicauda brevicada* and unable to compare the color patterns of live specimens from the upper reaches of Doe Run and *A. brevicauda brevicauda.* Until such examination and comparison have been made, preferably on material gathered entirely from Doe Run, subspecific status for Walker's taxon is appropriate. It may be added that through the courtesy of Dr. L. A. Krumholz, University of Louisville, an attempt to examine live material from Doe Run was made, but unfortunately the material did not survive the postal journey.

Asellus brevicauda brevicauda Forbes

FIGURES 11, 12, 14

Asellus brevicauda Forbes, 1876, pp. 8–10.
Asellus brevicaudus Mackin and Hubricht, 1938, pp. 631–632.

TYPE MATERIAL.—Lectotype, adult ♂, deposited in the Museum of Comparative Zoology; the reference is the specific name (catalog number 6800): Labels read: "MCZ Illinois: Union Co., July 30, 1876; S. A. Forbes coll. *Asellus brevicauda* Forbes" and "hololectotype."

DESCRIPTION OF LECTOTYPE.—Body: Length, 13.0 mm.

Head (Figure 11A): Eyes large and distinct; posterolateral lobes large, prominent and rounded, and with numerous strong spines.

First antenna (Figure 11B): Flagellum 12-merous and tip reaching to point about two-thirds distally along last segment of peduncle of second antenna; penultimate 2 segments bearing aesthetascs. Flagellum about two-thirds length of peduncle. First segment of peduncle slightly shorter than second; third segment about half length of second. First segment of peduncle about twice as long as wide and bearing distally a circlet of short strong spines; second and third segments respectively about 3 and 2.5 times as long as wide.

Second antenna: Length (8.0 mm) about three-fifths (0.62) that of body. Flagellum 80-merous. Fourth and fifth segments of peduncle respectively about 2.5 and 4.5 times as long as wide, but peduncle otherwise similar to *A. communis.*

First peraeopod (Figure 11C): Dactylus slightly longer than palm with 8 teethlike spines on inner margin and ending in a long terminal claw. Propodus about three-fifths (0.61) as wide as long, and subtrapezoidal in shape; palm with a small, low, conical projection near midpoint, a very large toothlike spine proximally, and a submarginal row of spines on inner and outer surfaces.

Second to seventh peraeopoda: Similar in construction to *A. communis;* most noticeable minor difference is occurrence of fewer teethlike spines on inner margin of each dactylus.

First pleopod (Figure 12A): Total length of appendage slightly greater (1.15) than that of second pleopod. Sympod subrectangular, about three-fifths as wide as long; inner margin with 7 hooklike protuberances for coupling. Distal segment also subrectangular, but distinctly curved outward so that the outer lateral margin is deeply concave and the inner lateral margin is convex; proximal width slightly greater than distal width; maximum width slightly less (0.47) than half maximum length; distal margin bearing 11 long plumose spines and 9 shorter simple spines somewhat irregularly arranged; lateral distal angle with a row of short strong spines arranged regularly; inner proximal angle with 2 short simple spines.

Second pleopod (Figures 12B–D): Sympod subrectangular, maximum length over one and a half (1.65) times maximum width; medial and lateral margins more or less straight, and medial margin bearing 4 simple spines beneath attachment of endopodite. Proximal segment of exopod with 7 simple spines on outer margin, inner margin conspicuously sclerotized. Distal segment of exopod subtriangular with 17 long plumose spines marginally and conspicuously sclerotized near inner proximal angle. Endopod narrow and gently curved outward in long axis, total length subequal to that of exopod; a prominent inner basal apophysis and a less prominent outer basal apophysis are present. Cannula short and wide and completely overlapped ventrally by a flattened, expanded, and rounded lateral process. Ventral groove prominent, moderately long and wide. Mesial process large, sclerotized, and expanded so that it wholly occupies the inner lateral margin of the endopod tip; distally its outer face is concave. Caudal process not developed, but dorsal surface of distal tip of endopod with several minute, short spinules.

Uropod (Figure 11D): About half as long (0.48) as telson. Peduncle about as wide as long and bearing distally numerous short to moderately long spines; subtriangular in shape. Exopod as long as peduncle and about twice as long as greatest width; endopod slightly

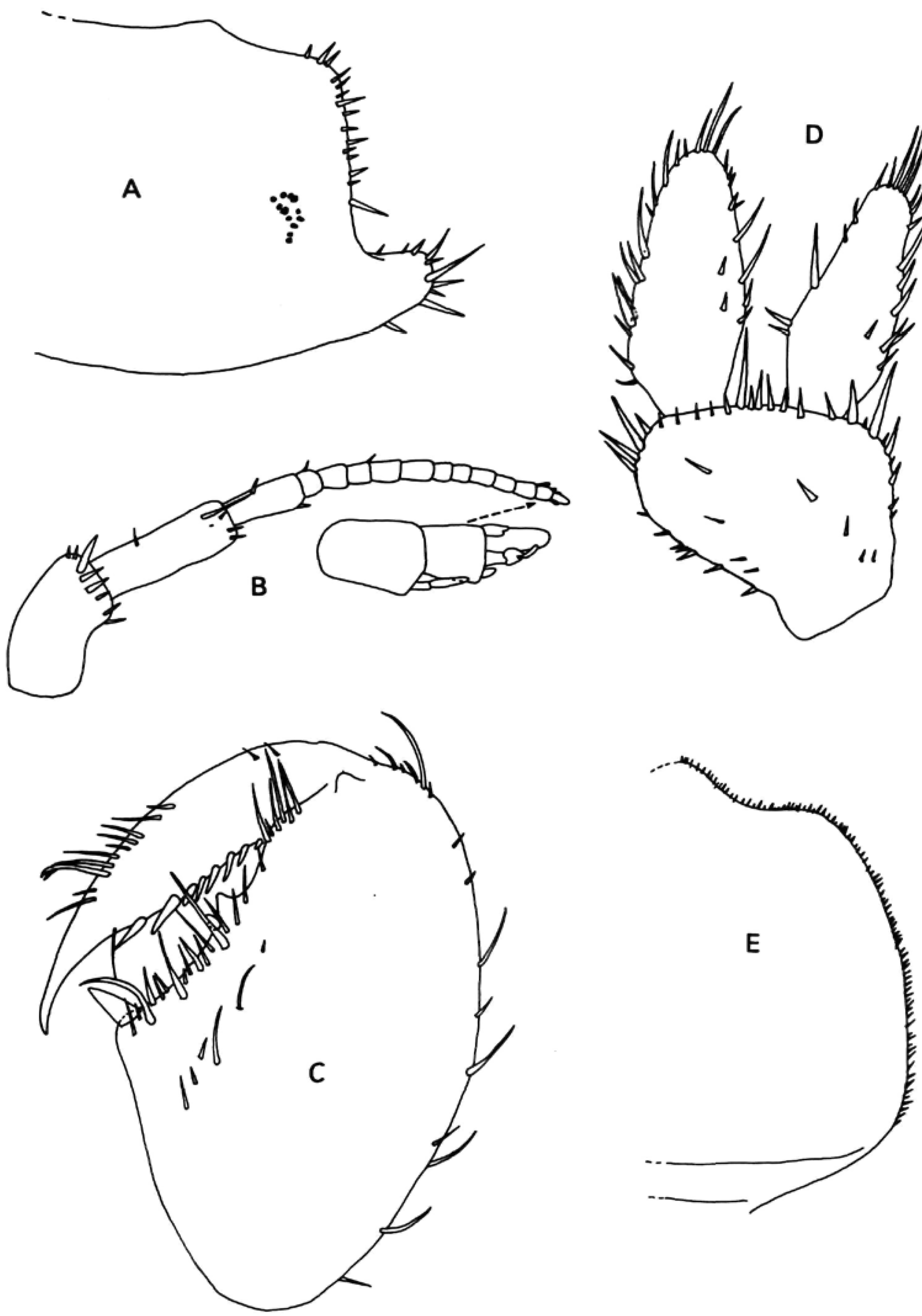

FIGURE 11.—*Asellus brevicauda brevicauda,* lectotype: A, head; B, first antenna; C, dactylus and propodus of first peraeopod; D, uropod; E, telson.

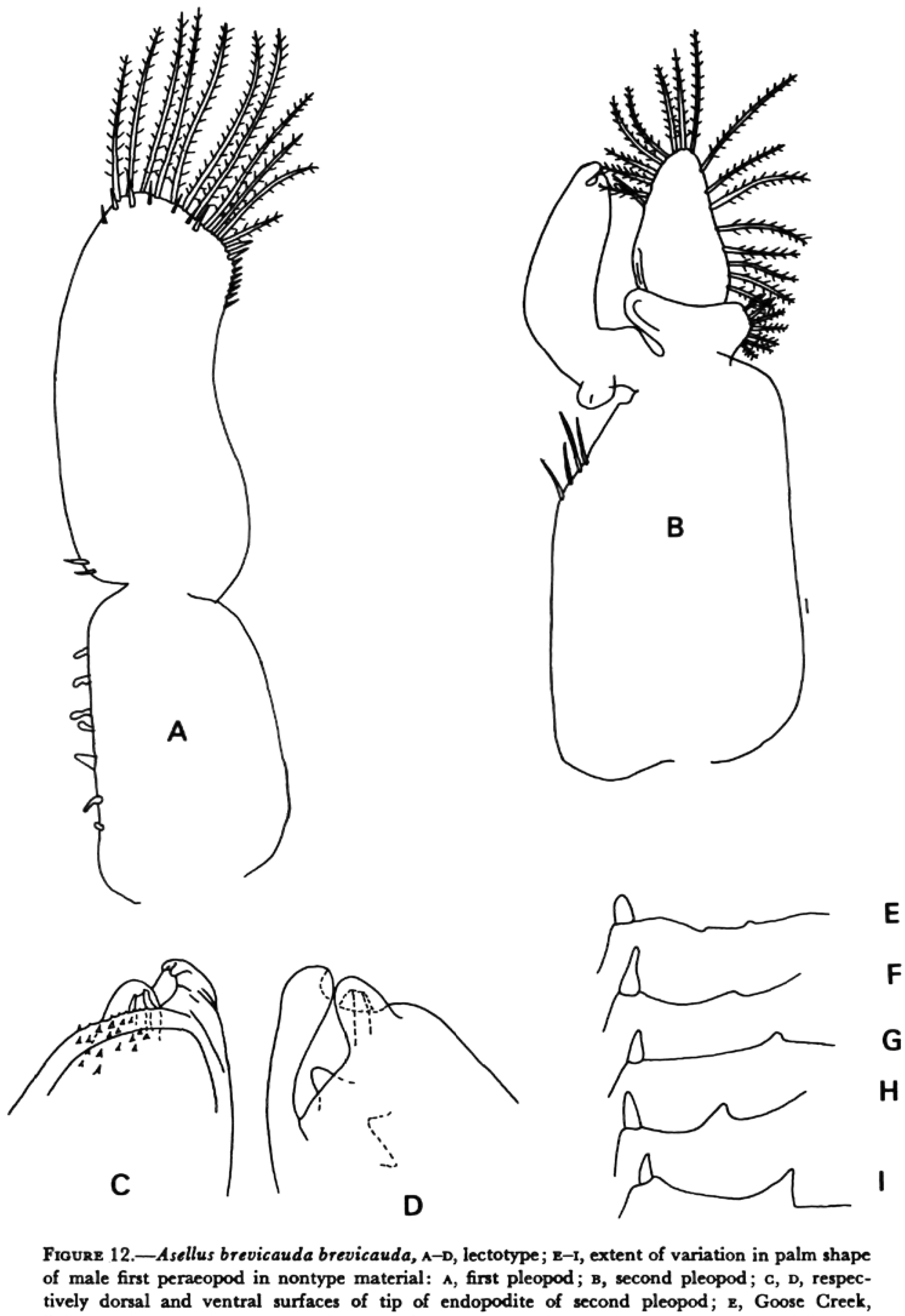

FIGURE 12.—*Asellus brevicauda brevicauda,* A–D, lectotype; E–I, extent of variation in palm shape of male first peraeopod in nontype material: A, first pleopod; B, second pleopod; C, D, respectively dorsal and ventral surfaces of tip of endopodite of second pleopod; E, Goose Creek, Jefferson County, Kentucky; F, Harine, Jefferson County, Missouri; G, Boone County, Missouri; H, near Fountains Gap, Monroe County, Illinois; I, Burkesville, Monroe County, Illinois.

longer than peduncle (1.13) and also about twice as long as greatest width; both exopod and endopod bear numerous strong and relatively short spines.

Telson (Figure 11E): Subcircular, as long as wide; uropodal sinuses prominent.

MATERIAL EXAMINED.—ILLINOIS: Fountain Gap, Monroe County, ∞♂♂, coll. L. Hubricht, 26.v.1937 (USNM); Burkesville, Monroe County, ∞♂♂, coll. L. Hubricht, 6.xi.1937 (USNM); Bluffside, St. Clair County, ∞♂♂, coll. L. Hubricht, 16.i.1938 (USNM); Burkesville, ∞♂♂, coll. Burk et al., 24.i.1947 (INHS); Shawnee National Forest, Union County, 1♂, coll. R. L. Lippson, 7.iv.1967.

KENTUCKY: Goose Creek,* Jefferson County, 1♂, coll. G. A. Cole, 4.v.1955.

MISSOURI: Glencoe Creek, St. Louis County, ∞♂♂, coll. L. Hubricht, 1.iii.1936 (USNM); Harine, Jefferson County, ∞♂♂, coll. L. Hubricht, 21.v.1936 (USNM); Gray Summit, Franklin County, ∞♂♂, coll. L. Hubricht, 29.v.1937 (USNM); Antonia, Jefferson County; ∞♂♂, coll. L. Hubricht, 6.vi.1937 (USNM); St. Louis, ∞♂♂, coll. L. Hubricht, 25.xi.1937 (USNM); Cave brook, Boone County, ∞♂♂, coll. C. Boll, 6.x.1956 (NMC).

GEOGRAPHICAL DISTRIBUTION AND ECOLOGY.—The localities detailed above, together with the type locality, are plotted in Figure 13. From some of the localities, *A. brevicauda* has been recorded by Mackin and Hubricht (1938); none of their additional records are plotted. This procedure gives greater certainty to and does not detract substantially from the conclusions that may be drawn from Figure 13, since they recorded *A. brevicauda* from only one additional State, Arkansas (1 locality). From Figure 13 it is clear that *A. brevicauda brevicauda* occurs in a large but relatively restricted area of east-central United States, south of Lake Michigan.

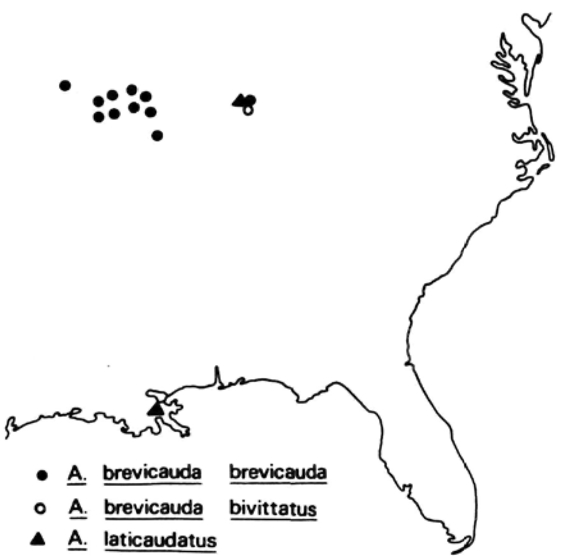

FIGURE 13.—Geographical distribution.

According to the data on labels in the collections examined, *A. brevicauda brevicauda* is typically a species associated with springs or spring-fed streams. It has also been collected on a few occasions, however, from cave streams, from which macrohabitat *A. brevicauda* was recorded also by Mackin and Hubricht (1938).

FURTHER DESCRIPTION (♂).—Body: The largest male examined was 17.0 mm long, and the smallest 8.5 mm.

First antenna: Flagellum 11- to 17-merous; flagellum tip reaching to midpoint or slightly beyond the distal margin of the last segment of the peduncle of the second antenna; penultimate 2 or 3 segments bear aesthetascs.

Second antenna: Length 0.53 to 0.76 times that of body. Flagellum 60- to 124-merous.

Mouthparts: See Table 1.

First peraeopod: Nearly always only one thick toothlike spine is present at proximal end of palm, but occasionally a smaller similar spine is also present. The small, low conical process near the midpoint of the palm, likewise, is almost invariably present; it was absent, however, in one male specimen examined. Dactylus with 8 to 14 teethlike spines on inner margin. Propodus 0.5 to 0.72 times as wide as long, but about two-thirds is the usual value. Figures 12E–I illustrate the range of variation which may occur in the shape of the palm. The typical shape is as shown by the lectotype (Figure 11C).

First pleopod: Total length of appendage 1.03 to 1.24 times as long as second pleopod. Inner margin of sympod with 4 to 7 (usually 6 or 7) coupling hooks. Maximum width of distal segment 0.43 to 0.52 times maximum length; distal margin bearing 5 to 11 long setose spines and 6 to 9 shorter simple spines somewhat irregularly arranged; lateral distal angle with a row of 7 to 11 short strong spines arranged more or less regularly.

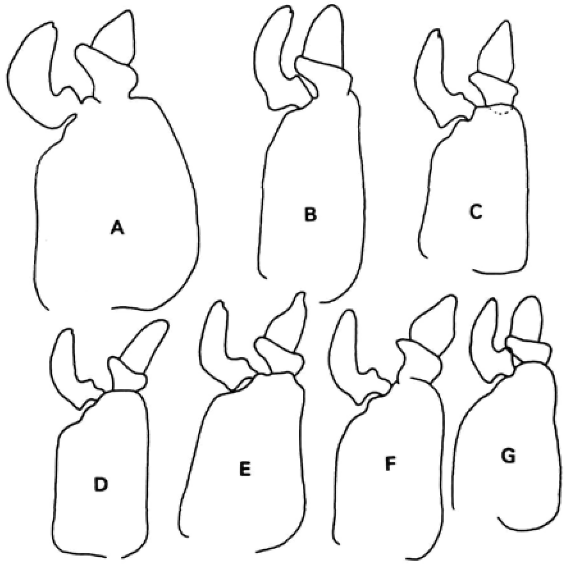

FIGURE 14.—*Asellus brevicauda brevicauda*, extent of variation in shape of sympod, endopod, and exopod of male second pleopod: A, near Fountains Gap, Monroe County, Illinois; B, Burkesville, Monroe County, Illinois; C, Goose Creek, Jefferson County, Kentucky; D, Harine, Jefferson County, Missouri; E, Franklin County, Missouri; F, Antonia, Jefferson County, Missouri; G, St. Louis, Missouri.

Second pleopod: Maximum length of sympod from 1.37 to 2.00 times maximum width; medial and lateral margins of sympod more or less straight to slightly convex. Proximal segment of exopod with 3 to 7 simple spines on outer margin; distal segment with 12 to 17 long setose spines marginally, and subovate to elongate triangular in shape. The morphology of the tip of the endopodite displays very little variation. The greatest variation that occurs in the second pleopod involves the length/width ratio of the sympod, the shape of the distal segment of the exopod, and the relative positions of the distal tips of the exopod and endopod. Figure 14 illustrates the nature of this variation.

Uropod: See Table 2.

Asellus brevicauda bivittatus Walker, new combination.

FIGURE 15

Asellus bivittatus Walker, 1961, pp. 385–390, figs. 1–5.

TYPE MATERIAL.—Walker (1961) gives the following information concerning the deposition and collection of the types of her taxon: Holotype: adult ♂ 4.3 mm in length, USNM 107465. Paratypes: a series of 100 specimens, USNM 107466. Type locality: Doe Run, Meade County, Kentucky, approximately 3 miles east and 0.4 miles north of Ekron. The type material was collected 24 October 1959.

PARTIAL REDESCRIPTION OF HOLOTYPE.—As previously indicated, Walker's description of her taxon is detailed, the only significant omission being information upon the morphology of the tip of the endopodite of the male second pleopod (her omission of a description of the mouthparts is not significant). A reexamination of the holotype enables the description now to be completed.

Second pleopod (Figure 15): Sympod subrectangular, maximum length 1.34 times maximum width.

FIGURE 15.—*Asellus brevicauda bivittatus*, holotype: dorsal surface of right second pleopod.

Endopod rather wide, about half as wide as long. Dorsal surface of endopod near distal margin lacking minute spines, but otherwise morphology of tip of endopodite closely similar to that of *A. brevicauda brevicauda* (see Figures 12C, D).

MATERIAL EXAMINED.—KENTUCKY: Doe Run, Meade County, ∞ ♂♂, coll. W. L. Minckley, 4.viii.1962; Doe Run, Meade County, 10 ♂♂, coll. L. A. Krumholz, 22.viii.1967.

GEOGRAPHICAL DISTRIBUTION AND ECOLOGY.—The only locality from which *A. brevicauda bivittatus* is known is the type locality (Figure 13). This lies in the southern part of the range of the nominate subspecies. According to Minckley (1961), Doe Run is a large spring-fed creek with an average flow of 50 cubic feet per second. Only the upper 3 miles of the creek are inhabited by *A. brevicauda bivittatus.* Minckley (1963) provides a detailed description of the locality.

SEPARATION OF *A. brevicauda bivittatus* FROM THE NOMINATE SUBSPECIES (♂♂ only).—Comparison of Walker's description of *A. brevicauda bivittatus* with the description of *A. brevicauda brevicauda* given in this paper indicates that the principal differences between the two taxa are that *A. brevicauda bivittatus* is shorter in total length, has fewer segments in the flagella of its first and second antennae and fewer teeth-like spines on the dactylus of its gnathopod, lacks a triangular process near the midpoint on the palm of the propodus of the gnathopod, has a propodus which is only half as wide as long, bears fewer spines on the distal segment of the first pleopod and on the exopod of the second pleopod, and has a slightly shorter uropod. A consideration of topotypic material of *A. brevicauda bivittatus* negates one of these differences but supports the remainder. The one it negates is that relating to the width/length ratio of the propodus of the gnathopod; this ratio in *A. brevicauda bivittatus* (0.61 to 0.68) is similar to that displayed by *A. brevicauda brevicauda.* The principal differences between the two subspecies, as indicated by the material at my disposal, are shown in Table 3, which includes a further difference not apparent from the comparison of Walker's paper, namely that the distal segment of the first pleopod of *A. brevicauda bivittatus* is broader relative to length than it is in the nominate subspecies. Also the spines on the uropoda of *A. brevicauda bivittatus* are longer relative to the length of the rami than they are in *A. brevicauda brevicauda.*

Asellus intermedius Forbes

FIGURES 16–18, 20

Asellus intermedius Forbes, 1876, pp. 10–11.—Richardson, 1905, pp. 422–423, figs. 474–476.—Van Name, 1936, pp. 456–457, fig. 286.—Ellis, 1961, pp. 80–102, figs. 1–4.
Asellus militaris Hay, 1878, pp. 90–92.—Mackin, 1940, pp. 17–18.—Van Name, 1942, p. 317.

Although Forbes' original description in 1876 of *A. intermedius* lacked drawings, it did give a rather complete description of the species except for critical details of the morphology of the tip of the endopodite of the second pleopod; about this Forbes wrote only

TABLE 3.—*Principal differences between* Asellus brevicauda brevicauda *and* Asellus brevicauda bivittatus
[Males only]

	A. brevicauda brevicauda	*A. brevicauda bivittatus*
Maximum body length (mm)	17.0	5.5 [a]
Number of segments in flagellum of first antenna	11–17	8–9
Number of segments in flagellum of second antenna	60–124	31–44
Number of teethlike spines on dactylus of gnathopod	6–14	5–6
Triangular process near midpoint of palm of propodus	present [b]	absent
Number of coupling hooks on sympod of first pleopod	4–7	3–4
Width/length ratio of distal segment of first pleopod	0.40–0.50	0.50–0.62
Number of setose spines on distal segment of first pleopod	5–11	4–6
Length/width ratio of sympod of second pleopod	1.37–2.00	1.25–1.60
Number of setose spines on distal segment of exopod of second pleopod	12–17	5–10
Uropod length/telson length ratio	0.48–0.68	0.36–0.44

[a] Dr. L. A. Krumholz (personal communication, 23 August 1967) reports a maximum length of 7–8 mm.

[b] Rarely absent (one specimen noted).

(p. 11), "the outer terminal angle is prolonged into an incurved process, the inner provided with a movable (?) excurved claw." Forbes did not mention deposition of types, but in the redescription by Richardson (1905), which included drawings of the first and second pleopoda, Richardson mentioned she had been sent "types" [sic] from the Museum of Comparative Zoology of Harvard University. Her redescription was based on this material, but unfortunately, like Forbes, she omitted details of the endopodite tip of the second pleopod. Inquiries directed to Dr. H. W. Levi of the Museum of Comparative Zoology revealed that this institution possessed no collection clearly labeled as the type of *A. intermedius,* but it did possess a collection consisting of three male specimens and one female specimen of *Asellus* labeled *"Asellus intermedius* Forbes S.A. Forbes Union Co. Ill."

As the United States National Museum, with which institution Richardson was associated, also does not possess material labeled as the type of *A. intermedius* (T. E. Bowman, personal communication, 9 March 1967), we may reasonably assume that the collection examined by Richardson and referred to as type material was returned to the Museum of Comparative Zoology and is the same collection as that referred to above. Although no date of collection is given, the indication that the material had been collected by Forbes himself, and from an area within which he had collected specimens for the original description ("hill country of southern Illinois"), provides strong circumstantial evidence that the material is syntypic. This material, however, if it is syntypic, is not the only such material in existence. Inquiries to the Illinois Natural History Survey revealed the presence of two collections of *Asellus,* each one labeled "cotypes." One was labeled, "Cotypes *Asellus intermedius* Forbes" and "Callahan Cr. Cobden. Ill. May 30, 1876 S. A. Forbes" and contained five males and six females. The other was labeled, "cotypes *Asellus intermedius* Forbes" and "Stoneft. Cr. Makanda Ill. Jy 30, 1876. S. A. Forbes," and contained 13 males and 38 females; 2 of these males belonged to the taxon *A. brevicauda brevicauda,* whereas the other males belonged to a different taxon. The first of the two collections contained males belonging to a single species only, and since it predates the second collection, it is here regarded as consisting of syntype material and from it a lectotype and paralectotypes have been designated.

Asellus militaris was described without drawings by Hay in 1878. Shortly afterward (1882, p. 241) he commented that his taxon was the same as *A. communis* and this synonymy was accepted by Richardson (1905) and Van Name (1936). It was not accepted, however, by Mackin (1940) who regarded *A. militaris* as a valid species. Irrespective of the lengthy description given by Hay, his only comment on the morphology of the tip of the endopodite of the second pleopod was, "inner ramus navicular, notched at the distal extremity." It is thus impossible to be certain about the identity of this taxon from the original description alone. No mention is made in Hay's paper of type material, but there is in the collections of the Illinois Natural History Survey a collection of *Asellus* with the label, "Ill. State Lab. Nat. Hist. Abingdon Ill. O.P. Hay 1878 S.A. Forbes." Part of this label is in faded handwriting, namely "Abingdon Ill. O.P. Hay 1878", while the rest is printed. These locality data correspond closely with the locality data given by Hay for his original material (1878, p. 92: "near Abingdon, Knox county, Illinois"), suggesting that the material was that used by Hay in the preparation of his description. Further evidence for this was kindly provided by Dr. J. D. Unzicker, taxonomist at the Illinois Natural History Survey, who wrote (personal communication, 5 June 1967):

> I believe that the vial of *A. militaris* Hay, which I sent to you, is the type series for this species because (1) the collecting data correspond with that given in the original description, (2) the vial was in a rack labelled 'check for type material,' and (3) since Hay described this species in a paper published in our Bulletin series the type would ordinarily be deposited in our collection.

The material consisted of several detached peraeopoda and a detached pleon, two ovigerous females, the front half of a male specimen, one male specimen broken into two halves, and one almost complete male specimen. The last specimen was fully dissected and examined by the present author; only the genital pleopoda of the other damaged male were examined. The examinations revealed that the material was conspecific with lectotype material of *A. intermedius* and accordingly *A. militaris* may now be synonymized with this species. The first and second pleopod of the least damaged male are illustrated in Figure 16. The material remains in the collections of the Illinois Natural History Survey where it has no number and is referred to as "INHS (uncataloged)" (J. D. Unzicker, personal communication, 10 August 1967).

TYPE MATERIAL.—Lectotype, adult ♂. Paralectotypes, 4 ♂♂ and 6 ♀♀. All material is deposited in the

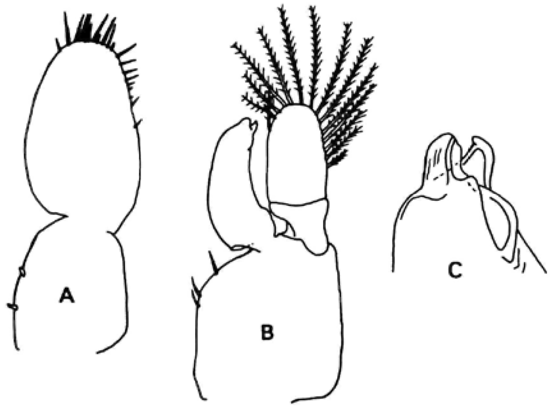

FIGURE 16.—*Asellus intermedius,* least damaged male specimen collected from Abingdon, Illinois, in 1878 by O. P. Hay: A, first pleopod; B, second pleopod; C, ventral surface of tip of endopodite of second pleopod.

Illinois Natural History Survey, Urbana; the material is not numbered, the reference is "INHS (uncataloged)." Data on original label reads: "Callahan Cr. Cobden. Ill. May 30, 1876 S.A. Forbes" and "Cotypes *Asellus intermedius* Forbes."

DESCRIPTION OF LECTOTYPE.—Body: Length, 4.5 mm.

Head: Eyes large and distinct. Anterolateral lobes not prominent.

First antenna: Tip of flagellum broken off, flagellum at least 5-merous and reaching to point one-third distally along last segment of peduncle of second antenna. All segments of peduncle about twice as long as wide; first segment longest, second about three-quarters length of first, and third about three-quarters length of second.

Second antenna: Tip of flagellum broken off, but length of antenna (2.5 mm) at least half (0.55) body length. Flagellum at least 31-merous.

First peraeopod (Figure 17A): Dactylus slightly longer than palm of propodus and with 6 teethlike spines on palmar edge and a long terminal claw. Propodus about 1.5 times as long as wide, almost subtriangular; palm with a large obtuse triangular projection about half width of opposing dactylus situated near midpoint, 1 large toothlike spine at proximal end, and a submarginal row of spines on inner and outer surfaces.

First pleopod (Figure 17B): Total length of appendage 1.10 times as long as second pleopod. Sympod subcircular, about as wide as long; inner margin with 3 hooklike protuberances for coupling. Distal segment subovate but distal margin somewhat truncate and distal part of segment distinctly narrower than proximal part; maximum width slightly greater (0.57) than half maximum length; distal margin and adjacent part of outer lateral margin with 9 simple spines of moderate length.

Second pleopod (Figures 17C–E): Sympod subsquare, maximum length equal to maximum width. Proximal segment of exopod with a single spine on outer margin. Distal segment of exopod ovate with 2 short and 11 long setose spines. Endopod subrectangular, rather wide (maximum width about half maximum length), and total length subequal to that of exopod; conspicuous basal apophyses not present. Cannula prominent, wide, as long as wide, and subequal in length to caudal process. Caudal process prominent, sclerotized, and terminated by a sharp point. Mesial process not developed.

Uropod (Figures 18A,B): Slightly shorter (0.77) than telson. Peduncle about twice as long as greatest width. Exopod as long as peduncle, endopod rather longer (1.3); both rami have a number of long fine spines distally, and numerous shorter and stronger spines laterally.

PARTIAL DESCRIPTION OF FEMALE PARALECTOTYPE.—"First" pleopod (Figure 18C): Approximately trapezoidal in shape, almost (2.3) two and a half times as long as maximum width. Distal margin and distal half of outer margin with 7 long and 3 shorter finely plumose spines; a short simple spine occurs near inner proximal angle.

MATERIAL EXAMINED.—ONTARIO: Humber River,* York County, 4♂♂, coll. Ontario P. & D., 12.vi.1946 (NMC); Underwood Creek, Collingwood, 7♂♂, coll. J. B. Sprague, 2.iv.1955 (ROM); Rideau River, 4♂♂, coll. Macoun Field Club, 30.iv.1955 (NMC); Rideau River, 2♂♂, coll. E. L. Bousfield, 7.v.1955 (NMC); stream east of Houghton, 2♂♂, coll. Ontario P. & D., 7.vi.1955 (NMC); Little Otter Creek, 2♂♂, coll. Ontario P. & D., 9.vii.1955 (NMC); Rideau River, 1♂, coll. Macoun Field Club, 12.v.1956 (NMC); Underwood Creek, Collingwood, 5♂♂, coll. J. B. Sprague, 11.viii.1956 (NMC); Frazer Dontile Quarry Pond, Ottawa, 8♂♂, coll. E. L. Bousfield, 29.ix.1956 (NMC); Taylor's Hill Quarry, Ottawa, 4♂♂, coll. E. L. Bousfield, 13.iv.1957 (NMC); Taylor's Hill Quarry, Ottawa, 3♂♂, coll. E. L. Bous-

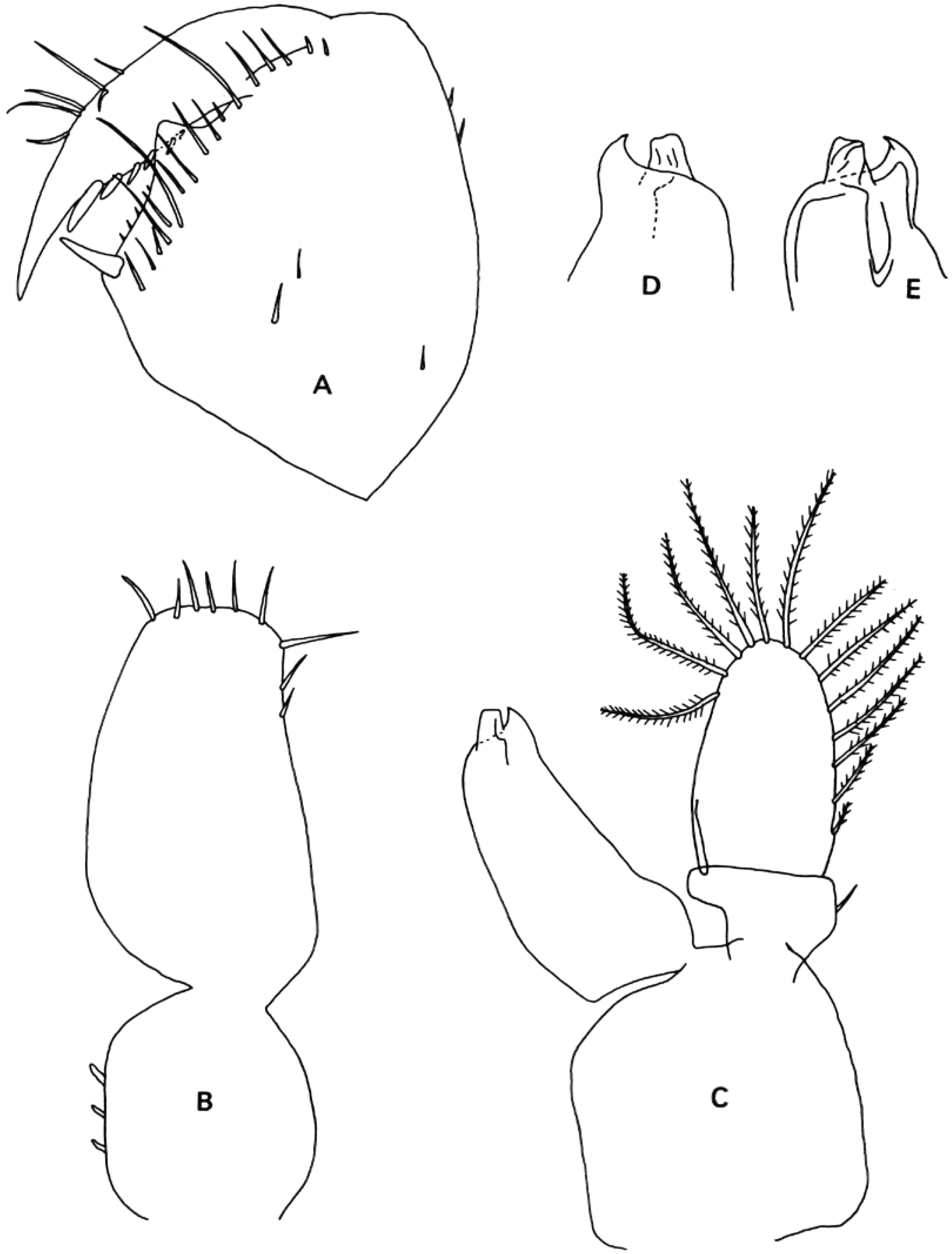

FIGURE 17.—*Asellus intermedius*, lectotype: A, dactylus and palm of first peraeopod; B, first pleopod; C, second pleopod; D, E, respectively dorsal and ventral surfaces of tip of endopodite of second pleopod.

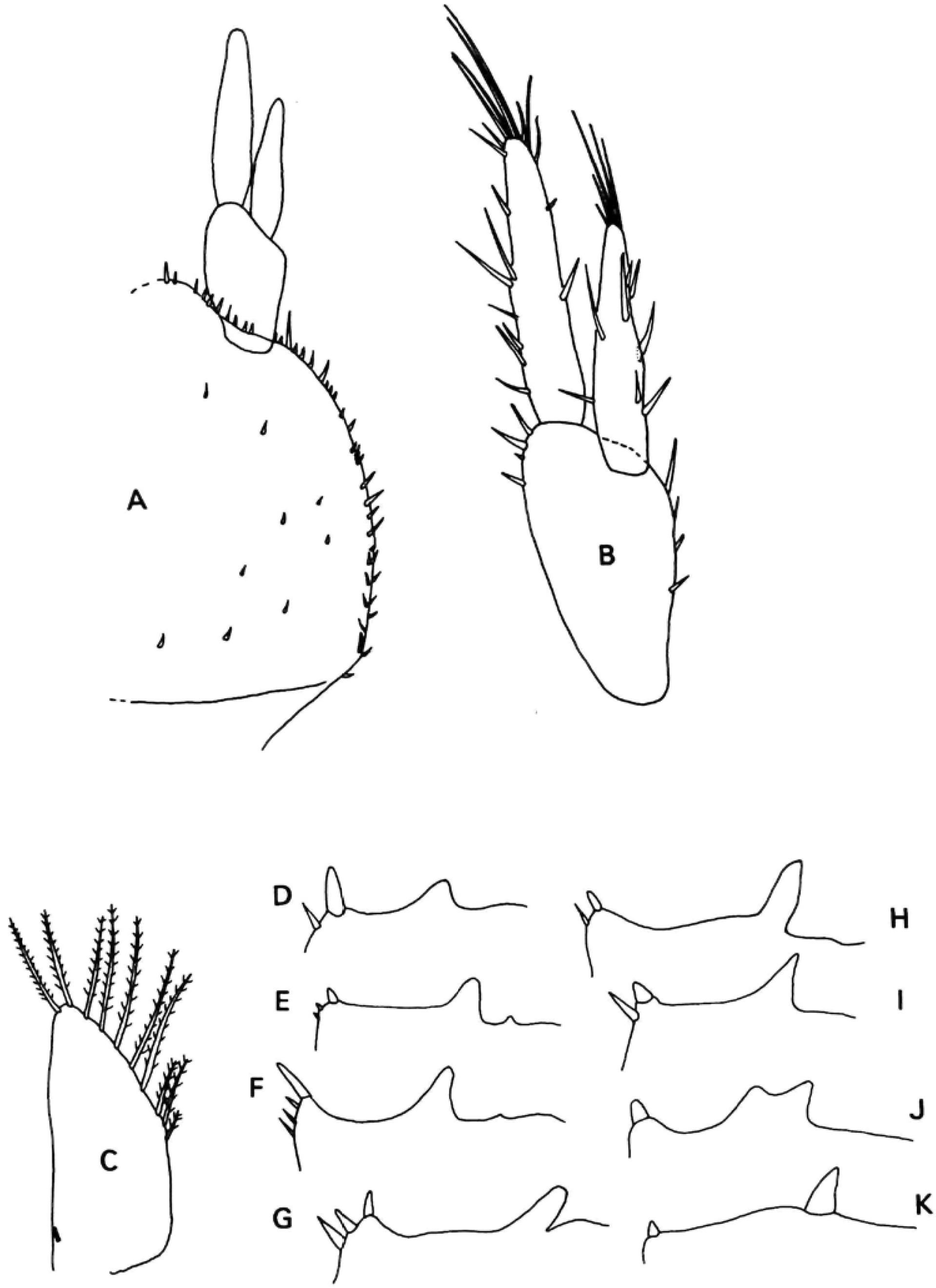

FIGURE 18.—*Asellus intermedius,* A, B, lectotype; C, female paralectotype; D–K, extent of variation in palm shape of male first peraeopod in nontype material: A, uropod and telson; B, uropod; C, "first" pleopod; D, F, I, Ottawa, Ontario; E, Cook County, Illinois; G, Shawnee National Forest, Illinois; H, Swedesburg, Iowa; J, Jefferson County, Kentucky; K, Lake Mendota, Wisconsin.

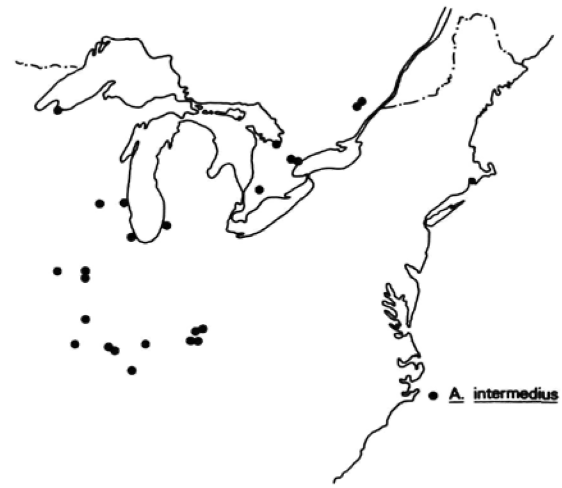

FIGURE 19.—Geographical distribution.

field, 4.v.1957 (NMC); Cooksville, 5♂♂, coll. D. Barr, 5.iv.1962 (ROM); Cooksville, 14♂♂, 5.iv.1962 (ROM); Ottawa, 5♂♂, coll. E. L. Bousfield, 21.v. 1962 (NMC); Cooksville, 14♂♂, coll. D. Barr, 14.vii. 1962 (ROM).

ILLINOIS: Golconda, 3♂♂, coll. B. D. Burks, 12.iii.1940 (INHS); Palas Hills, Cook County, ∞♂♂, coll. L. Hubricht, 2.v.1941 (USNM); Lemont, Cook County, ∞♂♂, coll. L. Hubricht, 3.v. 1941 (USNM); Galesburg, Knox County, ∞♂♂, coll. L. Hubricht, 4.v.1941 (USNM); Glendale, 1♂, coll. Messrs. Ross and Burks, 18.iv.1942 (INHS); Carbondale, 4♂♂, coll. R. L. Lippson, 6.iv.1967; Hutchin's Creek, Union County, 4♂♂, coll. R. L. Lippson, 7.iv.1965.

INDIANA: Wabash River, New Harmony, 1♂, coll. U.S. Dept. Interior, 29.ix.1965; Wabash River, New Harmony, 1♂, coll. U.S. Dept. Interior, 20.xii. 1965.

IOWA: Swedesburg, Henry County, ∞♂♂, coll. L. Hubricht, 24.iv.1942 (USNM).

KENTUCKY: Fish Pond Creek, Jefferson County, 3♂♂, coll. G. A. Cole, 21.iii.1954; Pennsylvania Creek, Jefferson County, 7♂♂, coll. G. A. Cole, 21.iii. 1954; Cedar Creek, Jefferson County, 1♂, coll. G. A. Cole, 28.iii.1954; Fern Creek, Jefferson County, 7♂♂, coll. G. A. Cole, 4.iv.1954; Beargrass Creek, Jefferson County, 2♂♂, coll. G. A. Cole, 25.iv.1954; Pennsylvania Run, Jefferson County, 1♂, coll. G. A. Cole, 23.v.1954; Spring, Oldham County, 3♂♂, coll. G. A. Cole, 17.iv.1955 (NMC); Goose Creek,* Jefferson County, 4♂♂, coll. G. A. Cole, 4.v.1955; Acc. 59–173, Jefferson County, 1♂, coll. G. A. Cole, 1957 (NMC).

MICHIGAN: Wolf Lake Hatchery, Van Buren County, 1♂, coll. R. L. Lippson, 25.xi.1965.

MISSOURI: Meramec State Park, Franklin County, ∞♂♂, coll. L. Hubricht, 25.vii.1937 (USNM).

WISCONSIN: Lake Mendota, 32♂♂, coll. H. W. Levi, September 1948 (CMZ); Lake Superior, Ashland, 6♂♂, coll. E. L. Bousfield, 26.vi.1957 (NMC); Lake Mendota, ∞♂♂, coll. H. B. N. Hynes, 15.viii. 1962; Milwaukee River, 1♂, coll. U.S. Dept. Interior, 23.viii.1962.

GEOGRAPHICAL DISTRIBUTION AND ECOLOGY.—The localities listed above, together with the type locality, are plotted in Figure 19. From this it can be seen that *A. intermedius* occurs within a large area of east-central United States and southern Ontario. Over a part of its range it is sympatric with *A. brevicauda brevicauda,* but its range is more extensive than that of this species and it extends farther northward.

Most of the collections examined, as indicated by the data on labels, had been obtained from creeks, streams, or rivers, so that we may assume that *A. intermedius* is characteristically associated with running waters. Some of the collections, however, were from springs, lakes, ditches, or ponds, and it is clear that *A. intermedius* is by no means restricted to running waters. The ecology of this species has been intensively studied by Ellis (1961); certainly for his correct identification of the species is provided by his drawings of the male genital pleopods (1961, figs. 2–4), which are undoubtedly those of *A. intermedius.*

FURTHER DESCRIPTION (♂).—Body: The largest ♂ examined was 16.0 mm long, and the smallest 4.0 mm.

First antenna: Flagellum 7- to 17-merous; flagellum tip reaching to one-third along or to distal end of the last segment of the peduncle of the second antenna; penultimate 2 to 4 (unusually 3) segments bear aesthetascs.

Second antenna: Length 0.48 to 0.79 times that of body. Flagellum 32- to 93-merous, depending upon size.

Mouthparts: See Table 1.

First peraeopod: Dactylus with 4 to 14 teethlike spines on palmar margin; in general, these spines are large and few in small specimens, and small and many in large ones. The shape of the palm shown in Figure 17A (lectotype) occurs only in young specimens, and the shapes typically encountered in large adult males are more like those illustrated in Figures 18D–K, which indicate the range of variation that occurs. Thus, the large triangular structure near the midpoint of the palm is always large and quite prominent (often sharply pointed and occasionally toothlike), and the proximal end of the palm is also usually produced outward, this projection bearing a blunt wide tooth (very occasionally 2 such teeth) and beyond this 1 to 4 but usually 2 stout spines.

First pleopod: Total length of appendage 0.88 to 1.22 times as long as second pleopod. Inner margin of sympod with 3 to 5 (usually 3 or 4) coupling hooks. Maximum width of distal segment 0.36 to 0.71 times maximum length; marginal spines few to numerous, but always simple and of moderate length. The typical shape of the distal segment is subovate; only a little variation occurs.

Second pleopod: Maximum length of sympod from 1.0 to 1.2 times maximum width. Proximal segment of exopod with 1 to 6 spines on outer margin; distal segment with 7 to 23 plumose spines on margin. Inner basal angle of endopod obtuse, sharply angled, or produced into a small acutely pointed apophysis. The main features of the morphology of the tip of the endopod are constant, the principal variation occurring only in the shape and extent of development of the caudal process; this may be rounded, pointed, or have a terminal claw; it is frequently produced at approximately right angles to the main body of the endopod, and may in some cases have pointed basal protuberances, although this is not usually so and is found only in very large specimens. Figure 20 indicates the range of variation in the morphology of the endopod tip. The typical morphology is as illustrated for the lectotype (Figures 17D, E).

Uropod: See Table 2.

Asellus attenuatus Richardson

FIGURES 21, 22

Asellus attenuatus Richardson, 1900, p. 297.—Richardson, 1901, pp. 552–553, figs. 26–28.—Richardson, 1905, pp. 426–428, figs. 482–485.—Van Name, 1936, pp. 461–462, fig. 289.

The name *Asellus attenuatus* was first published as part of an identification key for North American Asellidae, and the only distinguishing characters mentioned were confined to the uropoda and propodus of the first peraeopod (sex unstated) (Richardson, 1900). The description sensu stricto was not published until the following year (Richardson, 1901). This, while more

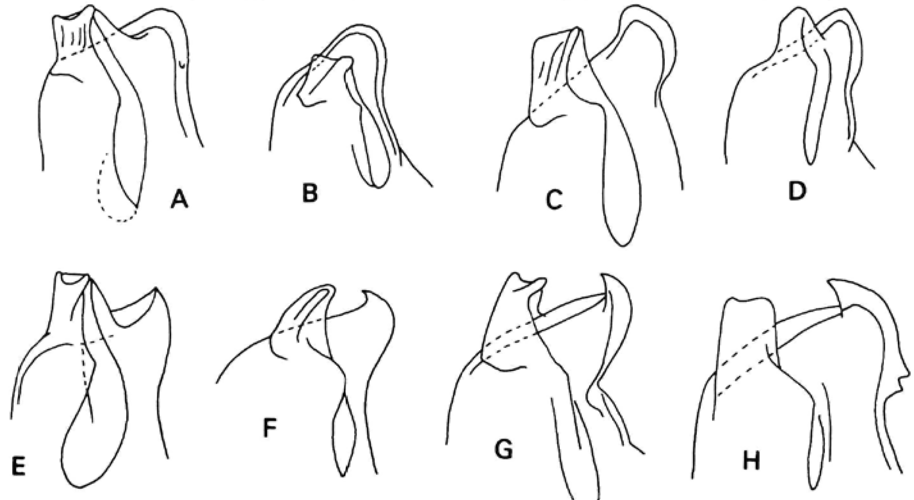

FIGURE 20.—*Asellus intermedius*, extent of variation in morphology of endopod tip of male second pleopod: A, E, Oldham County, Kentucky; B, D, Jefferson County, Kentucky; C, Meramec State Park, Franklin County, Missouri; F, Lake Mendota, Wisconsin; G, Wabash River, Indiana; H, Collingwood, Ontario.

complete and accompanied by some drawings, is insufficiently detailed to enable adequate identification of Richardson's taxon; no mention is made, for example, of the form of any pleopoda. It is not surprising, therefore, that no further material of this species has been identified since the original type collection was made (1899). Some additional descriptive details concerning the female genital pleopoda and the propodus of the male first peraeopod were given by Richardson in 1905, but these details likewise are insufficient to clarify the species identity.

Fortunately, type material of *A. attenuatus* was set aside by Richardson, this being noted in her publications (1901, 1905) as: "Type [sic].—Cat. No. 23910, U.S.N.M." Through the courtesy of Dr. T. E. Bowman, National Museum of Natural History, I have been able to reexamine this material. It was contained in two tubes in a jar labeled "23910 *Asellus attenuatus*." One tube contained 2 specimens (1 ♂, 1 nonovigerous ♀) and the other 100 specimens (9 ♂ ♂, 90 nonovigerous ♀ ♀, 1 juvenile). The material in the first tube had obviously been withdrawn from the larger collection at some time, for there is a note that it had been "given to Hubricht in exchange and returned by Hubricht as gift." Several labels were in the second tube, of which the significant one read: "United States National Museum 23910 *Asellus attenuatus* Richardson Washington Ditch, Dismal Swamp, Va. June 9, 1899 Wm. Palmer and Paul Bartsch for the Museum. Type 106 id. H. Richardson Acc. No. 35186." Two microvials were also present in the jar, one containing the damaged posterior half of a specimen and the other a detached peraeopod and maxilliped. All specimens were damaged and no single complete male was present; the least damaged male lacked only uropoda, while all remaining males lacked at least their second antennae. Of the females present only five possessed attached second antennae. The least damaged male has been designated lectotype, the remaining specimens as paralectotypes.

Type material.—Lectotype, adult ♂. Paralectotypes, 9 ♂ ♂, 91 nonovigerous ♀ ♀, 1 juvenile. All material is deposited in the National Museum of Natural History, USNM 23910.

Description of lectotype.—Body: Length, 9.5 mm.

Head: Eyes large and distinct; posterolateral lobe not prominent but bearing a single long and robust spine.

First antenna: Flagellum 14-merous and tip reaching to midpoint of last segment of peduncle of second antenna; penultimate 2 segments bear aesthetascs. Flagellum subequal in length to peduncle. First and second segments of peduncle subequal in length; third segment about two-thirds length of second. First segment of peduncle about twice as long as wide; second and third each 4 times as long as wide.

Second antenna: Length (10.5 mm) slightly longer (1.11) than body. Flagellum 82-merous. First, second, and third segments of peduncle stout, about twice as wide as long; fourth segment twice as long as first three combined, 4 times as long as wide; fifth segment about 1.5 times as long as fourth, about 8 times as long as wide.

Mouthparts: See Table 1.

First peraeopod (Figure 21A): Dactylus about 1.5 times longer than palm, with 10 teethlike spines on palmar margin and a distinct terminal claw. Propodus slightly less than twice as long as wide, subovate; palm with a single low blunt triangular projection near midpoint, a very long and strong tooth at proximal end, and numerous short to long submarginal spines.

First pleopod (Figure 21B): Total length of appendage only three-quarters length of second pleopod. The division of the appendage into proximal and distal segments is incomplete so that it appears somewhat dumbell-shaped; the basal portion has 3 hooklike coupling protuberances on its inner margin, and the subovate distal portion has 11 short, simple (apparently) spines on its distal margin.

Second pleopod (Figures 21C,E): Sympod subovate, maximum length 1.44 times maximum width. Proximal segment of exopod with a single spine on outer margin. Distal segment of exopod with 1 short and simple spine and 17 long plumose spines on margin. Endopod rather narrow, more or less straight in long axis, and about 3.5 times central width; endopod three-fifths total length of exopod, but distinctly shorter (0.72) than distal segment of exopod; inner and outer basal apophyses present but not well developed. Cannula long and tubular and extending beyond caudal process. Mesial process long, subequal in length to cannula, sclerotized, and ending in a sharp point. Caudal process present but not well developed and more or less rounded in outline with no associated hooks or spines.

Uropod: Missing (see below).

Partial description of male paralectotype.—Uropod (Figure 21F): Same length as telson. Peduncle

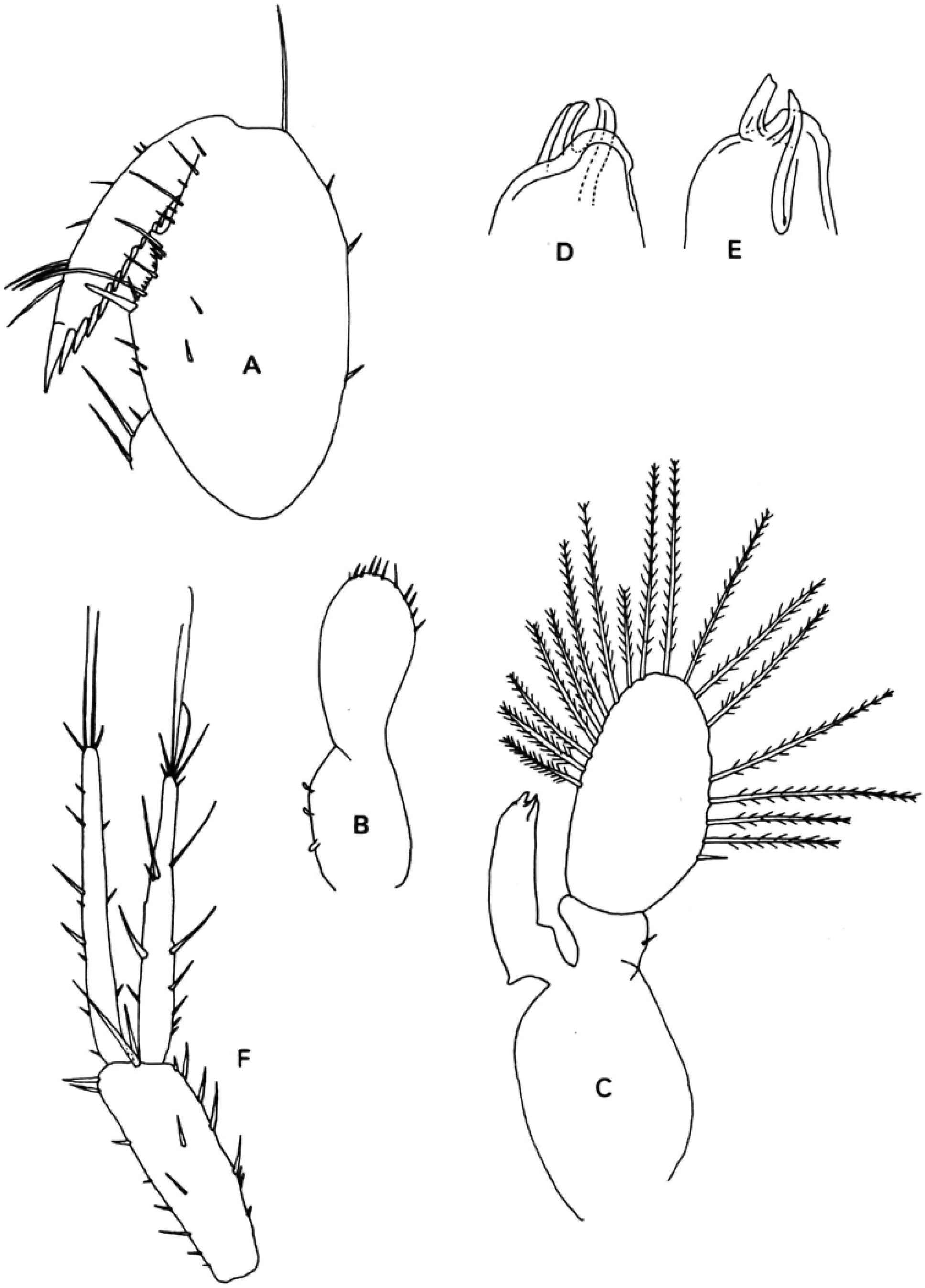

FIGURE 21.—*Asellus attenuatus*, A–C, E, lectotype; D, F, male paralectotype: A, dactylus and propodus of first peraeopod; B, first pleopod; C, second pleopod; D, E, respectively dorsal and ventral surfaces of tip of endopodite of second pleopod; F, uropod.

about 3 times as long as greatest width with several marginal spines. Exopod and endopod respectively 1.2 and 1.3 times peduncle length; both rami narrow and with a small group of very long fine spines at distal tip as well as several stout marginal spines.

PARTIAL DESCRIPTION OF FEMALE PARALECTOTYPE.—Body: Length, 11.0 mm; maximum width, 4.5 mm.

Second antenna: Length (13.0 mm) distinctly greater (1.18) than body length.

First peraeopod (Figures 22A,B): Relatively slender and not subchelate. Dactylus about as long as palm of propodus with 12 teethlike spines on margin and a larger terminal spine. Propodus subovate, about twice as long as greatest width. Carpus triangular, small. Merus subtriangular, about as wide as long, with 2 long and strong spines at anterodistal angle. Ischium subrectangular, not quite twice as long as merus, twice as long as wide. Basis subtrapezoidal, about 1.5 times as long as ischium, twice as long as wide.

"First" pleopod (Figure 22C): Shape almost subrectangular, distal width slightly greater than proximal width, length 2.5 times maximum width. Distal margin with 17 long plumose spines and a single short simple spine at outer distal angle.

DISCUSSION.—The damaged condition of the type material, and especially the presence of only a few specimens with attached second antennae, is rather unfortunate, for it appears that the ratio of the length of the second antennae to the body length constitutes one of the salient characters of this species, as indicated by Richardson's name for it. In the five females with attached second antennae, the ratio—length of second antenna/body length—varied from 0.94 to 1.31.

The paucity of male specimens is also most unfortunate for it precludes the determination of the extent of phenotypic variation in the genital pleopoda and other critical parts of males of this species. At first it was thought that the incomplete division and relatively small size of the first pleopod was perhaps an aberration of the sort known to occur occasionally in single specimens of *Asellus* (cf. Williams, 1962a), but the same configuration was displayed by the first pleopod of a male paralectotype. At all events, study of further material is certainly needed to indicate the extent of

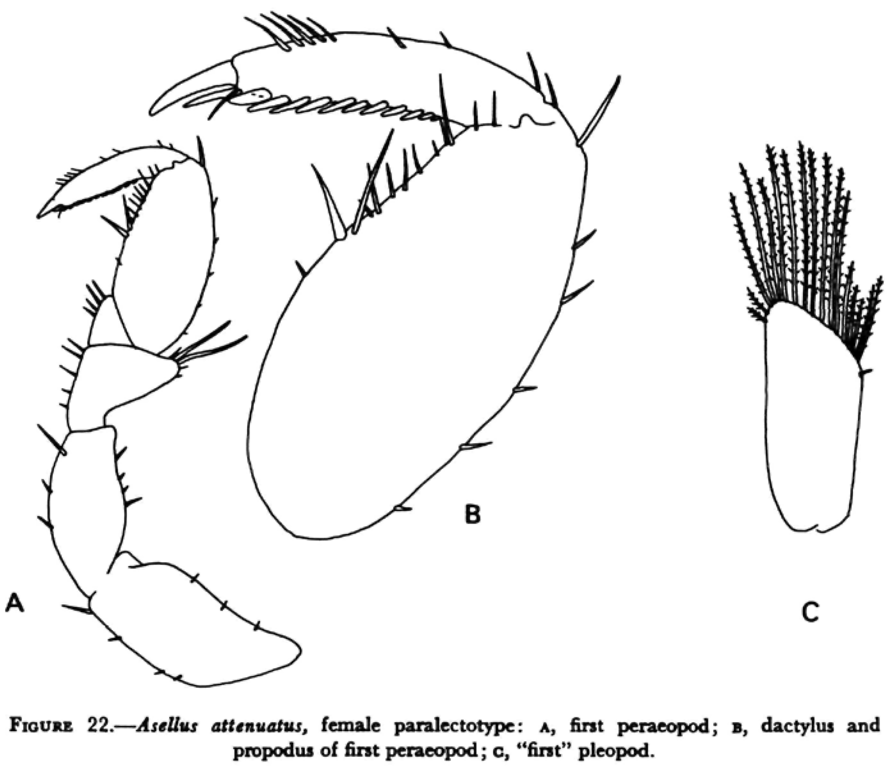

FIGURE 22.—*Asellus attenuatus*, female paralectotype: A, first peraeopod; B, dactylus and propodus of first peraeopod; C, "first" pleopod.

morphological variation in *A. attenuatus*. It must be recorded that no such material was encountered during the present revision, indicating perhaps that *A. attenuatus* has a restricted range of distribution. The only Dismal Swamp in Virginia known to the writer lies in the extreme southeastern corner of the state just west of Portsmouth (Figure 30).

In the morphology of the tip of the endopod of the second male pleopod, *A. attenuatus* closely approaches *A. racovitzai,* and the taxa may perhaps prove to be no more than subspecifically separate. However, the lack of a well-developed caudal process and the somewhat more elongated nature of the cannula and mesial process, combined with other differences between the taxa, indicate that until further study of material of Richardson's taxon has been made it is appropriate at present to retain specific status for it. The other differences, as indicated by the study of lectotype material, are that in both sexes of *A. attenuatus* the second antennae are longer (almost as long as or longer than the body), and that in males the first pleopod is significantly shorter than the second and is incompletely divided into a proximal portion and a subovate distal portion, and the endopod of the second pleopod is distinctly shorter than the distal segment of the corresponding exopod. Other apparent differences, such as those in the proportions of the antennal segments and the shape and armature of the first male peraeopod and the uropod, are perhaps less significant for these appendages in *Asellus* are known to be rather variable in structure.

Asellus dentadactylus Mackin and Hubricht

Figure 23

Asellus dentadactylus Mackin and Hubricht, 1938, pp. 629–630, figs. 3–6, 8.—Van Name, 1940, pp. 127–128, fig. 20.

The original description of *A. dentadacytylus* is certainly sufficient to allow identification of this species with considerable confidence, as the morphology of the tip of the endopodite of the male second pleopod is described in some detail and figured. The accuracy of the original description and figures was checked by reexamination of the type material deposited by Mackin and Hubricht in the United States National Museum. This material consisted of specimens distributed within two jars, one containing 24 specimens and labeled both "paratypes" and "cotypes," the other containing 8 specimens and labeled only "cotypes." From the second jar one adult male has been designated the lectotype; the remaining 4 ♂♂ and 3 ovigerous ♀♀ in this jar, and all the specimens in the other jar, have been designated paralectotypes. A label in the second jar reads: "A 2659 April 11, 1936 *Asellus dentadactylus* Mackin and Hubricht Small creek, ½ mile S. of Locust Cottage, Jefferson Co., Arkansas Leslie Hubricht coll. Cotype. Cat. No. 74841 USNM." Other labels in both jars gave the same information.

Although Mackin and Hubricht's description supplies the more significant details concerning the morphology of *A. dentadactylus,* their description is incomplete, and at least with regard to the fine structure of the endopodite tip of the male second pleopod several differences are apparent between their drawings and my own based on the lectotype. Furthermore, it is not possible to discern from their drawing (fig. 4) the relationships of the various processes surrounding the cannula, nor indeed to be certain of the position of the cannula itself. Concerning the morphology of the endopodite tip Mackin and Hubricht state only (1938, p. 629), "truncate tip with wide opening." For these reasons, a description of the lectotype is given below. Van Name (1940) simply repeated the descriptive details given by Mackin and Hubricht (1938).

Description of lectotype (♂).—Body: Length, 7.5 mm; maximum width, 2.0 mm.

Head: Eyes distinct.

First antenna: Flagellum 10-merous and tip reaching to midpoint of last segment of peduncle of second antenna. Flagellum three-quarters length of peduncle. First segment of peduncle about three-quarters length of second, second about twice as long as third. First segment about twice as long as wide, second and third each about 4 times as long as wide.

Second antenna: Length (6.0 mm) four-fifths body length. Flagellum about 56-merous.

Mouthparts: See Table 1.

First peraeopod (Figure 23A): Dactylus subequal in length to palm, with 9 small denticles on palmar margin and a large terminal claw. Propodus 1.3 times as long as wide, subtriangular; palm with a large acutely pointed triangular projection near midpoint, one toothlike spine and 2 stout spines at proximal end, and numerous short to long submarginal spines.

First pleopod (Figure 23B): Total length of appendage distinctly longer (1.35) than second pleopod. Sympod subrectangular, about 1.5 times as long as

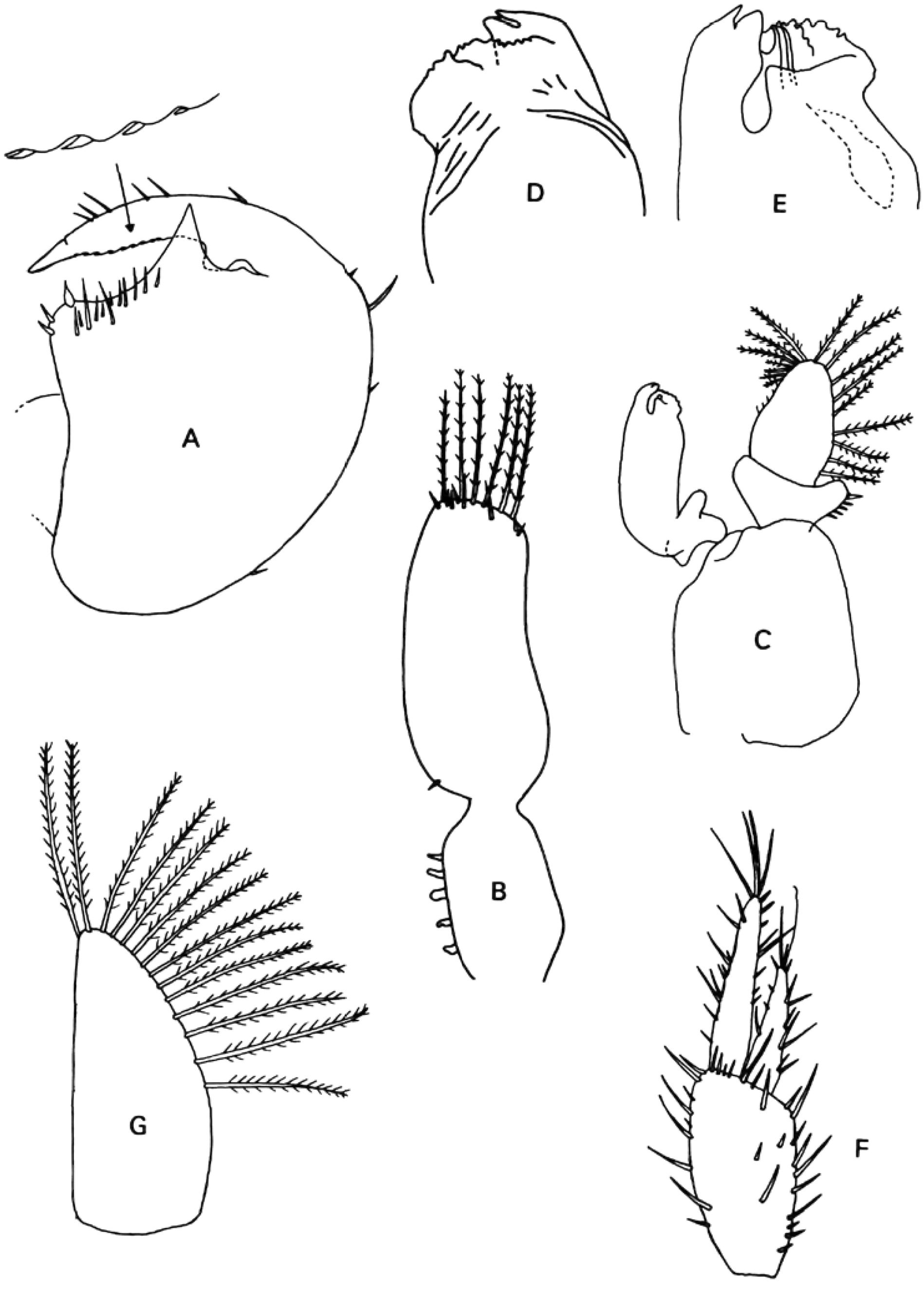

FIGURE 23.—*Asellus dentadactylus*, A–F, lectotype; G, female paralectotype: A, dactylus and propodus of first peraeopod; B, first pleopod; C, second pleopod; D, E, respectively dorsal and ventral surfaces of tip of endopodite of second pleopod; F, uropod; G, "first" pleopod.

wide; inner margin with 5 hooklike protuberances for coupling. Distal segment also subrectangular, but gently curved outward so that the outer lateral margin is distinctly concave and the inner lateral margin convex; proximal width slightly greater than distal width; maximum width slightly less (0.46) than half maximum length; distal margin bearing 6 long sparsely setose spines and 8 shorter simple spines somewhat irregularly arranged; inner proximal angle with a short simple spine.

Second pleopod (Figures 23C-E): Sympod subquadrate, maximum length only slightly greater (1.2) than maximum width; medial and lateral margins more or less straight. Proximal segment of exopod cupulate, outer margin with 5 short simple spines. Distal segment of exopodite subovate, about 1.5 times as long as wide, and with 16 long plumose spines on outer and distal margins and several fine short spines on inner margin. Endopod about as long as exopod; prominent inner and outer apophyses occur basally. Cannula short and narrow. Ventral groove short. Mesial process large and well developed, bifid, and extending beyond cannula. Lateral process not prominent. Caudal process wide, not protruding beyond cannula, and irregularly dentate.

Fourth pleopod: Six plumose spines on outer distal margin in addition to those spines occurring along outer proximal margin.

Uropod (Figure 23F): As long as telson. Peduncle about twice as long as greatest width. Exopod two-thirds (0.63) length of peduncle, endopod almost as long (0.91) as peduncle; both rami have a number of long fine spines distally, and numerous shorter and stronger ones laterally.

Partial description of female paralectotype.—First peraeopod: General shape and setation similar to that described for a female paralectotype of *A. attenuatus* but propodus has a single moderately long and strong toothlike spine near proximal end of palm. Palmar margin of dactylus with 4 teethlike spines.

"First" pleopod (Figure 23G): Shape subtriangular, but outer margin convex with 14 long plumose spines on distal half.

Geographical distribution and ecology.—No further material of this species was encountered during the present investigation, and I cannot add therefore to the two localities from which the species has hitherto been recorded (Mackin and Hubricht, 1938). The known localities are in Arkansas (type locality) and Louisiana (Natchitoches Parish, 2 miles south of Saline); their positions are indicated in Figure 7.

Concerning the ecology of this species, it can only be said that specimens have been taken from a small creek, and from among dead leaves in a small creek below an artificial pond (Mackin and Hubricht, 1938).

Asellus montanus Mackin and Hubricht

Figure 24

Asellus montanus Mackin and Hubricht, 1938, pp. 630–631, figs. 1, 2, 7, 9, 10.—Van Name, 1940, pp. 126–127, fig. 19.

Like *A. dentadactylus* discussed above, the original description of *A. montanus* is certainly sufficient to allow specific identification with considerable confidence; the morphology of the tip of the endopodite of the male second pleopod of this species also is described in some detail and figured. The accuracy of the original description and figures is supported by a reexamination of the type material deposited by Mackin and Hubricht in the United States National Museum. This material consisted of 14 specimens in a jar with the label: "United States National Museum 74842 *Asellus montanus* Creek, Y-city, 4 miles S. of Boles, Scott Co., Ark. L. Hubricht (coll. & don.) April 27, 1936 id. Mackin and Hubricht Acc. No. 145424 Cotypes." The specimens were actually in a tube inside the jar and this tube had its own label which, however, gave the same information as the one in the jar. The 14 specimens consisted of 7 ♂♂, 5 ovigerous ♀♀, and 2 nonovigerous ♀♀. All males were damaged to a greater or lesser extent; the least damaged male was designated the lectotype and all other material was designated paralectotypes.

As was the case for *A. dentadactylus,* although Mackin and Hubricht's description gives the pertinent details concerning the morphology of *A. montanus,* it is incomplete, and with regard to the fine structure of the tip of the endopod of the male second pleopod minor differences are again apparent between their drawing and my own based on the lectotype. For these reasons a description of the lectotype is given below. Van Name (1940) simply repeated the descriptive details given by Mackin and Hubricht (1938).

Description of lectotype (♂).—Descriptive details are omitted when these refer to parts of the body that are similar in construction in *A. communis* (neo-

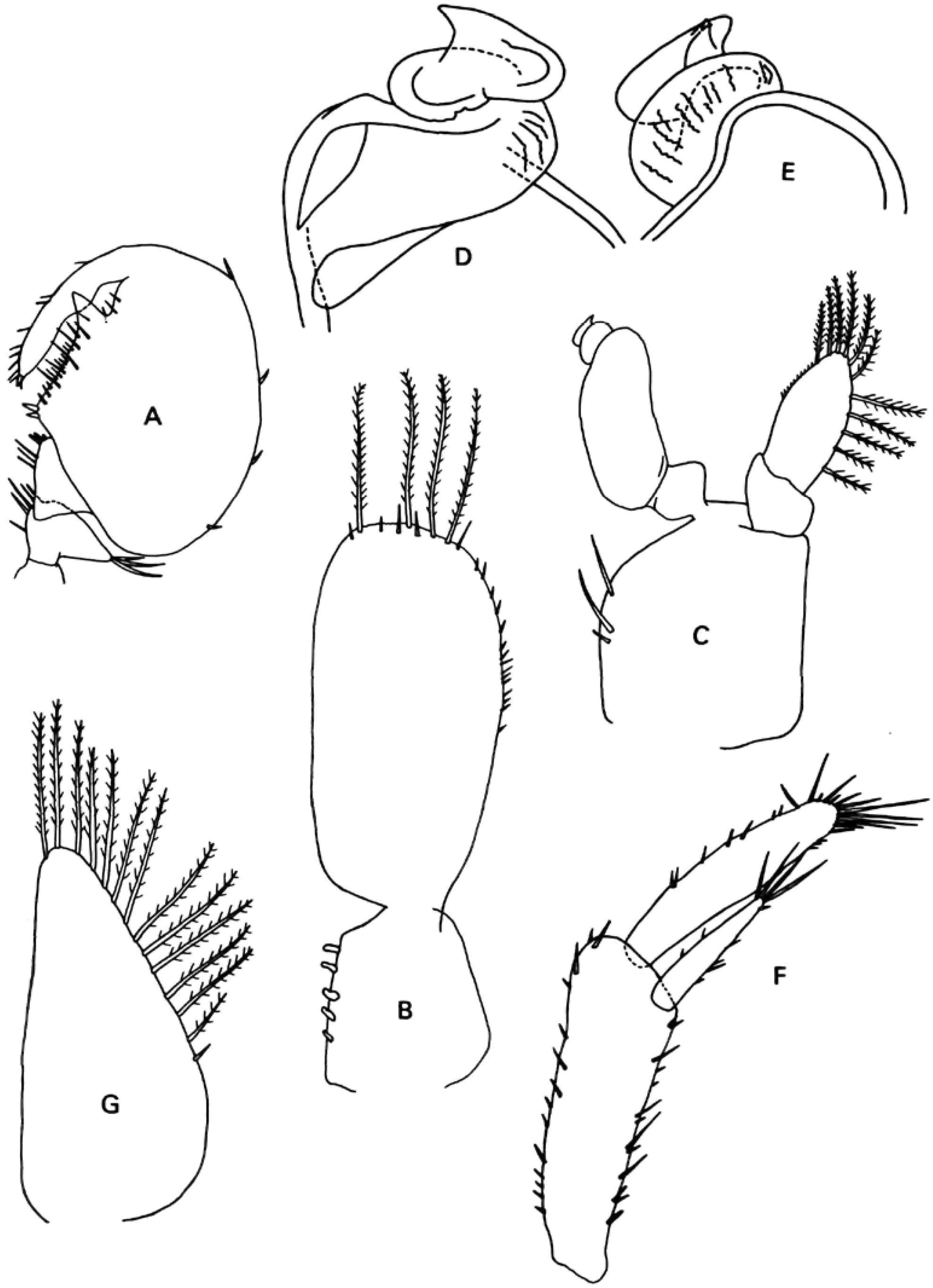

FIGURE 24.—*Asellus montanus*, A–F, lectotype; G, female paralectotype: A, distal segments of first peraeopod; B, first pleopod; C, second pleopod; D, E, respectively dorsal and ventral surfaces of tip of endopodite of second pleopod; F, uropod; G, "first" pleopod.

type), or, where indicated, *A. dentadactylus* (lectotype).

Body: Length, 11.5 mm; maximum width, 2.5 mm.

Head: Eyes relatively large and distinct.

First antenna: Flagellum 13-merous. Otherwise similar to *A. dentadactylus*.

Second antenna: Length (9.0 mm) four-fifths body length. Flagellum 94-merous and about twice length of peduncle. Fourth segment of peduncle about 1.5 times as long as first three segments combined, 4 times as long as wide; fifth segment about 1.5 times length of fourth, 6 times as long as wide.

Mouthparts: See Table 1.

First peraeopod (Figure 24A): Dactylus slightly shorter than palm, lacking spines or denticles on palmar margin but with a short and rather blunt terminal claw. Propodus 1.5 times as long as wide, subquadrate; palm with a large acutely pointed triangular projection near midpoint, 2 small but stout toothlike spines at proximal end, and numerous short to long submarginal spines.

Second to seventh peraeopoda: Segments generally more elongated than as described for *A. communis*, and dactyli bear fewer teethlike marginal spines. The proportions of the segments to each other in a given peraeopod are nevertheless similar to those described for *A. communis*.

First pleopod (Figure 24B): Total length of appendage distinctly (1.32) longer than second pleopod. Sympod subquadrate, about as long as wide; inner margin with 5 hooklike protuberances for coupling. Distal segment broadly ovate, widest about two-thirds toward distal margin; maximum width half maximum length; numerous short and simple spines occur on the distal margin and the distal half of the outer margin, and in addition 4 long plumose spines are present on the distal margin.

Second pleopod (Figures 24C-E): Sympod subquadrate, maximum length only slightly greater (1.2) than maximum width; medial and lateral margins more or less straight. Proximal segment of exopod irregularly subtriangular, marginal spines absent. Distal segment of exopod subovate, twice as long as wide, with 11 long plumose spines on outer and distal margins, and a row of very fine short spines on inner margin. Endopod a little longer (1.17) than exopod. The body and associated structures of the endopod are arranged in a spiral fashion; thus, the main body appears to be twisted through 180° so that the terminal groove, which lies ventrally in other species, here lies dorsally. The terminal processes are subject to even more twisting and appear to coil at least 1.5 times. The actual processes involved in the coiling are difficult to discern, but it appears that the caudal process is not involved (and is not developed) and the lateral one is. The cannula is not visible. Basally, the endopod has an indistinct inner apophysis and a distinct outer right-angled apophysis.

Uropod (Figure 24F): Slightly longer (1.1) than telson. Peduncle about 3 times as long as greatest width. Exopod slender, about half (0.46) length of peduncle; endopod rather spathulate, four-fifths length of peduncle; both rami have a number of long fine spines distally (the endopod more than the exopod), and a few short ones laterally.

Partial description of female paralectotype.—First peraeopod: General shape and setation similar to that described for a female paralectotype of *A. attenuatus* but propodus has 2 strong teethlike spines near proximal end of palm, one moderately long and one shorter. Palmar margin of dactylus with 2 teethlike spines.

"First" pleopod (Figure 24G): Triangular, distal two-thirds of outer margin more or less straight and with 1 short simple spine and 13 long plumose spines.

Geographical distribution and ecology.—No further material of this species was encountered during the present study, and I cannot add therefore to the 5 localities from which the species has been recorded (Mackin and Hubricht, 1938). The known localities are in Arkansas (type locality, and near Minturn) and Oklahoma (two localities in Leflore County and one in Latimer County); their positions are indicated in Figure 7. Mackin and Hubricht (1938) record the species from a roadside slough and creeks or streams.

Asellus kenki Bowman

Figure 25, 26

Asellus kenki Bowman, 1967, pp. 131–140, figs. 1–44.

Asellus kenki was recently described by Bowman (1967) in what is undoubtedly the best description of a North American epigean species of *Asellus* that has appeared. I need add nothing to this description and there is certainly no point in reproducing it in entirety here. The species is characterized principally by the shape of the uropoda, the configuration of the first and

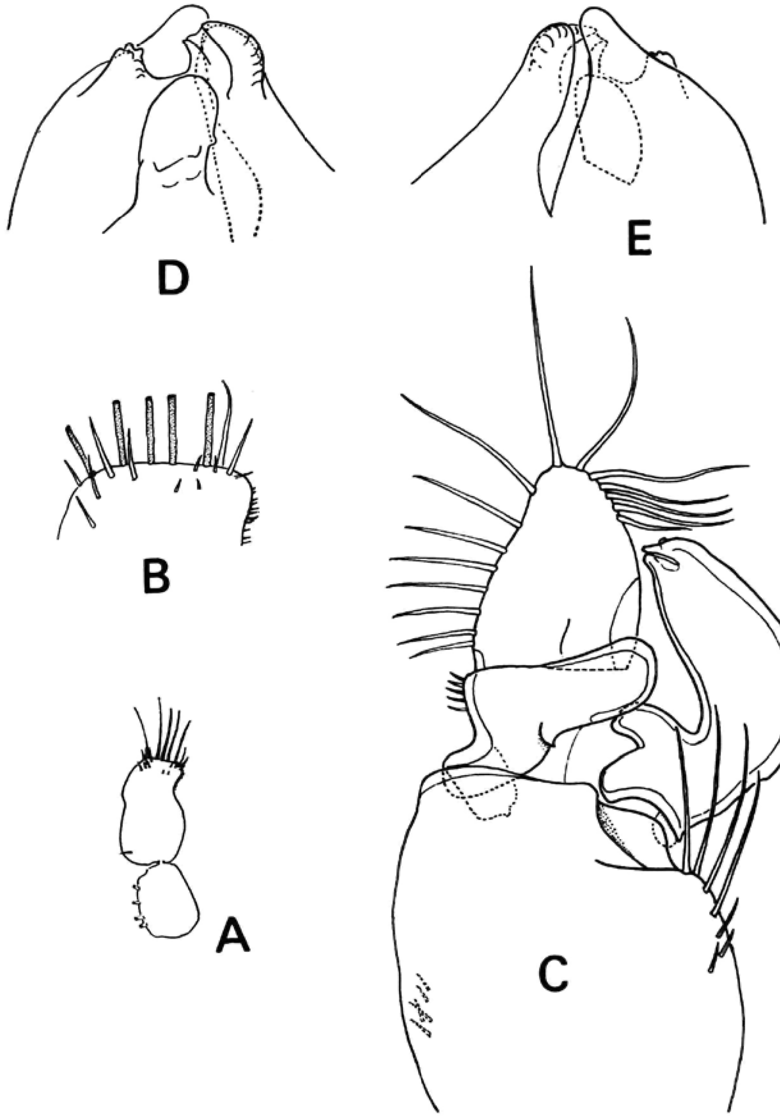

FIGURE 25.—*Asellus kenki,* male: A, first pleopod; B, distal margin of first pleopod; C, second pleopod; D, E, respectively dorsal (= posterior) and ventral (= anterior) surfaces of tip of endopodite of second pleopod. From Bowman (1967) with permission.

second pleopoda in males, and above all by the morphology of the tip of the endopodite of the male second pleopod. For comprehensiveness and convenience, Bowman's description of these features is reproduced here, and they are again illustrated (Figures 25, 26). The figures have been prepared entirely by selection from the drawings given by Bowman.

TYPE MATERIAL AND TYPE LOCALITY.—Holotype: adult ♂, USNM 119808. Paratypes: numerous other specimens from the type locality, USNM. Type locality: spring-fed pool located 0.91 km SSW of the Nature Center, Rock Creek Park, Washington, D.C.

PARTIAL DESCRIPTION (reproduced from Bowman, 1967).—Body: Moderately small, largest male 14 mm in length, but most mature males considerably shorter; ovigerous females reaching 7-8 mm.

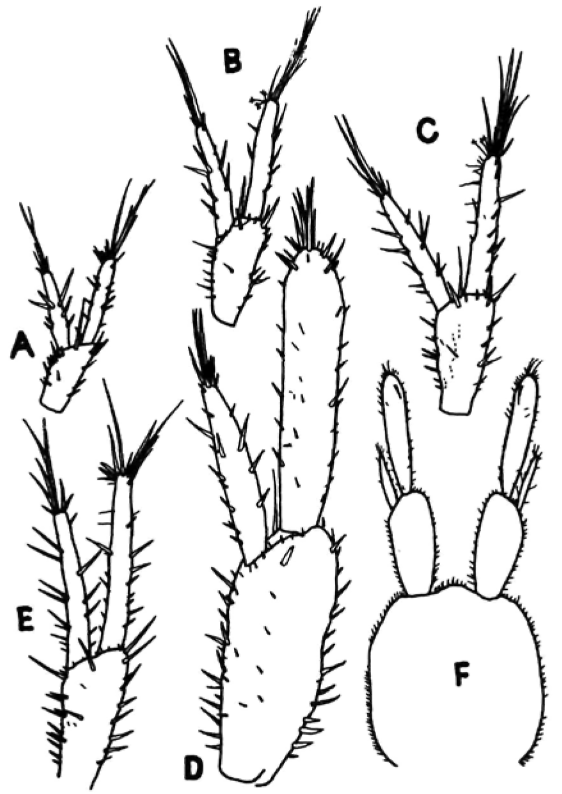

FIGURE 26.—*Asellus kenki*, right uropod or both uropoda and telson, dorsal views: A, 3.5 mm male; B, 5.0 mm male; C, 6.5 mm male; D, 8.2 mm male; E, 6.5 mm ovigerous female; F, 13.0 mm male. From Bowman (1967) with permission.

Eyes: Small, slightly longer than broad, composed of few facets.

Second antenna: 0.75 to 0.8 as long as body (excluding uropoda); flagellum about 70-merous.

Male first pleopod (Figures 25A,B): Peduncle three-quarters as long as exopod, with 3 or 4 coupling spines. Exopod about 1.6 times longer than wide, distal part with concave lateral margin, bent laterad, and bearing 5 long plumose setae on broad apex and several shorter setae proximal to apical setae; distal part of lateral margin with row of setules.

Male second pleopod (Figures 25C–E): Peduncle about one-third longer than wide, with about 5 setae on distomedial margin and 5 short setae on posterior surface near proximolateral margin. Exopod about three-quarters as long as peduncle; proximal segment cupulate, inserted into peduncle by truncate base with heavily sclerotized lateral margin, bearing rectangular flap on posterior surface, distal part of segment widening into rounded lobes on each side; lateral lobe with sclerotized margin continuous with that of base, bearing 4 or 5 short setae; medial lobe produced beyond insertion of distal segment, margin sclerotized. Distal segment of exopod narrowing apically, armed with plumose setae on lateral margin and distal third of medial margin; proximal third of medial margin with broad sclerotization. Endopod shorter than exopod, with well-developed medial apophysis in proximal part; distal to apophysis endopod curves strongly laterad and ends in 5 processes: a straight rounded lateral process, a medial process consisting of a lobe overriding medial process and a rugose lobe posterior and proximal to it, a medially curving cannular posterior to lateral process, and a broadly rounded posterior process [? caudal process] with a few rugosities [Bowman uses the terms anterior and posterior in place of respectively ventral and dorsal; the latter terms are to be preferred as they are a more accurate description of the position of the appendages in life].

Uropod (Figures 26A–F): In females and immature males, exopod about 1.1 times longer than peduncle; endopod 1.1 times longer than exopod; both rami linear, armed with spines on margins and at apex. Uropod of mature male modified: exopod shorter than peduncle; endopod spatulate, much longer and broader than exopod.

MATERIAL EXAMINED.—MARYLAND: Montgomery County, 3♂♂, 3 ovigerous ♀♀, 1 nonovigerous ♀, col. C.R. Shoemaker, 28.v.1916 (USNM).

In all fundamental details this material agreed closely with Bowman's description of *A. kenki*. However, the second antennae of one specimen were as long as the body, the first pleopod (male) lacked a notch on the inner edge of the distal segment and more coupling protuberances (6) were on the proximal segment, and the broadly rounded posterior or dorsal process at the tip of the endopodite of the second pleopod was by no means as prominent as suggested by Bowman's drawings.

GEOGRAPHICAL DISTRIBUTION AND ECOLOGY.—Bowman gives a long list of material examined by him. This had been collected from various localities in the District of Columbia, Maryland, Pennsylvania, and Virginia. The additional material seen by me is therefore well within the known range of distribution of this species. As a basis for comparison with the geographical distribution of other North American species

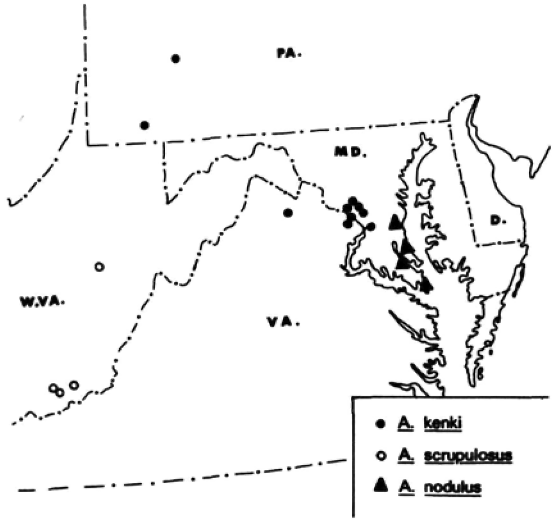

FIGURE 27.—Geographical distribution.

of *Asellus*, Bowman's records and the single new one are combined in Figure 27. The figure indicates the restriction of the species to a relatively small region in the central part of the far eastern side of the United States.

According to Bowman (1967), *A. kenki* is an inhabitant of springs and spring-fed streams and is not found in large streams and ponds within its range of distribution. The associated fauna in the type locality and some further ecological remarks are also noted by Bowman.

Asellus aquaticus (Linnaeus)

FIGURE 28

Oniscus aquaticus Linnaeus, 1758, p. 637.—Otho Fabricius, 1780, p. 251.

Asellus aquaticus (L.).—Geoffrey St. Hilaire, 1764, p. 672.—Sars, 1899, p. 97.—Racovitza, 1919, pp. 31–41, figs. 1–6.—Richardson, 1905, pp. 428–431, fig. 486.—Stephensen, 1917, pp. 239–240.—Van Name, 1936, pp. 458–459, fig. 287.—Birstein, 1951, pp. 57–60, figs. 18–26.—Williams, 1962b, pp. 78–80.

Asellus vulgaris Latreille, 1803, p. 359.—Not Gould, 1841, p. 337.

Asellus grönlandicus? Krøyer, 1838, p. 318—Not Packard, 1867, p. 296.—Hansen, 1888, p. 190.

A complete synonymy for *Asellus aquaticus* would be extremely long and complex and is not needed here, as this species is probably restricted to the Palaearctic and more complete synonymies have been given elsewhere (e.g., Bovallius, 1886; Gruner, 1965). The synonymies and references given above cover the orginal description and generic transference, the most pertinent references to *A. aquaticus* in the Palaearctic, and all references to the synonyms of the species in North America.

Asellus aquaticus was first indicated as present in North America by Otho Fabricius (1780) who recorded it from Greenland. A further Greenland record was given by Krøyer (1838) who recorded what he said was undoubtedly the same species as Fabricius, but who tentatively gave it separate specific status (as *A. grönlandicus*), a separation of which Hansen (1888), who referred to it as "*A. grønlandicus,*" had great doubts. Richardson (1905) gave yet another record of *A. aquaticus* in Greenland based upon material sent her by the Museum of Comparative Zoology at Harvard and labeled "*Asellus grönlandicus.*"

Stephensen (1917) summarized the old records of *A. aquaticus* in Greenland, and on the basis of his summary and a personal communication from Dr. Ulrich Røen, who had examined many hundreds of freshwater localities in Greenland, I came to the conclusion (Williams, 1962b) that *A. aquaticus* is probably absent from Greenland. It is now necessary to add, however, that a collection of material in the Museum of Comparative Zoology at Harvard and clearly labeled "M C Z Greenland *Asellus aquaticus* (Linnaeus)" on examination proved to contain material which is probably *A. aquaticus*. The material consisted of two specimens, both of which had dried out and were in very bad condition. Gentle warming in alcohol helped to soften them, but unfortunately one was still completely unrecognizable at the species level. The other, however, though impossible to identify definitively to species, could be seen to possess many features characteristic of *A. aquaticus*. The most important features are indicated in Figures 28A–C. From these it can be seen that the specimen (a male) possessed a prominent basal spur on the endopod of the second pleopod (a feature possessed by no other epigean species recorded from North America), its first pleopod can reasonably be reconstructed to a shape similar to that of the first pleopod of *A. aquaticus,* and the propodus of its first peraeopod lacked a triangular projection near the midpoint of its palm. This material would seem to be that examined by Richardson in 1905, and my reexamination of it, therefore, gives support to her identification as *A. aquaticus*.

The reexamination although solving partly one of the problems associated with records of *A. aquaticus* in

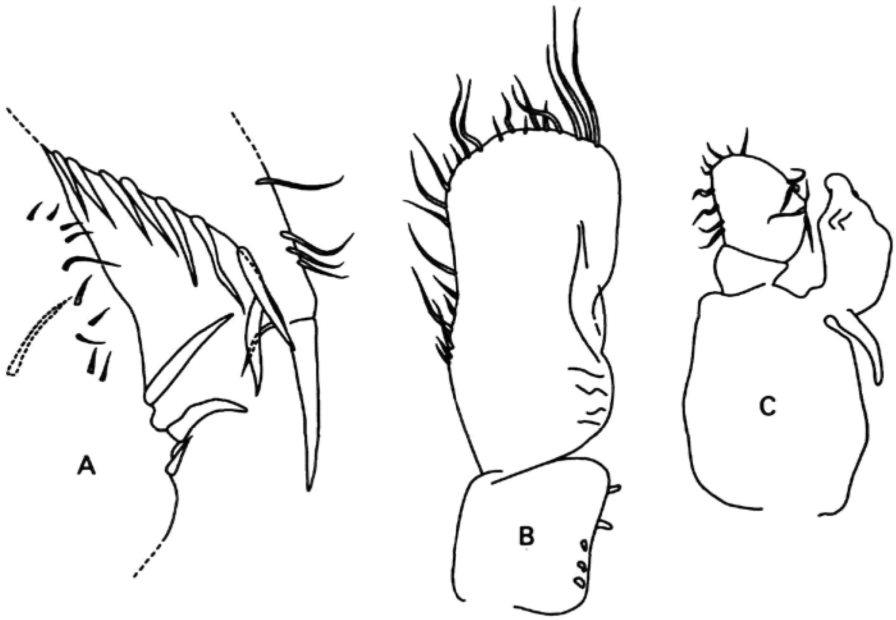

FIGURE 28.—*Asellus ?aquaticus*, least damaged specimen (male) labeled "MCZ Greenland *Asellus aquaticus* (Linnaeus)": A, palm of propodus and part of dactylus of first peraeopod; B, first pleopod; C, second pleopod.

North America, namely reliable identification, does not really clarify the present status of the species. The conclusion remains, it seems reasonable to state, that *A. aquaticus* is not present in Greenland, a conclusion with which Dr. Røen (personal communication, 7 June 1967), who has examined many further Greenland localities since his original communication to me (see Røen, 1962), still agrees. The specimens belonging to the Museum of Comparative Zoology may, as suggested by Røen (in Williams, 1962b, p. 80) for older records, have come originally from Denmark in ships' water tanks, have been introduced temporarily to suitable waters in Greenland near ship bases there, and then have been collected as a "native" species.

It should be added that *A. aquaticus* has not been recorded for North America outside Greenland, and no further material has been encountered during the present study of North American collections. Packard's (1867) record of *A. aquaticus* from Labrador related in fact to a terrestial isopod (Johansen, 1926).

The name *Asellus vulgaris* advanced by Latreille in 1803 for European material has been consistently synonymized with *A. aquaticus* (see, for example, Birstein, 1951; Gruner, 1965), and there is little to gainsay this. Gould recorded a taxon he referred to as "*A. vulgaris?* Latr." from Massachusetts in 1841, but as he says only that is was common, was larger than the two species described by Say [1818, *A. communis* and *A. lineatus* (=*Lirceus lineatus*)], and that he could find no differences from "the foreign species," we are left in considerable doubt as to identity of his specimens. In view of the almost certain absence of *A. aquaticus* from North America apart from Greenland, it is most unlikely that Gould's specimens were *A. aquaticus.* Through the courtesy of Dr. H. W. Levi and Miss A. B. Bliss, I have examined all available material of *Asellus* in the Museum of Comparative Zoology, the principal institution for the deposition of zoological material in Massachusetts, and did not encounter any material that could have been seen by Gould. Gould's species has been synonymized with *A. communis* by Richardson (1905) and Van Name (1936), but neither author advanced reasons for this synonymy. The identity of the species recorded by Gould must remain unknown.

Asellus racovitzai, new species

Asellus communis Say.—Racovitza, 1920, pp. 79–95, figs. 52–73.

As indicated under *A. communis,* Racovitza (1920) described fully a species, which he took to be *A. com-*

munis Say, on the basis of three specimens (2♂♂, 1♀) from the Potomac River, Virginia, a locality some 125 miles from the place where we may presume Say had collected his material of *A. communis*. Racovitza's assumption of conspecificity between this material and *A. communis* appears to have been quite arbitrary. As the neotype of *A. communis* is quite clearly a different species from the one described by Racovitza, a new name now needs to be applied to the species described by him. It is appropriate that this be *A. racovitzai* in his honor.

There is no doubt of the identity of *A. racovitzai* or of the fact that it is a species quite distinct from *A. communis;* not only is Racovitza's description very complete, but also there is still in existence the remains of the collection from whence came the three specimens sent to him. Examination of this confirmed the accuracy of his description.

During the examination of material referable to *A. racovitzai,* it became clear that two minor taxa were involved, one widespread in northeastern United States and southeastern Canada but occurring also in British Columbia and Washington State (see below), and one confined to a smaller region (Georgia and Florida) in southeastern United States. The differences between these two taxa are considered to be of subspecific value. The taxon first described by Racovitza is regarded as the nominate subspecies and its further description given here and the selection of type material for it is based upon the remains of the collection in the United States National Museum from which Racovitza was sent 3 specimens; the taxon known thus far only from the southeast United States is given the name *A. racovitzai australis*.

Asellus racovitzai racovitzai, new subspecies

FIGURES 29, 31, 32

Asellus communis Say—Racovitza, 1920, pp. 79–95, figs. 52–73.

TYPE MATERIAL AND TYPE LOCALITY.—Holotype: adult ♂, USNM 122066. Allotype: adult nonovigerous ♀, USNM 122067. Paratypes: 18 ♂♂, 2 nonovigerous and 2 ovigerous ♀♀, USNM 122068. Type locality (according to data on original label in type collection): edge of Potomac River just below aqueduct bridge [Washington, D.C.], Virginia side. The collection was made 15 March 1896 by W. P. Hay.

DESCRIPTION OF HOLOTYPE.—Body: Length, 13.5 mm; greatest width, 5.0 mm.

Head: Eyes large and distinct.

First antenna: Flagellum 15-merous and tip reaching to point about two-thirds distally along last segment of peduncle of second antenna; penultimate 2 segments bear aesthetascs. First and third segments of peduncle subequal in length, and about two-thirds length of second segment. First peduncle segment about 1.5 times as long as wide; second and third segments respectively 4 and 3 times as long as wide.

Second antenna: Length (8.0 mm) about three-fifths (0.59) body length. Flagellum 67-merous.

First peraeopod (Figure 29A): Propodus 1.3 times as long as wide, almost subtriangular; palm with a single large triangular projection about 1.5 times width of opposing dactylus and about twice as long as basal width situated near midpoint, a small projection between larger projection and point of attachment of dactylus, 2 large and 1 small teethlike spines at proximal end, and a submarginal row of spines on inner and outer surfaces.

First pleopod (Figure 29B): Total length of appendage 1.1 times as long as second pleopod. Sympod subrectangular, about three-fourths as wide as long; inner margin with 2 hooklike protuberances for coupling. Distal segment also subrectangular, but distal width less than proximal width; outer margin not concave; twice as long as wide and almost twice as long as sympod; distal margin and distal two-thirds of outer margin bearing numerous short to moderately long simple spines; inner proximal angle with single spine.

Second pleopod (Figures 29C–E): Sympod subsquare, with 2 simple spines near inner distal angle. Proximal segment of exopod with 6 simple spines on outer margin. Distal segment of exopod ovate with 22 long plumose spines and 3 short simple spines marginally, some minute simple spines on inner margin, and groups of fine setae on surface of segment near inner margin. Endopod narrow, more or less straight in long axis, and about 3 times as long as greatest width; endopod about three-fourths total length of exopod and also of sympod but slightly longer (1.1) than distal segment of exopod; inner and outer apophyses occur basally. Cannula triangular in shape, distal width about half basal width, and not reaching beyond caudal process. Ventral groove wide and prominent. Mesial process well developed, sclerotized, acutely pointed, and almost as long as cannula. Lateral process not developed. Caudal process large, ending in prominent apex distally and bearing several groups

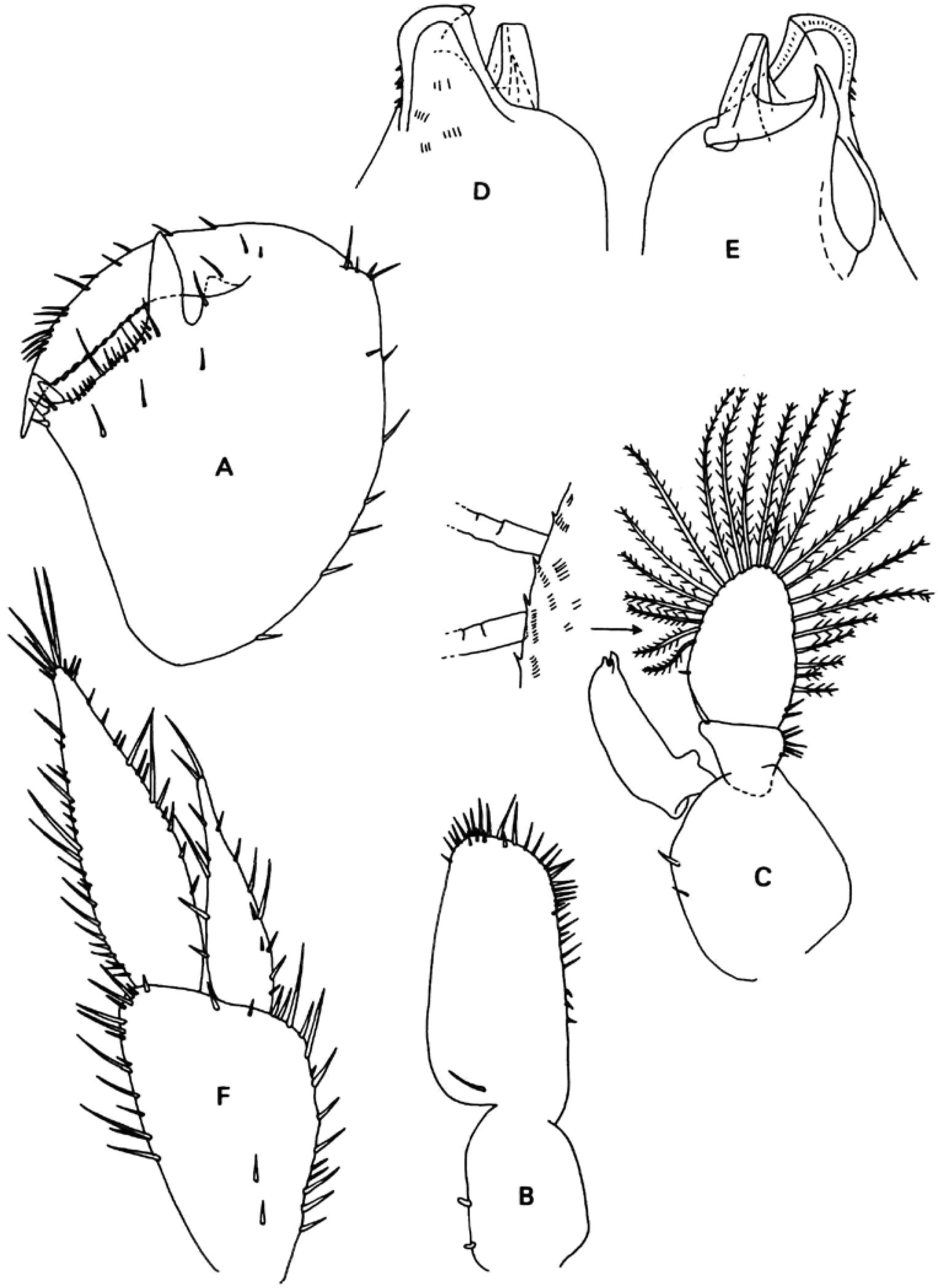

FIGURE 29.—*Asellus racovitzai racovitzai*, holotype: A, dactylus and propodus of first peraeopod; B, first pleopod; C, second pleopod; D, E, respectively dorsal and ventral surfaces of tip of endopodite of second pleopod; F, uropod.

of 3 to 5 fine simple spines on dorsal surface, some of which are visible on outer lateral margin.

Uropod (Figure 29F): About the same length as telson. Peduncle about 1.5 times as long as greatest width with many marginal spines. Exopod almost as long (0.83) as peduncle; endopod slightly longer (1.1) than peduncle and about 3 times as long as wide.

PARTIAL DESCRIPTION OF ALLOTYPE (♀).—First peraeopod: General shape and setation similar to that described for a female paralectotype of *A. attenuatus*. Palmar margin of dactylus with 8 teethlike spines.

"First" pleopod: Shape similar to that described for a female paralectotype of *A. intermedius*, but distal margin and distal half of outer margin with 16 finely plumose spines, and inner proximal angle with 2 short simple spines.

MATERIAL EXAMINED.—GREAT LAKES: Lake Erie: Sta. C–25, 3♂♂, coll. J. Hiltunen, 7.ix.1963; Sta. 145, 28 meters, 6♂♂, coll. J. Hiltunen, 10.ix.1963; 70 localities at various depths from 10.5–30 meters, 250♂♂, all coll. Great Lakes Institute, 3.vi.1963–16.xi.1965 (GLI). Lake Huron: 4 localities at various depths from 21–28 meters, 8♂♂, all coll. Great Lakes Institute, 16–24.xi.1964 (GLI). Lake Ontario: USB CF Sta. 35, ∞♂♂, coll. J. Hiltunen, 16.ix.1964; 25 localities at various depths from 20–42 meters, 63 ♂♂, all coll. Great Lakes Institute, 22.i.1964–6.i.1966 (GLI). Lake St. Clair: Sta. LS–13, ∞♂♂, coll. J. Hiltunen, 5.v.1963. Lake Superior: Munising, Michigan, 1♂, coll. E. L. Bousfield, 26.vi.1957; Batchawana Bay, Ontario, 1♂, 29.viii.1959, 1♂, 7.ix.1959, 2♂♂, 9.ix.1959, 1♂, 25.ix.1959, 2♂♂, 1.x.1959, all coll. M.L.H. Thomas (NMC).

ONTARIO: Toronto, ∞♂♂, coll. A. G. Huntsman, 18.x.1912 (ROM); Hamilton, 3♂♂, coll. Messrs. Spragg and Dymond, 8.iv.1933 (ROM); Lake Simcoe, 1♂, coll. D. S. Rawson, no date (ROM); Humber River,* York County, 4♂♂, coll. Ont. Dept. P. & D., 12.vi.1946 (NMC); Moira River, Hastings County, 2♂♂, coll. Ont. Dept. P. & D., 8.viii.1947 (NMC); Moira River, Hastings County, 1♂, coll. Ont. Dept. P. & D., 27.viii.1947 (NMC); Port Dover, 2♂♂, coll. Ont. Dept. P. & D., June 1955 (NMC); Port Rowan, 1♂, coll. Ont. P. & D., 12.viii.1955 (NMC); Ottawa River, 6♂♂, coll. E. L. Bousfield, 4.v.1957 (NMC); Moira River, Hastings County, 16 ♂♂, coll. E. L. Bousfield, 28.v.1957 (NMC); Walpole Island, 12♂♂, coll. G. B. Wiggins, 6.v.1959 (ROM); Long Point, pond, 2♂♂, coll. D. Barr, 26.v.1963 (ROM); Chaffey's Locks, Leeds County, 3 ♂♂, coll. D. Barr, 21.vi.1964 (ROM); Rondeau Province Park, 1♂, coll. I. M. Smith, 3.vi.1965 (ROM); Dundas, ∞♂♂, coll. N. Kaushik, November 1966; Port Credit, ∞♂♂, coll. R. O. Brinkhurst, 29.iii.1967.

QUEBEC: Lièvre River, ∞♂♂, coll. F. Ide, 8.ix.1928; Gatineau River, 3♂♂, coll. E. L. Bousfield, November 1950 (NMC); Manikuagan, 4♂♂, coll. E. L. Bousfield, 29.viii.1953 (NMC); Fairy Lake, Hull, 3♂♂, coll. E. L. Bousfield, 24.v.1957 (NMC).

DISTRICT OF COLUMBIA: Chain Bridge, 7 ♂♂, coll. A. C. Weed, 13.xii.1908 (USNM).

INDIANA: Ohio River, Evansville, 1♂, coll. U.S. Dept. Interior, 16.vi.1965.

MARYLAND: Marshall Hall, 3♂♂, coll. A. Pizzini, 26.v.1934 (USNM).

MASSACHUSETTS: Amhurst, 3♂♂, coll. H. B. N. Hynes, 23.ix.1960; Bull Hill, Montague, 1♂, coll. H. B. N. Hynes, September 1960.

MICHIGAN: Sugar Island, Chippewa County, 16 ♂♂, coll. J. K. Hiltunen, 8.iii.1967.

VERMONT: Lake Champlain,* 1♂, coll. E.L. Bousfield, 19.vi.1956 (NMC).

WASHINGTON: Echo Lake,* King County, 5♂♂, coll. E.L. Bousfield, 20.vi.1955 (NMC).

GEOGRAPHICAL DISTRIBUTION AND ECOLOGY.—The localities detailed above, together with the type locality, are plotted in Figure 30. In general and except for its absence from Colorado, *A. racovitzai racovitzai* has a somewhat similar distribution to *A. communis*, its main area of distribution being in southeastern Canada and northeastern United States. It seems, however, not to extend so far east as does *A. communis*, although this may be the result of an inadequate number of collections. The occurrence of the subspecies together with *A. communis* (the two taxa occurred in the same collection) in Echo Lake, King County, Washington, is of considerable interest, and Bousfield's remarks on this locality, as well as the comment concerning the possibility of missorting of labels and Hatch's (1947) key, are again pertinent.

The large amount of material examined from the Great Lakes, especially Lakes Erie and Ontario, suggests that *A. racovitzai racovitzai* is the dominant, if not the exclusive, species of *Asellus* in the Great Lakes. The only other species encountered in these collections was *A. forbesi*, and this, as indicated by a single specimen, occurs in Lake Huron. Within the Great Lakes, *A. racovitzai racovitzai* obviously has a wide vertical distribution, for it occurred in collections (GLI) from

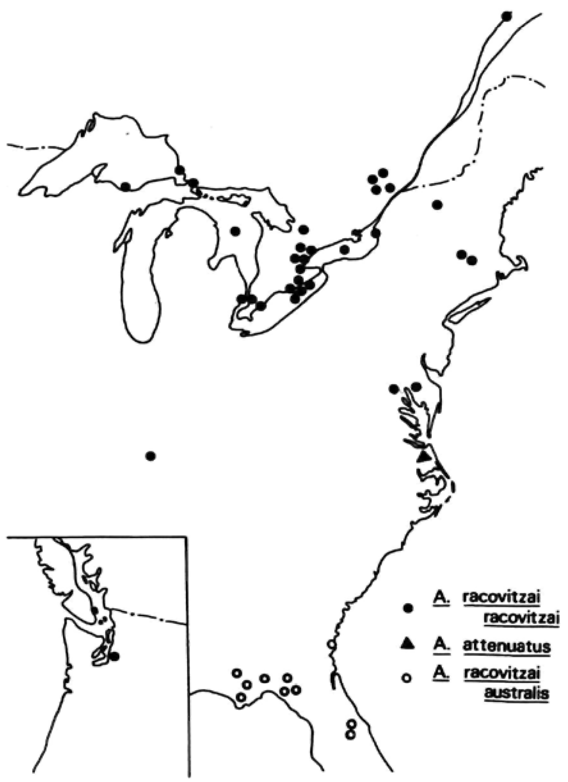

FIGURE 30.—Geographical distribution.

20 to 42 meters deep. Apart from large lakes, the data on labels in collections examined show that the taxon may also occur in creeks, rivers, ponds, small lakes, and swamps. Like *A. communis,* it appears to be wide ranging with regard to choice of macrohabitat.

FURTHER DESCRIPTION (♂).—Body: The smallest male with well-developed secondary sexual characteristics had a body length of 4.0 mm; the largest male examined was 15.0 mm.

First antenna: Flagellum 7- to 15-merous, the number of segments depending to some extent upon the size of the specimen; flagellum tip reaching to proximal third or to distal margin of the last segment of the peduncle of the second antenna; penultimate 2 or 3 segments bear aesthetascs.

Second antenna: Length 0.44 to 0.8 times that of body, the fraction showing a rough inverse correlation with absolute body length (as indicated by plotting the appropriate values for the largest male in each of twenty-seven collections). Flagellum 26- to 92-merous, the number of segments showing a rough direct correlation with body length.

Mouthparts: See Table 1.

First peraeopod: 2 or 3 (usually 2) very strong, teethlike spines at proximal end of palm. Some variation occurs in the shape of the palm and its triangular process (Figure 31). The typical shape is as illustrated for the holotype.

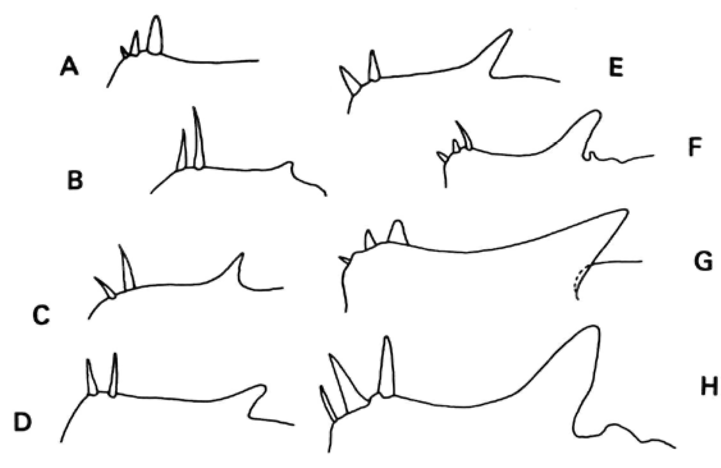

FIGURE 31.—*Asellus racovitzai racovitzai,* extent of variation in palm shape of male first peraeopod: A, Lake Opinicon, Ontario; B, Amhurst, Massachusetts; C, Lake Superior; D, Hull, Quebec; E, Echo Lake, Washington; F, Hamilton, Ontario; G, Washington, D.C.; H, Sugar Island, Michigan.

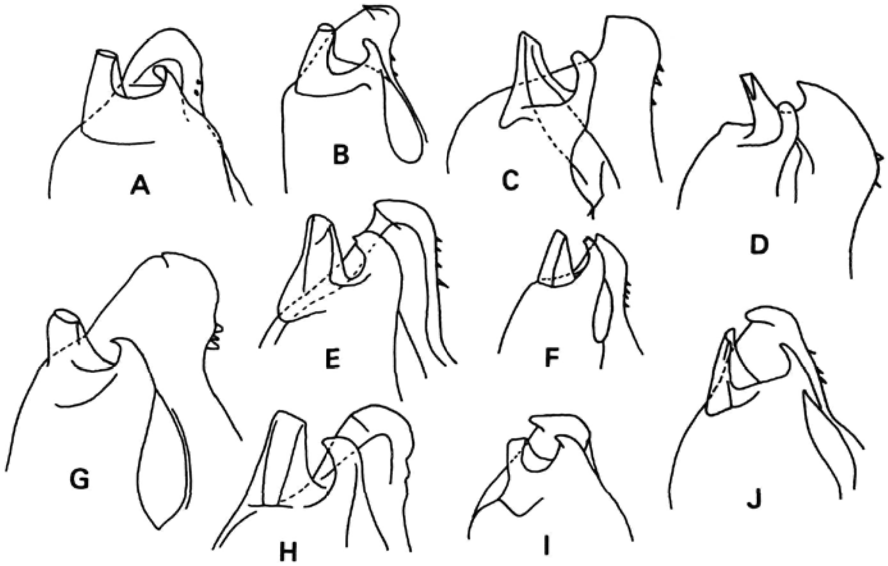

FIGURE 32.—*Asellus racovitzai racovitzai,* extent of variation in morphology of endopodite tip of male second pleopod: A, Lake Erie; B, Batchawana Bay, Lake Superior; C, J, Toronto, Ontario; D, H, Ottawa, Ontario; E, Port Credit, Ontario; F, Sugar Island, Michigan; G, Rondeau Provincial Park, Ontario; I, Echo Lake, Washington.

First pleopod: Total length of appendage 1.0 to 1.3 times as long as second pleopod. Inner margin of sympod with 2 to 5 (usually 2 or 3) coupling hooks. Maximum width of distal segment 0.41 to 0.56 times maximum length; outer margin slightly concave to straight.

Second pleopod: 0 to 4 (usually 2) simple spines near inner distal angle of sympod. Proximal segment of exopod with 2 to 6 spines on outer margin, and distal segment with 13 to 24 marginal spines. Maximum length of distal segment of exopod 0.96 to 1.91 times maximum width. Endopod 1.1 to 1.9 times as long as distal segment of exopod. No gross morphological variations occur in the morphology of the tip of the endopodite, but minor variations occur both within a single collection of specimens and between collections from different localities. The range of variation is illustrated in Figure 32. The cannula may vary from a wide triangular structure (the usual condition, as displayed by Figures 29D,E for the holotype), to a rather narrow tubular one. The mesial process displays its greatest variation in the nature of its tip, which may be acutely pointed or appear to be quite rounded. A somewhat similar sort of variation is displayed by the caudal process which, nevertheless, is always prominent and never reduced. The small spines on the outer lateral edge of the caudal process may or may not be visible according to the position of mounting of the appendage. Figure 32 includes a drawing of the endopodite tip of a specimen collected from Echo Lake, Washington.

Uropod: See Table 2.

Asellus racovitzai australis, new subspecies

FIGURES 33–36

ETYMOLOGY.—From the Latin *australis,* southern.

TYPE MATERIAL AND TYPE LOCALITY.—Holotype: adult ♂, USNM 122687. Allotype: adult nonovigerous ♀, USNM 122688. Paratypes: 17 ♂♂, 5 nonovigerous and 3 ovigerous ♀♀, USNM 122689. Type locality: small spring run, Leon County, Florida (no further data available). The collection was made 10 April 1963 by Dr. W. M. Beck.

DESCRIPTION OF HOLOTYPE.—Body: Length, 9.0 mm.

Head: Eyes large and distinct.

First antenna: Flagellum 8-merous and tip reaching to distal margin of last segment of peduncle of second antenna. First and second segments of peduncle subequal in length; third, three-quarters length of second or first. First peduncle segment twice as long as wide; second and third respectively 3.5 and about 4 times as long as wide.

Second antenna: Length (6.0 mm) two-thirds body length. Flagellum 54-merous.

First peraeopod (Figure 33A): Dactylus slightly longer than palm of propodus. Propodus 1.41 times as long as wide, subtriangular; palm with a large triangular projection near midpoint about twice as long as basal width, a much smaller projection between larger projection and point of attachment of dactylus, 1 large and 2 smaller teethlike spines on a slightly raised proximal projection, and a submarginal row of spines on inner and outer surfaces.

First pleopod (Figure 33B): Total length of appendage 1.08 times that of second pleopod. Sympod subrectangular, 1.4 times as long as wide; inner margin with 4 hooklike protuberances for coupling. Distal segment also subrectangular, but distal corners rounded; inner and outer lateral margins more or less parallel; twice as long as wide and 1.65 times as long as sympod; distal margin and distal half of outer margin with numerous short to moderately long simple spines.

Second pleopod (Figures 33C–E): Sympod subsquare, maximum length only slightly greater (1.12) than maximum width; 2 small simple spines occur near inner distal angle. Proximal segment of exopod with 3 short plumose spines on outer margin. Distal segment of exopod ovate, maximum length 1.66 times maximum width, with 20 short to very long plumose spines on margin. Endopod about three-quarters total length of exopod, and slightly shorter (0.95) than length of distal segment of exopod; endopod narrow, about (2.4) two and a half times maximum width (exclusive of apophyses); inner and outer apophyses occur basally. Cannula wide, not markedly triangular in shape, outer edge thickened and not membranous; slightly shorter than caudal process. Caudal process large, ending in acute point terminally, and bearing groups of fine setae on dorsal surface; lateral margin with some small spines. Mesial process well developed, sclerotized, acutely pointed, and almost as long as cannula.

Uropod (Figure 33F): 1.23 times as long as telson. Peduncle about 3.5 times as long as greatest width with many marginal spines. Exopod about two-thirds as long as peduncle; endopod slightly shorter (0.96) than peduncle.

PARTIAL DESCRIPTION OF ALLOTYPE (♀).—First peraeopod: Shape and setation similar to that described for a female paralectotype of *A. attenuatus*. Palmar margin of dactylus with 9 teethlike spines.

"First" pleopod (Figure 33G): Shape almost subovate; distal margin and distal half of outer margin with 12 finely plumose spines; 3 short simple spines are present submarginally along the proximal half of the inner margin.

MATERIAL EXAMINED.—FLORIDA: Perry Creek, Taylor County, ∞ ♂♂, coll. W. M. Beck, 21.vii.1953; Lafayette County, 21 ♂♂, coll. W. M. Beck, 12.xi.1953; Waddell's Mill Creek, Jackson County, 2 ♂♂, coll. W. M. Beck, 7.x.1954; Withlacoochee River, Madison County, 7 ♂♂, coll. W. M. Beck, 20.vii.1955; Lake Econlockhatchee River, Seminole County, 1 ♂, coll. W. M. Beck, 27.iii.1956; Lake Econlockhatchee River, Iron Bridge, Seminole County, 2 ♂♂, coll. W. M. Beck, 26.vi.1956; Waddell's Mill Creek, Jackson County, 2 ♂♂, coll. W. M. Beck, 28.xi.1960; Torreya St. Park,* Liberty County, 1 ♂, coll. W. M. Beck, 10.xii.1960; Aucilla River, Taylor County, 14 ♂♂, coll. W. M. Beck, 9.iii.1961; Depot Creek, Gulf County, 1 ♂, coll. W. M. Beck, 19.ix.1961; Econlockhatchee River, Seminole County, 26 ♂♂, coll. W. M. Beck, 5.iii.1962; Lake Econlockhatchee River, Orange County, 1 ♂, coll. W. M. Beck, 6.iii.1962; Waddell's Mill Creek,* Jackson County, 3 ♂♂, coll. W. M. Beck, 19.iii.1963.

GEORGIA: Darien,* 1 ♂, coll. E. L. Bousfield, 2.iii.1963.

GEOGRAPHICAL DISTRIBUTION AND ECOLOGY.—This subspecies appears to be confined to the southeast United States (Figure 30). Within this region it has been collected from creeks and rivers.

FURTHER DESCRIPTION (♂).—Body: The largest ♂ examined was 11.0 mm long, and the smallest, 3.0 mm.

First antenna: Flagellum 10- to 16-merous; last 3 penultimate segments bear aesthetascs.

Second antenna: Length 0.67 to 1.0 (usually 0.8 to 1.0) times that of body. Flagellum 46- to 78-merous.

Mouthparts: See Table 1.

First peraeopod: 2 to 4 but usually 3 teethlike spines at proximal end of palm. The range of variation in palm shape is indicated in Figure 34.

First pleopod: Total length of appendage 1.0 to 1.2 times as long as second pleopod. Inner margin of sympod with 2 to 5 coupling hooks. Maximum width of distal segment 0.35 to 0.65 times maximum length; the shape of the distal segment is somewhat variable (Figure 35), but the distal margin is always rounded.

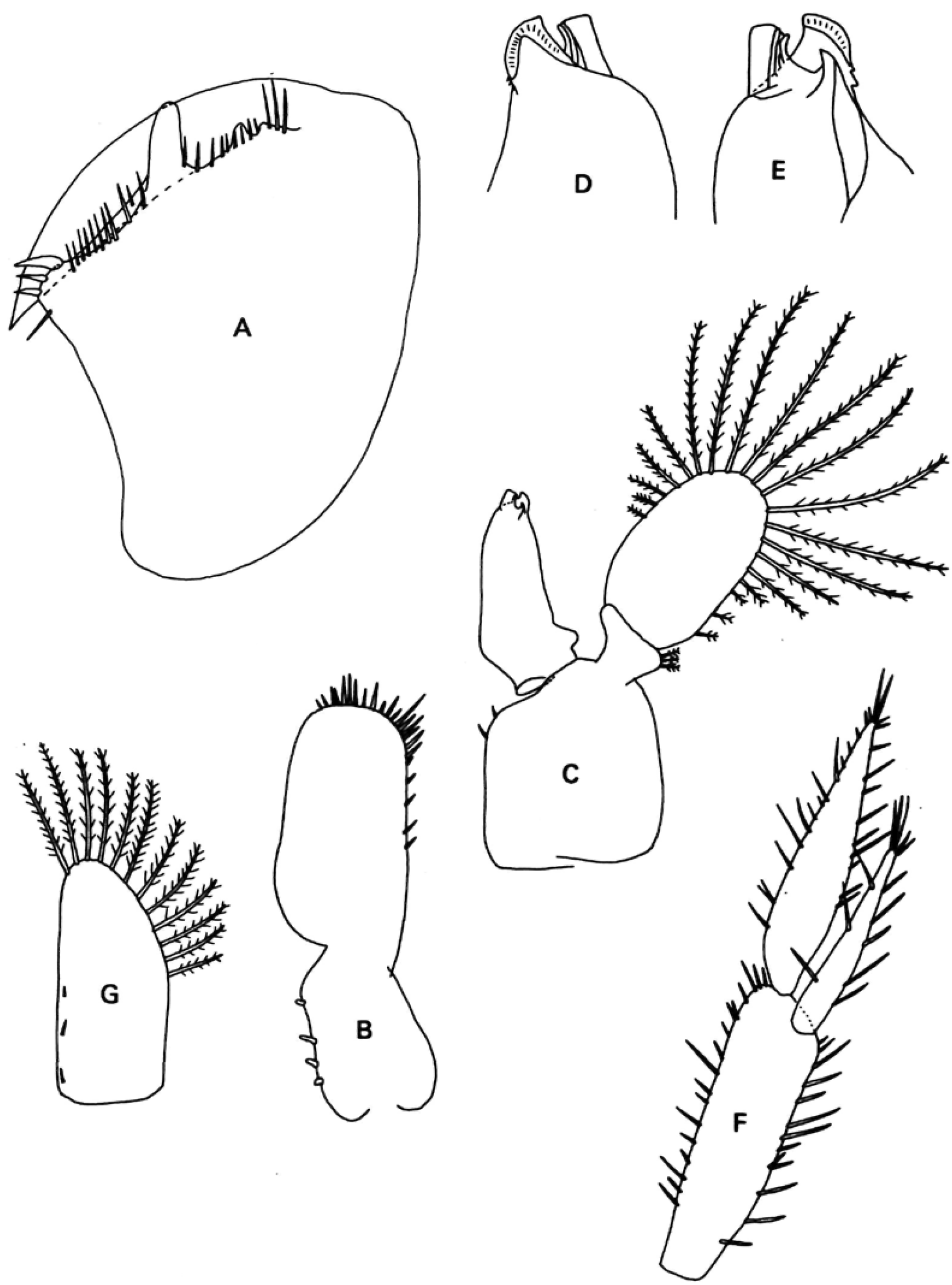

FIGURE 33.—*Asellus racovitzai australis,* A–F, holotype; G, allotype: A, dactylus and propodus of first peraeopod; B, first pleopod; C, second pleopod; D, E, respectively dorsal and ventral surfaces of tip of endopodite of second pleopod; F, uropod; G, "first" pleopod.

378-615 O - 70 - 5

FIGURE 34.—*Asellus racovitzai australis,* extent of variation in palm shape of male first peraeopod: A, Madison County, Florida; B, E, Jackson County, Florida; C, Seminole County, Florida; D, Taylor County, Florida.

Second pleopod: 1 to 4 simple spines near inner distal angle of sympod. Proximal segment of exopod with 2 to 5 spines on outer margin, and distal segment with 14 to 23 marginal spines. Maximum length of distal segment of exopod 1.48 to 2.47 times maximum width. Endopod 0.72 to 1.2 (usually 0.9 to 1.0) times as long as distal segment of exopod. The extent of variation in the morphology of the tip of the endopodite is indicated in Figure 36. Although there is less variation than displayed by *A. racovitzai racovitzai* (cf. Figure 32), nevertheless, the three main components—the caudal process, the cannula, and the mesial process—do display some variation. The usual pattern displayed by these structures is as indicated for the holotype (Figure 33E).

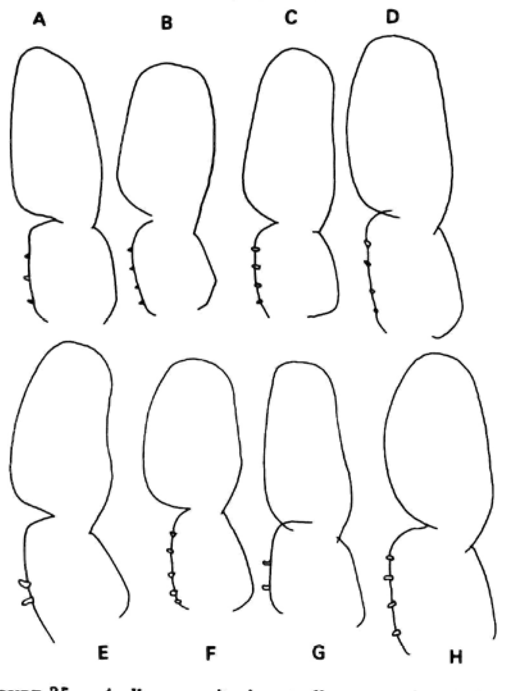

FIGURE 35.—*Asellus racovitzai australis,* extent of variation in shape of first pleopod of male: A, Leon County, Florida; B, F, G, H, Taylor County, Florida; C, Lafayette County, Florida; D, E, Seminole County, Florida.

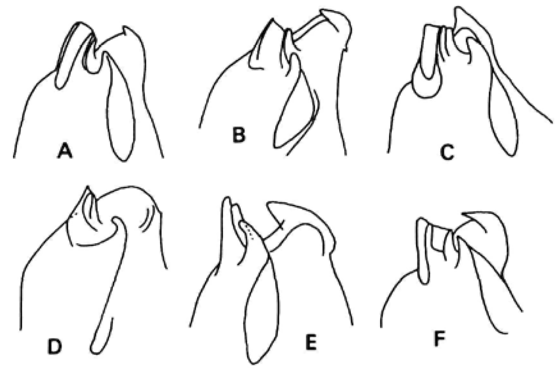

FIGURE 36.—*Asellus racovitzai australis,* extent of variation in morphology of endopodite tip of male second pleopod: A, Taylor County, Florida; B, Lafayette County, Florida; C, F, Seminole County, Florida; D, Darien, Georgia; E, Jackson County, Florida.

Uropod: See Table 2.

SEPARATION OF *A. racovitzai australis* FROM THE NOMINATE SUBSPECIES (♂♂ only).—*Asellus racovitzai australis* is principally distinguished from *A. racovitzai racovitzai* in that: (1) the length of the second antennae relative to body length is greater in *A. racovitzai australis;* (2) the shape of the distal segment of the first pleopod is more rounded in *A. racovitzai australis;* (3) the distal segment of the exopod of the second pleopod is longer relative to the length of the endopod in *A. racovitzai australis,* and in this subspecies it is also longer relative to maximum width; (4) the endopod of the second pleopod is shorter relative to maximum width in *A. racovitzai australis;* and (5) the cannula at the tip of the endopod of the second male pleopod is wider in *A. racovitzai australis* and its outer lateral margin is thickened. The most important of these differences are quantified in Table 4, which also indicates the level of significance of each of the subspecific differences.

Asellus forbesi, new species

FIGURES 37, 38, 40–42

ETYMOLOGY.—Named for S. A. Forbes.

TYPE MATERIAL AND TYPE LOCALITY.—Holotype: adult ♂, USNM 122052. Allotype: adult nonoviger-

TABLE 4.—*Principal differences between* Asellus racovitzai racovitzai *and* Asellus racovitzai australis

[males only]

		A. racovitzai racovitzai	*A. racovitzai australis*
length of second antennae / body length	Range M [a] ±S.D.	0.44–0.80 0.60 0.08	0.67–1.00 0.80 0.09
length of endopod / length of distal segment of exopod (pleopod 2)	Range M [a] ±S.D.	1.05–1.89 1.34 0.18	0.72–1.20 0.96 0.11
length / width (distal segment of exopod, pleopod 2)	Range M [a] ±S.D.	0.96–2.00 1.45 0.20	1.48–2.47 1.78 0.25
length / width (endopod, pleopod 2)	Range M [a] ±S.D.	2.34–3.20 2.78 0.24	2.15–2.80 2.49 0.17

[a] Difference between means highly significant in all comparisons (by "t" test, P=<0.001).

ous ♀, USNM 122053. Paratypes: 5♂♂, 5 nonovigerous and 9 ovigerous ♀♀, USNM 122054. Type locality: flood pool of Rappahannock River, Culpeper County, Virginia. The type collection was made 28 March 1967 by Dr. A. Weaver.

DESCRIPTION OF HOLOTYPE.—Body: Length, 12.5 mm.

Head: Eyes large and distinct.

First antenna: Flagellum 14-merous and tip reaching to point about two-thirds along last segment of peduncle of second antenna; penultimate 3 segments bearing aesthetascs. Second segment of peduncle longest; first, three-quarters length of second; third, two-thirds length of second. First peduncle segment about 1.5 times as long as wide; second and third respectively 4 and 3 times as long as wide.

Second antenna: Length (8.5 mm) about two-thirds (0.68) body length. Flagellum 66-merous.

First peraeopod (Figure 37A): Dactylus distinctly longer than palm of propodus. Propodus 1.2 times as long as wide, subovate; palm with a single large triangular projection near midpoint, a smaller blunt projection between larger projection and point of attachment of dactylus, a single toothlike spine on a low proximal projection with 3 stout spines proximal to this, and a submarginal row of spines on inner and outer surfaces.

First pleopod (Figure 37B): Total length subequal (1.06) to that of second pleopod. Sympod subrectangular, about 1.33 times as long as wide; inner margin with one hooklike protuberance for coupling. Distal segment subovate, widest about one-third towards distal margin; maximum width just over half (0.59) maximum length; several simple short spines occur on the distal margin.

Second pleopod (Figures 37C–E): Sympod subquadrate, maximum length only slightly greater (1.17) than maximum width; medial and lateral margins very slightly convex. Proximal segment of exopod irregularly subtriangular, with 3 short and simple spines on outer margin. Distal segment of exopod ovate, almost twice (1.87) as long as wide, with 13 long plumose spines on margin of distal half of segment, and a row of very fine short spines on inner proximal margin. Endopod two-thirds total length of exopod, and about three-quarters (0.77) length of distal segment of exopod; endopod slightly less (1.86) than twice as long as maximum width (regarded in all specimens of *A. forbesi* as the distance between the outer margin of the outer basal apophysis and the inner proximal angle of endopod). Outer basal apophysis not well developed, rounded in outline; inner basal apophysis scarcely present. Cannula short and wide. Ventral groove prominent. Mesial process sclerotized, large, wide, hooklike, and as long as cannula. Lateral process not prominent. Caudal process wide, margin broadly rounded and sclerotized, without associated hooks or spines, and not protruding far beyond cannula and mesial process.

Uropod (Figures 37F, G): 1.33 times as long as telson. Peduncle about twice as long as maximum width. Exopod two-thirds length of peduncle, endopod as long as peduncle; both rami have several moderately

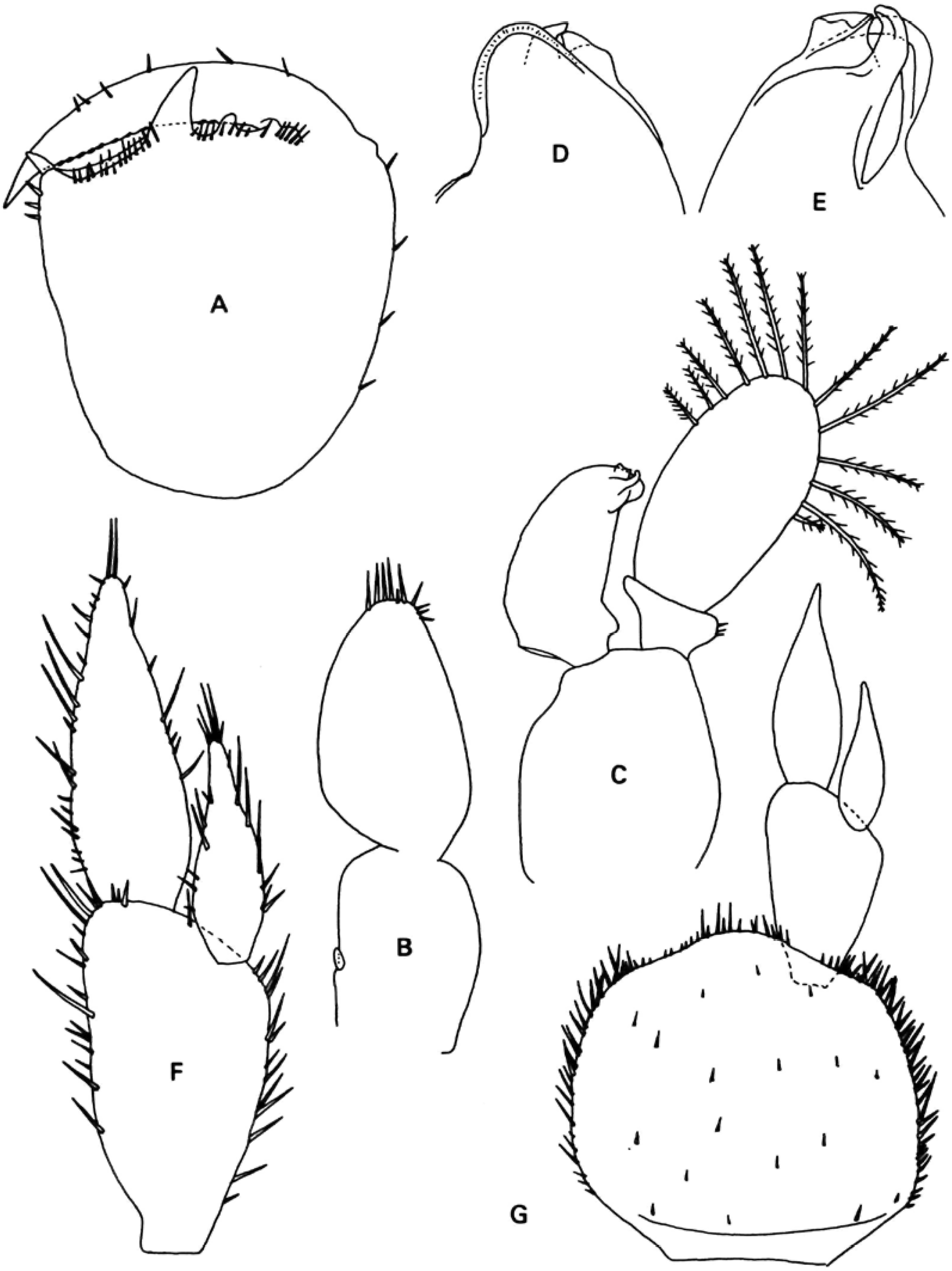

FIGURE 37.—*Asellus forbesi,* holotype: A, dactylus and propodus of first peraeopod; B, first pleopod; C, second pleopod; D, E, respectively dorsal and ventral surfaces of tip of endopodite of second pleopod; F, uropod; G, uropod and telson.

TABLE 5.—*Principal differences between* Asellus forbesi *and* Asellus obtusus

[males only]

		A. forbesi	*A. obtusus*
Maximum body length (mm)	—	18.5	12.5
length of second antennae / body length	Range M [a] ± S.D.	0.5–1.0 0.75 0.12	0.8–1.5 1.03 0.19
No. of marginal spines on proximal segment of exopod of second pleopod	—	0–4	0
length / width (endopod, pleopod 2)	Range M [a] ± S.D.	1.65–2.64 2.05 0.22	1.39–1.84 1.63 0.15
uropod length / telson length	Range M [a] ± S.D.	0.67–1.5 1.16 0.20	1.0–2.0 1.48 0.32

[a] Difference between means highly significant in all comparisons (by "t" test, P=<0.001).

long and fine spines distally, and numerous stronger ones laterally.

PARTIAL DESCRIPTION OF ALLOTYPE (♀).—First peraeopod (FIGURES 38A, B): Relatively slender, but dactylus and propodus arranged in a subchelate manner. Dactylus distinctly longer than palm of propodus and with 8 teethlike spines on inner margin and a long terminal claw. Propodus subtriangular, about 1.5 times as long as maximum width; palm with a low triangular projection near midpoint, and at proximal end 2 long teethlike spines. Otherwise as described for a female paralectotype of *A. attenuatus*.

"First" pleopod (Figure 38C): Almost subrectangular in shape. Distal margin with 14 long finely plumose spines.

MATERIAL EXAMINED.—GREAT LAKES: Lake Huron: Sta. 13, 15 meters, 1♂, coll. Great Lakes Institute, 6.xi.1963 (GLI).

ONTARIO: Go Home Bay, 1♂, Coll. W. A. Clemens, August 1912 (ROM); New Durham, Brant County, 4♂♂, coll. R. F. Cain, 24.v.1929 (ROM); Lake Nipissing, 1♂, coll. J. Oughton, 8.vii.1929 (ROM); L. Nipissing, 1♂, coll. J. Oughton, 8.viii.1930 (ROM); Laird, ∞ ♂♂, coll. unmarked, June 1931 (ROM); Beattie Point, Ottawa R., 5♂♂, coll. Macoun Field Club, 28.iv.1955 (NMC); Spitler Ck., Holbrook, 3♂♂, coll. Ont. P. & D., 1.vi.1955 NMC); Tillsonburg, 18♂♂, coll. E. L. Bousfield, 30.viii.1956 (NMC); Metcalfe, 3♂♂, coll. W. Sinclair, 4.v.1957 (NMC); Spitler Cr., Norwich, 9♂♂, coll. E. L. Bousfield, 29.v.1957 (NMC); Long Point, 5♂♂, coll. D. Barr, 26.v.1963 (ROM); Rondeau Province Pk., Kent Co., 4♂♂, coll. I. M. Smith, 2.vi.1965 (ROM); Chalk River, ∞ ♂♂, coll. H. B. N. Hynes, 27.v.1966; Perch Creek, 8♂♂, coll. J. Bishop, 2.v.1967; Pond near Laurel Creek Reservoir, ∞ ♂♂, coll. C. Patterson, 16.v.1967.

DISTRICT OF COLUMBIA: Carberry Meadows, ∞ ♂♂, coll. W. P. Hay, 10.xii.1892 (USNM); Piney Branch, 3♂♂, coll. W.H. Ball, 7.iv.1930 (USNM); Piney Branch, ∞ ♂♂, coll. W. H. Ball, 1.v.1930 (USNM); Georgetown, ∞ ♂♂, coll. L. Hubricht, date unmarked (USNM).

INDIANA: Hammond, 4♂♂, coll. V. E. Shelford, 25.iv.1908 (USNM); La Porte, La Porte County, ∞ ♂♂, coll. L. Hubricht, 2.v.1941 (USNM).

IOWA: Riverside, Washington County, ∞ ♂♂, coll. L. Hubricht, 24.iv.1942 (USNM).

KENTUCKY: Bullitt County, 2♂♂, coll. G. A. Cole, 7.iii.1954; Caperton Swamp, 4♂♂, coll. G. A. Cole, 26.iii.1954; Jefferson County, 1♂, coll. G. A. Cole, 2.v.1954; Louisville, 9♂♂, coll. G. A. Cole, 26.xii.1954; Jefferson County, 7♂♂, coll. G. A. Cole, 24.iii.1956 (NMC).

MARYLAND: Great Falls, 7♂♂, coll. W. D. Appel, 9.xi.1912 (USNM); Linden, ∞ ♂♂, coll. J. E. Benedict, 28.ii.1926 (USNM); Hyattsville, ∞ ♂♂, coll. R. Greenfield, 18.ii.1928 (USNM); Hyattsville, ∞ ♂♂, coll. R. Greenfield, 10.ii.1929 (USNM); Ridge, St. Mary's County, 11♂♂, coll. W. H. Ball, 26.iv.1930 (USNM); Point No Point, 1♂, coll. W. H. Ball, 27.iv.1930 (USNM); near Plummer's Island, ∞ ♂♂, coll. W. D. Appel, 5.v.1935 (USNM); near

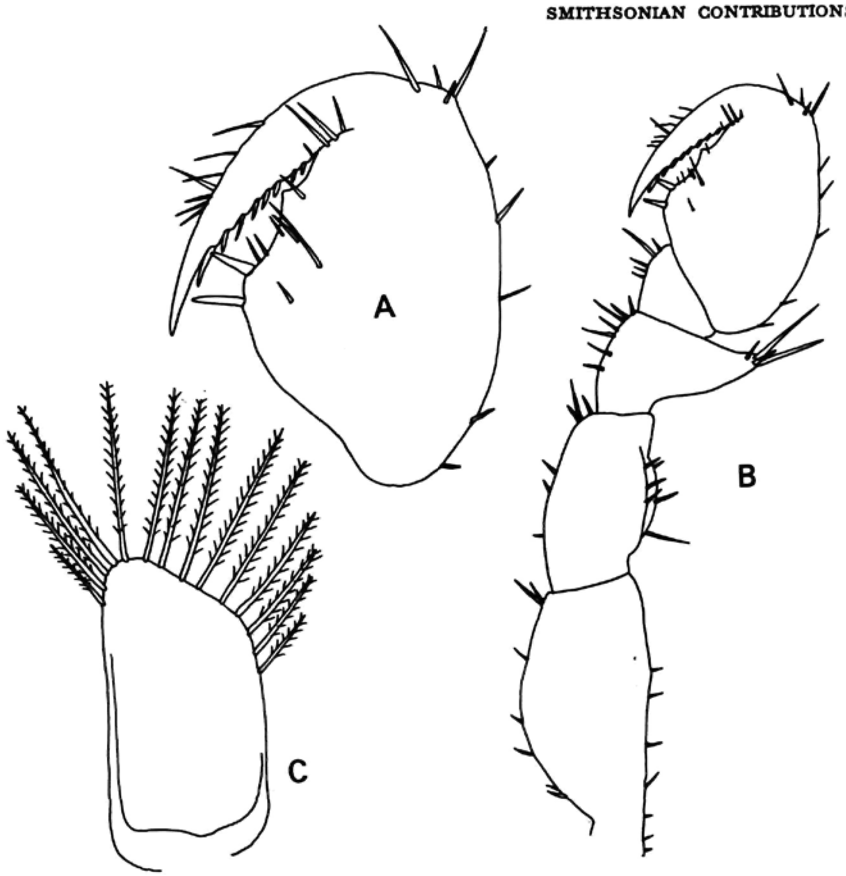

FIGURE 38.—*Asellus forbesi,* allotype: A, dactylus and propodus of first peraeopod; B, first peraeopod; C, "first" pleopod.

Plummer's Island, 5♂♂, coll. W. D. Appel, 19.v.1935 (USNM).

MICHIGAN: Ann Arbor, ∞♂♂, coll. L. Hubricht, 30.iv.1941 (USNM); Fenton, ∞♂♂, coll. L. Hubricht, 19.iv.1942 (USNM); Kalamazoo County, 2♂♂, coll. R. L. Lippson, 12.iv.1967.

MISSOURI: Benbush, St. Louis County, ∞♂♂, coll. L. Hubricht, 8.iii.1936 (USNM); St. Charles, 11♂♂, coll. L. Hubricht, 24.iv.1937 (USNM); River Kirkwood, St. Louis County, ∞♂♂, coll. L. Hubricht, 10.iv.1938 (USNM); Grimsby, ∞♂♂, coll. L. Hubricht, 25.iv.1938 (USNM).

NORTH CAROLINA: Chapel Hill, Durham County, 6♂♂, coll. A. Weaver, 4.xii.1966; Chapel Hill, Durham County, 2♂♂, coll. A. Weaver, 27.iii.1967.

OHIO: Shreve, Wayne County, 2♂♂, coll. W. A. Shear, 23.iii.1967.

SOUTH CAROLINA: Anderson County, 4♂♂, coll. R. Prinz, 6.i.1966.

VIRGINIA: Driver, ∞♂♂, coll. L. Hubricht, 26.iii.1944 (USNM); South Gap, Bland County, 6♂♂, coll. A. Weaver, 21.iii.1967; Prince William County, 14♂♂, coll. A. Weaver, 28.iii.1967; Keysville, 4♂♂, coll. A. Weaver, 28.iii.1967; Culpepper County, 7♂♂, coll. A. Weaver, 28.iii.1967.

WEST VIRGINIA: Mercer County, 3♂♂, coll. W. A. Shear, 16.iv.1966; Mercer County, 1♂, coll. A. Weaver, 1.xii.1966.

GEOGRAPHICAL DISTRIBUTION AND ECOLOGY.—The localities listed above, together with the type locality, are plotted in Figure 39. This indicates that *A. forbesi* is found over a very large area of east-central United States and in southern Ontario. It is clearly one of the most widespread species occurring in North America.

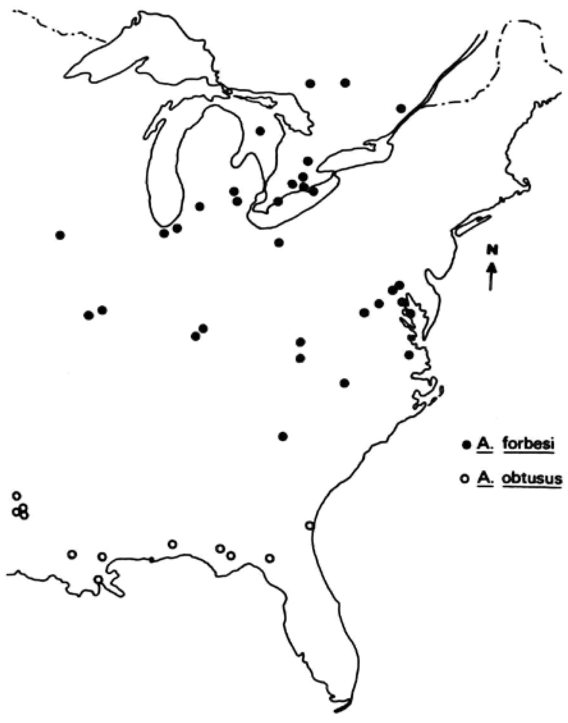

FIGURE 39.—Geographical distribution.

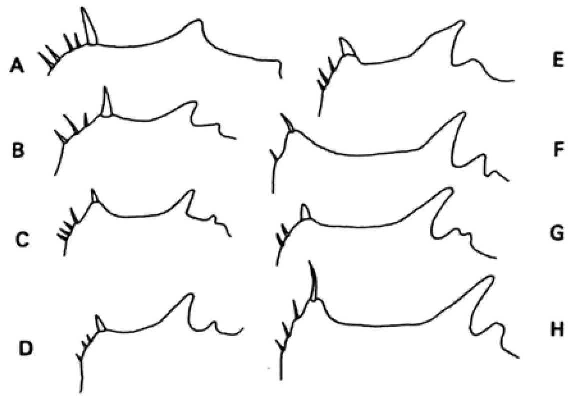

FIGURE 40.—*Asellus forbesi*, extent of variation in palm shape of male first peraeopod: A, Kalamazoo, Michigan; B, Chalk River, Ontario; C, Long Point, Ontario; D, Washington, D.C.; E, Hyattsville, Maryland; F, St. Charles County, Missouri; G, Jefferson County, Kentucky; H, Nansemond County, Virginia.

The most frequently mentioned sort of locality from which collections have been made are temporary ponds, flood pools, and sloughs. However, the species has also been collected from marshes, small creeks, and at least on a few occasions from lakes also. One of the lakes from which it has been collected is Lake Huron where the species was obtained from a depth of 15 m. Like several other geographically widespread species of *Asellus* in North America, *A. forbesi* is clearly able to live in a variety of macrohabitats.

FURTHER DESCRIPTION (♂).—Body: The largest ♂ examined was 18.5 mm long, and the smallest 6.0 mm.

First antenna: Flagellum 10- to 17-merous; flagellum tip reaching to midpoint or to distal end of the last segment of the peduncle of the second antenna; penultimate 3 segments bear aesthetascs.

Second antenna: Length 0.5 to 1.0 times that of body, but usual length between one-half and two-thirds body length. Flagellum 40- to 87-merous depending upon size.

Mouthparts: See Table 1.

First peraeopod: Spine on proximal projection of palm usually toothlike but sometimes relatively slender; proximal projection itself prominent to scarcely developed, and with 1 to 5 relatively long spines on proximal margin. Some variation occurs in the shape of the palm (cf. Figure 40).

First pleopod: Total length of appendage 0.84 to 1.19 times as long as second pleopod. Inner margin of sympod with 0 to 4 (usually 2 or 3) coupling hooks. Maximum width of distal segment 0.48 to 0.69 times maximum length. Distal spines few to numerous, but always simple and of moderate length. The typical shape of the distal segment is subovate, but a little variation occurs.

Second pleopod: Maximum length of sympod from 1.10 to 1.60 (usually 1.2 to 1.4) times maximum width. Proximal segment of exopod with 0 to 4 short and simple spines on outer margin; distal segment with 10 to 20 marginal spines. The shape of the distal segment of the exopod varies from almost subcircular to elongate oval, the maximum length ranging from 1.48 to 2.54 times the maximum width; the usual shape, however, is ovate, and the maximum length is usually about twice the maximum width. Endopod shape is also rather variable, particularly concerning the extent of development of the basal apophyses; an indication of the range of variation is given in Figure 41. Considerable variation in endopod shape may occur even within a single population, but the typical shape is that shown for the holotype (Figure 37G). The maximum length of the endopod is from 1.65 to 2.64 (usually 1.9

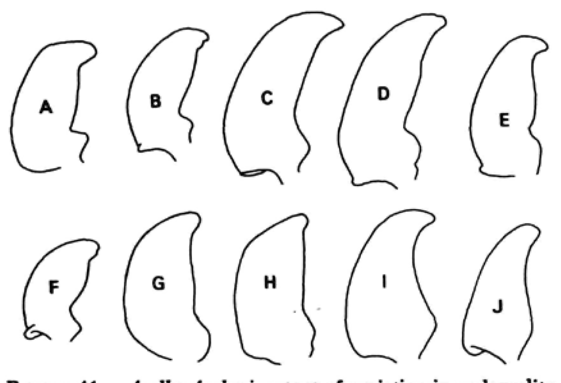

FIGURE 41.—*Asellus forbesi*, extent of variation in endopodite shape of male second pleopod: A, Beattie Point, Ontario; B, Laird, Ontario; C, D, J, Nansemond County, Virginia; E, G, H, paratypes; F, Jefferson County, Kentucky; I, St. Charles County, Missouri.

to 2.3) times the maximum width; the length in proportion to the length of the distal segment of the exopod ranges from 0.60 to 1.04. The morphology of the tip of the endopodite, while constant in fundamental characters, is subject to some variation particularly in the nature of the cannula and the mesial process and the relationship these have to each other. Figure 42 has been compiled to illustrate the range of this variation. As may be seen, the mesial process may appear to be much shorter than the cannula in some specimens, subequal in length in others, and even in some slightly longer; its shape, moreover, is rather variable and its tip may be blunt and rounded or acute and narrow.

Depending to at least some extent it seems upon the state and nature of preservation of the specimen involved and the position of mounting of the pleopod for examination, the cannula may appear as a prominent semitubular structure or as a scarcely visible and almost flattened structure; it is always membranous. The caudal process is always rounded, sometimes irregularly so, sclerotized, and lacks associated protuberances. With regard to the morphology of the tip of the endopodite, *A. forbesi* appears to be one of the more variable of North American epigean species of *Asellus*, and the same can also be applied with respect to the overall shape of the endopod. A study of the available material did not indicate that any of this variation had an obvious geographical basis, although this is not to say of course that the variability is not correlated with the very wide geographical distribution of the species (the wide geographical distribution may be a consequence of the variability).

Uropoda: See Table 2.

REMARKS.—Several collections from the United States and belonging to the USNM had been collected

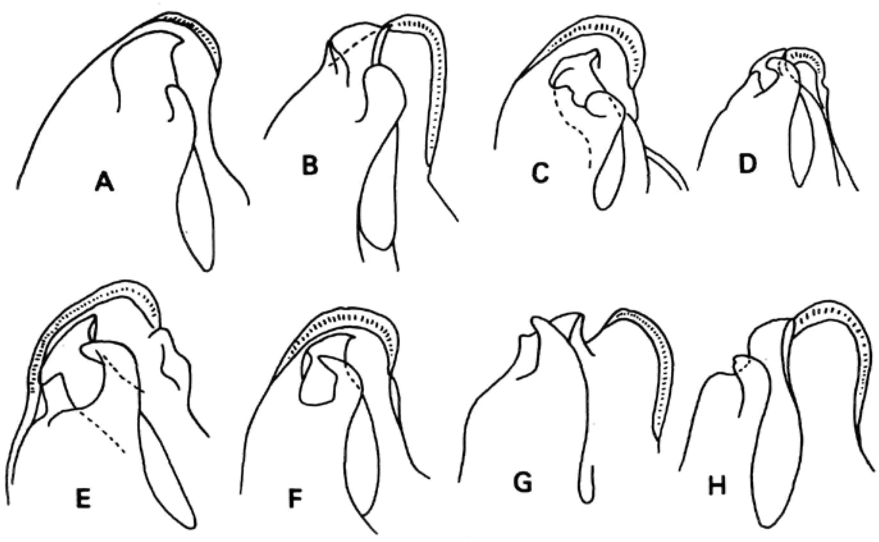

FIGURE 42.—*Asellus forbesi*, extent of variation in morphology of endopodite tip of male second pleopod: A, Brant County, Ontario; B, G, Beattie Point, Ontario; C, Jefferson County, Kentucky; D, Washington, D.C.; E, Hammond, Indiana; F, Chalk River, Ontario; H, Genesee County, Michigan.

by L. Hubricht, and most of these but not all had associated labels indicating that Hubricht regarded the material as belonging to the species "*A. militaris*." Several Canadian collections belonging to the ROM likewise were so labeled, but for these identification had been carried out by J. G. Mackin. As indicated previously, the name *A. militaris* is a synonym for *A. intermedius* and the resurrection of the name by Mackin (1940) following its synonymy with *A. communis* by Hay (1882), Richardson (1905), and Van Name (1936) has no validity. It seems clear, nevertheless, that Mackin and Hubricht, who worked in close collaboration, should be credited with an awareness of the separate identity of the taxon here referred to as *A. forbesi*. In the case of Hubricht the awareness was by no means exact, for some collections that are undoubtedly referable to *A. forbesi* are labeled as "*A. intermedius*."

Asellus obtusus, new species

FIGURES 43–45

ETYMOLOGY.—From the Latin *obtusus*, blunt.

TYPE MATERIAL AND TYPE LOCALITY.—Holotype: adult ♂, USNM 122060. Allotype: adult ovigerous ♀, USNM 122061. Paratypes: 9♂♂, 1 ovigerous ♀, USNM 122062. Type locality: temporary pond, Florenville, St. Tammany Parish, Louisiana. The type collection was made 26 February 1966 by Dr. W. G. Moore.

DESCRIPTION OF HOLOTYPE.—Body: Length, 9.5 mm.

Head: Eyes large and distinct.

First antenna: Flagellum 17-merous and tip reaching to point about one-third along last segment of peduncle of second antenna; penultimate three segments with aesthetascs. Flagellum slightly longer than peduncle. Second segment of peduncle longest; first, three-quarters length of second; third, half length of second. First peduncle segment about twice as long as wide; second and third respectively about 4 and 3.5 times as long as wide.

Second antenna: Length (10.5 mm) slightly greater (1.1) than body. Flagellum 85-merous. Fourth and fifth segments of peduncle respectively 5 and 9 times as long as wide.

First peraeopod (Figure 43A): Propodus 1.4 times as long as wide, of irregular triangular shape; palm with a single large triangular projection near midpoint, a second blunter projection half height of larger projection and lying between this and point of attachment of dactylus, a low proximal projection bearing apically a long stout spine and proximally two smaller spines, and a submarginal row of spines on inner and outer surfaces.

Second to seventh peraeopoda: Segments generally a little more elongated and setose than as described for *A. communis*, and dactyli bear slightly more teethlike marginal spines. The proportions of the segments to each other in a given peraeopod are nevertheless similar to those described for *A. communis*. Figure 43B, which illustrates the fifth peraepod, serves as an example of these differences (cf. Figure 4A).

First pleopod (Figure 44A): Total length subequal (1.1) to that of second pleopod. Sympod subsquare, maximum length only slightly greater (1.14) than maximum width; inner margin with 3 hooklike protuberances for coupling. Distal segment subovate, widest near midpoint; maximum width just over half (0.59) maximum length; several simple short spines occur on distal margin.

Second pleopod (Figures 44B–D): Sympod subrectangular, maximum length 1.3 times maximum width; medial and lateral margins more or less straight. Proximal segment of exopod subrectangular, lacking marginal spines. Distal segment of exopod ovate, maximum length slightly greater (2.1) than twice maximum width, and with 1 short and 13 long plumose spines on margin of distal half of segment. Endopod two-thirds total length of exopod, and three-quarters length of distal segment of exopod; endopod 1.73 times as long as maximum width (regarded in all specimens of *A. obtusus* as the distance between the apex of the outer basal bulge and the inner proximal angle of the endopod). Basal apophyses not developed; inner proximal angle almost a right angle. Cannula very short and wide; outer margin forming a distinct recurved lip. Ventral groove short and wide. Mesial process sclerotized, large, very wide, blunt, and as long as cannula. Lateral process not prominent. Caudal process wide, margin broadly rounded and sclerotized, without associated hooks or spines, and not protruding far beyond cannula and mesial process.

Uropod (Figure 43C): One and three-quarters as long as telson. Peduncle slightly more than twice as long as maximum width. Exopod as long as peduncle, endopod slightly longer (1.13) than peduncle. Both rami and peduncle bear laterally very many long fine and simple spines.

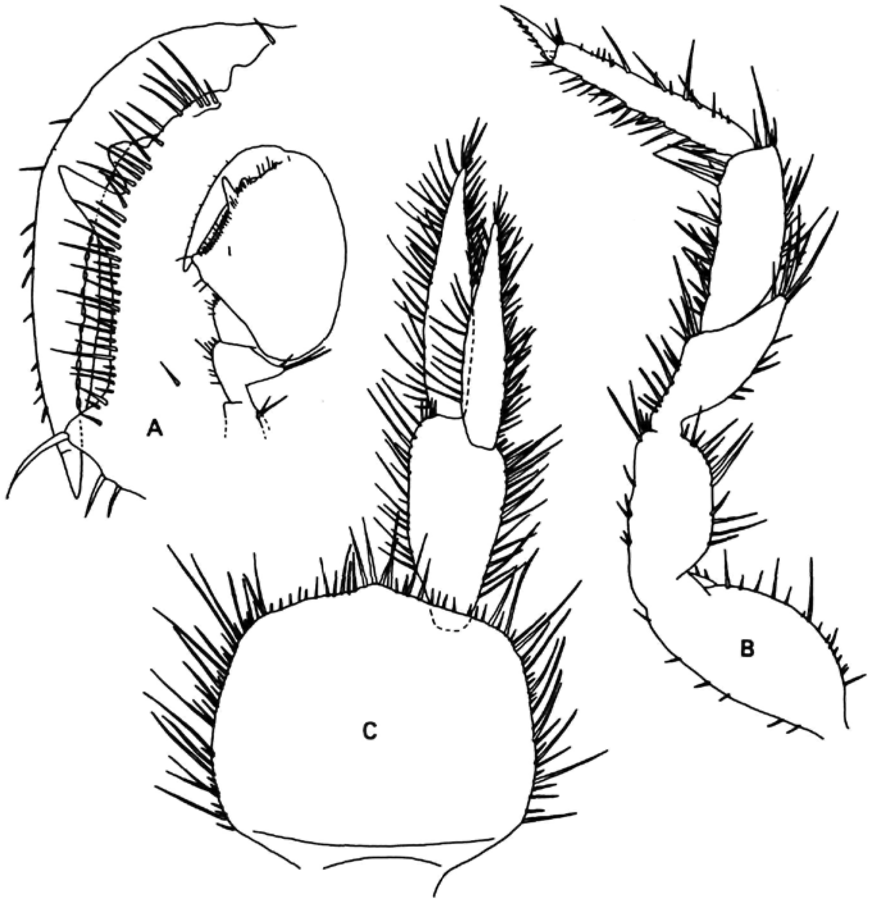

FIGURE 43.—*Asellus obtusus,* holotype: A, distal segments of first peraeopod (palm and dactylus shown in greater detail); B, fifth peraeopod; C, uropod and telson.

Telson (Figure 43C): Lateral and distal margins with numerous short and very long fine and simple spines.

PARTIAL DESCRIPTION OF ALLOTYPE (♀).—First peraeopod (Figure 44E): Relatively slender, but dactylus and propodus almost subchelate. Dactylus about as long as palm of propodus and with 10 stout spines on inner margin and a terminal claw. Otherwise similar to the description given for this appendage in a female paralectotype of *A. attenuatus.*

"First" pleopod: Subtrapezoidal in shape, but broader distally than proximally; generally of similar outline to the "first" pleopod as described for a female paralectotype of *A. attenuatus* (Figure 22C), but width rather broader in proportion to length. Distal margin with 18 long finely plumose spines.

MATERIAL EXAMINED.—FLORIDA: Torreya St. Park,* Liberty County, 1♂, coll. W. Beck, 10.xii.1960; roadside ditch, Jefferson County, ∞♂♂, coll. W. Beck, 17.ix.1961; Waddell's Mill,* Jackson County, 10♂♂, coll. W. Beck, 19.iii.1963; Escambia River, Escambia County, 1♂, coll. W. Beck, 19.xi.1963.

GEORGIA: Darien,* 1♂, coll. E. L. Bousfield, 2.iii.1963 (NCM).

LOUISIANA: Baton Rouge, 1♂, coll. T. E. Simpson, 19.i.1965 (NMC); St. Tammany Parish, 11♂♂, coll. W. G. Moore, 2.ii. 1966; Florenville, St. Tammany Parish, 11♂♂, coll. W. G. Moore, 26.ii.1966; Bridge City, Jefferson Parish, 8♂♂, coll. W. G. Moore, 19.iii.1966; Crown Point, Jefferson Parish, 1♂, coll. W. G. Moore, 4.iii.1967; Bossier Parish, 6♂♂, coll. W. G. Moore, 29.iv.1967; Natchitoches Parish, 10♂♂,

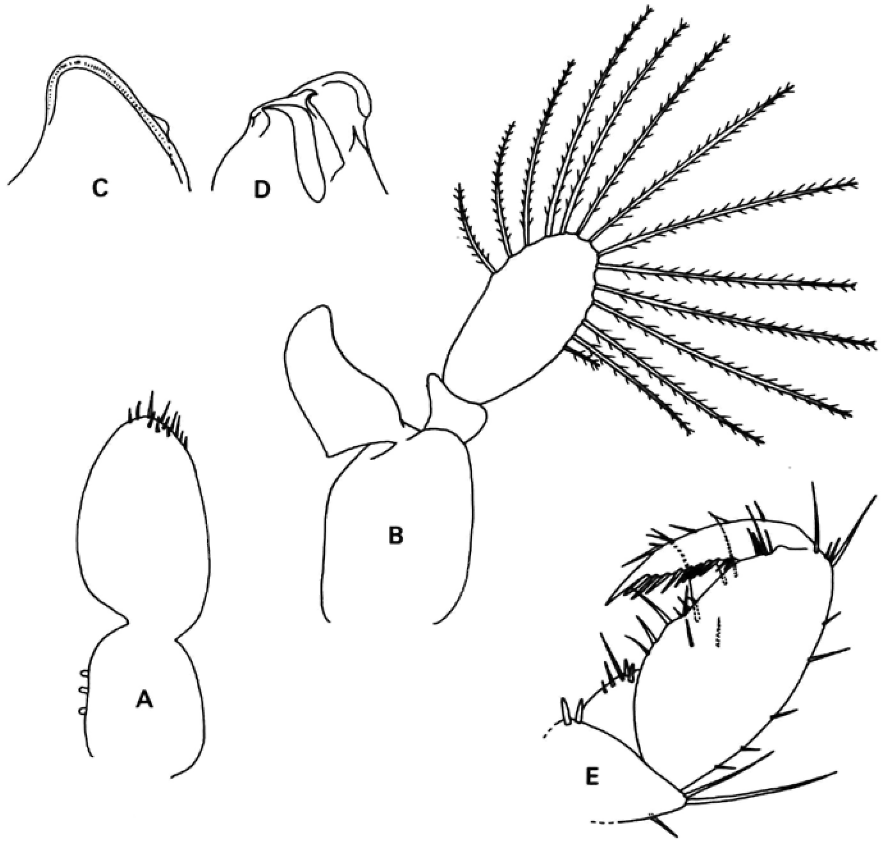

FIGURE 44.—*Asellus obtusus*, A–D, holotype; E, allotype: A, first pleopod; B, second pleopod; C, D, respectively dorsal and ventral surfaces of tip of endopodite of second pleopod; E, terminal segments of first peraeopod.

coll. W. G. Moore, 29.iv.1967; Red River Valley, Rapides Parish, 2♂♂, coll. W. G. Moore, 29.iv.1967; near Grand Bayou, Red River Parish, 2♂♂, coll. W. G. Moore, 29.iv.1967.

GEOGRAPHICAL DISTRIBUTION AND ECOLOGY.—As may be seen from the map (Figure 39) in which the above localities are plotted, *A. obtusus* is known only from a relatively small region in the southeastern corner of the United States. Within this region it seems to inhabit a variety of waters and has been recorded from swamps, roadside ditches, temporary ponds, and in one case each a river and a small stream.

FURTHER DESCRIPTION (♂).—Body: The largest ♂ examined was 12.5 mm long, and the smallest 6.0 mm.

First antenna: Flagellum 12- to 23-merous; flagellum tip reaching one-third along or to distal margin of the last segment of the peduncle of the second antenna.

Second antenna: Length 0.81 to 1.5 times that of body, but usual length subequal to body length. Flagellum 50- to 85-merous, depending on size.

Mouthparts: See Table 1.

First peraeopod: 2 to 4 spines may occur on the proximal margin of the low proximal projection of the palm; shape of palm shows little variation from that illustrated for the holotype.

First pleopod: Total length of appendage 0.85 to 1.19 times as long as second pleopod. Inner margin of sympod with 2 to 5 coupling hooks. Maximum width of distal segment 0.52 to 0.66 times maximum length. Distal spines few to numerous, but always simple and of moderate length. The typical shape of the distal segment is subovate.

Second pleopod: Maximum length of sympod from 1.07 to 1.50 (usually 1.1 to 1.3) times maximum width. Proximal segment of exopod without marginal spines; distal segment with 11 to 16 plumose marginal spines. The shape of the distal segment is always ovate, the maximum length, however, ranging from 1.42 to 2.19 (usually 1.6 to 1.9) times the maximum width. Endopod shape is relatively constant (cf. *A. forbesi*), the maximum length ranging from only 1.39 to 1.84 (usually 1.4 to 1.7) times the maximum width; the length in proportion to the length of the distal segment of the exopod varies from 0.64 to 1.06.

Although constant in fundamental construction, the morphology of the tip of the endopod seems to provide a variety of appearances depending upon the state of preservation of the specimen, the position of the endopod when examined, real differences between individuals, and perhaps other factors also. Figure 45 illustrates in part the extent of this variation; it is based mainly on paratype material. As shown, the outer lip of the cannula is developed to different degrees, the ventral groove may be relatively narrow or broad and open, and the caudal outline (including the caudal process) while always rounded exhibits some variation in shape. The mesial process shows the most variation of all; it may be relatively narrow and long, wide and short, rounded or pointed. Like *A. forbesi*, *A. obtusus* appears to be one of the more variable of North American epigean species with regard to the conformation of the tip of the endopod.

Uropoda: See Table 2. Peduncle and rami always with many long fine lateral spines.

Discussion.—The morphology of the tip of the endopod of the second male pleopod in typical specimens of *A. obtusus* is sufficiently unlike that of any other *Asellus* species to suggest that the taxon warrants specific status on this criterion alone. Because this morphology is basically similar in general plan to that shown by *A. forbesi* for the same structure, however, it is occasionally possible to be uncertain of the specific identity using the morphology of the endopod tip by itself. The two species can, nevertheless, always be separated on a number of other characters: (1) *A. obtusus* is a smaller species than *A. forbesi;* (2) the second antennae are longer relative to body length in *A. obtusus;* (3) the proximal projection on the palm of the first ♂ peraeopod of *A. obtusus* bears apically a long stout spine and never a toothlike spine as is usual in *A. forbesi;* (4) the proximal segment of the exopod of the second ♂ pleopod never has marginal spines in *A. obtusus,* whereas it frequently does in *A. forbesi;* (5) the endopod of the second ♂ pleopod in *A. obtusus* is more squat, wider relative to length, always without a developed outer basal apophysis, and with the inner proximal angle almost a right angle; (6) the telson and uropoda are much more spinose in *A. obtusus* than *A. forbesi* (cf. Figures 43c, 37F, G); and (7) the uropoda of *A. obtusus* relative to telson length are generally longer than those of *A. forbesi.* Many of these differences are quantified in Table 5. Considered together with the differences in the morphology of the

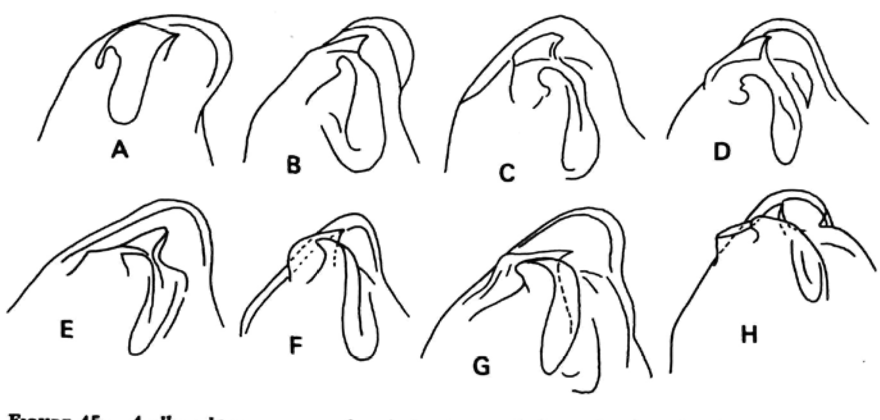

Figure 45.—*Asellus obtusus,* extent of variation in morphology of endopodite tip of male second pleopod: A, Jefferson County, Florida; B–E, G, H, paratypes; F, Red River Valley Parish, Louisiana.

endopod tip of the second ♂ pleopod, they provide firm grounds for the specific separation of the two taxa.

Asellus laticaudatus, new species

FIGURES 46–48

ETYMOLOGY.—From the Latin *latus*, broad, and *caudatus*, having a tail.

TYPE MATERIAL AND TYPE LOCALITY.— Holotype: adult ♂, USNM 122055. Allotype: adult nonovigerous ♀. USNM 122056. Paratypes: 8♂♂, 1 nonovigerous and 1 ovigerous ♀, USNM 122057. Type locality: roadside ditch near Haynes Boulevard, New Orleans, Orleans Parish, Louisiana. The type collection was made 29 April 1961 by Dr. W. G. Moore.

DESCRIPTION OF HOLOTYPE.—Body: Length, 8.0 mm.

Head: Eyes large and distinct.

First antenna: Flagellum 10-merous and tip reaching to point about two-thirds along last segment of peduncle of second antenna; last 3 segments bear aesthetascs. Second segment of peduncle longest; first, three-quarters length of second; third, two-thirds length of second. First peduncle segment about 1.5 times as long as wide.

Second antenna: Length (5.0 mm) about two-thirds (0.63) body length. Flagellum broken near tip; flagellum at least 61-merous and at least twice length of peduncle.

First peraeopod (Figure 46A): Propodus 1.2 times as long as wide, subtriangular; palm with a broad and large triangular projection near midpoint, a smaller blunt projection between larger projection and point of attachment of dactylus, 3 teethlike spines at proximal end, and a submarginal row of spines on inner and outer surfaces.

First pleopod (Figure 46B): Total length 1.34 times that of second pleopod. Sympod subrectangular, about 1.5 times as long as broad; inner margin with 5 (left) or 6 (right) hooklike protuberances for coupling. Distal segment also subrectangular, but distal margin somewhat rounded; maximum width half maximum length; distal margin and distal half of outer lateral margin with numerous short to moderately long simple spines rather irregularly arranged; inner distal angle with a single simple spine.

Second pleopod (Figures 46C-E): Sympod subquadrate, maximum length only slightly greater (1.20) than maximum width; medial and lateral margins slightly convex. Proximal segment of exopod subtrapezoidal, with 5 short and simple spines on outer margin. Distal segment of exopod ovate, 1.45 times as long as wide, with 19 short to long plumose spines arranged marginally, and a row of fine short spines on inner margin. Endopod four-fifths total length of exopod, and the same length as the distal segment of the exopod; endopod slightly greater (2.62) than two and a half times as long as maximum width (regarded in all specimens of *A. laticaudatus* as the distance between the inner and outer margins of the endopod immediately distal to the basal apophyses). Both inner and outer basal apophyses prominent and well developed. Cannula long and wide and protruding prominently at distal end of endopod. Ventral groove short, narrow, and not prominent. Mesial, lateral, and caudal processes not developed, but distal part of mesial side of ventral groove sclerotized and forming a flaplike structure. At the distal end of the endopod on the dorsal surface numerous groups of about 3–6 minute setae occur in the form of small combs.

Uropod (Figure 46F): Slightly longer (1.11) than telson. Peduncle twice as long as maximum width. Exopod about two-thirds (0.62) length of peduncle, endopod as long as peduncle; both rami are flat, lanceolate, and broad, the exopod being 3 times as long as the maximum width, and the endopod 2.23 times. Rami and peduncle bear numerous short to moderately long spines on their lateral margins.

Telson (Figure 46G): Subsquare; lateral and distal margins with numerous short and moderately long fine and simple spines.

PARTIAL DESCRIPTION OF ALLOTYPE (♀).—First peraeopod (Figures 47A, B): Relatively stout in general proportions, and dactylus and propodus arranged in a subchelate manner. Dactylus about same length as palm of propodus and with 5 teethlike spines on inner margin and a long terminal claw. Propodus broadly subovate, 1.7 times as long as wide; palm with a single long toothlike spine near midpoint, a very small triangular projection between long spine and point of attachment of dactylus, and several long simple submarginal spines. Otherwise as described for a female paralectotype of *A. attenuatus*.

"First" pleopod (Figure 47C): Shape similar to that described for the allotype of *A. forbesi*, but setation

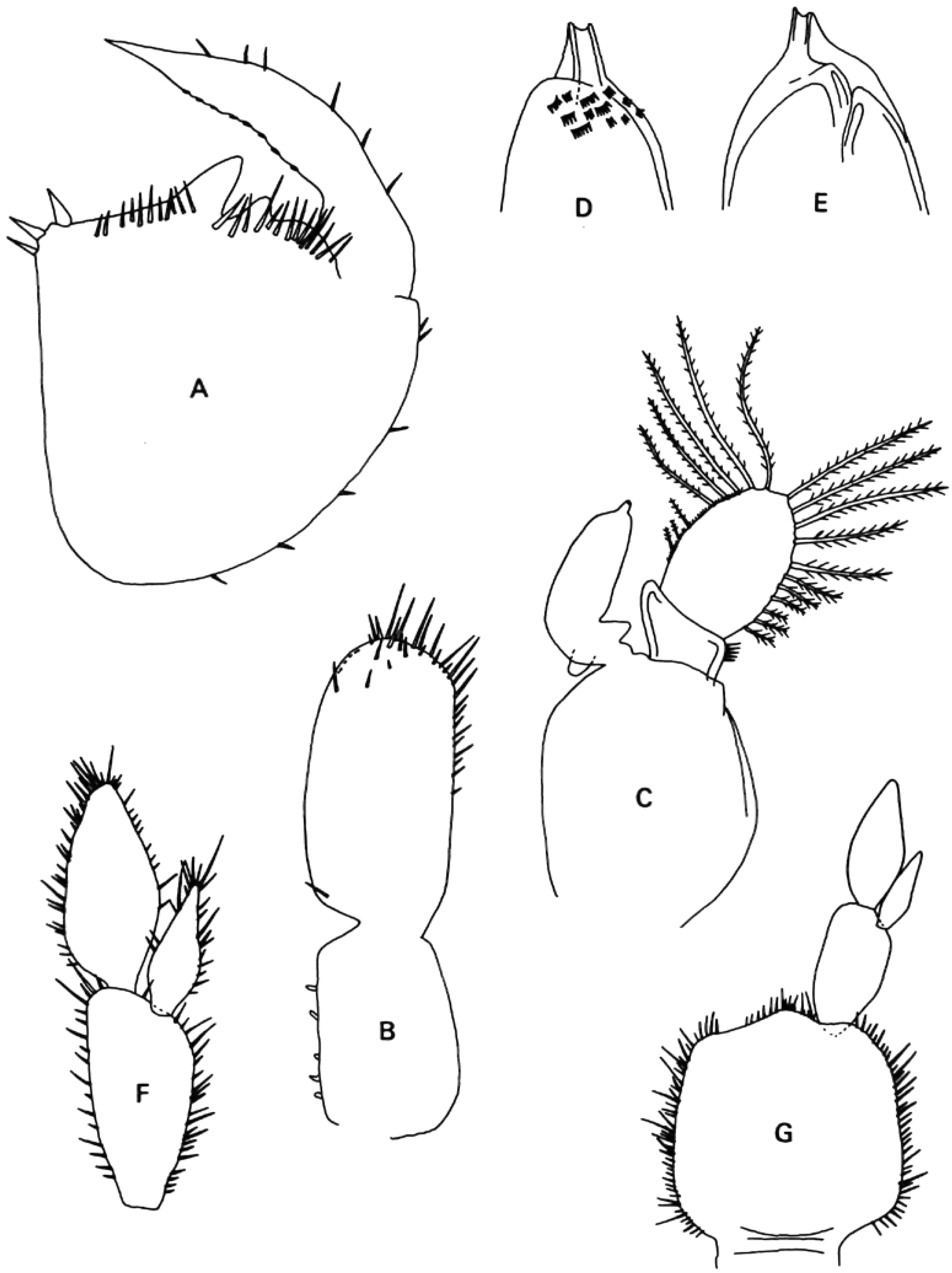

FIGURE 46.—*Asellus laticaudatus,* holotype: A, dactylus and propodus of first peraeopod; B, first pleopod; C, second pleopod; D, E, respectively dorsal and ventral surfaces of tip of endopodite of second pleopod; F, uropod; G, uropod and telson.

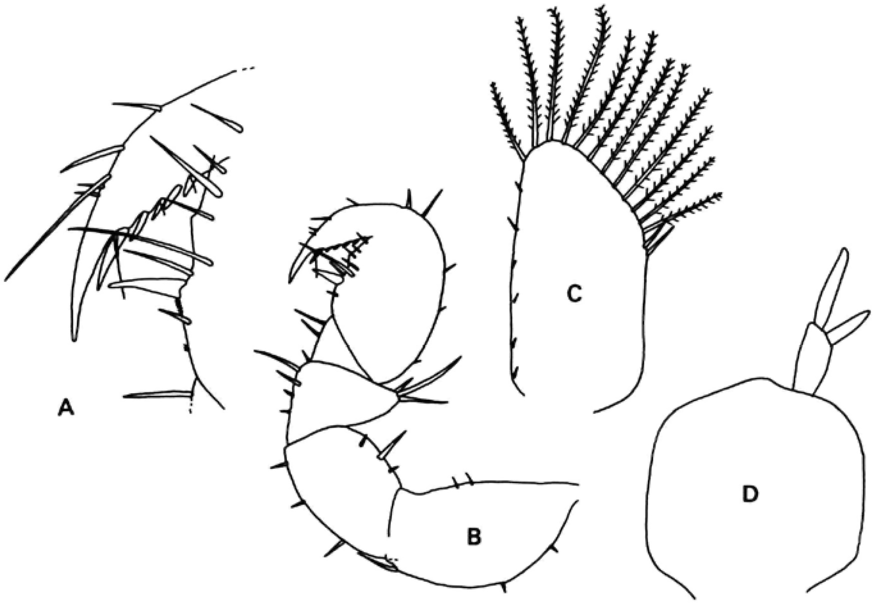

FIGURE 47.—*Asellus laticaudatus*, allotype: A, dactylus and palm of first peraeopod; B, first peraeopod; C, "first" pleopod; D, uropod and telson.

slightly different; inner margin with 6 short simple spines, outer distal margin with 12 long plumose spines and 2 short simple ones.

Uropod (Figure 47D): Distinctly shorter (0.71) than telson. Peduncle twice as long as maximum width. Exopod about three-quarters (0.71) length of peduncle, endopod slightly longer (1.14) than peduncle; both rami narrow and not markedly lanceolate.

MATERIAL EXAMINED.—KENTUCKY: Beargrass Creek, Louisville, 14 ♂♂, coll. G. A. Cole, 15.ix.1955; Louisville, 1 ♂, coll. G. A. Cole, December 1956.

LOUISIANA: Haynes Boulevard, New Orleans, 10 ♂♂, coll. W. G. Moore, 29.iv.1961.

GEOGRAPHICAL DISTRIBUTION AND ECOLOGY.—The above records together with the type locality are plotted in Figure 13. The great distance between the two regions from where the species is presently known suggests that the species has a wide distribution in southeast United States. Unfortunately no collections of *Asellus* from the intermediate states of Alabama, Mississippi, or Tennessee were available for study during the present investigation. A study of such collections is needed for confirmation or otherwise of this distribution.

FURTHER DESCRIPTION (♂).—Body: The largest ♂ examined was 11.5 mm long, and the smallest 6.0 mm.

First antenna: Flagellum 10- to 12-merous; last 3 segments bear aesthetascs.

Second antenna: Length 0.6 to 1.0 times that of body. Flagellum about 65-merous.

Mouthparts: See Table 1.

First peraeopod: 2 or 3 spines at proximal end of palm.

First pleopod: Total length of appendage 1.16 to 1.34 times as long as second pleopod. Inner margin of sympod with 4 to 6 coupling hooks. Maximum width of distal segment 0.49 to 0.58 times maximum length.

Second pleopod: Maximum length of sympod from 1.03 to 1.26 times maximum width. Proximal segment of exopod with 2 to 5 short and simple spines on outer margin; distal segment with 13 to 23 plumose, marginal spines. The shape of the distal segment of the exopod is always ovate, the maximum length, however, ranging from 1.23 to 1.63 times the maximum width. Endopod shape is relatively constant, the maximum length ranging from only 2.47 to 2.93 times the maximum width; the length in proportion to the length of the distal segment of the exopod varies from 0.84 to

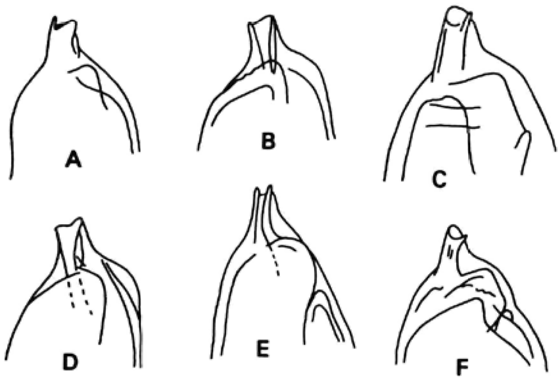

FIGURE 48.—*Asellus laticaudatus*, extent of variation in morphology of endopodite tip of male second pleopod: A, Beargrass Creek, Kentucky; B, D, Haynes Boulevard, Louisiana; C, Louisville, Kentucky; E, F, paratypes.

1.14. The morphology of the tip of the endopod is relatively constant, only minor differences being apparent between individuals (Figure 48).

Uropoda: See Table 2. Both rami are always flat, lanceolate, and broad; the endopod is from 2.23 to 2.5 times as long as maximum width.

Asellus scrupulosus, new species

FIGURES 49, 50

ETYMOLOGY.—From the Latin *scrupulosus*, rough or jagged.

TYPE MATERIAL AND TYPE LOCALITY.—Holotype: adult ♂, USNM 122069. Allotype: adult nonovigerous ♀, USNM 122070. Paratypes: 25♂♂, 21 nonovigerous and 4 ovigerous ♀♀, USNM 122071. Type locality: Lick Creek Road, Summers, 5 miles NE of Athens, West Virginia. The type collection was made 19 March 1966 by Dr. W. A. Shear.

DESCRIPTION OF HOLOTYPE.—Body: length, 8.5 mm. Head: Eyes distinct.

First antenna: Flagellum 10-merous and tip reaching to point about two-thirds along last segment of peduncle of second antenna; penultimate 3 segments bearing aesthetascs. Second segment of peduncle longest; first, three-quarters length of second; third, about two-thirds length of second. First peduncle segment about 1.5 times as long as wide; second and third respectively 3.5 and 3 times as long as wide.

Second antenna: Length (6.0 mm) about three-quarters (0.71) body length. Number of segments in flagellum unknown (impossible to count accurately) but flagellum about 2.5 times length of peduncle.

First peraeopod (Figure 49A): Dactylus slightly longer than palm of propodus, with numerous very small denticles on inner margin. Propodus 1.24 times as long as wide, subtriangular; palm drawn out centrally into a very large triangular projection, and with a much smaller projection between large projection and point of attachment of dactylus, 1 large and 2 smaller teethlike spines at proximal end, and with a submarginal row of spines on inner and outer surfaces.

First pleopod (Figure 49B): Total length 1.18 times that of second pleopod. Sympod subrectangular, about 1.5 times as long as wide; inner margin with 4 hooklike protuberances for coupling. Distal segment subovate, but slightly curved outward so that the distal part of the outer lateral margin is shallowly concave and the inner lateral margin convex; maximum width occurring about one-third toward distal margin and half maximum length; distal margin with 5 very long plumose spines and 5 very short simple submarginal spines; inner distal angle with a single simple spine.

Second pleopod (Figures 49C–E): Sympod subrectangular, maximum length 1.54 times maximum width; medial and lateral margins more or less straight. Proximal segment of exopod cupulate, with 3 short and simple spines on outer margin and a distinctly sclerotized inner margin. Distal segment of exopod subcircular, maximum length only 1.3 times maximum width, with 8 very long plumose spines on outer and outer-distal margins, 4 shorter plumose and 3 shorter simple spines on inner-distal margin, numerous minute setae on inner and inner-distal margins, and with both proximal angles distinctly sclerotized. Endopod slightly longer (1.05) than total length of exopod, and 1.4 times as long as the distal segment of the exopod; endopod about (2.44) two and a half times as long as maximum width (exclusive of apophyses). Both inner and outer basal apophyses prominent and well developed. Cannula small and narrow. Ventral groove distinct, but short and narrow. Mesial process prominent, wide, long, and 4-toothed marginally. Lateral process also prominent, but narrower and hooklike. Caudal process not developed.

Uropod (Figure 49F): As long as telson. Peduncle slightly longer (2.28) than twice maximum width. Exopod three-quarters length of peduncle, endopod slightly shorter (0.91) than peduncle.

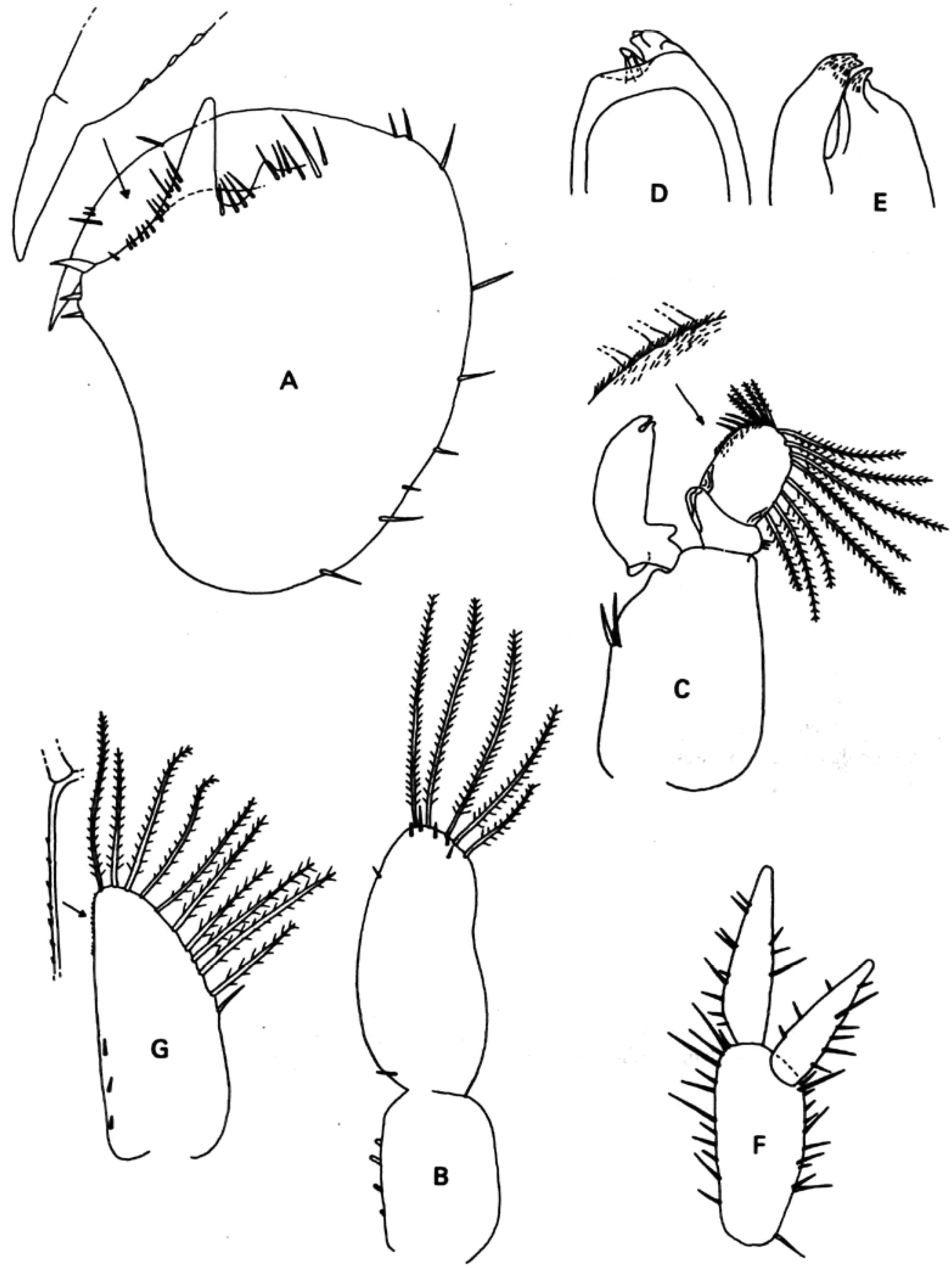

FIGURE 49.—*Asellus scrupulosus*, A–F, holotype; G, allotype: A, dactylus and propodus of first peraeopod; B, first pleopod; C, second pleopod; D, E, respectively dorsal and ventral surfaces of tip of endopodite of second pleopod; F, uropod; G, "first" pleopod.

PARTIAL DESCRIPTION OF ALLOTYPE (♀).—First peraeopod: Relatively slender, but dactylus and propodus almost subchelate, as in the allotype of *A. obtusus* (cf. Figure 44E). Dactylus slightly longer than palm of propodus and with 5 teethlike spines on inner margin and a long terminal claw. Otherwise similar to the description given for this appendage in a female paralectotype of *A. attenuatus*.

"First" pleopod (Figure 49G): Shape subtriangular, but outer margin gently convex with 1 short and simple and 10 long and plumose spines on distal half. Inner margin with a row of minute spinules near distal end and 3 short simple spines on proximal half.

MATERIAL EXAMINED.—WEST VIRGINIA: Summers County, 3♂♂, coll. A. Weaver, 1.xii.1966; Camp Creek State Forest, Mercer County, 3♂♂, coll. W. A. Shear, 22.iii.1967; Hacker Valley, Webster County, 2♂♂, coll. A. Weaver, 25.iii.1967.

GEOGRAPHICAL DISTRIBUTION AND ECOLOGY.—The species is known only from West Virginia (Figure 27), where it has been collected from vernal and woodland pools.

FURTHER DESCRIPTION (♂).—Body: The largest ♂ examined was 11.5 mm long.

First antenna: Flagellum 10- to 15-merous; last 3 penultimate segments bear aesthetascs.

Second antenna: Length 0.58 to 0.71 times that of body. Flagellum 59- to 71-merous.

Mouthparts: See Table 1.

First peraeopod: 2 or 3 teethlike spines at proximal end of palm. The shape of the palm seems to display little variation.

First pleopod: Total length of appendage 1.17 to 1.34 times as long as second pleopod. Inner margin of sympod with 3 to 4 coupling hooks. Maximum width of distal segment 0.4 to 0.5 times length; distal margin with 3 to 6 very long plumose spines.

Second pleopod: Maximum length of sympod from 1.2 to 1.5 times maximum width. Proximal segment of exopod with 3 or 4 short and simple spines on outer margin; distal segment with 12 to 15 long and shorter marginal spines, and maximum length 1.2 to 1.55 times maximum width. Endopod shape is relatively constant, but the maximum length varies from 2.4 to 3.3 times the maximum width; the length in proportion to the length of the distal segment of the exopod varies from 1.2 to 1.4. The morphology of the tip of the endopod

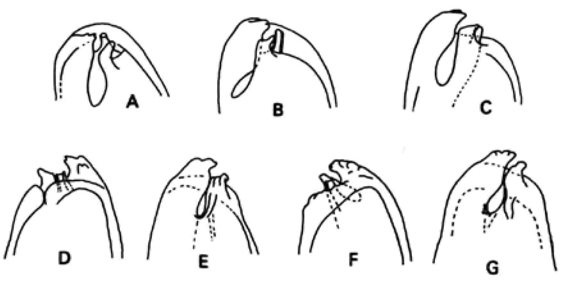

FIGURE 50.—*Asellus scrupulosus*, extent of variation in morphology of endopodite tip of male second pleopod: A, B, Summers County, West Virginia; C, Webster County, West Virginia; D/E, F/G, two paratypes. A–C, E, G, ventral views; D, F, dorsal views.

is quite constant, only minor differences being apparent between individuals (Figure 50).

Uropoda: See Table 2.

Asellus nodulus, new species

Figures 51, 52

ETYMOLOGY.—From the Latin *nodulus*, nobbly.

TYPE MATERIAL AND TYPE LOCALITY.—Holotype: adult ♂, USNM 122058. Allotype: adult ovigerous ♀, USNM 122059. Type locality: boggy ground in Gray's Cypress Swamp, below Prince Frederick, Calvert County, Maryland. The type collection was made 17 April 1938 by C.R. Shoemaker, and was formerly labeled USNM "147/533."

DESCRIPTION OF HOLOTYPE.—Body: Length, 7.0 mm.

Head: Eyes small but distinct.

First antenna: Flagellum 13-merous and tip reaching to about midpoint of last segment of peduncle of second antenna; penultimate 3 segments bearing aesthetascs. Second segment of peduncle longest; first, three-quarters length of second; third, two-thirds length of second. First peduncle segment twice as long as wide; second and third respectively 2.5 and 3 times as long as wide.

Second antenna: Length (6.0 mm) slightly less (0.86) than that of body. Flagellum 67-merous and about 2.5 times as long as peduncle. Fifth segment of peduncle about 5 times as long as wide.

First peraeopod (Figures 51A,B): Dactylus with 4 teethlike spines on inner margin and a very long terminal claw. Propodus 1.78 times as long as wide, ovate;

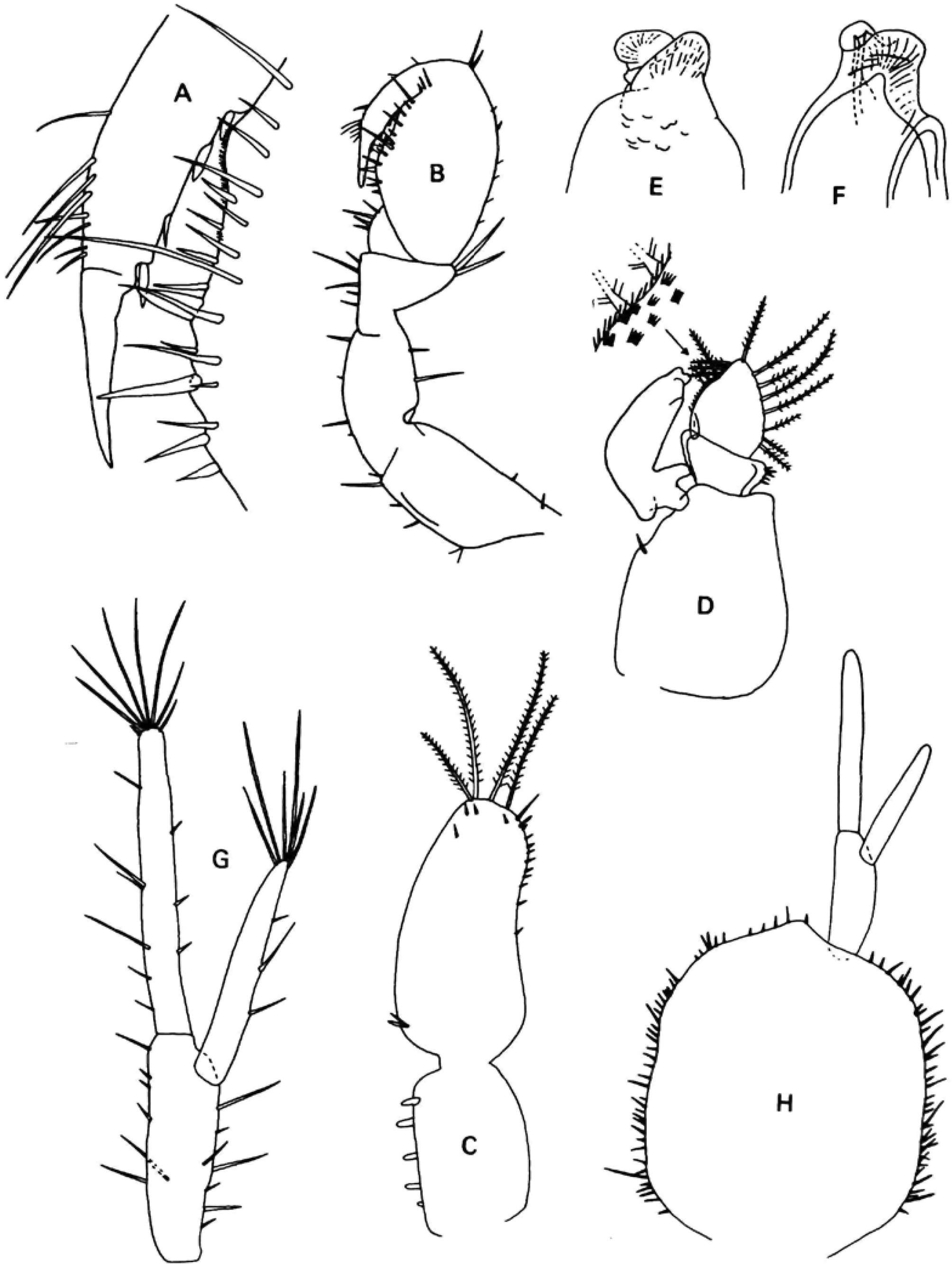

FIGURE 51.—*Asellus nodulus*, holotype: A, dactylus and palm of first peraeopod; B, first peraeopod; C, first pleopod; D, second pleopod; E, F, respectively dorsal and ventral surfaces of tip of endopodite of second pleopod; G, uropod; H, uropod and telson.

378-615 O - 70 - 6

palm without triangular projections, but with 4 strong teethlike spines on proximal half, and several short to long spines in a submarginal row on inner and outer surfaces.

First pleopod (Figure 51C): Total length 1.34 times that of second pleopod. Sympod subrectangular, about 1.33 times as long as wide; inner margin with 4 large and 1 small hooklike protuberances for coupling. Distal segment subovate, but curved outward so that the outer lateral margin is shallowly concave and the inner lateral margin convex; maximum width about one-third toward distal margin, and half maximum length; distal margin with 4 very long plumose spines; distal half of outer distal margin with several short and simple spines, and some similar spines also occur submarginally near distal margin; inner distal angle with 2 simple spines.

Second pleopod (Figures 51D-F): Sympod subsquare, maximum length 1.28 times maximum width; medial and lateral margins more or less straight. Proximal segment of exopod irregularly triangular, with 5 short and simple spines on outer margin. Distal segment of exopod broadly subtriangular, maximum length only 1.19 times maximum width, with 7 long plumose spines on outer margin, 1 long plumose spine at apex, 6 moderately long plumose spines on distal half of inner margin, a fringe of very short setae on inner margin some setae of which extend submarginally in the form of small combs of 3–5 minute setae, and a distinctly sclerotized inner proximal angle. Endopod same length as total length of exopod, and 1.5 times as long as the distal segment of the exopod; endopod about (2.64) two and a half times as long as maximum width (exclusive of apophyses). Both inner and outer basal apophyses prominent and well developed, particularly the outer which is subtriangular in side view. Cannula short, relatively narrow, and completely enclosed between prominent and heavily sclerotized ventral and dorsal processes. The total morphology is unique and difficult to homologize with other North American species of *Asellus;* apparently the tip of the endopod has been subject to some torsion, so that the ventral groove has come to lie near the outer lateral margin; the prominent, broadly rounded ventral process perhaps represents an enlarged and slightly twisted (as indicated by striata) mesial process, whereas the prominent, triangular, dorsal process perhaps represents the caudal process.

Uropod (Figure 51G): Almost (0.93) as long as telson. Peduncle slightly longer (3.3) than three times maximum width. Exopod as long as peduncle, endopod 1.33 times as long as peduncle; both rami with almost parallel sides, several long fine setae on rounded distal tips, and only sparsely spinose laterally.

Telson (Figure 51H): Subcircular, but maximum length 1.2 times maximum width.

PARTIAL DESCRIPTION OF ALLOTYPE (♀).—First peraeopod: Relatively slender, but dactylus and propodus almost subchelate, as in the allotype of *A. obtusus* (cf. Figure 44E). Dactylus about as long as palm of propodus and with 5 teethlike spines on inner margin and a long terminal claw. Otherwise similar to the description given for this appendage in a female paralectotype of *A. attenuatus*.

"First" pleopod: Shape similar to that described for the allotype of *A. scrupulosus* (cf. Figure 49G), but setation rather different; 1 long and simple and 13 long plumose spines present on distal lateral margin, 4 short and simple spines irregularly arranged near inner proximal corner, and 1 short and simple spine at outer proximal angle.

MATERIAL EXAMINED.—MARYLAND: Ridge, St. Mary's County, 2♂♂, coll. W. H. Ball, 26.iv.1930 (USNM); Mechanicsville, St. Mary's County, 1♂, coll. W. H. Ball, 11.v.1937 (USNM); Bristol, 1♂, coll. A. Pizzini, 31.x.1937 (USNM).

GEOGRAPHICAL DISTRIBUTION AND ECOLOGY.—The species is known only from Maryland (Figure 27), where it has been collected from a variety of habitats: boggy ground in a swamp, rainwater in roadside ditch, a woodland stream, and the outlet of a spring. All known localities lie on the small peninsula southeast of Washington, D.C., bounded by the Potomac River and Chesapeake Bay.

FURTHER DESCRIPTION (♂).—Body: The longest ♂ examined was 10.5 mm long.

First antenna: Flagellum 13- or 14-merous; last 3 penultimate segments bear aesthetascs.

Second antenna: Length 0.67 to 0.89 times that of body. Flagellum 61- to 85-merous.

Mouthparts: See Table 1.

First peraeopod: Considerable variation was apparent in the setation and palmar shape of the propodus in the material examined. Thus referring to Figure 51A (holotype) and Figure 52 (all other known male material), it can be seen that the extent of develop-

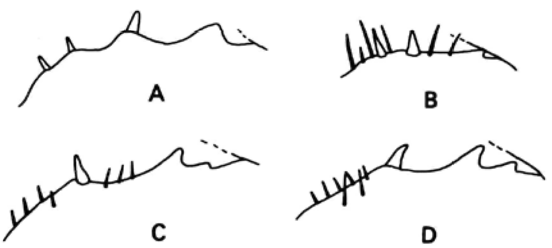

FIGURE 52.—*Asellus nodulus*, extent of variation in palm shape of male first peraeopod: A, C, Ridge, St. Mary's County, Maryland; B, Mechanicsville, St. Mary's County, Maryland; D, Bristol, Maryland.

ment of triangular processes on the palm is variable, as also is the number of proximal teethlike spines.

First pleopod: Total length of appendage 1.27 to 1.36 times as long as second pleopod. Inner margin of sympod with 5 to 6 coupling hooks. Maximum width of distal segment 0.48 to 0.52 times length; distal margin with 3 to 5 very long plumose spines.

Second pleopod: Maximum length of sympod from 1.2 to 1.3 times maximum width. Proximal segment of exopod with 5 or 6 short and simple spines on outer margin; distal segment with 4 to 9 shorter and 8 to 10 longer plumose marginal spines (total: 12 to 17), and maximum length 1.2 to 1.3 times maximum width. Endopod shape is relatively constant, but the maximum length varies from 2.5 to 3.0 times the maximum width; the length in proportion to the length of the distal segment of the exopod varies from 1.3 to 1.5. The morphology of the tip of the endopod is quite constant.

Uropod: See Table 2.

Telson: Maximum length 1.0 to 1.2 times maximum length.

Asellus occidentalis, new species

FIGURES 53, 55, 56

ETYMOLOGY.—From the Latin *occidentalis*, western.

TYPE MATERIAL AND TYPE LOCALITY.—Holotype: adult ♂, USNM 122063. Allotype: adult nonovigerous ♀, USNM 122064. Paratypes: 9♂♂, 6 nonovigerous and 1 ovigerous ♀♀, USNM 122065. Type locality: Klamath River, near Falls between Lake Ewuana and Upper Klamath Lake, Oregon. The type collection was made 16 November 1965 by Mr. W.C. Johnson and forwarded for study by Dr. J. B. Anderson, Federal Water Pollution Control Administration, United States Department of Interior.

DESCRIPTION OF HOLOTYPE.—Body: Length, 7.0 mm.

Head: Eyes distinct.

First antenna: Flagellum 11-merous and tip reaching to midpoint of last segment of peduncle of second antenna; penultimate 3 segments bearing aesthetascs. Second segment of peduncle longest; first, three-quarters length of second; third, about two-third length of second. First peduncle segment about 1.5 times as long as wide; second and third about 3.5 times as long as wide.

Second antenna: Length (6.5 mm) almost (0.93) equal to that of body. Flagellum 55-merous and about 3 times as long as peduncle.

First peraeopod (Figure 53 A): Dactylus with about 7 teethlike spines on inner margin. Propodus 1.76 times as long as wide, subovate; palm without triangular processes, with 4 prominent teethlike spines on proximal half, and with numerous simple spines submarginally.

First pleopod (Figure 53B): Total length 1.34 times that of second pleopod. Sympod subrectangular, about 1.5 times as long as wide; inner margin with 3 hooklike protuberances for coupling. Distal segment subovate, but inner margin more or less straight; maximum width occurring about two-thirds toward distal margin, distinctly greater than width of sympod, and about two-thirds maximum length; distal and outer-distal margins with several long plumose spines and numerous shorter and simple spines somewhat irregularly arranged.

Second pleopod (Figures 53C-E): Sympod subrectangular, maximum length 1.23 times maximum width; medial and lateral margins gently convex; several moderately long simple spines occur near the inner distal angle. Proximal segment of exopod irregularly triangular, without marginal spines. Distal segment of exopod broadly subtriangular, maximum length 1.5 times maximum width, with 17 long to moderately long plumose spines on outer margin and distal half of inner margin, a fringe of marginal setae on distal two-thirds of inner margin, and a distinctly sclerotized inner proximal margin. Endopod slightly shorter (0.92) than total length of exopod, and 1.28 times as long as distal segment of exopod; endopod about (2.57) two and a half times as long as maximum width. Endopod bent at approximately right

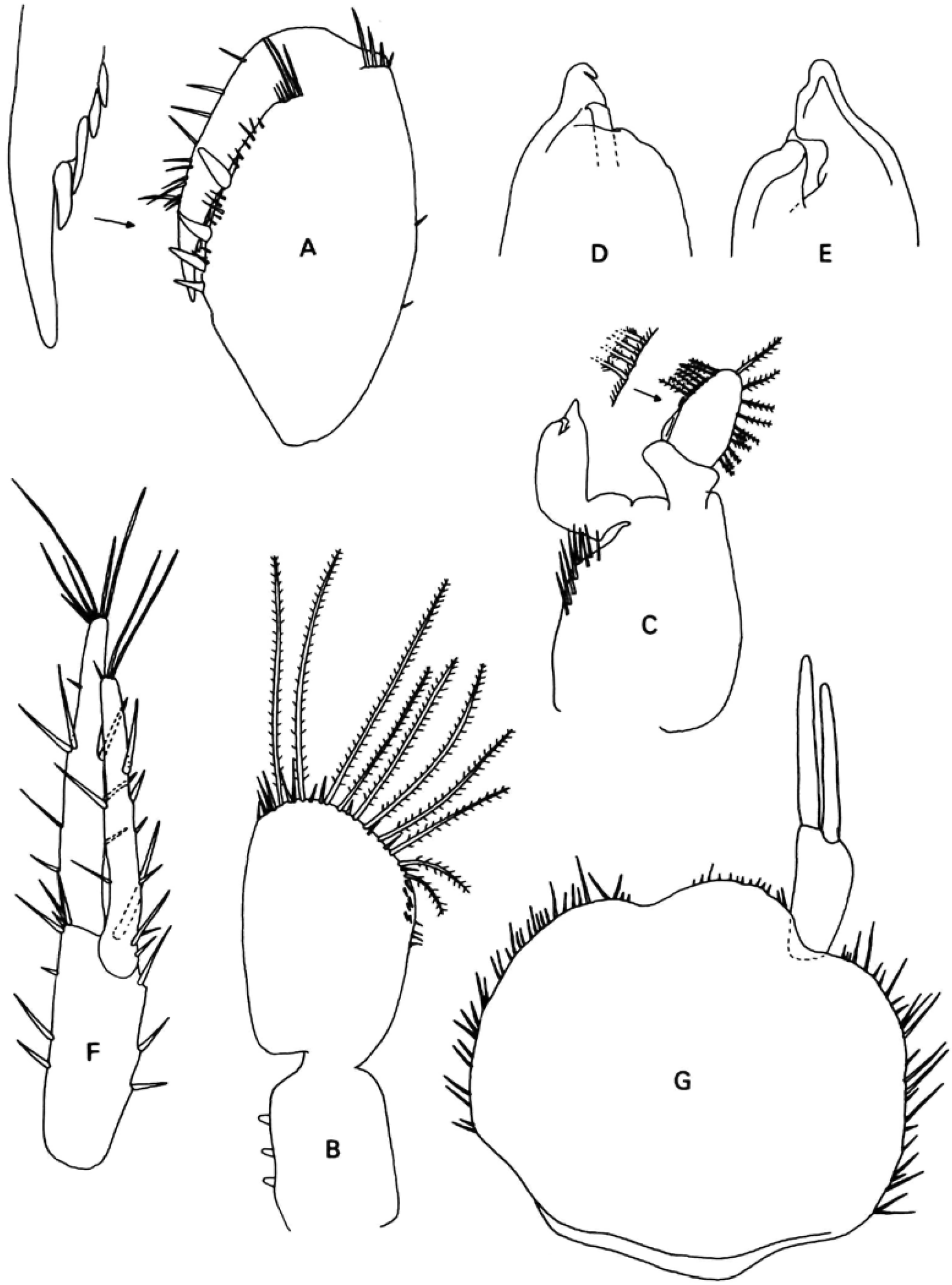

FIGURE 53.—*Asellus occidentalis,* holotype: A, dactylus and propodus of first peraeopod; B, first pleopod; C, second pleopod; D, E, respectively dorsal and ventral surfaces of tip of endopodite of second pleopod; F, uropod; G, uropod and telson.

angles near basal apophyses; outer basal apophysis rounded, not well developed; inner basal apophysis distinct, well developed, flaplike. Cannula short, moderately narrow, and completely hidden in ventral view behind lateral process. Ventral groove prominent, short, and wide. Mesial and caudal processes scarcely developed. Lateral process well developed, large, subtriangular, bent dorsally at tip, and without associated setae or spines.

Uropod (Figure 53F): Not quite (0.83) as long as telson. Peduncle about 2.5 times as long as wide. Exopod distinctly longer (1.27) than peduncle, and endoped slightly longer (1.03) than exopod; both rami with several long fine spines on distal tips and several stout long spines laterally.

Telson (Figure 53G): Subcircular, but maximum width greater (1.17) than maximum length; uropodal sinuses distinct.

PARTIAL DESCRIPTION OF ALLOTYPE (♀).—First peraeopod: General shape and setation similar to that described for a female paralectotype of *A. attenuatus*, but propodus with 2 long and stout teethlike spines near middle of palm. Palmar margin of dactylus with 7 teethlike spines.

"First" pleopod: Shape similar to that described for a female paralectotype of *A. intermedius* (cf. Figure 18C). Distal margin and distal half of outer margin with 10 finely plumose spines.

MATERIAL EXAMINED.—BRITISH COLUMBIA: Nanaimo, Vancouver Island, 3♂♂, coll. E. L. Bousfield, 24.vii.1955 (NMC); Clayoquot Island, 10♂♂, coll. E. L. Bousfield, 6.viii.1955 (NMC); Double Bay, Vancouver Island, 6♂♂, coll. E. L. Bousfield, 5.viii.-1959 (NMC).

OREGON: Philomath, Benton County, 2♂♂, coll. G. B. Wiggins, 24.iv.1964 (ROM); Klamath River, 10♂♂, coll. U.S. Dept. Interior, 1.xii.1965; Klamath River, 1♂, coll. U.S. Dept. Interior, no date marked.

WASHINGTON: Fort Simcoe, near Yakima, 3♂♂, coll. Margaret Anderson, 26.vi.1967.

GEOGRAPHICAL DISTRIBUTION AND ECOLOGY.—The species is recorded only from the far northwestern part of the United States and the extreme southwestern corner of British Columbia (Figure 54). Within this area of distribution it has been collected from spring-brooks, streams, rivers, and on one occasion from the marshy edge of a lake.

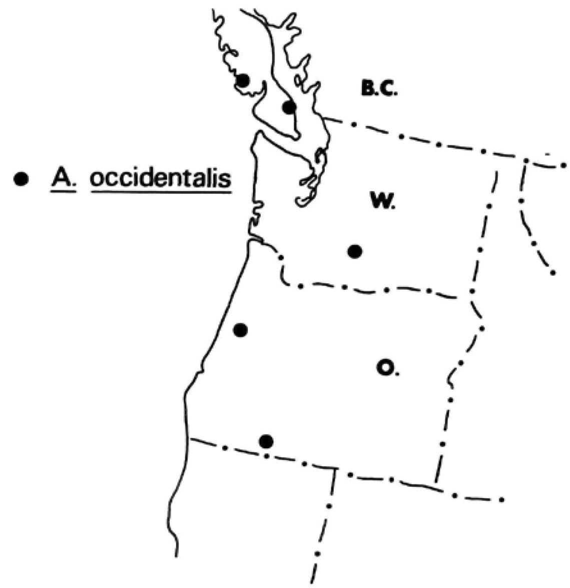

FIGURE 54.—Geographical distribution.

FURTHER DESCRIPTION (♂).—Body: The longest ♂ examined was 11.0 mm long.

First antenna: Flagellum 9- to 12-merous; last 2 or 3 penultimate segments bear aesthetascs.

Second antenna: Length 0.68 to 0.93 times that of body. Flagellum 42- to 60-merous.

Mouthparts: See Table 1.

First peraeopod: Palm of propodus always without triangular process, with 3 to 5 prominent teethlike spines variously arranged (Figure 55), and with numerous simple spines submarginally.

First pleopod: Total length of appendage 1.15 to 1.45 times as long as second pleopod. Inner margin of sympod with 2 to 4 coupling hooks. Maximum width of distal segment 0.56 to 0.73 times length; distal margin with 7 to 13 long plumose spines.

Second pleopod: Maximum length of sympod from 1.08 to 1.27 times maximum width. Proximal segment of exopod with 0 to 1 short and simple spine on outer margin; distal segment with 8 to 18 marginal spines (apart from fringe of setae on inner margin), and maximum length 1.06 to 1.57 times maximum width. Endopod shape more or less constant in character, length 2.06 to 2.72 times maximum width, and 1.15 to 2.24 times length of distal segment of exopod.

A little variation is displayed by the terminal arrangement of the endopod (Figure 56).

Uropod: See Table 2.

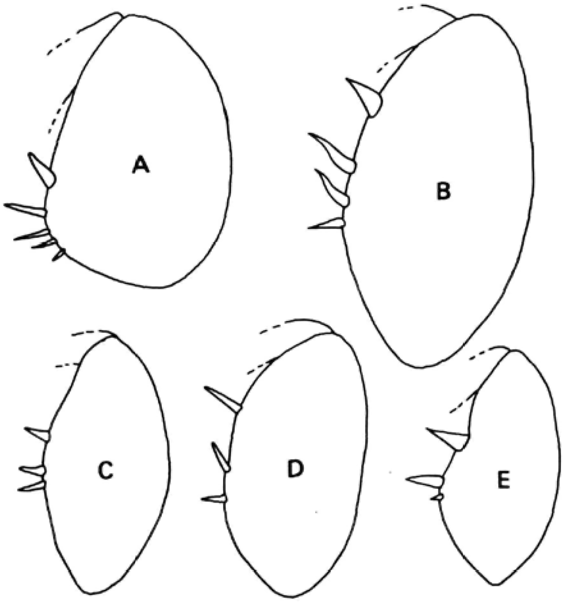

FIGURE 55.—*Asellus occidentalis*, extent of variation in shape and spinulation of propodus of male first peraeopod: A, Victoria Island, British Columbia; B, Clayoquot Island, British Columbia; C, Klamath River, Oregon; D, Fort Simcoe, Washington; E, Nanaimo, British Columbia.

Uncertain Name

The name *Asellus tomalensis* was first proposed by Harford in 1877 (pp. 54–55) for a single specimen of *Asellus* obtained from "Tomales Bay and vicinity." The description was very short, unaccompanied by drawings, and was impossible to use for the certain identification of the taxon involved. Richardson (1900, p. 297) was aware of this, and consequently only tentatively referred to *A. tomalensis* some material that had been collected from Lake Washington, Seattle (1904a, b). This material was actually compared (by Dr. W. E. Ritter) with the single specimen of *A. tomalensis* identified by Harford, but the comparison was clearly superficial as indicated by Richardson's report of it (1904a, pp. 224–225). Richardson did provide a description of her material, but this description likewise is insufficient for diagnostic purposes, and gives, for example, no details for any pleopod (cf. Van Name, 1936, p. 406). Harford's type was redescribed in 1904 by Holmes, but the redescription, though more complete, provided no further clarification of the species identity; moreover, it indicated that the specimen was a female: "first pair of pleopods very small and oblong; second pair not fused in the middle, and forming an operculum over the succeeding ones" (1904, p. 322). This specimen, which had been deposited in the California Academy of Sciences, Registration No. 2609, was subsequently destroyed by fire and earthquake in

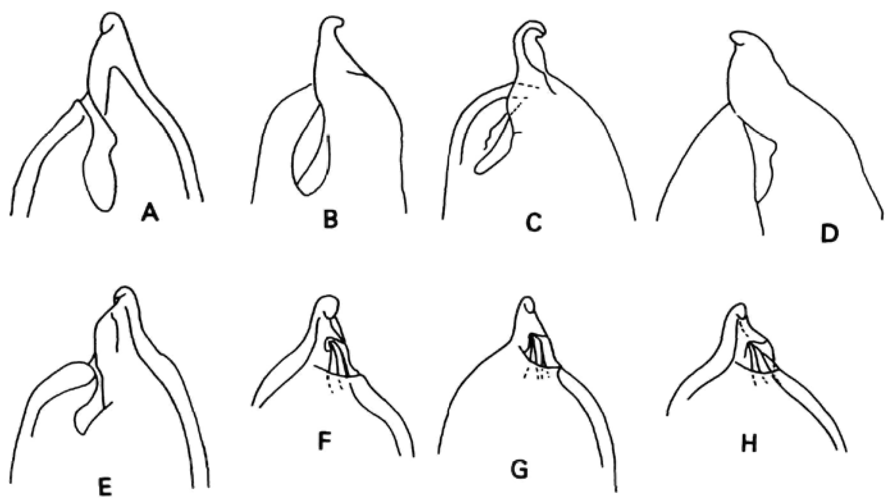

FIGURE 56.—*Asellus occidentalis*, extent of variation in morphology of endopodite tip of male second pleopod: A, B, Victoria Island, British Columbia; 3, Clayoquot Island, British Columbia; D, Benton County, Oregon; E–H, paratypes. A–E, ventral views; F–H, dorsal views.

1906 according to D. Chivers and G. E. Lindsay, respectively staff member and director of the California Academy of Sciences, San Francisco (personal communication, 27 July 1967).

In view of the certain destruction of the type, the absence of an adequate description, the failure of colleagues (Drs. N. H. Anderson and G. E. Clothier) to collect *Asellus* from the Tomales Bay area of California, and the occurrence of at least three distinct epigean taxa of *Asellus* (*A. racovitzai racovitzai, A. communis,* and *A. occidentalis*) in the western part of North America, *Asellus tomalensis* is here regarded as a name not certainly applicable to any known taxon. The application of the name by several authors (e.g. Carl, 1937; Hatch, 1947) to material examined by them is without firm foundation. It is possible that the new species described in this paper as *A. occidentalis* is conspecific with Harford's taxon but this cannot be verified, and the situation seems best resolved by the course of action here adopted.

Species Originally Referred to *Asellus*

In addition to the names mentioned in this paper, reference should also be made to species originally described as species of *Asellus* but subsequently transferred to the genus *Lirceus*. The original names are *Asellus lineatus* Say, *Asellus tenax* Smith, *Asellus hoppinae* Faxon, *Asellus hoppiae* Packard, and *Asellus incisus* Van Name.

Lirceus lineatus was described by Say in 1818. The description although exceedingly brief and without figures did indicate that there was on the head "a sinus each side in the middle" (p. 438); it may be presumed that this refers to a lateral incision of the head margin, a feature of frequent occurrence in the genus *Lirceus* but never present in *Asellus*. Its occurrence provides firm support for the inclusion of the species in the genus *Lirceus* (Hubricht and Mackin, 1949). The name *Asellus tenax* was put forward by Smith (in Smith and Verrill, 1871). Smith noted (see also Smith, 1874) that his taxon lacked mandibular palpi, and after transference to the genus *Asellopsis* by Harger (1874) and then *Mancasellus* (Harger, 1876), it was synonymized by Hubricht and Mackin (1949) with *L. lineatus*. The lack of a mandibular palp certainly excludes it from the genus *Asellus*.

Lirceus hoppinae was described by Faxon (in Garman, 1889) and was treated as a species of *Asellus* until fairly recently (e.g., Van Name, 1936; Mackin and Hubricht, 1938). It was transferred to the genus *Lirceus* and redescribed by Hubricht and Mackin in 1949, although these authors did not state what specimens they used as a basis for their description and do not mention type material. Through the courtesy of Miss A. B. Bliss, Museum of Comparative Zoology, original type material (three slightly damaged adult males in alcohol) was located in that Museum, and from the labels inside the container and the state of the material itself it seems not to have been examined by Hubricht and Mackin. There is no record that these authors examined this material (Miss A. B. Bliss, personal communication, 11 December 1967). The labels read: "Mus. Comp. Zoöl. Cambridge Mass. No. 4203 Coll. Miss Ruth Hoppin *Asellus hoppinae* Fax. Typus Day's Cave, Mo.," "25: J–4," "Dave's Cave in mud under stones," and "4203." Examination of this material confirmed the correctness of the generic transference effected by Hubricht and Mackin and also of critical details in their specific redescription. Thus, the specimens have the typical body outline facies of *Lirceus,* and have 3-jointed mandibular palps, third pleopoda with the exopodite divided by a diagonal suture into a large proximal portion and a smaller moon-shaped distal portion, and in appearance of the telson, uropoda and gnathopoda agree with the drawing given by Hubricht and Mackin (1938; plate 3 A–C) for *L. hoppinae hoppinae*. Packard's (1894) name, *Asellus hoppiae,* was synonymized by Van Name (1936) with *Asellus hoppinae* and accordingly becomes a synonym of *L. hoppinae hoppinae*.

A further synonym of *L. hoppinae,* according to Hubricht and Mackin (1949), is *Asellus incisus* described by Van Name (1936). The generic transference, at least, is undoubtedly warranted for Van Name's original description includes a clear diagram of the head (fig. 202), showing incised lateral margins and the frontal shape typical for the anterior head margin of *Lirceus*.

Coexistence of Species

The vast majority of collections examined during the present investigation were unispecific, at least as far as males were concerned. A few, however, were not, emphasizing the need for care in determining material. The number of collections containing two species, and the species involved, are indicated below:

A. communis	+*A. racovitzai racovitzai*	2 collections
A. intermedius	+*A. racovitzai racovitzai*	1 collection
A. intermedius	+*A. brevicauda brevicauda*	1 collection
A. obtusus	+*A. racovitzai australis*	3 collections

Phylogenetic Relationships

It is clear that any attempt to determine phylogenetic relationships within the North American epigean species of *Asellus* must be based almost entirely upon the structure of the male genital pleopods, and particularly upon the morphology of the endopod tip of the male second pleopod; apart from the shape of the palm of the male first peraeopod, other parts of the body while providing some characters of diagnostic use may be more or less discounted in this respect. Steeves (1966), who dealt with the evolution of North American troglobic *Asellus,* clearly recognized this and indeed based his conclusions upon only the endopodial tip of the male second pleopod. On other grounds, however, certain general criticisms can be raised against Steeves' method of evolutionary analysis. Thus, his evolutionary scheme was the result principally of a series of hypothetical derivations of increasing complexity from ancestors that to him appeared to have the simplest (= most primitive) structure of endopod tip. Further, it took no account of sister groups and involved multiple derivation of species from a single taxon ("*alabamensis*"), a concept which is, as emphasized generally by Brundin (1966), unrealistic. Steeves' method of evolutionary analysis, like all such methods, is therefore open to the same type of criticism that Brundin (1966) has leveled, justifiably for the most part in the opinion of the present author, at the numerous "phylogenies" purporting to indicate phylogenetic relationships but which take no cognizance of the sort of strict phylogenetic principles first enunciated clearly by Hennig (1950).

Hennig's ideas, which emphasize the relative importance of plesiomorphic (primitive) and especially apomorphic (derived) characters, and the importance of sister group delimitation, provide a much more precise basis for determining phylogenetic relationships, and in the following discussion dealing with the relationships of North American epigean species of *Asellus* an attempt is made to apply them. Although there are many difficulties in such an application, resulting mainly from the paucity of useful characters, and, in part consequence of this, from varying degrees of uncertainty as to whether a given character is plesiomorphic or apomorphic, it is felt that it is only by the application of Hennig's ideas that true relationships within *Asellus* can be ascertained.

It should perhaps first be stated that it seems valid to deal with the evolution of the North American epigean asellids as a single entity without involving intercontinental relationships (*A. aquaticus* is not considered in this section), for only two phylogenetic groups seem to be involved. One group, the largest and containing all but one species, seems to be of monophyletic origin in that with two exceptions all included taxa possess the undoubtedly synapomorphic character of a large triangular projection on the palm of the propodus of the male first peraeopod. The exceptions, *A. brevicauda bivittatus* and *A. nodulus,* may reasonably be regarded as having secondarily lost the triangular process; there can be no doubt of the close relationship of *A. brevicauda bivittatus* to *A. brevicauda brevicauda* which has the triangular process, and the triangular process is in fact sometimes present in *A. nodulus.* Secondary loss of the triangular process cannot reasonably be advanced to explain its absence in the western species, *A. occidentalis,* and we must therefore regard this taxon as constituting a second phylogenetic group of uncertain affinities with the first. No synapomorphic characters seem to be possessed by these two groups which set them apart as a single unit from Palaearctic species of *Asellus.* The great extension of the lateral process and the absence of either well-developed caudal or mesial processes on the endopod of the male second pleopod of *A. occidentalis* is also a structural pattern not displayed by any other North American epigean species of *Asellus* and gives further support for regarding *A. occidentalis* as part of a separate phylogenetic group.

In dealing with the relationships of the major phylogenetic group, we may take as an arbitrary starting point the decidedly apomorphic species *A. montanus.* It is difficult to equate the morphology of the endopod tip of the male second pleopod of this species with any other species, but there can be no doubt that the torsion of the endopod is an apomorphic character. The only other species which displays torsion of the endopod is *A. nodulus,* and it is this species, therefore, which must be regarded as the sister species of *A. montanus.* Parallel evolution may have been involved in producing the torsion effect, but as pointed out by Brundin (1966) unless there is proof to the contrary synapomorphies must in the first instance be regarded as indicating phylogenetic relationship and not used to anticipate parallelism.

Both *A. montanus* and *A. nodulus* possess a first pleopod that is distinctly longer than the second, and which has an elongate distal segment with long plumose spines on its distal margin. The only other eastern species to possess a similar first pleopod are *A. brevicauda, A. scrupulosus, A. kenki,* and *A. dentadactylus;* the remaining species have a first pleopod that is shorter or more or less subequal in length to the second and lacks plumose distal spines. It is not possible to be certain as to which of these two structural patterns is apomorphic and which plesiomorphic, but the distinction between them is so clear and must surely involve so many genic differences that it seems reasonable to regard the distinction as of considerable phylogenetic significance. Accordingly, the four species *A. brevicauda, A. scrupulosus, A. kenki,* and *A. dentadactylus,* are here regarded as comprising the sister group to *A. montanus* and *A. nodulus.* For present purposes, we may regard all six species as related principally by their synapomorphic first pleopods.

Apart from *A. montanus* and *A. nodulus,* the structure of the endopod tip of the male second pleopod in all other North American species of *Asellus* may be conceived as a series of developments of three main structures associated with the ventral groove and terminal cannula: the mesial, lateral, and caudal processes. It seems reasonable to presume that any of these structures that is highly or peculiarly developed constitutes an apomorphic character, and, conversely, that absence or slight development indicates plesiomorphy.

The lateral process is variously developed in *A. brevicauda, A. scrupulosus,* and *A. kenki,* but not in *A. dentadactylus,* in which species, however, the caudal process is well developed and dentate. The first three species, therefore, may be regarded as the sister group to *A. dentadactylus.* In *A. kenki* the mesial process, according to Bowman (1967), is a simple rounded structure, but in *A. brevicauda* and *A. scrupulosus* it is sclerotized and either rugose or dentate. The latter condition is probably the apomorphic one, and it unites these two species as the sister group to *A. kenki.* The basic structure of the endopod tip of the male second pleopod in *A. scrupulosus* and *A. brevicauda* is very similar, but in the former species the mesial process is dentate and the lateral process heavily sclerotized, suggesting that of these two species *A. scrupulosus* is the more apomorphic. It may be noted, however, that the very short uropoda of *A. brevicauda* are certainly apomorphic.

Turning now to those species that have a first pleopod of an apparently plesiomorphic nature, that is, short and lacking plumose setae, two distinct sister groups are clearly involved: one in which the mesial process is well developed, and one, presumably more plesiomorphic, in which it is not. Of the former group, *A. racovitzai* appears to be the most apomorphic species, showing relative prolongation of the cannula and mesial process, and with a well developed and pointed caudal process having a series of setal combs on its dorsal surface. The sister species to *A. racovitzai* is unquestionably *A. attenuatus.* Both *A. forbesi* and *A. obtusus* have caudal processes of a simple and apparently plesiomorphic nature, and in both the cannula is short and wide; they probably represent, therefore, the more plesiomorphic sister group to the *A. racovitzai/A. attenuatus* group. The relatively greater development of the mesial process of *A. forbesi* suggests that it is more apomorphic with regard to its endopodial armature than *A. obtusus.*

Of the three species without a well developed mesial process, namely, *A. communis, A. intermedius,* and *A. laticaudatus,* the former two appear to be related by their possession of a more or less well-developed caudal process, and they form, consequently, the sister group to the more plesiomorphic species *A. laticaudatus* which lacks a caudal process.

The tentative phylogenetic relationships suggested above are expressed in diagrammatic form in Figure 57.

Acknowledgments

The major part of the work reported in this paper was carried out in the Department of Biology, University of Waterloo, Canada, and was supported by the award to me of a Canadian Government Research Fellowship. It was completed and prepared for publication at the Limnologische Fluβstation, Schlitz, Western Germany, where I was a guest of the Max-Planck-Instituts für Limnologie. In Canada, Prof. H. B. N. Hynes, Chairman, Department of Biology, provided stimulation, encouragement, and facilities and he is gratefully acknowledged for these; in Germany, Prof. J. Illies, Director, Limnologische Fluβstation, likewise showed great interest in the work and is also thanked.

Without the cooperation of a very large number of North American colleagues the extent of this work

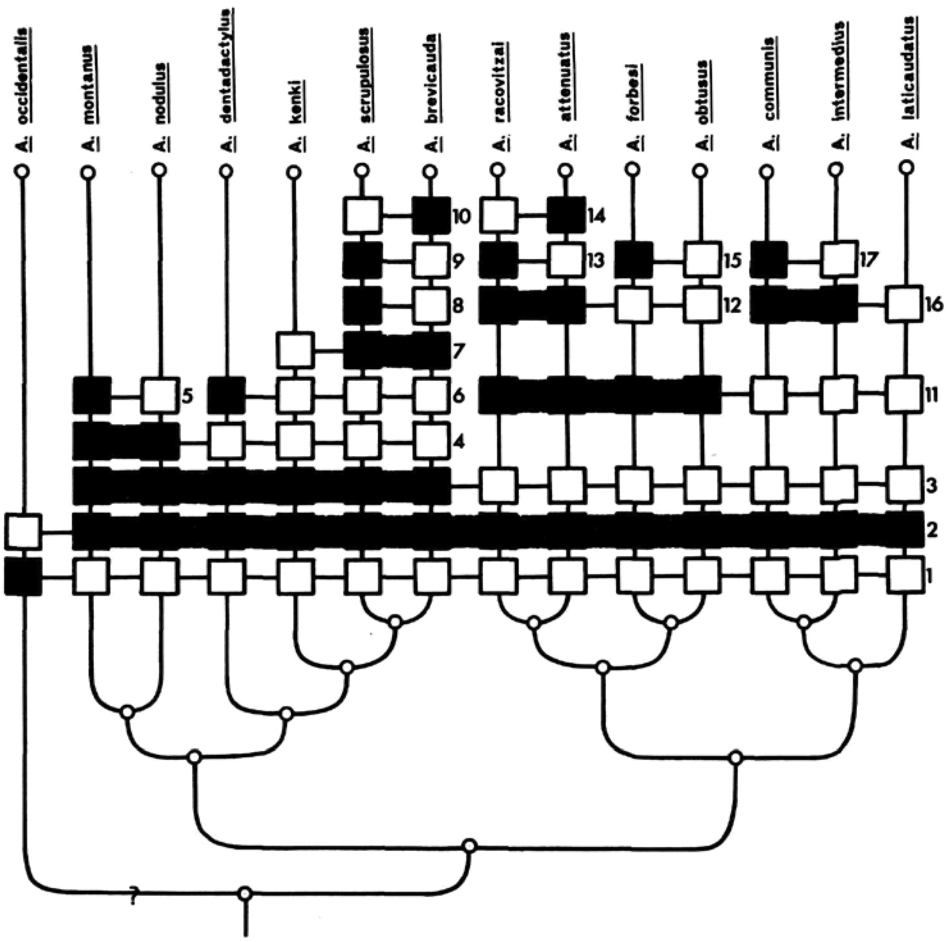

FIGURE 57.—Tentative phylogenetic relationships of North American epigean species of *Asellus,* arranged according to the ideas of Hennig (1950). Black squares indicate apomorphic grades, empty squares plesiomorphic grades. Synapomorphies are indicated by darker stippling. The following characters are referred to and are indicated by the number to the right of the linked apomorphic and plesiomorphic grades (a, apomorphic grade; p, plesiomorphic grade. Cannula, and lateral, caudal, and mesial processes refer to the endopodial armature of the male second pleopod; endopod also refers to this appendage): 1, lateral process greatly extended (a) or not (p); 2, propodus of male first peraeopod with large triangular process on palm or having secondarily lost this (a) or primitively without such a process (p); 3, male first pleopod distinctly longer than second, with an elongate distal segment having long plumose spines on distal margin (a) or male first pleopod shorter or more or less subequal in length to second and lacking plumose distal spines (p); 4, endopod displaying torsion (a) or not (p); 5, tip of endopod coiled spirally (a) or not (p); 6, caudal process dentate (a) or not (p); 7, mesial process sclerotized and either rugose or dentate (a) or simple and rounded (p); 8, mesial process dentate (a) or not (p); 9, lateral process heavily sclerotized (a) or not (p); 10, uropoda very short (a) or of moderate length (p); 11, mesial process well developed (a) or not (p); 12, cannula long and narrow (a) or short and wide (p); 13, caudal process well developed with associated setae on dorsal surface (a) or not well developed and lacking such setae (p); 14, male first pleopod reduced (a) or not (p); 15, mesial process prominent (a) or less well developed (p); 16, caudal process present (a) or absent (p); 17, cannula long and narrow (a) or short and wide (p).

would have been considerably less. I would like to extend my sincere appreciation to all the following who either gave or loaned me specimens: Dr. J. B. Anderson, United States Department of the Interior; Dr. N. H. and Margaret Anderson, Oregon State University; Dr. W. M. Beck, Jr., Florida State Board of Health; Mr. J. Bishop, University of Waterloo; Miss A. B. Bliss, Museum of Comparative Zoology, Harvard University; Dr. R. O. Brinkhurst, University of Toronto; Dr. E. L. Bousfield, National Museum of Canada, Ottawa; Dr. T. E. Bowman, National Museum of Natural History, Washington, D.C.; Dr. G. A. Cole, Arizona State University; Prof. J. S. Dendy, Auburn University; the Director, Great Lakes Institute, Toronto; Mr. S. Herrman, University of Colorado; Dr. J. K. Hiltunen, United States Department of the Interior; Prof. H. B. N. Hynes, and Mr. N. Kaushik, University of Waterloo; Dr. L. A. Krumholz, University of Louisville; Dr. G. H. Lauff, Kellogg Biological Station; Dr. H. W. Levi, Museum of Comparative Zoology, Harvard University; Mr. R. L. Lippson, Kellogg Biological Station; Dr. W. G. Moore, Loyola University; Dr. C. G. Paterson, University of Waterloo; Dr. S. B. Beck, Museum of Comparative Zoology, Harvard University; Prof. R. W. Pennak, University of Colorado; Dr. R. Prins, Clemson University; Dr. W. A. Shear, Concord College; Dr. J. D. Unzicker, Illinois Natural History Survey; Dr. T. F. Waters, University of Minnesota; Dr. A. A. Weaver, the College of Wooster; and Dr. G. B. Wiggins, Royal Ontario Museum, Toronto. I would also like to thank the following colleagues who provided information concerning the whereabouts of type material or other matters: Miss A. B. Bliss; Dr. E. L. Bousfield; Dr. T. E. Bowman; Dr. G. E. Clothier, Sonoma State College; Mr. C. W. Hart, the Academy of Natural Sciences of Philadelphia; Prof. H. B. N. Hynes; Dr. L. A. Krumholz, Dr. H. W. Levi; Dr. G. E. Lindsay and Mr. D. Chivers, both at the California Academy of Sciences in San Francisco; Dr. R. Prins; Dr. Ulrich Røen, University of Copenhagen; Dr. W. N. Rosine, Augustana College; Dr. E. H. Smith, Pacific Marine Station; Dr. P. W. Smith, Illinois Natural History Survey; Dr. R. I. Smith, University of California, Berkeley; and Dr. J. D. Unzicker.

The manuscript was criticized by Dr. E. L. Bousfield and Dr. T. E. Bowman; my thanks are offered for their helpful comments. I wish also to express my appreciation to my wife and Mrs. T. McConnell who were responsible for the typing of the manuscript.

References

Birstein, Ya. A.
1951. *Freshwater Isopods (Asellota)*. Fauna of U.S.S.R. [English translation by Israel Program for Scientific Translations.]

Bousfield, E. L.
1961. New Records of Fresh-water Amphipod Crustaceans from Oregon. *Natural History Papers, National Museum of Canada,* 12:1–7.

Bovallius, C.
1886. Notes on the Family Asellidae. *Bihang Kungliga Svenska Vetenskapakademiens Handlingar,* 11:1–54.

Bowman, T. E.
1967. *Asellus kenki,* a New Isopod Crustacean from Springs in the Eastern United States. *Proceedings of the Biological Society of Washington,* 80:131–140.

Bresson, J.
1955. Aselles de sources et de grottes d'Eurasie et d'Amerique du Nord. *Archives de Zoologie expérimentale et générale,* 92:45–77.

Brundin, L.
1966. Transantarctic Relationships and Their Significance, As Evidenced by Chironomid Midges, with a Monograph of the Subfamilies Podonominae and Aphroteniinae and the Austral Heptagyiae. *Kungliga Svenska Vetenskapsakademiens Handlingar, Fjärde Serien,* 11(1):1–472.

Carl, G. C.
1937. Flora and Fauna of Brackish Water. *Ecology,* 18:447–453.

Chappius, P. A.
1955. Remarques générales sur le genre Asellus et description de quatre espèces nouvelles. *Notes Biospéologiques,* 10:163–182.

Dexter, R. W.
1954. A Record of the Blind Isopod, *Asellus tridentatus,* from an Open Stream Habitat. *American Midland Naturalist,* 52:256.

Ellis, R. J.
1961. A Life-History Study of *Asellus intermedius* Forbes. *Transactions of the American Microscopical Society,* 80:80–102.

Fabricius, O.
1780. *Fauna Groenlandica.* Copenhagen.*

Forbes, S. A.
1876. List of Illinois Crustacea, with Descriptions of New Species. *Bulletin of the Illinois Museum of Natural History,* 1:3–25.

* Not seen.

Garman, S.
1889. Cave Animals from Southwestern Missouri. *Bulletin of the Museum of Comparative Zoology*, 17(6):225–239.

Geoffroy Saint-Hilaire, E. L.
1764. *Histoire abrégèe des Insectes qui se trouvent aux environs de Paris.* Paris.*

Gould, A. A.
1841. *Report on the Invertebrate Animals of Massachusetts.* Cambridge: Massachusetts.

Gruner, H. E.
1965. *Die Tierwelt Deutschlands.* Krebstiere oder Crustacea. V. Isopoda. 53. Teil, 2 Lf. Jena.

Hansen, H. J.
1888. Oversigt over det vestlige Grönlands Fauna. *Videnskabelige Meddelelser fra dansk Naturhistorisk Forening Kjöbenhavn*, 1887:177–198.

Harford, W. G. W.
1877. Description of a New Genus and Three New Species of Sessile Eyed Crustacea. *Proceedings of the California Academy of Science*, 7:53–55.

Harger, O.
1874. On a New Genus of Asellidae. *American Journal of Science and Arts*, 3(7):601–602.
1876. Description of *Mancasellus brachyurus*, a New Fresh-water Isopod. *American Journal of Science and Arts*, 3(11):304–305.

Hatch, M. H.
1947. The Chelifera and Isopoda of Washington and Adjacent Regions. *University of Washington Publications in Biology*, 10:155–274.

Hatchett, S. P.
1947. Biology of the Isopoda of Michigan. *Ecological Monographs*, 17:47–79.

Hay, O. P.
1878. Description of a New Species of *Asellus. Illinois State Laboratory, Natural History Bulletin*, 2:90–92.
1882. Notes on Some Fresh-Water Crustacea, Together with Descriptions of Two New Species. *American Naturalist*, 16:143–146, 241–243.

Hennig, W.
1950. *Grundzüge einer Theorie der phylogenetischen Systematik.* Deutscher Zentralverlag. 370 pages.

Holmes, S. J.
1904. On Some New or Imperfectly Known Species of West American Crustacea. *Proceedings of the California Academy of Science*, 3:307–328.

Hubricht, L., and J. G. Mackin
1949. The Freshwater Isopods of the Genus *Lirceus* (Asellota, Asellidae). *American Midland Naturalist*, 42:334–349.

Johansen, F.
1926. *Asellus aquaticus* Not Found in Labrador. *Canadian Field Naturalist*, 60:140.

*Not seen.

Krøyer, H.
1838. Grönlands Amphipoder. *Kongelige danske videnskabernes Selskabbiologiske Skrifter*, 7:229–326.

Latreille, P. A.
1803. *Histoire naturelle, générale et particulière, des Crustacés et des Insectes*, 6:1–391. Paris.*

Leonard, A. B., and L. H. Ponder
1949. Crustacea of Eastern Kansas. *Transactions of the Kansas Academy of Science*, 52:168–204.

Levi, H. W.
1949. Two New Species of Cave Isopods from Pennsylvania. *Notulae Naturae*, 220:1–6.

Linnaeus, C.
1758. *Systema Naturae.* 10th Edition, 824 pages*

Mackin, J. G.
1940. A Key to the Oklahoma Species of the Family Asellidae. *Proceedings of the Oklahoma Academy of Science*, 20:17–18.

Mackin, J. G., and L. Hubricht
1938. Records of Distribution of Species of Isopods in Central and Southern United States, with Descriptions of Four New Species of *Mancasellus* and *Asellus* (Asellota, Asellidae). *American Midland Naturalist*, 19:628–637.

Minckley, W. L.
1961. Occurrence of Subterranean Isopods in Epigean Waters. *American Midland Naturalist*, 66:452–455.
1963. The Ecology of a Spring Stream, Doe Run, Meade County, Kentucky. *Wildlife Monographs*, 11:1–124.

Packard, A. S.
1867. Review of the Recent Invertebrate Fauna of Labrador. *Memoirs of the Boston Society of Natural History*, 1:296.
1894. On the Origin of the Subterranean Fauna of North America. *American Naturalist*, 28:727–751.

Racovitza, E. G.
1919. V. Notes sur les Isopodes. 1. *Asellus aquaticus* auct. est une erreur taxonomique. 2. *Asellus aquaticus* L. et *A. meridianus* n. sp. *Archives de Zoologie expérimentale et générale. Notes et Revue*, 58:31–43.
1920. VII. Notes sur les isopodes. 6. *Asellus communis* Say. 7, Les pléopodes I et II des Asellides; Morphologie et développement. *Archives de Zoologie expérimentale et générale, Notes et Revue* 58:79–115.

Richardson, H.
1900. Synopses of North-American Invertebrates. VIII. The Isopoda. Part II. *American Naturalist*, 34:295–309.
1901. Key to the Isopods of the Atlantic Coast of North America with Descriptions of New and Little Known Species. *Proceedings of the United States National Museum*, 23:494–579.
1904a. Isopod Crustaceans of the Northwest Coast of North America. Crustacea. *Harriman Alaska Expedition*, X:213–230.

1904b. Contributions to the Natural History of the Isopoda. V. Isopod Crustaceans of the Northwest Coast of North America. *Proceedings of the United States National Museum,* 27:657–671. [Reprint of previous paper.]

1905. A monograph of the Isopods of North America. *United States National Museum Bulletin,* 54:1–727.

Røen, U. I.

1962. Studies on Freshwater Entomostraca in Greenland. II. *Meddelelser om Grønland,* 170:1–249.

Sars, G. O.

1899. *An Account of the Crustacea of Norway with Short Descriptions and Figures of all the Species.* Vol. II. Isopoda. Bergen.

Say, T.

1818. An Account of the Crustacea of the United States. *Journal of the Academy of Natural Sciences of Philadelphia,* 1:374–401.

Smith, S. I.

1874. The Crustacea of the Fresh Waters of the United States. *Report of the United States Commission of Fisheries,* 2:637–665.

Smith, S. I., and A. E. Verrill

1871. Notice of the Invertebrata Dredged in Lake Superior in 1871, by the U.S. Lake Survey, under the Direction of General C. B. Comstock, S. I. Smith, Naturalist. *American Journal of Science and Arts,* 3(2):448–454.

Stammer, H. J.

1932. Zur Kenntniss der Verbreitung und Systematik der Gattung *Asellus,* inbesondere der mitteleuropäischen Arten (Isopoda). *Zoologischer Anzeiger,* 99:113–131.

Steeves, H. R., III

1963a. The Troglobitic Asellids of the United States: the Stygius Group. *American Midland Naturalist,* 69:470–481.

1963b. Two New Troglobitic Asellids from West Virginia. *American Midland Naturalist,* 70:462–465.

1964a. The Troglobitic Asellids of the United States: the Hobbsi group. *American Midland Naturalist,* 71:445–451.

1964b. *Asellus bicrenatus,* a Synonym of *A. alabamensis. American Midland Naturalist,* 71:503–504.

1965. Two New Species of Troglobitic Asellids from the United States. *American Midland Naturalist,* 73:81–84.

1966. Evolutionary Aspects of the Troglobitic Asellids of the United States: the Hobbsi, Stygius and Cannulus groups. *American Midland Naturalist,* 75:392–403.

Stephensen, K.

1917. Grønlands Krebsdyr og Pycnogonider (Conspectus Crustaceorum et Pycnogonidorum Grœnlandicae). *Meddelelser om Grønland,* 22.

Van Name, W. G.

1936. The American Land and Fresh-Water Isopod Crustacea. *Bulletin of the American Museum of Natural History,* 71:1–535.

1940. A Supplement to the American Land and Fresh-Water Isopod Crustacea. *Bulletin of the American Museum of Natural History,* 77:109–142.

1942. A Second Supplement to the American Land and Fresh-Water Isopod Crustacea. *Bulletin of the American Museum of Natural History,* 80:299–329.

Walker, B. A.

1961. Studies on Doe Run, Meade County, Kentucky, IV. A New Species of Isopod Crustacean (Genus *Asellus*) from Kentucky. *Transactions of the American Microscopical Society,* 80:385–390.

Williams, W. D.

1962a. A Note on the Sexual Pleopods of *Asellus. Crustaceana,* 4:244–245.

1962b. The Geographical Distribution of the Isopods *Asellus aquaticus* (L.) and *A. meridianus* Rac. *Proceedings of the Zoological Society of London,* 139:75–96.

Index

[Names of new species in *italics,* page numbers of principal accounts in **boldface**]

Publication in *Smithsonian Contributions to Zoology*

Manuscripts for serial publications are accepted by the Smithsonian Institution Press, subject to substantive review, only through departments of the various Smithsonian museums. Non-Smithsonian authors should address inquiries to the appropriate department. If submission is invited, the following format requirements of the Press will govern the preparation of copy. (An instruction sheet for the preparation of illustrations is available from the Press on request.)

Copy must be typewritten, double-spaced, on one side of standard white bond paper, with 1½" top and left margins, submitted in ribbon copy with a carbon or duplicate, and accompanied by the original artwork. Duplicate copies of all material, including illustrations, should be retained by the author. There may be several paragraphs to a page, but each page should begin with a new paragraph. Number consecutively all pages, including title page, abstract, text, literature cited, legends, and tables. The minimum length is 30 pages of typescript and illustrations.

The *title* should be complete and clear for easy indexing by abstracting services. Taxonomic titles will carry a final line indicating the higher categories to which the taxon is referable: "(Hymenoptera: Sphecidae)." Include an *abstract* as an introductory part of the text. Identify the *author* on the first page of text with an unnumbered footnote that includes his professional mailing address. A *table of contents* is optional. An *index*, if required, may be supplied by the author when he returns page proof.

Two *headings* are used: (1) text heads (boldface in print) for major sections and chapters and (2) paragraph sideheads (caps and small caps in print) for subdivisions. Further headings may be worked out with the editor.

In *taxonomic keys*, number only the first item of each couplet; if there is only one couplet, omit the number. For easy reference, number also the taxa and their corresponding headings throughout the text; do not incorporate page references in the key.

In *synonymy*, use the short form (taxon, author, date, page) with a full reference at the end of the paper under "Literature Cited." Begin each taxon at the left margin with subsequent lines indented about three spaces. Within a taxon, use a period-dash (.—) to separate each reference. Enclose with square brackets any annotation in or at the end of the taxon. For *references within the text*, use the author-date system: "(Jones, 1910)" or "Jones (1910)." If the reference is expanded, abbreviate the data: "Jones (1910, p. 122, pl. 20: fig. 1)."

Simple *tabulations* in the text (e.g., columns of data) may carry headings or not, but they should not contain rules. Formal *tables* must be submitted as pages separate from the text, and each table, no matter how large, should be pasted up as a single sheet of copy.

For *measurements and weights*, use the metric system instead of (or in addition to) the English system.

Illustrations (line drawings, maps, photographs, shaded drawings) can be intermixed throughout the printed text. They will be termed *Figures* and should be numbered consecutively; however, if a group of figures is treated as a single figure, the individual components should be indicated by lowercase italic letters on the illustration, in the legend, and in text references: "Figure 9*b*." If illustrations (usually tone photographs) are printed separately from the text as full pages on a different stock of paper, they will be termed *Plates*, and individual components should be lettered (Plate 9*b*) but may be numbered (Plate 9: figure 2). Never combine the numbering system of text illustrations with that of plate illustrations. Submit all legends on pages separate from the text and not attached to the artwork.

In the *bibliography* (usually called "Literature Cited"), spell out book, journal, and article titles, using initial caps with all words except minor terms such as "and, of, the." (For capitalization of titles in foreign languages, follow the national practice of each language.) Underscore (for italics) book and journal titles. Use the colon-parentheses system for volume, number, and page citations: "10(2):5–9." Spell out such words as "figures" and "plates" (or "pages" when used alone).

For *free copies* of his own paper, a Smithsonian author should indicate his requirements on "Form 36" (submitted to the Press with the manuscript). A non-Smithsonian author will receive 50 free copies; order forms for quantities above this amount with instructions for payment will be supplied when page proof is forwarded.

SMITHSONIAN INSTITUTION
WASHINGTON, D.C.